Christoph T. Sliwowski

IMPLANTOLOGY STEP BY STEP








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Christoph T. Sliwowski

IMPLANTOLOGY STEP BY STEP

2nd Edition, fully revised and extended

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Dominika Sliwowska
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Introduction

Dear reader, dear colleagues,

A few years ago saw the publication of the two-volume work *Implantologie Step by Step*, starting with part I “Maxilla” and followed by part II “Mandible,” in both German and Polish. Interest in a practical implantology “cookbook” was great and both volumes quickly became bestsellers. Since then, implantology has evolved with such speed that it seemed a good idea to revise both volumes fully, and to update and extend them. The result is now in your hands.

The division into maxilla and mandible has been retained, but the two parts have now been brought together in a single volume. Sub-sections covering the anterior and posterior regions and the edentulous jaw have also been retained. A section on totally edentulous patients has been added for the sake of completeness. Chapter 3 entitled “The Edentulous Mandible” has been totally revised, describing not only the cantilever fixed bridge but also the new Sliwowski Overdenture System concept. This technique makes it possible to provide the patient with a high-quality immediate restoration on a minimally invasive and economic basis.

The diagnostic tools and treatment plan are outlined before each treatment is described. One new feature is that the year when the treatment began is given in the summary at the end of each case, alongside the treatment course and timings of the various procedures. The aim of this is to allow you to place the treatment on the developmental timeline of implantology. Another new addition to the case reports is the “Continued follow-up” section, which may span a number of years, allowing better evaluation of the long-term results. As in the first edition, both general and important additional information relating to the described cases is highlighted under the “Note” or “Attention” headings.

The authors’ attitude to the presented material has also changed. We present not just a selection of “good” and successful cases, but also those particularly critical, controversial and problematic ones which can teach us a lot, but which we practitioners rarely bring to light in the normal course of things, and usually prefer to keep “in the drawer.”

Along with long-established and tried-and-tested concepts, this book also gives consideration to further developments and current trends in implantology. Conventional 2D diagnosis is becoming more and more a thing of the past and is being replaced by 3D diagnosis and planning. The availability of cone beam computed tomography (CBCT) scanners continues to grow, making this type of diagnosis a reality. The immediate non-functional and functional loading of implants is also increasing, often replacing the conventional load-free healing period of implant treatment.

Finally, I would like to extend my most cordial thanks to all our readers for their huge interest in the previous edition, and wish all our colleagues lots of enjoyment in referring to this book and much success with the treatment of their patients.

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Authors



Dr Med Dent Christoph T. Sliwowski

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Christoph T. Sliwowski studied Dentistry in Warsaw (graduating in 1982). He has been practicing in Germany since 1987. Since 1989, his main interest has been implantology; in 1995, he took his doctorate in this subject with Prof Hubertus Spiekermann in Aachen. Since 1997, his main focus of activity has been in implantology, and since 2003 he has been an Accredited Implantology Specialist with the German Society for Dental Implantology (DGZI) and the European Association of Dental Implantologists (BDIZ EDI). From 1998 to 2008, he was Medical Superintendent at the Zahnklinik Rhein-Ruhr, a specialist clinic for implant dentistry and esthetics in Mülheim on the Ruhr. Since 2010, he has been Director of the Zahnimplantat Klinik Düsseldorf, a dental implant clinic that he set up at the St. Vinzenz Hospital in Düsseldorf.

Dr Sliwowski is a member of several implantology societies, including the German Society for Implantology (DGI), the German Center for Oral Implantology (DZOI), BDIZ and the Polish Association of Implant Dentistry (OSIS); he is an Active Member of the DGZI and Diplomate of the International Congress of Oral Implantologists (ICOI). Since 2003, he has been a consultant for continuing professional development with the BDIZ, the German Association of Oral Surgeons (BDO), the German Association for Oral and Maxillofacial Surgery (DG MKG), DGI and DGZI. Since 2007, he has acted as an expert assessor with the BDIZ EDI and as Vice-President of the Polish Medical Association in Germany (Polnische Medizinische Gesellschaft in Deutschland e. V.).

Dr Sliwowski is also author of the patent for the Sliwowski Overdenture System, an innovative restoration concept for the edentulous mandible.



Dr Med Dent Stefan Hümmeke

Stefan Hümmeke, born in 1972, studied Dentistry at the University of Münster, Germany and took his doctorate in dentistry in 1998. In 2003, after several years of further training, he was awarded the title of Dental Surgeon Specialist in Oral Surgery.

From 2001 to 2007, he worked at the Department of Oral and Maxillofacial Surgery at the Klinikum Osnabrück hospital in Osnabrück, Germany, as Senior Staff Member from 2004. From 2007 to 2009, he worked with Prof E. Esser at the Implantat Centrum Osnabrück (ICOS) center for implant treatment. In January 2010, he founded the oral surgery center Oralchirugie Osnabrück (OCOS) and set up his own oral surgery and implantology practice in Osnabrück.

The main focus of his work is on all-ceramic restorations, along with imaging investigations and the surgical implementation of virtual implant planning by navigation surgery and stereolithographic surgical templates.

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Dominika Sliwowska, DDS

Dominika Sliwowska studied Dentistry in Poznan´, Poland from 2004 to 2009, graduating as a Doctor of Dental Surgery (DDS). From 2010, she was Assistant Dentist and, since 2013, she

has been Junior Partner at the Zahnimplantat Klinik Düsseldorf, the dental implant clinic at the St. Vinzenz Hospital in Düsseldorf, Germany. Her key activities include implant-supported prosthodontics, periodontology and the treatment of peri-implantitis.



Dr Med Dent Habil Christian F. J. Stappert, DDS, MS, PhD

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Christian Stappert studied Dentistry and earned his doctorate and DDS from the Johannes Gutenberg University Mainz, Germany. After working as an Assistant Professor and research associate at the Department of Prosthodontics at the University RWTH Aachen, Germany (under Prof H. Spiekermann), from 1997, he continued his postgraduate Prosthodontics training at the Department of Prosthodontics (Prof J. R. Strub) of the Albert-Ludwigs University in Freiburg, Germany (as Senior Staff Member from 2001), where he gained his postdoctoral teaching qualification in 2008, in the key area of prosthodontics.

Until March 2012, Dr Stappert worked as Director of Aesthetics and Periodontal Prosthodontics at the Department of Periodontology & Implant Dentistry (under Prof D. Tarnow) and also as Chief Research Officer at the Department of Biomaterials & Biomimetics (under Prof Dr V. Thompson) of the New York University College of Dentistry. He is currently Professor and Director of Implant Periodontal Prosthodontics at the Department of Periodontics at the University of Maryland School of Dentistry.

His research focus is on ceramic materials and restorations. He has published internationally on these topics and is an editorial board member of several learned journals in his field.

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First, I would like to extend my very warmest thanks to my co-authors, Dr Christian F. J. Stappert, Dr Stefan Hümmeke and my daughter and Junior Partner Dominika Sliwowska, DDS, for the outstanding collaborative work involved in producing this book.

My most particular thanks must go to my wife, Dr Beata Sliwowska, for her support in working on this book and for patiently and repeatedly proofreading the manuscript.

I want to give my warmest thanks to my former business partners and colleagues Dr Michael Weber and Dr Ali Alexander Pacyna for their close and confidential collaboration in the joint treatment of our patients.

Thanks must go to my prosthodontist colleagues Dr Roland Althoff, Dr Gregor Cwajgart, Dr Uwe Hildebrand, Dr Eberhard Helbig, Dr Hubertus Klaus, Dr Barbara Wonschik and Dentist Markus Peters for our first-class and successful collaboration.

I want to thank my former assistants, Sahra Osmani, Andrea Graf, Dorothea Vogel, Christel Kloster, Andrea Terjung-Jahn, Caroline Wojtynowski, Gülcan Cek and Aldijana Gashi, as well as my current assistants at the Zahnimplantat Klinik Düsseldorf, Andrea Karst, Sandra Bohnen and Anna Schmiebusch, for their dedicated work and assistance in the treatment of patients and for the accompanying photographic and radiologic documentation.

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To the management of Quintessenz Verlags, Dr Horst-Wolfgang Haase, Christian Haase and Johannes Wolters in Berlin, along with Ireneusz Czyzewski and Iwona Koziel in Warsaw, I give thanks for the huge dedication without which this book would never have come into existence.

Christoph T. Sliwowski

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Contents

Chapter 1 The Anterior Mandible

3D diagnosis and planning
Pronounced residual ridge atrophy
Shortage of space, insufficient distance to the neighboring teeth

Single-tooth gap

Typical treatment course
Late implant placement with immediate loading
Atypical treatment course – problematic baseline situation
Immediate implant placement following extraction
Note: Narrow and high gap between neighboring teeth
Problems and complications
Horizontal augmentation of a knife-edge residual ridge
Immediate restoration
Immediate implant placement and immediate loading

Multi-tooth gap

Typical treatment course
Replacement of three incisors on two implants
Atypical treatment course – problematic baseline situation
Preventive horizontal augmentation
Problems and complications
Implant placement in an extensive bone defect
Immediate loading
Immediate fixed partial denture loaded onto definitive implants
Flapless implant placement and augmentation with immediate loading

Chapter 2 The Posterior Mandible

3D diagnosis and SimPlant planning
3D planning of a single-tooth implant
3D planning of a free-end situation

Single-tooth gap

Typical treatment course

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Replacing a molar with two implants
Replacement of a molar with an implant with vertical mucosal distraction
Atypical treatment course – problematic baseline situation
Replacement of a molar with one implant in a large gap
Problems and complications
Fracture of a non-WP implant
Note: Iatrogenic complication with nerve involvement
Immediate loading
Immediate provisional loading of a definitive implant

Multi-tooth gap and free-end situation

Typical treatment course
Two-session approach with augmentation
Atypical treatment course – problematic baseline situation
Single-session approach with augmentation and transmucosal healing
Large bone defect following the loss of implants
Problems and complications
Fracture of an implant with a tooth/implant-supported fixed partial denture
Failed augmentation with a bone block in a patient with an extremely narrow residual ridge

Immediate loading of provisional implants

Typical treatment course
Bilateral free-end situation
Atypical treatment course
Customizing provisional implants
Problems and complications
Loosened blade implant, provisional implants to protect the augmentation material

Immediate loading of definitive implants

3D implant planning and its surgical implementation
Diagnostic possibilities of cone beam CT imaging
Stereolithographic surgical guides
Implant placement with the stereolithographic SurgiGuide surgical template
Navigation technique

Chapter 3 The Edentulous Mandible

Diagnosis
3D CBCT diagnosis and SimPlant planning
3D diagnosis and SimPlant planning for the fabrication of the Sliwowski Overdenture

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System (SOS) SurgiGuide template
Note: Extremely narrow mandible

Rehabilitation with implant placement only in the interforaminal region

Removable prostheses on two implants

Typical treatment course
Removable immediate prosthesis on two implants and one prefabricated bar – the SOS method
Notes on the SOS method
Atypical treatment course – problematic baseline situation
Treatment of an extremely narrow residual ridge with the SOS method
SOS with osteoplasty and augmentation
Immediate implant placement following extraction and direct loading with SOS without a template
Problems and complications
Early loss of an SOS implant and re-implantation
Large mandibular defect and unexpected complication due to a slight change in position of the template
Note on impression taking

Removable prostheses on several implants

Typical treatment course
Immediate fixed bridge on five implants and definitive bar-retained restoration
Note: Connecting bar with a locking mechanism
Atypical treatment course – problematic baseline situation
Immediate loading with a provisional bar and an age-appropriate, definitive telescopic crown-retained prosthesis
Problems and complications
Inadequate dental prosthesis on two non-preservable implants – implant re-insertion and immediate loading

Fixed bridges on several implants

Typical treatment course
Fixed immediate bridge – implant placement with a 3D template
Atypical treatment course – problematic baseline situation
Extraction, immediate implant placement and immediate fixed bridge
Immediate fixed bridge loaded onto provisional implants
Problems and complications
Destruction of the residual ridge due to peri-implantitis
Removal of an incorrectly placed implant

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Full rehabilitation including implant placement in the posterior mandible

Typical treatment course
- Fixed bridges for prosthetic restoration of the entire mandible
- Immediate mandibular prosthetic restoration loaded onto provisional implants

Atypical treatment course – problematic baseline situation
- Fixed immediate prosthesis following extensive dental treatment and augmentation
- Selective extractions for the optimal positioning of definitive implants

Problems and complications
- Premature loosening of provisional implants
- Iatrogenic complication during the removal of provisional implants and peri-implantitis after 10 years of functional use

Immediate loading of definitive implants
- Immediate loading of permanent implants with a fixed bridge

Chapter 4 The Anterior Maxilla

Diagnosis with esthetic considerations
3D diagnosis and SimPlant planning

Single-tooth replacement

Typical treatment course
- Single-tooth implant – Simpler in Practice technique
- *Note: Simpler in Practice Technique*
  - *Fabrication of the provisional restoration – Simpler in Practice*
- Esthetic requirements dictated by a high smile line

Atypical treatment course – problematic baseline situation
- Single-tooth implants in an adolescent girl presenting with shortage of space
- *Note: Implants in adolescents*
- Emergency implant placement following traumatic loss of an anterior tooth

Problems and complications
- Spontaneous perforation of the mucosa
- *Note: Fracture risk of ceramic abutments*
- Biological and mechanical complications: suture dehiscence and loosening of the screw retention
- Development of an apical cyst at an anterior dental implant

Immediate loading of a single-tooth implant in the presence of a well-preserved residual ridge
- Immediate implant placement and immediate loading following extraction of the primary canines

Immediate restoration of a single-tooth implant

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Immediate implant placement following an inflammatory process around tooth

Premolar implants and several single-tooth implants

Premolar implant in a patient with a high smile line
Several single-tooth gaps following traumatic tooth loss
Restoration of several single-tooth gaps

Restoration of multi-tooth gaps

Typical treatment course

Replacement of four missing incisors on four implants
Replacement of four missing incisors on two implants

Atypical treatment course – problematic baseline situation

Restoration of a multi-tooth gap with preservation of the anatomical structures
Note: The "corkscrew technique"
Simultaneous immediate and delayed implant placement to replace two central incisors

Problems and complications

Implant treatment following the loss of an implant-supported restoration
Note: Mucosal graft technique
Immediate restoration loaded onto provisional implants following loss of the old implant-supported restoration

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Chapter 5 The Posterior Maxilla

Diagnosis

Conventional diagnosis
Fabrication of a radiologic or surgical template
Note: Shaping the surgical template

3D diagnosis and planning

Restoration of single- and multi-tooth gaps

Typical treatment course

Fixed bridge with multiple abutments
Note: Cosine curve technique to improve the gingival situation

Atypical treatment course – problematic baseline situation

Restoration in a case of pronounced, one-sided residual ridge atrophy
Note: The cast coping laboratory method (relating to the case history on page 331)
Sinus floor elevation with vertical and horizontal augmentation and single-tooth implant with orthodontic treatment

Problems and complications

Sinus floor elevation with reconstruction of the residual ridge and gingiva
Implant treatment after sinus floor elevation in two sessions

Immediate loading

Immediate loading of a restoration on both provisional implants and natural teeth

Note: Aligning IPIs

Sinus floor elevation with horizontal augmentation, implant placement and immediate restoration loaded onto IPIs

Immediate restoration supported on definitive implants and one natural tooth

Free-end situation

Simple treatment course (without sinus floor elevation)

Restoration in the form of an abbreviated dental arch without sinus floor elevation

Implant placement without sinus floor elevation with a 3D template

Typical treatment course

Sinus floor elevation with lateral augmentation and mucosal distraction

Note: Sinus elevation (sinus floor elevation, sinus lift)

Implant placement with sinus floor elevation using the two-session approach

Atypical treatment course – problematic baseline situation

Implant placement with sinus floor elevation accompanied by concomitant apicoectomy and lateral bone augmentation

Extensive augmentation in several directions

Problems and complications

Sinus floor elevation involving avoidance of a blood vessel and perforation of the maxillary sinus mucosa

Apical granuloma on a smooth machined implant

Immediate loading

Immediate restoration with concomitant sinus floor elevation

Sinus floor elevation, implant placement and immediate restoration loaded onto IPIs

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Chapter 6 The Edentulous Maxilla

3D diagnosis with a custom template

Note on the stabilization of the template

Rehabilitation without reconstruction of the posterior maxilla

Typical treatment course

Bar connector restoration on six implants

Note: Exposure technique

Cantilever implant bridge on nine implants

Atypical treatment course – problematic baseline situation

Removable restoration – incidental finding by CT imaging

Problems and complications

Fixed restoration with a change in implant inclination – a mechanical complication
Note: Mechanical complications

Immediate loading

Immediate loading of definitive implants with NobelGuide
Note: Immediate restoration on healing abutments

Rehabilitation with reconstruction of the posterior maxilla

Typical treatment course

Sinus floor elevation and implant placement in a single session
Severe residual ridge atrophy: sinus floor elevation and vertical augmentation prior to implant placement
Note: Several augmentative procedures in one operation

Atypical treatment course – problematic baseline situation

Extremely problematic baseline situation following the loss of sinus augmentation material and implants
Extreme residual ridge atrophy, sinus floor elevation with no bony sinus floor

Problems and complications

Severe horizontal residual ridge atrophy and loss of an implant
Sinus floor elevation and implant placement following loss of the old implants

Immediate loading

Typical treatment course

Immediate restoration of provisional implants following extraction
Immediate restoration with sinus floor elevation and implant placement

Atypical treatment course – problematic baseline situation

Sinus floor elevation and subsequent implant placement with immediate restoration loaded onto mixed implants
Sinus floor elevation with immediate restoration of provisional implants and no definitive implants

Problems and complications

Premature loss of provisional implants
Sinus floor elevation and immediate restoration loaded onto provisional implants, implant loss during the healing phase

Chapter 7 The Edentulous Maxilla and Mandible

Full rehabilitation of the maxilla and mandible

3D diagnosis

3D planning for implant placement in the maxilla and a Sliwowski Overdenture System

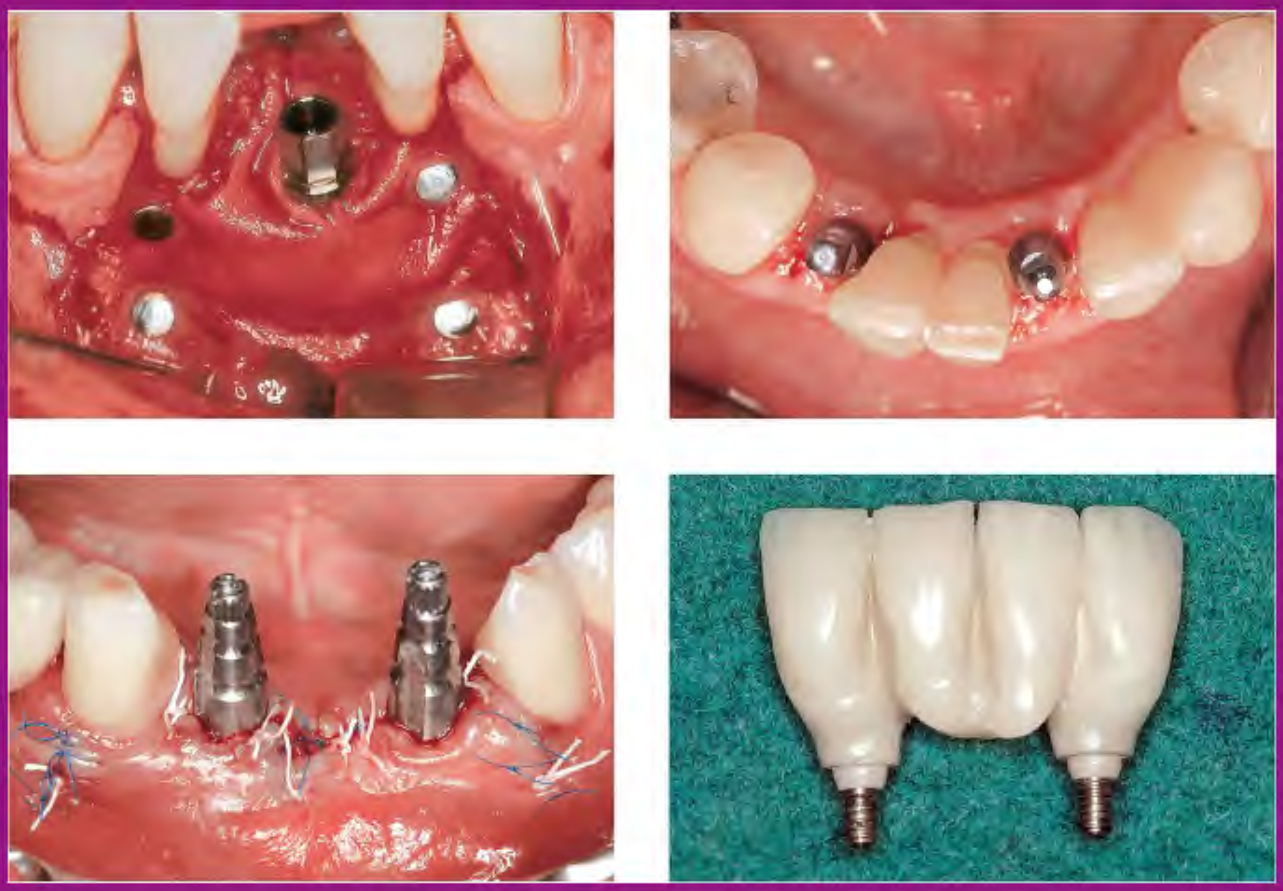
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(SOS) in the mandible
3D planning for sinus elevation in the maxilla and implant placement in the mandible
Typical treatment course
Bar structures with locking attachments in both maxilla and mandible
Sinus elevation and subsequent implant placement, reconstruction of the gingival zone
Note on split-thickness flaps and roll flaps
Atypical treatment course – problematic baseline situation
Sinus elevation, subsequent implant placement without immediate prosthetic loading
Switch from overdentures to implant-supported fixed restorations in both jaws
Problems and complications
Complication following an earlier treatment with disk implants in a heavy smoker with poor oral hygiene
Implant-supported restoration in a heavy smoker with poor oral hygiene
Immediate loading
Immediate restoration of provisional implants directly after dental treatment
Immediate restoration of provisional implants in the maxilla and definitive implants in the mandible, with a life-threatening complication
Notes on life-threatening hemorrhage

References
List of materials

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1
The Anterior Mandible



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The anterior mandible represents the most comfortable operating area for the implantologist. The main contributing factors for this include: good access and a good view of the operation site; a generally sufficient bone supply; no sensory anatomical structures; a lower risk of esthetic problems than in the maxilla; and less functional stress on the implants. For reasons such as these, this region is best suited for immediate non-functional or even immediate functional loading. However, the chief problem in this area is the smaller diameter of the mandibular incisors relative to standard implants. The replacement of one or two adjacent incisors presents a particular challenge.

3D diagnosis and planning

Pronounced residual ridge atrophy

Radiologic and dental cast analyses are two key components of the preoperative diagnostic investigations. In the standard panoramic radiograph, the visualization of the anatomical structures in the anterior tooth region often lacks sharpness, so that it needs to be supplemented with a single-tooth radiograph. Far more reliable planning can be achieved with the aid of either conventional computed tomography (CT) or cone beam CT imaging (CBCT), also known as digital volume tomography (DVT). Both methods provide a metrically exact representation of the region, free of any superimpositions, thus allowing precise three-dimensional (3D) planning.

A CBCT image provides not only a pictorial overview of the situation, but also enables very detailed planning. The 3D reconstruction gives the best overview. In the case presented here, tooth 41 is sited far from the residual ridge and hangs loosely in the soft tissue (Fig 1-1a). The bone defect that has developed appears correspondingly extensive, and it may be assumed that augmentation will be necessary. The gap following the loss of tooth 31 has closed completely, so that only one incisor can be replaced, even though both the middle ones are missing. The distance between the roots of the neighboring teeth is relatively big, so that sufficient space is available in the mesiodistal direction (Fig 1-1a). For detailed planning, the data are input into a planning program, in this instance SimPlant (Dentsply). In the SimPlant program, the intended implant can be taken from a library (collection of all current implant types) and placed in the jaw. An abutment can also be selected after the positioning of the implant, and placed onto it. In this case, the program allows a Brånemark System implant (Nobel Biocare), 18-mm long and with a diameter of 3.75 mm, to be selected based on the available bone supply. The implant abutment (in this case, CeraOne (Nobel Biocare), height 5 mm) can be seen in all three dimensions and in the 3D reconstruction (Fig 1-1b). The distance between the implant and the neighboring teeth is best assessed on the consecutive panoramic sections (Fig 1-1c). The most important view when planning each individual implant is the cross-sectional view, which shows the width of the residual ridge (Fig 1-1d). It allows the transverse and vertical bone supply to be assessed accurately, providing a basis for the prognosis of the primary stability of the implant. Any bone deficits that are present can be identified and a need for augmentation already becomes apparent in the planning phase. The 3D reconstruction provides a good overview of the available bone supply and the positioning of the implant (Fig 1-1e). Better assessment of the position of the implant relative to the nerve (which needs to be marked manually; Fig 1-1f) is delivered by the semi-transparent view or full fade-out of the bone structures. The model, with the section going through the implant, may be rotated in any direction, giving a view of the planned implant position from all perspectives (Fig 1-1g). The bone densitometry function provides good guidance on the expected bone quality at the implant

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site (Fig 1-1h). However, because of the poorer quality of the detailed visualization compared to CT, this analysis is of limited use when applied to CBCT images.

For the treatment course, see page 13.

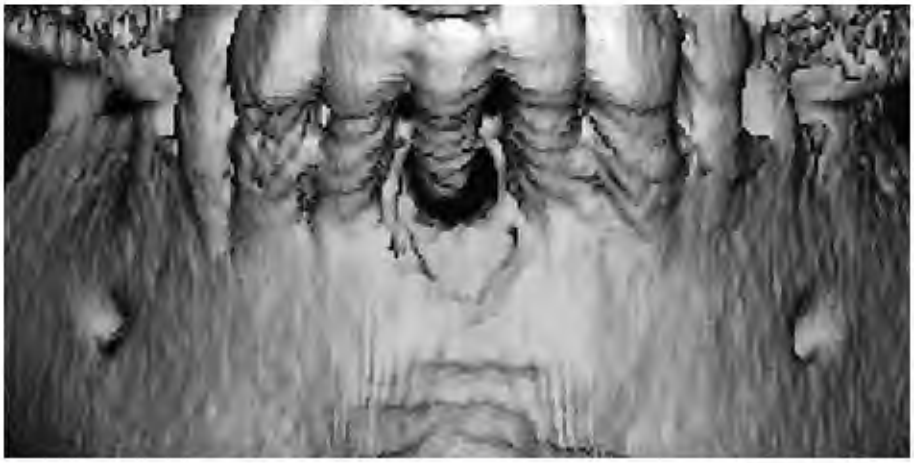


Fig 1-1a 3D reconstruction. Tooth 41 is now being retained only by the soft tissue.

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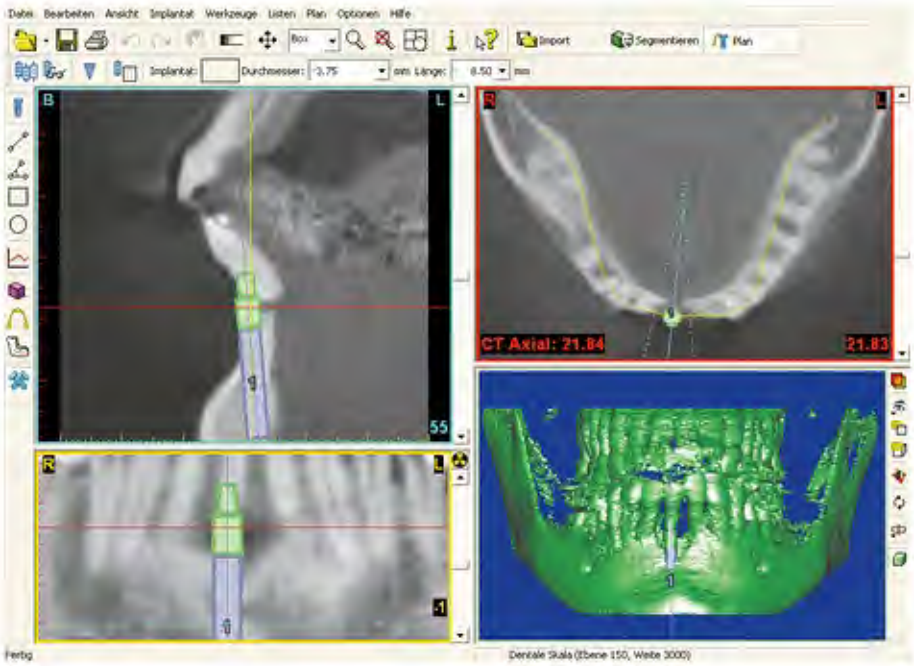


Fig 1-1b Implant planning with the SimPlant program: viewed in three aspects and 3D reconstruction.

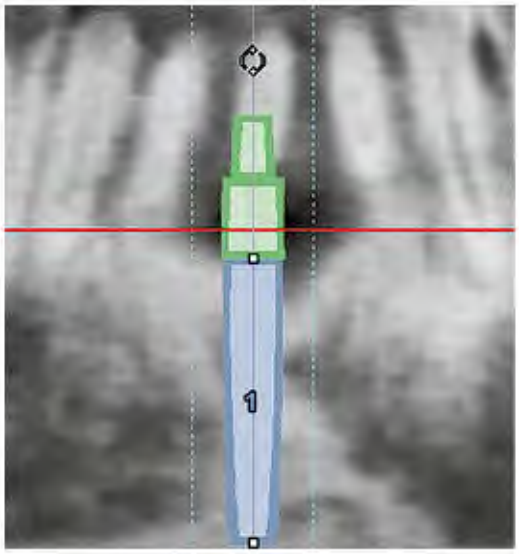


Fig 1-1c Panoramic section. Virtually inserted 3.75 × 18-mm Brånemark System implant with a 5-mm CeraOne abutment.

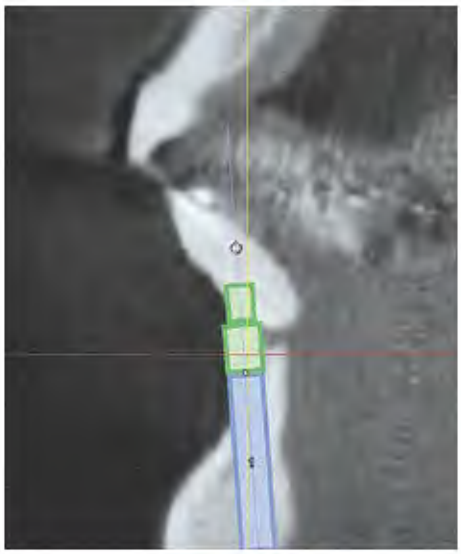


Fig 1-1d Cross-sectional view. Narrow residual ridge – labial bone deficit.

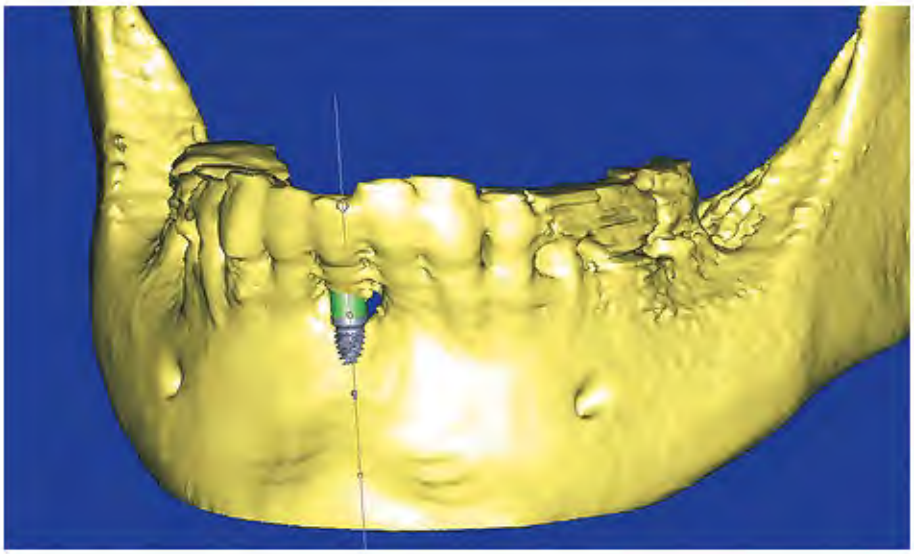


Fig 1-1e 3D reconstruction. Visualization of the position of the implant.

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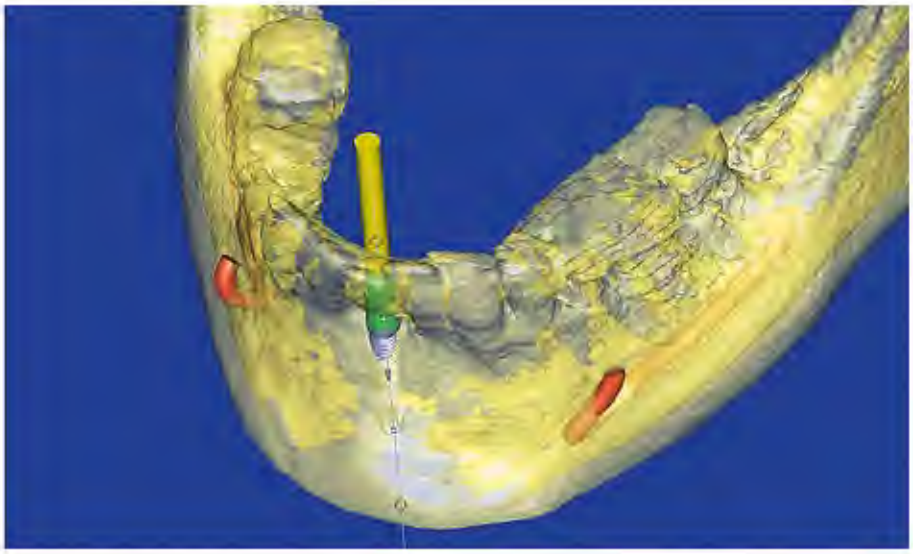


Fig 1-1f Semi-transparent 3D reconstruction with the nerves and longitudinal axis of the implant marked.

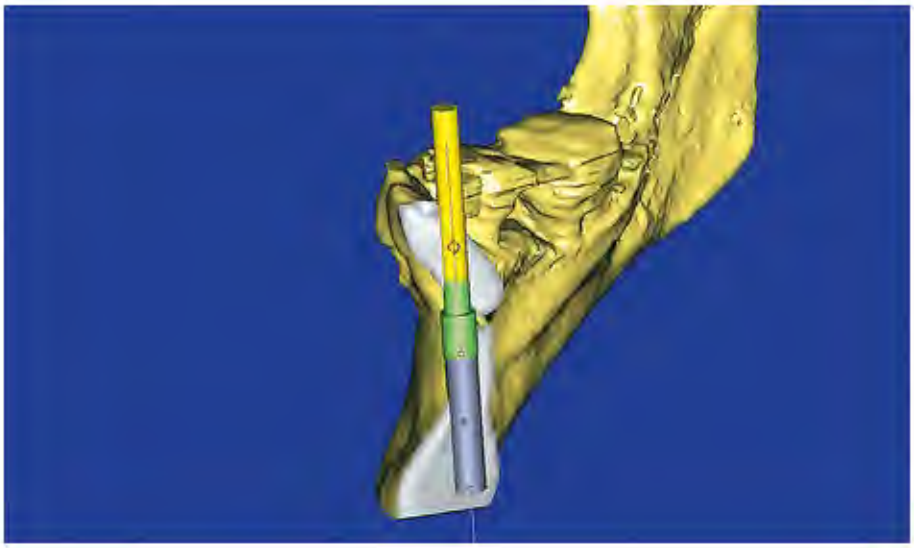


Fig 1-1g 3D visualization of the cross-sectional view.

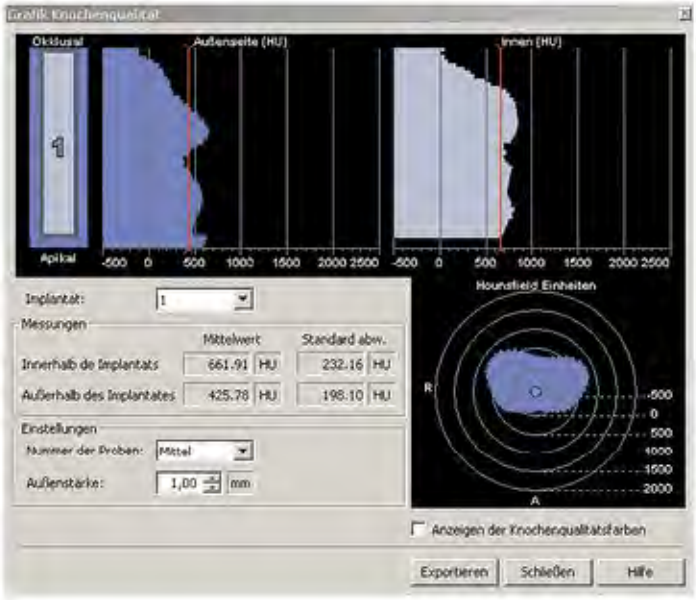


Fig 1-1h Bone densitometry around the planned implant.

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Fig 1-1i Dental cast analysis after tooth 31 has been removed.

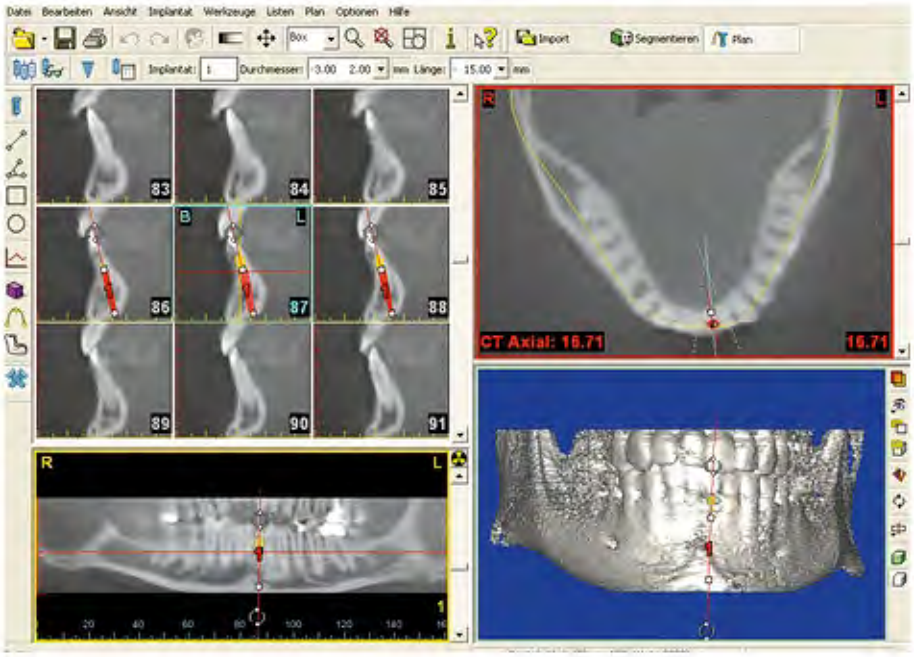


Fig 1-1j SimPlant planning.

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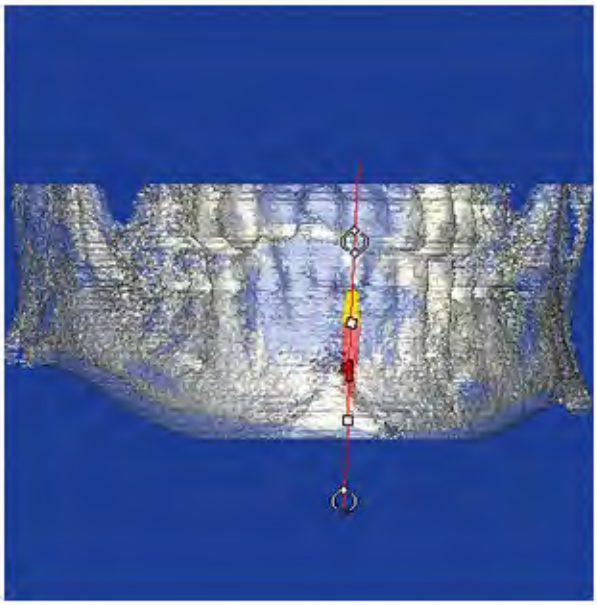


Fig 1-1k Semi-transparent 3D reconstruction with planned implant.

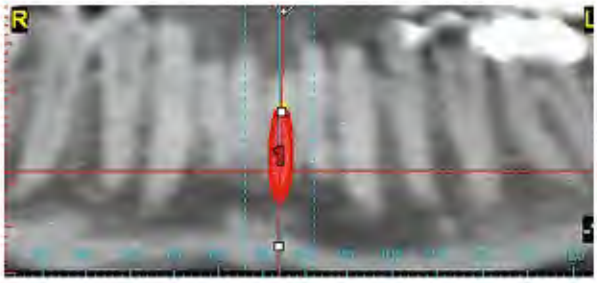


Fig 1-1l Panoramic section. Checking distance to neighboring teeth on the consecutive slices (from labial to lingual).

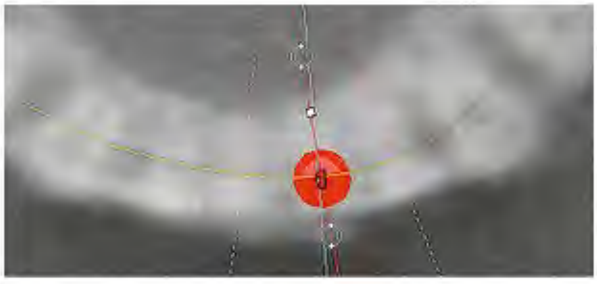


Fig 1-1m Axial section. Checking distance to neighboring teeth on the consecutive slices (from apical to coronal).

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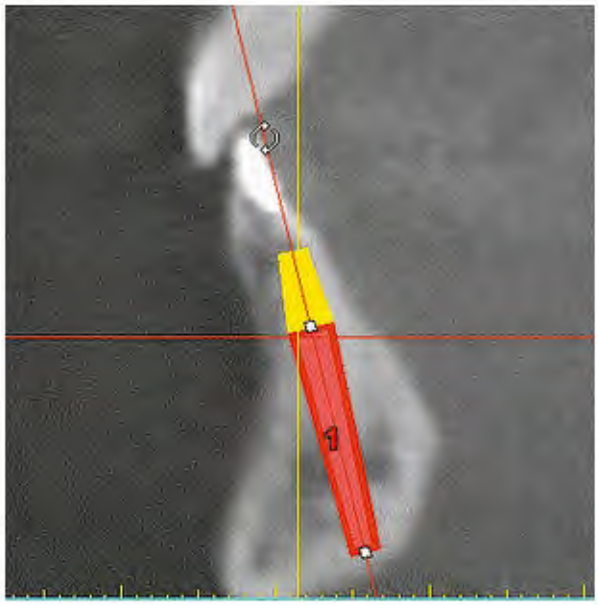


Fig 1-1n Cross section. Orientation of the implant taking account of anatomical and functional aspects.

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Shortage of space, insufficient distance to the neighboring teeth

In this case, tooth 31 is not preservable due to painful internal resorption, and must therefore be extracted. This internal resorption has been confirmed on the CBCT images in all three planes. The width of the gap can be measured with high accuracy, not only radiologically, but also on the model after erasing tooth 31 (Fig 1-1i). The implant is planned using the SimPlant software (Fig 1-1j). One of the narrowest available implants, NobelDirect (Nobel Biocare), 16-mm long and with a diameter of 3 mm, has been selected due to the shortage of space. This implant is placed into the jaw virtually. The planning process is performed in all three planes and also with the aid of the 3D reconstruction. A visual representation of the positioned implant and its spatial relationship to the neighboring structures, particularly the teeth, becomes clearly apparent on the semi-transparent 3D reconstruction (Fig 1-1k). The panoramic section allows good assessment of the problem zones along the roots (Fig 1-1l).

It is advantageous to carry out an additional check of the spatial visualization on the horizontal (axial) section (Fig 1-1m). The most important evidence in most cases – the cross-sectional view – confirms that the dimensions of the residual ridge are adequate in this instance (Fig 1-1n).

For the treatment course, see page 16.

Single-tooth gap

The implant rehabilitation of a single-tooth gap in the anterior mandible, following the loss of

one mandibular incisor, requires not only a special set of instruments, but also a particularly high level of precision from the implantologist. In most cases, the resultant gap is very narrow and the available space between the roots of the neighboring teeth extremely limited. Iatrogenic injury to the neighboring teeth can only be avoided with detailed preoperative radiologic investigations and by performing the surgical procedure with great care. If the residual ridge has healed, the freshly inserted implant can be loaded directly with a prosthesis, which is highly advantageous for both the patient and the dentist.

Because of the limited space, implants of reduced diameter, ie, narrow platform (NP) implants such as NobelActive (diameter 3.0 and 3.3 mm) and NobelDirect (diameter 3.0 mm) from Nobel Biocare, or Touareg (diameter 3.0 mm) from Adin or the K.S.I. Bauer screws, are particularly suitable for minimizing the risk of damage to the roots of neighboring teeth. Instruments required for implant placement include long shank drills, extra-long thread cutters and dental screwdrivers, as well as drill extensions, which can reach to the required depth in the narrow gap between the neighboring teeth (see page 16). Surgical guides or templates are used only in rare cases due to the limited space.

In the anterior tooth region, the single-tooth implant may be inserted directly after the tooth is extracted (immediate implant placement) or after the socket has fully healed (delayed implant placement). Requirements for immediate implant placement include: first, an adequate bone supply of good quality to anchor the implant with primary stability; and, second, the absence of any acute inflammation. After implant placement, the implant can be fitted with a cover screw and allowed to heal submerged, or with a healing abutment for transmucosal healing. In immediate implant placement, a healing abutment helps preserve the anatomical structures, such as the gingival margin and interdental papillae. Instead of a healing abutment, this function can also be performed by an interim crown on a provisional abutment, but these must be placed entirely out of both static and dynamic occlusion.

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For the preoperative 3D investigations, see page 2.

Typical treatment course

Late implant placement with immediate loading

Baseline situation

Having lost teeth 31 and 43, this patient was fitted with a removable prosthesis that she had worn for many years, but that she found very uncomfortable and troublesome (Fig 1-2a). The patient wished to be rid of the prosthesis as soon as possible. Both gaps were very narrow and the jaw, particularly the region of tooth 43, had degenerated considerably (Fig 1-2b).

Diagnostic tools

- Clinical examination
- Dental cast analysis
- CBCT and SimPlant planning

Treatment plan

1. Implant placement, augmentation and immediate loading



Fig 1-2a Missing teeth 31 and 43.



Fig 1-2b Horizontal atrophy.

3D analysis and SimPlant planning

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A CBCT image was taken before implant placement and the implants were virtually positioned in the SimPlant program (Fig 1-2c). Because of the shortage of space and good bone quality, the plan was to use K.S.I. Bauer screws for both sites.

Attention: ***The advantage of K.S.I. Bauer screws is that they provide good primary stability and can be loaded immediately. They have been successfully used by the main author for many years as provisional implants for immediate loading. Despite earlier doubts, they are eminently suitable for use as definitive implants in extremely narrow gaps. They have a flexible section to allow the crown to be adjusted with regard to any prosthetic aspects.***

Implant placement

Implant placement took place under general anesthesia and was performed in combination with the osteotomy of retained tooth 28 and bilateral sinus elevation. Before implant placement, the teeth located either side of the gaps were stripped slightly, to make more space for the crowns. The incision was made centrally over the residual ridge and extended further horizontally below papilla 41, 42 to provide a join. A labial flap was constructed, preserving the papilla, and both implants were inserted. The labial atrophy was treated with the harvested bone chips. Alignment of the implant heads was followed by tight closure of the incision with Gore-Tex (W. L. Gore and Associates) and Mopylen 6-0 sutures (Resorba) (Fig 1-2d). The first provisional crowns were manufactured and directly incorporated with the aid of theromoplastic foil. (Fig 1-2e).

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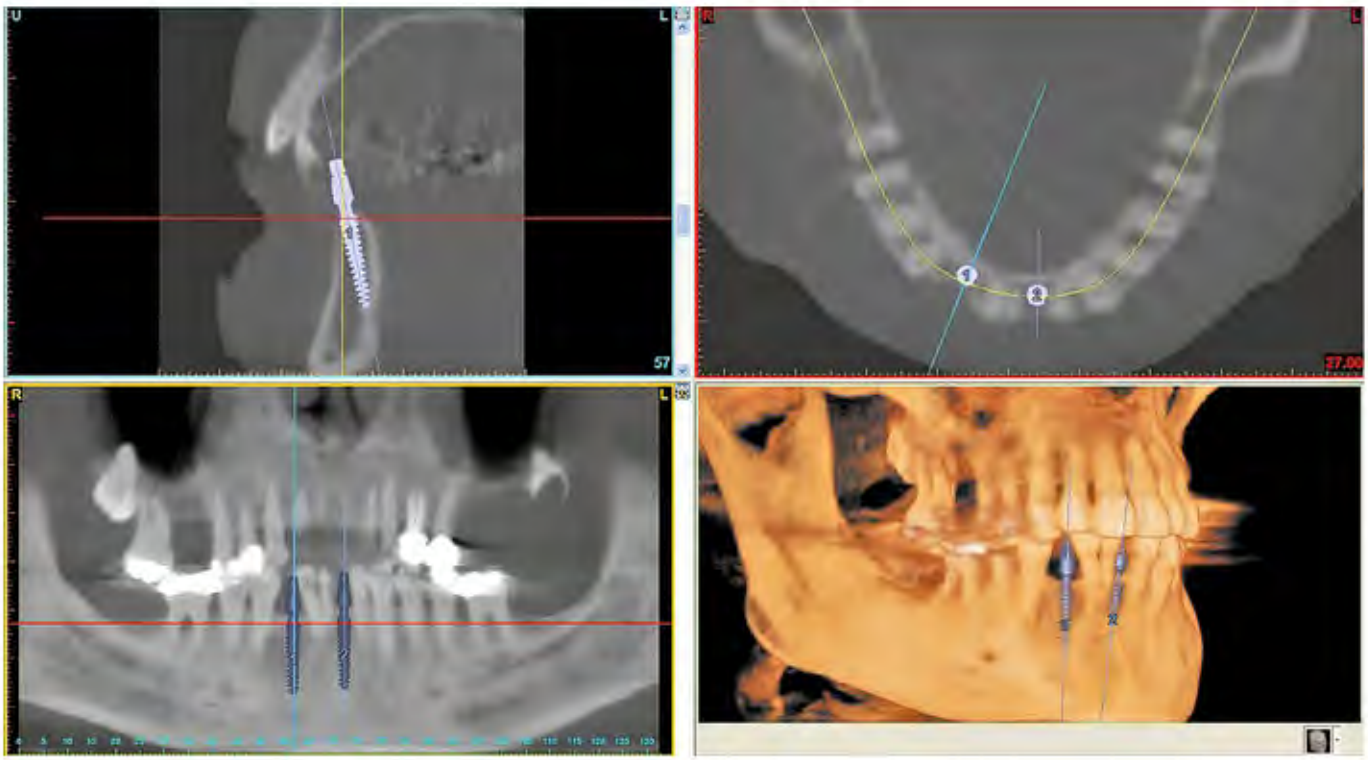


Fig 1-2c SimPlant planning of implants 31 and 43.

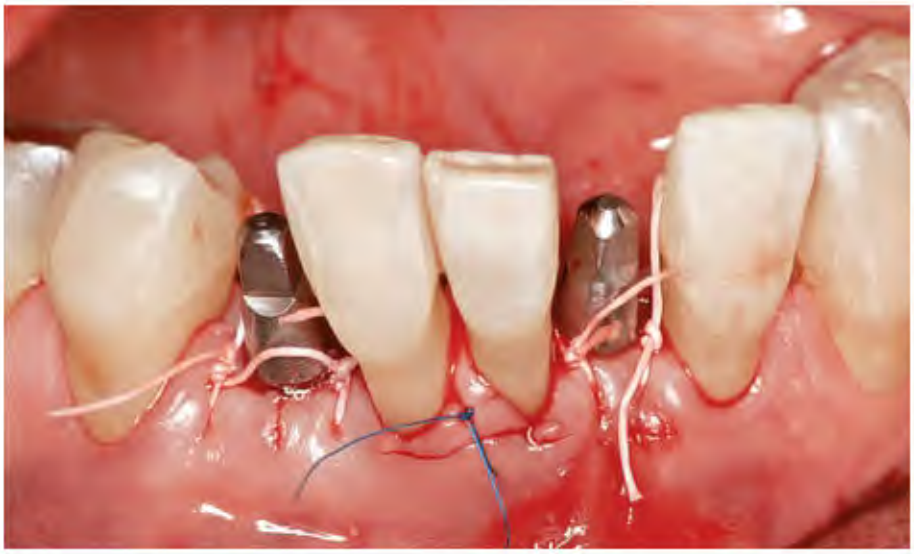


Fig 1-2d Inserted implants in the regions of teeth 31 and 43.



Fig 1-2e Provisional immediate crowns on the implants.

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Prosthetic loading

One week later, the sutures were removed and the long-term crowns fabricated in the laboratory were incorporated (Fig 1-2f). The labial contour of the residual ridge looks considerably better even after simple augmentation (Fig 1-2g). Implant placement into the maxilla following sinus elevation was planned for 1 year later. The new CBCT image also provided a view of the peri-implant bone in the mandible in all three planes (Fig 1-2h). Comparison of the planned implant 31 (Fig 1-2i) with the implant already in situ (Fig 1-2j) in a cross-sectional view showed slight deviation of the apex of the positioned implant in the labial direction. This has resulted from the considerable resistance offered by the hard lingual cortical bone. The inclination of the implant head (Fig 1-2j) could be corrected by bending it. After 1 year, the bone and gingival situation around the implants continued to be stable. The patient was so happy with the appearance and function of the provisional crowns that she did

not even want to have the definitive crowns fitted (Fig 1-2k).



Fig 1-2f Incorporation of the long-term provisional crowns after 1 week.



Fig 1-2g Residual ridge shaped by augmentation.

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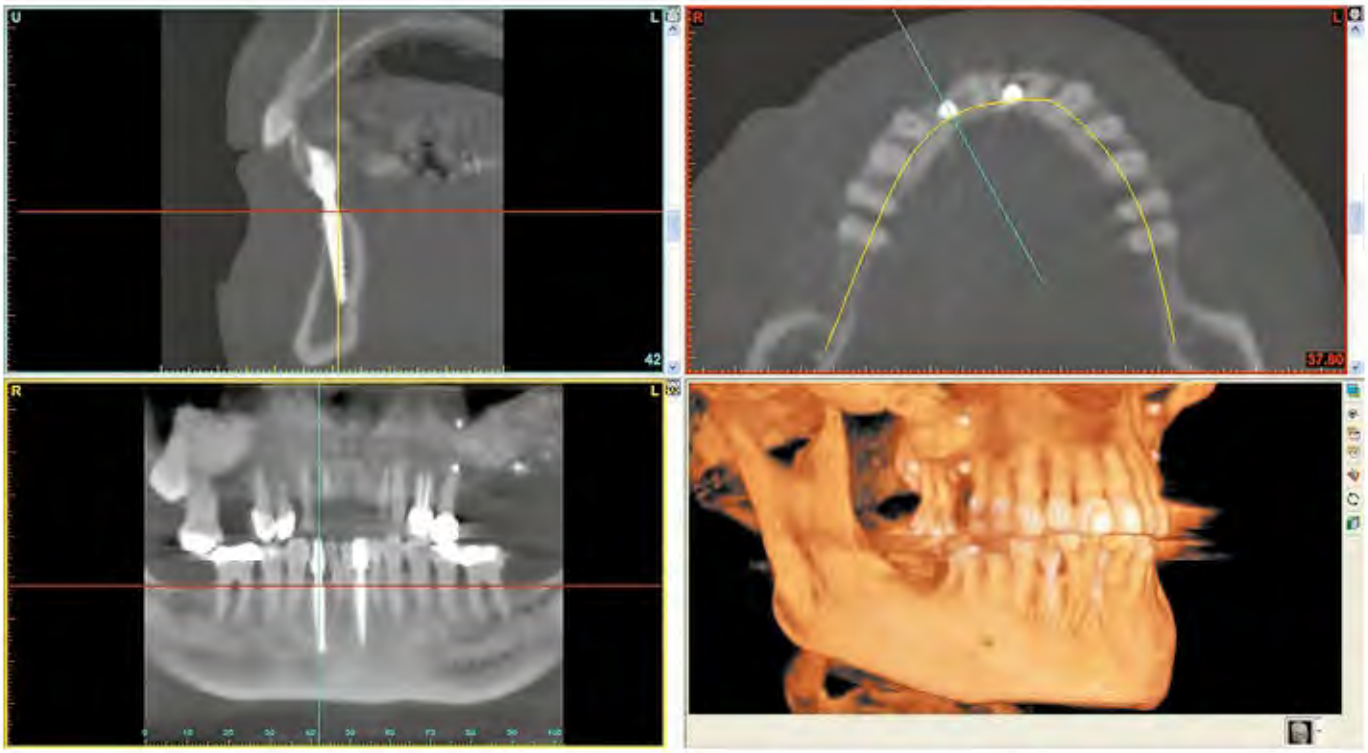


Fig 1-2h CBCT after 1 year and before the implant placement in the maxilla.

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Fig 1-2i Planned position for implant 31.

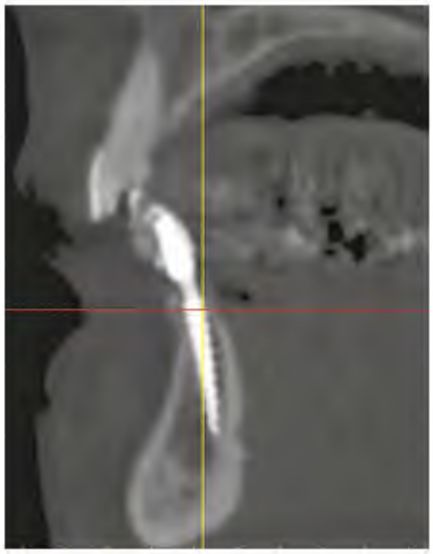


Fig 1-2j Cross-sectional view of implant 31 with a slightly bent head.



Fig 1-2k Provisional crowns (definitive at the patient's request) after 1 year of functional use.

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Treatment course

- Implant placement, augmentation and immediate loading (2010)

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental technician Ludger Jansen, DentaLab

Atypical treatment course – problematic baseline situation

Immediate implant placement following extraction

Baseline situation

Tooth 32, which shows little of note clinically but is very loose, can no longer be preserved due to a periodontal bone defect extending to its apex (Figs 1-3a and 1-3b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Single-tooth radiograph
- Dental cast analysis

Treatment plan

1. Extraction, immediate implant placement with augmentation
2. Secondary exposure
3. Cemented ceramic crown on a single-tooth implant



Fig 1-3a Tooth 32, no longer preservable.

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Fig 1-3b Periodontal bone defect extending to the apex.

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Extraction and implant placement

Extraction of the tooth and creation of a mucoperiosteal flap exposed an extensive bone defect, which had also led to exposure of one root surface of tooth 31 (Fig 1-3c). A regular platform (RP) implant (diameter 3.75 mm), 21-mm long and with a conical neck, was inserted centrally into this defect and the underlying residual ridge (Fig 1-3d).

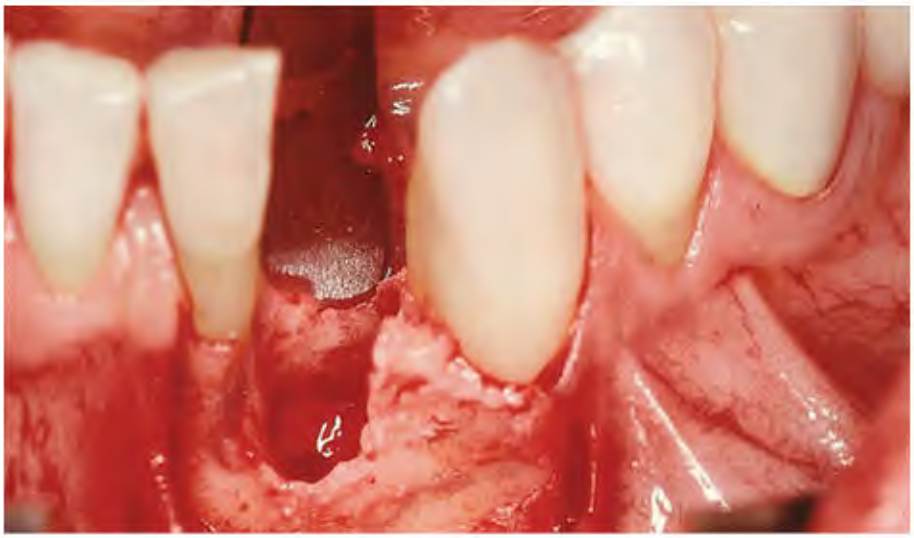


Fig 1-3c Exposed three-wall bone defect.



Fig 1-3d Inserted implant.

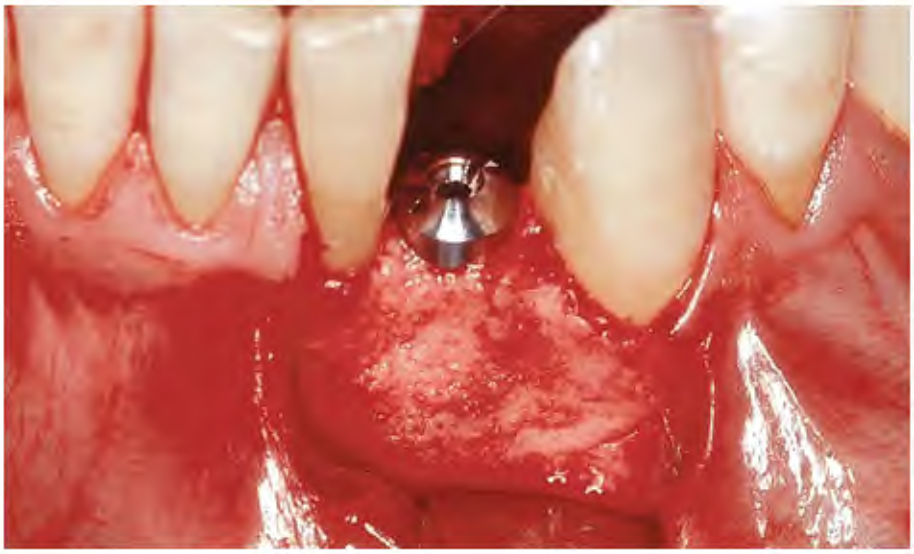


Fig 1-3e Augmentation with bone chips.



Fig 1-3f Wound closure with 6-0 sutures.

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Instead of a cover screw, a 2-mm-high healing abutment was screwed onto the implant to act as a spacer. The remaining crevices in the bone defect were filled with the bone chips harvested during preparation of the implant bed (Fig 1-3e). Saliva-proof wound closure was performed following periosteal slitting and mobilization of a trapezoid flap, using monofilament, microsurgical 6-0 sutures (Fig 1-3f). Use of a membrane was not necessary for this three-wall bone defect.

Attention: ***Implants of reduced diameter (NP, approximately 3 mm) are best suited for replacing a lower incisor. Only narrow implants allow an adequate distance to be maintained from neighboring teeth. At the time (in 1998), the longest NP implant in the Brånemark System was 15 mm long; stable anchoring in the bone was doubtful at this length. The extraordinary implant length of 21 mm is an enormous advantage where a deep defect is present: it ensures stable anchoring in basal bone, which is so important in immediate implant placement, thus resulting in sufficient primary stability.***

Exposure and prosthetic loading

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After a 5-month healing period, the implant was exposed and the healing abutment exchanged for a higher one (Fig 1-3g). At this point, the panoramic radiograph showed stable anchoring of the implant in the bone, along with good regeneration of the former bone defect (Fig 1-3h). The implant was fitted with a CeraOne abutment and prosthetically loaded with an all-ceramic crown. In view of the very small distance between the implant and neighboring tooth 31 (one disadvantage of an RP implant) and the lack of bone before implant placement (Fig 1-3d), it was not possible to create an interdental papilla. However, this caused no impairment to the patient, even with his widest smile (Figs 1-3i and 1-3j).



Fig 1-3g Displacement of the gum and interdental papilla 31 to 32.



Fig 1-3h Panoramic radiograph prior to the prosthetic loading.



Fig 1-3i Clinical situation 4 years after the loading.



Fig 1-3j The patient 4 years after the loading.

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Treatment course

- Implant placement (1998)
- 5 months to exposure
- 2 weeks to impression taking and fabrication

Treatment

Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Roland Althoff
Dental technology: Ivonne Lewik

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Note

Narrow and high gap between neighboring teeth

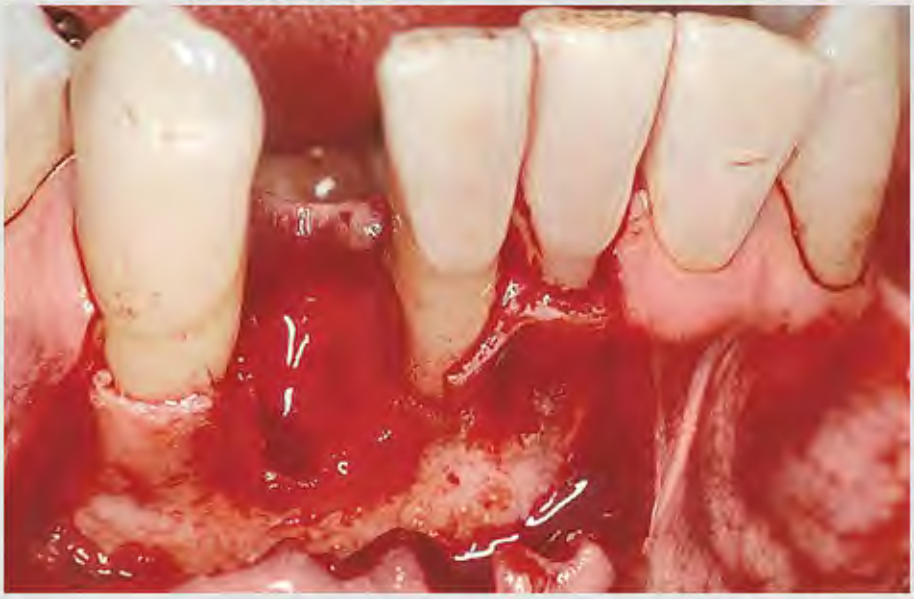


Fig 1-4a Exposure of the three-wall defect.



Fig 1-4b Insertion of the 3i Micro Mini implant with extra-long implant mount.



Fig 1-4c Inserted implant.

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Fig 1-4d Provisional abutment.

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The single-tooth gap following the loss of an incisor is very narrow at both crown and root (Fig 1-4a). This lack of space means that implants of reduced diameter should be inserted here, reducing the risk of injury to the neighboring teeth. Extra-long drills and thread cutters (possibly with an extension shaft) will need to be used when preparing the implant bed. An extra-long insertion driver or implant mount will also be necessary when placing the implant (Fig 1-4b).

The implant bed is prepared at the midpoint between the neighboring teeth, as an extension of the socket. Here, the gap is wide enough to insert a 3i Micro Mini (Biomet 3i) implant 3.25 mm in diameter with an extra-long implant mount (Fig 1-4b). Following insertion (Fig 1-4c), a cover screw or provisional abutment that will take the immediate crown is screwed onto the implant; this also requires the use of an extra-long screwdriver (Fig 1-4d).

Problems and complications

Horizontal augmentation of a knife-edge residual ridge

This treatment course follows on from the 3D diagnostic investigations on page 2.

Baseline situation

This patient had only three mandibular incisors left following the closure of the gap left by tooth 31 (Fig 1-5a). Moreover, tooth 41 has suffered severe periodontal damage and is being retained only by an adhesive composite resin splint attached to the neighboring teeth (see Fig 1-5a). There is no attached gingiva whatsoever.

Diagnostic tools

- Clinical examination
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction, immediate implant placement, implant-supported single-tooth crown
2. All-ceramic crown on the CeraOne abutment



Fig 1-5a Tooth 41 is being retained only by a ligature splint.



Fig 1-5b Exposure of the one-wall defect.

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Fig 1-5c Inserted TiUnite implant.

Extraction and implant placement

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Once the tooth was removed, a wide mucoperiosteal flap was created between teeth 32 and 42 (Fig 1-5b). The gap was of sufficient width for a Nobel Biocare RP TiUnite implant (diameter 3.75 mm). The 18-mm long implant was inserted and a 5-mm-high CeraOne abutment was screwed on with the required torque of 32 N/cm. Augmentation was necessary to restore the contours of the residual ridge and cover the exposed implant threads (Fig 1-5c).

To encourage revascularization of the augmentation material, the labial cortical bone was perforated several times with a fine spiral bur (Fig 1-5d). The bone chips harvested during preparation of the implant bed were mixed with a regenerative bone substitute (Bio-Oss; Geistlich) and filled into the defect. A resorbable collagen membrane (Bio-Gide; Geistlich), fixed with small titanium pins, was used to stabilize the augmentation material (Fig 1-5e). The augmentation was overextended both horizontally and vertically to compensate for subsequent resorptive loss. Following saliva-proof suturing of the operation site, a provisional cap was fitted onto the CeraOne abutment (Fig 1-5f) and a provisional immediate crown with no functional loading prepared (Fig 1-5g).



Fig 1-5d Perforations in the cortical bone for better revascularization; the CeraOne abutment has been screwed into place.

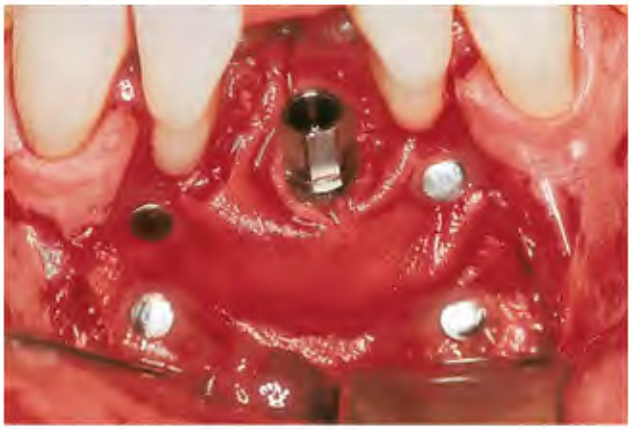


Fig 1-5e The Bio-Gide membrane fixed into place.

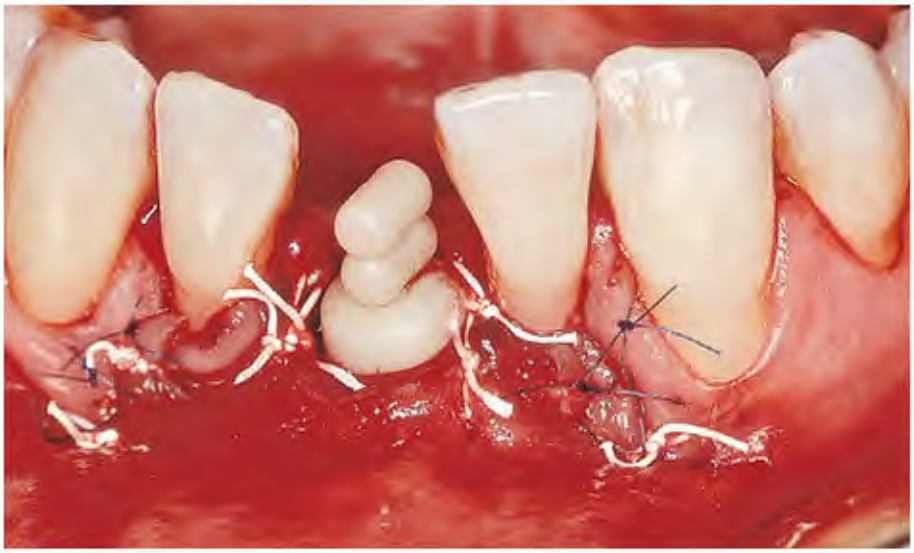


Fig 1-5f Sutured wound and with provisional cap in place.

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Fig 1-5g Provisional immediate crown.

Prosthetic loading

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To achieve an optimal esthetic result when manufacturing the definitive crown, the CeraOne abutment, which was rather too long, should have been exchanged for an all-ceramic CerAdapt (Nobel Biocare) abutment (Fig 1-5h). However, the patient was happy to accept the metal rim that was only just visible, and did not want the abutment to be changed for financial reasons. Therefore, the definitive all-ceramic crown was incorporated on the existing abutment. Figure 1-5i shows the clinical situation 6 years following incorporation of the crown.



Fig 1-5h CeraOne abutment; the metal rim is visible on the labial side.



Fig 1-5i Cement-retained all-ceramic crown. Situation after 6 years.

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Treatment course

- Extraction, implant placement with augmentation
- and immediate loading (2001)
- 6 months to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Roland Althoff
Dental technology:	Horst Mosch

Immediate restoration

Immediate implant placement and immediate loading

This treatment course follows on from the 3D diagnostic investigations on page 4.

Baseline situation

In this 24-year-old woman, tooth 31 was not preservable due to painful internal resorption. Therefore, it was due to be extracted and, if possible, replaced by an implant-supported immediate crown in the same session (Fig 1-6a). (See the diagnostic investigationson page 4.) Following extensive radiologic investigations and dental cast analysis, and in view of the extremely small distance between the neighboring teeth,

measured at only 5 mm, the plan was to perform immediate implant placement with a NobelDirect implant (diameter 3 mm) and to prepare a provisional crown in the laboratory.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction, immediate implant placement, augmentation and immediate loading, implant-supported single-tooth crown



Fig 1-6a Tooth 31, not worth preserving.

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Extraction, immediate implant placement, augmentation and immediate loading

Due to the advanced internal resorption, the tooth fractured as soon as the dental forceps were applied. The remaining root was extracted using a periotome and a compression screw (Fig 1-6b) using the non-destructive “corkscrew technique” (see page 294), without damaging the

bony socket. Following the non-destructive root extraction, a NobelDirect implant, 16-mm and with the smallest diameter (3 mm), was inserted into the socket (Fig 1-6c). The prepared provisional crown was cemented on with TempBond (Kerr Corporation) (Fig 1-6d).

Since part of the vestibular lamella could no longer be fully preserved, the small defect was augmented with the bone substitute OSTIM (Heraeus Kulzer) (hydroxylapatite; Fig 1-6e). The periosteal flap was repositioned without the use of a membrane and fixed with 6-0 sutures (Fig 1-6f). To ensure that implant healing was not endangered, the crown was placed completely out of occlusion (Fig 1-6g). The gingival situation (Fig 1-6h) stabilized after only a few weeks, and the implant was harmoniously incorporated into the overall situation (Fig 1-6i).



Fig 1-6b Extraction using the corkscrew technique.

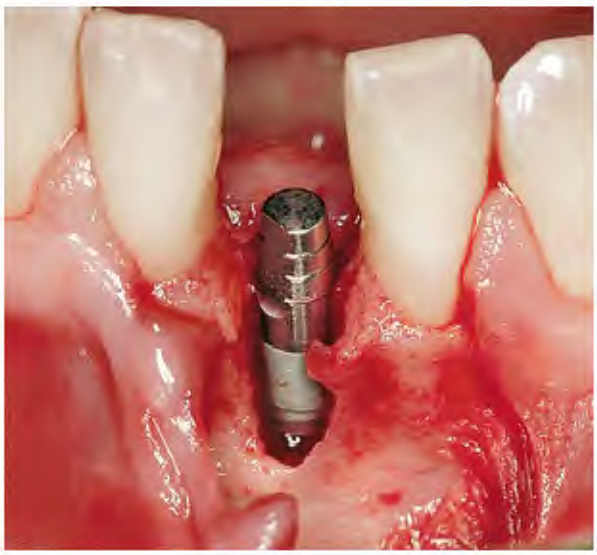


Fig 1-6c Inserted NobelDirect implant.

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Fig 1-6d Provisional crown in situ.



Fig 1-6e Augmentation with OSTIM.

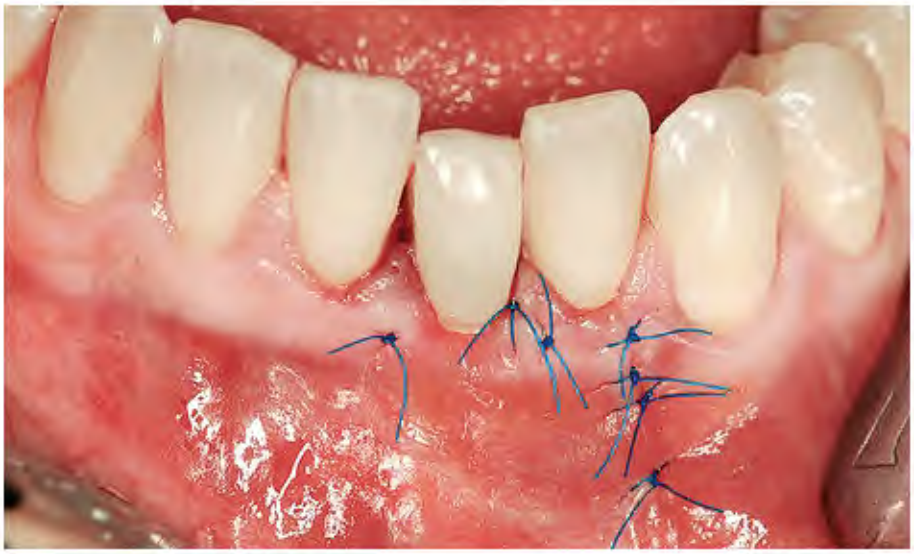


Fig 1-6f Suturing of the wound.

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Fig 1-6g Crown placed out of occlusion.



Fig 1-6h Stabilization of the gingival situation.

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Treatment course

- Implant placement (2003)
- 6 months to impression taking and definitive loading

Treatment

Surgery and provisional crown:	Dr Christoph T. Sliwowski
Dental technology:	Ute Olbers



Fig 1-6i Overall appearance of the implant crown.

Multi-tooth gap

If several teeth have been lost from the anterior mandible, the level of difficulty of the implant treatment depends significantly on the width of the resultant gap. If three or four incisors have been lost, a functionally and esthetically satisfactory restoration can be achieved in most cases using two implants. A situation that presents a much greater therapeutic challenge is when two adjacent incisors have been lost and the gap is too wide for one implant, but too narrow for two. The insertion of a single implant and the subsequent reconstruction of both missing teeth is unfavorable both esthetically and functionally. If the restoration is to be accomplished with the aid of two implants, these should be as narrow as possible.

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Typical treatment course

Replacement of three incisors on two implants

Baseline situation

Following the extraction of teeth 31, 32 and 41, this patient was fitted with a provisional removable cast prosthesis (Fig 1-7a).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Implant placement of two implants
2. Secondary exposure
3. Prosthetic loading with a three-unit fixed bridge



Fig 1-7a Provisional restoration with a removable cast prosthesis.

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Implant placement

Implant placement was performed 6 weeks after extraction (Fig 1-7b). At this point, mobilization of the mucoperiosteal flap revealed that the extraction sockets had not yet healed (Fig 1-7c). Preparation of the implant bed in the regions of teeth 32 and 41 (Fig 1-7d) was followed by the insertion of two Replace Select implants (Nobel Biocare), 3.5 mm in diameter (Fig 1-7e). Vertical augmentation was necessary to enable the correct prosthetic positioning of the implants. Healing abutments 2 mm high were fitted instead of cover screws, to support the augmentation material (Fig 1-7f). The peri-implant bone defects were filled with the bone chips harvested during preparation (Fig 1-7g). The postoperative follow-up radiograph shows the positioning of the implants relative to the roots of the neighboring teeth (Fig 1-7h).



Fig 1-7b Multi-tooth gap, region of teeth 32 to 41.

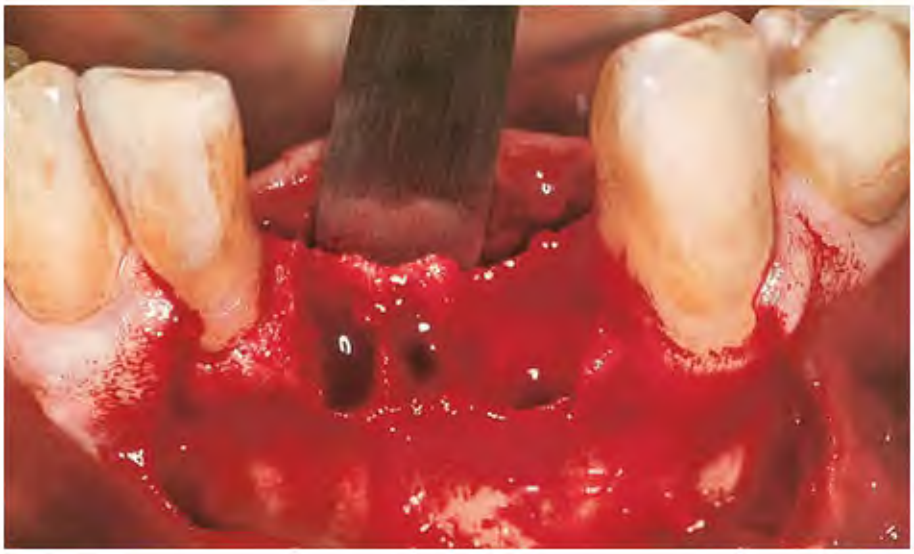


Fig 1-7c Unhealed sockets.

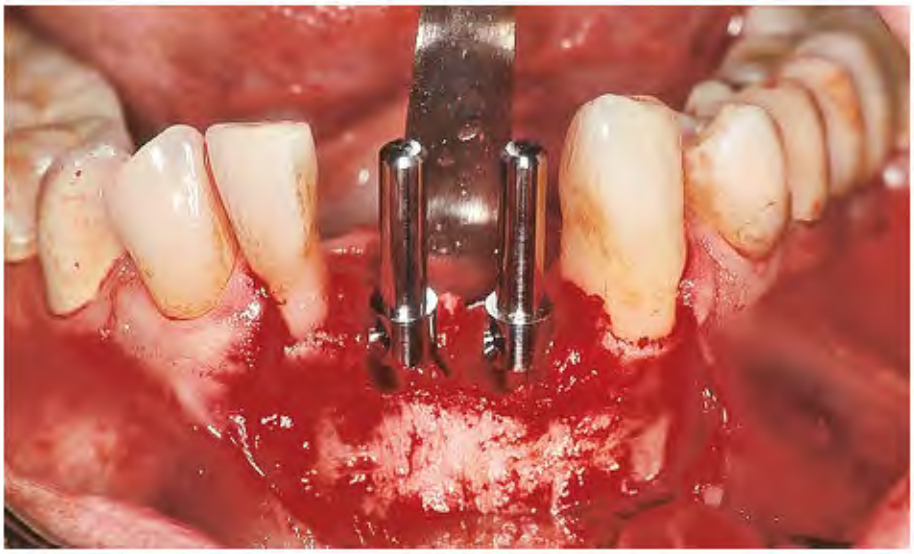


Fig 1-7d Preparation of the implant beds.

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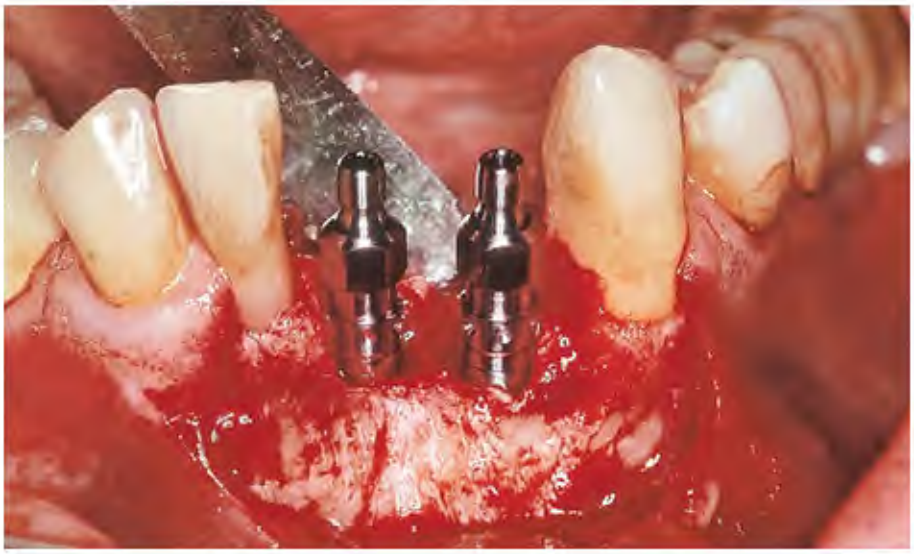


Fig 1-7e Insertion of the Replace Select implants.

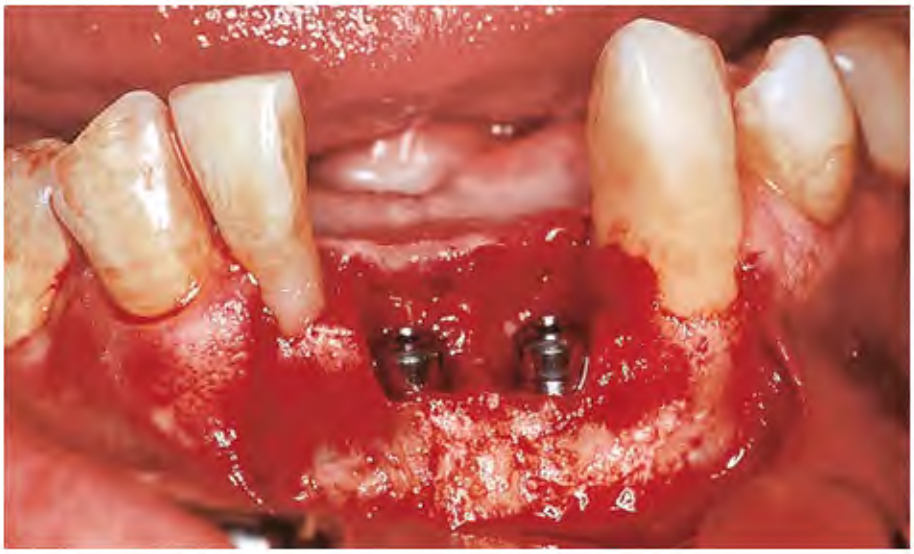


Fig 1-7f The healing abutments have been screwed into place.

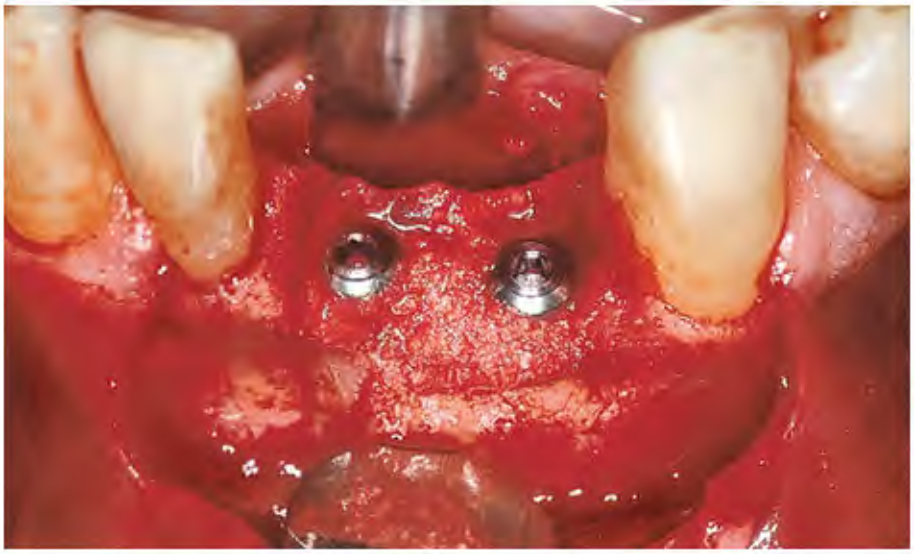


Fig 1-7g Augmentation.

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This is already the third implantological procedure undergone by this patient: tooth 36 had been replaced by a crown loaded onto two implants, followed by implant placement and augmentation on both sides of the maxilla.



Fig 1-7h Follow-up panoramic radiograph.



Fig 1-7i Situation prior to exposure.

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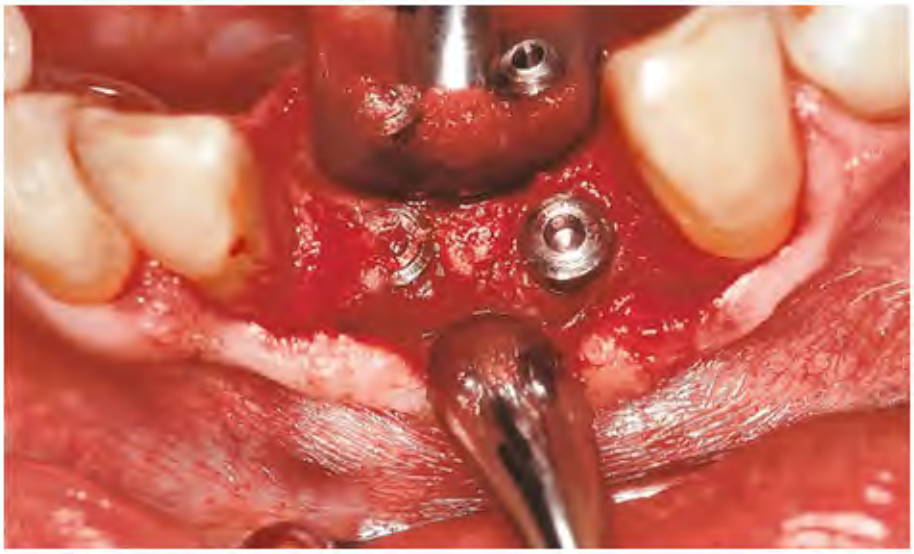


Fig 1-7j Implant 41 overgrown with bone.



Fig 1-7k Implant 41 following modeling osteoplasty.

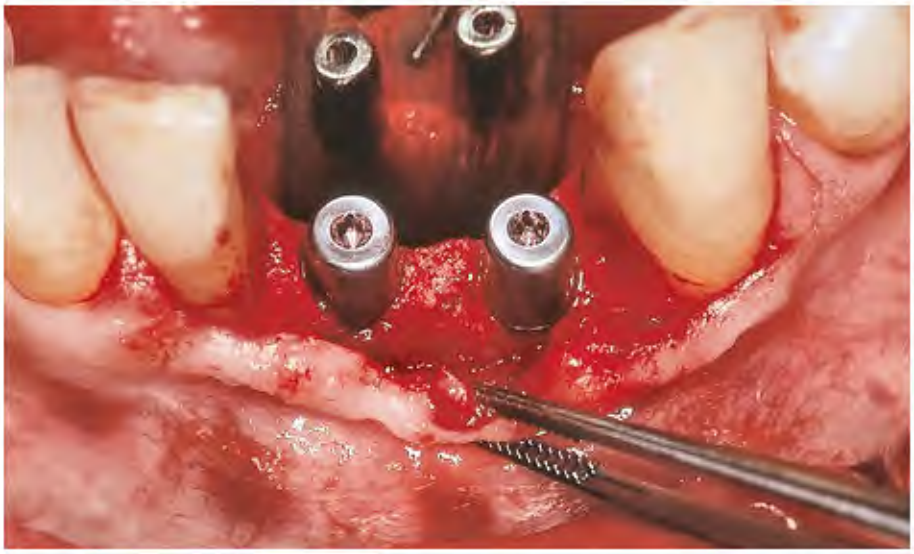


Fig 1-7l Healing abutments (5 mm high).

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Fig 1-7m Customized abutments.



Fig 1-7n Metal-ceramic fixed bridge.

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Exposure and prosthetic loading

Five months after insertion of the implants (Fig 1-7i), exposure showed good osseous regeneration, particularly in the region of implant 41 (Fig 1-7j). Full exposure of implant 41 also required excess bone to be carefully removed with a reamer (Fig 1-7k). The supporting 2-mm healing abutments were exchanged for 5-mm healing abutments (Fig 1-7l). Once the postoperative gingival swelling had subsided, an impression was taken and the customized abutments were created (Fig 1-7m). The metal-ceramic fixed bridge replacing the missing incisors was cemented on with TempBond (Fig 1-7n).



Fig 1-7o Clinical situation after 13 years.



Fig 1-7p Radiology findings after 13 years. All the “old” implants are in situ along with the new immediate implant in the region of tooth 44.

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Continued follow-up

Thirteen years after the anterior tooth implant placement, the patient experienced problems with tooth 44 and required an additional implant at this location. An up-to-date photograph of the fixed bridge replacing the anterior teeth was taken at that time (Fig 1-7o). Tooth 44 had to be extracted, with an implant directly inserted in its place and prosthetically loaded. The follow-up panoramic radiograph shows the patient’s overall rehabilitation in all four quadrants and confirms the stable bone situation around all the implants (Fig 1-7p).

Treatment course

- Extraction
- 6 weeks to implant placement (1998)
- 5 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Roland Althoff
Dental technology:	Horst Mosch

Atypical treatment course – problematic baseline situation

Preventive horizontal augmentation

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Baseline situation

Following the loss of all four incisors, the intention was to perform implantological restoration of the resultant multi-tooth gap from 32 to 42 with an implant-supported fixed partial denture (Fig 1-8a). Clinical assessment revealed horizontal atrophy within the gap, which would probably necessitate augmentation.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Insertion of two implants with simultaneous augmentation
2. Secondary exposure
3. Prosthetic loading with a screw-retained fixed bridge



Fig 1-8a Baseline clinical situation.

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Implant placement and augmentation

Exposure of the bony residual ridge was followed by preparation of the two implant beds in the regions of teeth 32 and 42 with the subsequent insertion of two Brånemark System RP implants (diameter 3.75 mm) (Fig 1-8b). As a result of retraction of the labial alveolar process, the bony lamella lining it is so thin in places that a few screw threads can be seen shimmering through (Fig 1-8c). Augmentation was performed in this area to prevent subsequent resorption of the thin bony lamella. Small perforations in the cortical bone facilitated revascularization of the augmentation material (Fig 1-8d). A resorbable Bio-Gide membrane was first secured in the apical region with three titanium pins, and the harvested bone chips were applied directly onto the bone to form the first layer (Fig 1-8e). An alloplastic regenerative bone substitute (Cerasorb; curasan) was layered on to protect against resorption and to increase the volume of augmentation (Fig 1-8f). The membrane was adapted over the augmentation material and pushed under the periosteum on the lingual side for further fixation (Fig 1-8g). Due to the increase in volume, periosteal slitting was necessary to allow tension-free wound closure.

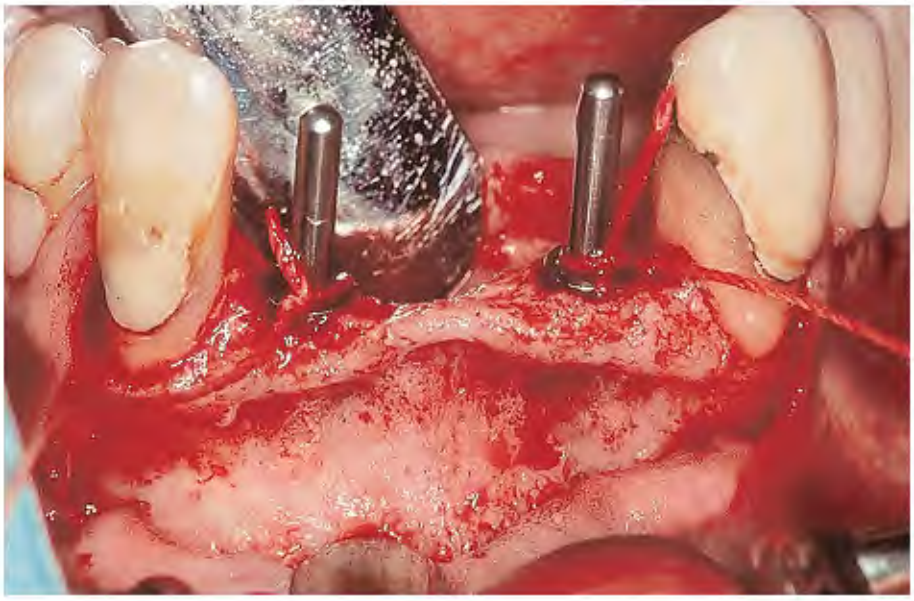


Fig 1-8b Preparation of the implant beds.

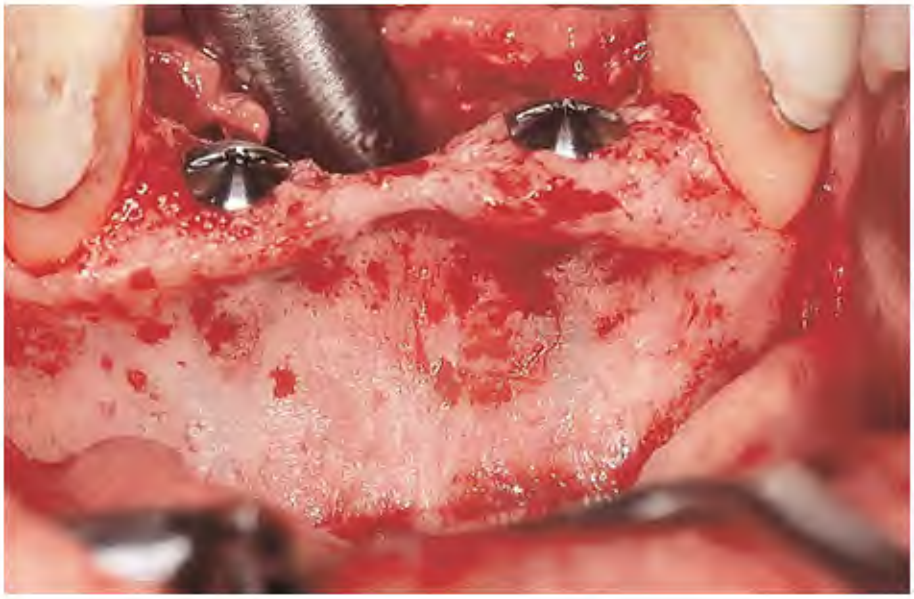


Fig 1-8c Implants shimmering through.

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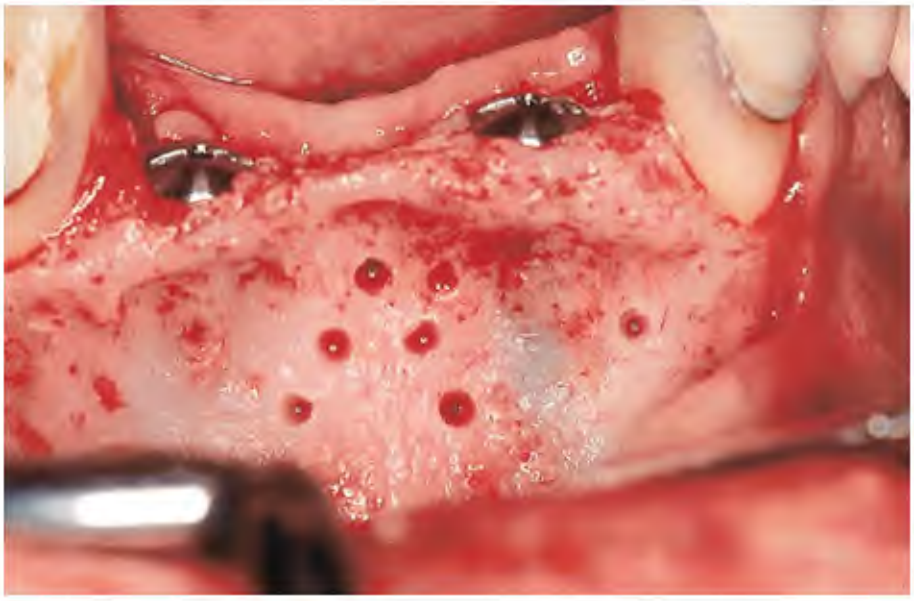


Fig 1-8d Perforations in the cortical bone to encourage revascularization.



Fig 1-8e Bone chips applied to the bone to form the first layer.

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Fig 1-8f Regenerative bone substitute as a spacer.

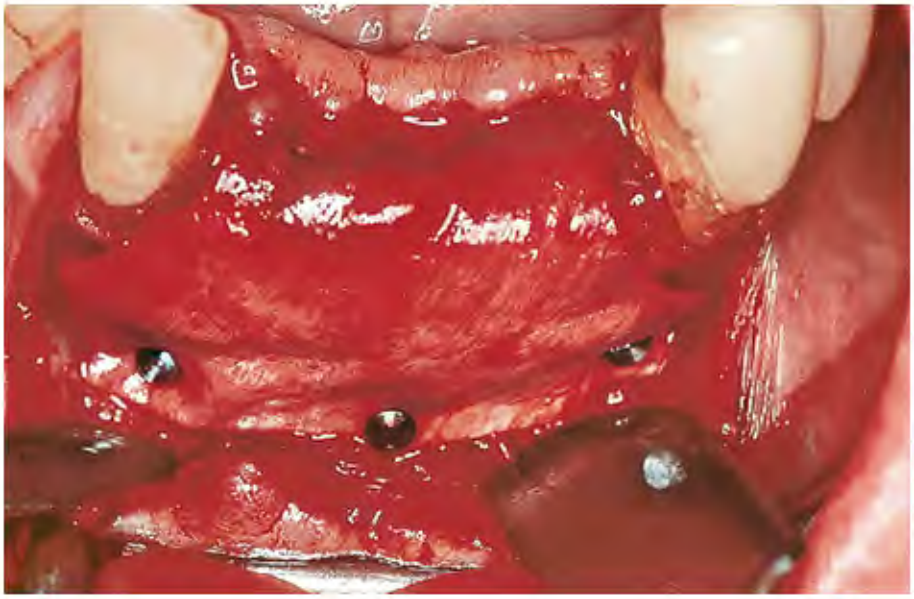


Fig 1-8g Membrane fixed into place with small pins.

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Fig 1-8h Clinical situation prior to exposure.



Fig 1-8i Tissue-sparing incision using the “cosine curve” technique.

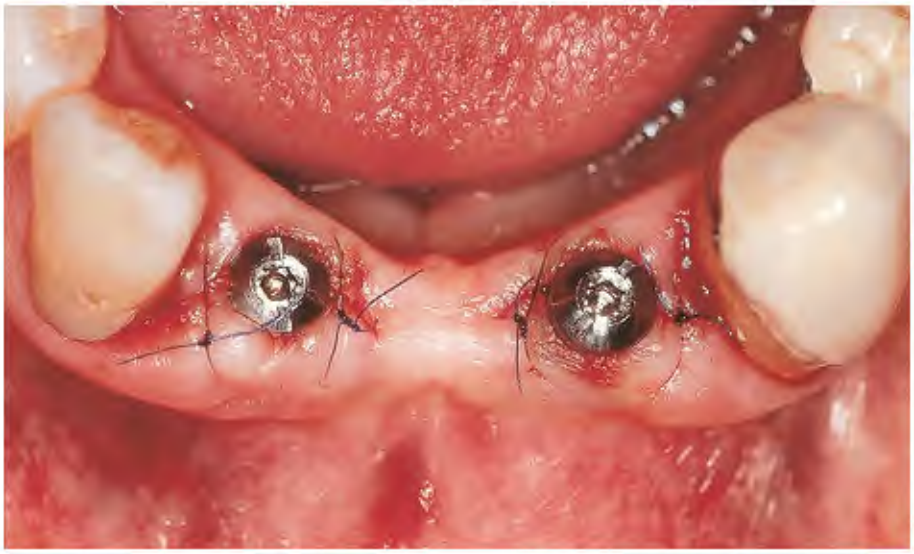


Fig 1-8j Reduced-diameter healing abutments.

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Fig 1-8k Prosthetic loading.



Fig 1-8l The happy patient.

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Fig 1-8m Panoramic radiograph after 7 years.



Fig 1-8n Clinical situation after 7 years.

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Exposure and prosthetic loading

Following an uncomplicated 5-month healing period (Fig 1-8h), a tissue-sparing incision using the “cosine curve” technique (see page 330) was selected for exposure of the implants (Fig 1-8i). Following insertion of reduced-diameter healing abutments (diameter 4.1 mm) for gradual contouring of the peri-implant soft tissue, the wound was closed with microsurgical 6-0 single sutures (Fig 1-8j).

The implants were then prosthetically loaded with a screw-retained partial denture with bridging units 31 and 41 (Fig 1-8k). Figure 1-8l shows the happy patient following incorporation of the superstructure. The final photographs show the stable gingival and bone situation 7 years later (Fig 1-8m and 1-8n). To date, the patient has not asked for the esthetically unsatisfactory prosthesis in the posterior region of the third quadrant to be

replaced.

Treatment course

- Implant placement (1999)
- 5 months to exposure
- 2 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Fernando Abrantes

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Problems and complications

Implant placement in an extensive bone defect

Baseline situation

This patient had a fairly extensive multi-tooth gap extending from the region of tooth 34 to the region of tooth 42 (Fig 1-9a). An extensive vertical bone defect, which required augmentation, was clinically and radiologically apparent particularly in the region of teeth 31 to 34, (Figs 1-9a and 1-9b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph with template
- Dental cast analysis

Treatment plan

1. Insertion of four implants with simultaneous augmentation
2. Secondary exposure
3. Prosthetic loading with a transocclusal screw-retained fixed partial denture



Fig 1-9a Multi-tooth gap in the region of teeth 34 to 42.



Fig 1-9b Large bone defect in the region of teeth 31 to 34.

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Implant placement and augmentation

A crestal incision with a vertical relieving incision at tooth 35 was followed by preparation of the mucoperiosteal flap to reveal the defect (Fig 1-9c). The preparation of the four implant beds was performed according to plan, with the bone chips harvested for the subsequent augmentation. Direction indicators were used to check the correct positioning and orientation of the implant axes (Fig 1-9d). The implants were inserted, with those in the regions of teeth 33 and 32 positioned slightly deeper because of the bone defect, to avoid excessive vertical augmentation with an increased risk of complications (Fig 1-9e). Since the bone chips alone were not sufficient to fill the 3D defect, a regenerative bone substitute (Bio-Oss) was also used for its augmentation (Fig 1-9f). In view of the expected resorption, the augmentation was

overcontoured, so that implants 33, 32 and 41 were completely covered by the augmentation material. To ensure stabilization of the augmentation material, it was covered with a resorbable Bio-Gide collagen membrane. This was fixed into place with small titanium pins (Fig 1-9g).

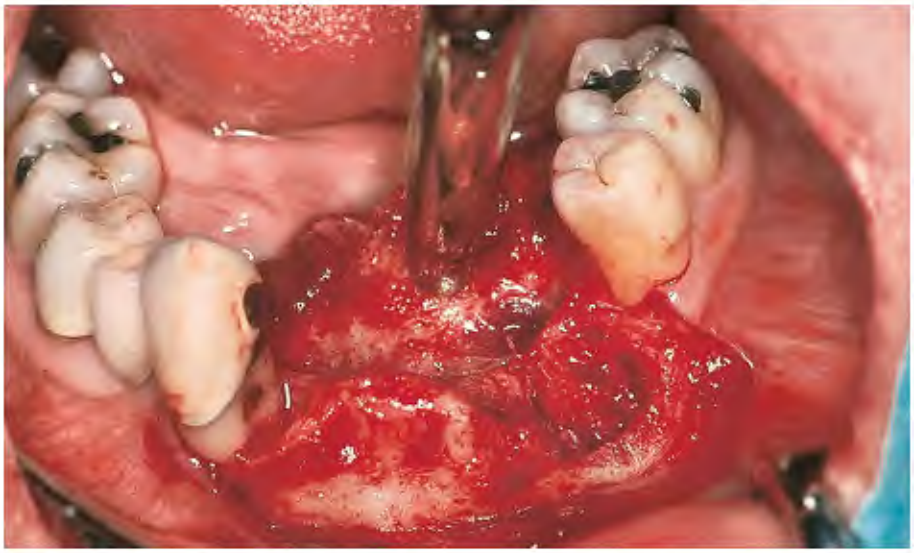


Fig 1-9c Exposure of the bone defect.

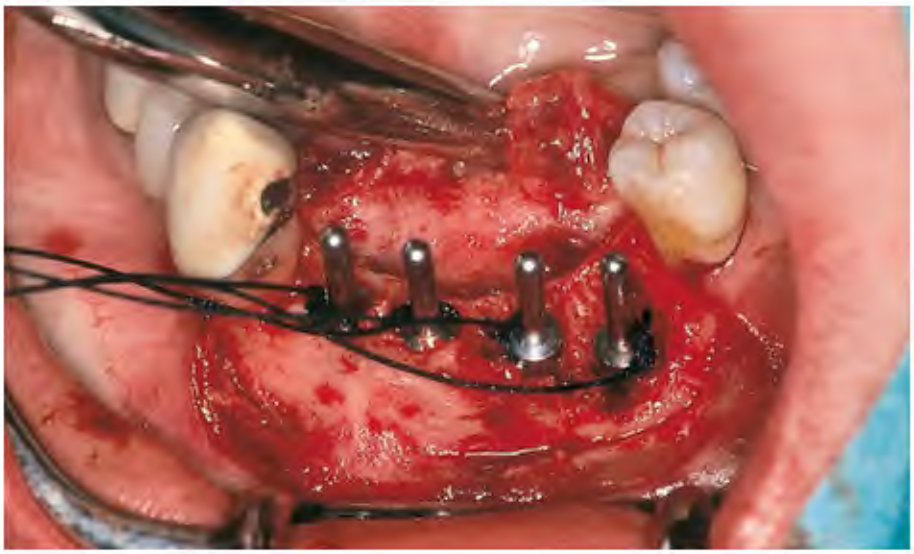


Fig 1-9d Preparation of the implant beds.

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Fig 1-9e Insertion of the implants.

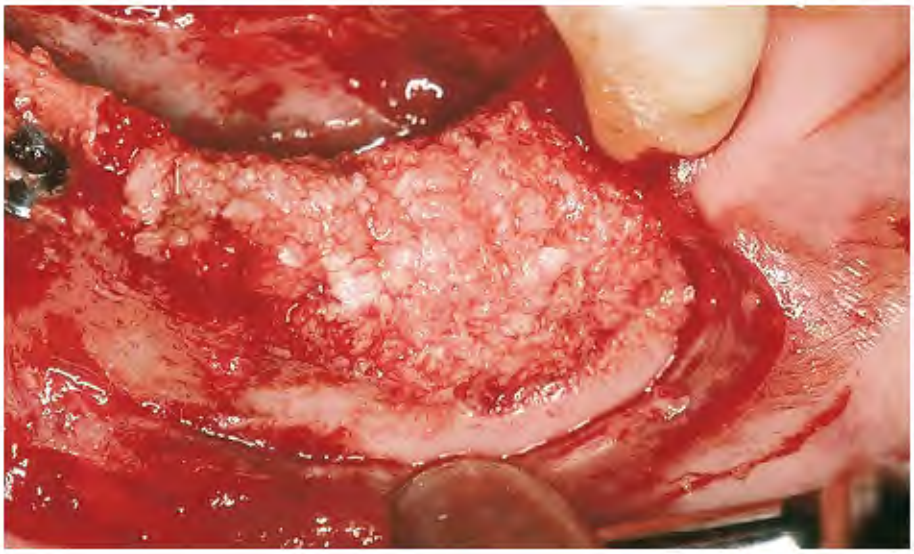


Fig 1-9f Augmentation with harvested bone chips.

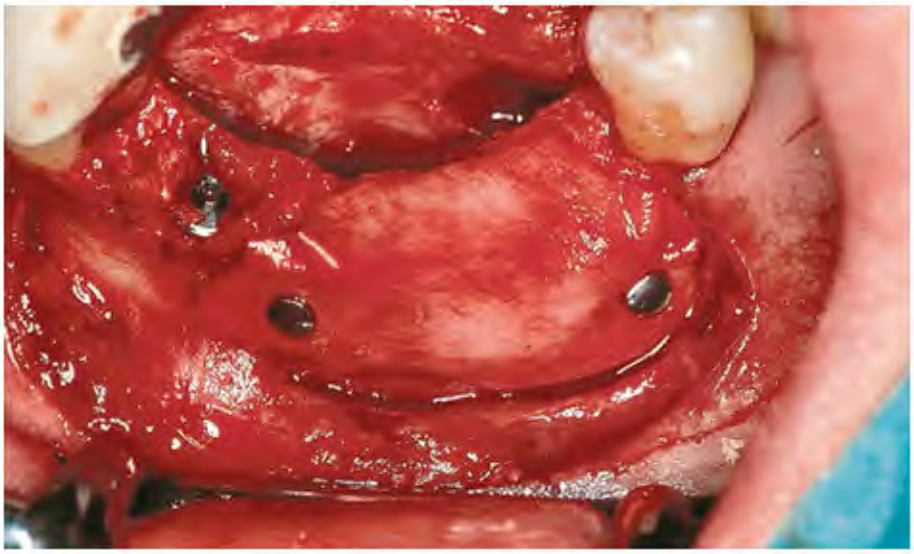


Fig 1-9g Fixation of the Bio-Gide membrane with pins.

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Exposure and prosthetic loading

After 6 months' healing (Fig 1-9h), the implants were exposed with a residual ridge incision. This revealed that the implants in the regions of teeth 33 and 32 were completely covered by the augmentation (Fig 1-9i). This regenerated bone needed to be carefully removed with a reamer prior to full exposure. Comparison of Figs 1-9j (taken at the time of implant placement) and 1-9k (exposure) clearly shows the extent of the successful augmentation.



Fig 1-9h Situation prior to exposure.

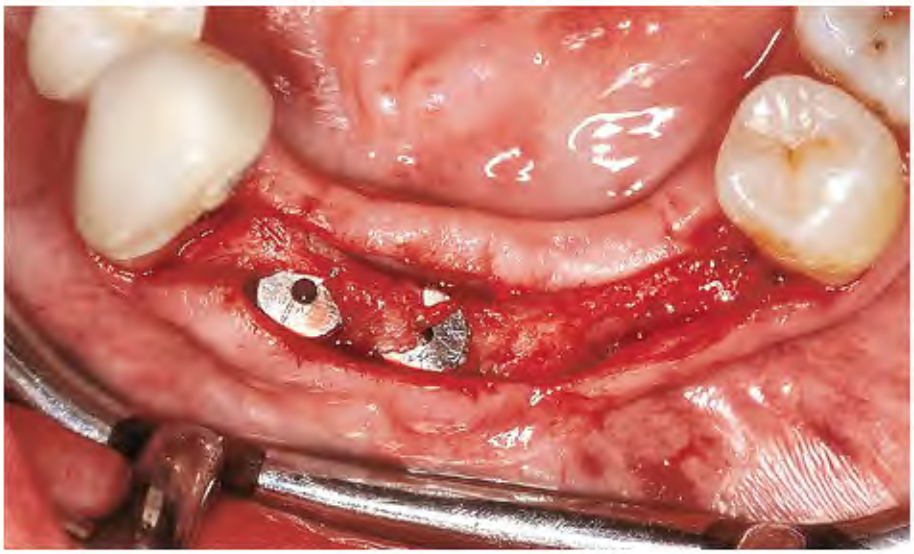


Fig 1-9i Implants 32 and 33 overgrown with bone.

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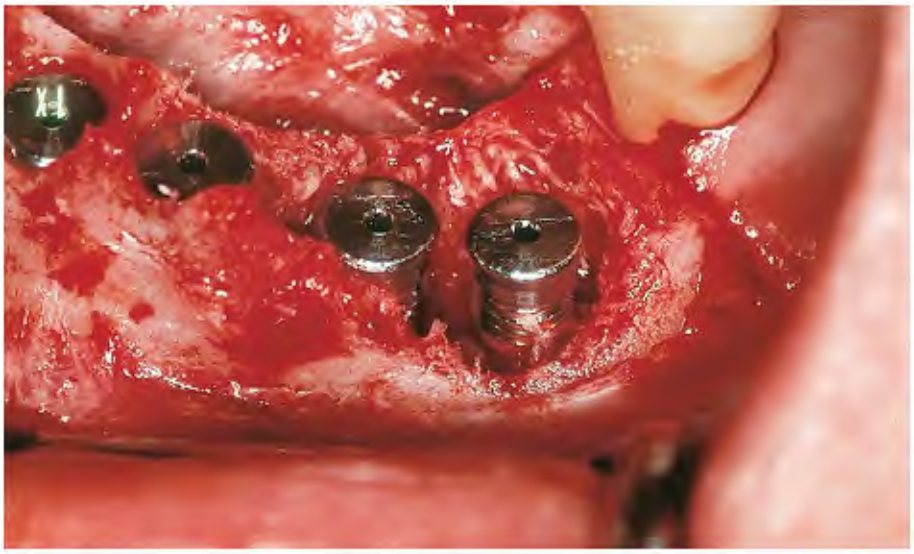


Fig 1-9j Comparison: situation at the time of implant placement.

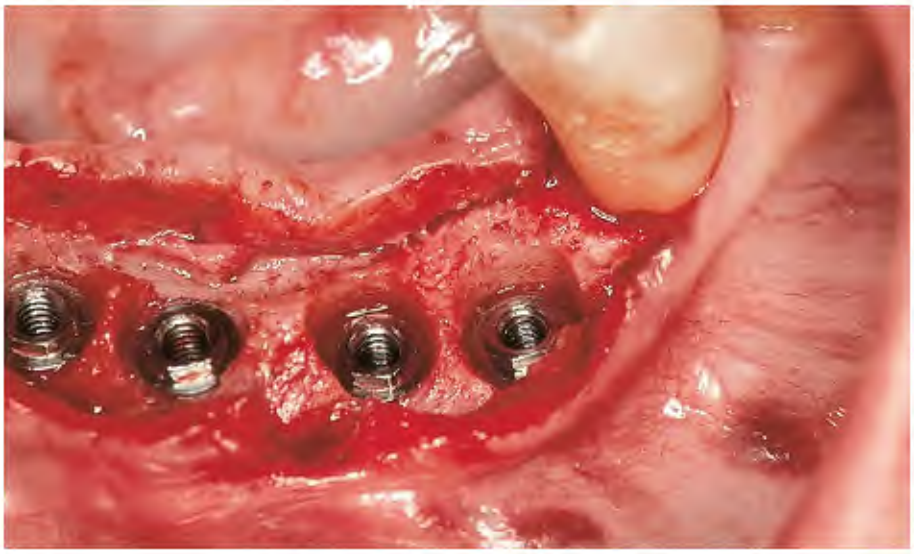


Fig 1-9k Exposure reveals massive bone regeneration.

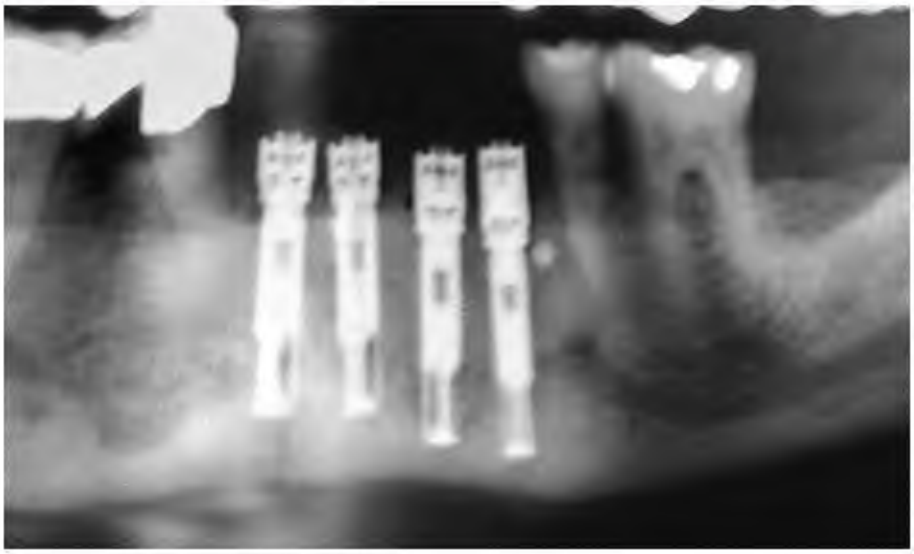


Fig 1-9l Standard abutments screwed into place.

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Fig 1-9m Clinical situation 8 years after the superstructure was fitted.

The differences in vertical implant insertion depths were compensated by using standard abutments 4, 5.5 and 7 mm long. Correct positioning of the abutments and the extent of the successful augmentation are clearly apparent on the follow-up radiograph (Fig 1-9l). The final photograph shows prosthetic loading with a transocclusal screw-retained fixed partial denture 8 years following placement of the implants (Fig 1-9m).

Continued follow-up

The clinical situation was checked and photographed at a follow-up examination 14 years after the implant placement (Fig 1-9n). A panoramic radiograph was taken at the same time (Fig 1-9o).



Fig 1-9n Clinical situation after 14 years.

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Fig 1-9o Radiologic findings after 14 years.

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Treatment course

- Implant placement (1996)
- 6 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Immediate loading

Immediate fixed partial denture loaded onto definitive implants

Baseline situation

This 48-year-old patient had already lost tooth 31, while teeth 32, 41 and 42 suffered severe periodontal damage and could no longer be preserved. The root of tooth 31 was removed and the available natural crown fixed to the neighboring teeth with composite resin (Fig 1-10a). The available bone volume visible on the panoramic radiograph allows long, stable implants to be inserted (Fig 1-10b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Extraction and insertion of two definitive implants with provisional immediate loading
2. Definitive prosthetic loading with a transocclusal screw-retained, metal-ceramic fixed partial denture



Fig 1-10a Non-preservable anterior teeth.



Fig 1-10b Panoramic radiograph taken for planning purposes.

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Extraction, implant placement and provisional loading

Working under local anesthesia, the incisors were first separated from one another, any hard and soft deposits removed and the teeth then gently extracted without tissue destruction. Exposure of the operation site was achieved by means of an incision made to expose the residual ridge. One releasing incision extended mesially from tooth 33 and the other distally from tooth 43 (Fig 1-10c). The implant beds in the regions of teeth 32 and 42 were prepared and checked using direction indicators (Fig 1-10d). Two implants (Neoss) (length 17 mm and diameter 4 mm) were inserted (Fig 1-10e). The prepared thermoplastic foil reproduce the positions of the dental crowns and can be helpful when checking the insertion depth (approximately 2 mm subgingivally (Fig 1-10f).

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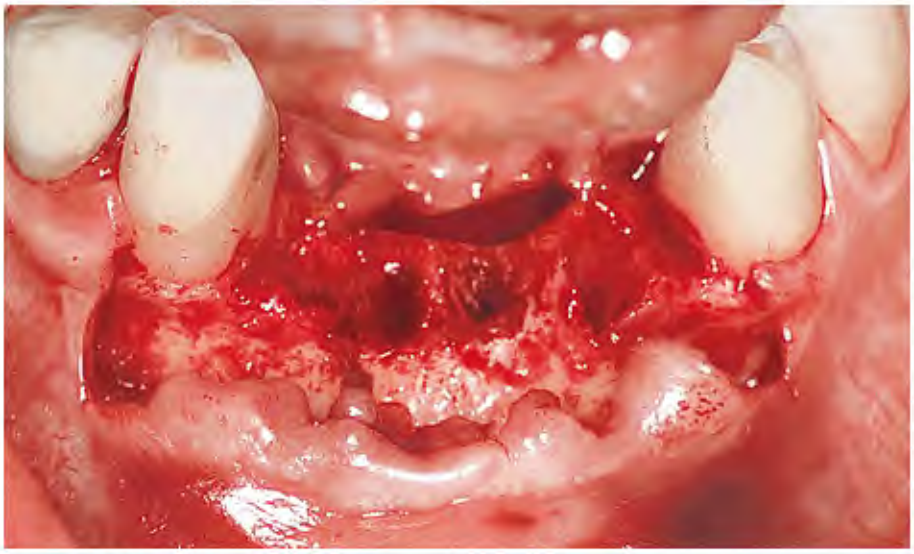


Fig 1-10c Creation of the mucoperiosteal flap.

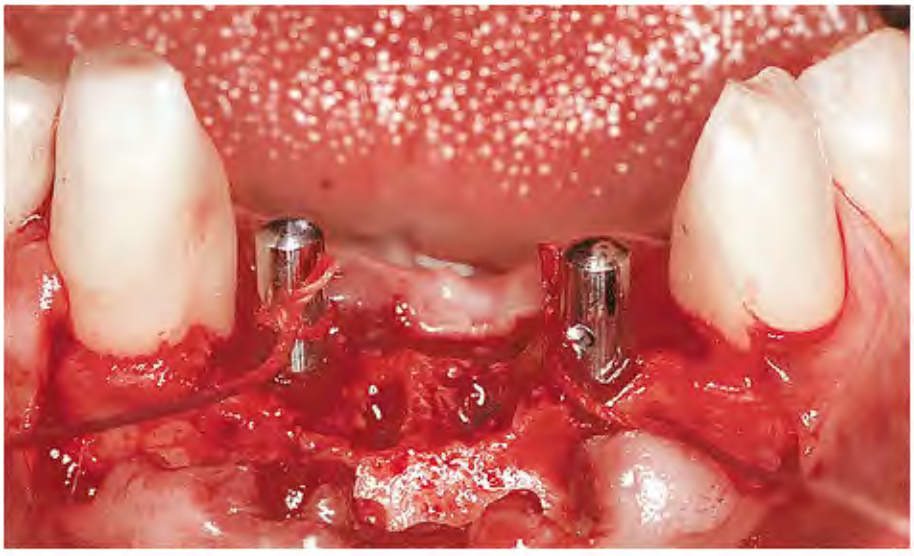


Fig 1-10d Preparation of the implant beds.

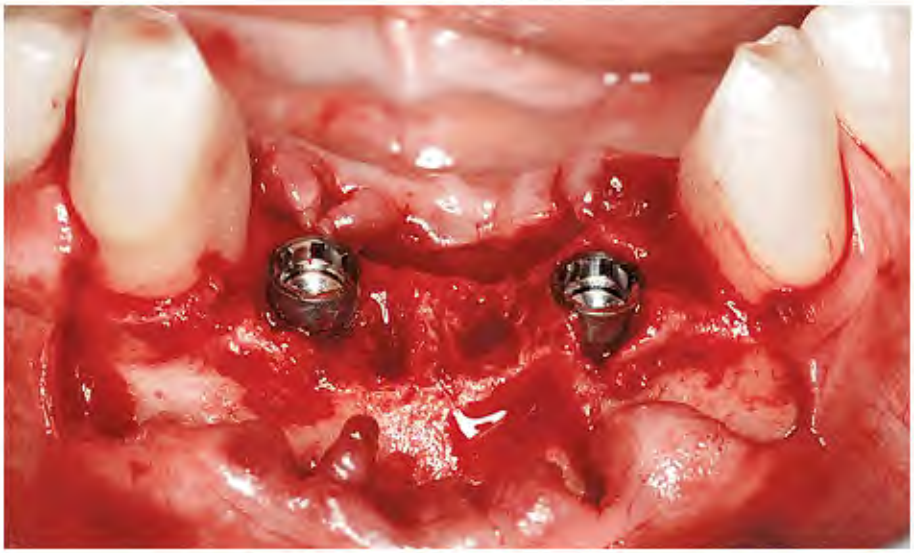


Fig 1-10e Inserted Neoss implants.

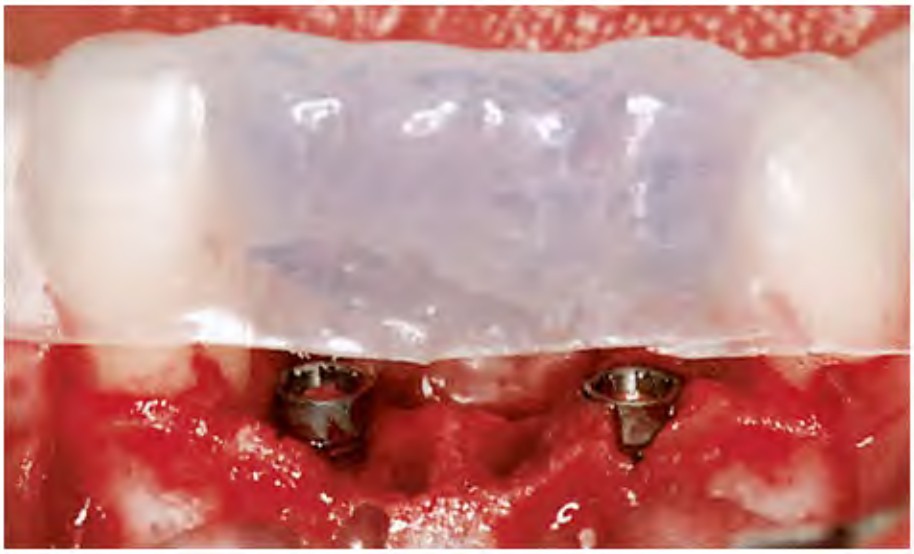


Fig 1-10f Checking the insertion depth.



Fig 1-10g The healing abutments have been screwed into place.

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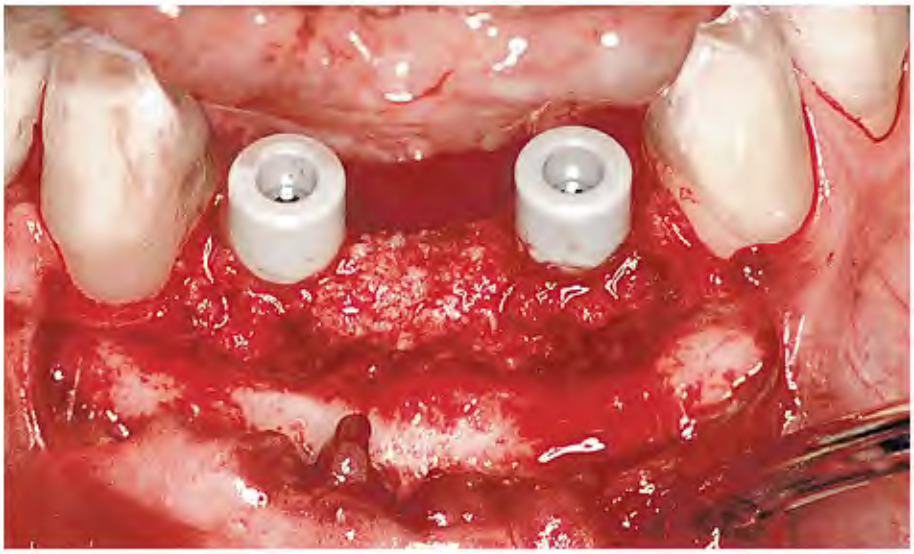


Fig 1-10h Augmentation.

Once the implant positions were accepted, the healing abutments were screwed onto the implants (Fig 1-10g). The bone defects were augmented with the harvested bone chips (Fig 1-10h). The augmentation material was covered with the mucoperiosteal flap without using a membrane and the flap fixed into place with Gore-Tex and microsurgical sutures (Fig 1-10i). The provisional immediate loading was performed via a prepared thermoplastic foil, filled with Protemp (3M ESPE) and repositioned onto the teeth over the healing abutments (Fig 1-10j). Before it hardened, the splint was briefly removed, and then replaced, and autopolymerization of the material awaited. Once it had hardened, the provisional restoration was removed and the healing abutments exchanged for impression posts (Fig 1-10k). Casting for the long-term provisional restoration was performed with the impression copings, using a custom molding tray filled with Impregum (3M ESPE). The time needed to take the impression can be used to shape the provisional restoration (Fig 1-10l). After removing the mold, the healing abutments were screwed back onto the implants and the first provisional restoration fitted onto them (Fig 1-10 m). Normally, the anchoring that is achieved is so good that no provisional cement is necessary. In the laboratory, a metal-reinforced, long-term provisional restoration was fabricated on the provisional cylinders (Fig 1-10n).

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Fig 1-10i Suturing the incision.



Fig 1-10j Building the first provisional restoration.



Fig 1-10k Preparation for the impression taking.

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Fig 1-10l Retention grooves in the provisional restoration.



Fig 1-10m Placement of the first provisional restoration.



Fig 1-10n Long-term provisional prepared in the laboratory.

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Fig 1-10o Fitting the long-term provisional.



Fig 1-10p Follow-up panoramic radiograph.



Fig 1-10q Definitive bridge.

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Fig 1-10r Patient after the treatment.



Fig 1-10s Clinical situation after 7 years.

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The long-term provisional restoration was fitted a few days later (Fig 1-10o). It was important for it to be placed completely out of static and dynamic occlusion. The postoperative panoramic follow-up radiograph shows favorably positioned implants solidly anchored in the mandibular bone (Fig 1-10p). The patient was very satisfied with the quick and, according to him, pain-free treatment and was happy to have been spared the need for a removable prosthesis (Figs 1-10q and 1-10r).

Continued follow-up

The patient was clinically examined 7 years after implant placement and an up-to-date photograph was taken (Fig 1-10s). This showed that a monofilament 6-0 suture had remained in place under the left canine, without causing any irritation.

Treatment course

- Implant placement and provisional loading of the definitive implants (2004)
- 4 months to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dentist Markus Peters
Dental technology:	Fernando Abrantes

Immediate loading

Flapless implant placement and augmentation with immediate loading

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Baseline situation

Ten years ago, this patient was fitted with an implant-supported, maxillary fixed full denture supported on seven implants, which he has been wearing to date with total satisfaction. His current issue is the anterior fixed partial denture on the loosened lateral incisors (Fig 1-11a). Both the height and width of the residual ridge in the planned implant placement zones is adequate for transgingival implant placement through the sockets (Figs 1-11b to 1-11d).

Diagnostic tools

- Clinical examination
- CBCT
- Planning with the SimPlant program
- Dental cast analysis

Treatment plan

1. Extraction; insertion of the implants through the sockets; augmentation; provisional immediate loading
2. Prosthetic loading with a metal-ceramic, transocclusal screw-retained, fixed partial denture



Fig 1-11a Dental bridge supported by the loosened lateral incisors.

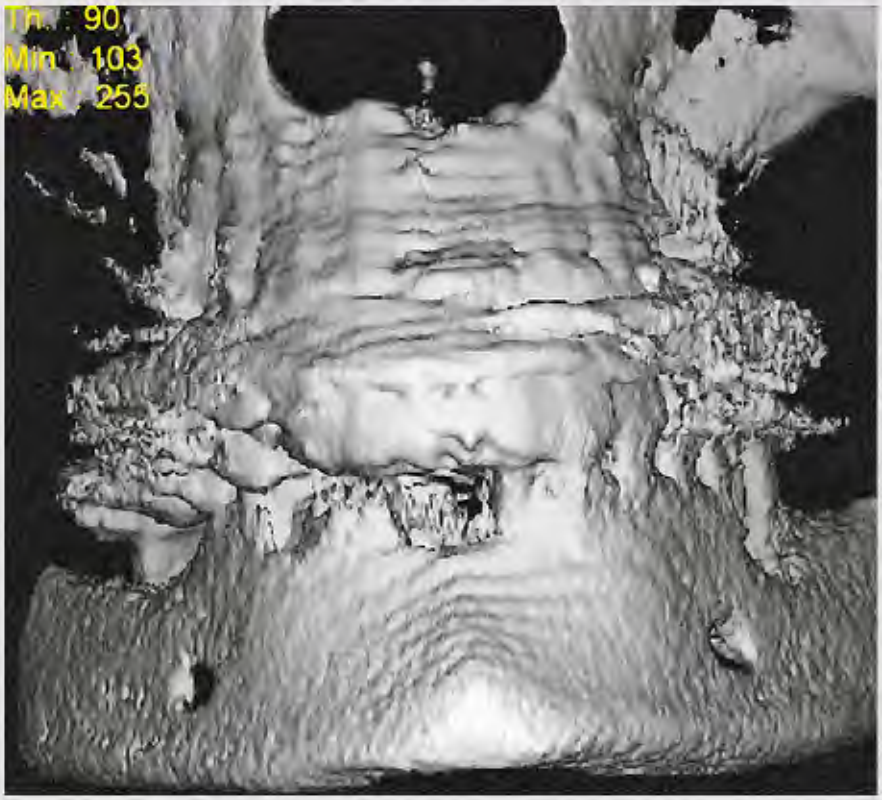


Fig 1-11b 3D reconstruction.

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Fig 1-11c Cross-sectional view of the tooth 42 region.

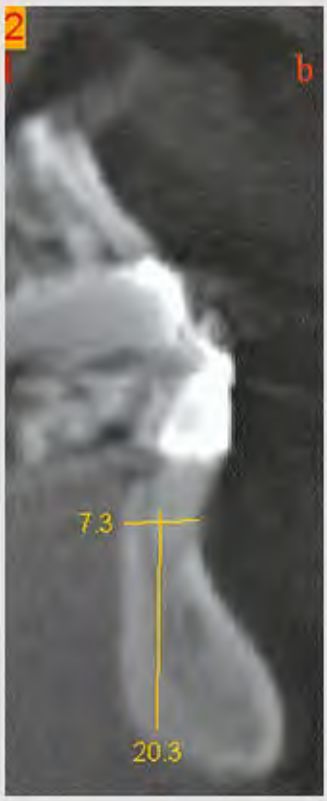


Fig 1-11d Cross-sectional view of the tooth 32 region.

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Fig 1-11e Vertical and horizontal residual ridge atrophy.

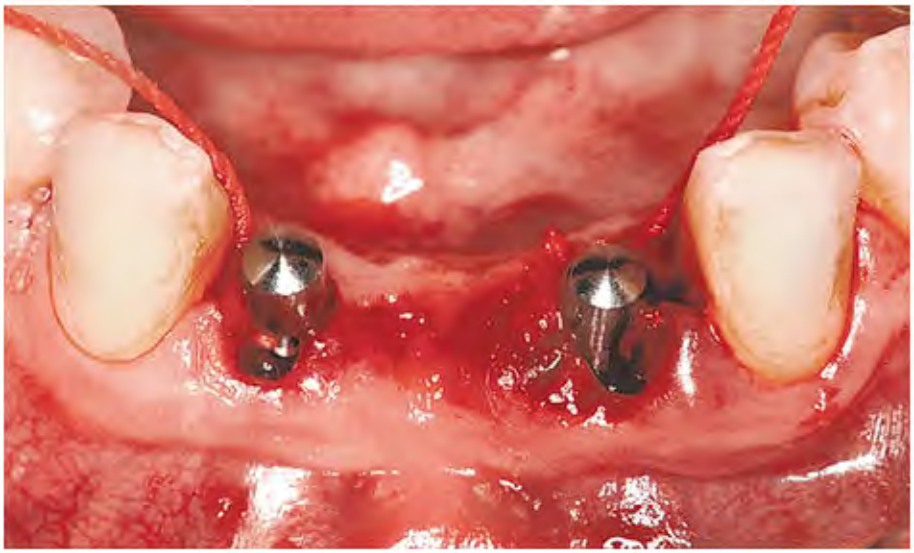


Fig 1-11f Preparation of the implant beds.

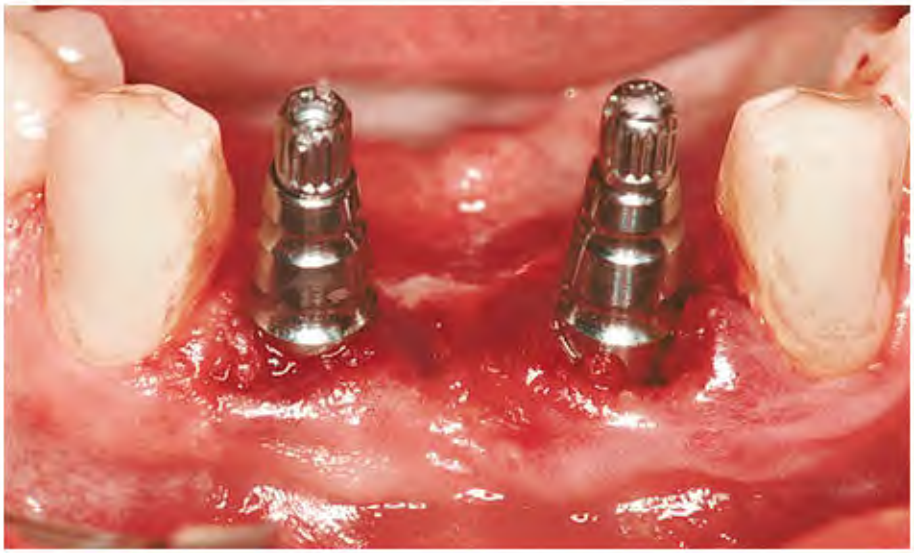


Fig 1-11g The impression copings screwed into place.

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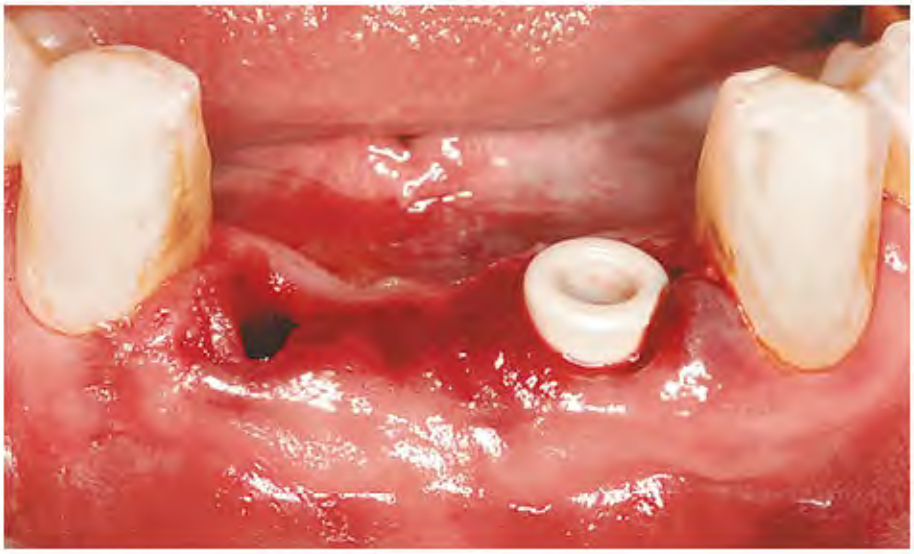


Fig 1-11h Healing abutment fitted onto implant 32, cover screw screwed onto implant 42.

Extraction, implant placement with augmentation, immediate loading

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Removal of the fixed partial denture bridging teeth 32 and 42 revealed the vertical and horizontal bone loss that had occurred following loss of the central incisors (Fig 1-11e). Teeth 32 and 42 were extracted and the implant beds prepared through the resultant sockets. The patient was spared an incision and creation of a mucoperiosteal flap. The implants' position, inclination and depth, as planned with the SimPlant program, were checked using direction indicators (Fig 1-11f).

Once the implants were placed, the impression copings were screwed onto them (Fig 1-11g), and an impression was taken for the long-term provisional restoration. Since the impression taking took place even before the augmentation, the technician needed to take the latter into account when creating the cast. For the flapless augmentation, a healing abutment was fitted onto implant 32 and a cover screw was screwed onto implant 42 (Fig 1-11h). Working through the perforation left by tooth 42, the soft tissue in the region of teeth 31 and 41 was dissected off the bone with the periosteum and the resultant space filled with the harvested bone chips. One advantage of the Neoss system is the fact that both the cover screw and the healing abutment are supplied with the implant, so that no additional components are needed. The cover screw on implant 42 protected the implant during the periosteal dissection and stopped bone particles from getting into it during augmentation. After augmentation, the cover screw was unscrewed and the healing abutment fitted into its place (Fig 1-11i). Because augmentation needed overcontouring due to the subsequent resorption, external retention on the healing abutments was lost. However, it was possible to retain the provisional prosthesis on the internal channels of the healing abutments (Fig 1-11j). The retention provided by the "root posts" and the adaptation to the canines was so good that no provisional cement was required (Fig 1-11k). Ten days later, although the gingival situation was not yet stable and no sutures needed removing, it was already possible to fit the patient with the long-term provisional bridge (Fig

1-11l). The postoperative panoramic radiograph shows not only the location of the implants in the mandible, but also the stable bone situation of the maxillary implants after 10 years (Fig 1-11m). The definitive prosthesis, in the form of a metal-ceramic fixed implant bridge fitted onto customized abutments, was incorporated 4 months after implant placement. After 8 months in functional use, the clinical situation was stable, although the patient's oral hygiene left something to be desired (Fig 1-11n).



Fig 1-11i Healing abutments on both implants after augmentation.



Fig 1-11j Retention for the immediate provisional prosthesis provided by the internal channels of the abutments.

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Fig 1-11k Inserted immediate provisional restoration.



Fig 1-11l Long-term provisional prosthesis.



Fig 1-11m Follow-up panoramic radiograph.

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Fig 1-11n Definitive implant bridge 8 months after it was loaded onto the implants. Stable peri-implant soft tissue situation.



Fig 1-11o Clinical situation in the mandible after 4 years.



Fig 1-11p Clinical situation in the maxilla after 14 years, showing neglected oral hygiene.

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Fig 1-11q Heavy deposits on the superstructure and teeth after 7 years.



Fig 1-11r Panoramic radiograph after 7 and 17 years.

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Continued follow-up

Four years after the implant treatment in the mandible, the gingival situation around the implants was stable (Fig 1-11o). The poor fit of the superstructure was now clearly visible as a result of the mild gingival displacement around implant 42. The clinical examination of the maxilla 14 years after implant placement also showed neglected oral hygiene (Fig 1-11p). However, the implants in the maxilla were in relatively good condition, despite the poor oral hygiene and hardly any attached gingiva.

After another 3 years, the oral hygiene, rather than improving, had deteriorated, making professional cleaning of the teeth imperative (Fig 1-11q). The panoramic radiograph after 7 and 17 years, respectively, shows a stable osseous situation in the anterior mandible, but also a few problems in other areas (Fig 1-11r). Implant 47, inserted 2 years following implant placement of the anterior teeth, shows considerable bone loss requiring treatment after another

5 years in functional use. Tooth abutments 35 and 47 need urgent extraction due to severe loosening and pain. The extraction, augmentation and further implant placement in the third quadrant are currently being planned. In the interim, it should be possible to make some changes to the connecting bar in the maxilla, as the standard abutment on implant 25 is not correctly positioned and a gap is visible between the implants and superstructure.

Treatment course

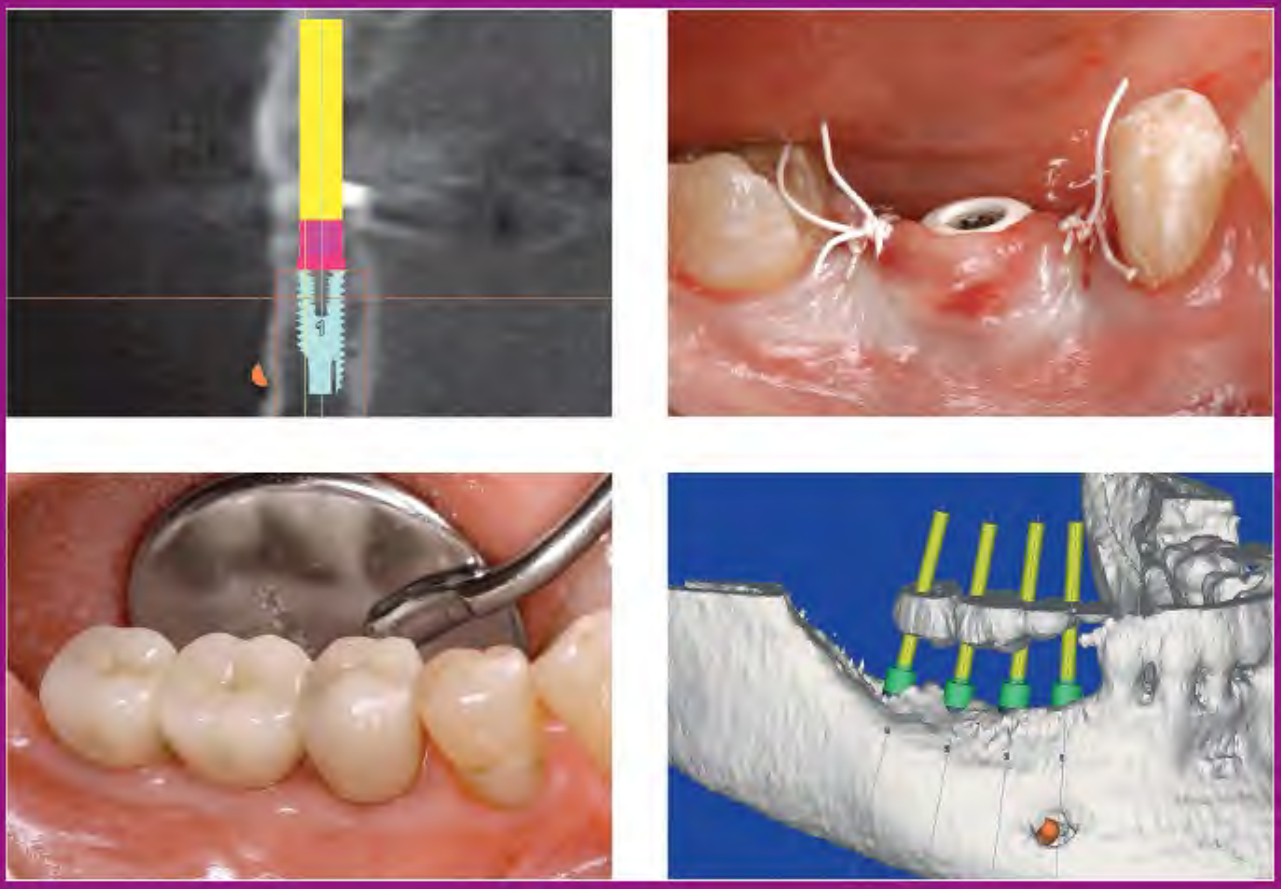
- Extraction, implant placement and augmentation, with provisional loading of the definitive implants (2005)
- 4 months to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dentist Markus Peters
Dental technology:	Ute Olbers

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2
The Posterior Mandible



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The posterior mandible requires exceptionally careful, reproducible preoperative investigation, for both medical and forensic reasons. The inferior alveolar nerve in particular is at risk from implant placement in the posterior mandible. Damage to this nerve has extremely unpleasant consequences for the patient, as it not only provides sensation to the teeth of the mandible, but also supplies sensory innervation to the lower lip, so that any damage can result in persistent dysesthesia in the latter. Since the functional deficits in the nerve can result from any touch or pressure, most clinicians require a minimum distance of 2 mm to be maintained when placing implants. The vertical position of the nerve canal is normally visible on the panoramic radiograph. However, the latter gives a superimposed view of the anatomical structures, so that an exact, three-dimensional (3D) assessment of the position of the nerve cannot be made on the basis of this radiograph alone. Only standard computed tomography

(CT) or cone beam CT (CBCT) allow its 3D position to be assessed precisely.

3D diagnosis and SimPlant planning

3D planning of a single-tooth implant

Clinical examination is followed by extensive diagnostic investigations. Apart from dental cast analysis, radiographic diagnosis is of key importance: it should include at least a panoramic radiograph with measuring template and, best of all, a CBCT or CT scan.

The panoramic image already provides an overview of the anatomical situation (Fig 2-1a). However, 3D diagnosis and planning are far more precise and reliable on the CBCT image. The third dimension, the width of the residual ridge, can be seen on the cross-sectional image (Fig 2-1b).

In such cross sections, the implants can be aligned in the buccolingual direction, while alignment in the mesiodistal direction is generally performed using the panoramic radiograph. Based on the measurements in this case, a wide platform (WP) implant, 13 mm long and 5 mm in diameter, was planned for the replacement of tooth 45. For the provisional loading, a 1-mm high CeraOne (Nobel Biocare) abutment was planned as the connecting component for the provisional crown.

Detailed planning was performed using the SimPlant program (Dentsply). Here, the WP implant was taken from the program library (color code pale blue in this case), virtually placed into the jaw and adjusted in all the planes (Fig 2-1c). The CeraOne abutment (color code pink) was also virtually placed onto the implant. For better visualization of the forces involved, the extension of the implant axis is represented as a yellow bar. If the structures lying behind the implant or in the same plane are to remain visible, the implant can be shown in outline only (Fig 2-1d). The inferior alveolar nerve, as the most important anatomical structure in the mandible, can be marked, allowing its course in relation to the planned implants to be assessed (Fig 2-1e). The marked nerve also appears on the cross-sectional images, so that its position relative to the implants can also be accurately evaluated in this plane (Fig 2-1f).

Moreover, the 3D reconstruction gives a very vivid visual depiction of the positioning of the implants and their relation to the nerve. In this mode, the bone structure can be shown in semi-transparent view (Fig 2-1g) or can even be faded out completely, to visualize the relationship of the implants to the nerve in isolation (Fig 2-1h).

For the treatment course, see page 60.

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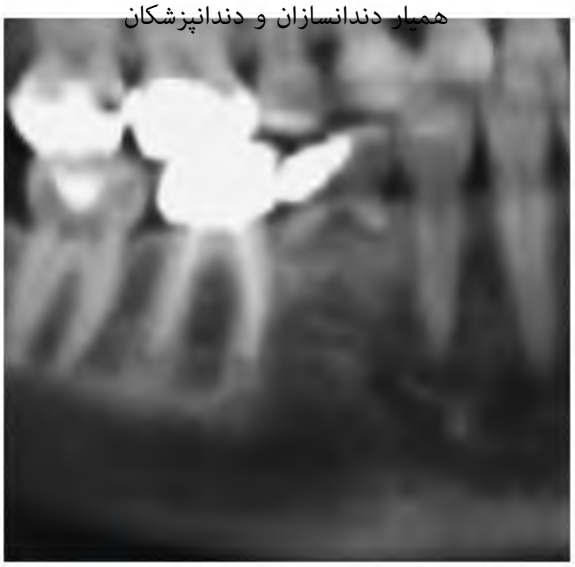


Fig 2-1a Section from the panoramic radiograph.

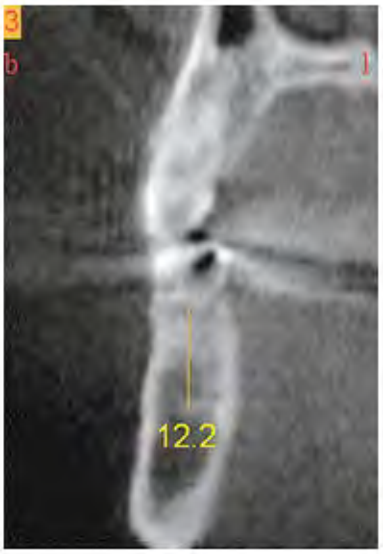


Fig 2-1b Cross section through the jaw.

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Fig 2-1c SimPlant planning.



Fig 2-1d Outline of the planned implant on the cross section.

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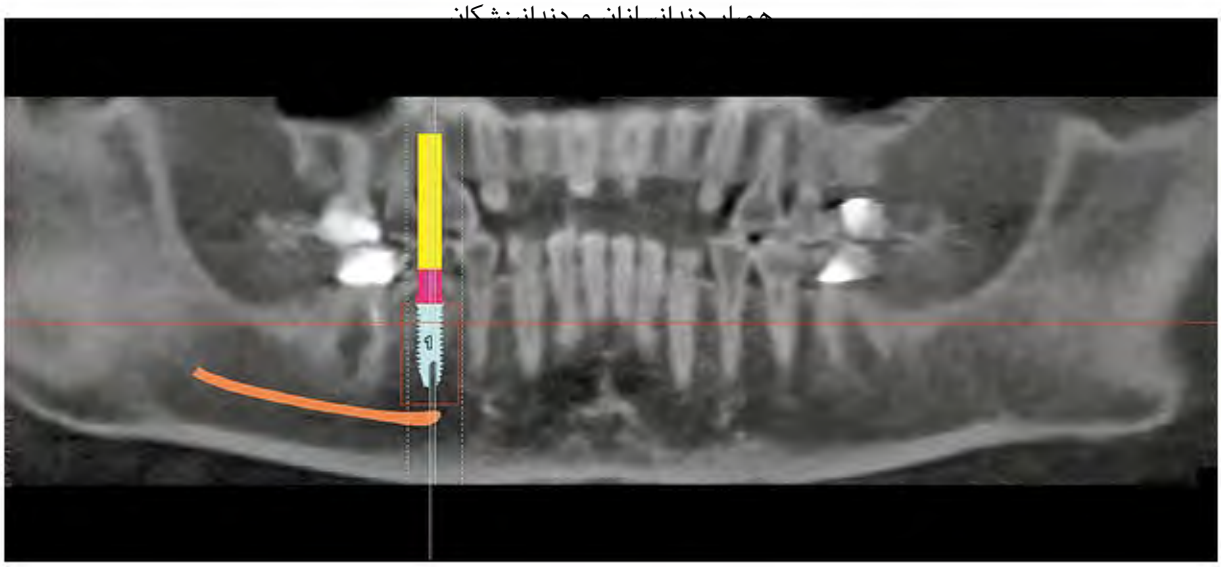


Fig 2-1e Marked inferior alveolar nerve.

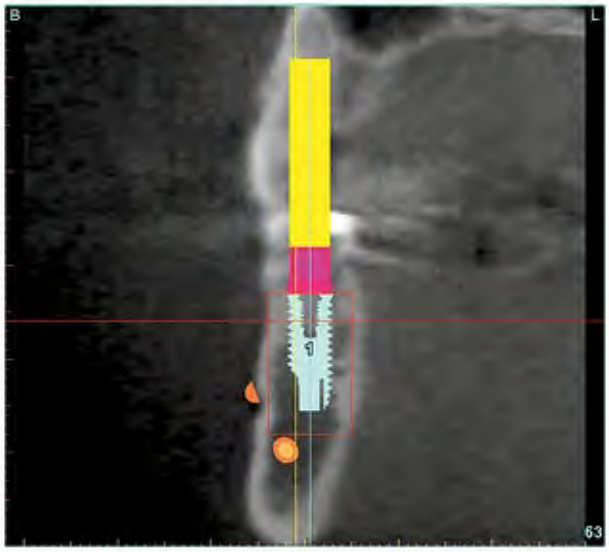


Fig 2-1f The implant in relation to the nerve in the cross-sectional view.

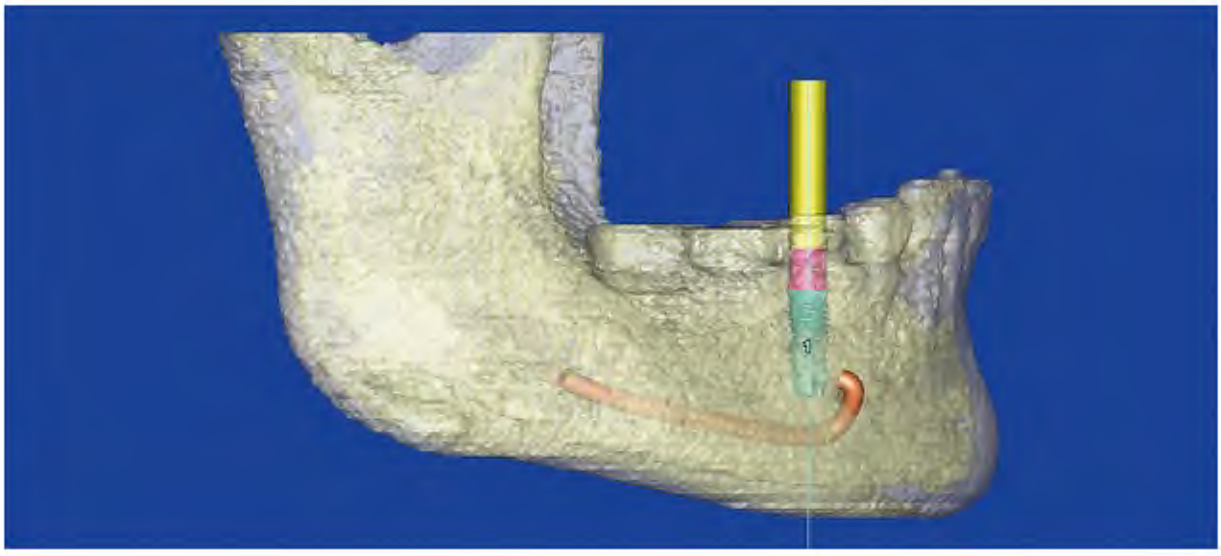


Fig 2-1g Relation of the implant to the nerve in a semi-transparent view of the jaw.

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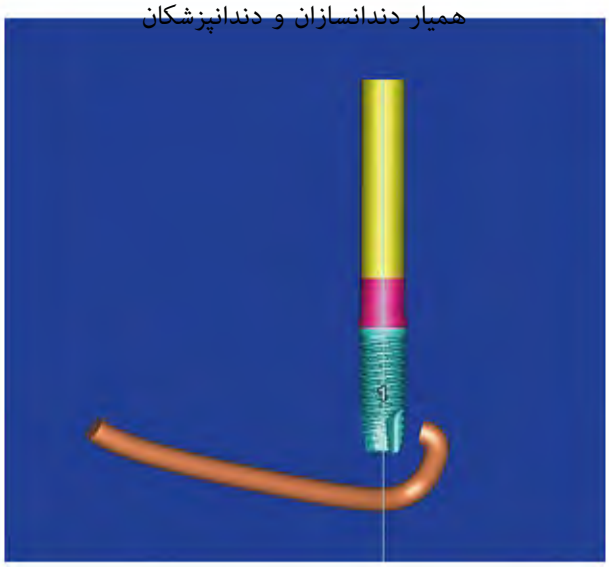


Fig 2-1h Relation of the implant to the nerve in isolation, with the bone faded out.



Fig 2-1i The panoramic radiograph shows the extent of the defect.

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Fig 2-1j SimPlant planning.

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3D planning of a free-end situation

The free-end situation is one of the most common indications for implant treatment in the mandible. In view of the large number of implants needed in this kind of situation, each individual implant needs to be planned with great care. Apart from the position of the nerve, another factor of key planning significance is the width of the residual ridge. In the case described here, a large mandibular defect had developed following the loss of implants placed at another clinic. The planned treatment included not only the insertion of five implants, but also extensive augmentation. The panoramic radiograph alone clearly showed the extent of the defect (Fig 2-1i). A much more accurate assessment of the situation can be obtained from the CBCT image in the SimPlant planning program (Fig 2-1j). The five planned implants need to be placed in such a way as to use all the available bone (Fig 2-1k). In order to achieve primary stability in the previously damaged, knife-edge jaw after the insertion, the plan was to use narrow platform (NP) implants with a diameter of 3.3 mm. Implants 1 and 3 are only weakly anchored in the bone and need augmentation on the buccal side (Figs 2-1l to 2-1n). The 3D reconstruction provided an insight into the intraoperative situation following insertion of the implants, and showed not only the extent of the defect but also how much bone needed to be

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augmented (Fig 2-1o).

For the treatment course, see page 70.

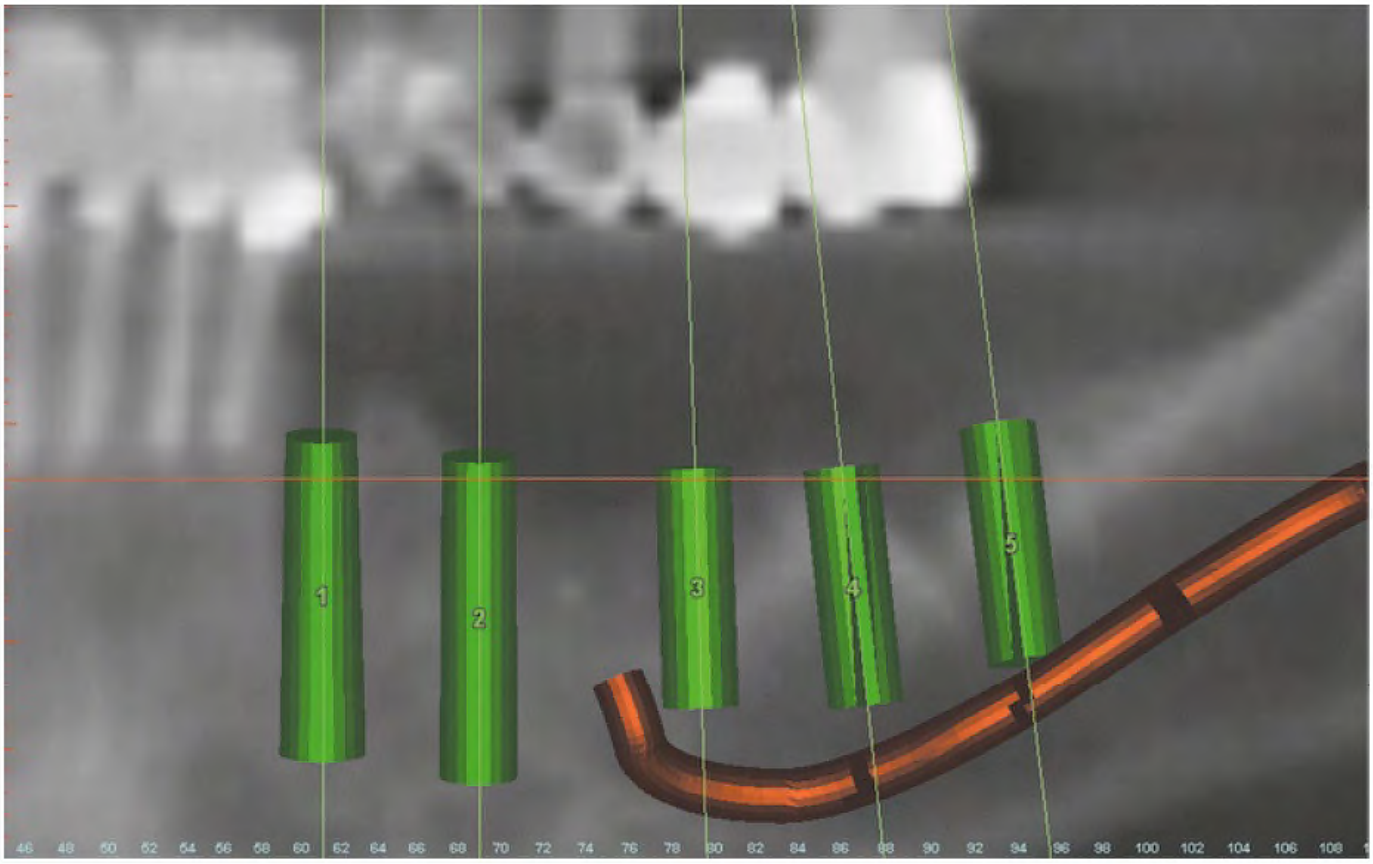
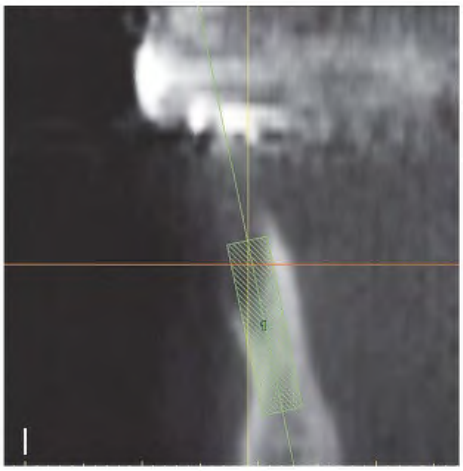
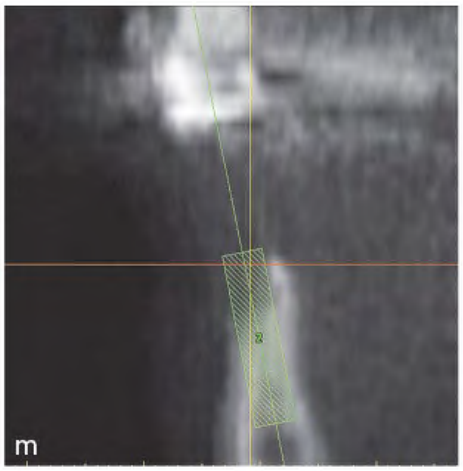


Fig 2-1k Planned position of the implants in the jaw.





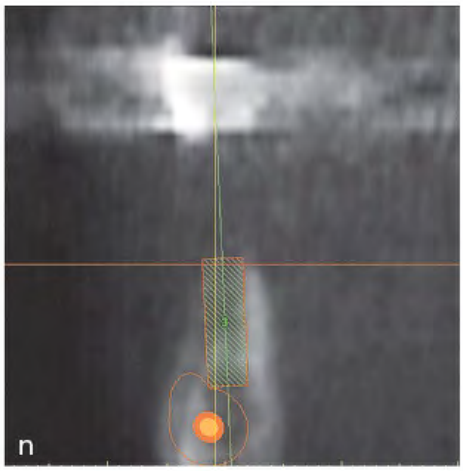


Fig 2-1l to 2-1n Cross sections of the jaw with the first three implants.

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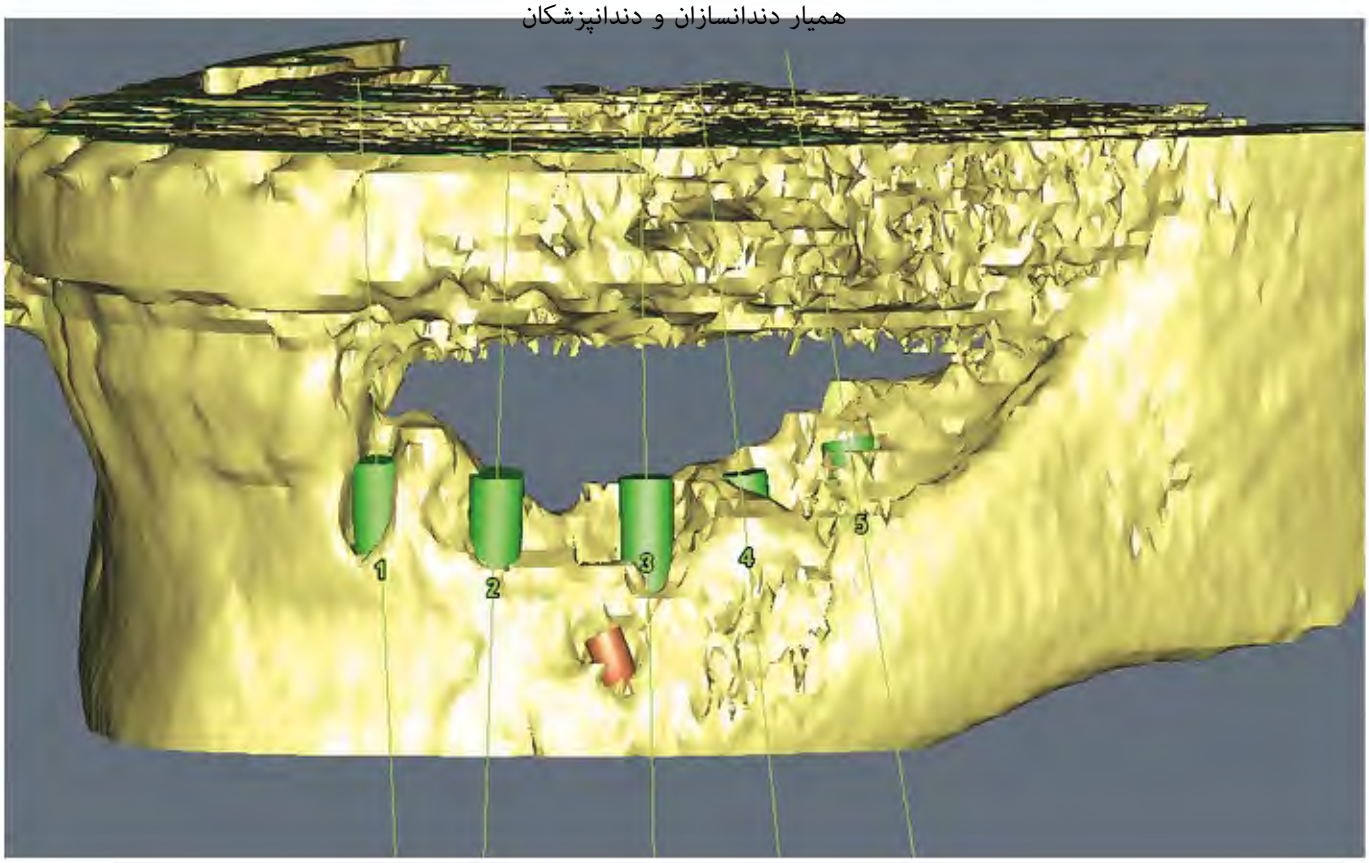


Fig 2-1o 3D reconstruction with the virtually inserted implants.

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Single-tooth gap

In the case of a single-tooth gap, the preoperative diagnostic investigations need to assess not only the location of the nerve, but also the extent of the gap in the mesiodistal direction and the available bone supply in the buccolingual (or labiolingual) dimension. The mesiodistal width of the gap can be determined exactly on the dental cast and approximately on the panoramic radiograph. The buccolingual width of the residual ridge can be determined on the model only in the coronal region, following a determination of mucosal thickness, whereas the panoramic radiograph provides no information on this aspect. Moreover, measuring mucosal thickness in the posterior tooth region is difficult for the dental surgeon, unpleasant for the patient and beset with errors. Thanks to modern 3D imaging techniques, it is now possible to determine the exact width and height of the residual ridge, as well as the position of the nerve, on the CT or CBCT scan images (see page 40).

Either premolars or molars may be replaced in the posterior region. The first molar is a far more common candidate for implantological restoration than the second molar. The first molar is at the center of the masticatory forces, and is thus exposed to a high level of stress. As a result, a single regular platform (RP) implant (diameter 3.75 mm) may become overloaded. Therefore, where sufficient space is available, a WP implant of increased diameter (5 mm) or two RP or even NP implants (diameter 3.3 mm) represent better alternatives. The use of two implants is generally preferable if the residual ridge is inherently narrow and the distance between neighboring teeth is >11 mm, whereas one implant should be the preferred option if

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the gap is <10 mm and the residual ridge is on the wider side. The considerations involved in replacing the first molar are difficult to reconcile with the rules set out by Dr Tarnow, which state that the distance between two implants should be at least 2 mm, and the distance to the neighboring tooth at least 1.5 mm.

Typical treatment course

Replacing a molar with two implants

Baseline situation

Moderate residual ridge atrophy was diagnosed in this 36-year-old man with missing tooth 46 (Fig 2-2a) The gap in the root region was suitable for the insertion of both one WP implant and two RP or NP implants into the extraction sockets (Fig 2-2b). While the well-maintained width of the residual ridge, which is clearly shown on the CT cross section (Fig 2-2c), would allow a wider WP implant to be inserted, it was decided to insert two implants for stability reasons.

Diagnostic tools

- Clinical examination
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Insertion of two implants, transmucosal healing
2. Prosthetic loading with a metal-ceramic crown on customized abutments

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Fig 2-2a Clinical baseline situation – moderate residual ridge atrophy.

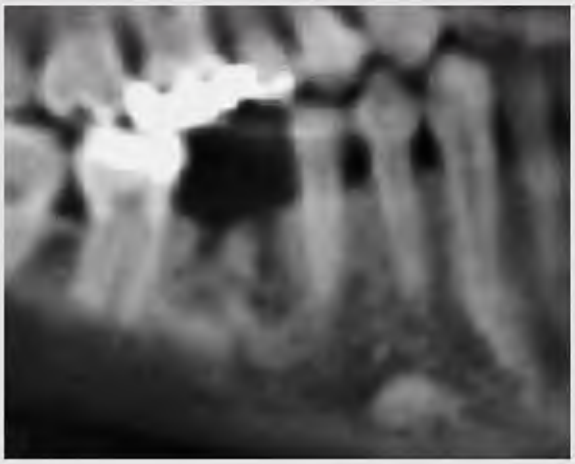


Fig 2-2b Panoramic radiograph section – gap for two implants.

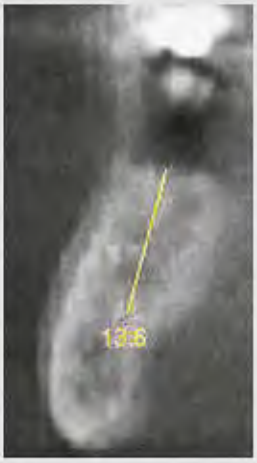


Fig 2-2c Adequate residual ridge width.

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Implant placement

Two Neoss implants were inserted into gap 46 under local anesthesia (Fig 2-2d). The implants were placed at the desired depth and the remaining bone defect was filled with the harvested bone chips. The polyetheretherketone (PEEK) healing abutments were then screwed onto the implants. One of the healing abutments needed shaping on one side due to the limited space and convergence of the implants (Fig 2-2e). To protect the implants from undesirable stresses, it is important that there is neither any contact between the healing abutments and the neighboring teeth, nor any occlusal contact with the dentition in the opposing jaw (Fig 2-2f).

Attention: ***Where there is good bone quality and adequate primary stability, the implants may be directly fitted with healing abutments and allowed to heal transmucosally. If bone quality is poor, it is advisable to allow the implant to heal submerged and to expose them only after 4 to 6 months.***

The postoperative panoramic radiograph shows the position of the implants relative to the neighboring teeth and demonstrates that there is adequate distance to the inferior alveolar nerve (Fig 2-2g). The final photograph shows the transocclusal, screw-retained metal-ceramic crown, which was first cemented onto the customized abutments (Fig 2-2h).

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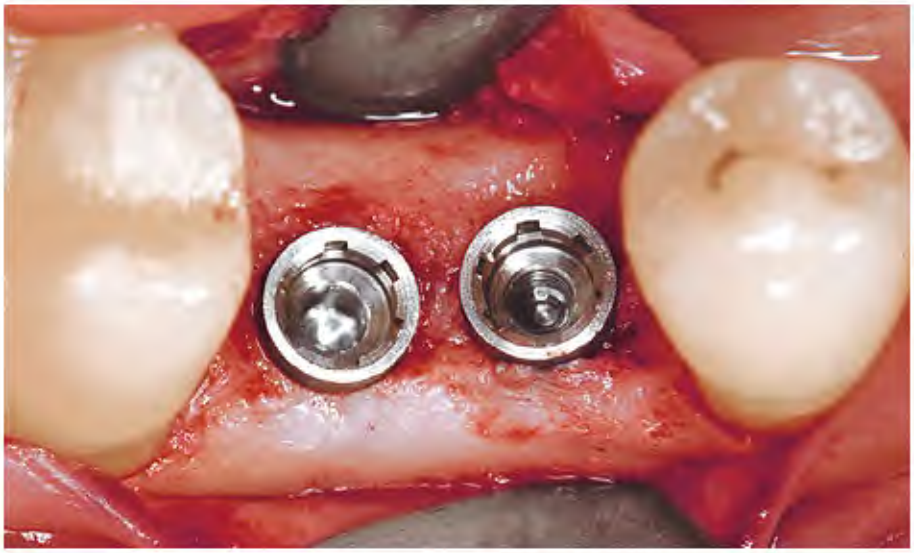


Fig 2-2d The two Neoss inserted implants.

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Fig 2-2e The healing abutments have been screwed into place and the distal abutment has been filed to shape.

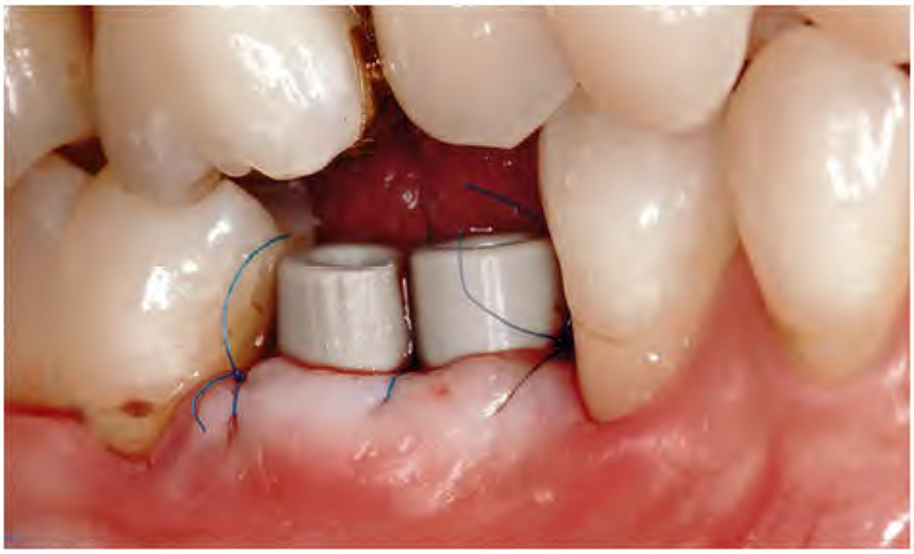


Fig 2-2f Sufficient distance from the opposing jaw has been maintained.

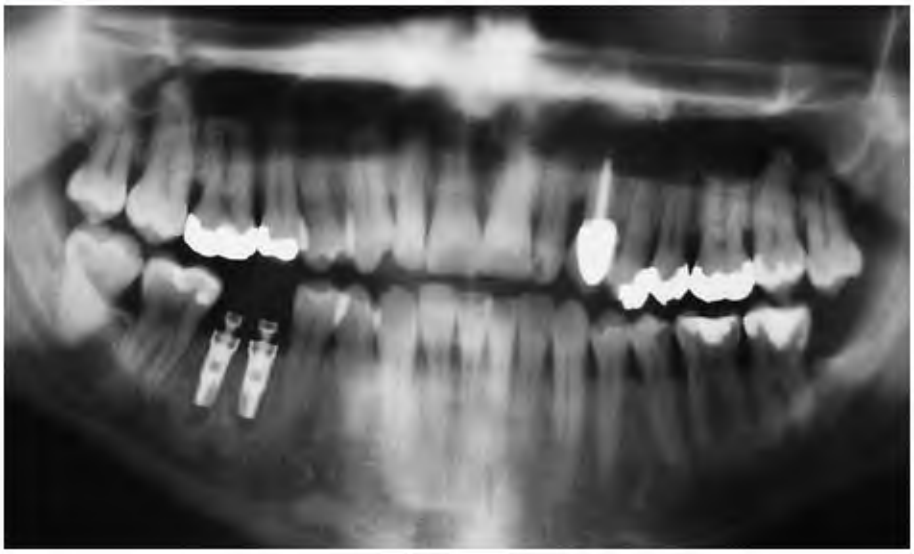


Fig 2-2g Postoperative radiograph.

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Fig 2-2h Screw-retained metal-ceramic crown on the customized abutments with cleaning channel.

Attention: ***To assure long-term success following implant loading, it is very important for the implants, the prosthetic crown and the neighboring teeth to be kept clean at all times. For optimal hygiene of the implant-supported restoration, the crown has been fabricated with a cleaning channel to admit interdental brushes (see Fig 2-2h).***

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Treatment course

- Implant placement (2004)
- 5 months to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Uwe Hildebrand
Dental technology:	Ute Olbers

Typical treatment course

Replacement of a molar with an implant with vertical mucosal distraction

Baseline situation

This patient was missing teeth 36 and 46 from her mandible. Since teeth 35 and 37 needed

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crowning, the plan was to use a conventional metal-ceramic dental bridge on the left side. One single-tooth crown on an implant has been planned on the right side. Tooth 47 had wandered in the mesial direction, so that a single implant fitted into the gap exactly (Fig 2-3a). The tooth had several amalgam fillings and was to be crowned at the same time as the implant loading. Both vertical (Fig 2-3a) and horizontal atrophy of the residual ridge (Fig 2-3b) were clearly apparent several years after the loss of tooth 46.

Diagnostic tools

- Clinical examination
- Panoramic radiograph, CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction and immediate implant placement with augmentation
2. Exposure and definitive prosthetic loading



Fig 2-3a The gap left by the loss of tooth 46.

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Fig 2-3b Horizontal atrophy.

Implant placement and mucosal distraction

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An arcuate incision was made on the lingual side, to allow the keratinized gingiva to be transplanted in the buccal direction (Fig 2-3c). Since transmucosal healing was planned, the implant was inserted 1 to 2 mm supracrestally (Fig 2-3d). A 5-mm-high PEEK healing abutment was fitted onto the implant (Fig 2-3e) and the harvested bone chips were layered onto the buccal side for the augmentation (Fig 2-3f). For financial reasons, the augmentation was performed without the use of synthetic materials, limiting its volume. The flap was repositioned and stabilized in the interproximal spaces with two 6-0 Mopylen (Resorba) sutures (Fig 2-3g).

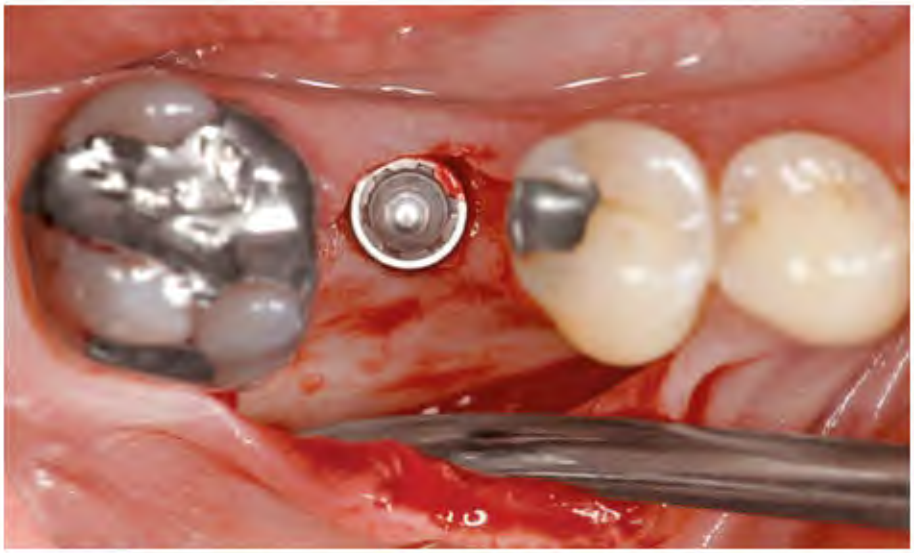


Fig 2-3c Arcuate incision.

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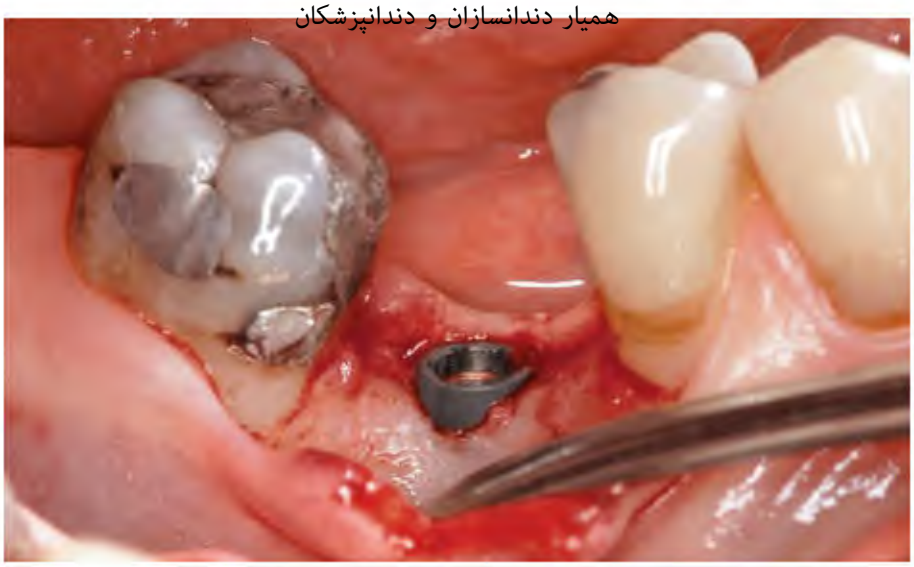


Fig 2-3d The implant inserted supracrestally.

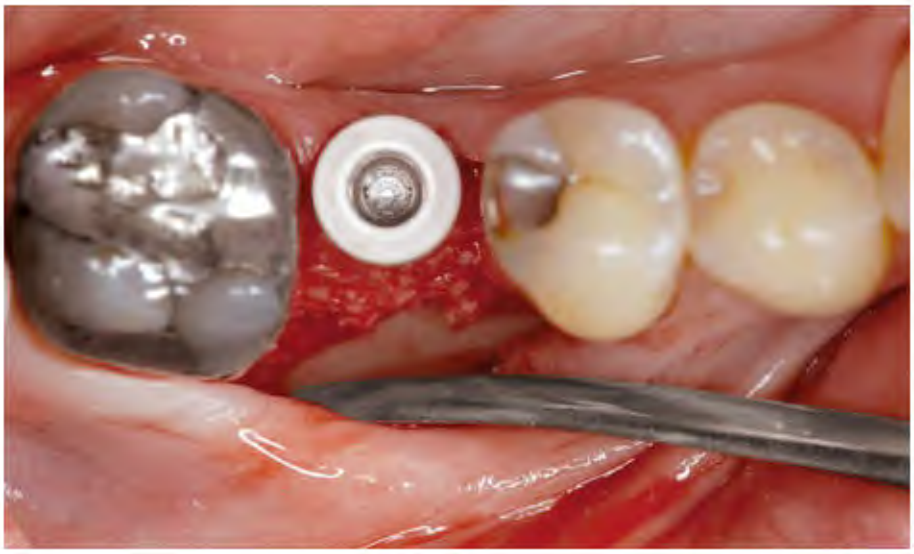


Fig 2-3e The abutment has been screwed into place.

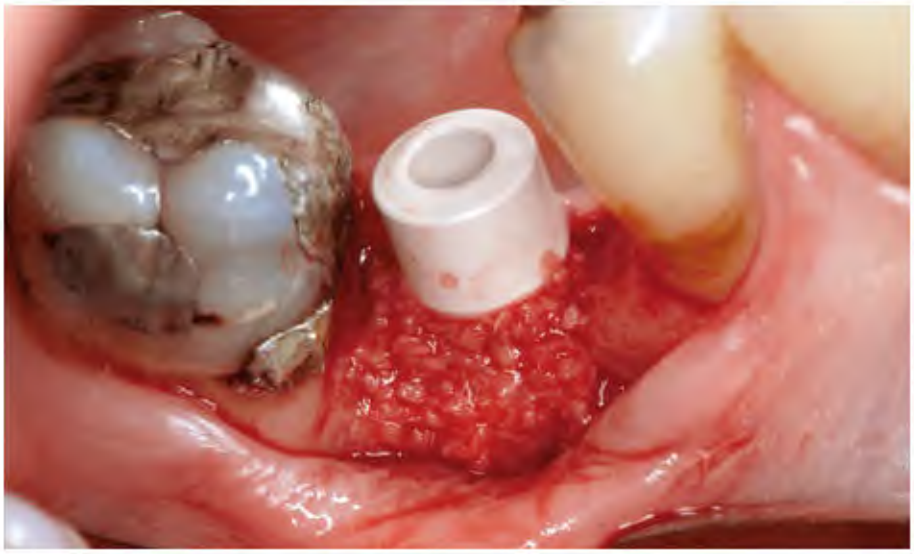


Fig 2-3f Augmentation.

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Fig 2-3g Suturing.



Fig 2-3h Vertical mucosal distraction.



Fig 2-3i Postoperative panoramic radiograph.

Despite transplantation of the keratinized gingiva, the contour of the residual ridge was not

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optimal, but could be improved slightly with vertical mucosal distraction. A small perforation was made in the plastic of the coronal part of the healing abutment, and the mucoperiosteal flap lifted up and fixed into this position with a suture (Fig 2-3h). The postoperative panoramic radiograph shows the implant in relation to the nerve and the neighboring teeth (Fig 2-3i).



Fig 2-3j Clinical situation before taking the impression.



Fig 2-3k Incorporated metal-ceramic crowns on the implant and on tooth 47.

Prosthetic loading

Four months after the implant placement, the soft tissue situation had stabilized; the implant had healed and could be loaded with a crown (Fig 2-3j). While the gingiva had receded somewhat, its contour was still more favorable than directly after implant placement (compare Figs 2-3g and 2-3j). This improvement could be ascribed to the vertical mucosal distraction (Fig 2-3j). The implant and tooth 47 were loaded with metal-ceramic crowns (Fig 2-3k). The patient was very satisfied with both the final result and the lower costs, and the reasonable extent of the

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treatment.

Treatment course

- Implant placement, augmentation and mucosal distraction (2006)
- 4 months to the prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Roland Althoff
Dental technology:	Angela Althoff

Atypical treatment course – problematic baseline situation

Replacement of a molar with one implant in a large gap

Baseline situation

After losing tooth 46, this young woman had been fitted with a fixed bridge at another practice a few years previously. The dental bridge was anchored with a full crown on tooth 45 and an inlay on tooth 47 (Fig 2-4a). Unfortunately, it repeatedly came loose, so that the patient made specific inquiries about an implant restoration.

Before the implant analysis, a provisional restoration was made out of plastic, to rule out any artifacts produced by the metal crowns during the tomography (Fig 2-4b). Volume tomography (CBCT) was performed with the NewTom scanner (QR) and the resultant data transferred to the SimPlant planning program in Digital Imaging and Communications in Medicine (DICOM) format. A Neoss implant, 15-mm long and 4 mm in diameter, was planned for the replacement of tooth 46, and virtually inserted on screen (Fig 2-4c). The implant was inserted approx 2 mm supracrestally, but the distance to the nerve, also 2 mm, was maintained. The planned position of the implant is best visualized on the semi-transparent 3D reconstruction with the nerve also visible (Fig 2-4d).

Diagnostic tools

- Clinical examination
- Panoramic radiograph, CBCT
- SimPlant planning

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- Dental cast analysis

Treatment plan

1. Implant placement with augmentation
2. Definitive prosthetic loading



Fig 2-4a Panoramic radiograph of the baseline situation.



Fig 2-4b Plastic provisional restoration for the CBCT scan.

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Fig 2-4c Implant planning in the SimPlant program.

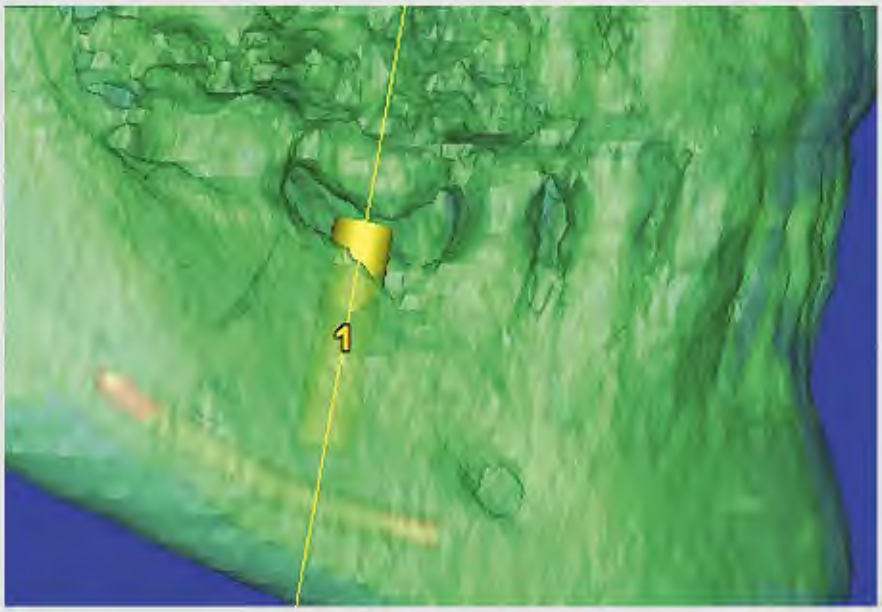


Fig 2-4d Semi-transparent 3D reconstruction.

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Fig 2-4e Vertical and horizontal residual ridge atrophy.



Fig 2-4f Lingual section on the residual ridge.

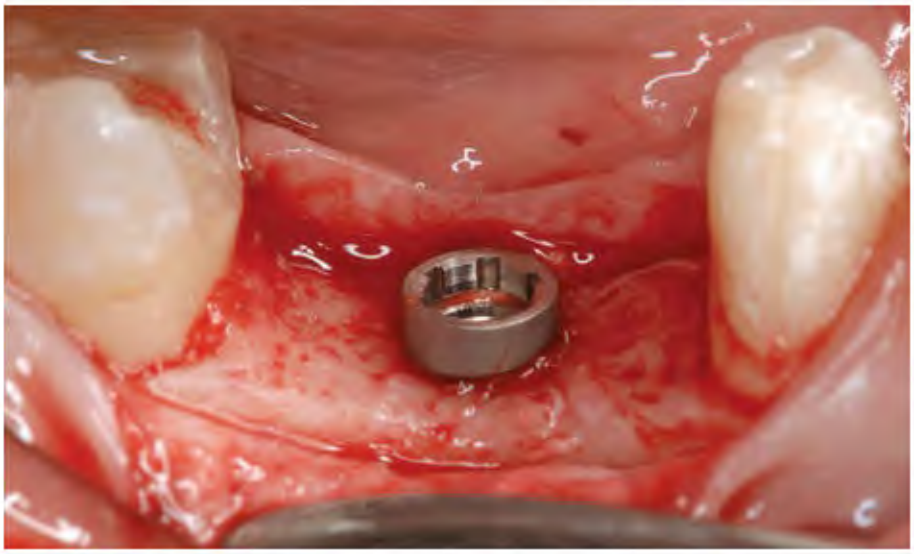


Fig 2-4g Implant inserted approx 2 mm supracrestally.

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Fig 2-4h Short PEEK healing abutment screwed into place.

Implant placement with augmentation

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Before implant placement, the right inferior alveolar nerve was numbed using block anesthesia and the provisional partial denture was removed (Fig 2-4e). This made the vertical and horizontal bone defect more clearly apparent. For the planned augmentation and condensation of the gingiva, the incision was made lingually, but still on the residual ridge (Fig 2-4f). Following mobilization of the buccal mucoperiosteal flap (with no releasing incisions), the implant was inserted approximately 2 mm supracrestally, as planned (Fig 2-4g). To spare the patient a second procedure, ie, implant exposure, a 2.7-mm-long PEEK healing abutment was screwed directly onto the implant (Fig 2-4h).

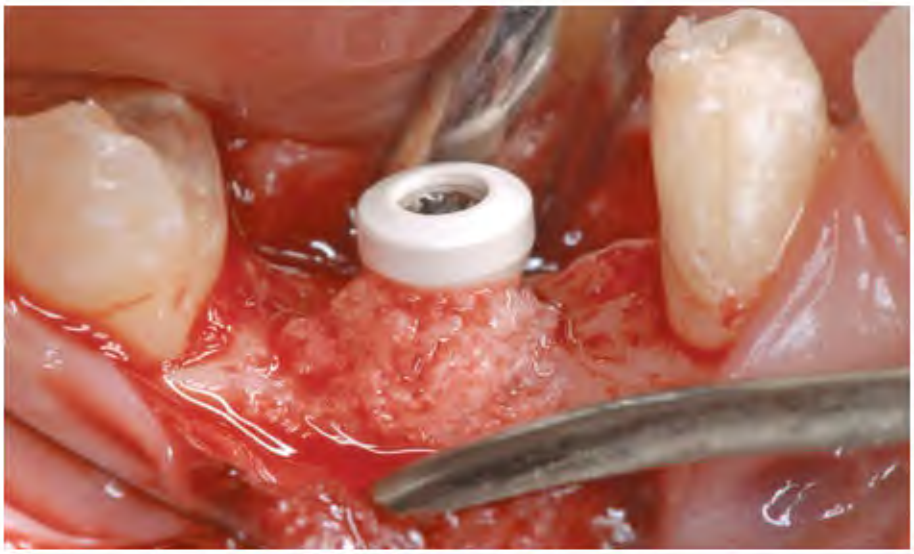


Fig 2-4i Augmentation with the bone chips.

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Fig 2-4j Suturing.



Fig 2-4k Postoperative panoramic radiograph.

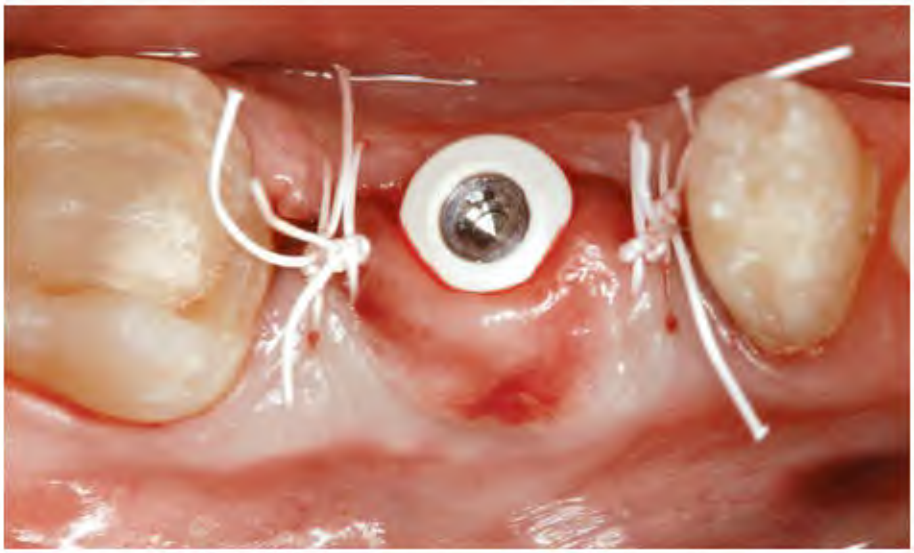


Fig 2-4l Buccal displacement of the fixed gingiva.

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Fig 2-4m Buccal shaping of the residual ridge.



Fig 2-4n Provisional restoration cut away at the base, reliably protecting the implant from masticatory stress.



Fig 2-4o Definitive implant crown after 5 years in functional use.

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Fig 2-4p Buccal shaping of the residual ridge.



Fig 2-4q Harmonious appearance of the prosthetic reconstructions.



Fig 2-4r Panoramic radiograph after 5 years with the incidental finding on tooth 47.

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For the augmentation, the cortical bone layer around the implant was perforated in several places to encourage revascularization, and bone chips collected in the filter were layered onto the buccal side of the residual ridge (Fig 2-4i). For larger augmentations, it would also have been possible to use a regenerative bone substitute and a membrane, but this would have meant greater financial cost.

The buccal flap was then repositioned and fixed around the healing abutment with Gore-Tex sutures (W. L. Gore and Associates) (Fig 2-4j). The postoperative panoramic radiograph shows the position of the implant relative to the nerve and the neighboring teeth (Fig 2-4k). The augmentation has had a positive effect not only vertically, but also in the horizontal plane (Fig 2-4l). The improved buccal contour of the residual ridge can be assessed postoperatively once the provisional bridge has been fitted (Fig 2-4 m). If the same provisional restoration is to be reused, sufficient place needs to be made for the protruding healing abutment. The reshaped provisional protects the implant not only from masticatory stresses, but also from possible pressure from the tongue, which can sometimes even be dangerous (Fig 2-4n).

Four months after implant placement, both the implant and the neighboring teeth were fitted with a prosthetic restoration. The final photographs show the clinical situation with apparently healthy gums after 5 years (Fig 2-4o). While the buccal bulge (*jugum alveolare*) over the implant is smaller than with some teeth, it is still more marked than before implant placement (compare Figs 2-4f and 2-4p). The prosthetic restoration has been harmoniously incorporated into the overall appearance of the mouth (Fig 2-4q). However, the panoramic radiograph after 5 years shows an incidental finding on tooth 47 (Fig 2-4r). According to the radiograph, implant 46 has undergone good osseous integration, but tooth 47 shows a distal zone of radiolucency, probably a periodontal-endodontic lesion, which requires urgent treatment although the patient has no symptoms and has not noticed the inflammation at all.

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Treatment course

- Implant placement, augmentation and mucosal distraction (2007)
- 4 months to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Roland Althoff
Dental technology:	Angela Althoff

Problems and complications

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Fracture of a non-WP implant

Baseline situation

A 16-mm-long, non-WP Straumann implant replacing molar 46 had been inserted and loaded with a crown at another center. In this patient's history, he had reported repeated loosening of the abutment screw. Finally, after being in place for about 1 year, the implant had fractured below bone level (Figs 2-5a and 2-5b), necessitating removal of the implant. The maximum utilization of the vertical bone supply through the use of the 16-mm implant complicated the removal considerably. Implant removal requires full reaming of the bone around the implant, which extends to just short of the nerve, with a risk of damaging the latter.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Explantation of the broken implant and augmentation of the bone defect
2. Insertion of two implants
3. Secondary exposure
4. Cement-retained metal-ceramic crown on two implants and customized abutments

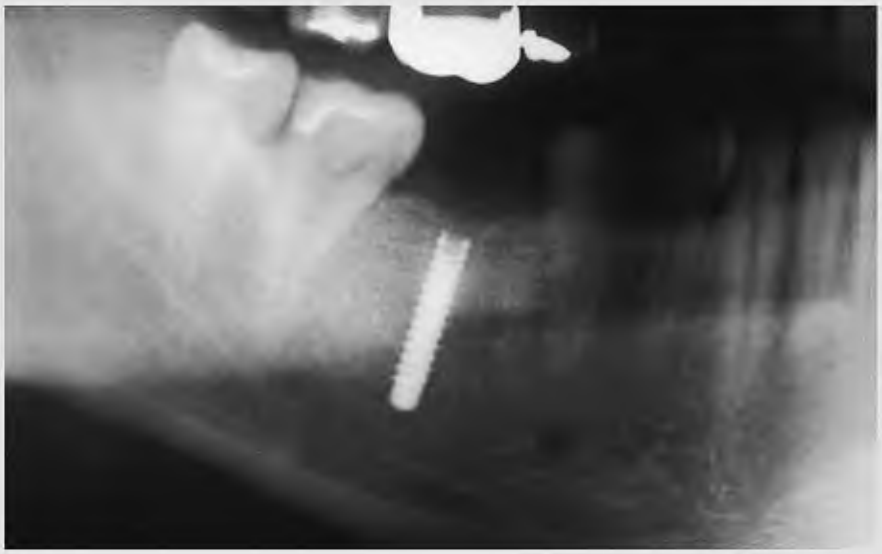


Fig 2-5a Fractured Straumann implant.

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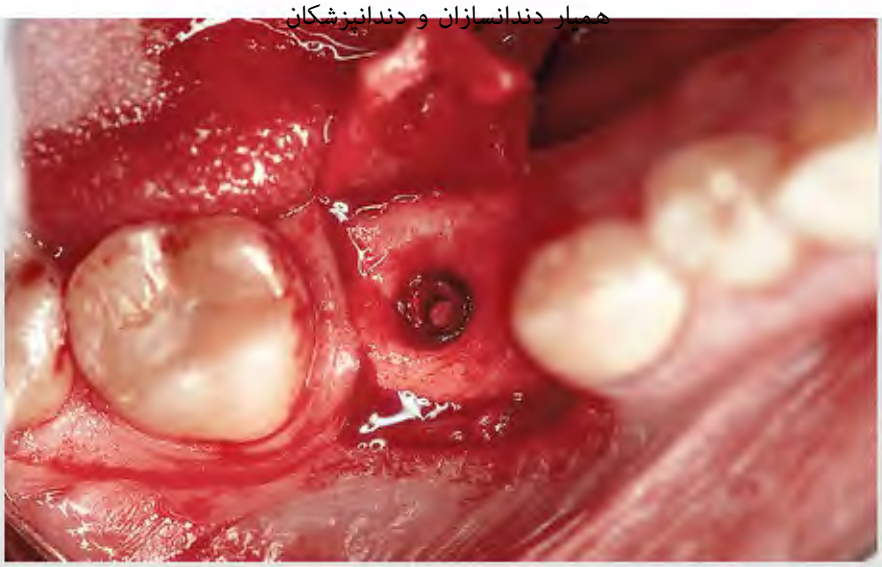


Fig 2-5b Fracture site below bone level.

Attention: ***The use of a standardized trephine, as small in diameter as possible, minimizes the resultant bone defect. For guidance when using a trephine, it can be helpful to screw an impression post screw onto the implant as a direction indicator. In this case, however, this was no longer possible because the implant thread had fractured completely.***

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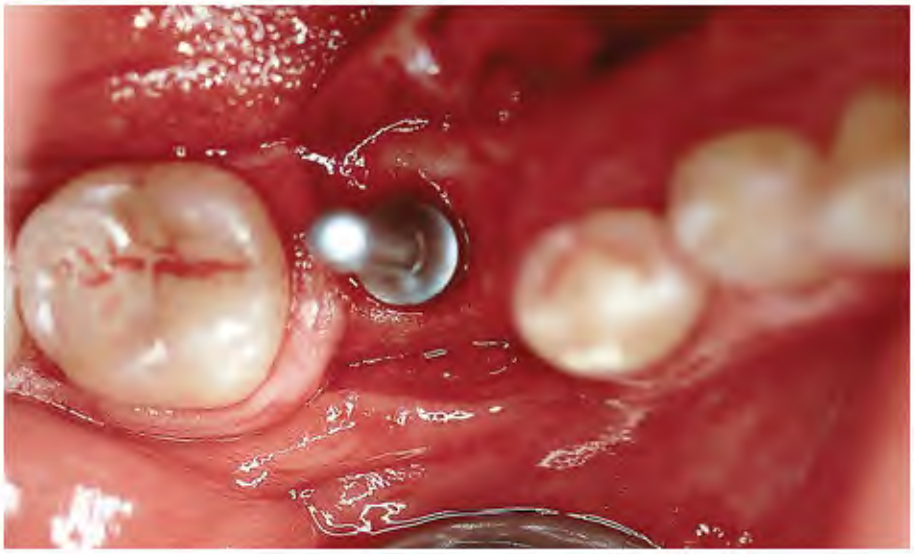


Fig 2-5c Trephine put into place.

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Fig 2-5d Radiograph showing the inserted trephine.



Fig 2-5e Oversized crown relative to the diameter of the implant.

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Fig 2-5f Bone defect following explantation.



Fig 2-5g The inserted mesial implant.

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Implant removal and augmentation

Following a buccal incision, the dissected flap was fixed to the premolar in the third quadrant with a single suture to give a clear view of the operation site. The drilling depth was initially determined from the preoperative measurements taken from the radiograph. An intraoperative radiograph with the trephine inserted provided an additional check of the drilling depth (Figs 2-5c and 2-5d). Once the bone around the implant had been fully reamed away, the implant was removed by careful luxation with a lever.

The fractured elements of the implant, with the crown structure screwed on via an abutment, suggest a fatigue fracture of the inadequately sized implant (Fig 2-5e). Based on his experience so far, the patient placed no trust in a single-tooth implant and wanted a restoration loaded on two implants to be on the safe side. However, the resultant bone defect prevented immediate implant placement in this area (Fig 2-5f). Initially, therefore, a single RP implant was inserted mesially of the defect (Fig 2-5g) and the defect augmented with a bone substitute (Bio-Oss; Geistlich).

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Fig 2-5h Preoperative radiograph.

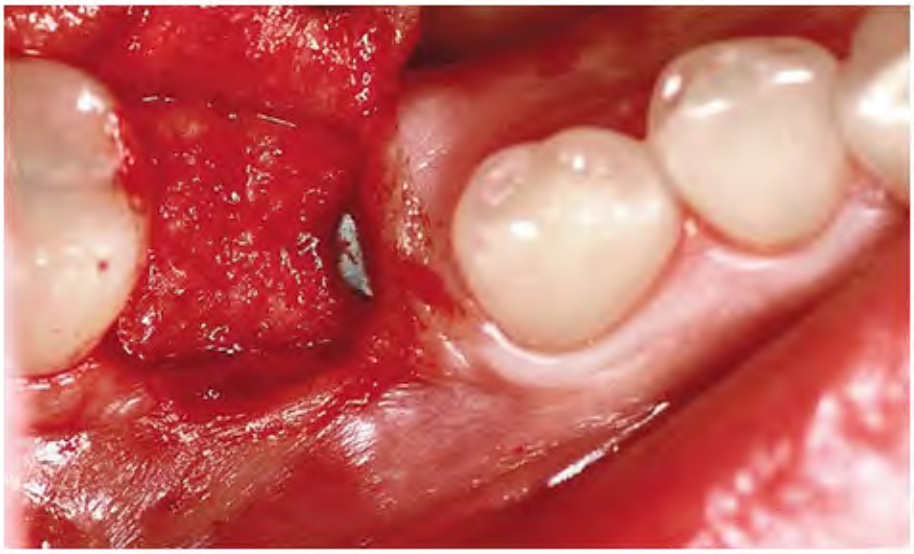


Fig 2-5i Regenerated bone defect.

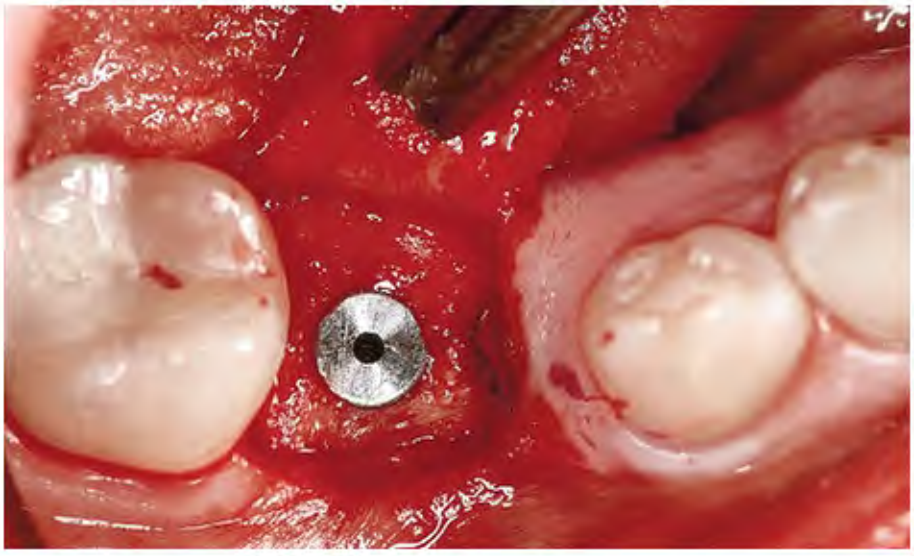


Fig 2-5j Inserted distal Brånemark System implant.

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Fig 2-5k Postoperative radiograph after implant placement.

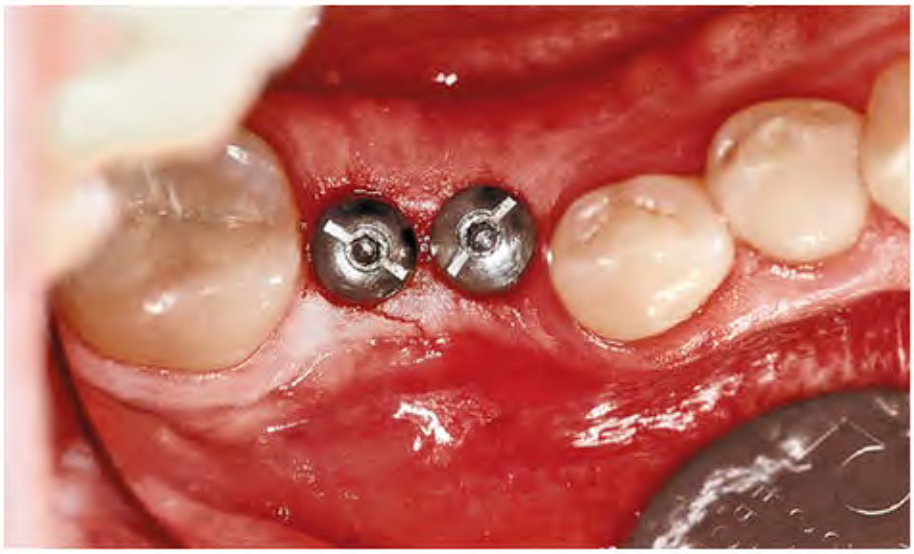


Fig 2-5l Exposed implants.



Fig 2-5m Customized abutments.

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Fig 2-5n Metal-ceramic crown after 7 years in functional use.

Delayed implant placement

The radiograph and clinical inspection after 6 months already showed clear reossification in the augmentation area (Fig 2-5h and 2-5i), allowing a second Brånemark System (Nobel Biocare) implant to be inserted (Fig 2-5j). The positioning of the new distal implant relative to the neighboring tooth and the mesial implant is clearly apparent on the radiograph (Fig 2-5k).

Exposure and prosthetic loading

The implants were exposed after a further 6 months (Fig 2-5l). They were then loaded with a prosthesis consisting of an interlocked crown on two customized abutments (Fig 2-5m). The clinical situation 7 years after the restoration was incorporated shows a stable peri-implant situation with no inflammation (Fig 2-5n).

Treatment course

- Explantation, augmentation and partial implant placement (1998)
- 6 months to the delayed implant placement
- 6 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery: Dr Christoph T. Sliwowski

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Prosthetics: Dr Uwe Hildebrand
Dental technology: Fernando Abrantes

Note

Iatrogenic complication with nerve involvement



Fig 2-6a Elongation of tooth 35.

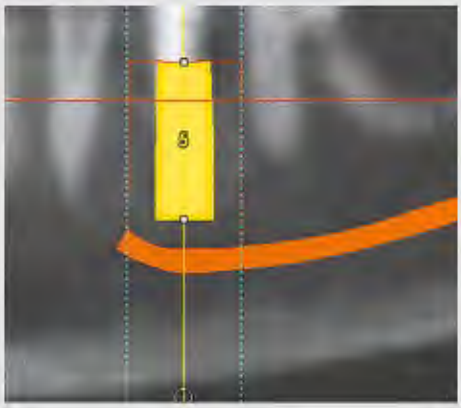


Fig 2-6b SimPlant planning.

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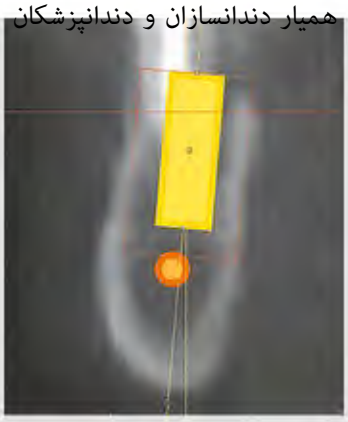


Fig 2-6c Planned implant in cross-sectional view.



Fig 2-6d Semi-transparent 3D reconstruction.

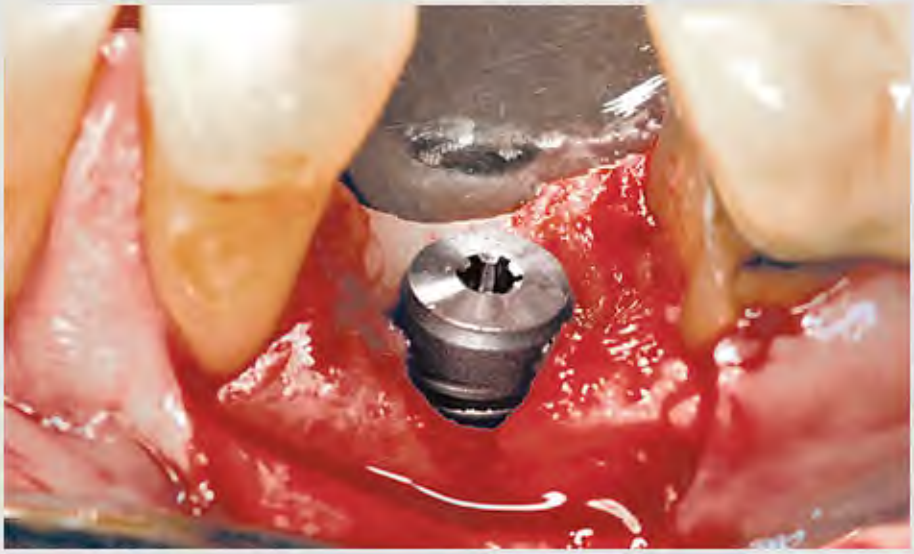


Fig 2-6e Implant placement directly after the extraction.

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Fig 2-6f Wound suturing.

In this patient, tooth 35 became elongated due to missing teeth in the maxilla (Fig 2-6a). The width of the residual ridge had been well maintained thanks to the presence of tooth 35, allowing optimal placement of the implant in the buccolingual dimension. Since the tooth was no longer securely anchored, as can be seen in the radiograph, atraumatic extraction appeared possible.

Analysis and virtual implant planning with the SimPlant planning program indicated sufficient bone availability for the insertion of a 13-mm-long implant, with a 4.5-mm diameter, maintaining the required safe distance of 2 mm to the nerve (Fig 2-6b). The distance to the nerve also appeared sufficient in the cross section of Fig 2-6c. Only the 3D reconstruction raised doubts as to the height of the preserved buccal lamella (Fig 2-6d). Exactly as in the planning procedure, the intended implant was inserted into the socket directly after the extraction (Fig 2-6e). Since implant placement followed on directly from extraction, there was no clearly defined bone height on the buccal side that would have allowed the virtual planning to be applied to the operation site. This deficiency is the most likely cause of the complication that was to follow. After the insertion, the buccal bone defect was filled with the harvested bone chips. The mucoperiosteal flap was mobilized sufficiently to allow saliva-proof wound closure with Gore-Tex and Surgipro (Covidien) sutures, without the use of a membrane (Fig 2-6f). A CBCT scan was performed for a postoperative check. The panoramic view suggested that the implant was placed deeper than planned (Fig 2-6g). This complication becomes even clearer in the cross-sectional views (Fig 2-6h). Marking the nerve in red shows the extent and site of the implant's collision with the nerve particularly well (Fig 2-6i). To avoid permanent nerve damage, the nerve needed to be decompressed as quickly as possible.

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Fig 2-6g to 2-6i Panoramic view (g). Cross section (h). Collision of the implant with the nerve (i).

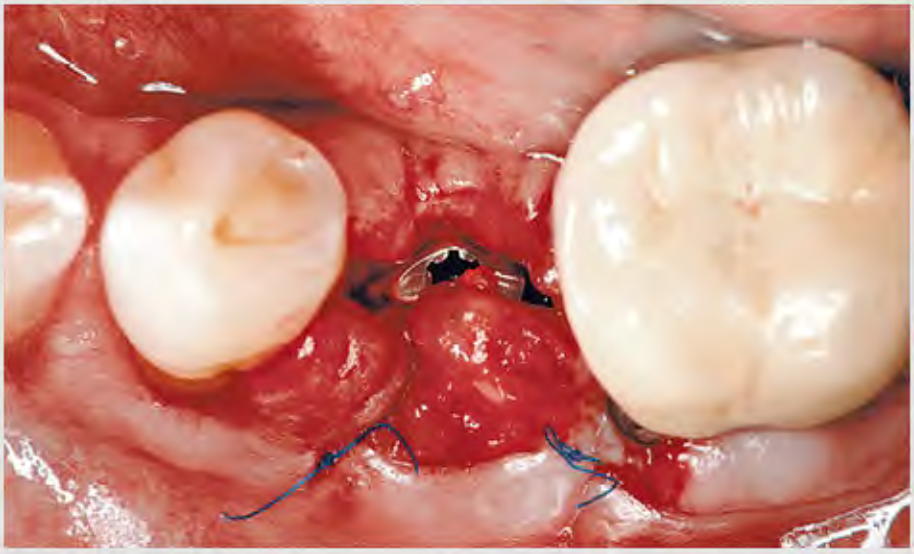


Fig 2-6j Partially reopened gum.

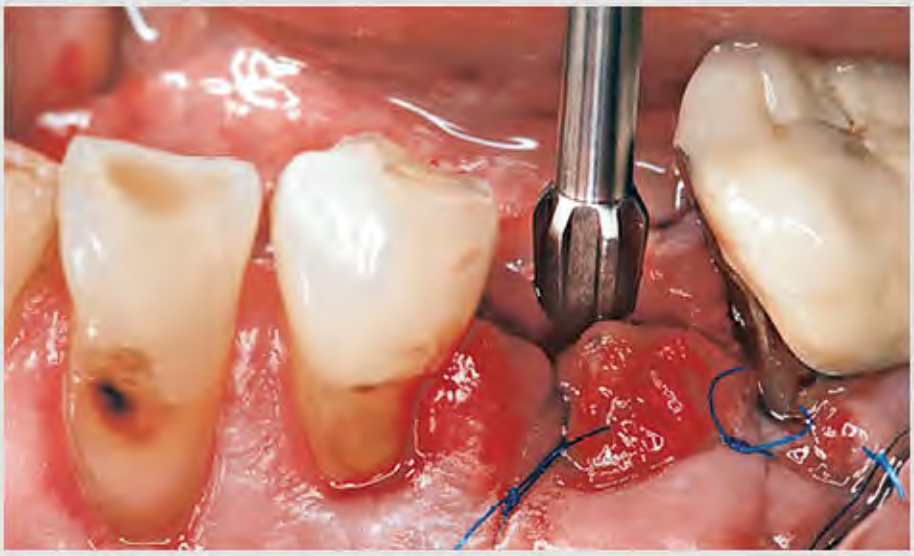


Fig 2-6k Unscrewing the implant by two turns.

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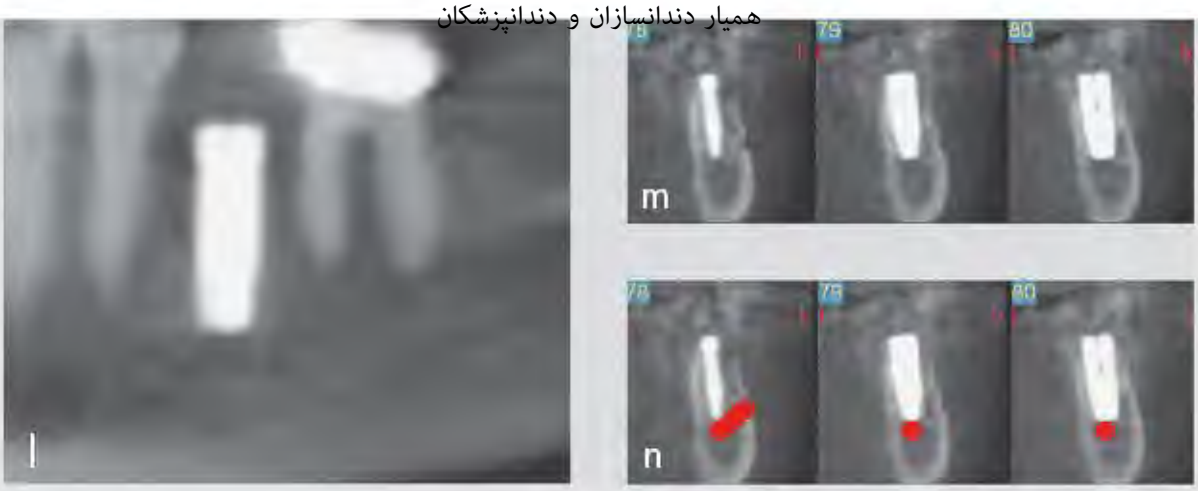


Fig 2-6l to 2-6n Improved implant position (l). Cross sections (m and n).

The next day (the patient having confirmed persistent numbing), the gum was partially reopened (Fig 2-6j) and the implant unscrewed by two turns (Fig 2-6k). Another CBCT scan was taken to check the situation and reconstructed with a slice thickness of 0.3 mm for maximum precision. The panoramic section now shows the more favorable location of the implant directly over the mental foramen (Fig 2-6l), and the cross sections, with and without the nerve marked in red, confirm that the implant has disappeared from the canal (Figs 2-6m and 2-6n).

In most similar cases, feeling returns to the lower lip after a few months at the latest, although the damage may remain irreversible and leave the patient with an unpleasant numbness in the lower lip for life. In this patient, sensitivity improved after only 3 weeks, with full sensation returning after 4 months.

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Immediate loading

With a single-tooth gap, the lack of space means that a provisional restoration cannot be achieved by inserting additional provisional implants, so that the provisional restoration will need to be loaded directly onto the definitive implant. Successful immediate loading requires a qualitatively and quantitatively good bone bed to anchor the implant securely and give it primary stability. It is essential to avoid functional overloading of the crown during the healing phase (3 to 6 months).

Immediate provisional loading of a definitive implant

This treatment course follows on from the 3D diagnostic investigations on page 40.

Baseline situation

In this 28-year-old woman, the persistent primary tooth 85 has taken on dark discoloration

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and is no longer preservable (Fig 2-7a). However, preserving the primary tooth until the implant treatment counteracts atrophy, ensuring optimum preservation of both the height and width of the alveolar process at the time of implant placement. The implant was to be inserted directly after the extraction and loaded with a provisional crown.

Diagnostic tools

- Clinical examination
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction of the primary tooth and immediate placement of a WP implant. Direct incorporation of a provisional crown after the implant placement
2. Prosthesis in the form of a cement-retained metal-ceramic crown



Fig 2-7a Remaining primary tooth 85.

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Laboratory technique

In the cast, tooth 85, which needed extracting, was erased and an implant or abutment analog in accordance with the CBCT-based 3D radiologic investigations (see diagnostic investigations, page 40) was inserted into the model (Fig 2-7b). The bone supply and the width of the gap permitted placement of a WP implant 5 mm in diameter. A CeraOne abutment with plastic cap was prepared in the laboratory to take the immediate provisional prosthesis (Fig 2-7c) and a

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plastic crown was prepared in the form of an eggshell provisional (Fig 2-7d). The provisional crown was to be polymerized onto the plastic cap following insertion of the implant.



Fig 2-7b CeraOne model abutment incorporated into the plaster cast.

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Fig 2-7c Shortened plastic cap.

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Fig 2-7d Provisional crown.

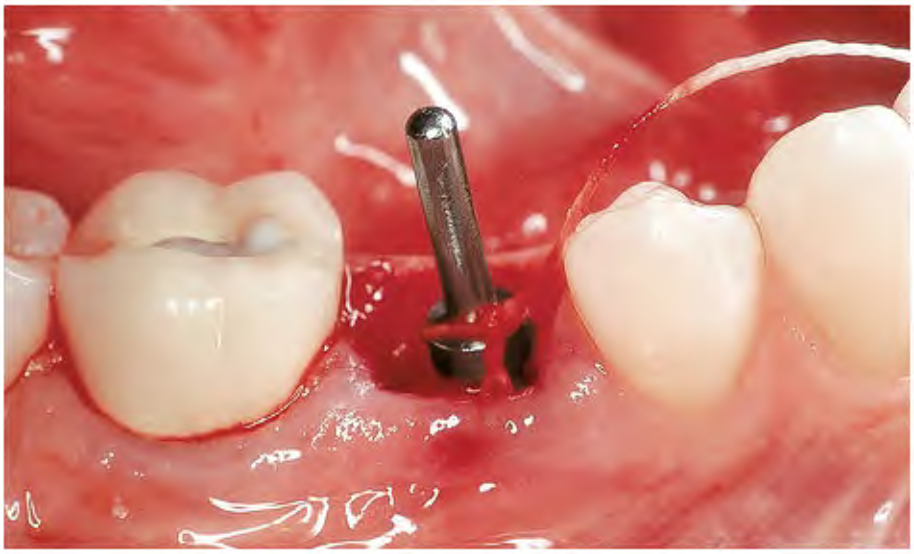


Fig 2-7e Checking the position and alignment of the implant bed.

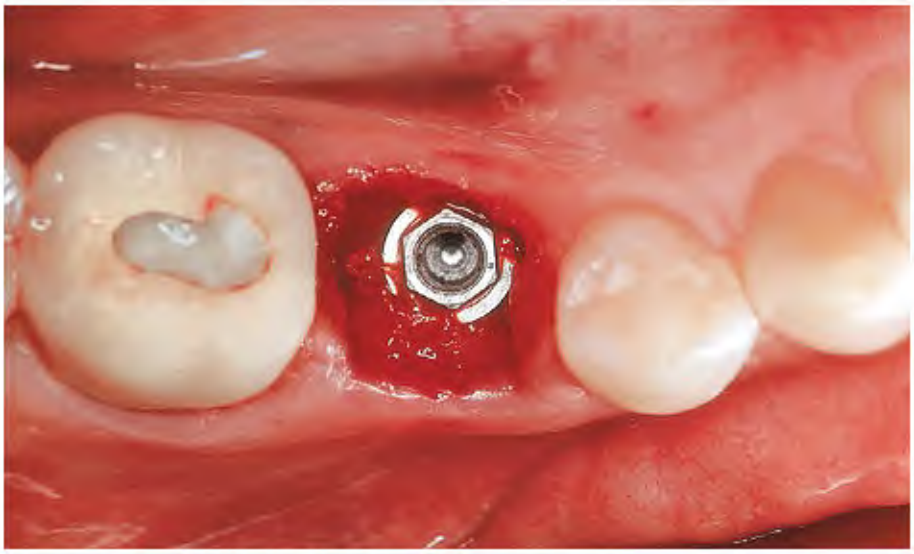


Fig 2-7f Inserted WP implant.

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Extraction, implant placement and provisional restoration

The primary tooth was extracted immediately before implant placement. After the initial preparation with the 2- and 3-mm drills, the position and alignment of the implant bed were checked using a direction indicator (Fig 2-7e).

The implant bed was then prepared to a further diameter of 4.3 mm. Once the process was completed with a thread cutter, the WP implant (diameter 5 mm) was inserted due to the dense bone structure at the site (Fig 2-7f).



Fig 2-7g CeraOne abutment screwed into place.



Fig 2-7h Adequate occlusal distance.



Fig 2-7i Inserted provisional crown.

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Fig 2-7j Provisional crown out of occlusion.



Fig 2-7k Metal-ceramic crown after 3 in functional use.

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The CeraOne abutment was screwed into place (Fig 2-7g). For the provisional crown, it was important to maintain an adequate occlusal distance (at least 2 mm) to the antagonist tooth (Fig 2-7h). The prepared eggshell provisional was filled with quick-hardening, autopolymerizing plastic and incorporated. After shaping, the provisional crown was cemented into place with TempBond (Kerr) (Fig 2-7i). The final photographs show the clinical situation 5 months after implant placement and 3 years after the incorporation of the definitive prosthetic restoration (Fig 2-7j and 2-7k).

Treatment course

- Implant placement and immediate loading (2002)
- 5 months to impression taking and fabrication

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Treatment

Surgery and provisional crown: Dr Christoph T. Sliwowski
Prosthetics: Dr Uwe Hildebrandt
Dental technology: Ivonne Lewik

Multi-tooth gap and free-end situation

Patients missing more than one tooth in the posterior mandible present with either a multi-tooth gap between teeth or a free-end situation, the second being far more common. Since treatment for both indications is similar, the focus here will be placed on the free-end situation. In the case of a free-end situation – in contrast to a multi-tooth gap between teeth – the only fixed prosthetic restoration option without the use of implants is a cantilever fixed partial denture. The number of implants depends on the size of the gap, with one implant recommended for each tooth that needs to be replaced. However, a minimum distance of 3 mm needs to be maintained between implants. In a free-end situation, at least two implants, but preferably three or four, are recommended. A superstructure supported on three or more implants shows far fewer complications than one loaded onto only two implants. These include both biologic complications (bone loss if the implants are overloaded) and mechanical complications (loosening or fracture of the retaining screws or even implant fractures).

Diagnosis and planning in the case of a large multi-tooth gap or free-end situation need to proceed with at least as much care as with single-tooth implant placement in the posterior mandible, because each individual implant may lead to damage to the inferior alveolar nerve. Implantology associations recommend a diagnostic measuring radiograph (panoramic image) with a template that contains incorporated measurement devices as the minimum imaging procedure. Its disadvantage is that it does not provide the most important information, namely the width of the residual ridge. A CBCT or CT scan is advisable in most cases not only for forensic but also practical reasons, due to the risk of nerve injury.

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Typical treatment course

Two-session approach with augmentation

Baseline situation

A 70-year-old man wished to have a fixed prosthetic restoration on both sides of the mandible. Dental treatment on the right side had already been completed, while tooth 37 remained to be extracted on the left side (Fig 2-8a).

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Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction and immediate implant placement or delayed immediate implant placement with augmentation
2. Exposure and definitive prosthetic loading



Fig 2-8a Tooth 37 before the extraction.

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Fig 2-8b Inserted implants on the left side.



Fig 2-8c Delayed immediate implant placement on the right side.

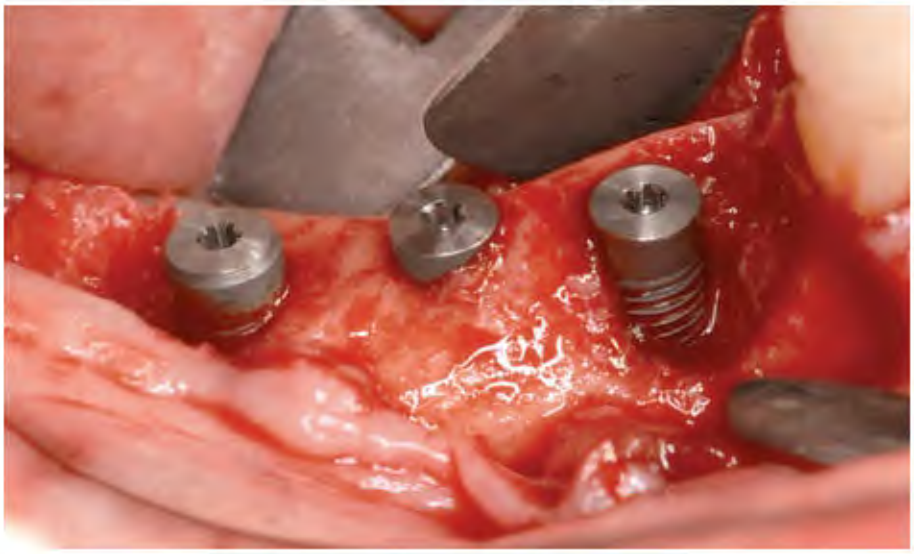


Fig 2-8d Bone deficits following the delayed immediate implant placement.

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Fig 2-8e Postoperative panoramic radiograph after the implant placement.

Attention: ***To avoid occlusal overload and to adjust the superstructure to the diameter of the implant, a few authors advocate "premolarization," ie, a premolar shape for the prosthetic restoration in the molar region, with three premolars normally needed to replace two molars.***

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Implant placement and augmentation

Tooth 37 was extracted under block and infiltration anesthesia and three Neoss implants were inserted in regions 35 and 36 and mesially of region 37. The implants were placed slightly supracrestally, to allow further vertical augmentation of the residual ridge (Fig 2-8b). Augmentation was also needed on the buccal side of implant 35 and the distal side of implant 37. The augmentation on the left side was carried out with the harvested bone chips, the bone substitute Bio-Oss and a Tutodent (Zimmer Dental) membrane measuring 15 × 20 mm. On the right side, teeth 45 and 47 had been extracted recently, so that the extraction sockets were still clearly visible (Fig 2-8c). The implants were inserted into sockets 45 and 47 and into the existing bone in region 46 (Fig 2-8d). The extensive defects around implants 45 and 47, in particular, needed augmenting. To compare the efficacy of the membranes, a 25 × 25 mm Bio-Gide membrane (Geistlich) was placed over the same augmentation material. The postoperative panoramic radiograph shows the position of the implants after insertion (Fig 2-8e).

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Fig 2-8f Implants showing through on the right side.

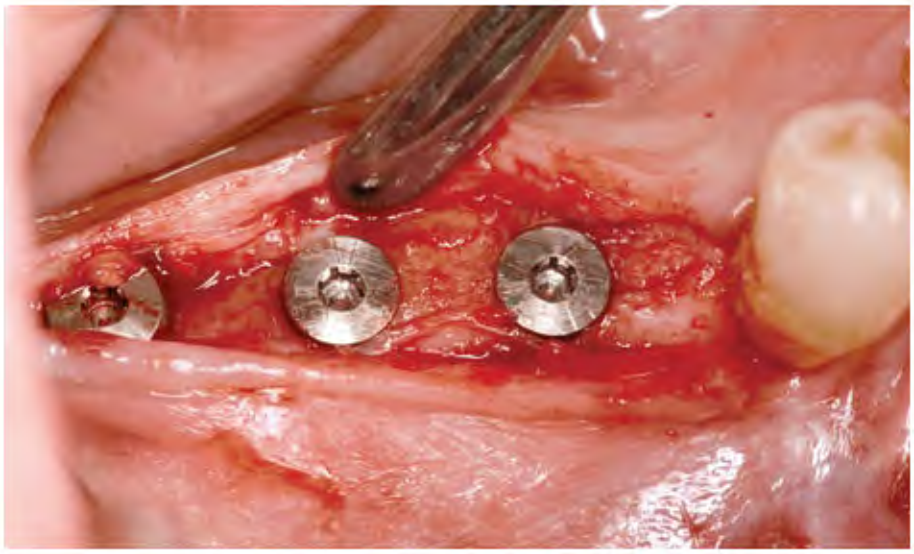


Fig 2-8g Augmentation result following use of the Bio-Gide membrane.

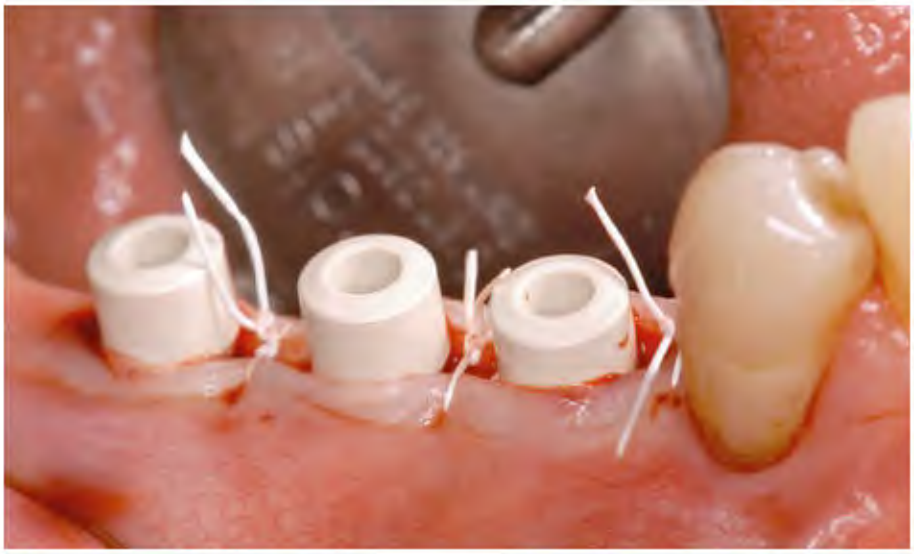


Fig 2-8h Exposed implants.

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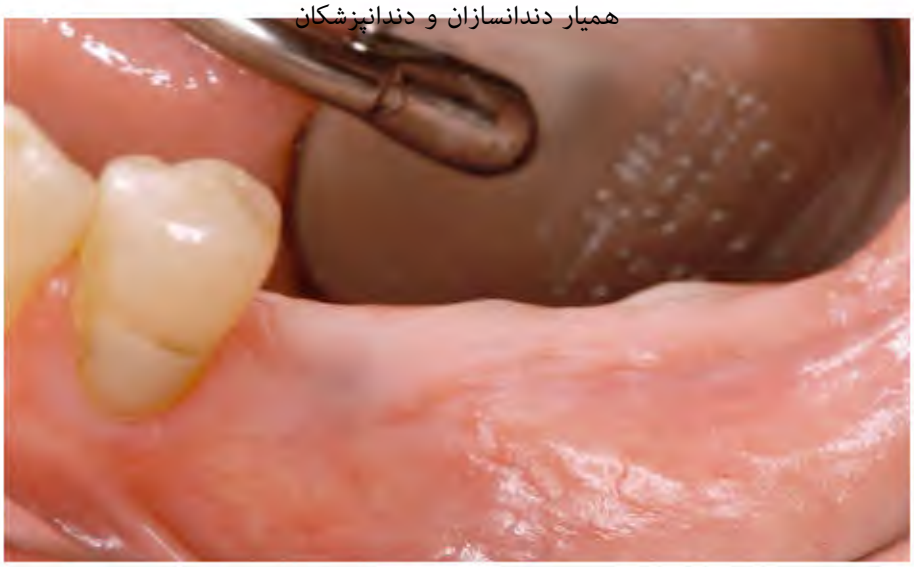


Fig 2-8i Left side before exposure.



Fig 2-8j Augmentation result following use of the Tutodent membrane.

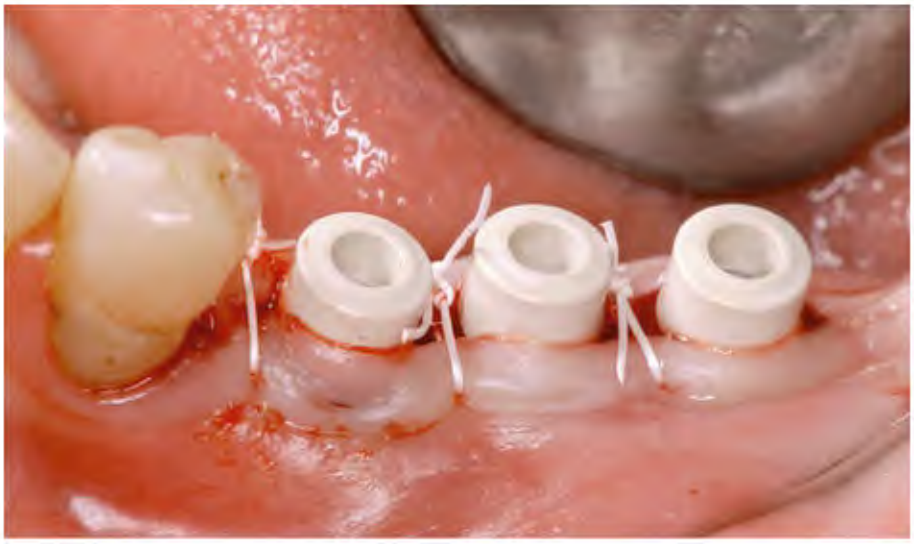


Fig 2-8k Widening the zone of attached gingiva.

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Exposure

Exposure of the implants took place 7 months after they were inserted. Both of the distal implants on the right side were identifiable on the lingual side, but the gingival situation on the buccal side appeared to be stable (Fig 2-8f). The incision was made centrally in the keratinized gingiva to widen it. The result of the augmentation with the Bio-Gide membrane on this side could rated as highly positive (Fig 2-8g). The PEEK healing abutments were fitted onto the implants and the wound margins were secured with Gore-Tex sutures (Fig 2-8h).

On the left side, the situation appeared to be similar (Fig 2-8i). The augmentation with the Tutodent membrane was also successful – even if the bone defects on this side were considerably smaller (Fig 2-8j). Healing abutments were screwed onto the implants on the left side as well. The zone of attached gingiva was also widened here (Fig 2-8k).

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Fig 2-8l Definitive restoration on the left side.



Fig 2-8m Definitive restoration on the right side.

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Fig 2-8n Implant bridge on the left side after 5 years in functional use.



Fig 2-8o Implant bridge on the right side after 5 years in functional use.

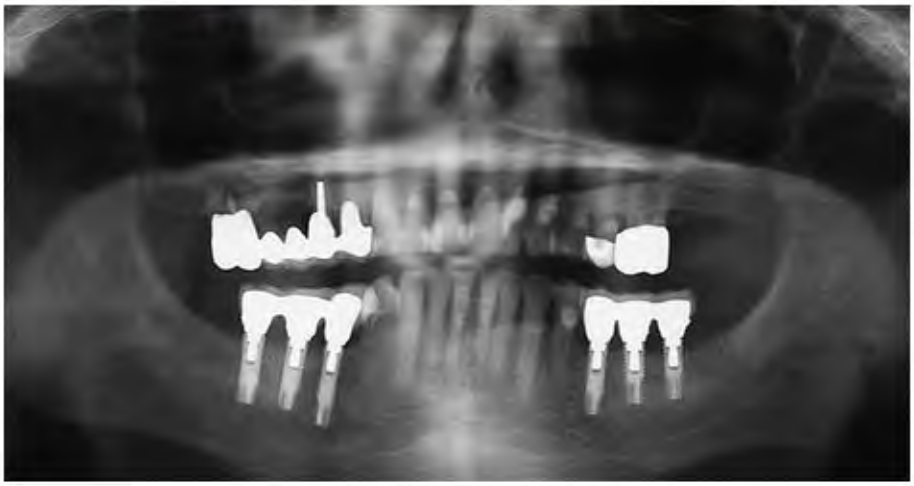


Fig 2-8p Follow-up panoramic radiograph after 5 years.

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Prosthetic loading

Four weeks after exposure, the prosthetic superstructures were created for both sides. Metal-ceramic compound crowns were incorporated onto the customized abutments, so that no access

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openings were visible from the occlusal margin (Fig 2-8l and 2-8m).

Continued follow-up

The clinical situation after 5 years of use is satisfactory on both sides (Fig 2-8n and 2-8o). The follow-up panoramic radiograph also confirms the stable osseous situation around the implants (Fig 2-8p).

Treatment course

- Extraction and implant placement (2007)
- 7 months to exposure
- 4 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Ali Alexander Pacyna
Dental technology:	Ludger Jansen

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Atypical treatment course – problematic baseline situation

Single-session approach with augmentation and transmucosal healing

Baseline situation

This patient, with terminal tooth 43, wanted her dental arch to be extended into the molar region. Clinical examination showed moderate residual ridge atrophy in the fourth quadrant, both horizontally and vertically (Fig 2-9a). In addition to the atrophy, the panoramic radiograph and CBCT scan images show a pronounced bone defect in the region of tooth 45 (Figs 2-9b and 2-9c).

Diagnostic tools

- Clinical examination
- Panoramic radiograph

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- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Insertion of three definitive implants, augmentation, transmucosal healing
2. Loading with a cement-retained metal-ceramic fixed implant bridge on customized abutments



Fig 2-9a Baseline image, free-end situation on the right side.



Fig 2-9b Panoramic radiograph.

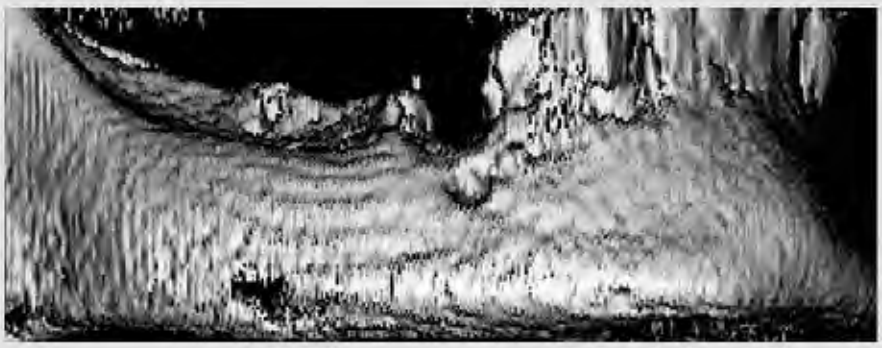


Fig 2-9c 3D reconstruction.

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After the surgical incision, the three implant beds in regions 44, 45 and 46 were prepared and three Neoss implants inserted. Only implants 44 and 46 were sufficiently covered with bone on the lingual side, whereas implant 45 exhibited bone deficits on both the buccal and labial sides. A compromise was decided on to even out the differences in height. The fully inserted implant 44 was slightly higher than implant 45, whereas the latter protruded considerably from the bone defect, despite being inserted deeper down (Fig 2-9d). Implant 46 was placed at the usual depth and required only slight augmentation. Healing abutments were fitted onto all the implants and the cortical bone perforated in several places for better revascularization (Fig 2-9e). The harvested bone chips were layered onto the residual ridge on the buccal side, particularly in the region of tooth 45, and covered with a Tutodent membrane. The flap was repositioned around the abutments and fixed into place with Gore-Tex sutures (Fig 2-9f). The postoperative panoramic radiograph shows the placement of the implants and their positions relative to the inferior alveolar nerve (Fig 2-9g).

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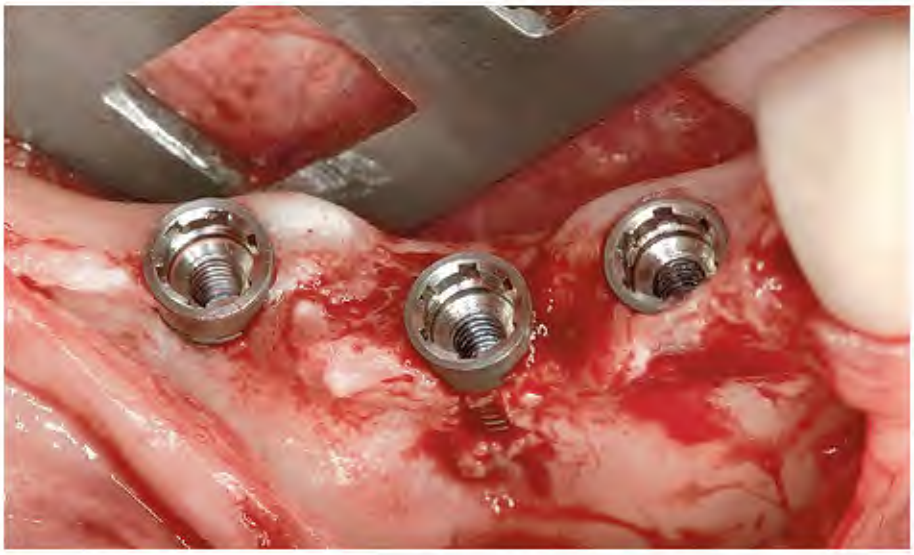


Fig 2-9d Three inserted Neoss implants.

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Fig 2-9e Healing abutments screwed into place. Perforations in the cortical bone for better revascularization.

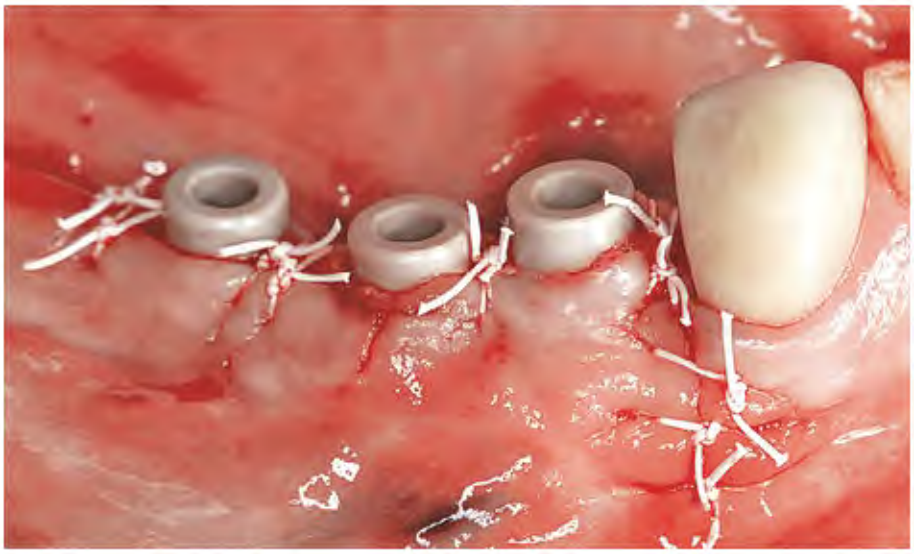


Fig 2-9f Tight suturing of the gum following augmentation.

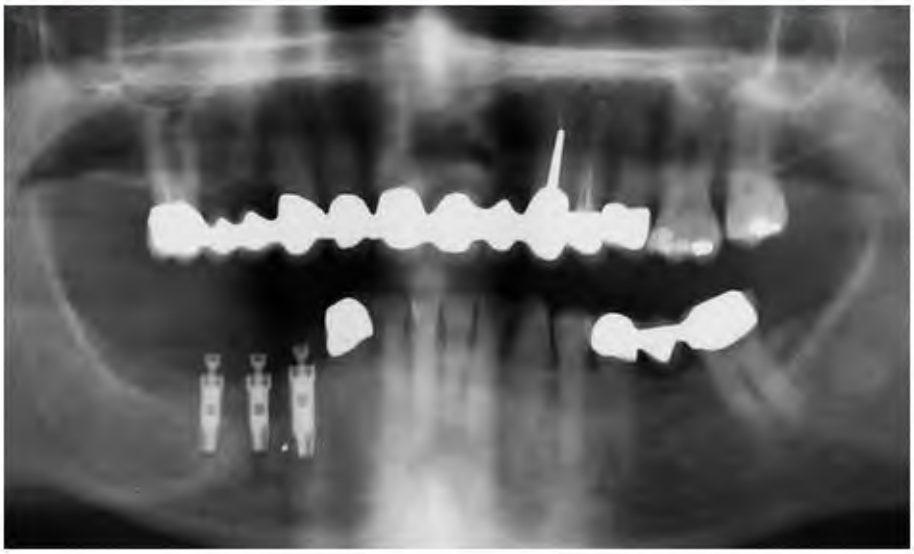


Fig 2-9g Postoperative radiograph after the implant placement.

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Fig 2-9h Stabilization of the mucosal situation after 3 months.



Fig 2-9i Metal-ceramic fixed implant bridge loaded onto the customized abutments.

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Fig 2-9j Patient after the end of her treatment.

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Three months after the implant placement, clinical inspection showed a stable gingival situation, although a slight tissue deficit was noted in the region of tooth 45 (Fig 2-9h). During this period, the distance between the healing abutments and the opposing teeth needed to be sufficient to rule out any occlusal load. Six months after the implant placement, the customized abutments were screwed into place and the metal-ceramic compound crowns cemented onto them (Fig 2-9i). The patient was not only happy with the final result, but also with the fact that it was achieved with only a single surgical procedure (Fig 2-9j).

Treatment course

- Implant placement and augmentation (2004)
- 6 months to impression taking and incorporation of the superstructure

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Ute Olbers

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Large bone defect following the loss of implants

This treatment follows on from the 3D diagnostic investigations on page 42.

Baseline situation

Two years before first presenting in our clinic, a 50-year-old woman had already undergone implant treatment at another institution. All three implants in the left maxilla had been lost shortly after insertion, resulting in an extensive bone defect (Fig 2-10a). In the panoramic radiograph, the extent of the defect was clearly apparent when the two sides of the mandible were compared (see diagnostic investigations, Fig 2-1i, page 42).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Implant placement with augmentation
2. Exposure and definitive prosthetic loading

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Fig 2-10a Pronounced residual ridge atrophy.

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Implant placement and augmentation

The bone defect was very pronounced in both horizontal and vertical directions. The vertical loss of the residual ridge was also clearly apparent on clinical inspection in the presence of a closed dental arch (Fig 2-10b). With a deep overbite of the anterior teeth, the vertical bone loss in the posterior region was estimated at more than 10 mm in places. The horizontal atrophy could be seen particularly clearly on the tomographic cross sections in the SimPlant planning program (see diagnostic investigations, Figs 2-1l, 2-1m and 2-1n, page 43), but is also readily apparent clinically in Fig 2-10b. As already determined during the planning process, the residual ridge was indeed particularly narrow in the region of teeth 33, 34 and 35 (Fig 2-10c). Three NP implants 3.3 mm in diameter were inserted there (Fig 2-10d). Although the bone spreading technique was to be used to widen the residual ridge, all of the NP implants were partially uncovered on both the lingual and buccal sides (Fig 2-10e). In the molar region, the residual ridge was slightly wider, allowing RP implants from the Brånemark System to be inserted here. Following insertion, all the implants protruded from the residual ridge by approximately 2 to 4 mm. This was done to give better vertical support for the augmentation.

Attention: ***Non-resorbable membranes are advantageous for major augmentative procedures, as they are considerably better at keeping their shape. This is offset by the disadvantage that they can become infected if exposed, thus endangering the entire augmentation. Moreover, they always need to be stably secured to the residual ridge. A few implantology centers advocate protecting the non-resorbable membrane with a resorbable one laid on top, to prevent exposure and infection.***

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Fig 2-10b Big gap between the lower residual ridge and the opposing teeth.

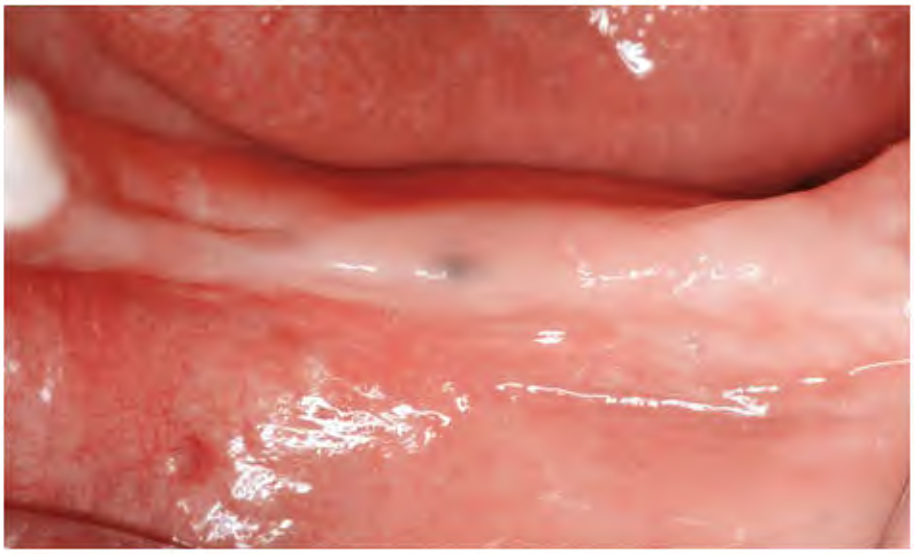


Fig 2-10c Very narrow residual ridge.



Fig 2-10d The reduced-diameter implants are wider than the residual ridge.

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Fig 2-10e Implants 33 and 34 are uncovered on the buccal side and implant 35 is uncovered on the lingual side.



Fig 2-10f Tension-free suturing.

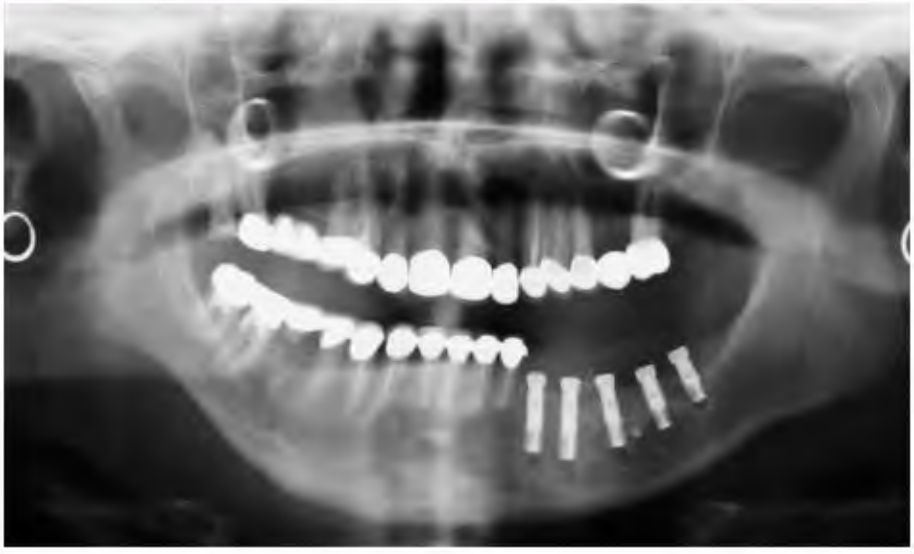


Fig 2-10g Follow-up panoramic radiograph.

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The residual ridge was extensively augmented with harvested bone chips and xenogenic bone substitute material (Bio-Oss) and the augmentation secured with a non-resorbable membrane (Gore-Tex TR6Y). The titanium-reinforced Gore-Tex membrane was attached to the residual ridge with small titanium pins. A resorbable membrane (OSSIX PLUS; Datum Dental Ltd) was placed over the non-resorbable one for protection. Adequate slitting of both the buccal and lingual periosteum ensured totally tension-free and saliva-proof closure of the operation site (Fig 2-10f). The postoperative panoramic radiograph shows the placement of the implants and the extent of augmentation (Fig 2-10g).



Fig 2-10h Dehiscence of implant 33.



Fig 2-10i Opening for the wound revision.

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Fig 2-10j Removed fragments of the membrane.

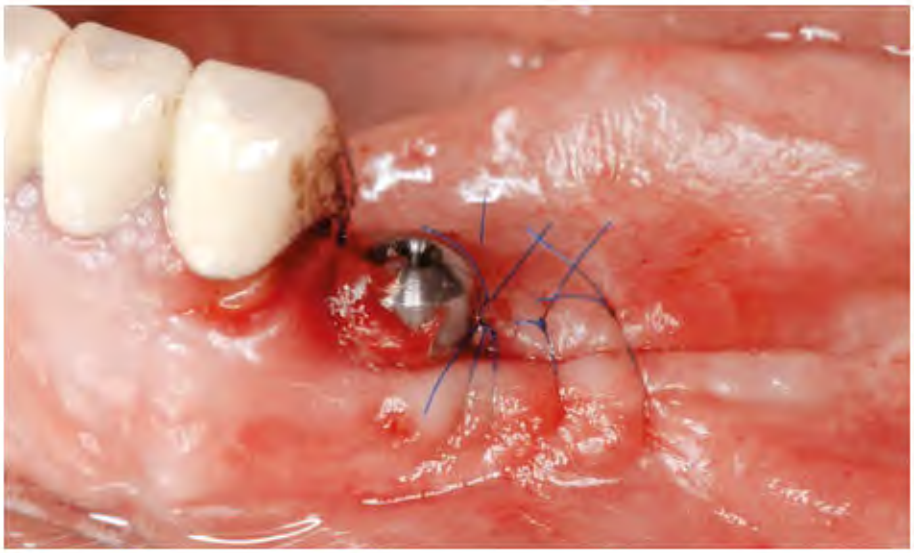


Fig 2-10k Wound closure around exposed implant 33.

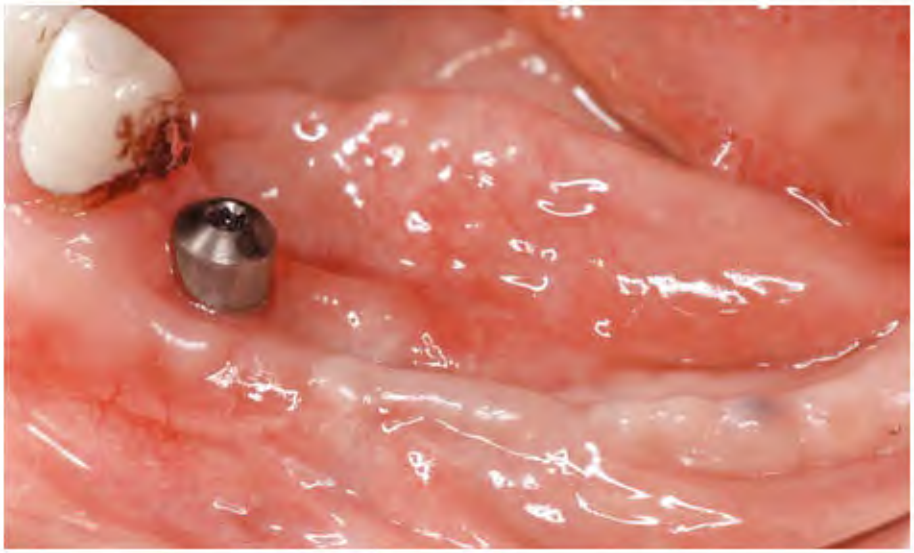


Fig 2-10l Stable healing course.

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Fig 2-10m Residual ridge before exposure. Note the calculus deposit on the healing abutment.

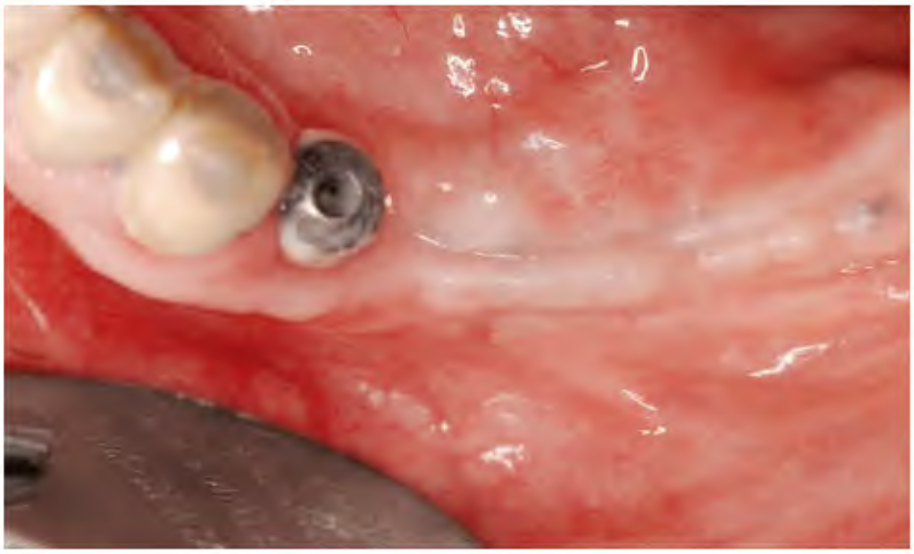


Fig 2-10n The residual ridge has been widened considerably.

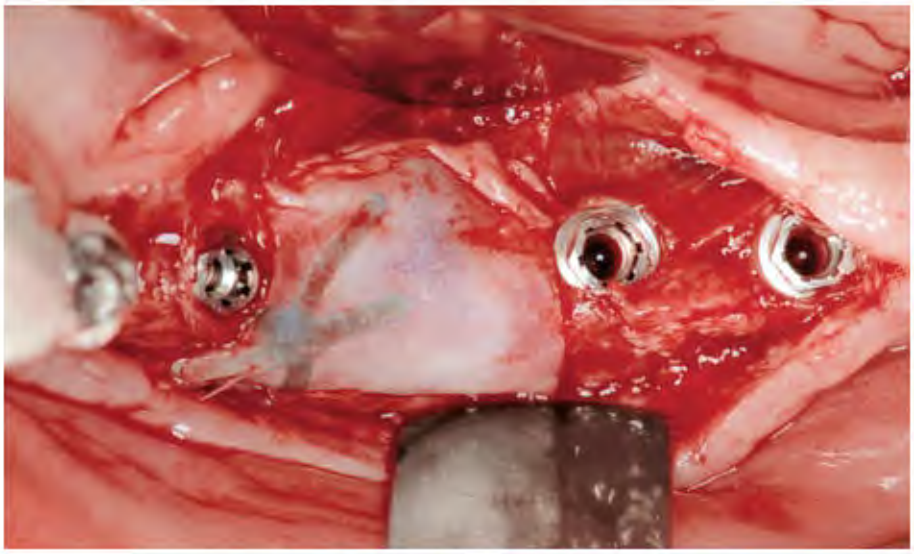


Fig 2-10o Gore-Tex membrane before removal.

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Fig 2-10p Horizontally augmented residual ridge.

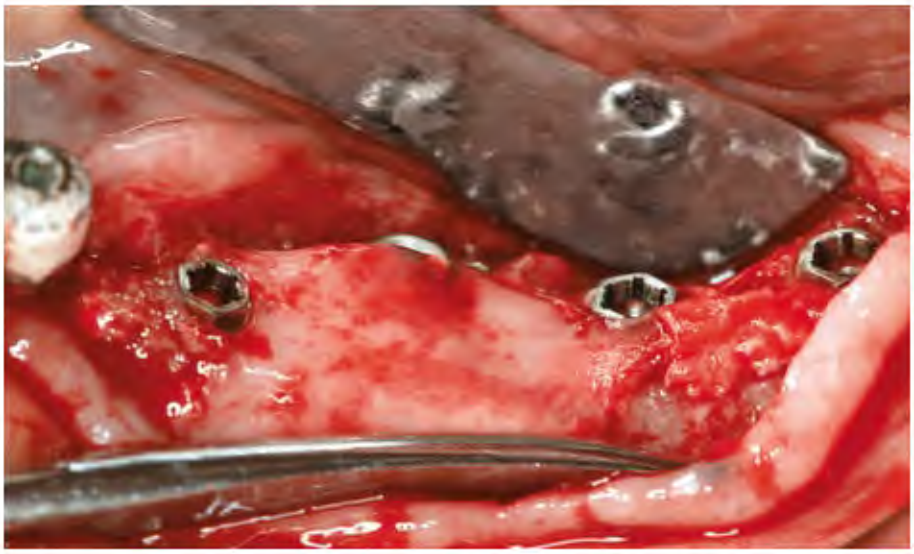


Fig 2-10q Vertically augmented residual ridge. Cover screw 35 has become overgrown with new bone.

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Complication – infection of the membrane

The sutures were gradually removed after 1, 2 and 3 weeks. At the last session to remove the sutures (after 3 weeks), a small region of dehiscence was observed over the membranes in the region of implant 33 (Fig 2-10h). To prevent inflammation, the wound was rinsed twice daily with chlorhexidine mouthwash and treated with chlorhexidine gel. However, this produced only slight improvement, so that mechanical cleansing of the wound with removal of the membrane fragments lying directly below it was undertaken after another 3 weeks. Since no further, visible improvement occurred despite this treatment, we decided to perform more extensive wound revision after a further 3 weeks. The incision was made over the two anterior implants and the buccal and lingual flaps were mobilized slightly (Fig 2-10i). The underlying infected Ossix and Gore-Tex membranes were removed with a safety margin, which also included the titanium reinforcement (Fig 2-10j). When doing so, it is important for no infected

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membrane fragments to remain in situ. The mucous membrane defect over implant 33 was closed by screwing a healing abutment directly onto this implant (Fig 2-10k). After the revision treatment, the inflammation was eliminated and the implants, together with the augmentation, were able to heal undisturbed for the rest of the period scheduled for the healing period (Fig 2-10l).

Exposure

Seven months after they were inserted, the implants were ready to be exposed (see Fig 2-10o). Despite poor oral hygiene and a heavy calculus deposit on healing abutment 33, there were no detectable signs of an inflammatory reaction (Fig 2-10m). The residual ridge already appeared much wider than before the treatment (compare Fig 2-10c and 2-10n). The incision to expose the implants was made centrally in the zone of keratinized gingiva on the residual ridge. The remaining fragments of the non-resorbable Gore-Tex membrane still needed to be removed, necessitating a wider access opening (Fig 2-10o). Removal of the membrane revealed the residual ridge, now augmented in width (compare Fig 2-10d and 2-10p).

The result of the augmentation was clearly apparent both horizontally and vertically (compare Fig 2-10d and 2-10q). It was even necessary to remove excess bone from implant 35, which was located under the membrane, before the healing abutments could be screwed on (Fig 2-10r). The dissected flap was repositioned and fixed into place with sutures (Fig 2-10s).

Prosthetic loading

The sutures were removed after 2 weeks. Healing was already seen to be progressing well at this point (Fig 2-10t). The gingival situation continued to stabilize, allowing the impression to be taken after a further week. At this point, the difference relative to baseline was already clearly apparent (compare Figs 2-10a and 2-10u). For the prosthesis, an occlusal screw-retained, metal-ceramic fixed implant bridge was prepared and loaded onto the implants (Fig 2-10v). While the clinical situation following completion of the treatment is not ideal, it is still greatly improved compared to baseline (Fig 2-10w).

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Fig 2-10r Healing abutments screwed into place.



Fig 2-10s Suturing.



Fig 2-10t Extended zone of attached gingiva.

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Fig 2-10u Reduced occlusal distance to the opposing jaw.



Fig 2-10v Incorporated metal-ceramic fixed implant bridge.



Fig 2-10w Satisfactory final result after the treatment.

The vertical augmentation allowed the lengths of the clinical crowns to be considerably reduced, which is of great significance from an esthetic point of view. The number of inserted

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implants (despite their reduced diameter) was also sufficient to support the structure in the long term. The patient was happy to have a fixed dental prosthesis again after the failure of her previous treatment.

Treatment course

- Implant placement and augmentation (2006)
- 2 months to the revision
- 5 months to exposure
- 4 weeks to impression taking and prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Hubertus Klaus
Dental technology:	Horst Mosch

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Problems and complications

Fracture of an implant with a tooth/implant-supported fixed partial denture

Baseline situation

Two years previously, at another institution, this patient underwent prosthetic restoration of a free-end situation in the right maxilla with a hybrid fixed partial denture (Fig 2-11a). In the interim, the implant screw had worked loose several times. The retaining screw for the hybrid fixed partial denture had fractured inside the implant (Fig 2-11b), and the referring treatment provider's attempts to unscrew the screw fragment from the implant or to remove it by reaming ended in failure. Since any continued implant functionality was thus ruled out, a new prosthetic restoration needed to be discussed with the patient. In view of the unfavorable experiences with the tooth/implant-supported hybrid fixed partial denture, the plan was to provide the patient with a purely implant-supported prosthesis with interlocked compound crowns following removal of the fractured Straumann implant.

Diagnostic tools

- Clinical examination

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- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Removal of the fractured implant, insertion of three plus one implants and augmentation, submerged healing
2. Exposure
3. Prosthetic restoration of the free-end situation with a transocclusal screw-retained fixed implant bridge

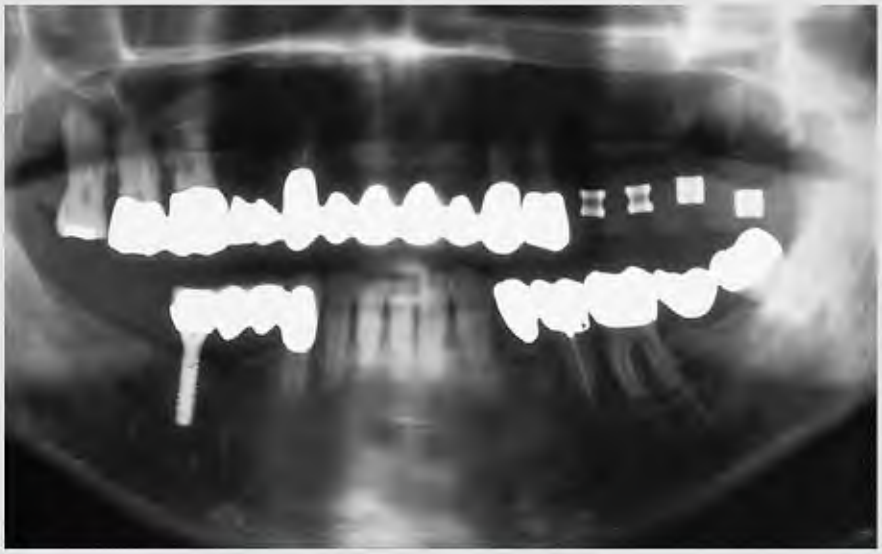


Fig 2-11a Unstable tooth implant-borne prosthesis in the fourth quadrant.



Fig 2-11b Fractured retaining screw.

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Fig 2-11c Severed implant head.



Fig 2-11d Prepared bone beds for the RP implants.



Fig 2-11e The implants have been inserted flush with the bone.

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Fig 2-11f Apical fenestration.

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Fig 2-11g The implant has been removed by reaming out the bone.

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Fig 2-11h Bone defect with preserved vestibular lamella.

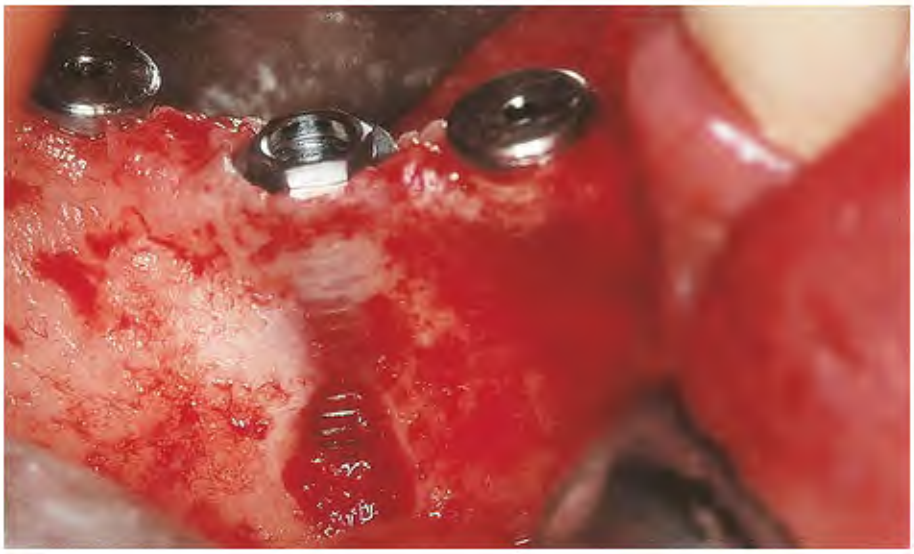


Fig 2-11i Inserted WP implant.

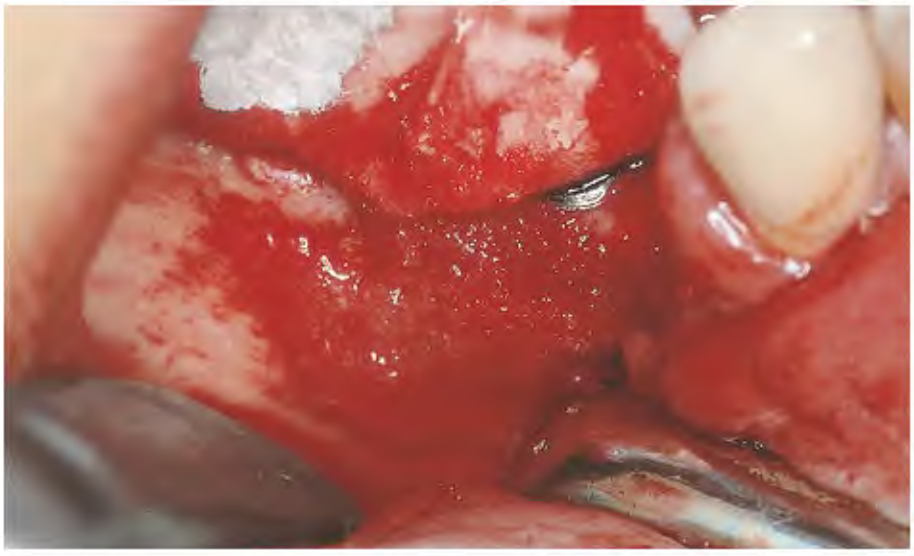


Fig 2-11j Augmentation with bone chips.

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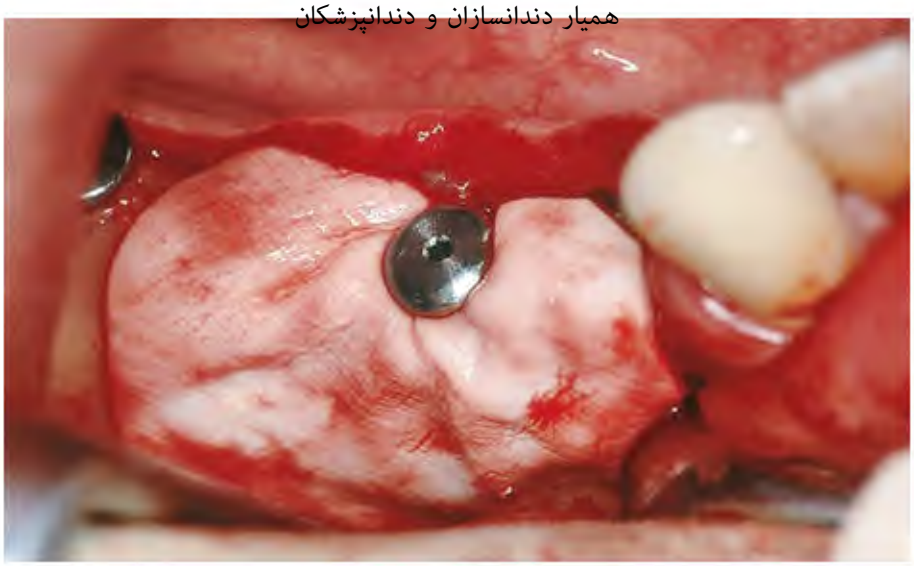


Fig 2-11k Bio-Gide membrane secured with a cover screw.

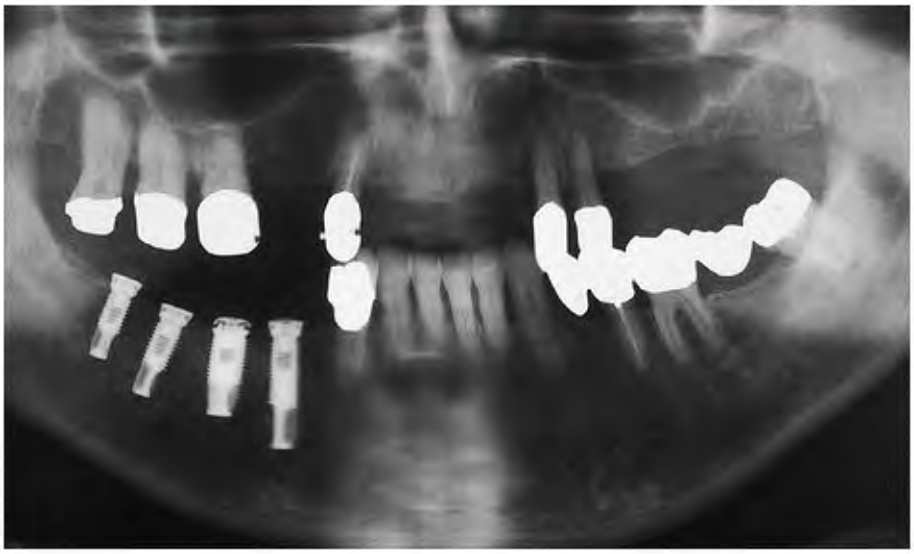


Fig 2-11l Postoperative radiograph.

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Implant placement, implant removal and augmentation

Following a crestal incision and exposure of the operation site, the flared head (“tulip”) of the ITI-Straumann implant was cut off (Fig 2-11c), to allow a trephine of the smallest possible diameter to be used to remove the implant. First, one RP implant was inserted in the region of tooth 44, and two further RP implants in regions 46 and 47 (Fig 2-11d and 2-11e). Part of the body of the fractured implant could be seen shimmering through the very thin buccal bone, making it easier to locate it. The exact site of the implant tip was located via a buccal access at the height of the implant apex. Implant removal was now performed by reaming around the implant with a standardized trephine (Fig 2-11f). The full osseous integration of the implant became apparent following its removal (Fig 2-11g). The difference in diameter between the body and head of the implant could also be seen. Proceeding with caution meant that the buccal bone lamella was almost completely preserved (Fig 2-11h). A WP implant (diameter 5 mm)

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was inserted to ensure sufficient primary stability of the new implant in the resultant defect (Fig 2-11i). The thin buccal bone as well as the buccal access cavity were augmented with the harvested bone chips (Fig 2-11j) and covered with a Bio-Gide membrane secured with the cover screw on the WP implant (Fig 2-11k). These augmentation measures necessitated periosteal slitting to ensure tight wound closure. The postoperative radiograph shows the positions of the implants relative to one another and to the inferior alveolar nerve (Fig 2-11l).



Fig 2-11m Uncomplicated submerged healing.



Fig 2-11n Exposure and insertion of healing abutments.

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Fig 2-11o Clinical situation after 10 years.



Fig 2-11p Follow-up panoramic radiograph after 10 years.

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Exposure and prosthetic loading

An uncomplicated healing period of 6 months (Fig 2-11m) was followed by exposure of the implants and insertion of the healing abutments (Fig 2-11n). Impressions were taken once the soft tissue had healed completely and a transocclusal screw-retained compound crown structure was prepared. The final images show the stable, problem-free clinical and radiologic situation 10 years following incorporation of the prosthetic restoration (Fig 2-11o and 2-11p).

Treatment course

- Implant removal and implant placement with augmentation (1996)

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- 6 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Michael Weber
Dental technology: Horst Mosch

Problems and complications

Failed augmentation with a bone block in a patient with an extremely narrow residual ridge

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Baseline situation

A 41-year-old woman had lost her posterior teeth while she was still a student and has not had them replaced to date. Tooth 34 has migrated distally into the gap (Fig 2-12a). years of disuse had resulted in severe residual atrophy, particularly in the horizontal direction; this was already apparent to the naked eye (Fig 2-12b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Augmentation with a bone block graft
2. Implant placement
3. Exposure and definitive prosthetic loading

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Fig 2-12a Free-end situation and tooth 34, which has migrated into the gap.



Fig 2-12b Extremely narrow residual ridge.

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Augmentation

A bone block graft appeared to be the best option for the augmentation of the virtually knife-edge residual ridge (Fig 2-12c). To spare the patient the added surgical trauma of a bone graft donor site, the plan was to use a ready-made block of Tutoplast (Zimmer Dental) cancellous bone (15 × 15 × 9 mm). Once the operation site was opened up, a reamer was used to prepare the residual ridge to take the block (Fig 2-12d). The outer cortical bone wall was perforated in several places to encourage a better blood supply (Fig 2-12e). The bone block was trimmed to fit the prepared bone bed until the two elements were congruent. After this, the bone block was fastened onto the residual ridge with osteosynthesis screws (Fig 2-12f). The sharp edges were rounded off and smoothed out and the gaps mesially and distally of the graft filled with the

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harvested bone chips and with Bio-Oss (Fig 2-12g). No covering membrane was used. Slits were cut into the periosteum on both the lingual and buccal sides and the operation site was closed by tension-free and saliva-proof suturing. The sutures were removed after 2 and 3 weeks. The clinical situation appeared to stabilize as time went on (Fig 2-12h), although one suspect site in the augmented area was found on close examination: this was a small dehiscence in region 36 on the lingual side (Fig 2-12i). The patient was informed about the risk of a dehiscence. She was instructed to rinse with chlorhexidine twice daily and to apply chlorhexidine gel to the problem area. The situation continued to be stable for about 4 months after augmentation. It then deteriorated suddenly: multiple fistulae discharging pus developed over the entire distal area (Fig 2-12j). Antibiotic treatment with metronidazole was initiated, supported by intensive rinsing. Wound revision was to take place as soon as the acute symptoms subsided.

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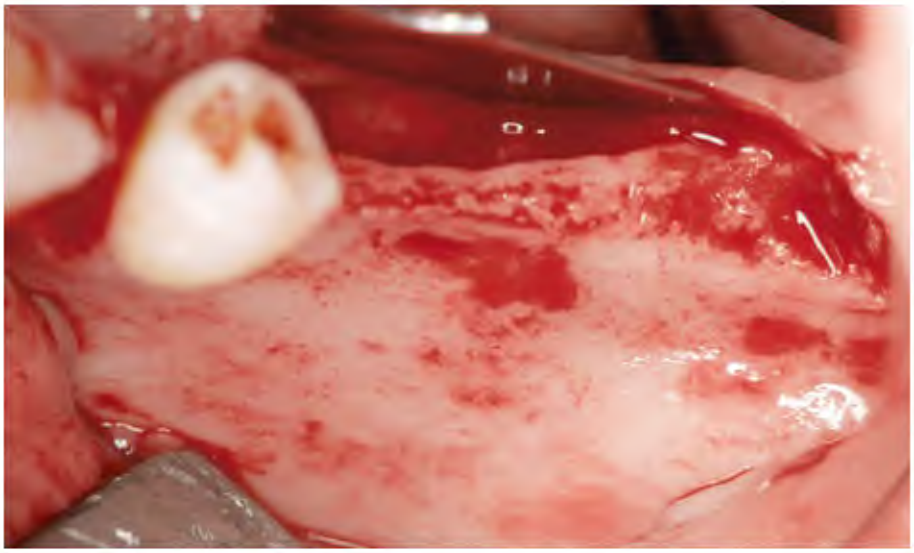


Fig 2-12c Severe horizontal atrophy.



Fig 2-12d Prepared bone bed.

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Fig 2-12e Cortical bone perforations for a better blood supply.

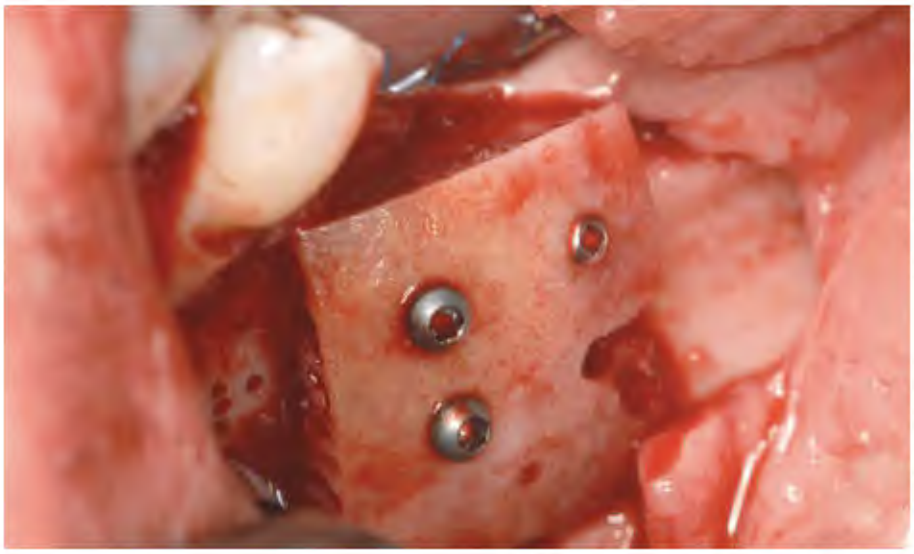


Fig 2-12f Bone block, secured into place with osteosynthesis screws.

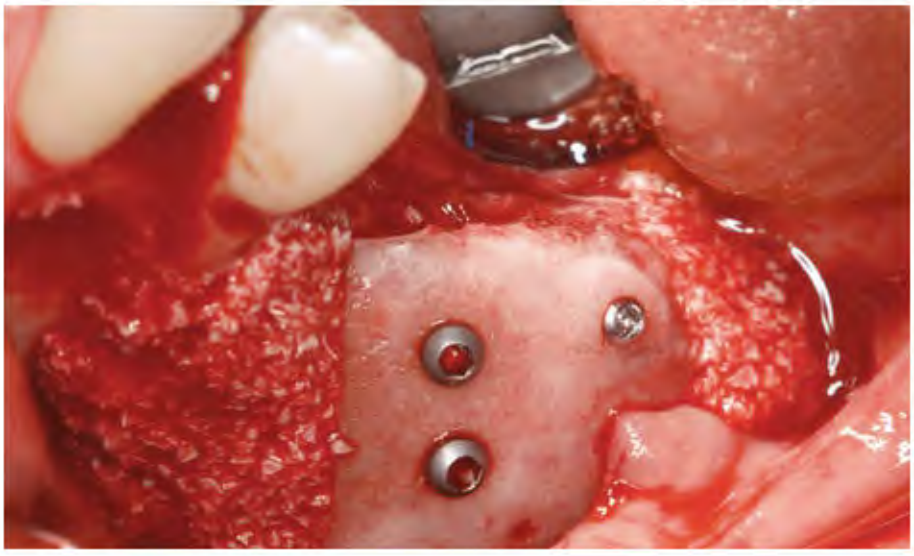


Fig 2-12g Harvested bone chips and Bio-Oss layered onto the block.

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Fig 2-12h Apparently normal wound healing.



Fig 2-12i Small lingual dehiscence in the region of tooth 36.



Fig 2-12j Multiple fistulation.

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Fig 2-12k CBCT scan images following the onset of complications.

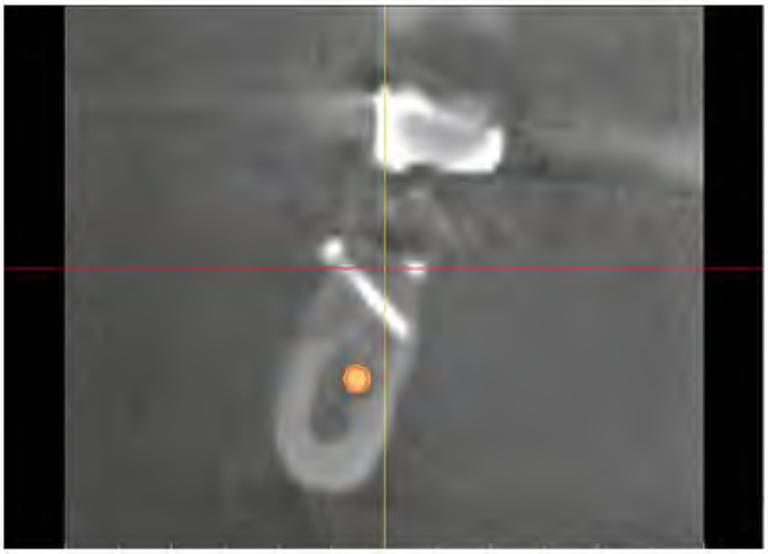


Fig 2-12l Good regeneration in region 36.



Fig 2-12m Loss of augmentation material in region 37.

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Fig 2-12n Planning the implants.

Wound revision and implantation

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A new CBCT scan was performed to clarify the situation (Fig 2-12k). Bone appeared to have been formed in the anterior region of the bone block (Fig 2-12l). In the distal region, where the last screw was located, there was a dark area on the radiograph, where no bone had formed (Fig 2-12m). However, despite the partial loss of augmentation material, sufficient bone was still available to allow the insertion of the implants with renewed augmentation to be planned together with the revision (Fig 2-12n). Sufficient bone was available for implant 35, but both vertical and horizontal augmentation was required at the site of implant 36, (Fig 2-12o) and, above all, around implant 37 (Fig 2-12p). When the wound area was opened up, we found that the anterior half of the block graft and the harvested bone chips and Bio-Oss were well-integrated mesially, as was to be expected from the CBCT scan image (Fig 2-12q). The distal fragment of the block graft was a very different color (white) and appeared to be necrotic. This fragment and the harvested bone chips and Bio-Oss in the distal region had not become incorporated, but were encapsulated with granulation tissue. All of the necrotic material, including the granulation tissue, was carefully removed and the bone still in situ extensively refreshed with a reamer (Fig 2-12r).

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Fig 2-12o Implant 36 in cross-sectional view.

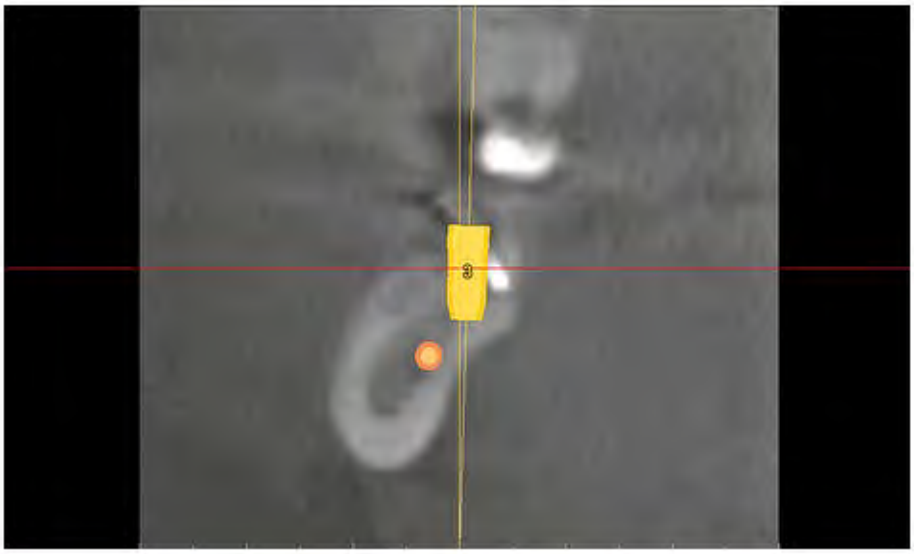


Fig 2-12p Vertical augmentation is needed at the site of implant 37.



Fig 2-12q Mesially healed and distally necrotic bone graft.

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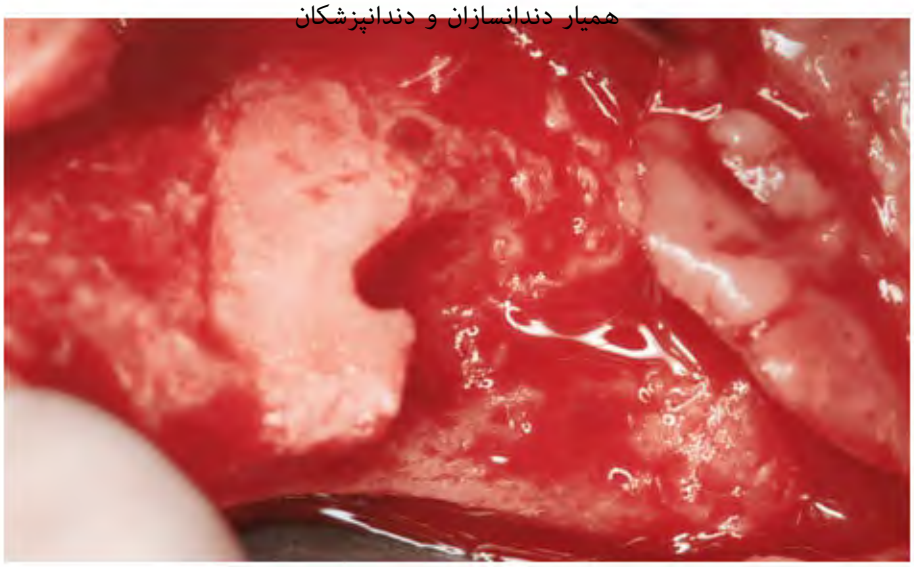


Fig 2-12r Refreshed bone bed.



Fig 2-12s Fractured screw.



Fig 2-12t Necrotic bone block fragment.

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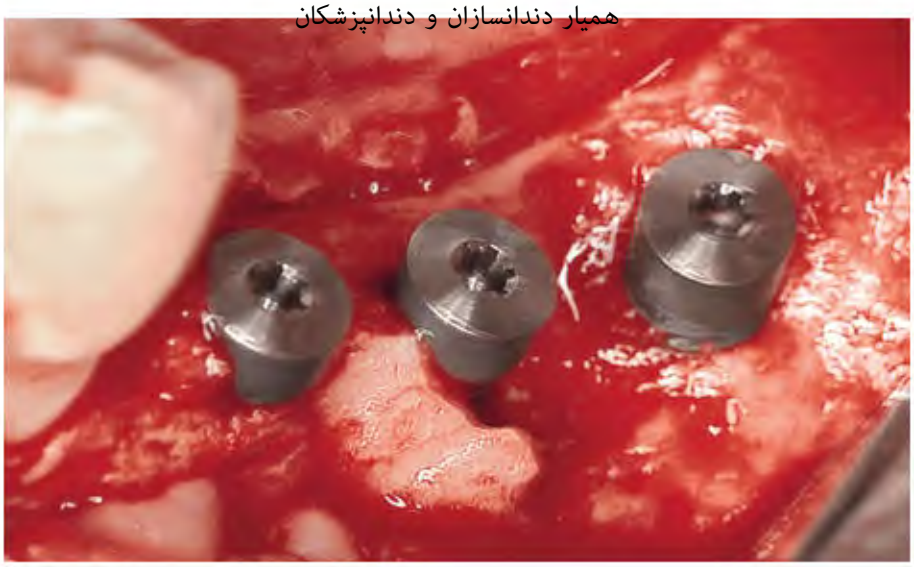


Fig 2-12u Firmly inserted implants.

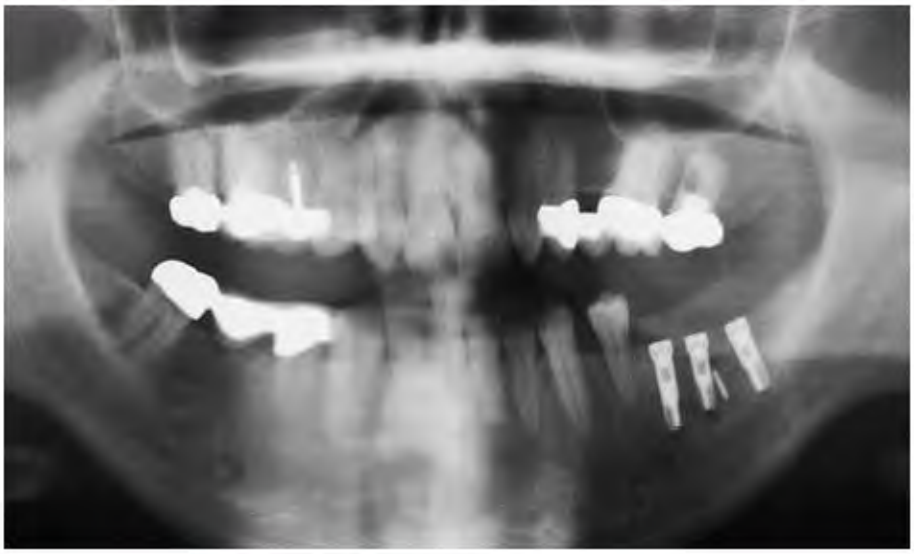


Fig 2-12v Postoperative panoramic radiograph.



Fig 2-12w Clinical situation before the exposure.

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Fig 2-12x Exposed implants.

When the screws were removed, there was an added complication: one of the titanium Meisinger screws had probably undergone osseous integration during graft healing, and fractured during removal (Fig 2-12s). To avoid causing any further bone loss, the screw fragment was left in the jaw. The necrotic block fragment was not joined to the bone; instead, its underside was fully encapsulated by granulation tissue (Fig 2-12t). Once the area was thoroughly cleaned and disinfected, three implants were stably inserted into the planned sites (Fig 2-12u). The defects around the implants were filled with pure Bio-Oss and covered with a Bio-Gide membrane. The postoperative panoramic radiograph shows the position of the implants and of the augmentation material, and also of the fractured screw fragment located deep inside the jaw (Fig 2-12v).

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Exposure

The implants were exposed 7 months after placement (Fig 2-12w). The incision was made on the residual ridge directly over the implants. Lifting the flap revealed the augmentation material, which, while not optimal, nevertheless appeared acceptable under the circumstances (Fig 2-12x). The cover screws were unscrewed and replaced with healing abutments (Fig 2-12y). The repositioned flap was fixed into the desired position with Gore-Tex sutures (Fig 2-12z). Two weeks later, the sutures were removed, and the prosthetic treatment could then take place after another 2 weeks. For the prosthetic restoration, a screw-retained metal-ceramic fixed implant bridge was made and fitted into place (Fig 2-12aa).

Despite the numerous complications, the treatment was completed to the patient’s full satisfaction. While the teeth and the residual ridge had been reconstructed, two details could still be improved. The gap between teeth 33 and 34 is troublesome, but could be closed using orthodontic methods, and the height of the crowns on the implants needed to be reduced due to the elongated teeth in the opposing jaw.

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Fig 2-12y Healing abutments screwed into place.

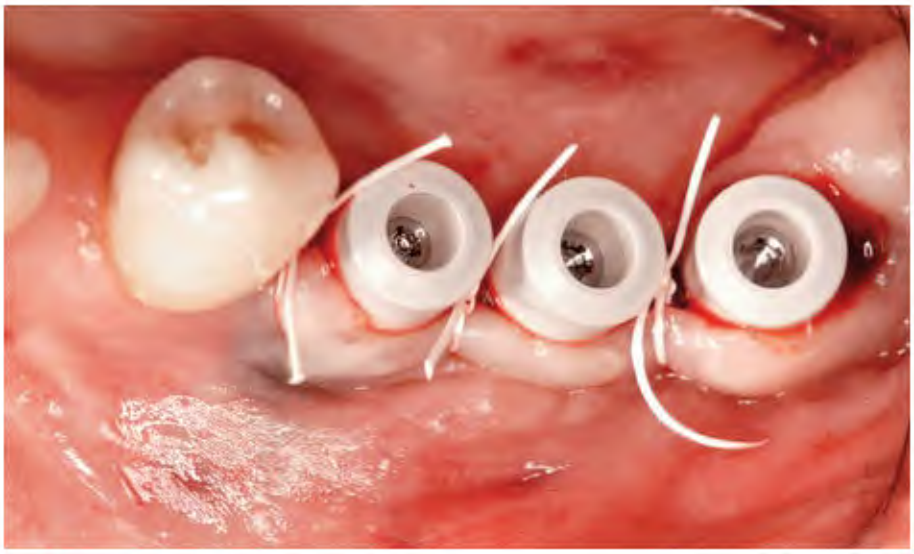


Fig 2-12z Widening the zone of attached gingiva.



Fig 2-12aa Loading with the prosthesis following completion of the treatment completion.

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Treatment course

- Augmentation (2007)
- 5 months to revision and implant insertion
- 7 months to exposure
- 4 weeks to impression taking and prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Hubertus Klaus
Dental technology:	Horst Mosch

Immediate loading of provisional implants

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Typical treatment course

Bilateral free-end situation

Baseline situation

A woman presented with bilateral free-end situations in the mandible, and anterior teeth 34 to 43, which were worth preserving, but with an inadequate prosthetic restoration, which needed replacing (Fig 2-13a). The plan was to fit purely implant-supported fixed partial dentures on both sides. Provisional implants were planned, to support a fixed provisional restoration, which was to be left in situ even during the healing phase.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

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1. Insertion of three definitive implants on each side and of provisional implants with immediate loading, submerged healing
2. Exposure
3. Loading with cement-retained metal-ceramic fixed partial dentures on customized abutments



Fig 2-13a Bilateral free-end situation in the mandible with inadequate restoration of the anterior teeth.

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Implant insertion

Once the old dental prosthesis was removed, three Brånemark System implants were initially inserted into the right mandible (Fig 2-13b). To enable immediate loading with a provisional prosthesis, two provisional implants were placed between the definitive ones (Fig 2-13c). For this purpose, the 14-mm-long provisional implants were shortened by approx 2 mm at the apex to avoid damage to the inferior alveolar nerve (see postoperative radiograph, Fig 2-13g). The same procedure was followed on the left side (Fig 2-13d).

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Fig 2-13b The three definitive Brånemark System implants inserted.

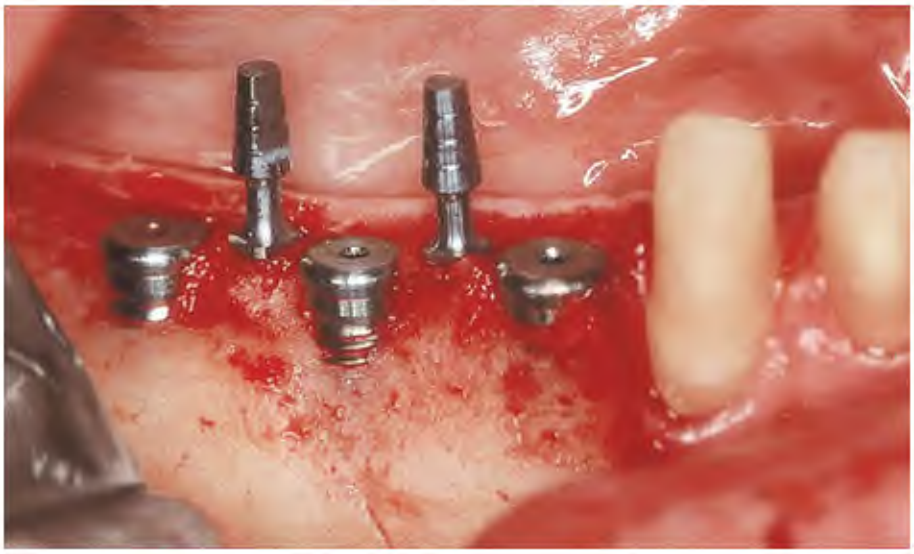


Fig 2-13c Two immediate provisional implants were placed between the definitive ones.

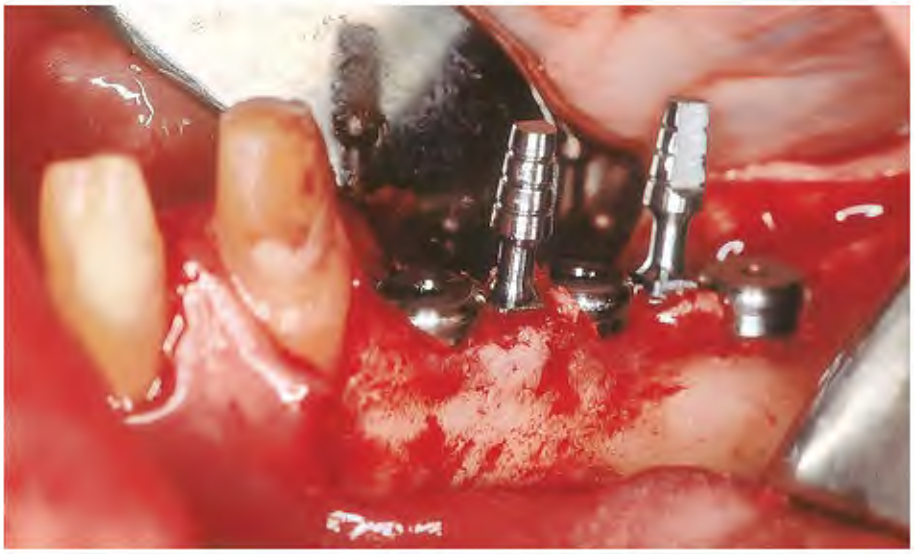


Fig 2-13d Implant placement on the left side.

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Fig 2-13e Aligning the provisional implants.



Fig 2-13f Quick immediate provisional restoration.

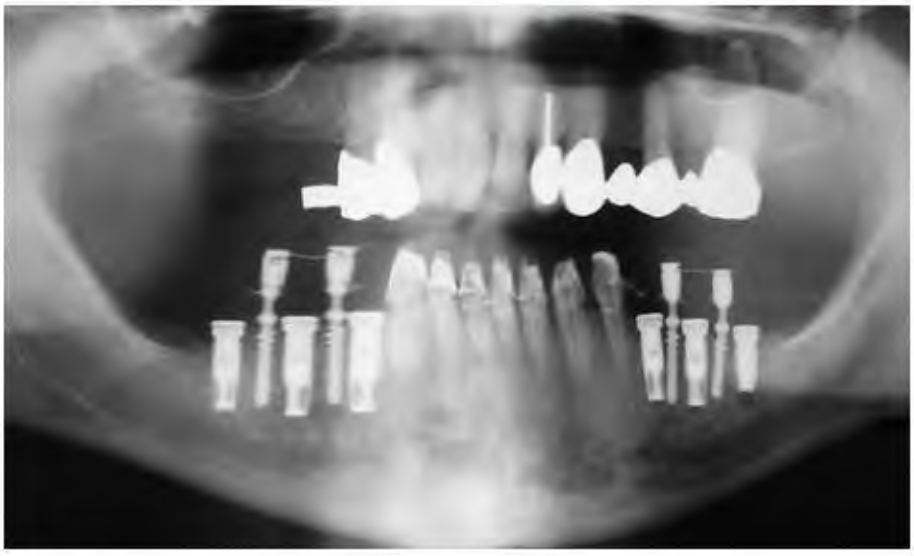


Fig 2-13g Postoperative radiograph after implant placement.

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Fig 2-13h Long-term provisional.



Fig 2-13i Exposed definitive implants.



Fig 2-13j Reshaped long-term provisional.

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Fig 2-13k Implant bridge fitted on the right side.



Fig 2-13l View of the left side.

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The harvested bone chips were layered onto the buccal side and the operation sites were tightly sutured (Fig 2-13e). Using a prepared thermoplastic foil, an immediate provisional restoration was made out of Trim (Harry J. Bosworth Company) immediately after the operation and incorporated (Fig 2-13f). The postoperative radiograph shows the alignment of the implants and their positions relative to the underlying nerves (Fig 2-13g). One week later, the immediate provisional restoration was exchanged for a metal-reinforced, long-term provisional that had been made in the laboratory in the interim (Fig 2-13h). The long-term provisional was supported by the seven preserved anterior teeth and also by the provisional implants in regions 35, 36 and 45, 46.

Exposure and prosthetic loading

After a 5-month healing period, the definitive implants were exposed (Fig 2-13i). Once the

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healing abutments were fitted, the long-term provisional needed to be trimmed back slightly to avoid contact with them (Fig 2-13j). The definitive restoration consisted of cement-retained fixed implant bridge made using a cast coping (see page 338; Figs 2-13k and 2-13l). A conventional metal-ceramic crowns, not linked to the implant-supported fixed bridges, was used to restore the anterior teeth.

Treatment course

- Implant placement and immediate loading (2001)
- 5 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Ivonne Lewik

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Atypical treatment course

Customizing provisional implants

Baseline situation

Many years ago, this patient underwent prosthetic restoration of the fourth quadrant in the form of a fixed partial denture bridging teeth 43 to 48 (Fig 2-14a). However, tooth 48 could no longer be preserved due to apical osteitis and needed to be extracted (Fig 2-14b). The patient wanted a new fixed prosthesis, which she also wanted to be in place while the definitive implants were healing.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

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1. Extraction with immediate implant placement of three to four definitive and two provisional implants; immediate loading
2. Exposure
3. Definitive loading with a purely implant-supported, transocclusal, screw-retained metal-ceramic fixed bridge



Fig 2-14a Baseline clinical situation. Non-preservable fixed partial denture bridging teeth 43 to 48.



Fig 2-14b Apical osteitis at distal fixed partial denture abutment 48.

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Extraction and implant placement

Once the fixed bridge was cut through and removed, tooth 48 was extracted atraumatically (Fig 2-14c), and the extraction was followed immediately by the insertion of four Brånemark System implants in the regions of teeth 44 to 47 (Fig 2-14d). In addition, two provisional

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implants (K.S.I. Bauer screws) were placed between the definitive implants (Fig 2-14e). Before insertion, the distal provisional implant needed to be shortened with side cutting pliers to minimize the risk of nerve damage (Fig 2-14f). The provisional implants also needed occlusal trimming to avoid interference with the opposing teeth (Fig 2-14g).



Fig 2-14c Removal of the bridge and extraction of tooth 48.



Fig 2-14d Insertion of four Brånemark System implants.

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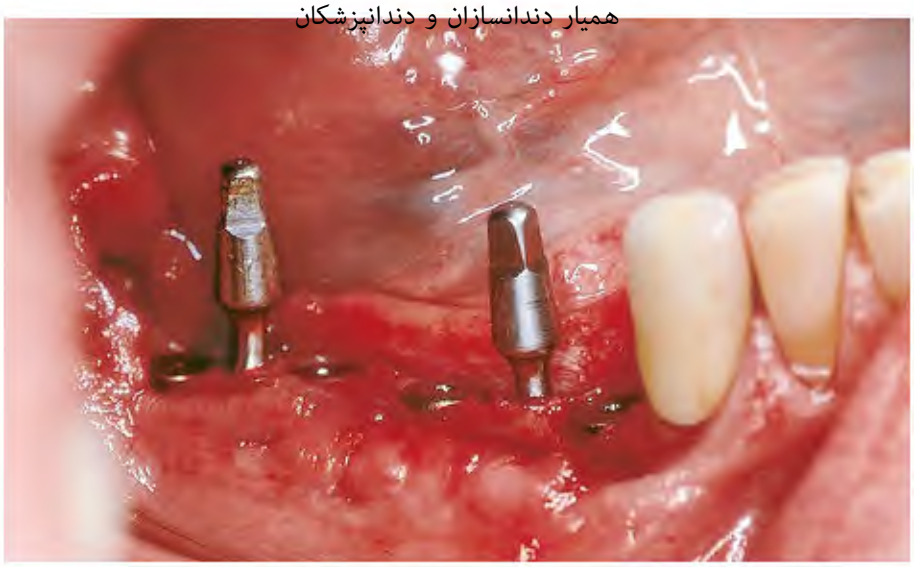


Fig 2-14e Insertion of two K.S.I. Bauer screws.



Fig 2-14f Postoperative radiograph.



Fig 2-14g Customizing the heads of the provisional implants.

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Fig 2-14h Long-term provisional restoration.

To increase the stability of the long-term provisional restoration, the crown of tooth 43 was removed and a metal-reinforced, provisional fixed partial denture was made with the two provisional implants and tooth 43 as abutments (Fig 2-14h).

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Fig 2-14i Radiograph taken following exposure.

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Fig 2-14j Fitting the EsthetiCone abutments.



Fig 2-14k Occlusal record base screwed into place.

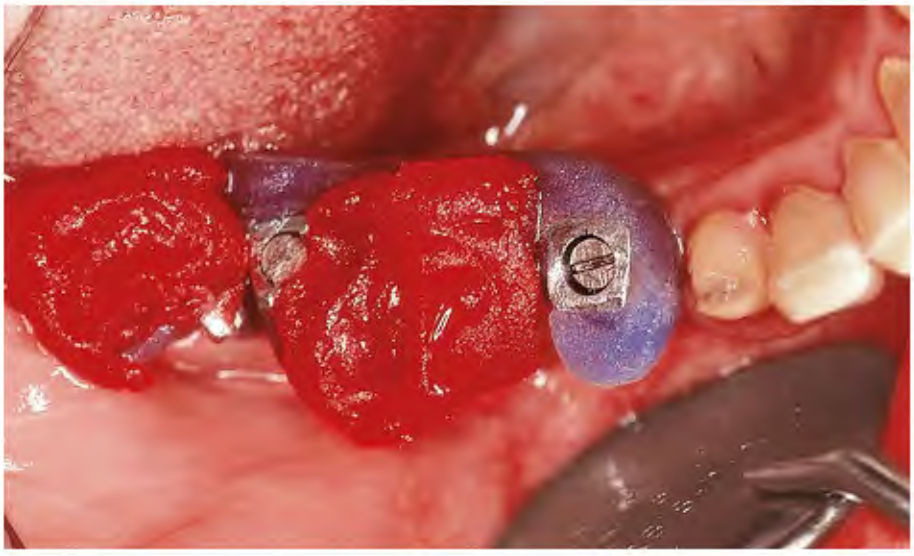


Fig 2-14l Stable occlusal record.

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Fig 2-14m Occlusal record on the cast.



Fig 2-14n Metal framework.

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Exposure, occlusal record and laboratory methods

Following a healing period of 5 months, the implants were exposed and fitted with healing abutments of reduced diameter (4.1 mm) due to the restricted space available (Fig 2-14i). After some minor corrections, the patient was able to continue wearing the long-term provisional prosthesis. We waited for full healing of the peri-implant soft tissue was before taking the impression. EsthetiCone (Nobel Biocare) abutments were screwed on to allow the creation of a transocclusal screw-retained fixed implant bridge (Fig 2-14j). Once the impression was taken, a screw-retained occlusal record base was made on the definitive cast, taking the provisional implants into account (Fig 2-14k). Very precise occlusal recording was achieved with Pattern Resin (GC America) on the screw-retained record base (Fig 2-14l). Moreover, the record base also allowed the precision of the definitive cast to be checked (Fig 2-14 m). The casts were articulated in this position.

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Fig 2-14o Finished prosthesis.

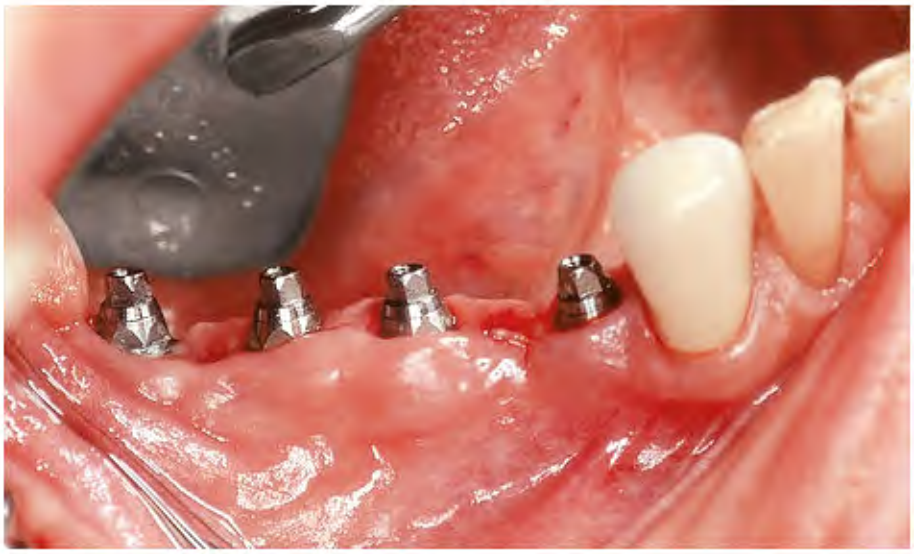


Fig 2-14p Removal of the provisional implants.



Fig 2-14q The complete provisional restoration.

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The provisional implants were removed from the master cast and the definitive fixed partial denture made in one step (Figs 2-14n and 2-14o).

Removal of the provisional implants and incorporation of the prosthesis

Since the heads of the provisional implants had been filed down, they could no longer be removed with the insertion wrench. It was only possible to twist out the provisional implants with great effort using pliers (Fig 2-14p). The complete provisional prosthesis following removal of the K.S.I. Bauer screws can be seen in Fig 2-14q; note the apical shortening of the distal implant. Following transocclusal screw retention of the definitive fixed implant bridge, only slight traces of the provisional implants were still visible directly after their removal (Fig 2-14r). The post-treatment radiograph confirms the precise positioning of the superstructure (Fig 2-14s).

Continued follow-up

The clinical situation after 15 years of functional use was examined and photographed at a follow-up assessment (Fig 2-14t). In these 15 years, the gum had receded slightly, revealing the edges of the EsthetiCone abutments. The ceramic veneer also seems to show some wear and the occlusal fillings have discolored. No complications have occurred throughout this time, and the patient feels as if the implant-supported prostheses are her own teeth. After 15 years, the panoramic radiograph also shows a stable osseous situation around the implants (Fig 2-14u).

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Fig 2-14r Transocclusal screw-retained fixed implant bridge.

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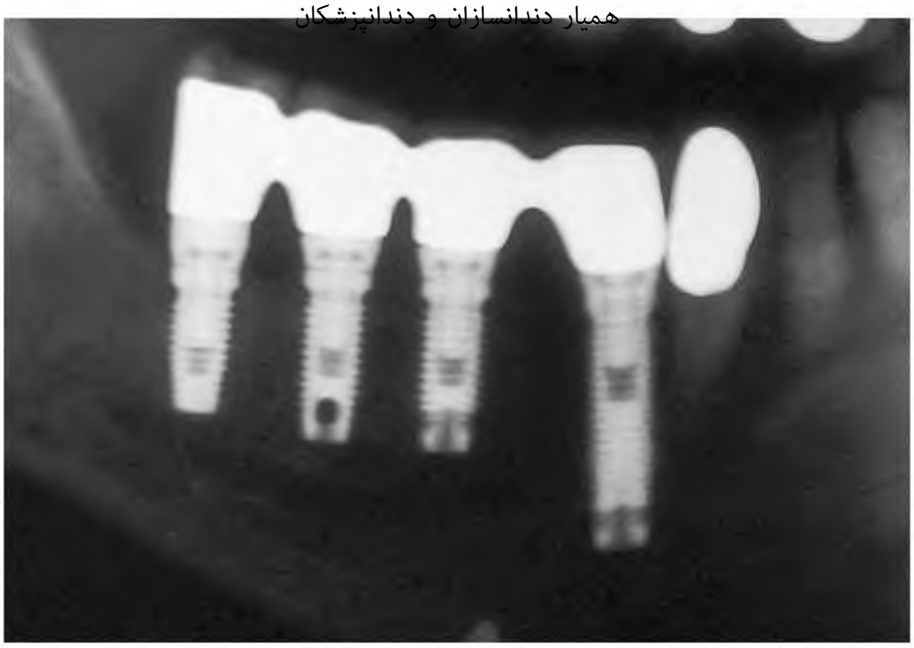


Fig 2-14s Panoramic radiograph following treatment completion.



Fig 2-14t Clinical situation after 15 years.

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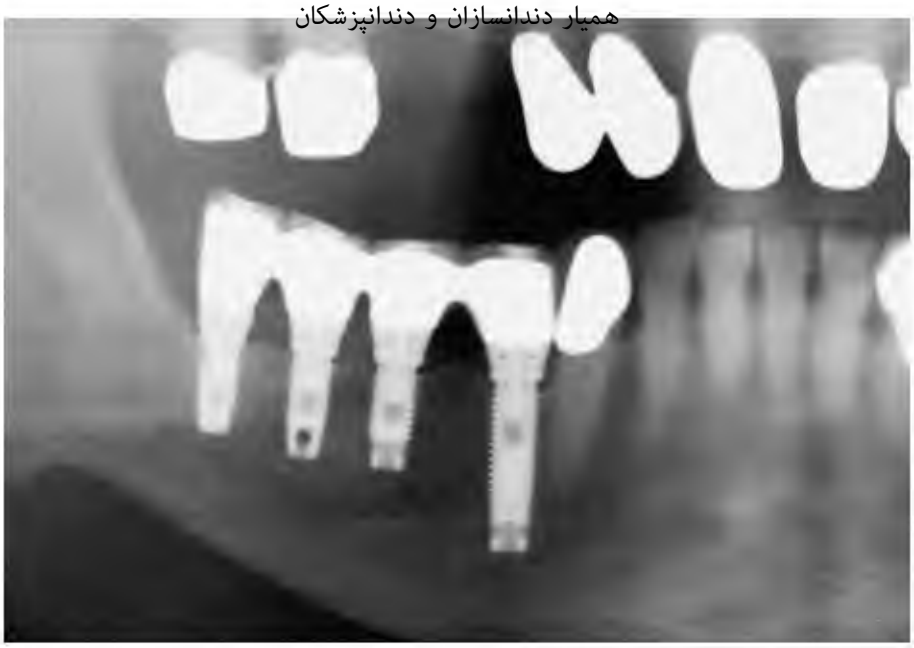


Fig 2-14u Radiologic status after 15 years.

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Treatment course

- Implant placement (1996)
- 5 months to exposure
- 4 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Fernando Abrantes

Problems and complications

Loosened blade implant, provisional implants to protect the augmentation material

Baseline situation

Five years ago, at another clinic, this patient had undergone prosthetic restoration in the right mandible, consisting of a blade endosteal implant and a tooth/implant-supported fixed partial denture bridging teeth 43 to 46/47 (Fig 2-15a). At the first examination, the

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entire prosthesis exhibited grade II loosening and was therefore not preservable. Extended radiologic diagnosis by CBCT showed a zone of marked peri-implant radiolucency as a sign of chronic inflammatory bone destruction (Figs 2-15b and 2-15c).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant analysis
- Dental cast analysis

Treatment plan

1. Removal of the blade endosteal implant, augmentation and immediate loading of a prosthesis onto the provisional implants
2. Insertions of definitive implants
3. Exposure
4. Metal-ceramic fixed implant bridge on three to four implants

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Fig 2-15a Old prosthetic restoration loaded onto a blade implant.



Fig 2-15b Visible osteolysis on the panoramic radiograph.

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Fig 2-15c Osteolysis in the cross-sectional view.

Removal of the blade implant

Although no acute inflammatory mucosal reaction was found around the implant following removal of the fixed partial denture (Fig 2-15d), an incision into the gum revealed circular bone defects around the implant posts of the highly loosened Linkow blade endosteal implant, now surrounded by soft tissue (Fig 2-15e). Once the bone bridge between the abutment posts was stripped back and the distal wing freed, the implant was removed without difficulty (Fig 2-15f). The full extent of the bone destruction was clearly revealed only following removal of the granulation tissue (Fig 2-15g).

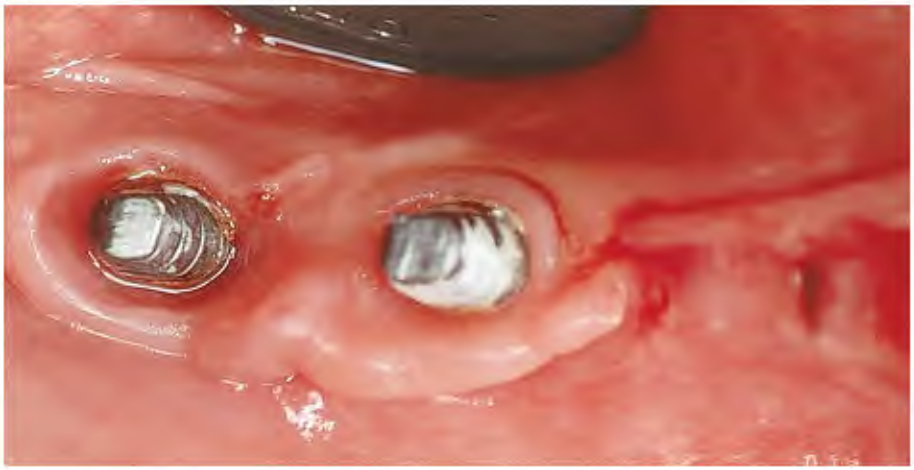


Fig 2-15d No visible pathology following removal of the fixed partial denture.

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Fig 2-15e Extensive peri-implant bone defects.



Fig 2-15f Explanted blade implant.

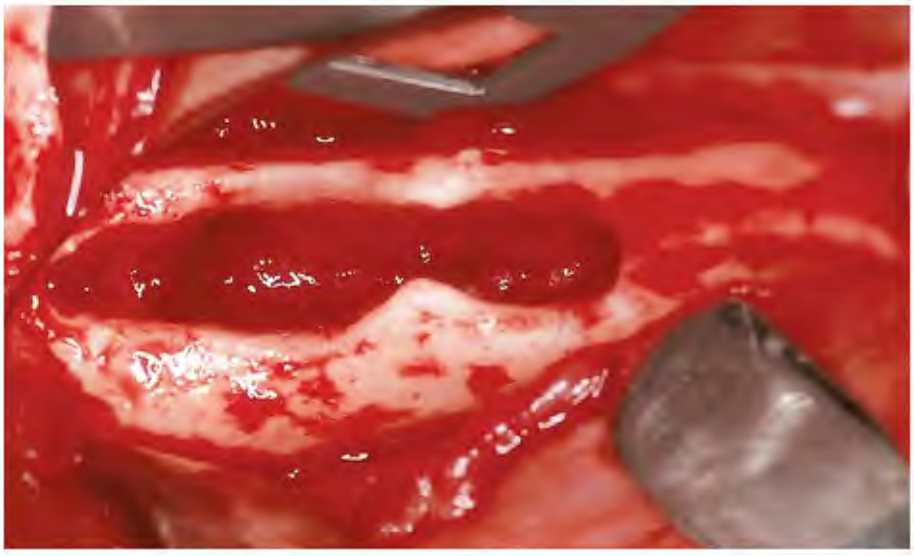


Fig 2-15g Defect following removal of the granulation tissue.

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Fig 2-15h Insertion of two IPIs mesially of the defect.

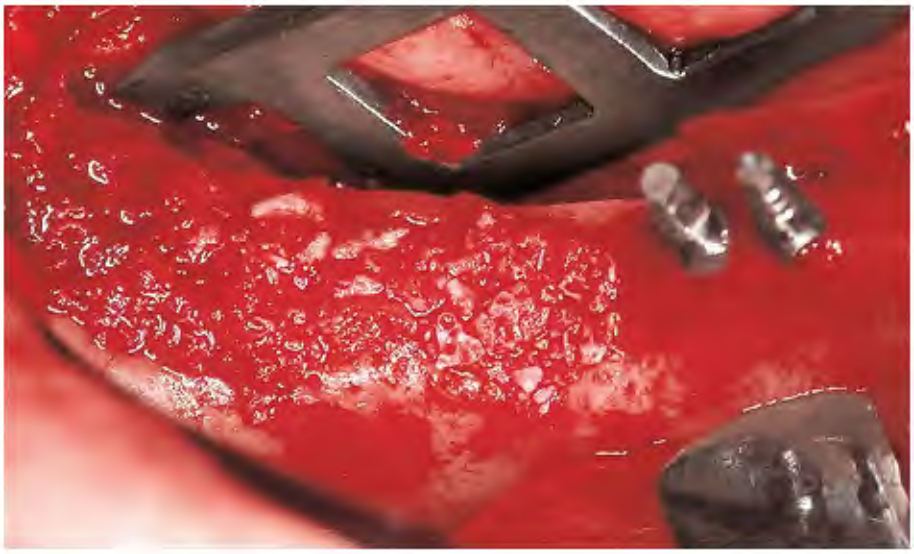


Fig 2-15i Augmentation.

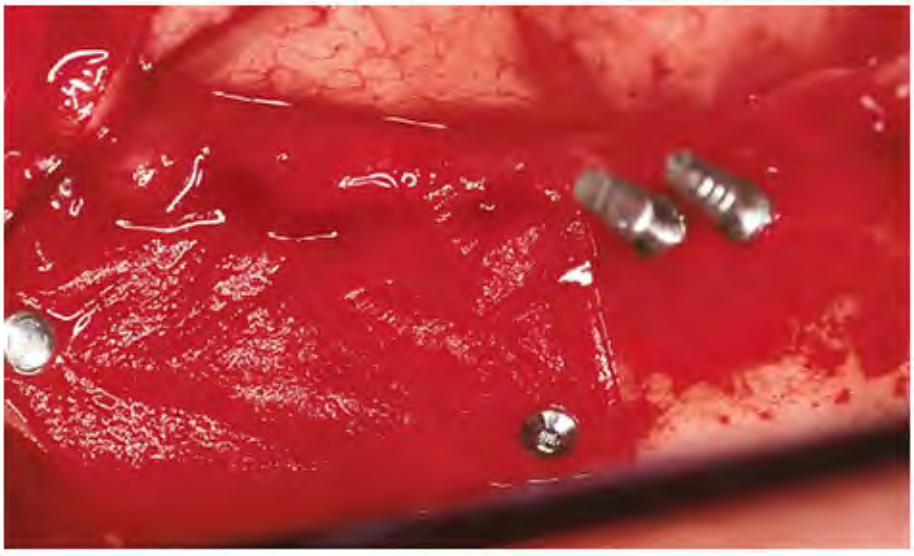


Fig 2-15j Securing the membrane.

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Fig 2-15k Tightly sutured wound. Adjustment of the heads of the IPIs.

Insertion of provisional implants and augmentation

Between the bone defect and terminal tooth 43, there was still sufficient space for the insertion of two immediate provisional implants (IPIs; Fig 2-15h). For the regeneration, the bone defect was filled with a mixture of autologous bone and bone substitute (Bio-Oss; Fig 2-15i). The augmented region was covered with a Bio-Gide membrane and the membrane secured into place with small titanium pins (Fig 2-15j). Following periosteal slitting, the operation site was tightly sutured and the heads of the provisional implants shortened to provide occlusal space for the provisional restoration (Fig 2-15k).

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Provisional restoration

Terminal tooth 43 and the two provisional implants provided abutments that could be used to anchor a provisional fixed bridge, allowing the augmentation to regenerate undisturbed. A prepared thermoplastic foil was used to make a provisional immediate fixed bridge out of Trim and to incorporate it directly after the operation (Fig 2-15l). After 1 week, this immediate provisional was exchanged for a metal-reinforced fixed bridge made in the laboratory (Fig 2-15m).

Implant placement

A follow-up radiograph of the augmentation was taken following an uncomplicated healing phase of 6 months. This showed good osseous regeneration in the region of the former defect (Fig 2-15n and 2-15o). The augmented area was revealed following a crestal incision (Fig 2-15p).

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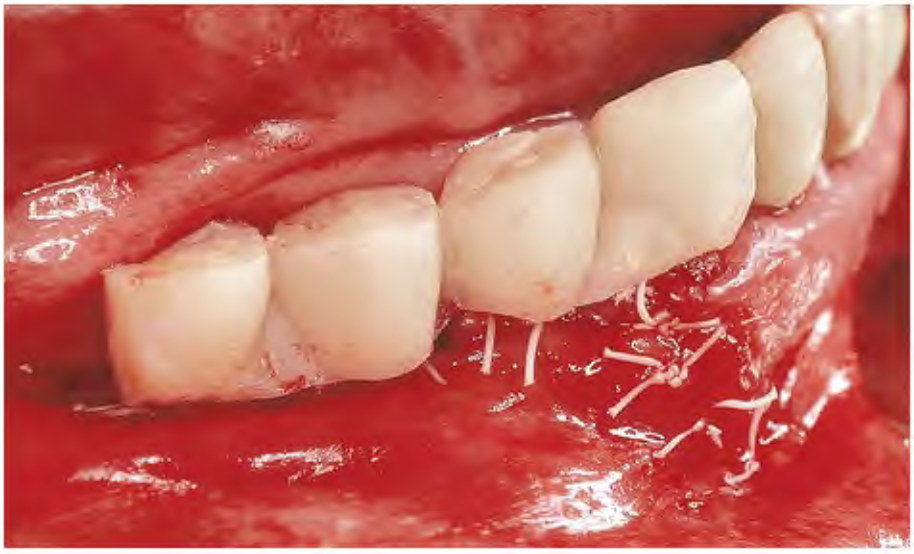


Fig 2-15l Immediate provisional restoration.



Fig 2-15m Long-term provisional.

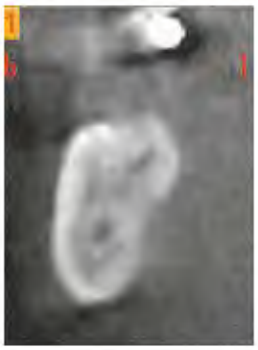


Fig 2-15n Osseous regeneration in the cross-sectional view.

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Fig 2-15o Osseous regeneration on the panoramic radiograph.



Fig 2-15p Clinical picture of the augmentation.



Fig 2-15q Checking the alignment of the implants.

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Fig 2-15r Insertion of four OSSEOTITE implants.

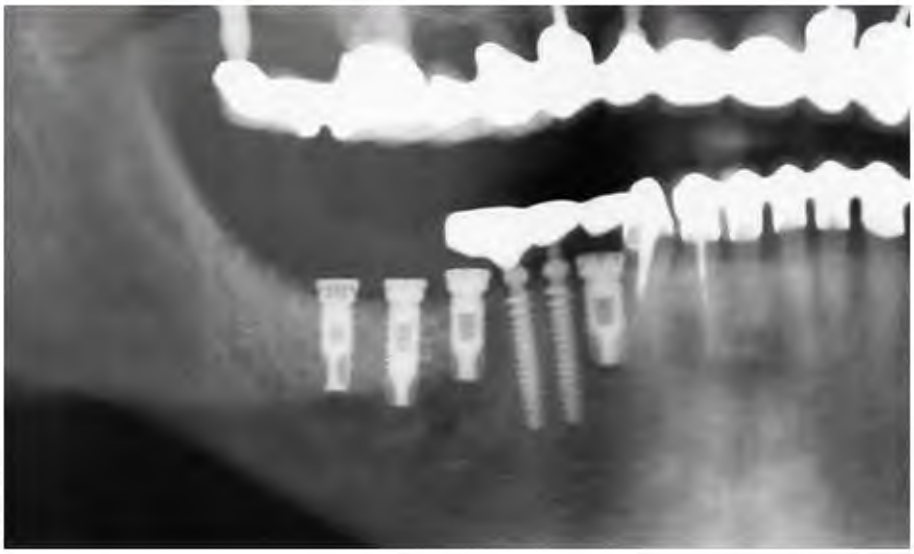


Fig 2-15s Panoramic radiograph after the implant placement.

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Attention: ***The regeneration potential of bone defects depends not only on their size, but also on their configuration. Even extensive defects can be regenerated almost in full if they are bordered by autochthonous bone on several sides. It is much more difficult to achieve regeneration when faced with one- or two-wall defects.***

An implant bed was prepared between terminal tooth 43 and the provisional implants, along with three further ones in the newly regenerated bone. The alignment of the implants was checked with direction indicators (Fig 2-15q). Four OSSEOTITE (Biomet 3i) implants were inserted into the prepared bone beds (Fig 2-15r).

The bone supply was adequate at all the sites, so that purely prophylactic augmentation was performed with the harvested bone chips, to be followed by saliva-proof wound closure with single button sutures. The postoperative panoramic radiograph shows the position of the implants following their insertion (Fig 2-15s). Implant 44 does not collide with tooth 42, although the close proximity, or even superimposition, of the two in the two-dimensional

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panoramic radiograph might suggest this.

Exposure and prosthetic loading

After another 6 months, the implants were exposed and fitted with healing abutments (Fig 2-15t). The fixed implant bridge was made on customized abutments using a cast coping (see page 338) and incorporated following removal of the provisional implants (Fig 2-15u).



Fig 2-15t Exposure of the implants.



Fig 2-15u Five-unit fixed partial denture on four implants.

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Treatment course

- Removal, augmentation and immediate loading (2003)

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- 6 months to implant placement
- 6 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Fernando Abrantes

Immediate loading of definitive implants

3D implant planning and its surgical implementation

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To avoid unnecessary exposure to radiation, methods showing high diagnostic efficacy and a low radiation load should be used in radiologic investigations. The standard methods (panoramic radiograph, single-tooth radiograph, special projections) suffice in many cases. However, these conventional, standard techniques always provide a superimposed view of the 3D anatomical structures, since all the tissues that lie along the path of the radiation beam absorb x-rays in accordance with their radiologic density, so that the image is the result of superimpositions. Enlargements and geometric distortions are produced, depending on the distance of the tissues to the film. Therefore, the potential for measurements and angle analyses is limited.

Investigations of complex conditions, especially in implantology, require 3D analysis of the bone structures. Computerized tomography and cone beam CT imaging deliver the required visualization free of distortions and superimpositions, with subsequent processing of the generated data by special software packages.

Diagnostic possibilities of cone beam CT imaging

(The text and figures from page 99 to the left column on page 101 are by Dr Stefan Hümmeke).

Computerized tomography

In conventional (sequential) CT, the supine patient is irradiated from the side with a fan-shaped, rotating bundle of rays, slice by slice. The beam is directed perpendicularly to the movement of the bed and the bed advances each time the scanner completes a full rotation.

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Depending on the distance by which the bed is set to advance (0.5 to 2 mm), this procedure generates a series of axial slices; these can then be used as a basis for calculating further, secondary slices perpendicular to the axial ones. Metal restorations and foreign bodies produce artifacts, which can considerably reduce the diagnostic value of the scan. However, at the aforementioned setting parameters, different axial slices will contain the artifacts (usually caused by fillings and crowns) and the diagnostically relevant bone structures.

Scan duration and radiation dose can be reduced with the aid of spiral CT. Here, the scanner rotates around the patient several times without interruption, while the bed is being continuously advanced. The disadvantage of this method is poorer resolution, compared to sequential tomography.

Cone beam CT imaging (CBCT)

Like CT scanning, CBCT also delivers a visual representation of bone structures, which is free of superimpositions and is suitable for metric analysis.

Using a cone-shaped beam, the entire imaging area is scanned with a single rotation (Fig 2-16a).

A radiation source detector unit rotates fully around the patient's skull (placed between the beam and detector) to generate the image.

A total of 360 individual projections are carried out at a distance of one degree each. An automatic exposure control device ensures minimal radiation exposure for the patient. Incorrect exposure parameters, such as those that might result from manual settings, are ruled out. The method ensures that metal restorations and foreign bodies do not produce artifacts. One lateral and one anteroposterior spot film are used to check the positioning of the patient and to determine the exposure parameters (Fig 2-16b and 2-16c).

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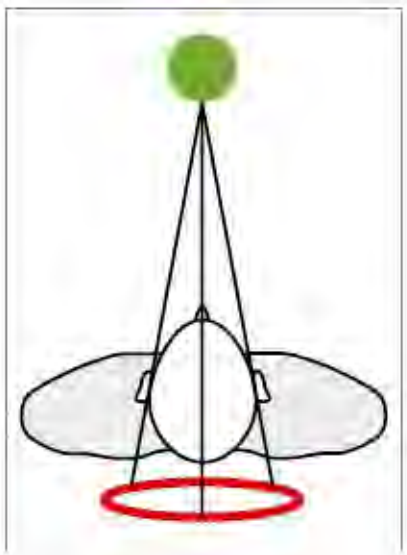


Fig 2-16a Schematic representation of the cone beam technique: a radiation source (green) and a detector unit (red) on the opposite side rotate around the patient's head.

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Fig 2-16b Spot film: frontal view.



Fig 2-16c Spot film: lateral view.

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Technical parameters

Tube voltage: 110 kV
Tube current: 0.5 to 10 mA
Exposure time per projection: 100 ms/s
Scan duration: 76 s
Scan area: diameter/h 150 × 105 mm
Image sensor matrix: 512 × 512 pixels
Geometric accuracy: <0.35 mm

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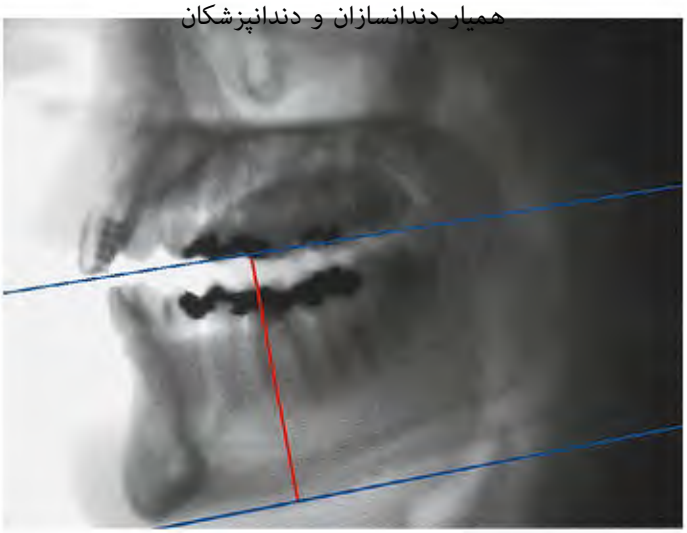


Fig 2-16d Lateral view showing the orientation of the axial sections.

Primary reconstruction

In the primary reconstruction, the raw data obtained are used to the calculate axial slices (slice thickness 0.3 mm, 1 mm or 2 mm), which are also familiar from conventional CT scanning. One important difference relative to the latter technique is that the orientation of the axial sections can be set in accordance with the diagnostic requirements, and several reconstructions can be generated if desired. To simplify spatial orientation and metric analysis, the axial slices for diagnostic investigations in the maxilla should be parallel to the level of the hard palate, while those in the mandible should be parallel to the latter's base. Thus, the axial sections are virtually perpendicular to the axes of the teeth or prospective implants and allow these objects to be depicted at their full length in subsequent sections (Fig 2-16d).

Secondary reconstruction

Starting with the axial sections created with the primary reconstruction, the secondary reconstruction involves further analysis of the data. Software tools specially designed for investigations in the mouth, jaw and facial area are available to generate the various views and also to perform metric analysis.

The most commonly used functions include generation of the following:

- Panoramic overview images
- Single and serial slices
- 3D views
- Marking functions
- Metric analysis functions.

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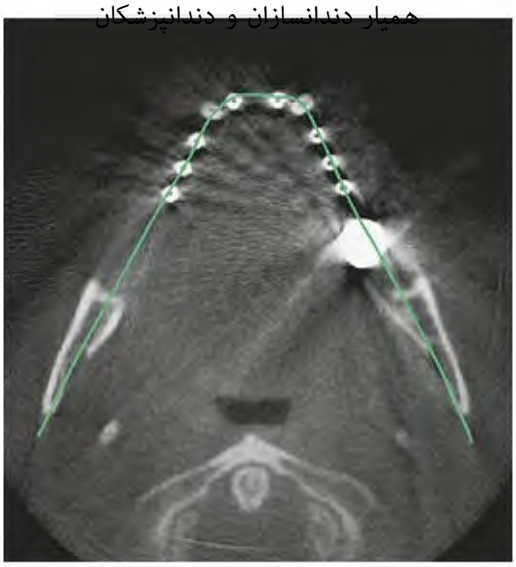


Fig 2-16e Axial section with line drawn in for the reconstruction of a panoramic view.

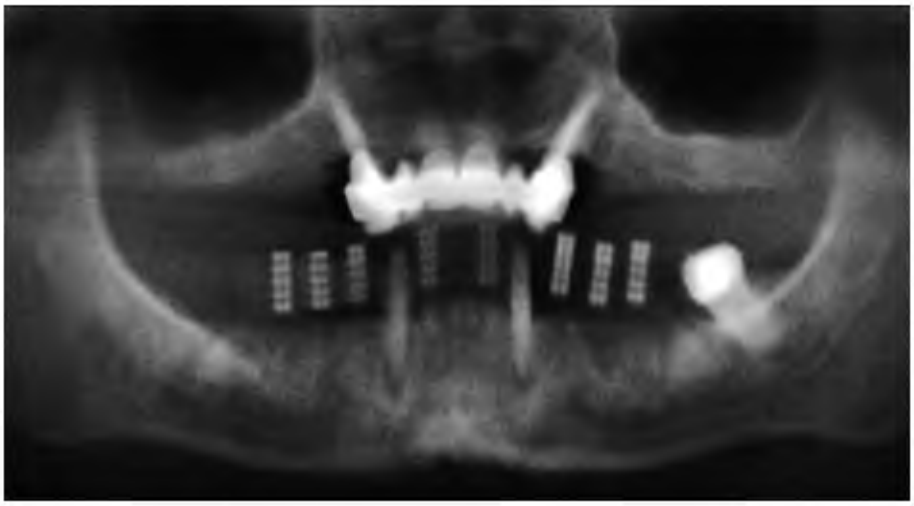


Fig 2-16f Panoramic view with radiopaque surgical guides.

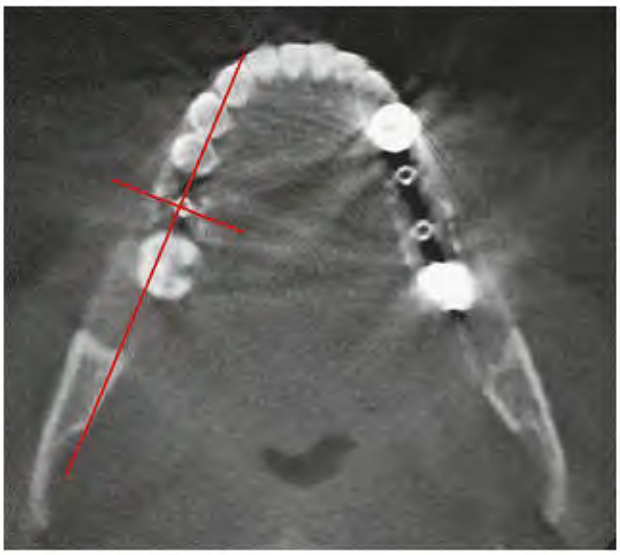


Fig 2-16g Axial section with cross section and sagittal section lines marked through the prospective implant region.

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Fig 2-16h Sagittal section with clearly visible but unmarked mandibular canal.



Fig 2-16i Transverse section (cross section) with the mandibular canal unmarked.

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Fig 2-16j Sagittal section with the mandibular canal marked in red.



Fig 2-16k Cross section, again with a mark showing the mandibular canal.

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Fig 2-16l Cross-section with measurements.

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Panoramic view images

The panoramic view also provides guidance for the analysis of CBCT data sets. The line indicating the desired panoramic plane is marked on a suitable axial section (Fig 2-16e). The slice thickness used to generate it may be set over a range of 1 to 50 mm, to provide the resolution required for the problem being investigated (Fig 2-16f).

Cross-sectional and marking functions

Sections through the region being examined are known as cross sectional functions. They cut through the axial section at a right angle, depicting the required structures without distortion and thereby enabling metric analysis. Cross sectional views along the course of the mandibular canal allow this structure to be identified relatively easily (Fig 2-16g and 2-16h), whereas it is often difficult to detect in cross section (Fig 2-16i). If the nerve is marked (Fig 2-16j), its position can then also be clearly identified in the transverse cross-sectional view (Fig 2-16k). Metric analysis completes the implantological planning (Fig 2-16l).

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Fig 2-16m Panoramic view with surgical guide sleeves in the regions of teeth 46 and 47.



Fig 2-16n Cross-sectional view with surgical guide sleeve in region 47.

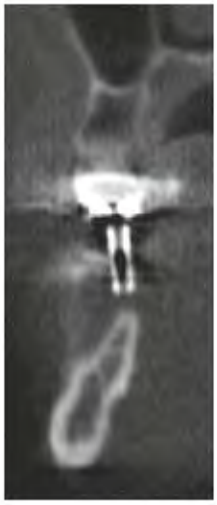


Fig 2-16o Cross-sectional view with surgical guide sleeves in region 46.

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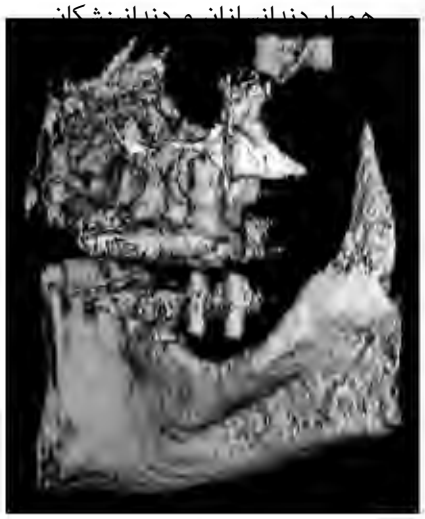


Fig 2-16p 3D lingual view with clearly identifiable basal retraction of the mandible below the mylohyoid line.

Implantological planning

Preparing a diagnostic wax-up with incorporated surgical guides is one method that allows the anatomical situation around the prospective implant bed to be analyzed. The surgical guide sleeves are positioned in a semi-adjustable articulator, from a purely prosthetic aspect. A 3D CBCT analysis is performed to check if the positions are surgically feasible (Fig 2-16m to 2-16p).

Reports

Whereas the generated images are assessed on the screen due to the higher quality it offers, the relevant sectional images can be compiled into clearly laid out reports and printed out. Figure 2-16q shows a report for a pre-implant placement diagnostic investigation of the maxilla. The typical resorption pattern is clearly apparent. In the anterior region, one can see the alveolar process, still very well preserved in terms of height, but very narrow; advanced atrophy with minimal vertical bone availability is apparent distally, as a result of increasing pneumatization of the maxillary sinus. The 3D views depict the osseous structures very vividly, and can greatly facilitate discussion with the patient regarding necessary accompanying measures, such as augmentation. In the example shown here, the 3D representation shows extreme atrophy of the maxilla and mandible. The ossified insertion of the genioglossus muscle is a conspicuous feature (Fig 2-16r).

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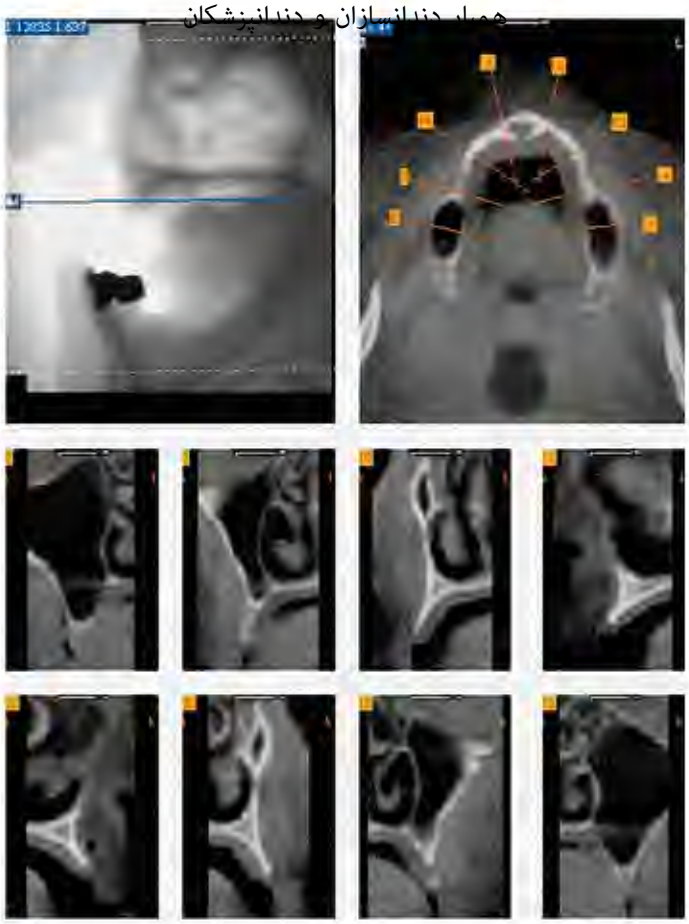


Fig 2-16q Report showing a highly atrophied maxilla.



Fig 2-16r Report with 3D representation of highly atrophied maxilla and mandible.

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Advantages of CBCT

Accurate preoperative knowledge of the anatomical structures involved contributes significantly to the success of the operation. CBCT provides an imaging method, which allows bone structures in dentistry to be represented three-dimensionally without the need for a radiologist. In implantology, in particular, it helps the practitioner make optimum use of the available bone supply while taking account into the prosthetic requirements. Precise knowledge of the location of relevant, vulnerable structures allows them to be safely avoided. In the author's own experience, it also enables a speedier surgical procedure.

The accuracy of reproduction provided by both conventional CT and CBCT is in the range of one tenth of a millimeter, so that the limiting factor is not the imaging technique, but the intraoperative implementation of the diagnostic data. In CBCT, due to the nature of the method, metallic restorations and foreign bodies do not produce the artifacts, which can considerably restrict the diagnostic value of conventional CT imaging. The orientation of the axial in CBCT imaging can be set individually in the primary reconstruction. For reasons of spatial orientation, optimal implant planning requires axial sections that are perpendicular to the axis of the prospective implant. An ideal representation of the maxilla and mandible can thus be produced with a single rotation of the scanner. Conventional CT requires several rotations, with the resultant additional radiation exposure, since the positioning of the patient in the scanner sets the position of the axial.

Compared to CT scanning with its traditional exposure parameters, CBCT is associated with considerably lower exposure to radiation (approximately fivefold according to Cohnen).

The software provided by various companies, specifically adapted for the investigation of dentoalveolar issues, especially the labeling function with the implant library, means that the treatment provider can perform a far more customized analysis than with conventional CT, with the corresponding therapeutic relevance this brings.

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Stereolithographic surgical guides

Using 3D diagnostic CT or CBCT imaging scans as a basis, it is possible to carry out virtual implant planning with the aid of special software applications (SimPlant, from Dentsply; med3D, coDiagnostiX (Dental Wings) or NobelClinician from Nobel Biocare) and then to use various methods to produce surgical guides, which allow the virtual plan to be precisely implemented during the operation. Whereas the med3D and coDiagnostiX methods allow for a surgical guide to be made by the dental laboratory with the aid of a special transfer table for referencing, in the SurgiGuide method from Dentsply, a stereolithographic surgical template is created solely on the basis of the patient's digital CT or CBCT image data set and the virtual planning generated by the SimPlant program.

NobelClinician (previously NobelGuide) works similarly to the SurgiGuide technique, the difference being that the latter method requires seven to eight glass beads as radiopaque markers in the radiologic template, while the former requires a similar number of gutta-percha

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points. Both methods allow good visualization of the prosthesis or radiologic scan template via the double-scan option. In this case, however, additional tomography of the prosthesis or template alone will be needed.

Implant planning

Virtual implant planning for the insertion of four implants in the fourth quadrant is carried out with the aid of the planning program SimPlant. The program shows the anatomical situation in four different views. Cross-sectional views are depicted in the left upper window, with a panoramic view below that. An axial view may be found at the top on the right, with a 3D view below it (Fig 2-17a). Anatomical structures can be marked in and are then shown in all the views. Whereas the 3D image provides a good overview, precise alignment of the implants is performed using the cross sectional, panoramic and axial views. The most meaningful way of performing the imaging is with a previously made radiopaque duplicate or scanning template, so that both anatomical structures and prosthetic requirements can be given optimal consideration in the virtual implant planning. Correct alignment of the implants is considerably facilitated by depicting the implant axes in extended form (Fig 2-17b). The jawbone can be erased to allow the relationship between the implant and the nerve to be assessed in isolation (Fig 2-17c).

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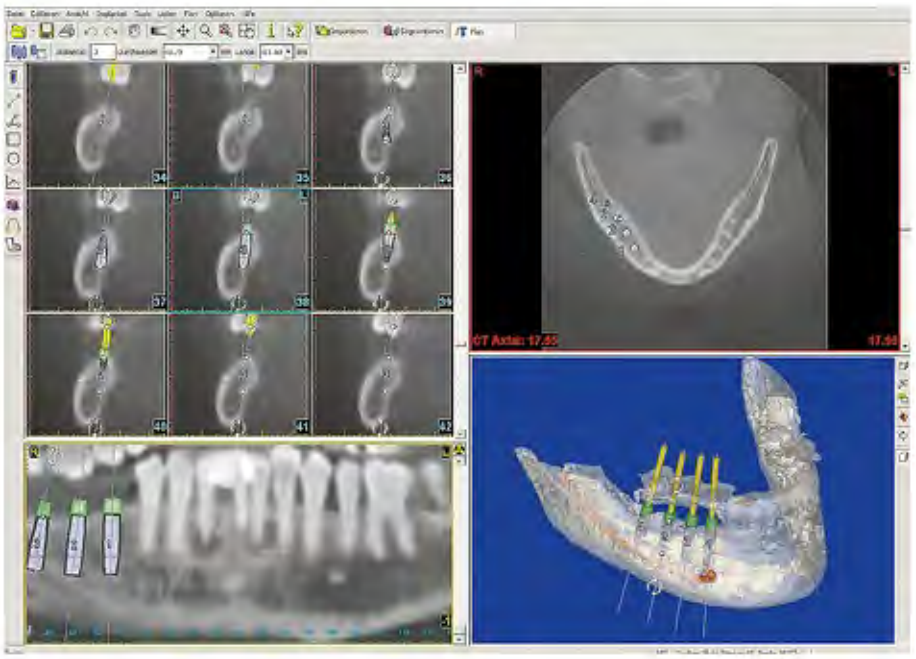


Fig 2-17a 3D planning with SimPlant.

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Fig 2-17b Extended implant axes make contact with the opposing teeth.

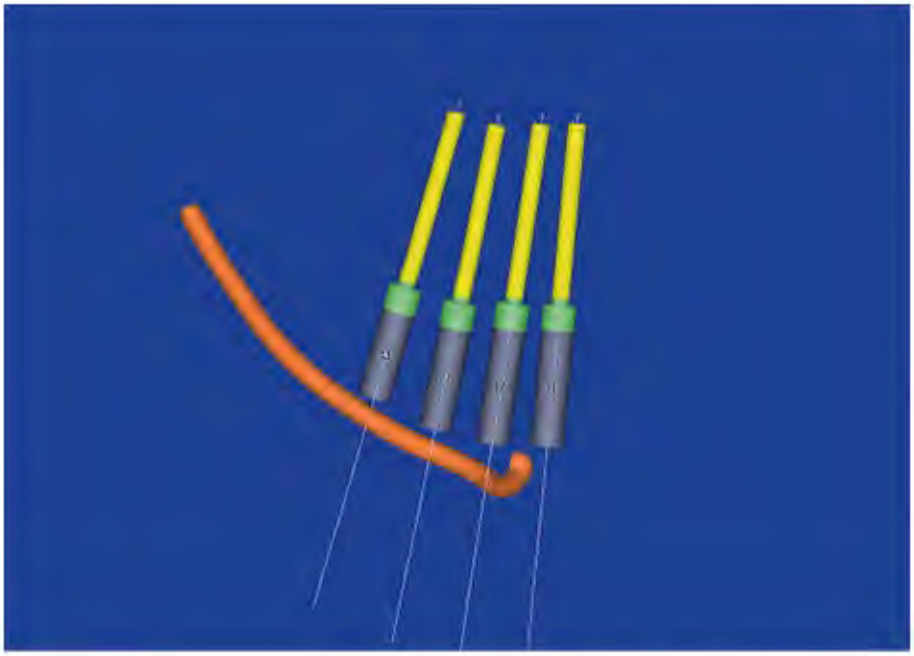


Fig 2-17c Relationship between the planned implants and nerve with the bone masked.

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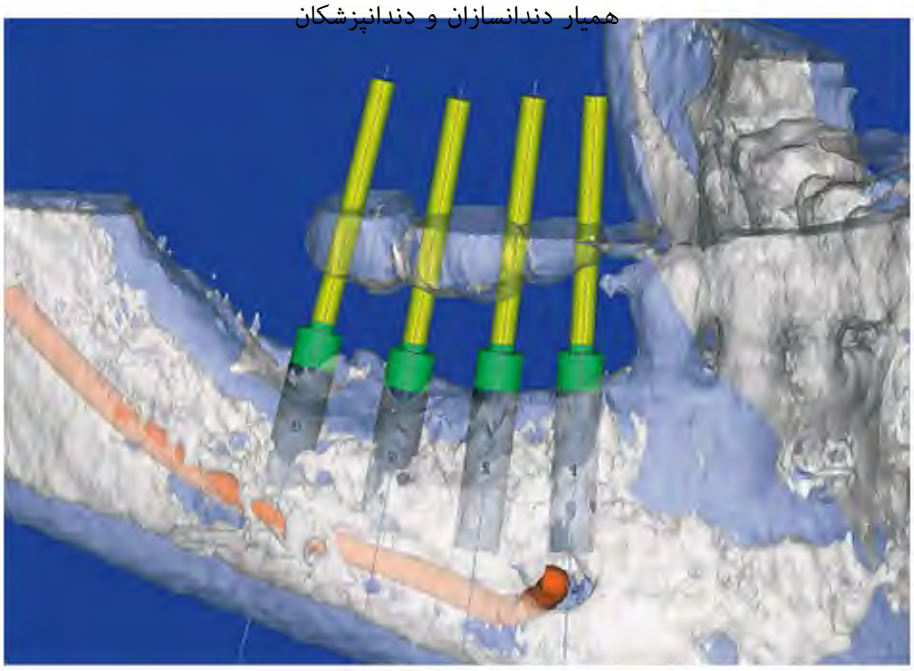


Fig 2-17d Semi-transparent representation of the jaw.

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There is also the option of depicting the bone in a semi-transparent view, to allow the previously located and marked nerve to be viewed from all sides in relation to the implant (Fig 2-17d). In addition to these visualization options, the SimPlant program offers numerous other options to measure and check position, which cannot be listed in full here.

Making the template

The completed plan, in the form of a data set (burned onto a CD or by email) is sent to the Materialise headquarters (now Dentsply) in Leuven, Belgium. The customer may order a bone-supported, mucosa-supported or tooth-supported surgical template to be produced. Whereas mucosa- and bone-supported surgical templates can be made up using the stereolithography technique on the basis of the digital data sets alone, a plaster cast of the jaw will also need to be sent if a tooth-supported template is required. This cast is then scanned to allow the stereolithographic surgical template to be made. Fillings and crowns cause artifacts in CT (but not CBCT) imaging, so that an additional optical scan of the cast is required for tooth-supported surgical templates (Fig 2-17e).

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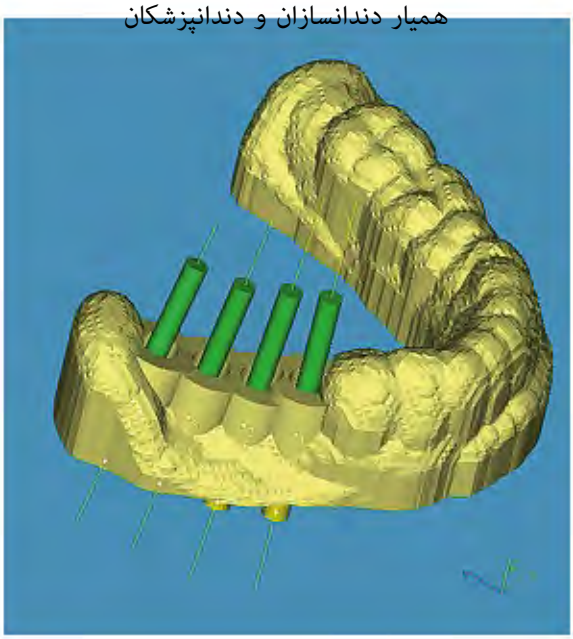


Fig 2-17e Virtual planning of the template on the model.

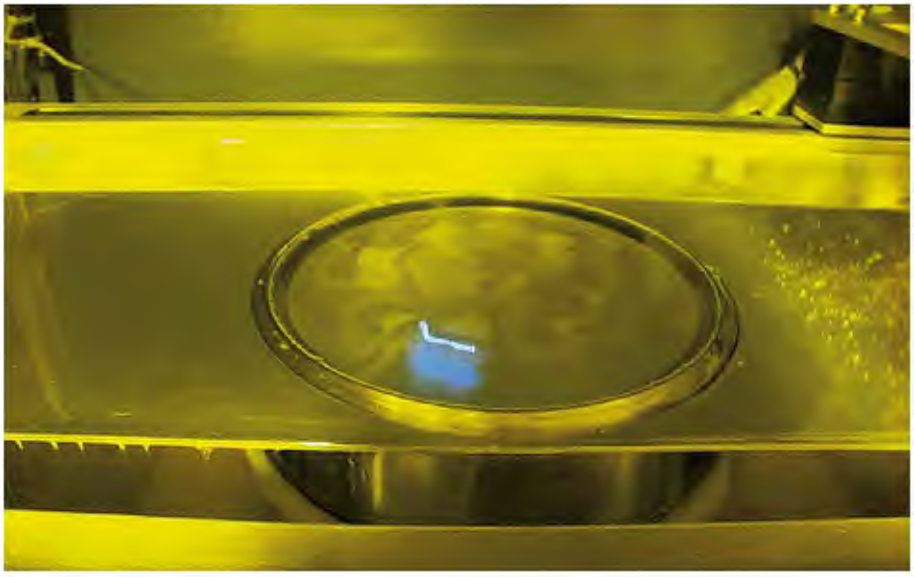


Fig 2-17f Laser polymerization using the stereolithography method.

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Fig 2-17g Shaping the template.



Fig 2-17h Titanium surgical guides fastened into the template.

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In stereolithography, a template is made from a synthetic resin by laser polymerization (Fig 2-17f). The templates are then custom-finished by a technician at Dentsply to remove the struts, which are needed to hold the template in place during the fabrication process (Fig 2-17g). Guided by the virtual planning, standardized recesses, into which metallic surgical guides will be fitted later on, are also incorporated into the template (Fig 2-17h).

Attention: ***In the near future, it is to be expected that complex, time-consuming stereolithographic techniques will be at least partially replaced by the greater convenience of 3D printers, which can be used at the practice or laboratory.***

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Fig 2-17i Plaster cast with incorporated model implants.



Fig 2-17j Adjusted provisional titanium cylinders.

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Fig 2-17k Prepared plastic provisional restoration.



Fig 2-17l Occlusal adjustment of the provisional implant.

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Preoperative fabrication of provisional prostheses

Since the precise positioning of the implants is already guaranteed, a provisional restoration can be prepared in the laboratory even before implant placement. In this “trial operation,” the template is placed onto the plaster cast and the implant analogs positioned through the surgical template into the cast, slotting them into the spaces specifically reamed out for this purpose, and fixed into place with composite resin. Once the implant is fixed into the model, the provisional cylinders are fitted and their sequence marked, eg, with notches (Fig 2-17i). It is important to leave sufficient space (minimum 2 mm) on the occlusal side (Fig 2-17j).

A plastic provisional restoration (preferably metal-reinforced) is fabricated over the prepared cylinders (Fig 2-17k). The plastic provisional needs to rest loosely on the cylinders, so that the spaces left in it to compensate for any inaccuracies can be polymerized in the mouth using a quick-hardening composite (Fig 2-17l).

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For continued treatment, see page 106.

Implant placement with the stereolithographic SurgiGuide surgical template

Diagnosis, planning and fabrication of the template and provisional restoration for this patient: see pages 102 to 105.

Baseline situation

The patient presented with a free-end situation in the right mandible; tooth 44 was the terminal tooth. The opposing teeth in the maxilla, ie, teeth 15, 16 and 17, were elongated and therefore limited vertical access to the operation site. Anterior teeth 32 and 42 showed apical inflammation and required either endodontic treatment or extraction.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant analysis and planning
- Dental cast analysis
- Casts and SimPlant planning (sent to Materialise in Belgium)

Treatment plan

1. Insertion of four definitive implants using the SurgiGuide template; immediate loading
2. Definitive loading with a cement-retained metal-ceramic fixed partial denture on customized abutments

Implant placement and immediate loading

In template-guided implant insertion using the SimPlant SurgiGuide method, all the implant placement treatment steps are performed through the surgical template, without the need to remove it. According to the manufacturers, specially aligned drills and implant insertion mounts allow precise implant bed preparation and insertion through the surgical template

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according to the virtual planning. The template is placed into the mouth and tested for stability (Fig 2-18a). To ensure secure stabilization, it is advantageous to anchor the template to the jaw with an additional horizontal stabilization pin. Holes can be punched in the gingiva at the implant placement sites through the template using a mucosal tissue punching device (Fig 2-18b). The punched-out pieces of mucosa are removed to allow free access to the jawbone (Fig 2-18c). The disadvantage of punching is that it often causes loss of attached gingiva on the buccal (or labial) side of the implants. The template is put in place again and implant bed preparation performed using standardized drills (Fig 2-18d). Drills and insertion mounts of different lengths are available, so that preparation at each implant site is carried out with the drill intended for that position. The drilling needs to be performed particularly gently and without applying pressure, as very little cooling fluid can get through the template and to the drill. Each individual implant is then inserted through the template with an insertion mount of the pre-specified length (Fig 2-18e).

Once the insertion mounts are unscrewed, the implants may be loaded with the provisional immediate bridge made preoperatively (Fig 2-18f). To do this, the prepared provisional cylinders are screwed onto the implants (Fig 2-18g) and the provisional partial denture is fitted onto the cylinders and adjusted as required (Fig 2-18h). The provisional partial denture is polymerized onto the cylinders with the aid of a quick-hardening composite (eg, Trim), and shaped outside the mouth (Fig 2-18i). The shaped provisional bridge is put into place and the screws tightened at 20 N/cm. The access holes to the screws are closed provisionally, eg, with Clip restorative (VOCO; Fig 2-18j). Even though the implants are immediately loaded, it is important for the loading not to be functional, ie, the provisional needs to be taken out of occlusion (Fig 2-18k) to encourage osseous integration. The postoperative CBCT shows the position of the implants in the jaw following insertion based on 3D planning and implant placement via a stereolithographic surgical guide (Figs 2-18l and 2-18m). The pathologic changes in the anterior dental region will be treated once the zones of support in the posterior region have been restored (Fig 2-18l).

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Fig 2-18a Inserting the template into the mouth.

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Fig 2-18b Punching holes into the gum.



Fig 2-18c Free access to the bone.

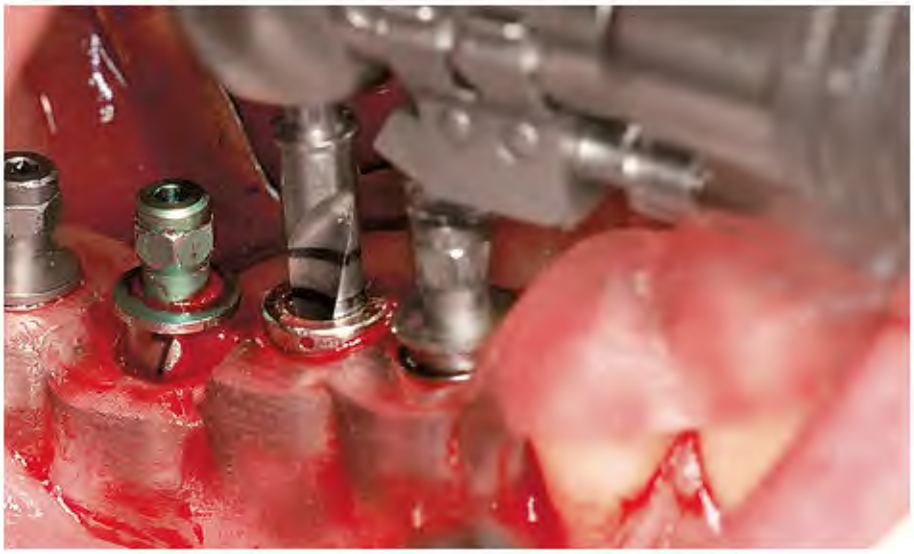


Fig 2-18d Drilling through the template.

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Fig 2-18e Placement using standardized insertion mounts.



Fig 2-18f The inserted implants.



Fig 2-18g The provisional cylinders have been screwed on.

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Fig 2-18h Adjusting the provisional restoration.



Fig 2-18i Finishing the provisional.



Fig 2-18j Placement of the provisional and closure of the access channels.

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Fig 2-18k Avoiding occlusal contact.



Fig 2-18l Postoperative CBCT image.

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Fig 2-18m Positions of the implants in cross-sectional view.

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Treatment course

- Implant placement and immediate loading (2004)
- 5 months to impression taking and fabrication

Treatment

Surgery and provisional restoration:	Dr Christoph T. Sliwowski
Dental technology:	Ute Olbers

Navigation technique

Navigation-based implant surgery provides another option for the surgical implementation of virtual implant planning.

Attention: ***Navigation in dental implantology has not yet become widespread in practice; in view of the high purchase cost of the equipment and the complexity involved in operating it, it remains to be seen whether it will become a routine technique in the future. In recent years, however, a marked decline in the use of this method has been observed, so it will not be discussed further in this text.***

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3
The Edentulous Mandible



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The edentulous mandible is the safest and most convenient site for implant treatment. It is characterized by a thick, hard layer of cortical bone, which provides good primary stability for the implants. The inferior alveolar nerve represents a natural anatomic boundary. It divides the mandible into the anterior, interforaminal region and posterior areas located distally of the mental foramina.

Diagnosis

Clinical examination and radiologic imaging form part of the standard diagnostic process. The clinical examination involves assessing the shape of the residual ridge and the width of the

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zone of attached gingiva, checking for the presence of osseous and mucosal defects and for a flabby ridge. A conventional panoramic radiograph represents the absolute minimum of basic radiologic diagnosis, but it is gradually being replaced by three-dimensional (3D) imaging investigations. Nowadays, the number of cone beam computed tomography (CBCT) scanners is increasing rapidly, and 3D diagnosis should become accessible to almost every implantologist in the near future.

3D CBCT diagnosis and SimPlant planning

The plan for this female patient was the immediate loading of a restoration on five implants directly following extraction of the four anterior teeth. A CBCT scan image was taken for the 3D planning (Fig 3-1a). The anterior part of the jaw, where the teeth were still in situ, appeared to be well preserved.

The posterior region, in contrast, was severely atrophied (Fig 3-1b). The alveolar nerves were marked on both sides to make them visible in all the imaging planes. Five implants were then planned in the interforaminal region (Fig 3-1c). The positions of the planned implants were checked in all the imaging planes and finely tuned (Fig 3-1d). Uniform distribution in the anterior residual ridge is best checked on the axial section (Fig 3-1e). The distances between the implants, and from the implants to the nerves, is to be measured in metric units. The distances between the individual implants should not be less than 3 mm, and a minimum distance of 2 mm to the nerve also needs to be maintained. The alignment of the implants was adjusted to the prosthetic requirements and to the anatomy of the jaw in the cross-sectional views. The implant in region 42 could be placed almost fully into the bone following extraction of the tooth and reduction of the residual ridge (Fig 3-1f).

This option was not available for the implant in the midline. In the coronal region, almost one third of it was exposed on the labial side (Fig 3-1g). It was the only implant for which exposed screw threads would need to be factored in at the planning stage (Fig 3-1h). When the 3D reconstruction was rotated and viewed dorsally, the same implant also showed up through the jaw (Fig 3-1i). The bone structure could be faded out for better evaluation of the relationship between the implants and the nerves (Fig 3-1j). Overall, it appeared possible to insert all five implants with good primary stability and to fit a provisional fixed implant bridge onto these implants.

For the treatment course, see page 156.

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Fig 3-1a CBCT scan images of the mandible before the treatment.

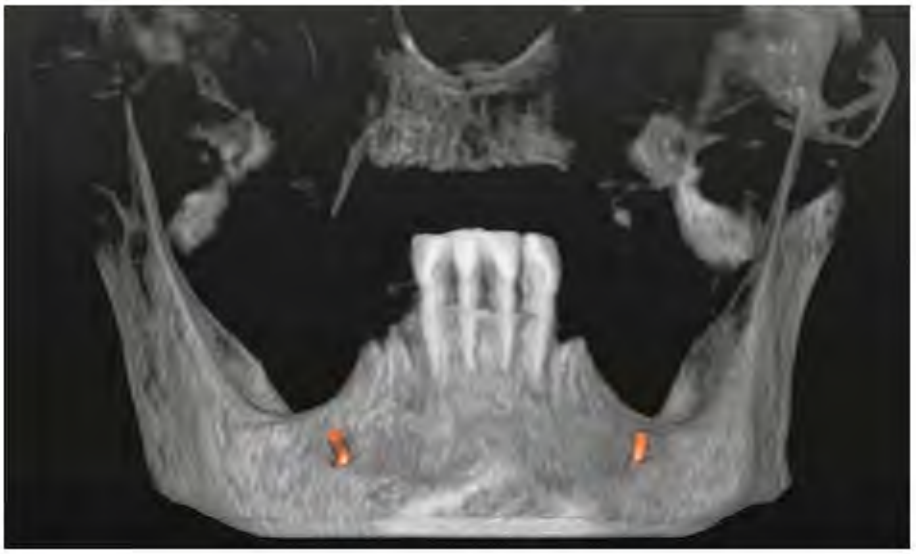


Fig 3-1b 3D reconstruction with marked nerves.

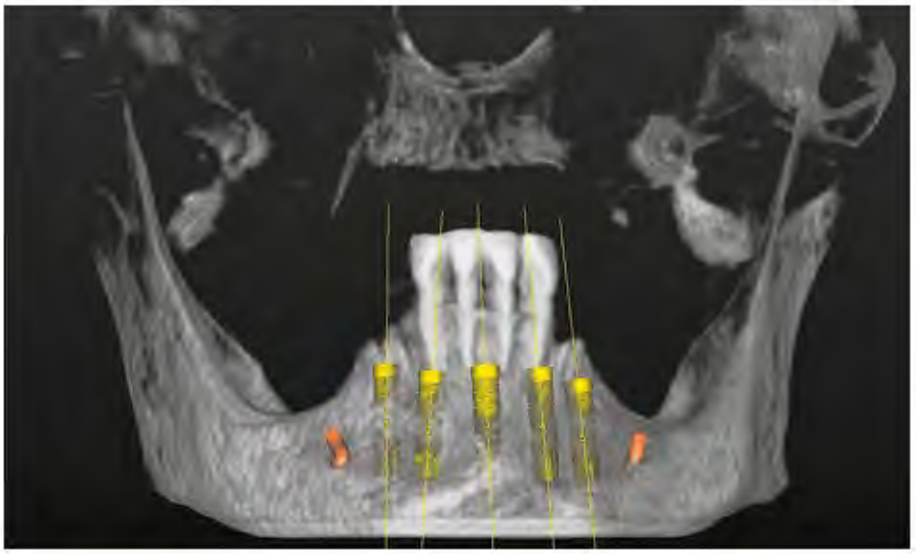


Fig 3-1c Planned implants in the 3D reconstruction.

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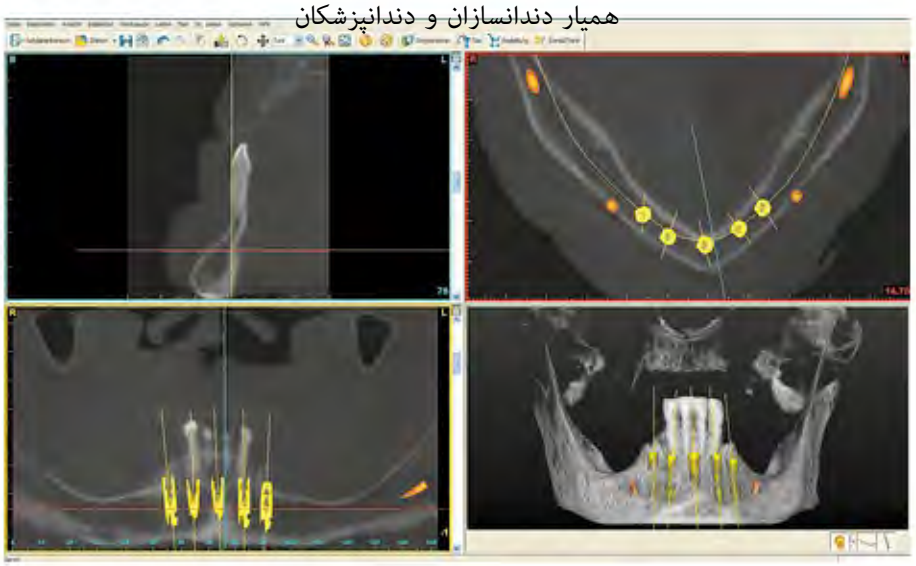


Fig 3-1d View of the implants in all the imaging planes.

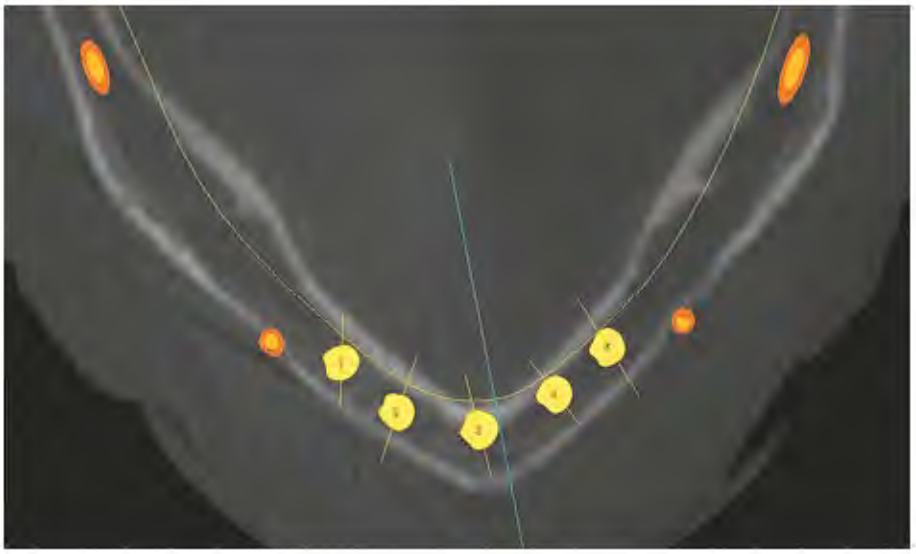


Fig 3-1e Checking the planned placement of the implants on the axial section.

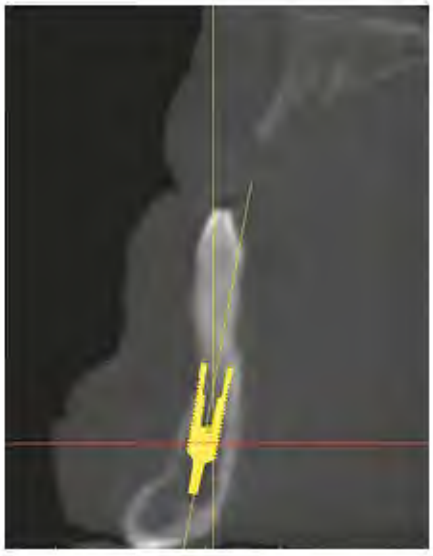


Fig 3-1f Cross-sectional view with implant 42.

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Fig 3-1g Labial bone deficit at the implant site, mid-mandible.

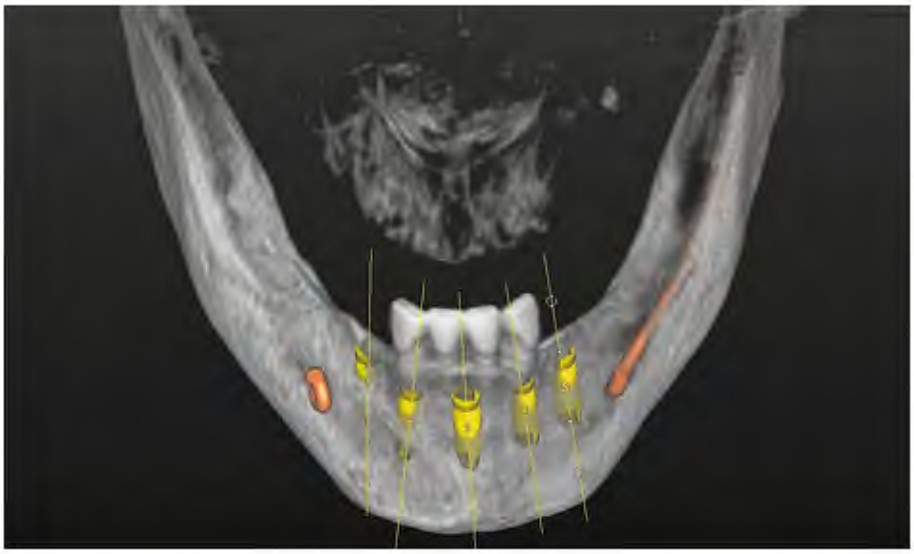


Fig 3-1h View of the 3D reconstruction with implants from the labial side.

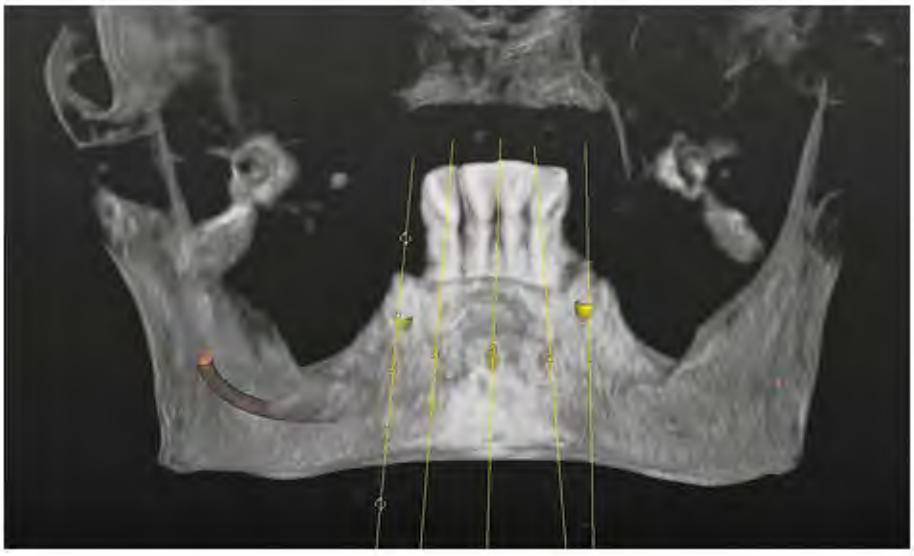


Fig 3-1i View of the 3D reconstruction with implants from the lingual side.

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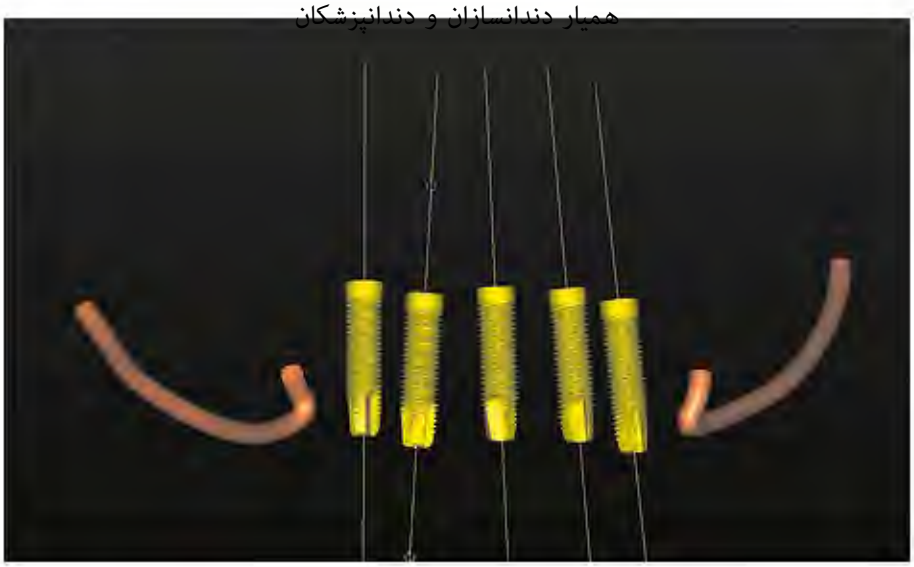


Fig 3-1j Implants and nerves with the bone faded out.

3D diagnosis and SimPlant planning for the fabrication of the Sliwowski Overdenture System (SOS) SurgiGuide template

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A female patient with an edentulous mandible wanted her prosthesis to be stabilized with implants. She inquired about a long-lasting, convenient prosthetic restoration avoiding prolonged treatment times. First, the extended cast denture that she had worn to date had to be replaced with a new complete denture made of acrylic, which could also act as a radiologic template.

Preparation of the prosthesis/radiologic template proceeded as usual up to the wax-up. The base of the denture needed to be extended if at all possible, including a caudal extension of the vestibular margin. After the last wax try-in, the prosthesis was remodeled into a radiologic template, by incorporating into it a few elements to act as radiologic markers. For the SurgiGuide template (SimPlant, Dentsply), these elements consist of seven to eight glass beads distributed along the line of the mandible. These beads are incorporated directly into the acrylic of the denture at the time of fabrication. They are the dark points that show through on the lingual side of the prosthesis (Fig 3-2a). Since a metal casing for the bar needs to be incorporated into the prosthesis on completion of the treatment, its position can also be virtually planned. For this purpose, the technician can make a replica of the bar casing out of a radiopaque material and incorporate it into the prosthesis at the most convenient place at his own discretion (Fig 3-2b). The desired position of the bar can then be taken into account in the planning process. Once the denture/radiologic template is fitted into the mouth, a CBCT scan of the patient is taken with the prosthesis in situ (Fig 3-2c). The prosthesis needs to be securely positioned and held in place by the opposing jaw. To be on the safe side, an occlusion record can help in the reproducible positioning of the template. A CBCT scan of the prosthesis alone was taken in parallel, and the two CBCTs were combined in the SimPlant program (Dentsply)

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in the double-scan mode (Fig 3-2d). The evenly distributed beads (white dots in the scan image) ensure that the prosthesis “lands” in the correct place relative to the jaw. Both nerves (inferior alveolar nerve and mental foramina) are marked before the planning. The two implants are then virtually placed into the jaw, parallel to each other with a distance of 18 mm between them.

The outline of the prosthesis (thin green line) and the opening in the bar casing replica (two vertical white bars) are very helpful when planning the first implant (Fig 3-2e). The first implant is placed slightly to the mesial side of canine 43 and aligned centrally in the mandible in the cross-sectional view (Fig 3-2f). The alignment of the implant is checked in all the imaging planes; once it has been accepted, the operator can click onto this implant with the right mouse button and onto the command “New implant at a distance of.” The operator then selects “Distance 18 mm,” followed by “Direction left” and “parallel in 3D,” and clicks on “OK.” After this, the second implant appears slightly to the mesial side of canine 33 (Fig 3-2g). Uniform, symmetric distribution of the implants can best be checked on the axial section at the height of the mental foramina (Fig 3-2h). If the positions have shifted, the second implant is deleted, the first corrected and the second newly placed using the same command. Once the positions of the implants are accepted, the next step is to plan the position of the stabilization pins. These are also planned on the cross sections: the pin is inserted through the labial margin of the prosthesis at an inclination of between 30 and 60 degrees, and extends into the bone up to the lingual cortical layer (Fig 3-2i). The two side pins are placed half-way between the mental foramen and the implant, perpendicularly to the course of the residual ridge (Fig 3-2j). The central pin is placed close to the midline. The locations of the pins in relation to the mental foramina and the implants are best evaluated on the 3D reconstruction with the bone faded out (Fig 3-2k). The overall plan is checked in all planes and projections, and then the template is ordered from Dentsply with a mouse click on “Order SurgiGuide” (Fig 3-2l). To ensure that the correct components are incorporated (bar casing replica), it is also necessary to select “Mucosa-supported” in the “Type of support” window, “Universal SurgiGuide” in “Solutions,” and “SurgiGuide for SOS Sliwowski Overdenture System” in “Comments.” The finished SurgiGuide template is delivered by package service after a few days (Fig 3-2m).

For the treatment course, see page 119.

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Fig 3-2a Prosthesis with incorporated glass beads.



Fig 3-2b Desired position of the bar casing.



Fig 3-2c CBCT with prosthesis and marked nerves.

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Fig 3-2d Double scan with the prosthesis.



Fig 3-2e Desired position of the bar in the prosthesis outline.

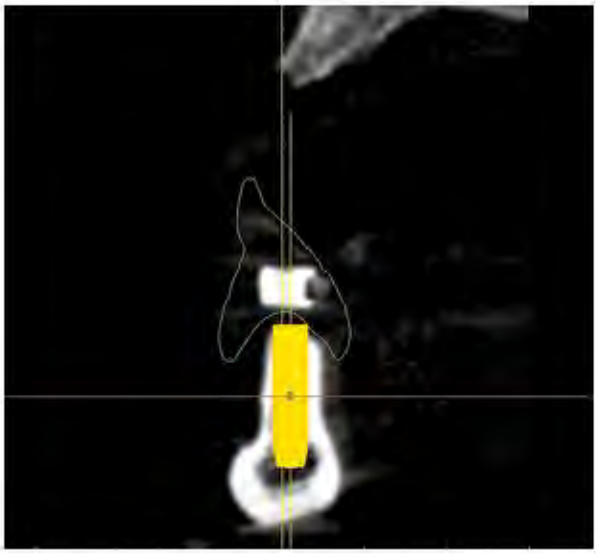


Fig 3-2f Positioning the first implant 42 to 43 while taking account of the anatomic and prosthetic aspects.

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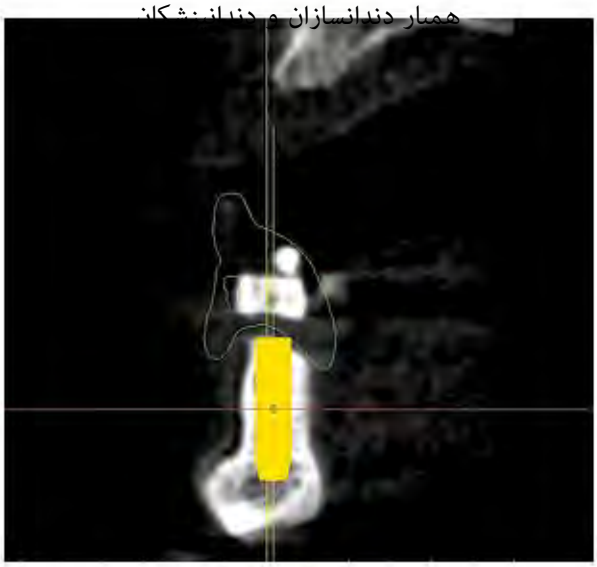


Fig 3-2g Automatic placement of the second implant 32 to 33.

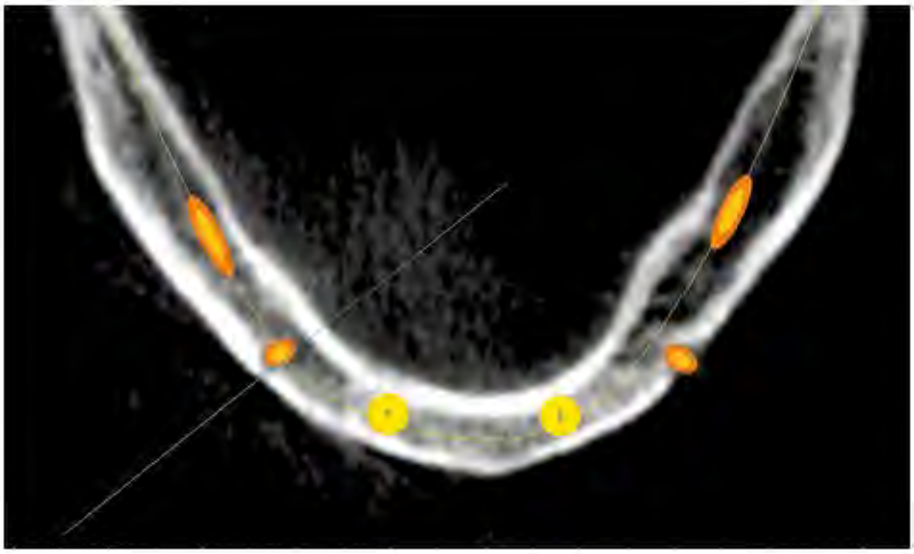


Fig 3-2h Central alignment of the two implants in the anterior region of the mandible.

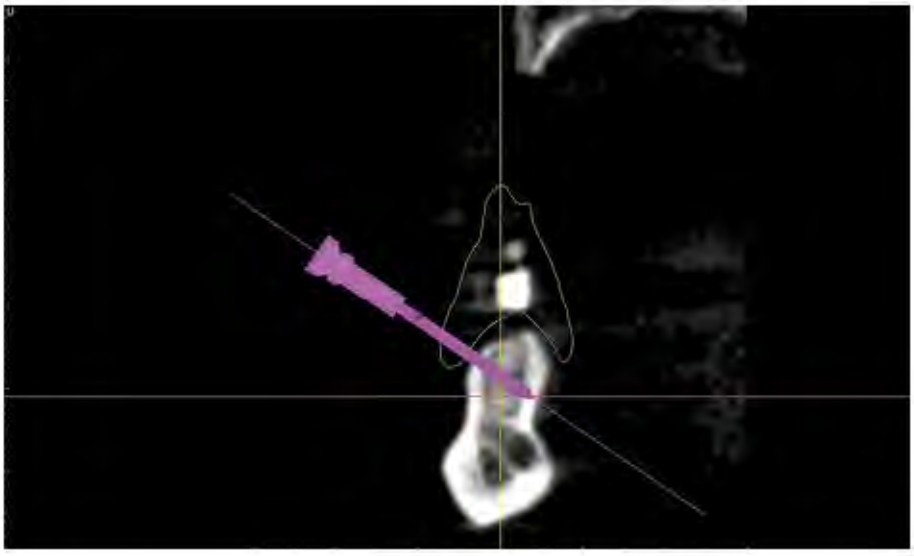


Fig 3-2i Positioning the stabilization pins.

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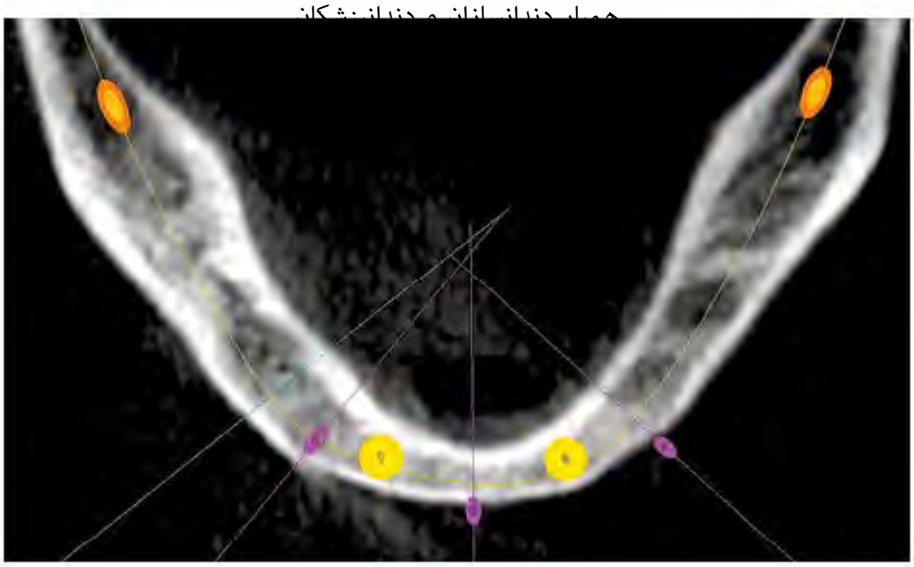


Fig 3-2j Vertical alignment of the pins relative to the residual ridge.

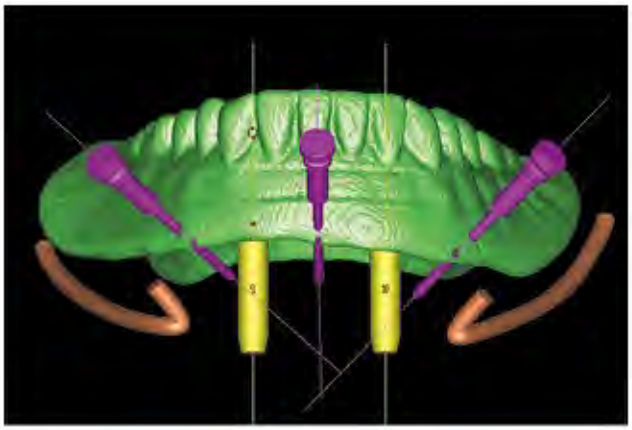


Fig 3-2k Collision check.

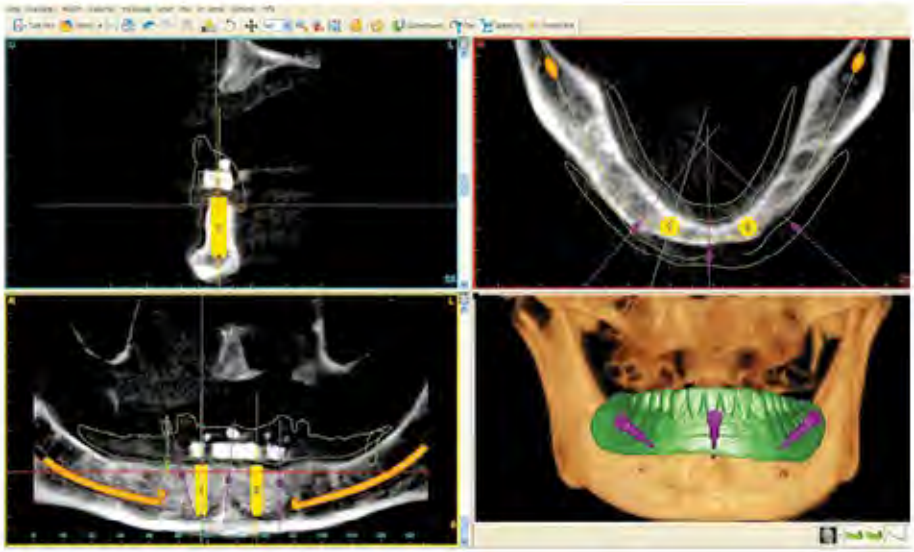


Fig 3-2l Completed SimPlant planning needed to order the SOS SurgiGuide template.

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Fig 3-2m Completed SOS SurgiGuide template.

Note

Extremely narrow mandible



Fig 3-3a Panoramic radiograph showing nothing of note, adequate bone height.

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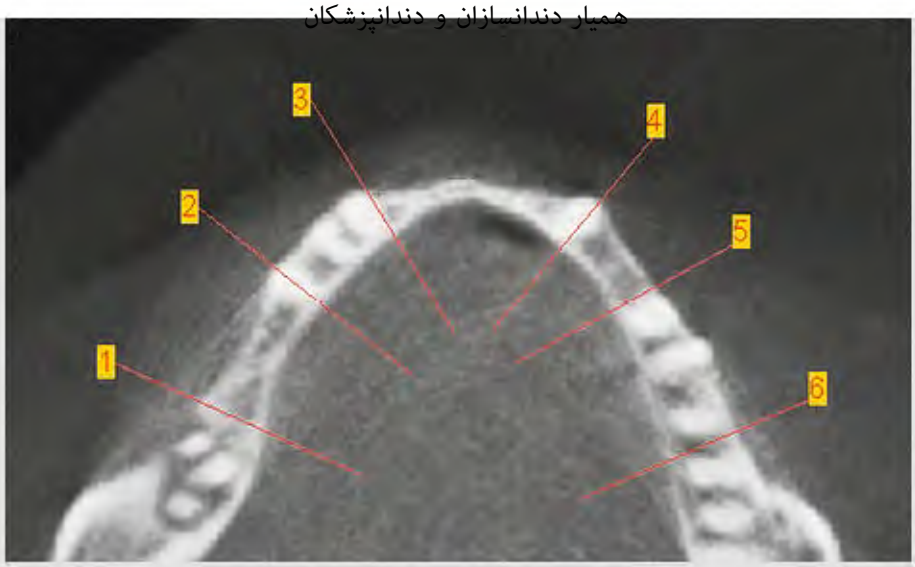


Fig 3-3b Marked locations of the cross sections on the axial section.

Cross sections in the following regions:

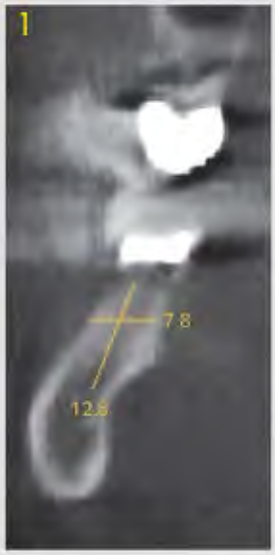


Fig 3-3c Right molar.

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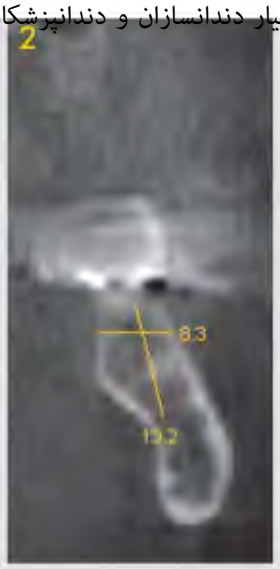


Fig 3-3d Left molar.

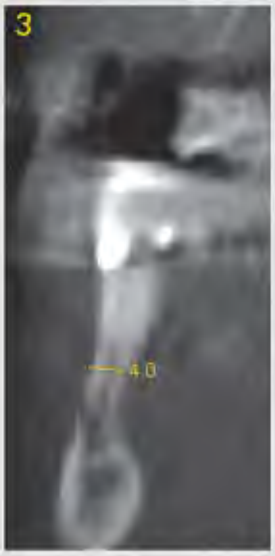


Fig 3-3e Right premolar.



Fig 3-3f Left premolar.

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Fig 3-3g Right canine.



Fig 3-3h Left canine.

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In rare cases, the mandible can be very narrow, a feature that is not normally visible on the panoramic radiograph (Fig 3-3a). However, the width of the residual ridge can be precisely determined if a CT or CBCT scan is available (Fig 3-3b). In the present case, the panoramic radiograph taken following implant treatment in the maxilla indicated no suspicion of an unsatisfactory bone situation in the mandible (Fig 3-3a). Analysis of the cross sections shows that the residual ridge is relatively wide in the molar region (Figs 3-3c and 3-3d), but already shows marked narrowing in the premolar region.

Above the mental foramen, the residual ridge is already so narrow – 3 and 4 mm respectively – as to require augmentative measures (Fig 3-3e and 3-3f). The situation in the anterior and canine regions looks even more problematic: here the residual ridge is less than 2 mm wide, allowing no implants to be placed in this segment (Fig 3-3g and 3-3h). Extensive augmentation is necessary before any implant placement can take place. In this situation, implant placement based on diagnosis by panoramic radiograph alone would inevitably lead to unexpected intraoperative problems.

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Rehabilitation with implant placement only in the interforaminal region

The interforaminal region is the most convenient and most comfortable part of the oral cavity for implant placement. The following factors contribute toward this: no limiting anatomical structures on the downward side (apart from the mental foramina); good access and good view during the procedure; good bone quality; and, almost always, a good bone supply to anchor the implants. For this reason, all the implantology statistics show the highest success rates in this region.

In the interforaminal region, if bone quality and quantity are good, immediate functional loading with a prosthetic restoration is almost always possible. Apart from ensuring that the optimal anatomic relationships are in place, the following conditions also need to be fulfilled:

- Long (15 to 18 mm), securely inserted implants (at least 40 N/cm, preferably bicortical support)
- Immediate primary interlocking of the implants (within a maximum of 48 h)
- No retention forces if using removable dentures
- No extensions if using fixed dentures
- Prosthesis adjusted for cuspless occlusion.

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Several options are available for prosthetic restoration of the edentulous mandible, all of them offering a good prognosis, well-established through prolonged clinical use. A removable denture requires two or four implants in the interforaminal region. The prosthesis can be fitted via connecting bar, magnetic, ball or telescopic attachments. The author has developed a special overdenture system, the Sliwowski Overdenture System (SOS), supported on two implants and a prefabricated bar; this is presented in detail on pages 114–115.

Four to six interforaminal implants are needed for a cantilever fixed partial denture. A maximum of 12 teeth can be replaced with this type of prosthetic restoration (up to the first molars). This represents a very acceptable solution for the great majority of patients, as regards both occlusal function and esthetic aspect.

A fixed provisional restoration fitted on the day of implant placement itself is also an option, achieved by inserting additional, provisional implants. Alternatively, immediate loading of definitive implants with a prosthesis can be achieved with a variety of treatment concepts, eg, Brånemark System Novum, NobelGuide, the Teeth-in-an-hour implant system (Nobel Biocare) and SurgiGuide (Dentsply) or SOS. As an alternative to these technically very complex methods, an immediate prosthesis can also be provided by taking an impression directly after the operation and fabricating an immediate provisional denture. This provisional can then be worn until the definitive prosthesis is fabricated.

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Typical treatment course

Removable immediate prosthesis on two implants and one prefabricated bar – the SOS method

Baseline situation

After losing her last teeth, a female patient with an edentulous mandible had been wearing a relined overdenture, which had long been obsolete. She was interested in an implant-supported restoration, but was afraid of the surgery and the high cost involved. Her wish was for a stable restoration, ideally immediately and at a reasonable price. The patient has heard about the SOS method, which would meet her expectations. After the clinical examination, it was decided to start with the preparation (Fig 3-4a). To begin with, this involved fabricating a full mandibular denture, which was also to act as a radiologic template.

For the SimPlant planning and fabrication of the SOS template, see diagnosis section on page 114.

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Diagnostic tools

- Clinical examination
- Fabrication of the new prosthesis (template)
- CBCT with the prepared template/prosthesis
- SimPlant planning required to order the SOS template

Treatment plan

1. Planning and ordering the SOS template
2. Insertion of two implants with the aid of the template and fitting of the bar, impression taking and incorporation of the definitive prosthesis

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Fig 3-4a The edentulous mandible before the treatment.

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Implant placement

The stable positioning of the template on the residual ridge and its relation to the dentition of the opposing jaw was first checked (Fig 3-4b). The mandible was then numbed with bilateral block anesthesia and infiltration in the interforaminal region.

Attention: ***The anesthesia has to take 100% effect, as any top-up is very difficult once the template has been fitted into place.***



Fig 3-4b Try-in of the SOS template.

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Fig 3-4c Stabilization of the template by the opposing dentition.



Fig 3-4d Horizontal bores for the stabilization pins.



Fig 3-4e Securing the template with three pins.

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Fig 3-4f Bar casing replica positioned exactly over the residual ridge.

The template was put back into the mouth, and the patient advised to bite down hard for a few minutes (Fig 3-4c). The pressure exerted by the template compressed the swelling due to the anesthetic, positioning the template more securely onto the jaw. The patient was covered with sterile drapes, after which the procedure could start. With the patient biting down, the first step was to drill three horizontal bores for the stabilization pins, working with a 1.5-mm spiral bone drill through the surgical template sleeves: first right and left, then in the middle (Fig 3-4d). All three pins were inserted up to the endpoint (Fig 3-4e). The patient could now open her mouth and the complete maxillary denture was removed. Stable positioning of the template was checked, after which preparation of the implant beds through the drill guides could begin (Fig 3-4f). Several drill guides (Fig 3-4g) of increasing diameter (from 1.5 to 3.4 mm) were available, which were screwed onto the bar casing replica (Fig 3-4h).

The bar casing replica sits firmly in the template and determines the planned positions of the implants in the jaw. Bores were drilled through the drill guides using the following spiral bone drills in succession: 1.5, 2.0, 2.8, 3.0 and 3.2 mm; the 3.4 mm drill was also used for hard bone (Fig 3-4i). After each bore was drilled, a vertical pin of the same diameter was inserted into the double surgical guide, the added stabilization ensuring even greater precision when drilling the second bore (Figs 3-4j and 3-4k).

Attention: ***The vertical pins are also needed to check the implant bed: after the drilling and removal of the double drill guide, they are inserted into the implant bed and moved in the labiolingual direction (Fig 3-4l). If no movement is possible, this means that the implant bed is in the bone. If the pin moves, then something is wrong with either the template or the preparation, and implant placement can only continue following flap reflection, with the surgeon working under visual control.***

After drilling with largest diameter drill of 3.2 mm (or 3.4 mm if the bone is hard), the implants were inserted through the template (Fig 3-4m). Implant placement can be carried out with a variety of systems, and special SOS implants are available from Osteoplant (Fig 3-4n).

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The implants are first driven in by hand or with a powered device up to a torque of 40 N/cm (Fig 3-4o). The insertion continues with a manual ratchet (Fig 3-4p), until the insertion posts are fully sunk into the casing replica (Fig 3-4q).

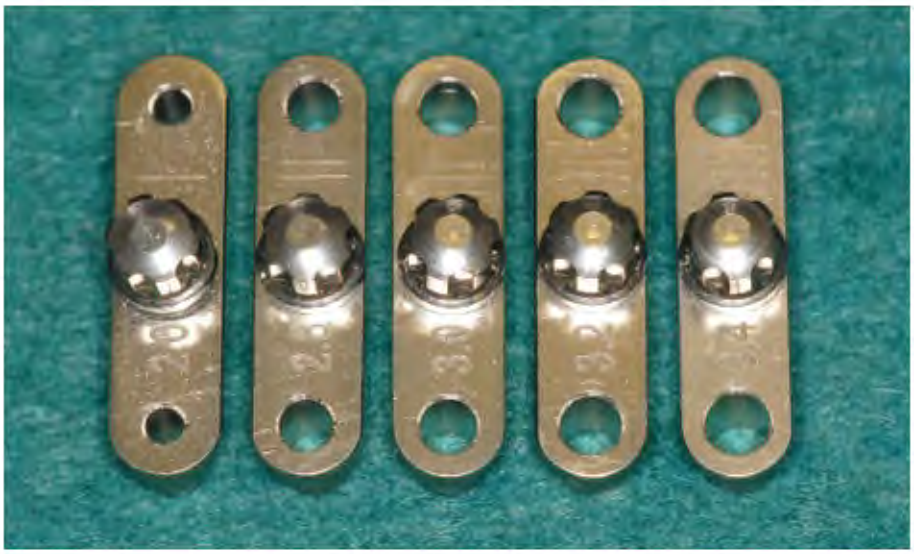


Fig 3-4g Double drill guides used for preparation of the implant bed.



Fig 3-4h Each drill guide was screwed onto the bar casing replica.

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Fig 3-4i Bore drilled with the 2-mm spiral drill.



Fig 3-4j Stabilization of the drill guide with the vertical pin.



Fig 3-4k The vertical pin is inserted into the first bore followed by drilling of the second.

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Fig 3-4l Checking stability with the pins.



Fig 3-4m Insertion of one implant.

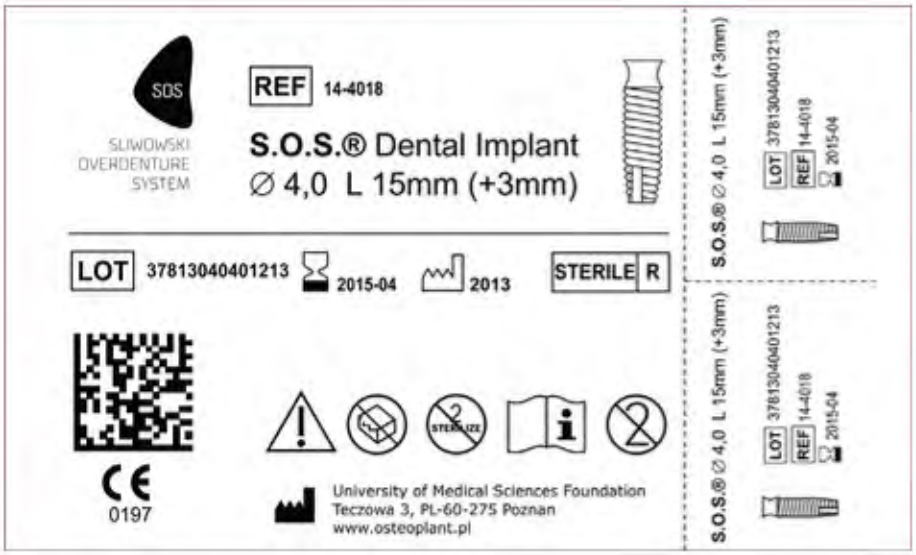


Fig 3-4n The SOS implant from the Polish manufacturer Osteoplant, Poznan' (available from: www.osteoplant.com.pl & www.system-sos.com).

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Fig 3-4o The implant can first be driven in with a powered device to ensure torque control.

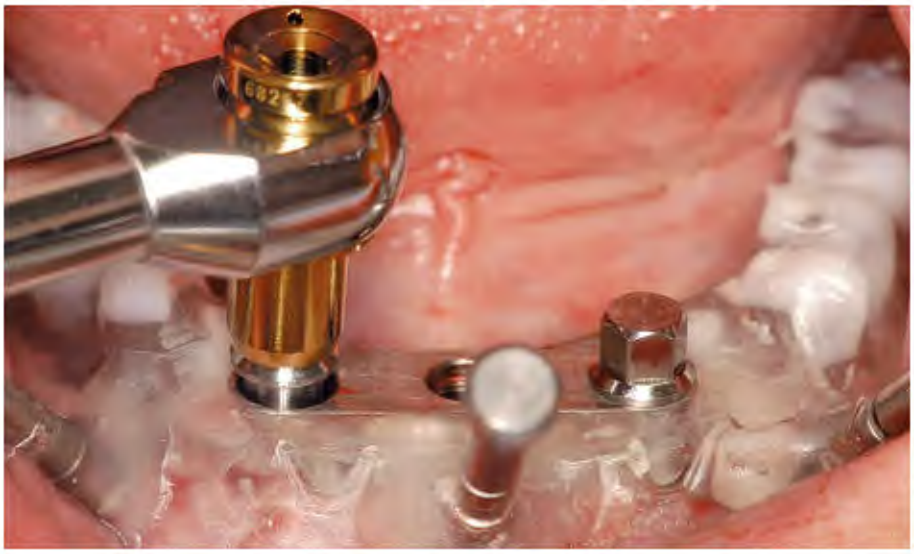


Fig 3-4p The insertion continues with the manual ratchet.

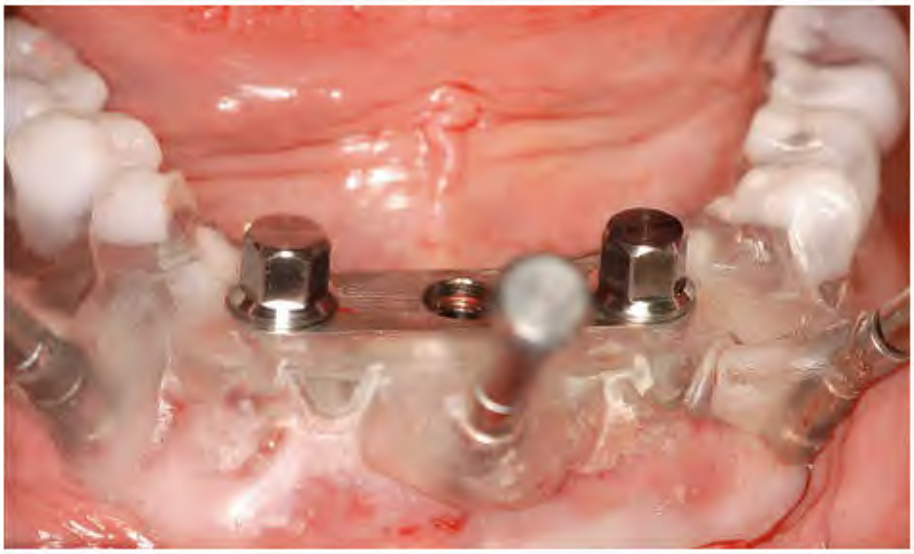


Fig 3-4q Both implants have been driven in up to the endpoint.

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Fig 3-4r The implant with insertion post in relation to the bar casing replica.

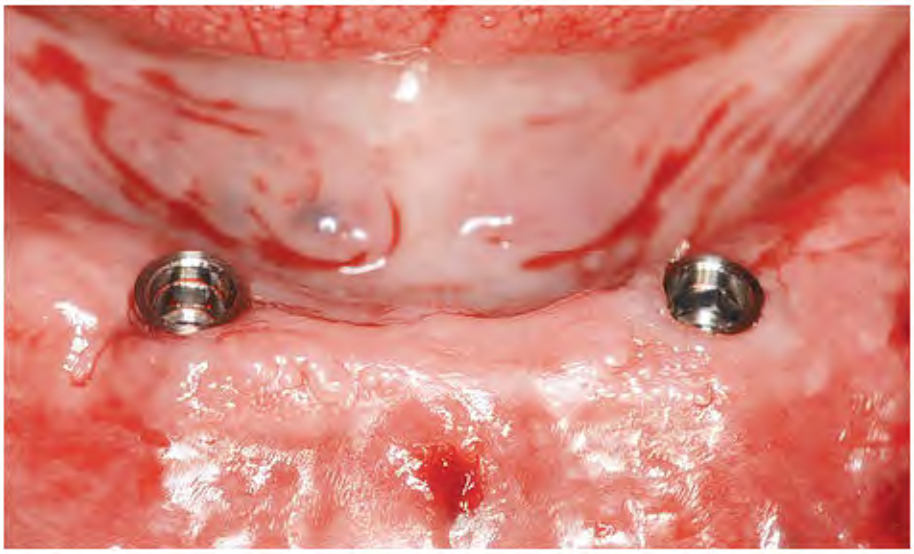


Fig 3-4s Inserted implants following removal of the template.

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When the insertion post has been sunk into the replica up to its endpoint, the implant lies just below the lower edge of the replica, ie, ideally in its final position (Fig 3-4r). The insertion posts and horizontal pins were then removed and the template taken out (Fig 3-4s). If the insertion posts jam in the replica, they should be turned very slightly to the left with the ratchet and taken out once the tension is released. If the implants are still above gingival level, they are driven in further with the manual ratchet (using the same number of turns for both implants) until they are flush with the gingiva. In addition to a visual check, the position of the implants can also be verified using the bar with the abutments inserted (Fig 3-4t).

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Fig 3-4t Testing insertion depth with the bar on abutments.

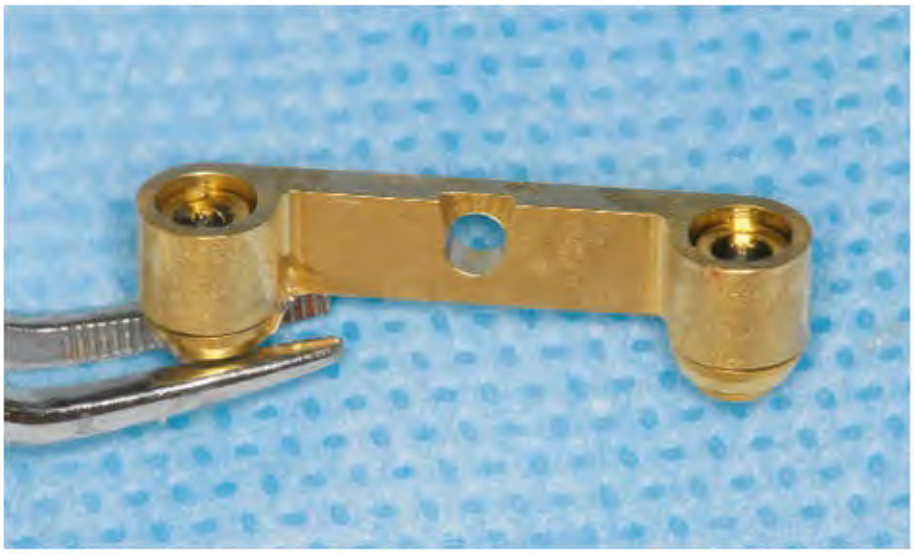


Fig 3-4u The abutments are held onto the bar with chlorhexidine gel.

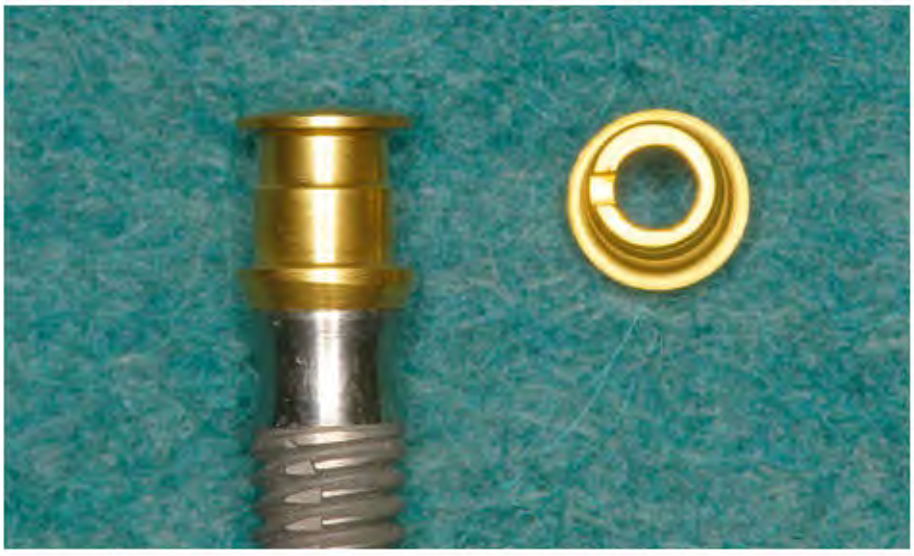


Fig 3-4v The EBF (Eccentric Bar Fixation) abutment is off the implant axis by 0.2 mm.

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Fig 3-4w The abutments are aligned with the notches pointing in the labial direction.

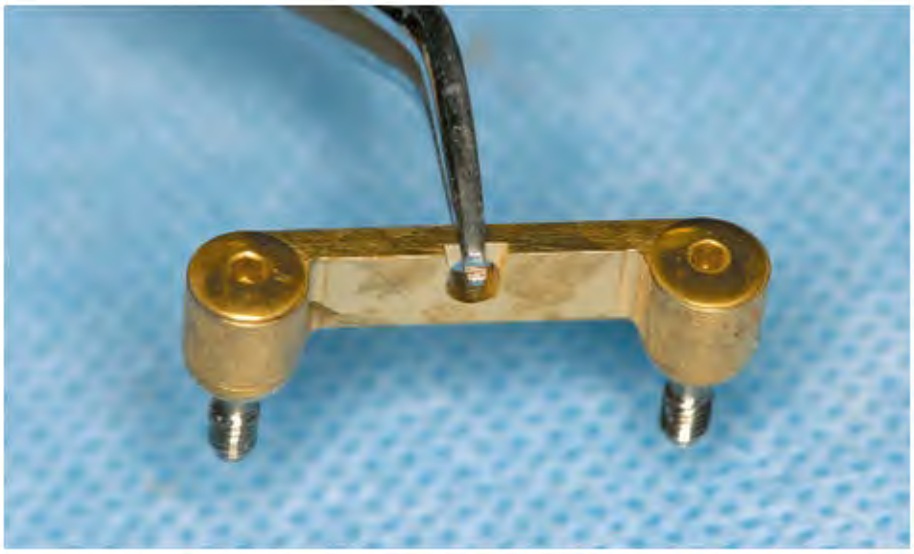


Fig 3-4x Abutments, screws and bar are held together with chlorhexidine gel.

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The bar can be prepared for this by slotting the abutments into the channels from below, eg, with the aid of chlorhexidine gel, and aligning the notches (Fig 3-4u).

Attention: ***The EBF (Eccentric Bar Fixation) abutments are constructed so that they can compensate for small deviations of up to 0.4 mm. They are eccentric, being 0.2 mm off the implant axis and the direction is marked with a notch (Fig 3-4v). This notch allows them to be turned with an instrument. If the distance between the implants is very slightly greater than 18 mm, the notches point inwards. If it is less than 18 mm, they point outwards. If it is exactly 18 mm, they point forwards, to position the bar towards labially as far as possible (Fig 3-4w).***

The bar with the aligned abutments is placed onto the implants with forceps (Fig 3-4x) and fastened with screws (Fig 3-4y). The definitive alignment of the abutments can be fine-tuned alternately on the two implants, taking out first one screw and then the other. The precise fit of

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the abutments needs to be checked from both labial and lingual aspects with magnifying glasses and a probe (Figs 3-4z and 3-4aa), before the screws are tightened with a 30 N/cm torque. During the operation, the technician can ream out the prosthesis in the region of the bar, so that it can be used as a customized tray for taking an Impregum (3M ESPE) impression (Fig 3-4bb). To ensure that the modeling compound does not escape from the prosthesis, the adhesive coating is supplemented with a number of lingual and labial retention holes. The impression is taken with the mouth closed and the mandibular prosthesis is held in place by the teeth of the opposing jaw (Fig 3-3cc).

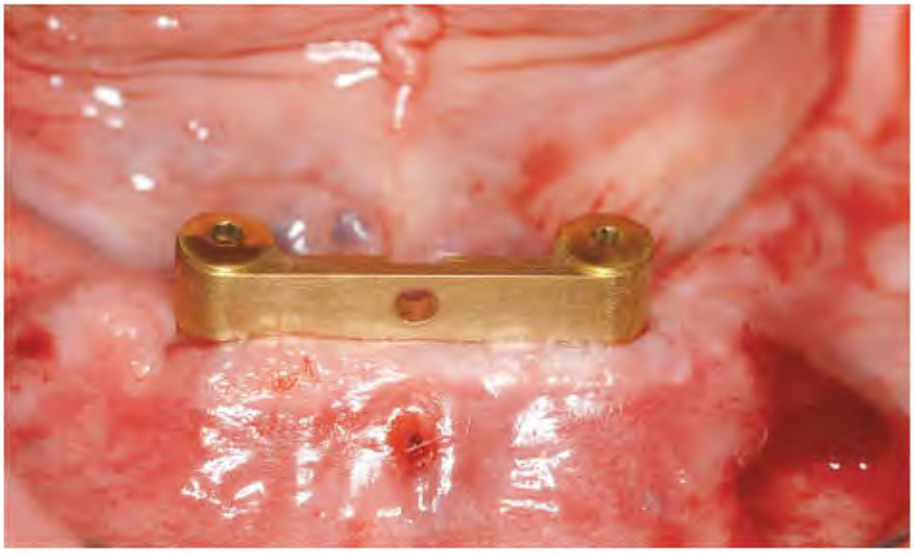


Fig 3-4y Bar fitted directly after implant placement.

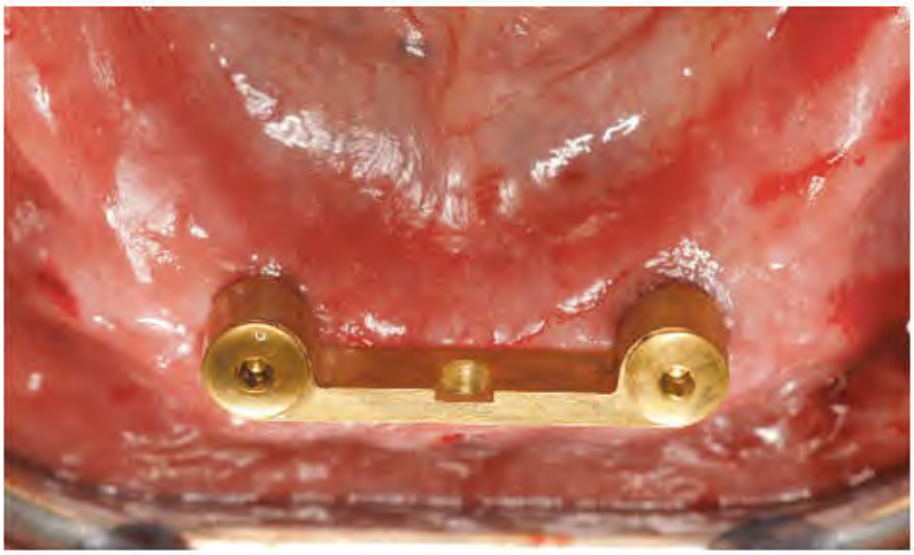


Fig 3-4z Occluso-lingual view of the bar.

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Fig 3-4aa Checking the fit of the abutments.



Fig 3-4bb Reamed-out prosthesis as an impression tray.



Fig 3-4cc Taking an impression with Impregum.

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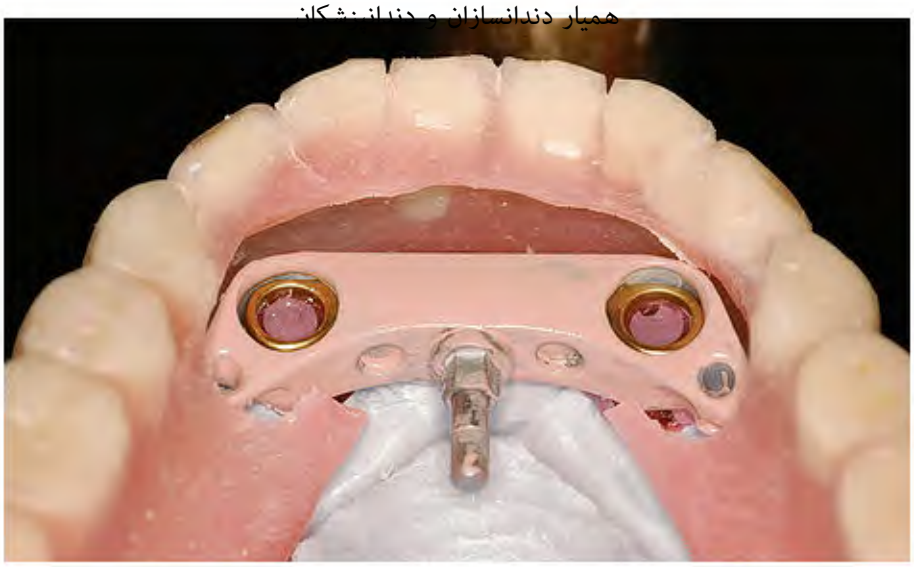


Fig 3-4dd Incorporating the bar casing into the prosthesis in the laboratory.



Fig 3-4ee Finished prosthesis with integrated casing.

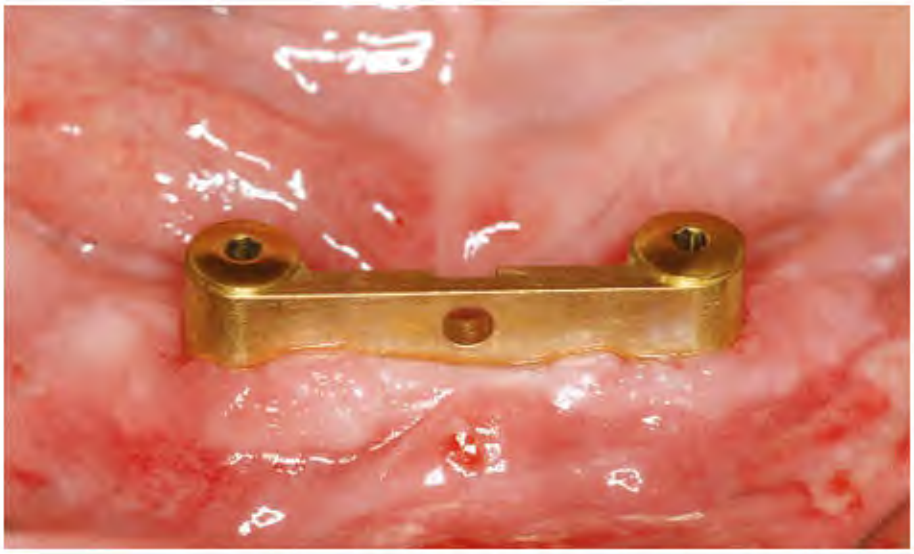


Fig 3-4ff Operation area after 1 day.

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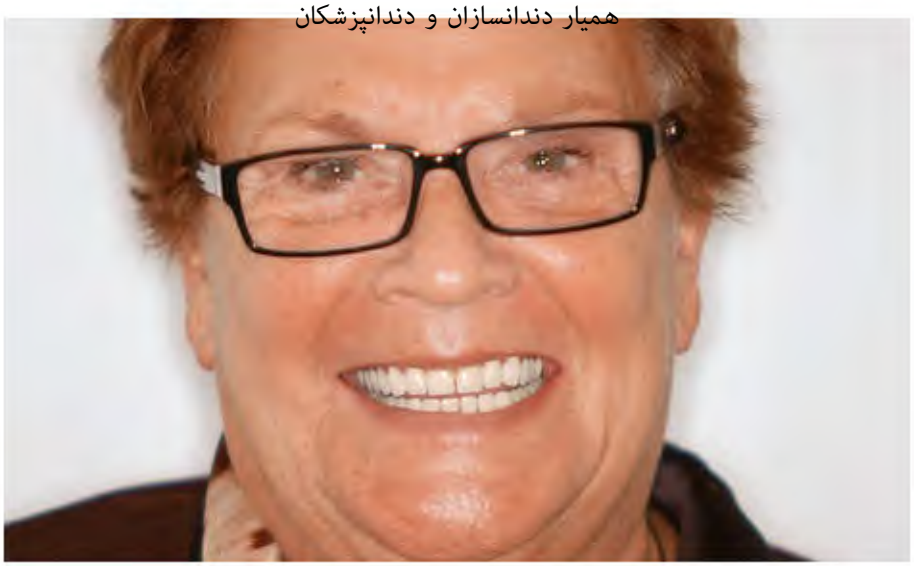


Fig 3-4gg Happy patient on the next day.

Prosthetic loading

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In the laboratory, a definitive cast was made from the impression and the casing replica was incorporated into the available prosthesis (Fig 3-4dd). The finished prosthesis could be fitted into the patient's mouth after approximately 2 to 3 h (Fig 3-4ee). In the present case, the fitting took place on the following day. The wounds caused by the pins were already healing, but slight gingival swelling developed overnight, so that the patient first had to bite down hard with the prosthesis for a few minutes before the MK1 attachment could be locked into place. The patient experienced no pain, there was no bleeding and the swelling was also minimal, so that she looked radiantly happy the day after the operation (Fig 3-4gg). She was instructed to wear the prosthesis for 1 to 2 days without removing it, before starting to practice using the locking attachment herself. She could unlock the attachment with the MK1 key (Fig 3-4hh).

Placing an index finger under her tongue, she can lock the prosthesis onto the bar (Fig 3-4ii). After 1 year of use, all is well with the bar (Fig 3-4jj) and the patient is delighted that her denture stays in place so securely.

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Fig 3-4hh Opening the locking attachment with the key.



Fig 3-4ii Unlocked attachment. The prosthesis can now be removed.



Fig 3-4jj Clinical situation after 1 year.

Treatment course

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- One-step treatment (2011)

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental technician Ludger Janssen, DentaLab

Notes on the SOS method

The SOS method presented here offers the following advantages:

1. The retention system is compatible with most leading implant systems, such as Neoss, the Brånemark System, Replace, Osteoplant, Straumann, 3i and Generica.
2. The prefabricated components offer high quality and a precise fit, which are difficult to achieve in traditional prosthetics.
3. The locking of the prosthesis onto the bar guarantees a high degree of wearer comfort and protects against an unwanted loss of stability.
4. The whole treatment can be done in 1 day.
5. Implant placement involves a virtually atraumatic surgical procedure of approximately 15 to 20 mins; swelling and postoperative pain are minimal.
6. The costs are considerably reduced compared to conventional methods.
7. The technique is easy to master, for both dentist and patient.
8. Mechanical or biological complications (from denture sores to implant loss) are very rare.

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Atypical treatment course – problematic baseline situation

Treatment of an extremely narrow residual ridge with the SOS method

Baseline situation

This 58-year-old woman was experiencing considerable suffering due to a barely retained denture in her edentulous mandible (Fig 3-5a). In the panoramic radiograph, the residual ridge appeared to be suitable for implant placement.

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- CBCT with template
- med3D planning
- Surgical 3D template

Treatment plan

1. Fabrication of the 3D template
2. Implant placement
3. Direct definitive loading



Fig 3-5a The edentulous mandible before the treatment.

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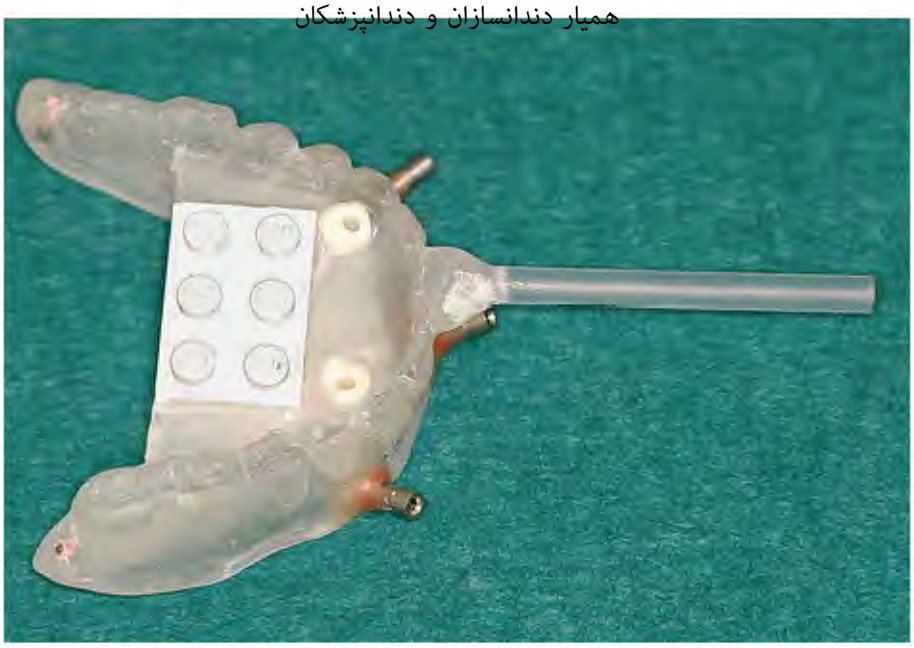


Fig 3-5b Template for the med3D planning program with integrated Lego block.

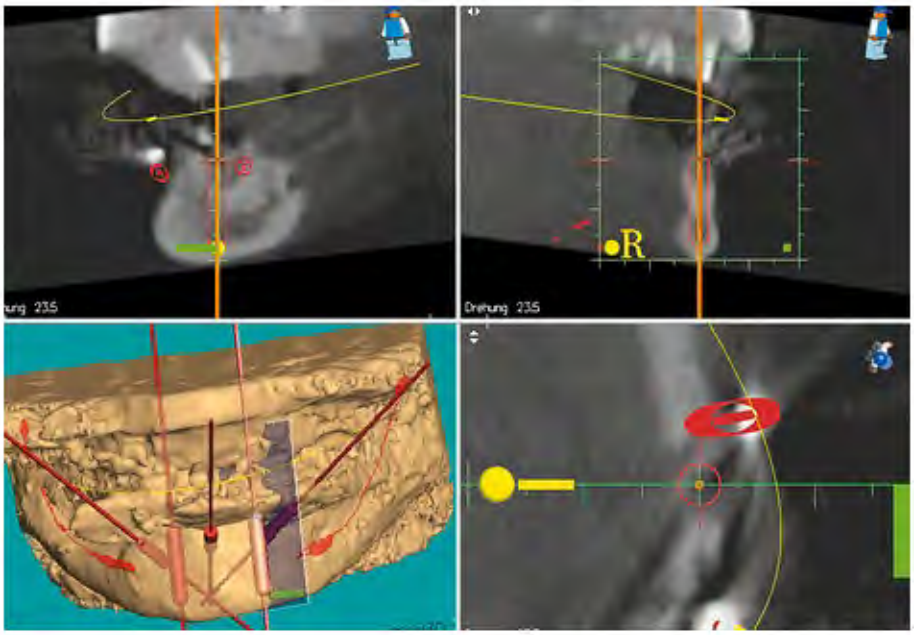


Fig 3-5c Planning the position of implant 33.

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Planning and implant placement

Implant placement was planned using the med3D program. This program requires a Lego block to be integrated into the template as a reference (Fig 3-5b). Only the CBCT scan revealed how problematic implant placement in the anterior mandibular region would be. Vertically, there is sufficient space for long implants; the problem lies in the horizontal dimension of the residual ridge. In cross section, it is obvious that there is hardly any space for a thin, 3.5-mm implant in the region of tooth 33 (Fig 3-5c). There is a very similar situation in region 43 (Fig 3-5d).

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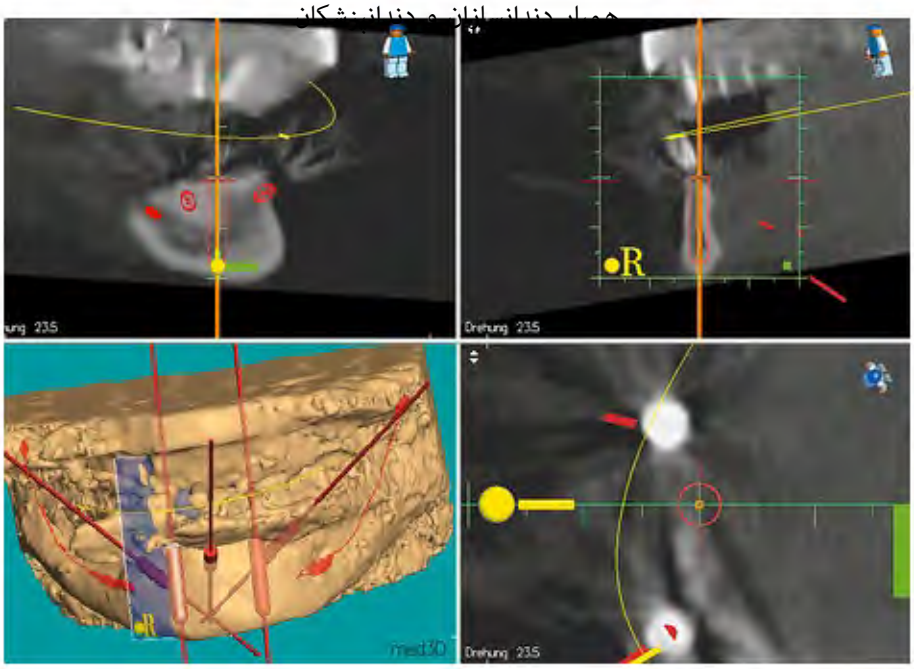


Fig 3-5d Planning the position of implant 43. The residual ridge is extremely narrow at both sites (see Fig 3-5c).

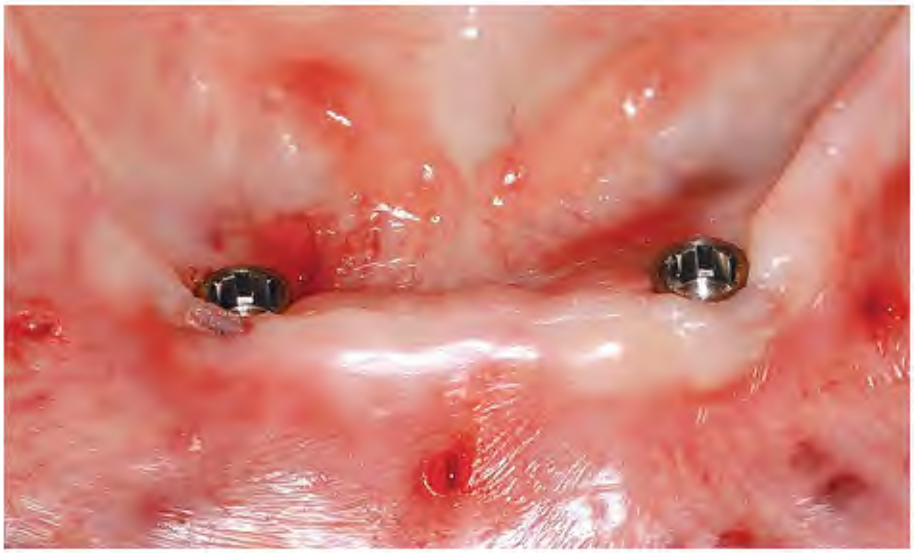


Fig 3-5e The implants directly after insertion.

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Fig 3-5f The abutments have been screwed into place.



Fig 3-5g SOS bar fitted onto the abutments.



Fig 3-5h Taking an impression with the available prosthesis.

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Attention: ***This very important diagnostic information cannot be read from the panoramic radiograph, but can only be obtained from 3D images (CBCT, CT). In such extreme situations, navigated insertion requires a template with almost 100% precision. Both the treatment provider and the patient need to be clear about the high risk involved.***

Implant placement proceeded without any problems, with the implants successfully inserted into the correct position and to the planned depth (Fig 3-5e). The abutments were screwed onto the implants. Once the bar was fitted (Fig 3-5g), an impression was taken using the reamed-out prosthesis, with the bar remaining embedded in the modeling compound (Fig 3-5h). The prosthesis was reshaped in the laboratory and fitted immediately (Fig 3-5i). Figure 3-5j shows the clinical situation 6 months after the treatment was completed. A panoramic radiograph was also taken at this point, confirming a stable bone situation around the implants (Fig 3-5k).

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Fig 3-5i Underside of the prosthesis following incorporation of the bar casing.

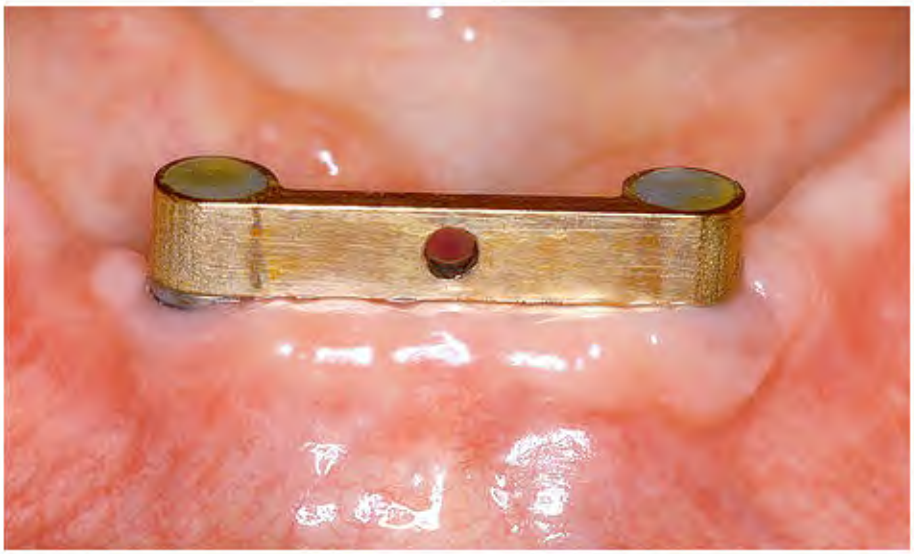


Fig 3-5j Fitted bar after 6 months of functional use.

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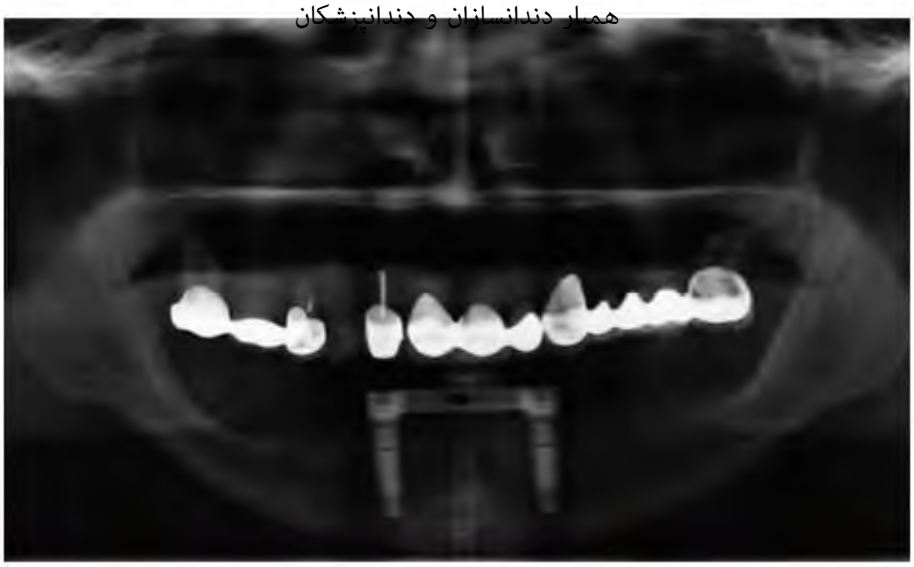


Fig 3-5k Follow-up panoramic radiograph after 6 months.

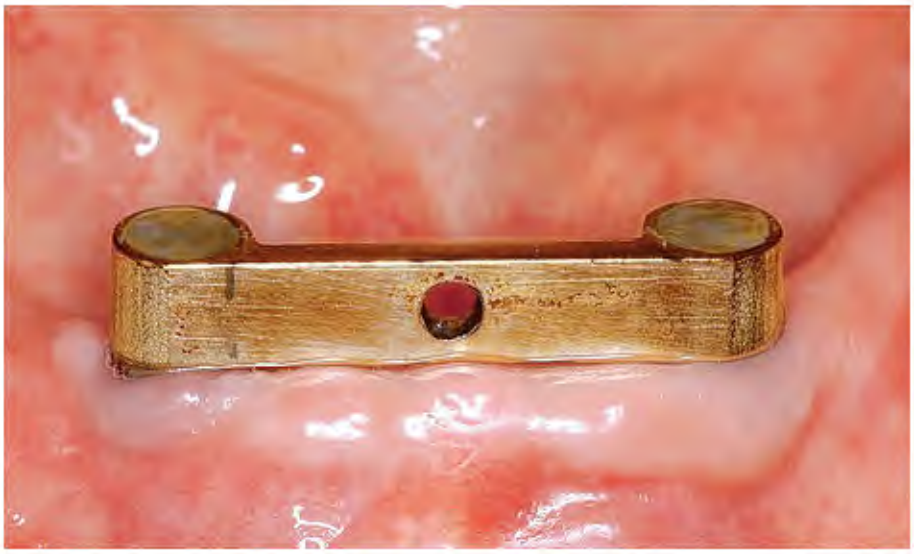


Fig 3-5l Clinical situation after 2 years.

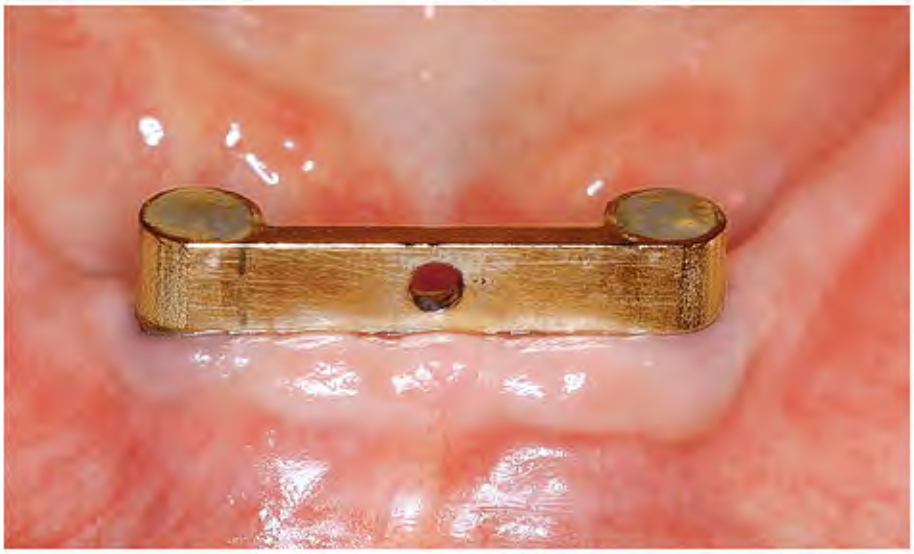


Fig 3-5m Clinical situation after 3 years.

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Fig 3-5n Deposits on the prosthesis after 3 years of functional use.



Fig 3-5o Satisfied patient 3 years after the treatment.

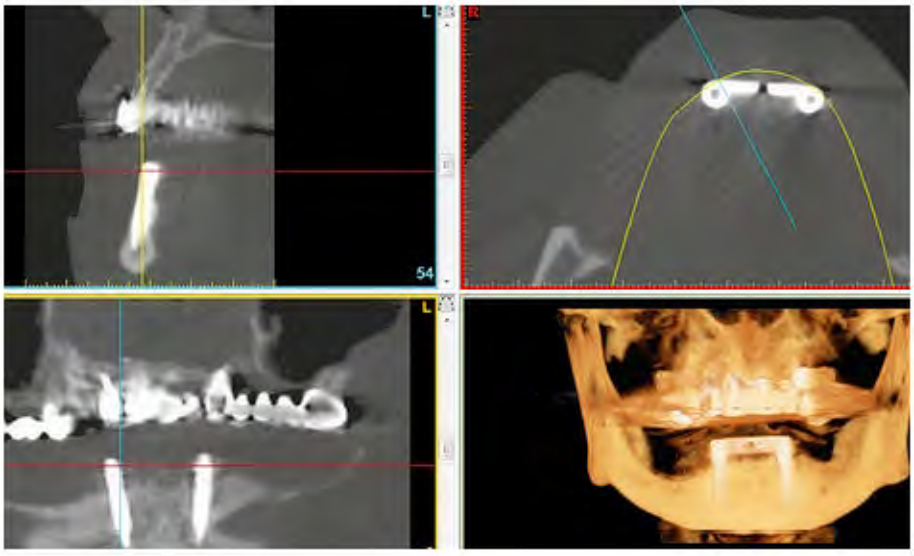


Fig 3-5p CBCT scan images after 3 years.

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Fig 3-5q Bone situation around implant 33 after 3 years, in the cross section generated from the CBCT scan.

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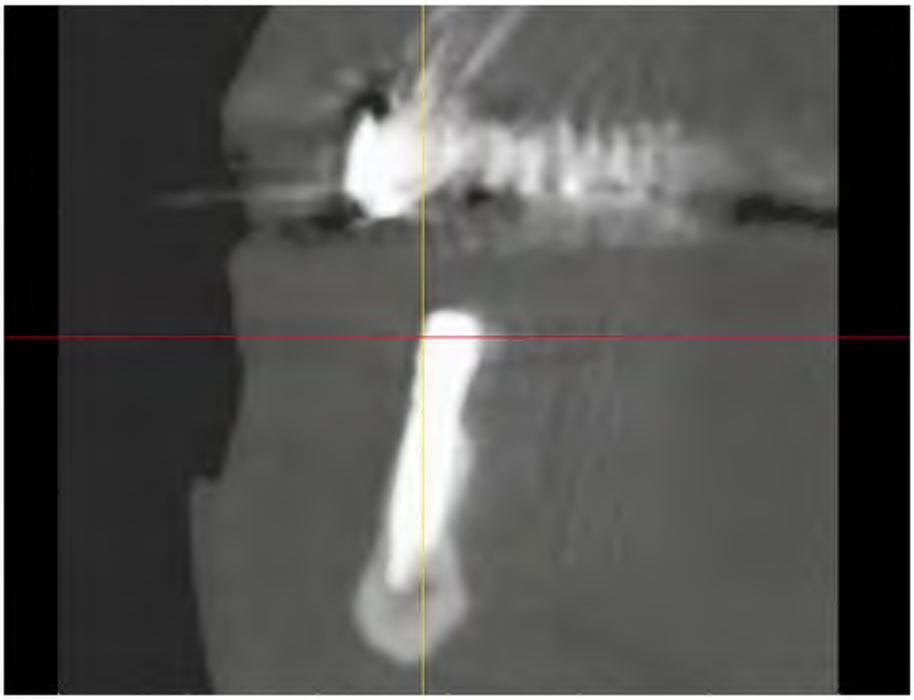


Fig 3-5r Bone situation around implant 43 at the same point in time.

Figures 3-5l and 3-5m show the clinical situation after 2 and 3 years of functional use. Deposits are visible on the prosthesis after 3 years: these were difficult for the patient to reach and were removed in the laboratory (Fig 3-5n).

The patient was very satisfied with the outcome of her treatment (Fig 3-5o). Another CBCT scan was performed after 3 years due to the impending restoration of the maxilla (Fig 3-5p). This opportunity was taken to check the bone situation around the implants in the mandible. The implant in region 33 had been inserted as planned and had integrated into the bone (Fig 3-5c and 3-5q). Implant 43 provides further confirmation of the high precision of the med3D

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template (Fig 3-5d and 3-5r).

Treatment course

- One-step treatment (2008)

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski
Dental technology: Dental Technician Ludger Jansen, DentaLab

Atypical treatment course – problematic baseline situation

SOS with osteoplasty and augmentation

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Baseline situation

This 60-year-old woman was experiencing considerable suffering from an edentulous mandible. The residual ridge was very narrow and the prosthesis, even when retained with adhesive, did not stay in place for long (Fig 3-6a). The panoramic radiograph shows a jaw of sufficient height, suitable for 18-mm implants (Fig 3-6b). Only the CBCT scan reveals that the ridge is knife-edged and not suitable for transmucosal implant placement without additional intervention (Fig 3-6c). The sharp edge is to be reduced by approximately 7 to 8 mm (Fig 3-6d).

Diagnostic tools

- Clinical examination
- Panoramic radiograph, CBCT with template
- SimPlant planning
- Surgical 3D template

Treatment plan

1. Fabrication of the SOS template
2. Implant placement
3. Osteoplasty with augmentation
4. Direct definitive loading

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Fig 3-6a Narrow residual ridge of the edentulous mandible.

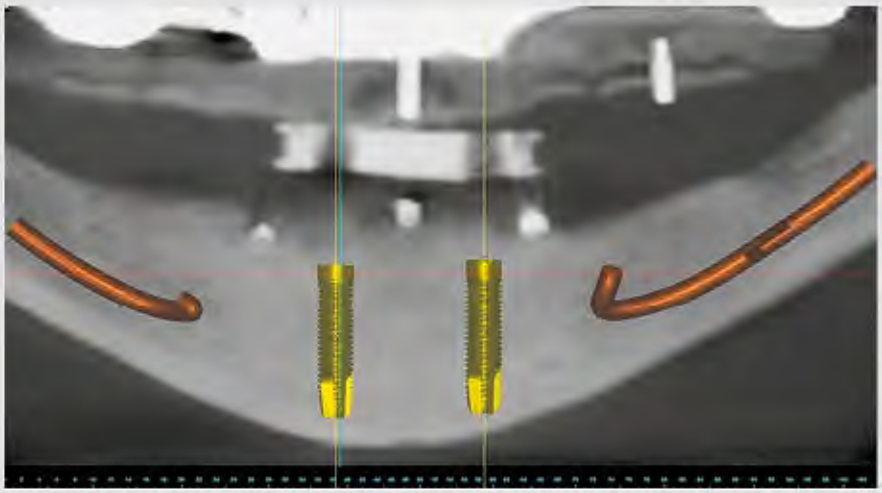


Fig 3-6b Panoramic section with the planned implants.

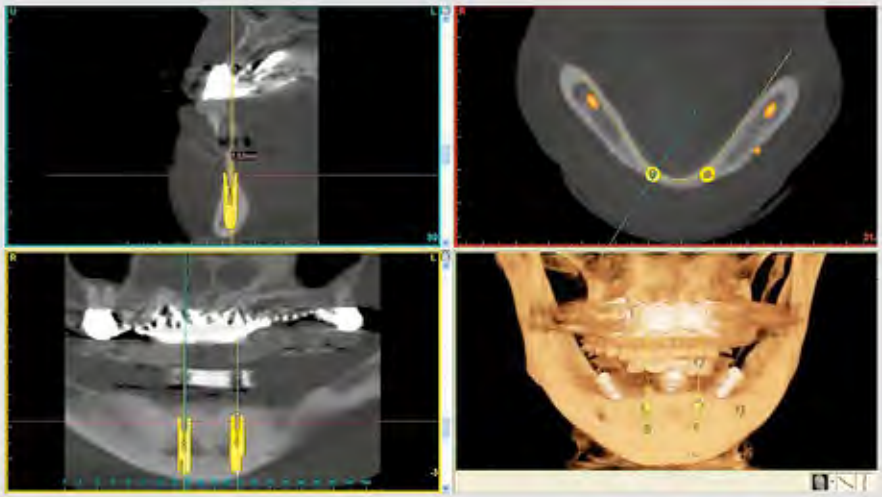


Fig 3-6c 3D diagnosis and SimPlant planning for the SOS template.

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Fig 3-6d The sharp edge of the residual ridge needs to be reduced.

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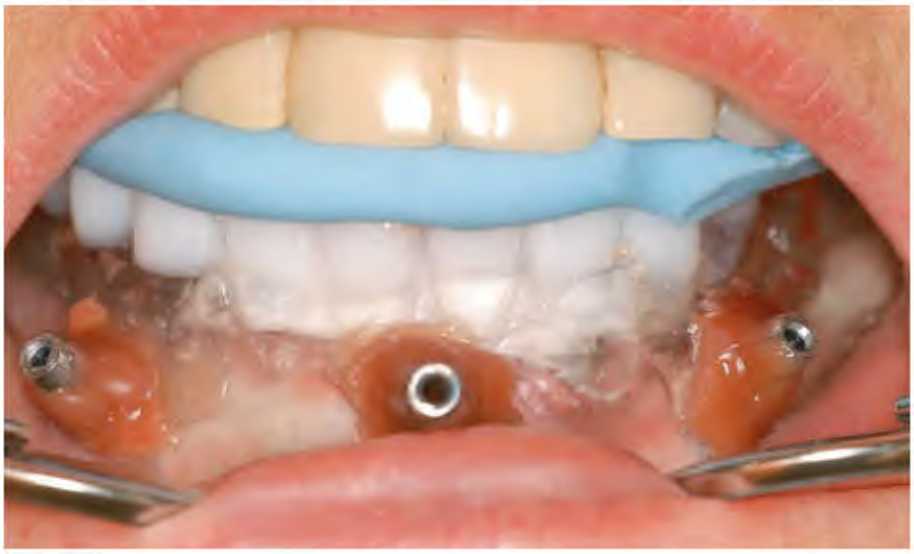


Fig 3-6e Positioning the template with an interocclusal record.

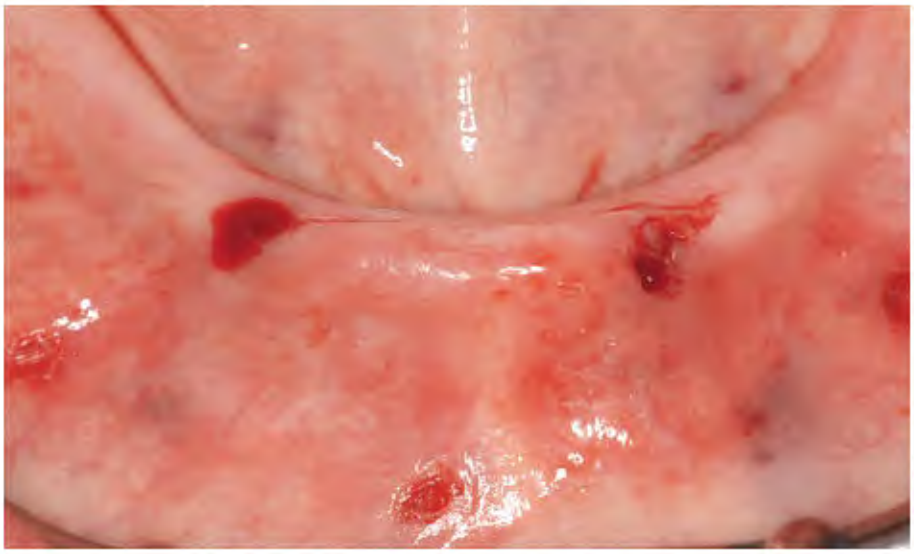


Fig 3-6f Prepared implant beds following removal of the template.

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Fig 3-6g Knife-edge residual ridge.



Fig 3-6h Residual ridge following osteoplasty.

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Implant placement with osteoplasty

Working under bilateral conduction and infiltration anesthesia, the template was positioned into the mouth under the occlusal record rim (Fig 3-6e). The template was first stabilized with the horizontal pins and the two implant beds were then prepared through the template. Once preparation was completed with the last spiral drill (3.2 mm), the template was removed from the mouth (Fig 3-6f). The incision was made centrally over the residual ridge, with a releasing incision at the front, and the lingual and labial flaps were dissected away (Fig 3-6g). The knife-edge residual ridge was reduced to a uniform plateau (Fig 3-6h), and a bone filter was used to collect the resultant bone chips, to be used for the augmentation. The height of the reduction can be assessed using the perforation made by the horizontal pin (compare Figs 3-6g and 3-6h).

The implants were inserted into the transmucosally prepared beds. Since they were located a

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bit further labially, several of the threads were exposed (Fig 3-6i). Once the implants were adjusted to the same height, the bar was screwed onto the eccentric abutments and the screws tightened with a 30 N/cm torque (Fig 3-6j). The labial augmentation was performed with the harvested bone chips and the operation area closed with sutures (Fig 3-6k). The postoperative panoramic radiograph shows the correctly positioned implants (Fig 3-6l).

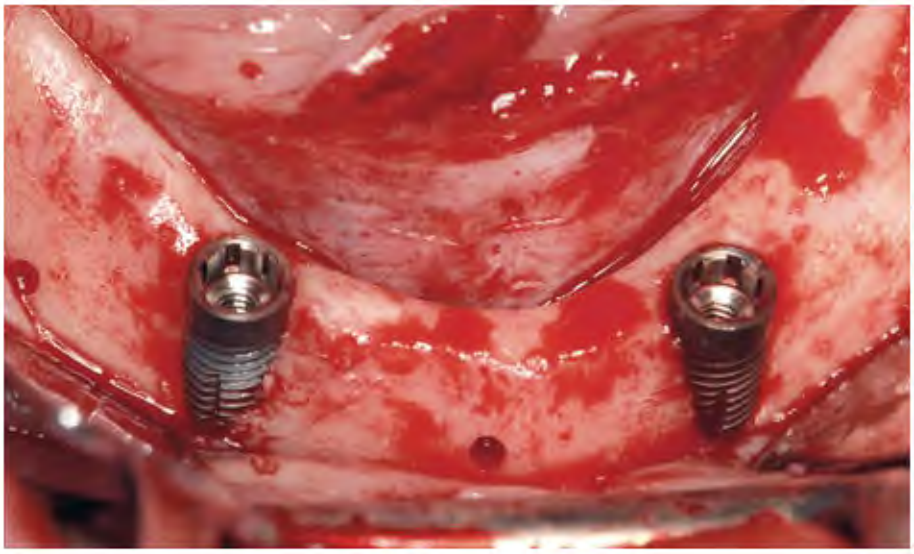


Fig 3-6i Inserted implants.

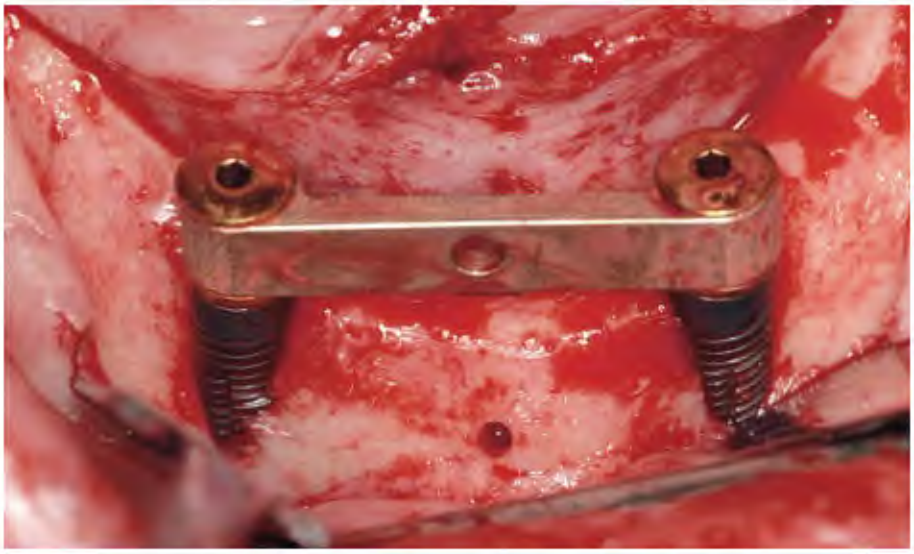


Fig 3-6j SOS bar fitted into place.

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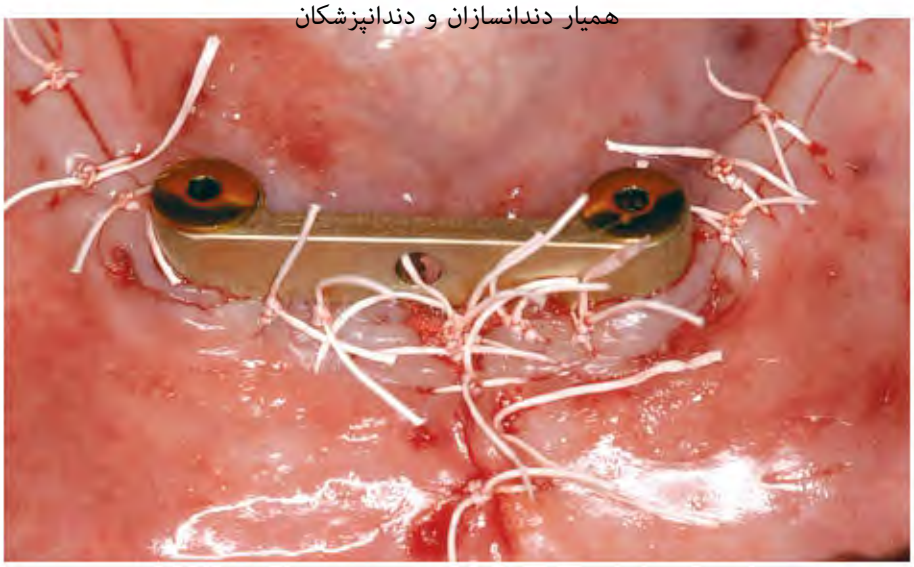


Fig 3-6k Closure by suturing after augmentation.

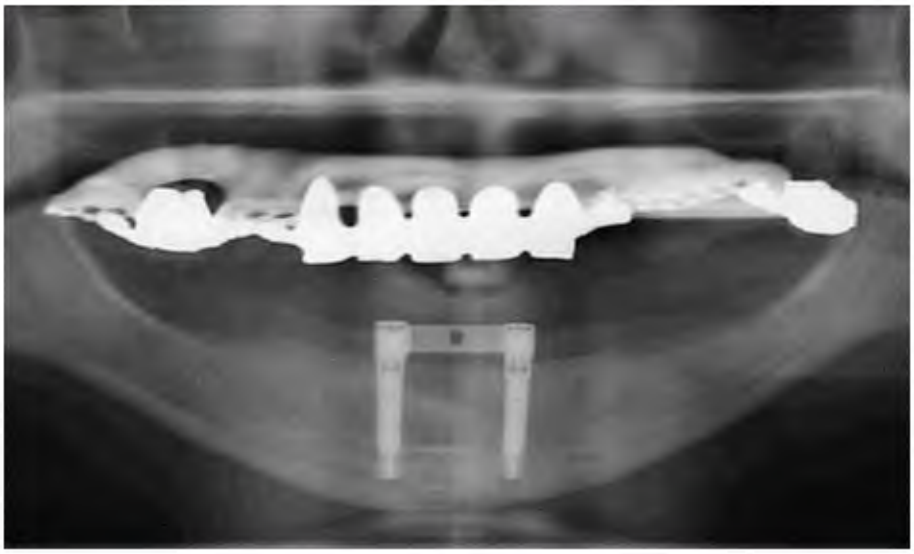


Fig 3-6l Postoperative panoramic radiograph.

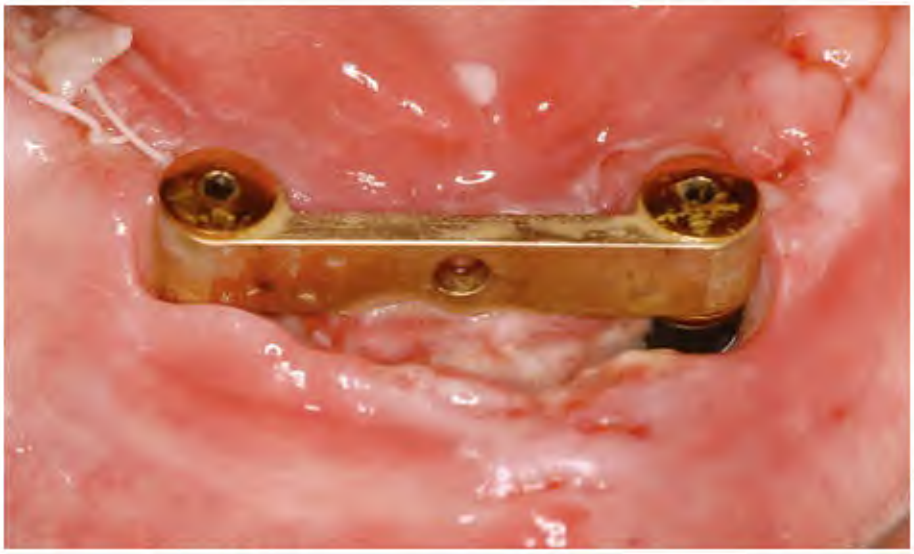


Fig 3-6m Dehiscence following removal of the sutures.

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Fig 3-6n Re-suturing.

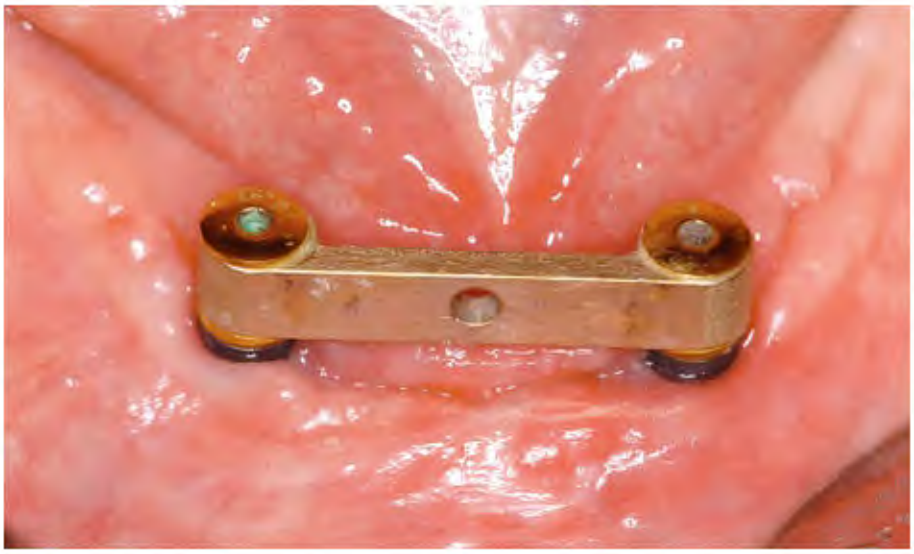


Fig 3-6o Closure of the dehiscence after 1 month.



Fig 3-6p Clinical situation after 2 years.

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Complication – wound dehiscence

The sutures were due to be removed 1 week after implant placement. At that point, we found that the sutures had torn in the middle, resulting in wound dehiscence under the bar (Fig 3-6m). The wound margins were refreshed with the scalpel and adapted with new sutures. After 1 more week, the wound closure appeared to have stabilized (Fig 3-6n). A few days later, it also proved possible to remove the remaining sutures. The dehiscence had healed completely after 2 more weeks (Fig 3-6o). Two years later, the mucosal situation was stable and no traces of the dehiscence remain (Fig 3-6p).

Treatment course

- One-step treatment (2010)

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental Technician Ludger Jansen, DentaLab

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Atypical treatment course – problematic baseline situation

Immediate implant placement following extraction and direct loading with SOS without a template

Baseline situation

A 70-year old man had six teeth remaining in the anterior mandible, but these could not be preserved in the long term (Fig 3-7a). He had heard of the SOS technique and was expressly requesting this type of prosthetic restoration, preferably as quickly as possible. He was skeptical and negative about the suggestion that he could be fitted with an overdenture resting on his remaining teeth. A CBCT scan was taken for the treatment planning and the option of inserting two implants for the SOS bar was verified (Fig 3-7b). At the patient's request, the plan was to perform immediate implant placement following the extraction.

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning

Treatment plan

1. Fabrication of an immediate complete prosthesis for the mandible
2. Extraction, implant placement, osteoplasty with augmentation, direct definitive loading



Fig 3-7a Residual teeth in the mandible.

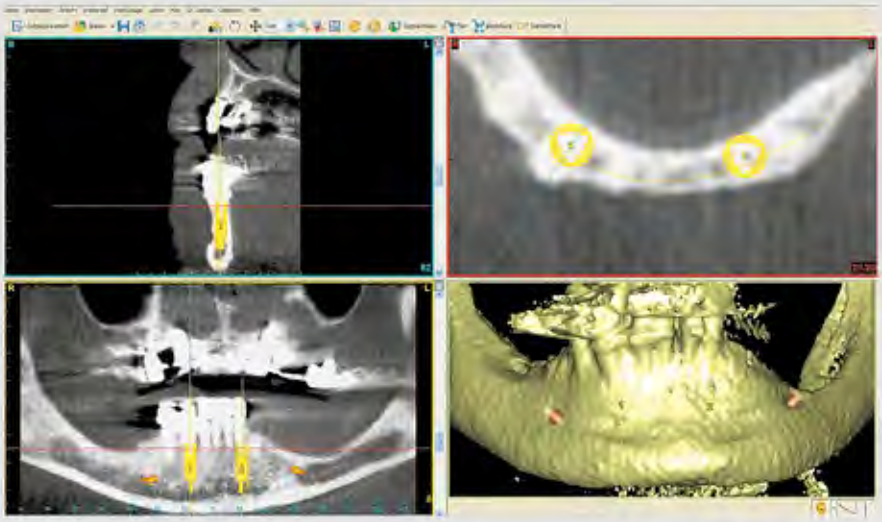


Fig 3-7b 3D analysis and planning.

Extraction and implant placement

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An immediate complete prosthesis was fabricated for the patient before the extraction. It was decided not to make up an SOS template due to the immediate implant placement. Implant placement was to take place directly after the extraction with the Rescue Kit for the SOS (see page 137). The procedure took place under bilateral conduction and infiltration anesthesia. All the teeth were first extracted and a lingual as well as a labial flap created. The sharp edges of the sockets were leveled off and the whole residual ridge smoothed down to the same level (Fig 3-7c). The right implant was inserted first, into the septum between sockets 42 and 43 (Fig 3-7d). The drill guide for the 1.5-mm drill from the Rescue Kit was fitted onto the inserted implant (Figs 3-7e and 3-7f).

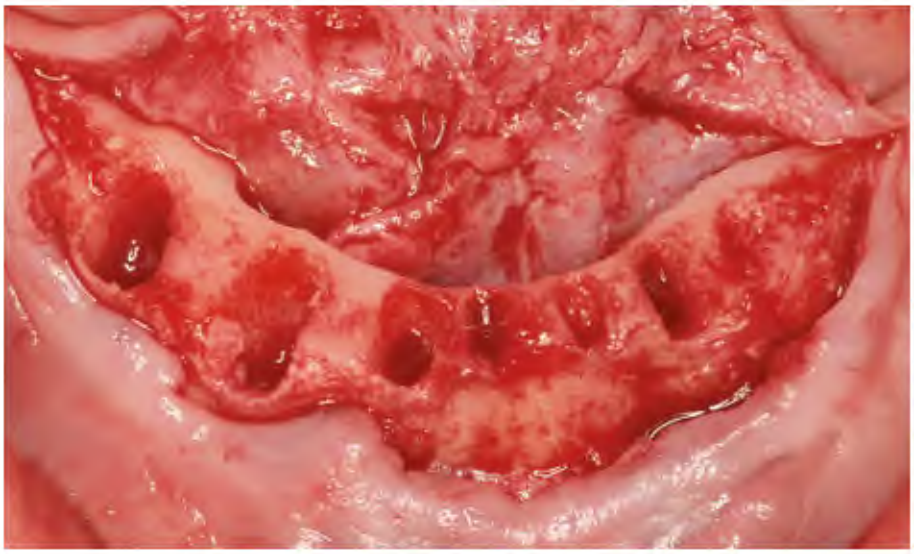


Fig 3-7c Osteoplasty of the residual ridge following the extraction.

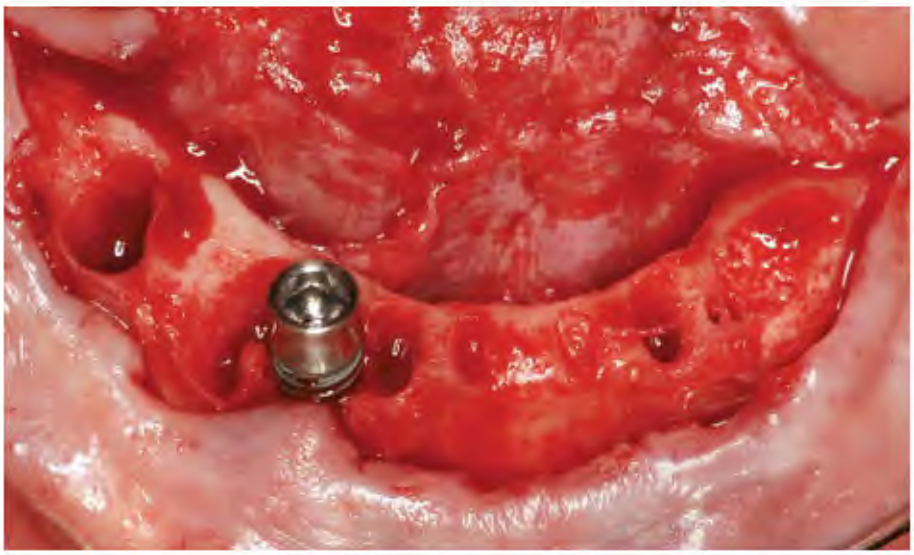


Fig 3-7d Insertion of the first implant into region 43.

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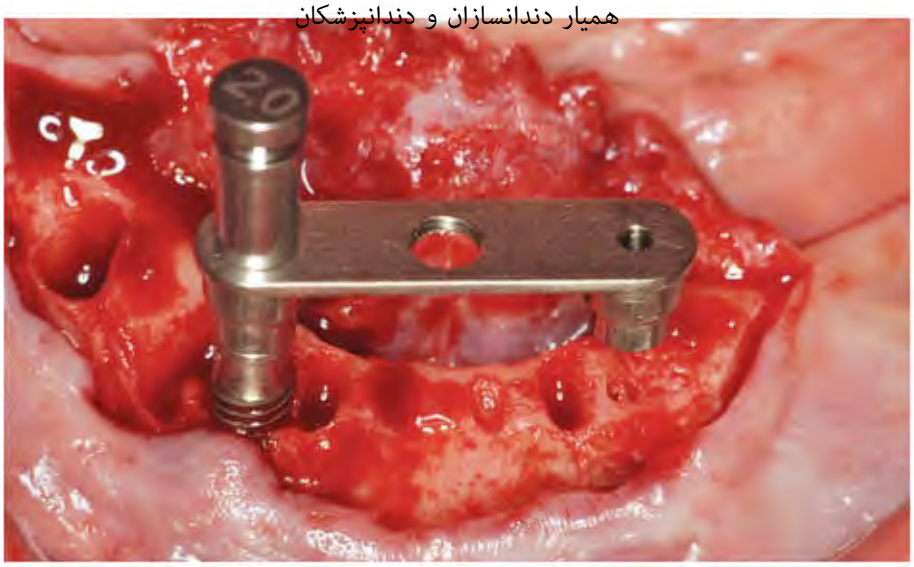


Fig 3-7e The drill guide has been screwed into place.

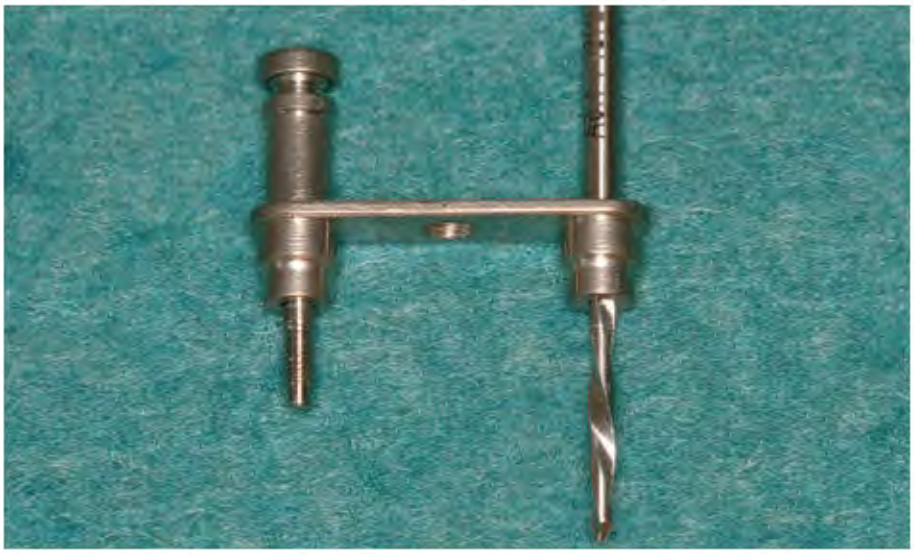


Fig 3-7f SOS Rescue Kit.



Fig 3-7g Drill guide fitted onto the implant.

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Fig 3-7h Additional pins used for stabilization of the drill guides.

Attention: ***The SOS Rescue Kit consists of the following components: double drill guide, with the 2-mm pin for the first 1.5-mm spiral bone drill, which can be screwed onto the implant (Figs 3-7f and 3-7g) and a sequence of screw-on pins for the subsequent drill guides from the set that are needed for preparation of the second implant bed (Fig 3-7h). The bar casing replica is also fitted onto the first implant, facilitating precise placement of the second implant (Fig 3-7i).***

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Fig 3-7i Bar casing replica for the insertion of the second implant.

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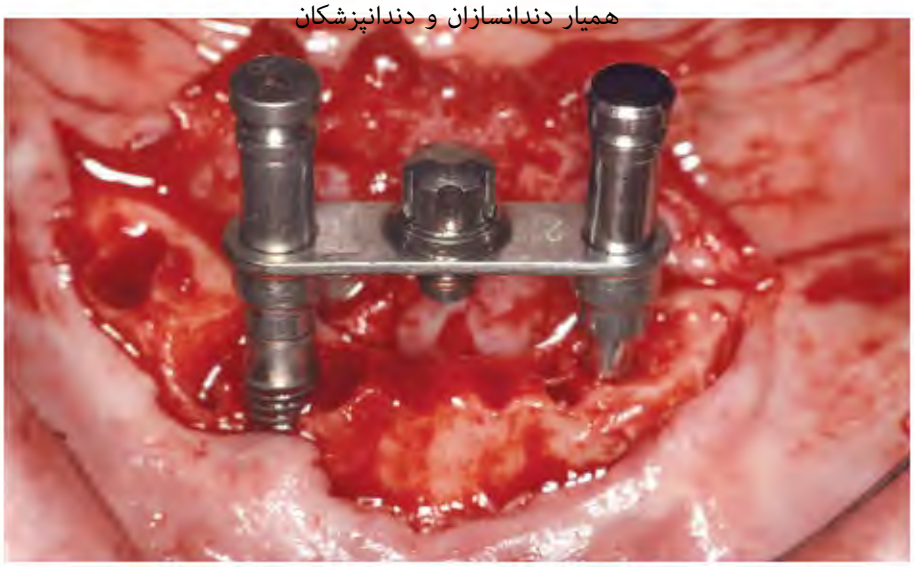


Fig 3-7j Preparation of the second implant bed.

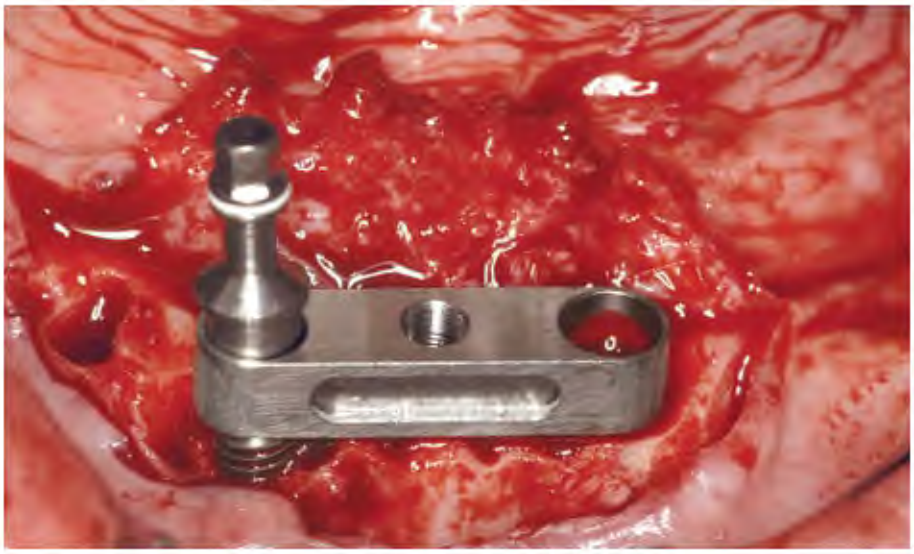


Fig 3-7k Bar casing replica fitted onto the first implant.

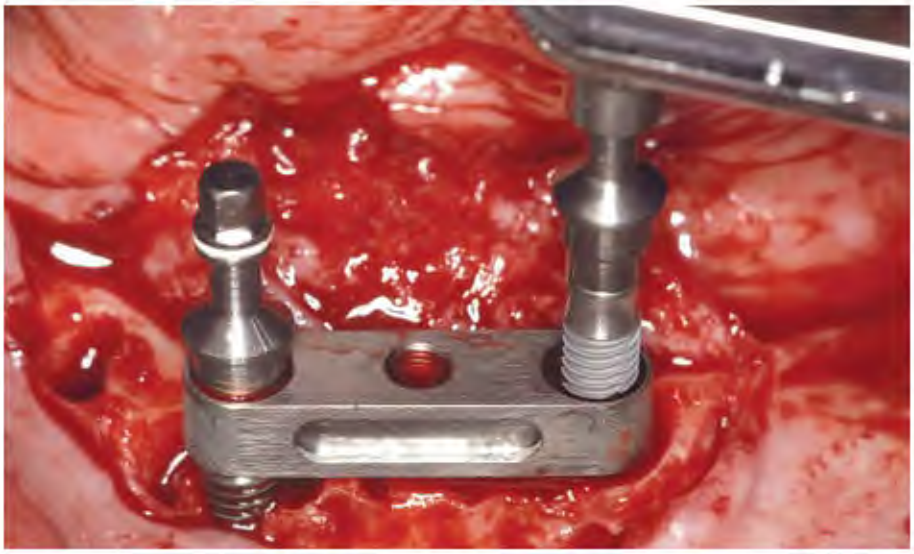


Fig 3-7l Insertion of the second implant.

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Fig 3-7m Fine-tuning the height of the two implants.

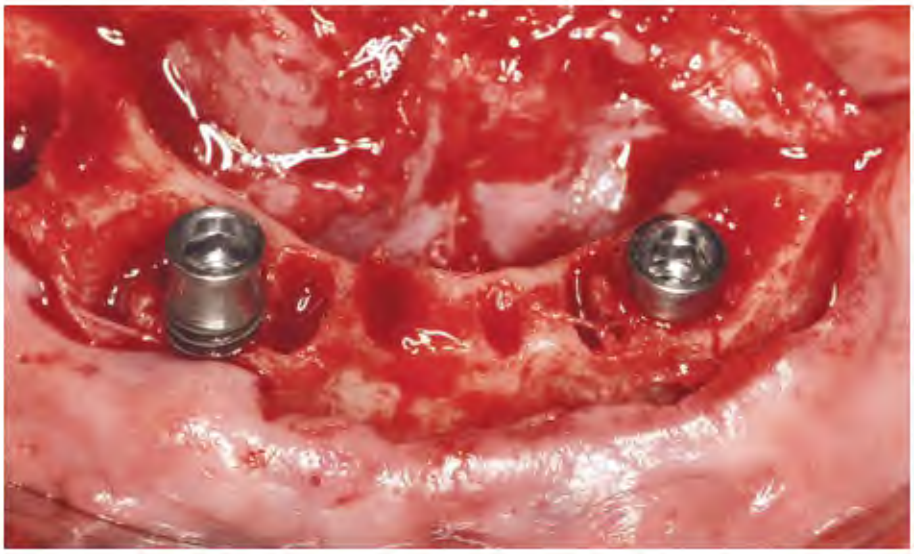


Fig 3-7n Implants in the final position.

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This was followed by further drilling through the drill guides fitted onto the first implant; these bores were then checked with the vertical stabilization pins (Figs 3-7h and 3-7j). Following preparation of the second implant bed, the bar casing replica with the insertion post was fitted onto the first implant (Fig 3-7k). The second implant was inserted through the bar casing replica (Figs 3-7i and 3-7l). The casing replica also provides guidance regarding the depth to which the second implant needs to be inserted, to ensure that both implants are placed at the same level (Figs 3-7i and 3-7m). The insertion posts and replica were now removed (Fig 3-7n) allowing the bar to be fitted (Fig 3-7o). The bone chips harvested during the osteoplasty of the residual ridge and the preparation of the implant beds were used to augment the mandibular defects (Fig 3-7p). The augmentation was stabilized with a small Bio-Gide membrane (Geistlich) and tightly closed with sutures (Fig 3-7q). The prosthesis, reamed out in the anterior region, was tried in and used to take an impression of the new situation in the mouth (Fig 3-7r).

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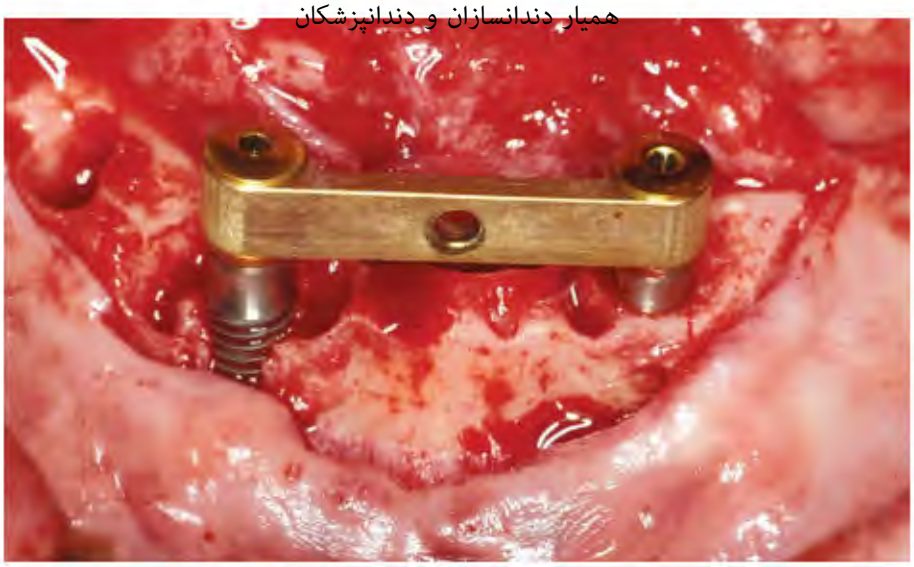


Fig 3-7o SOS bar fitted into place.

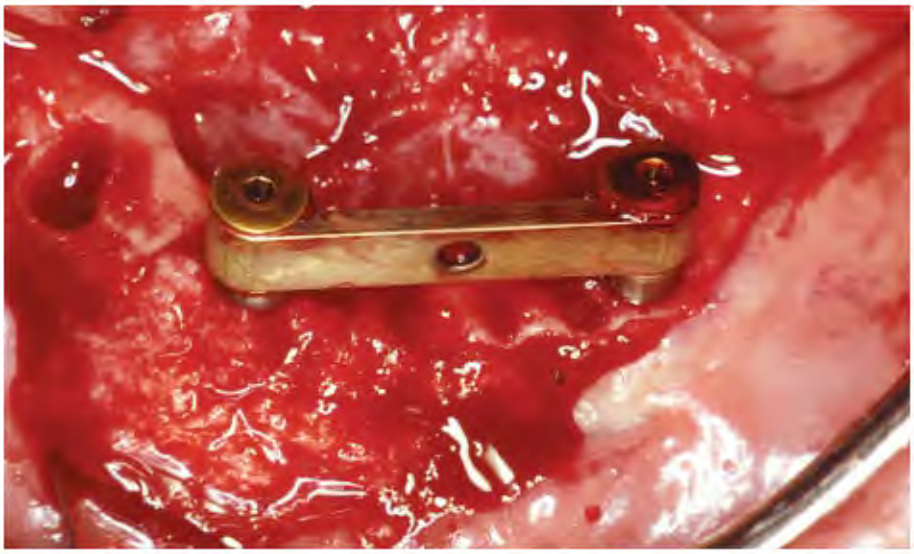


Fig 3-7p Augmentation of the bone defects.

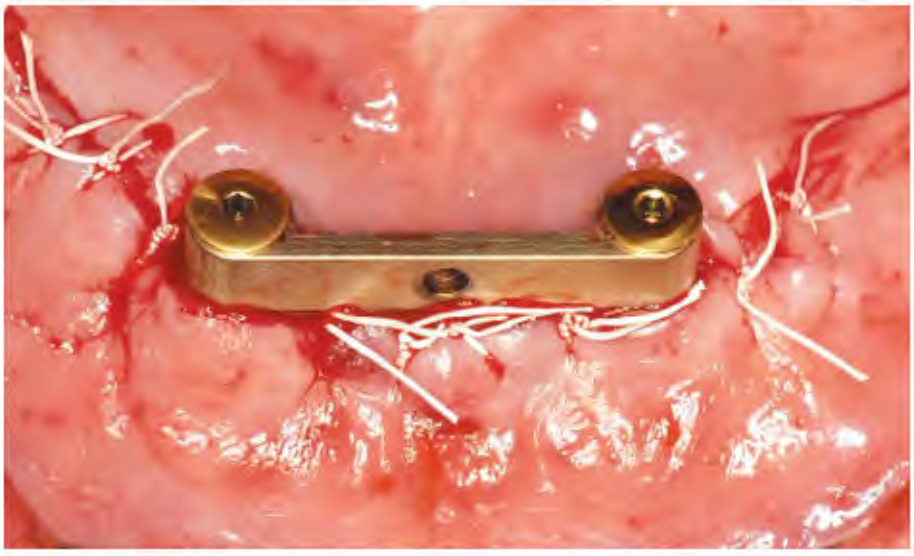


Fig 3-7q Suturing.

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Fig 3-7r The prosthesis has been prepared for impression taking.



Fig 3-7s Definitive prosthesis.

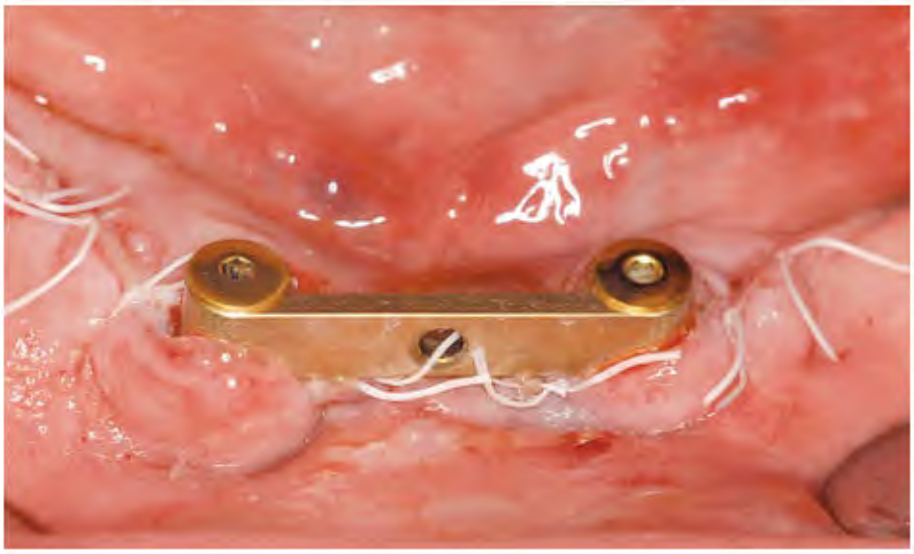


Fig 3-7t Clinical situation 1 day after implant placement.

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In the laboratory, the bar casing was incorporated into the denture, allowing the definitive prosthesis to be fitted (Fig 3-7s). While there was no further bleeding the day after implant placement, the entire operation area was swollen (Fig 3-7t). Before the prosthesis could be secured to the bar with the locking attachment, the patient had to bite down hard for a few minutes to displace the swollen tissue.



Fig 3-7u The prosthesis has been fitted.

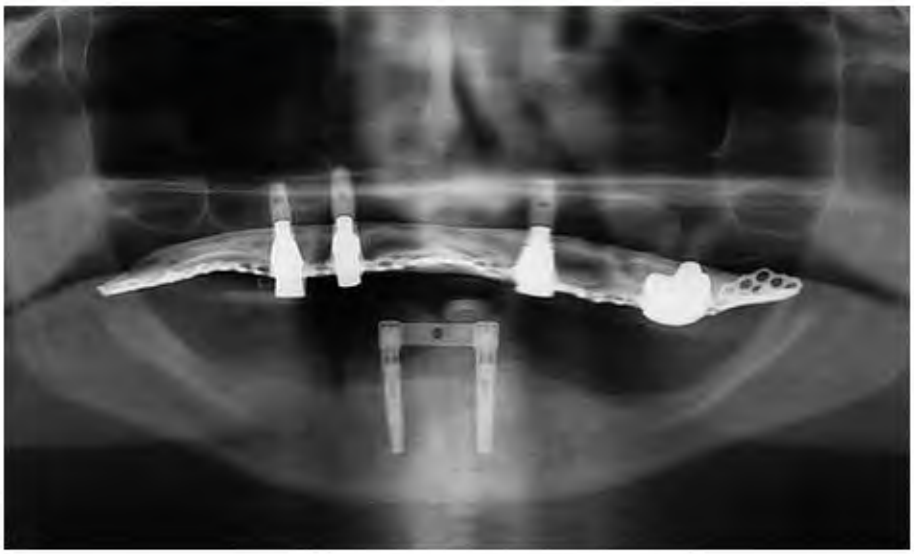


Fig 3-7v Follow-up panoramic radiograph.

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Fig 3-7w Labial view of the clinical situation after 6 months.

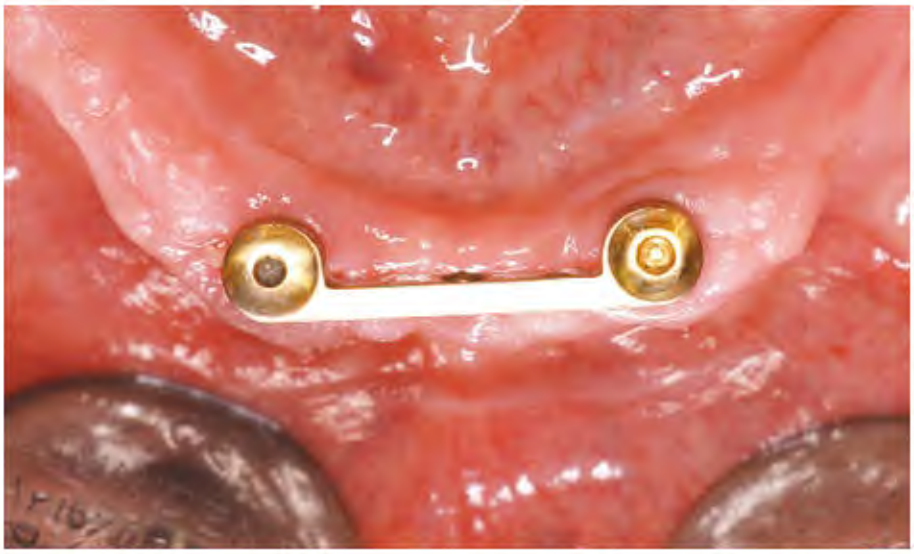


Fig 3-7x Lingual view.

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The finished denture remained in situ for 2 days before being taken out, to give the patient some practice in handling it (ie, how to insert and remove it; see Fig 3-7u). The postoperative radiograph confirmed that the implants were securely anchored in the jaw (Fig 3-7v). Six months after implant placement, the clinical situation was satisfactory, although oral hygiene was not yet optimal. The patient was very satisfied. The soft tissue around implant 43 has degenerated slightly in the augmented region, favoring the formation of deposits (Fig 3-7w). The situation on the lingual side looks much better (Fig 3-7x).

Treatment course

- One-step treatment: extraction, osteoplasty, implant placement and augmentation, immediate loading (2012)

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Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental Technician Ludger Jansen, DentaLab

Problems and complications

Early loss of an SOS implant and re-implantation

Baseline situation

A 40-year-old woman, relatively young but with multiple morbidities, a heavy smoker (30 to 40 cigarettes a day), had been suffering from toothlessness for years (Fig 3-8a). She had lost her last teeth approximately 15 years previously. Since then, there had been repeated attempts to provide her with removable complete dentures, with no success. She could not manage the dentures and hardly ever wore them. Consequently, she had lost her last set when leaving her backpack on the bus 2 years previously. No new prosthesis had been fitted since then. To date, various dental practices, clinics and even university clinics had refused the patient implant treatment due to her high risk and poor financial situation. Clinically, both jaws have atrophied severely and the mandibular residual ridge appears to be very narrow (Fig 3-8b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT with template
- SimPlant planning
- Surgical 3D SurgiGuide template

Treatment plan

1. Fabrication of the 3D template
2. Implant placement, direct definitive loading

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Fig 3-8a Relatively young edentulous patient before the treatment.



Fig 3-8b Narrow edentulous mandible.

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Fig 3-8c SimPlant planning of the SOS template.

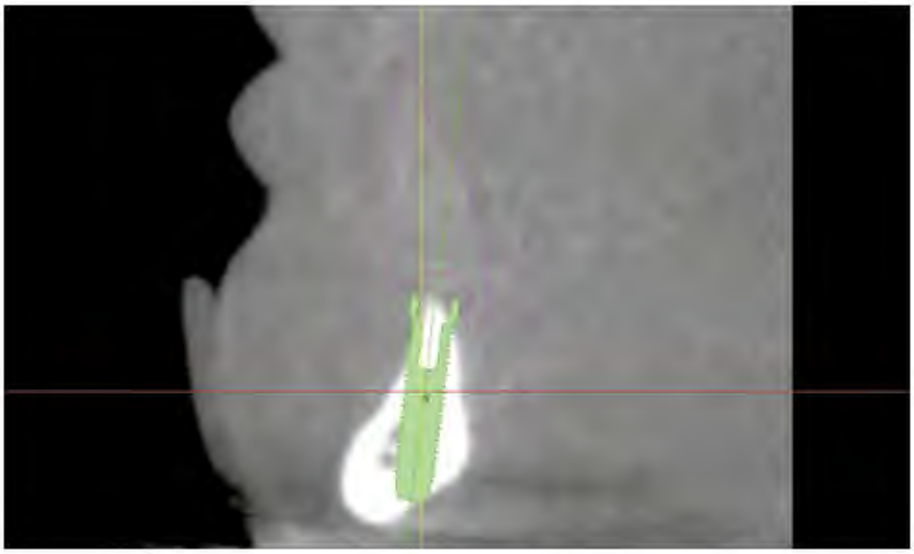


Fig 3-8d Positioning of implant 43 in the cross-sectional view.

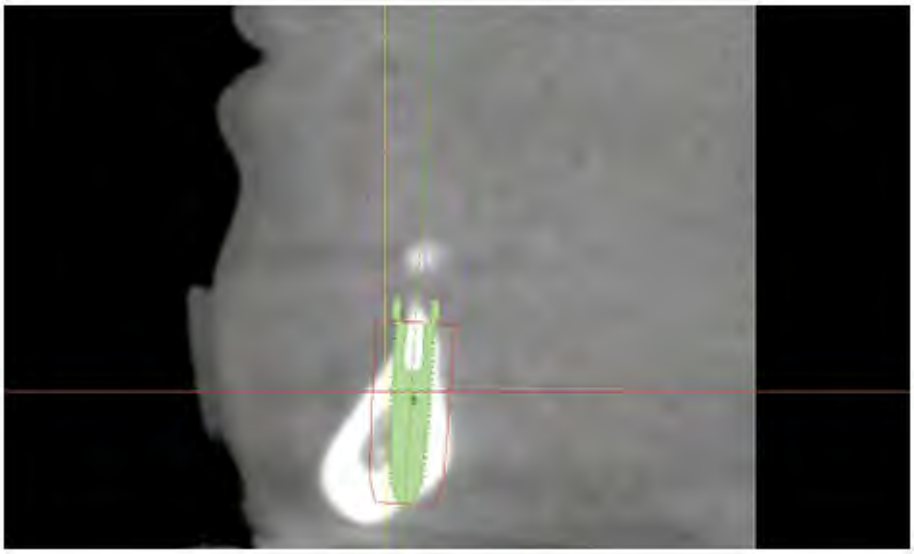


Fig 3-8e Positioning of implant 33 in the cross-sectional view. Thin lingual bone.

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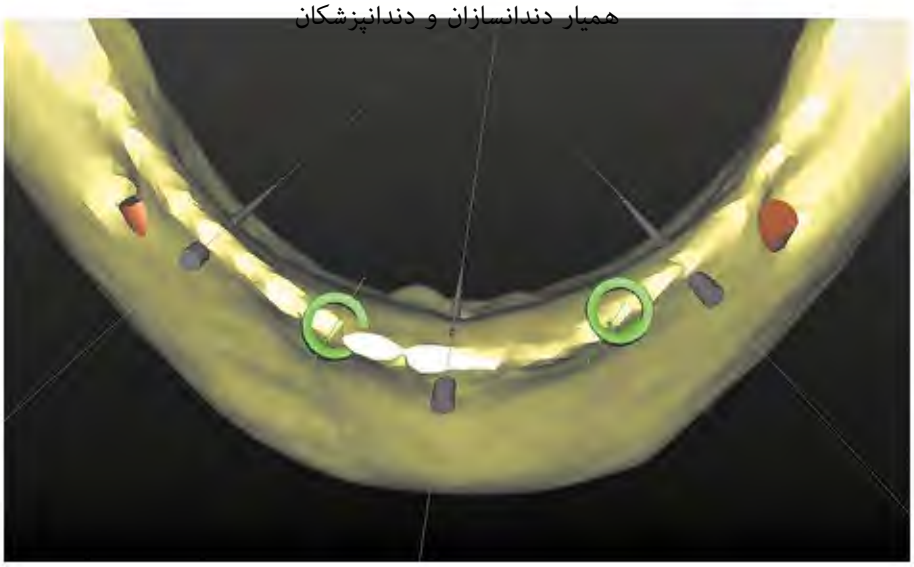


Fig 3-8f Occlusal view of the planning in the 3D reconstruction.

Fabrication of complete prostheses and 3D planning for the SOS SurgiGuide template

A new set of complete prostheses up to the wax-up stage was prepared first. During fabrication, eight glass beads were incorporated into the mandibular prosthesis to act as radiopaque markers. One CBCT scan was taken with this prosthesis in the mouth, and a second of the prosthesis alone. The double-scan function was used to combine the two scans, followed by the 3D planning (Fig 3-8c). Both nerves were marked in first and the implants and pins planned after that. The residual ridge was knife-edged, so that implant 43, aligned under the denture plate (pink outline) was partially exposed on both the labial and lingual side (Fig 3-8d). A similar situation was apparent with implant 33, and only the lingual bone layer was slightly thinner (Fig 3-8e). The sharp residual ridge and the positioning of the implants and stabilization pins can be seen in the occlusal view of the 3D reconstruction (Fig 3-8f). Despite the greater difficulty involved, the patient decided to have the implant treatment, and the SurgiGuide template was ordered from Dentsply.

Implant placement

The occlusal view of the residual ridge, even without flap reflection, confirmed the diagnosis based on the 3D reconstruction (Fig 3-8g). Before the start of the operation, the template was tried in the mouth and checked for stability (Fig 3-8h). During preparation, the template was removed and the stability of the vertical pins in the implant beds was checked (Fig 3-8i). Both implants were inserted with primary stability and the bar screwed into place (Fig 3-8j). After reshaping, the denture was fitted the same day. Over the next 2 months, the clinical situation appeared to be stable (Fig 3-8k). While the left implant in region 33 lies further lingually than

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planned, it was asymptomatic at the time (Fig 3-8l). At this point, the patient was satisfied with the treatment and enjoyed her “new,” securely fitting teeth (Fig 3-8m).



Fig 3-8g Occlusal view of the residual ridge.

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Fig 3-8h Try-in of the SurgiGuide template.

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Fig 3-8i Checking the stability of the implant bed preparation.

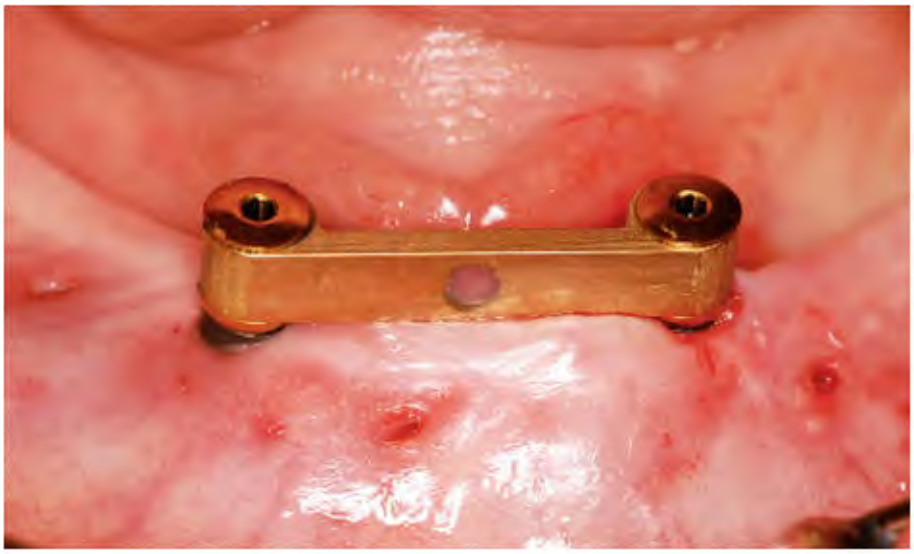


Fig 3-8j Fitted bar following implant placement.



Fig 3-8k Fitted bar after 2 months.

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Fig 3-8l Occlusal view of the bar. Implant 33 lies too far lingually.



Fig 3-8m Happy patient with her “new” teeth.

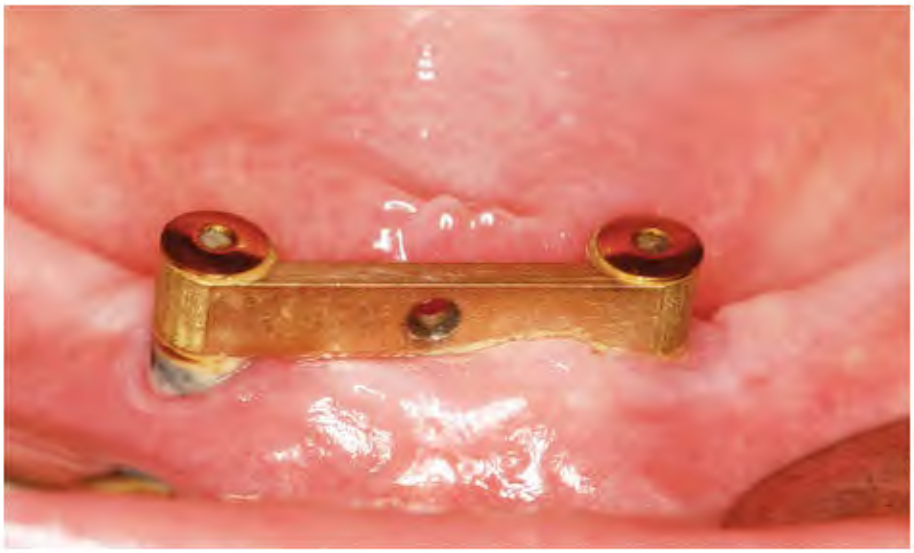


Fig 3-8n Clinical situation after 10 weeks.

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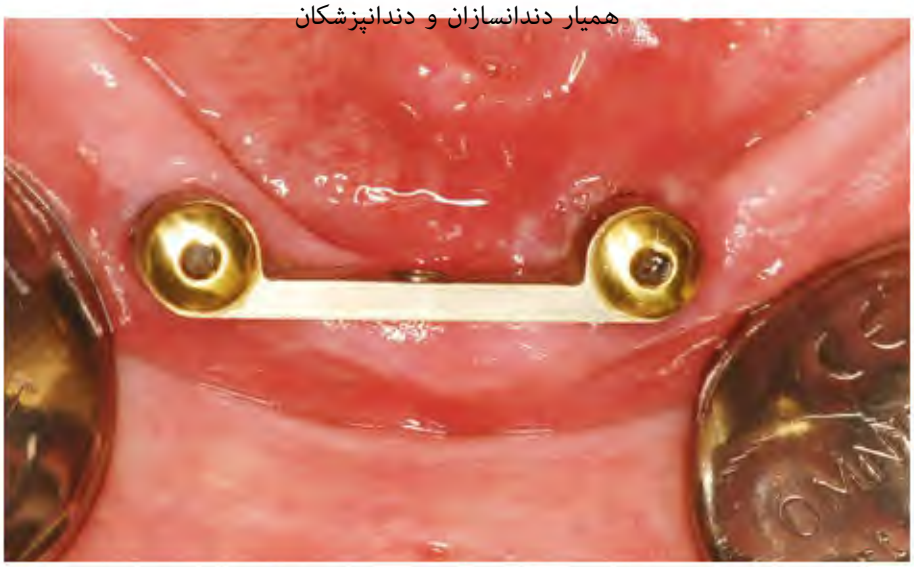


Fig 3-8o Peri-implantitis on the lingual side of implant 33.

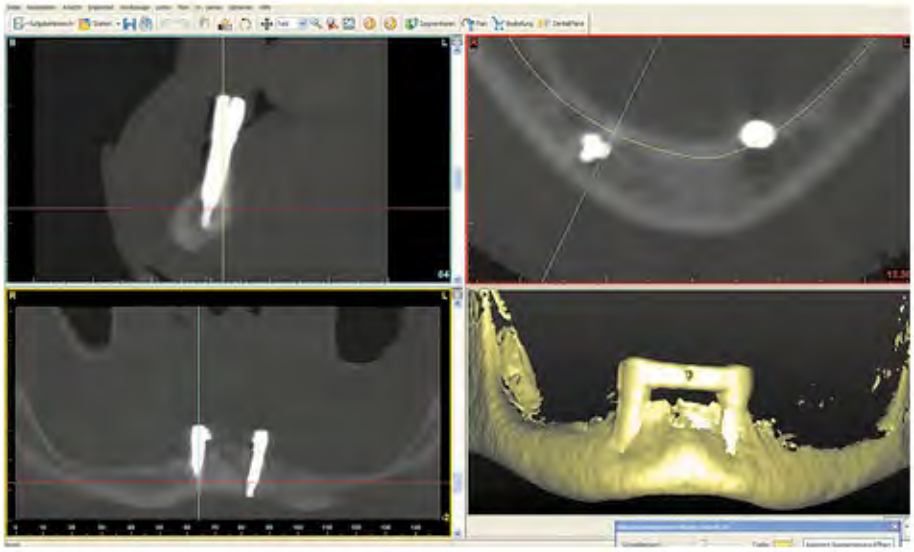


Fig 3-8p Follow-up CBCT scan.

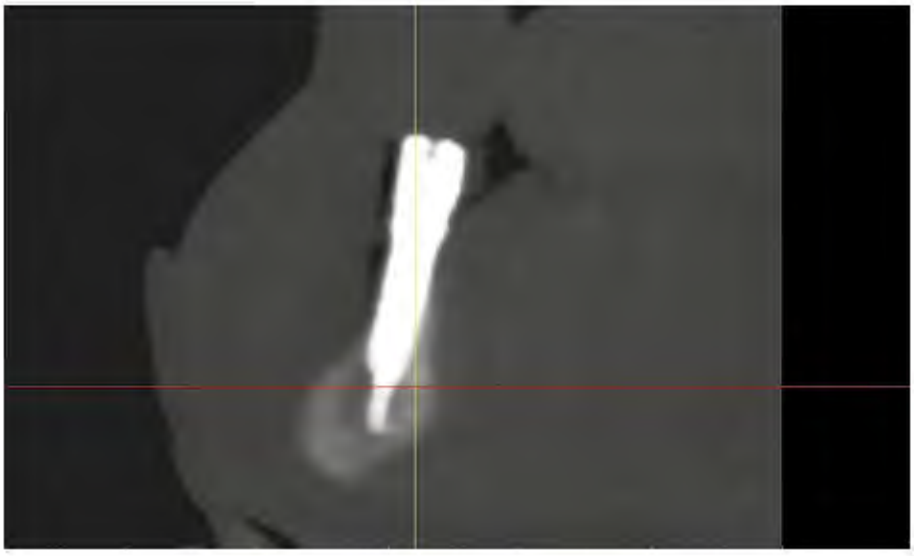


Fig 3-8q Implant 43 is anchored in the basal bone of the mandible.

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Fig 3-8r Implant 33 lies too far lingually.

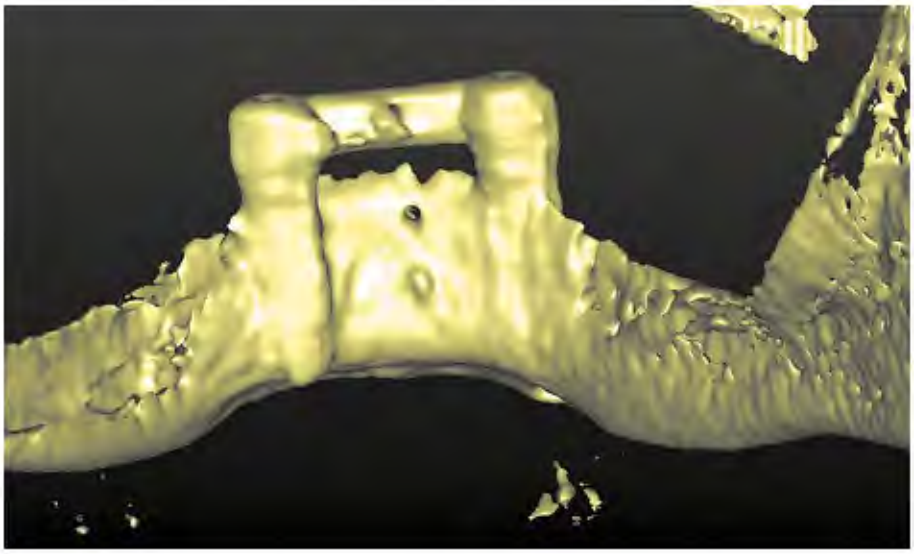


Fig 3-8s Lingual view of protruding implant 33.

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Complication

After another 2 weeks, there was an unexpected change in the situation. The patient complained of pain around the left implant, although little had changed on the labial side at first glance (Fig 3-8n). However, an inflammatory reaction around implant 33 was diagnosed on the lingual side (Fig 3-8o). The inflammation was treated with H_2O_2 irrigation and photodynamic antimicrobial chemotherapy (PACT) 3 times a week. Since no improvement was apparent after 1 week, a CBCT scan was taken (Fig 3-8p). Implant 43 was securely anchored in the middle of the mandible (Fig 3-8q). Implant 33 appeared to have no bone cover on the lingual side (Fig 3-8r). In the lingual view of the 3D reconstruction, this implant appeared to protrude from the bone throughout its length (Fig 3-8s). To relieve the load on implant 33, the entire structure was removed and both implants were capped with cover screws (Fig 3-8t).

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Fig 3-8t The bar has been removed and the cover screws fitted.

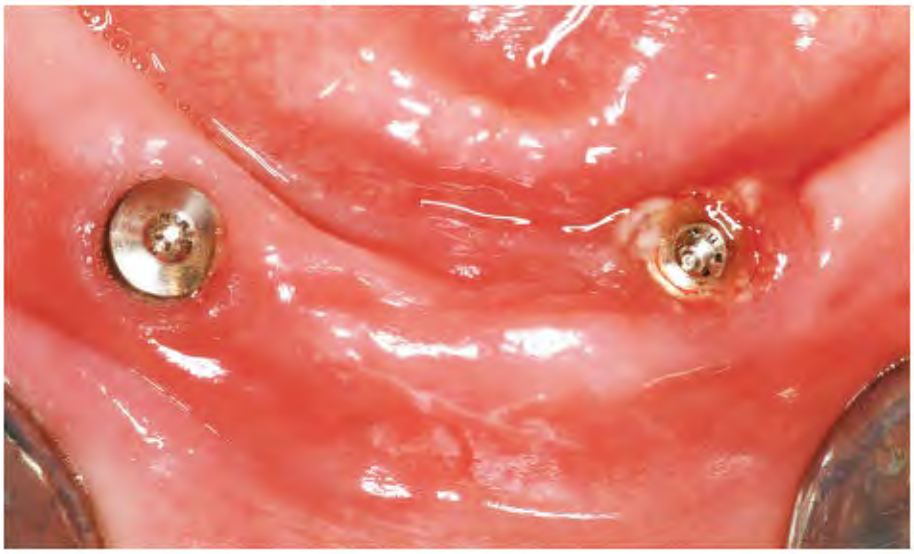


Fig 3-8u Peri-implantitis treatment around implant 33.



Fig 3-8v Minimal clinical improvement around implant 33, but with no pain relief.

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Fig 3-8w Explantation of implant 33.



Fig 3-8x Healed residual ridge 3 months after the explantation.

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Implant 33 was treated with H_2O_2 and PACT for another week (Fig 3-8u). Although a slight clinical improvement was apparent (Fig 3-8v), the patient insisted on removal of implant 33 due to the reportedly severe pain. Three months after insertion, implant 33 was unscrewed using a ratchet, with no difficulty apart from some initial resistance (Fig 3-8w).

Implant re-insertion

Following implant removal, the symptoms resolved and the residual ridge was left without a prosthetic restoration for another 3 months until it healed. The patient was able to do without prostheses for that time, since she had managed without them before. After 3 months, the residual ridge in the region of tooth 33 appeared to have healed (Fig 3-8x). However, an advanced dehiscence was identified around implant 43 on the labial side (Fig 3-8y). To re-insert the implants, the jaw was exposed with one incision over the ridge (Fig 3-8z). In the

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occlusal view, the residual ridge was still very narrow, and a slight retraction remained identifiable at the removal site (Fig 3-8aa). A drill guide was taken from the instrument set for precise preparation of the new implant bed in region 33. The abutment screw was 2-mm in diameter, allowing the 2-mm drill guide to be securely fitted onto the remaining implant (Fig 3-8bb). The first bore was prepared with the 2-mm spiral drill through the drill guide (Fig 3-8cc). The success of implant re-insertion depended on this first bore, as there could be no further perforation of the bone, particularly on the lingual side. After this drilling step, the preparation was closely checked using the 2-mm pin (Fig 3-8dd).



Fig 3-8y Mild peri-implantitis and dehiscence around implant 43.

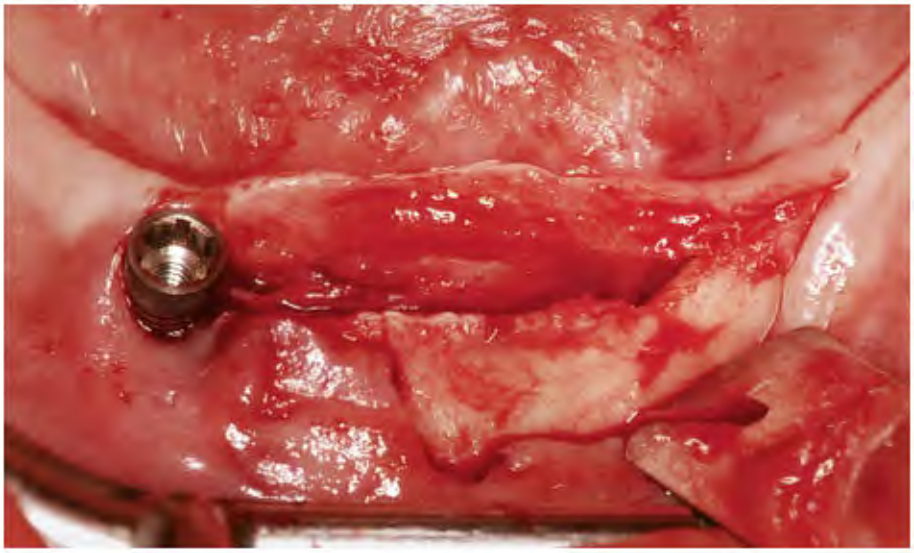


Fig 3-8z Crestal section over the residual ridge.

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Fig 3-8aa Narrow residual ridge with lingual retraction in region 33.

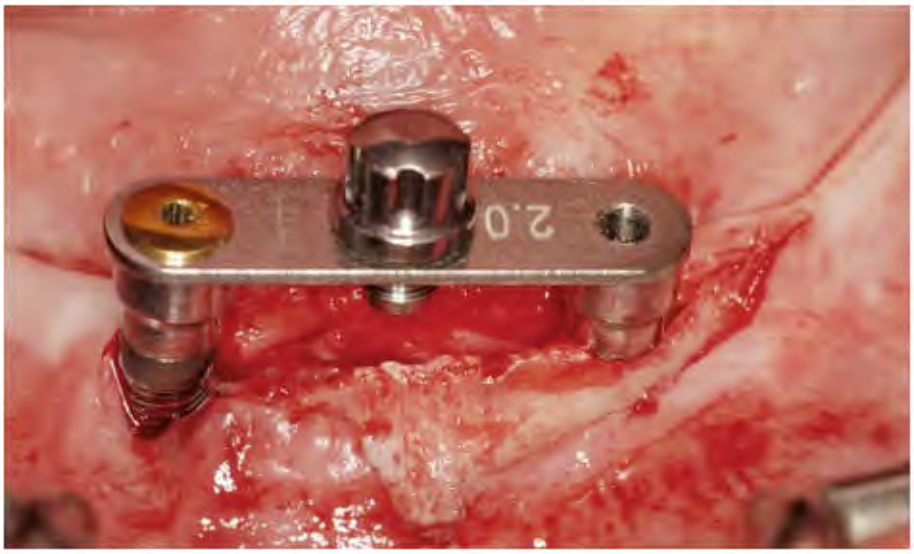


Fig 3-8bb 2-mm drill guide screwed onto implant 43.

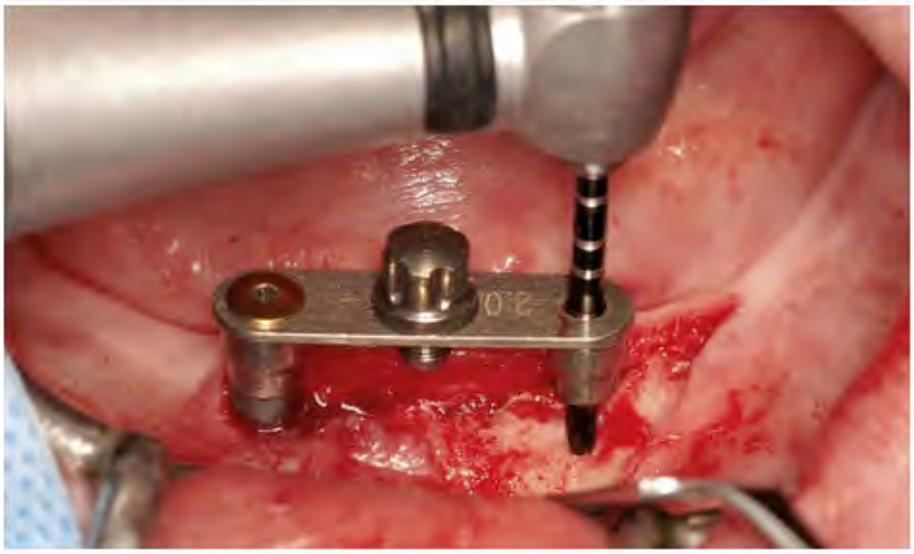


Fig 3-8cc Precise preparation with the 2-mm spiral drill.

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Fig 3-8dd Checking the preparation with the vertical 2-mm pin.

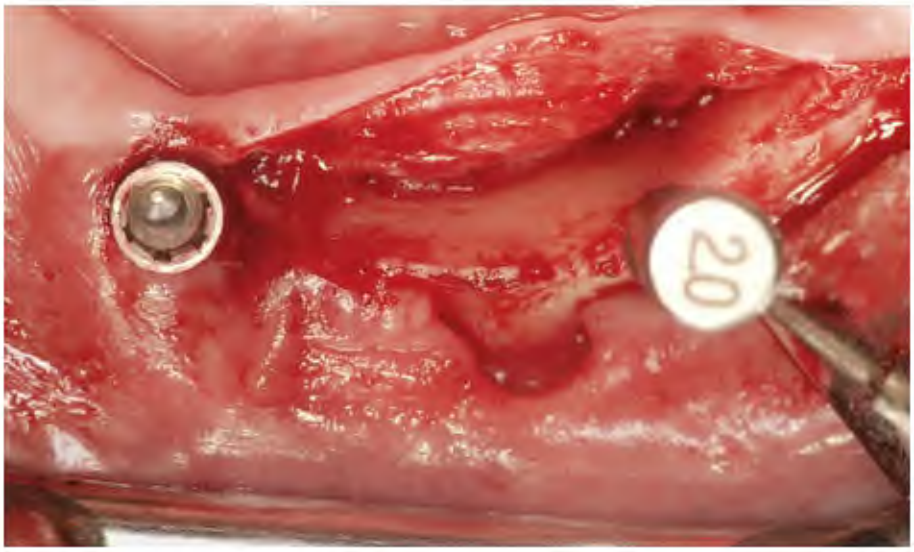


Fig 3-8ee Labiolingual positioning of the pin.

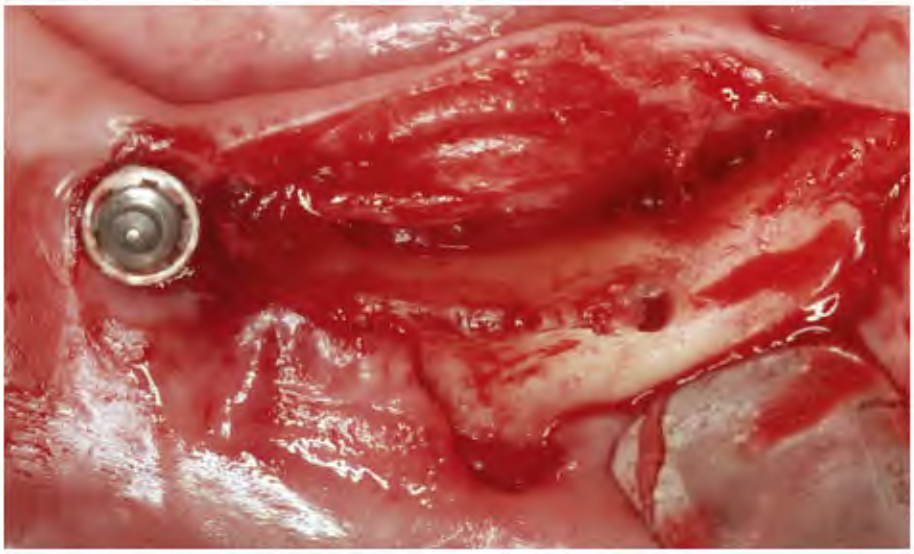


Fig 3-8ff Positioning the bore in the middle of the residual ridge.

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Fig 3-8gg Bar fitted onto implant 43 and continued preparation.

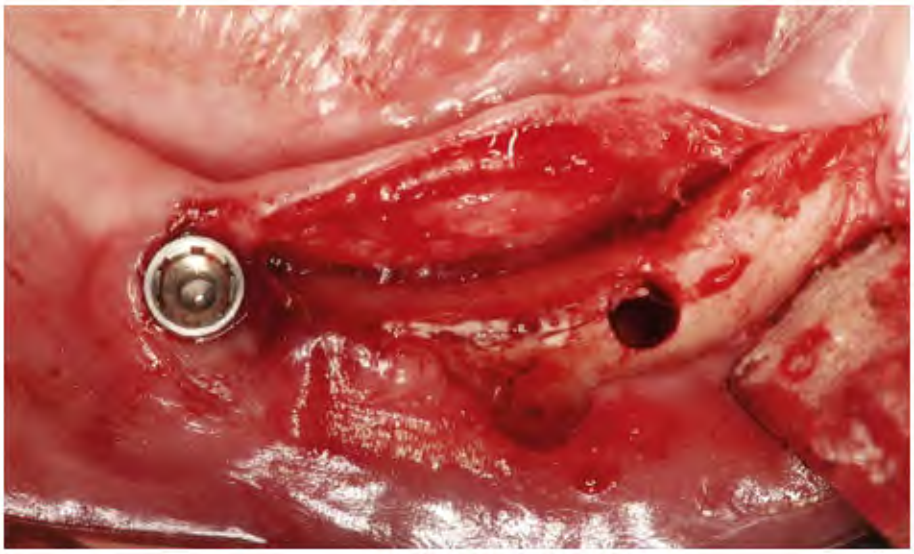


Fig 3-8hh Prepared implant bed.

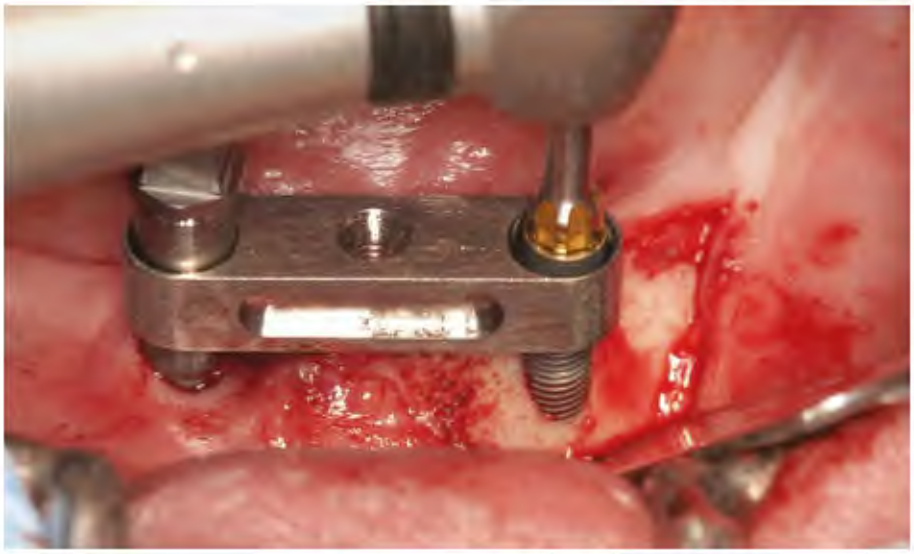


Fig 3-8ii Insertion of the implant through the bar casing replica fitted onto implant 43.

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Fig 3-8jj Labiolingual positioning of implant 33.

The labiolingual position of the bore needed to be checked with particular care (Fig 3-8ee). The preparation now appeared to be at a sufficient distance from the lingual wall (Fig 3-8ff). The existing bar was screwed into place to increase the precision of the continued preparation with the 2.8-mm and 3.0-mm spiral bone drills (Fig 3-8gg). The implant bed was widened to 3 mm and appeared to be optimally positioned at the center of the jaw (Fig 3-8hh). A bar casing replica was fitted onto the existing implant 43 to enable insertion of a 3.5-wide and 17-mm long Neoss implant (Fig 3-8ii). Once inserted, implant 33 now appeared to have sufficient bone on the lingual side, greatly improving its long-term prognosis (Fig 3-8jj). Since both implants showed several exposed screw threads on the labial side, the bone also needed augmenting. For this purpose, implant 43 was exposed and the cortical bone perforated in several places for better revascularization (Fig 3-8kk).

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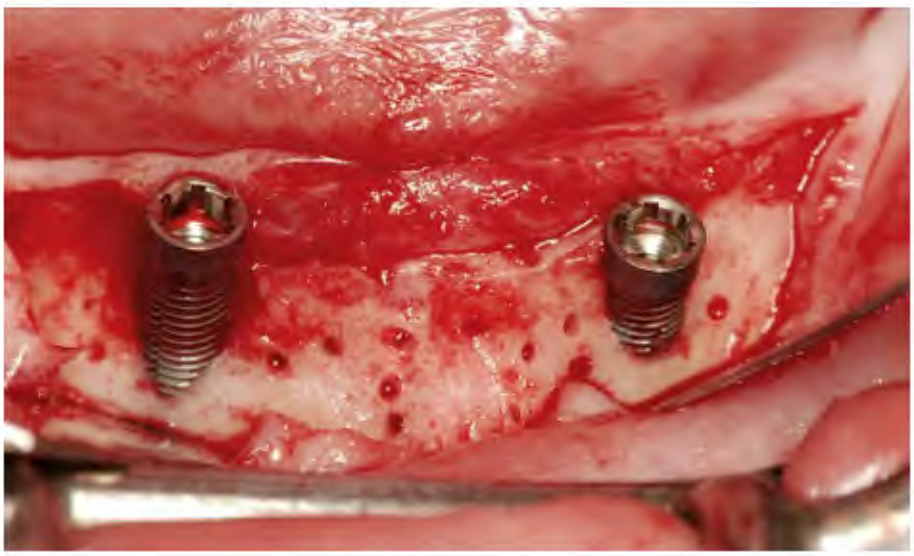


Fig 3-8kk Perforation of the cortical bone for the augmentation.

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Fig 3-8ll The bar has been screwed into place.

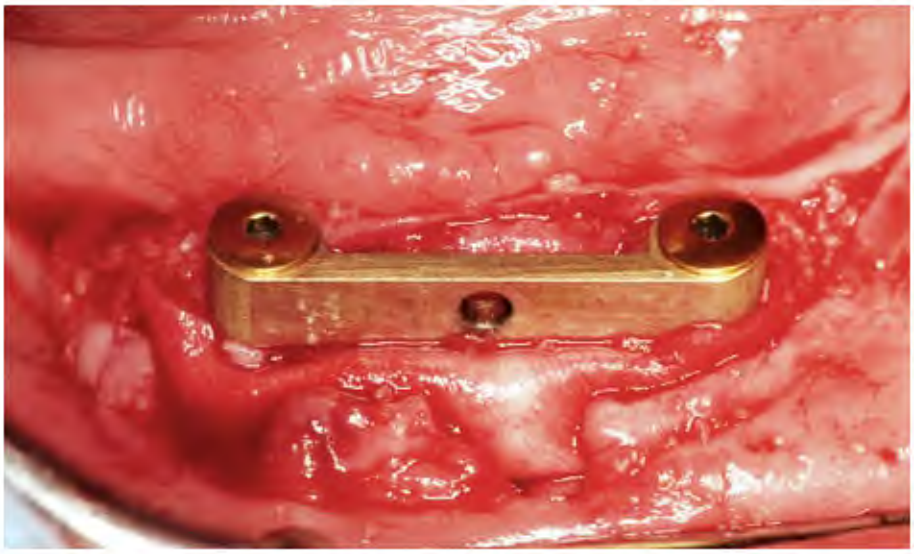


Fig 3-8mm Covering the augmentation material with Mucograft.

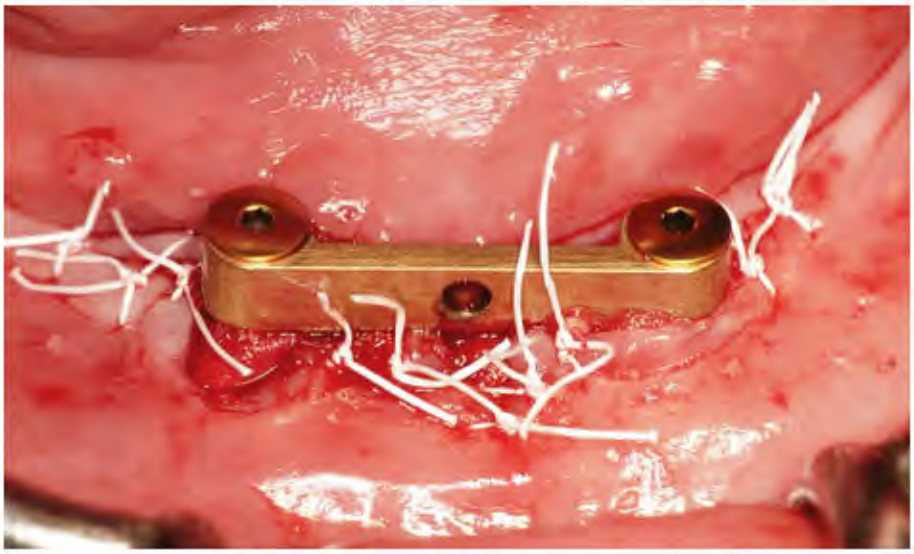


Fig 3-8nn Tension-free wound closure.

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Fig 3-8oo Clinical situation after 10 months.



Fig 3-8pp Redesigned prosthesis.

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The existing bar was then fitted onto the implants with the same abutments and the screws tightened with a 30 N/cm torque (Fig 3-8ll). The harvested bone chips were packed onto the jaw first, followed by human bone graft material (Puros, Zimmer Dental). Because of the dehiscence around implant 43 and the lack of attached gingiva on the labial side, the whole augmentation was covered with a Mucograft membrane (Geistlich), 20 × 30 mm in size (Fig 3-8 mm). The gingiva over the Mucograft membrane was adapted and secured with tension-free Gore-Tex sutures (W. L. Gore and Associates; Fig 3-8nn). The sutures were removed after 1 and 2 weeks. After another week, a new impression was taken with the old prosthesis and the bar casing was reincorporated into it (Fig 3-8pp). Despite the previous treatment failure, the clinical situation had largely stabilized, although the subsequent augmentation around implant 43 was of little benefit (Fig 3-8oo). The patient's heavy smoking, illness and poor oral hygiene had probably contributed to the moderate outcome.

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Treatment course

- Single-session procedure (2011)
- 3 months to removal
- 3 months to implant re-insertion
- 4 weeks to prosthetic loading

Treatment

Surgery and prosthetics: Dominika Sliwowska, DDS, Dr Christoph T. Sliwowski
Dental technology: Dental Technician Ludger Jansen, DentaLab

Problems and complications

Large mandibular defect and unexpected complication due to a slight change in position of the template

Baseline situation

A 48-year-old man had recently lost his last tooth 43 which, while already very loose, was still holding his denture in place to some extent. He was now suffering greatly from his loose denture, which barely stayed in place (Fig 3-9a). Once a new complete denture was made, a double CBCT scan was carried out and used to plan an SOS template with the aid of SimPlant (Fig 3-9b). This revealed that there was still a large mandibular defect at the planned site of the right-sided implant (Fig 3-9c). This problem, along with the possible need for osteoplasty and augmentation, was discussed with the patient.

Diagnostic tools

- Clinical examination
- Double CBCT scan
- SimPlant planning
- SOS SurgiGuide template

Treatment plan

1. Fabrication of a complete denture, which would also act as a CBCT template
2. Implant placement, possibly with osteoplasty and augmentation, direct definitive

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loading



Fig 3-9a Mandible before the treatment.

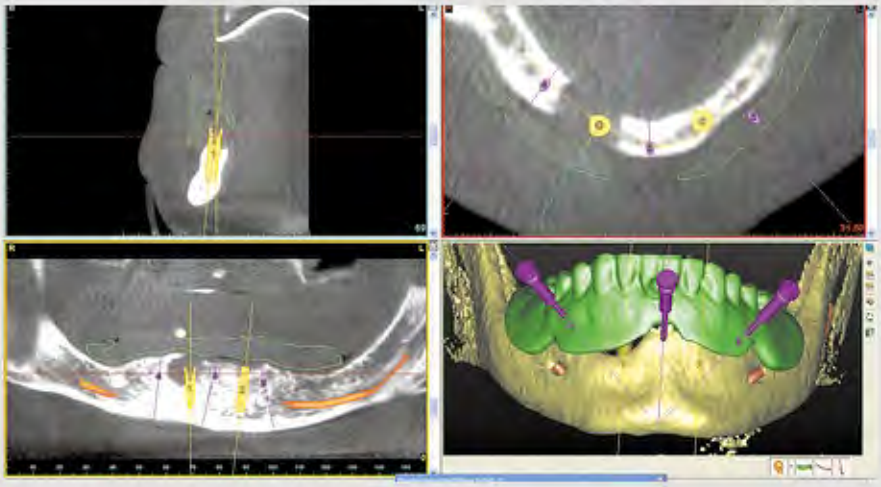


Fig 3-9b Planning the SOS template in double-scan mode.

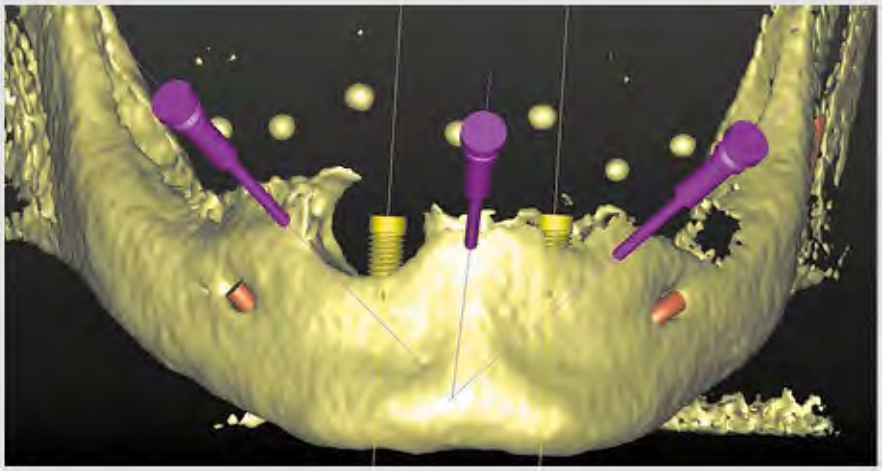


Fig 3-9c Large residual ridge defect in regions 43 and 44.

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Fig 3-9d Checking the positions of the implants following removal of the template.

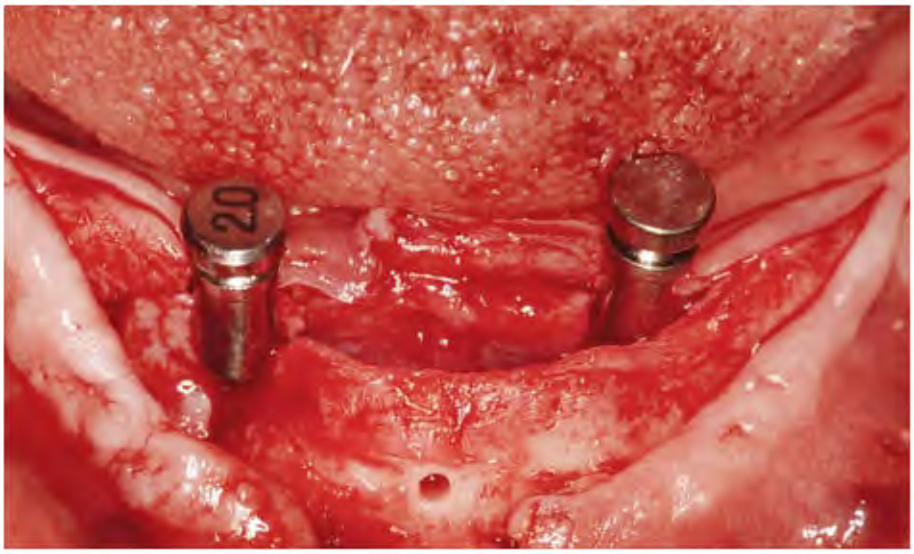


Fig 3-9e Opening up the operation area.

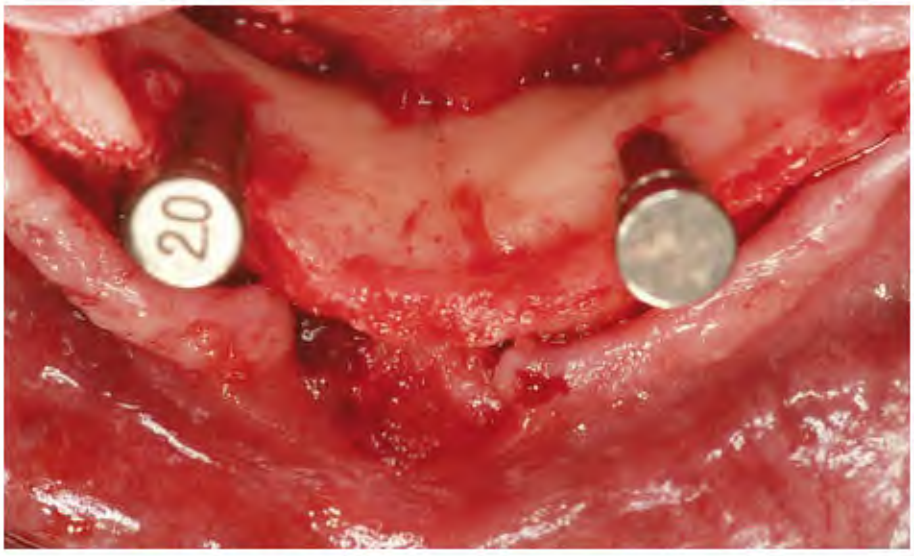


Fig 3-9f The preparation for implant 33 is positioned much too far in the lingual direction.

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Fig 3-9g New, correct positioning of implant 33.

Implant placement

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To make use of the spontaneous regenerative potential of bone, implant placement was not carried out until 3 months after the loss of tooth 43. The first bores were drilled conventionally through the SOS template using 1.5-mm and 2-mm drills. The template was then removed to check for correct placement of the implants. This revealed that the seemingly at-risk implant in region 43 was correctly positioned, but that implant 33 lay too far lingually (Fig 3-9d). Since the osteoplasty and augmentation had been taken into account in any case, no further use was made of the template and the open technique selected instead. A residual ridge incision was made between regions 35 and 45, creating one lingual and one labial flap (Fig 3-9e). The sharp edge was rounded off and, in particular, excess bone in regions 44 and 45 was removed, using the filter to collect the bone chips. The position of the bore in region 33 was inspected and deemed unacceptable (Fig 3-9f). Any extension of this bore would lead to loss of the bone of the lingual lamella, with resultant loss of primary implant stability. It was essential to shift the position of implant 33 in the labial direction.

The preparation for the new, corrected position of implant 33 took place more or less free-hand, using a sequence of drills of gradually increasing diameter (Fig 3-9g). A pin inserted into region 43 provided a spatial guide for the preparation. The preparation was finished with the 3.2-mm spiral drill and a 4.0-mm SOS implant was inserted (Fig 3-9h). Clinical inspection showed that implant 33 was now fully anchored in the residual ridge and would be used as a reference point for the second implant (Fig 3-9i). The SOS Rescue Kit was needed for the subsequent open procedure (see page 137).

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Fig 3-9h Insertion of implant 33.

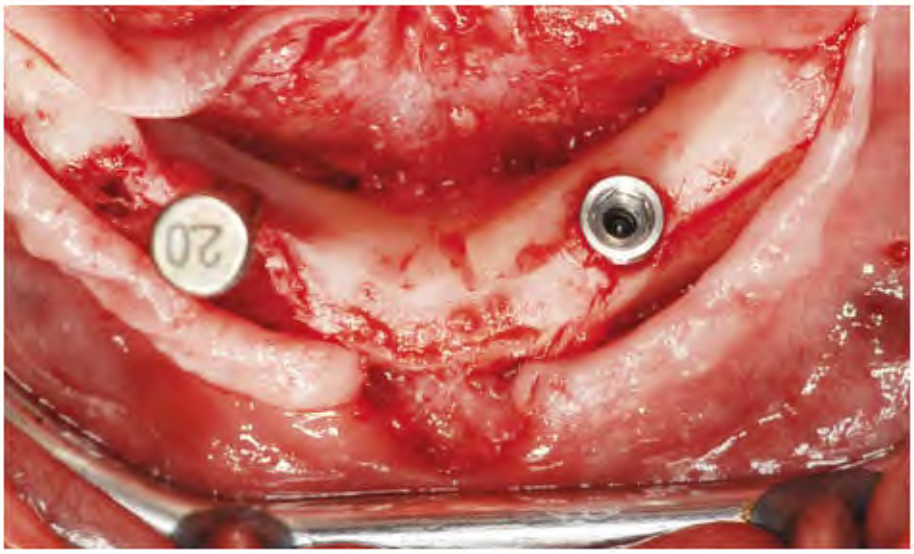


Fig 3-9i Implant 33 has been positioned centrally in the residual ridge.

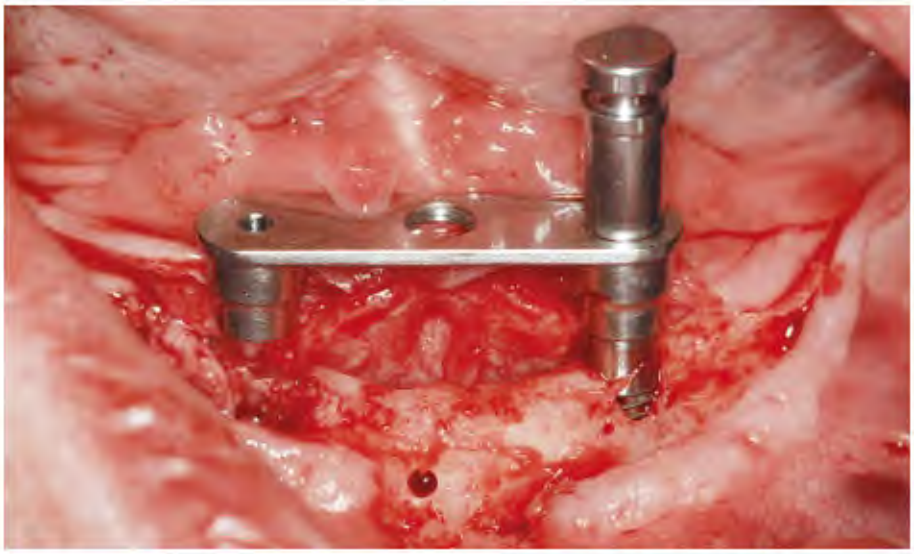


Fig 3-9j Double drill guide screwed into place onto implant 33.

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Fig 3-9k Preparation of implant bed 43 through the fixed double drill guide.

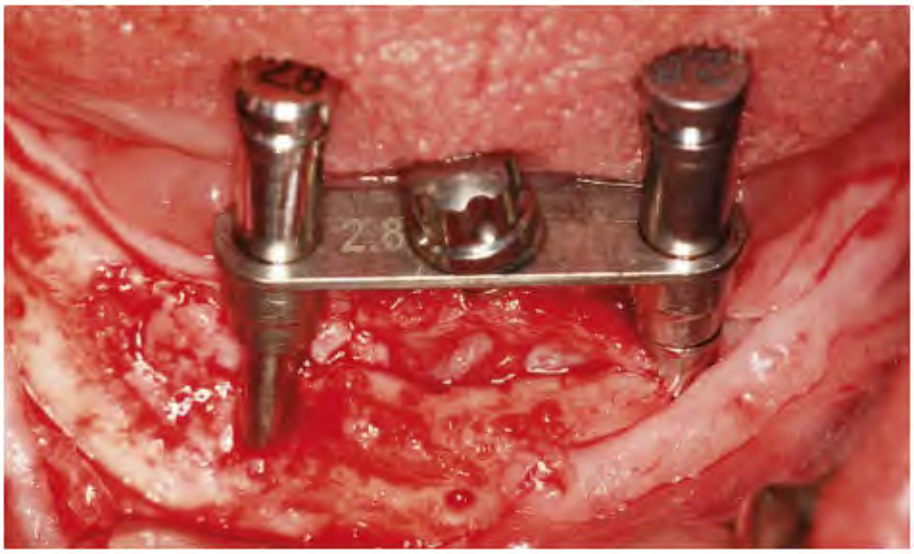


Fig 3-9l Checking implant bed 43.

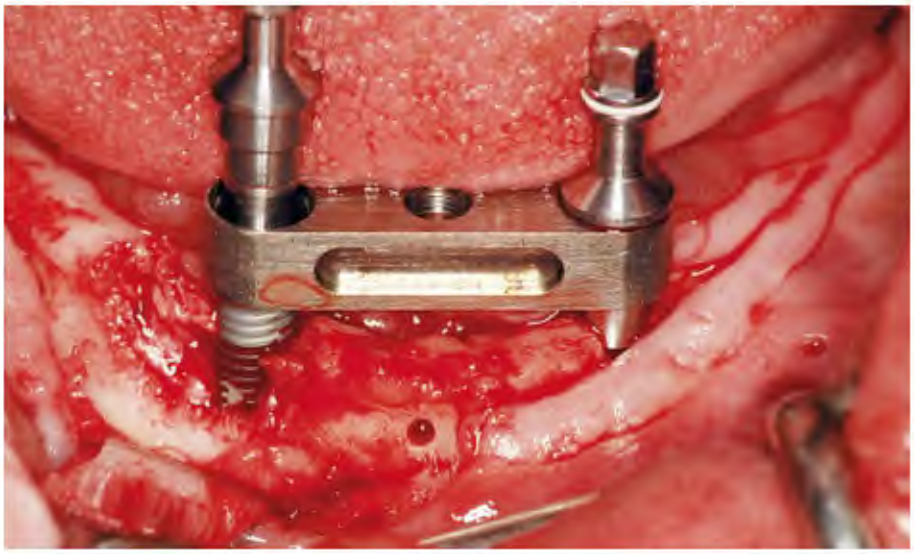


Fig 3-9m Implant 33, inserted through the bar casing replica fixed on implant 43.

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The position of implant 43 was reset with the aid of the special 2.0/1.5-mm drill guide from the SOS Rescue Kit and the 1.5-mm spiral drill (Fig 3-9j). Further graduated preparation followed using the double drill guides, in each case secured to implant 33 (Fig 3-9k). After each step in the preparation, the drill hole was checked with the corresponding vertical pin (Fig 3-9l). After the last step (3.2 mm), a bar casing replica was fixed to implant 33 with the insertion post and the implant inserted through the second opening (Fig 3-9m). Both implants were positioned almost centrally in the residual ridge and securely anchored (Fig 3-9n). A bar with abutments was used to bring the implants to the same height. The abutments in the bar were aligned to the zero position in the labial direction (see page 123) and the entire structure first screwed onto one implant.

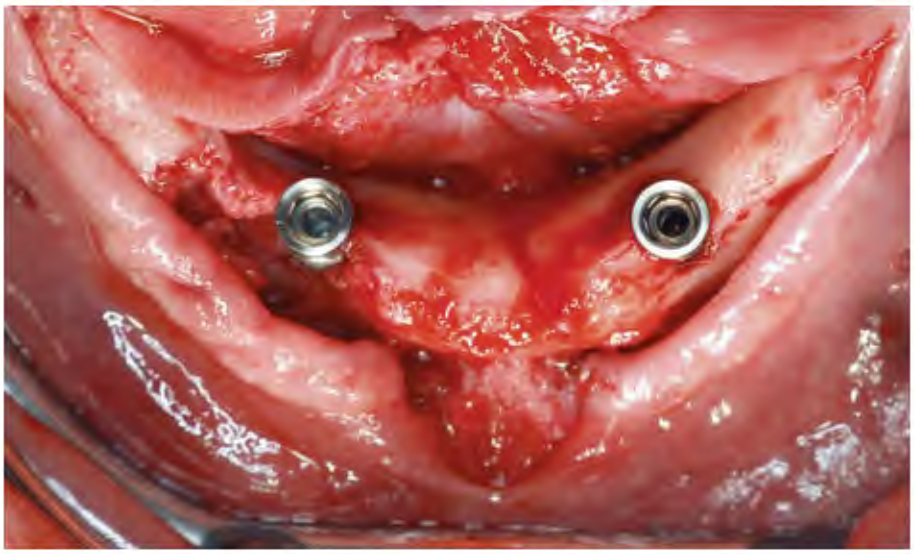


Fig 3-9n Both implants have been positioned centrally in the residual ridge.

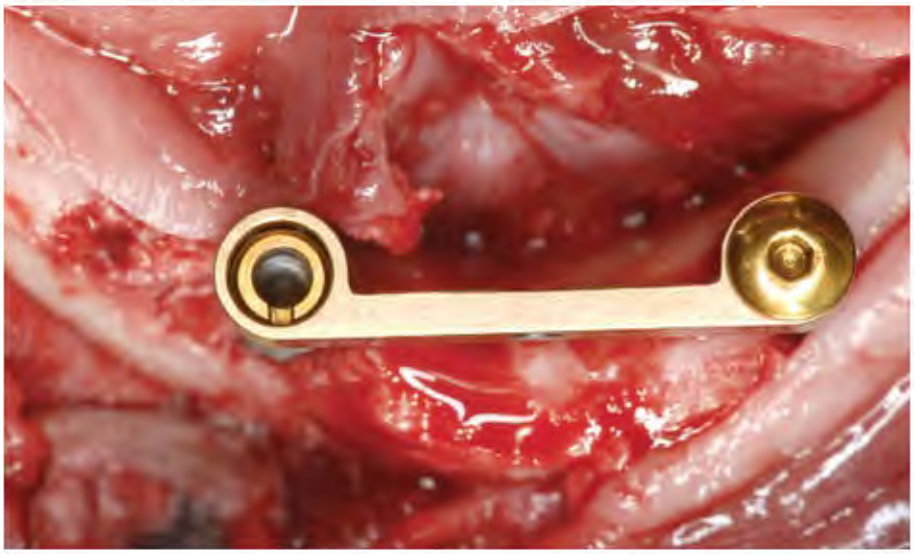


Fig 3-9o Very precise insertion of the implants, resulting in exact fit of the components.

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Fig 3-9p Labial augmentation.

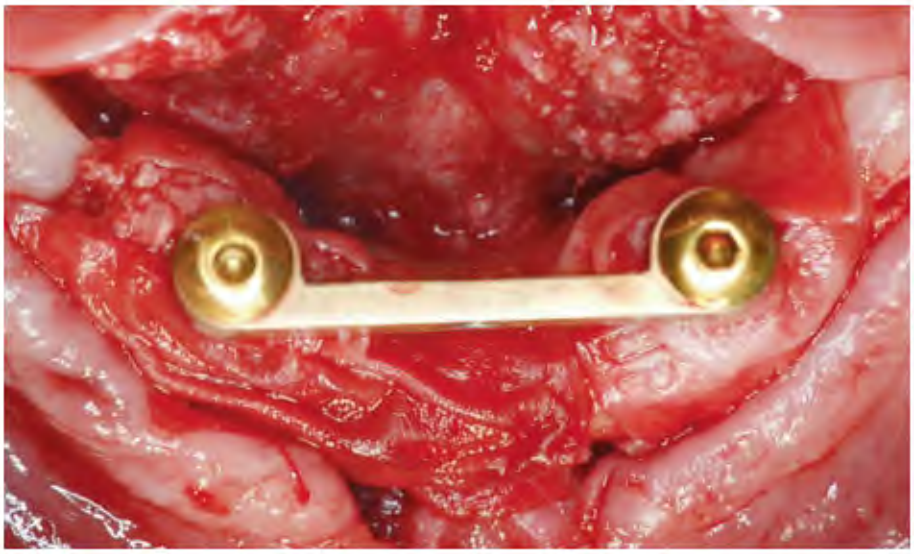


Fig 3-9q Lingual augmentation.

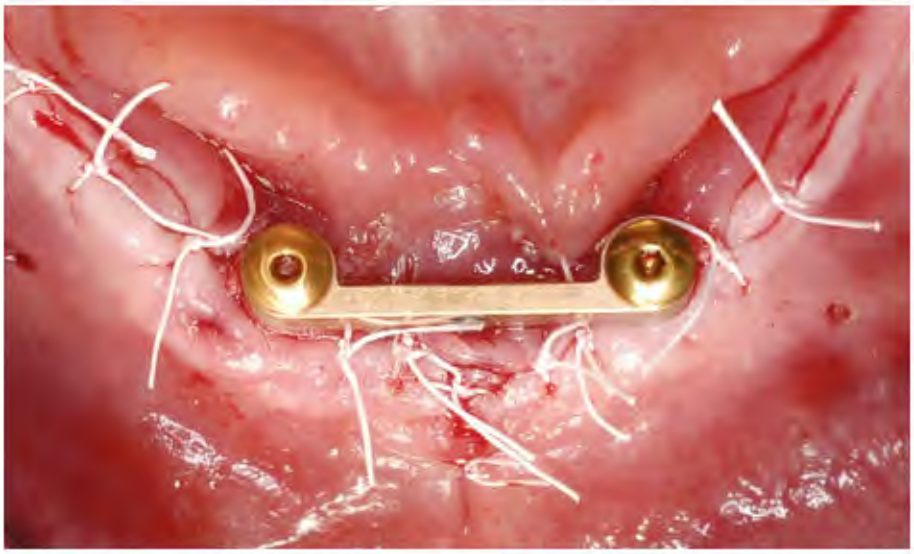


Fig 3-9r Tightly sutured wound.

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Fig 3-9s Completed SOS bar denture.

The neutral alignment of the second abutment confirmed the high precision of placement of both implants and the exact distance of 18 mm between them (Fig 3-9o). Once the bar was fitted into place, the augmentation of the labial bone defects, especially in region 43, was performed with the harvested bone chips and Bio-Gide membranes (Fig 3-9p). In this case, it seemed sensible also to perform the lingual augmentation with the same method (Fig 3-9q). After the augmentation, the flaps were repositioned and stabilized with Gore-Tex sutures (Fig 3-9r). Finally, the impression was taken using the prosthesis, with the patient biting down, and sent to the laboratory for incorporation of the bar casing. The prosthesis was ready the next day (Fig 3-9s) and was inserted without any problems despite the presence of a swelling (Fig 3-9t). The postoperative panoramic radiograph shows not only the incorporated SOS structure, but also the not yet fully healed defects, which had already been augmented (Fig 3-9u). The clinical situation after 8 months shows the outcome of the residual ridge correction, although slight degeneration of the augmentation material is detectable, especially around implant 43 (Fig 3-9v).

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Fig 3-9t Denture directly after fitting.

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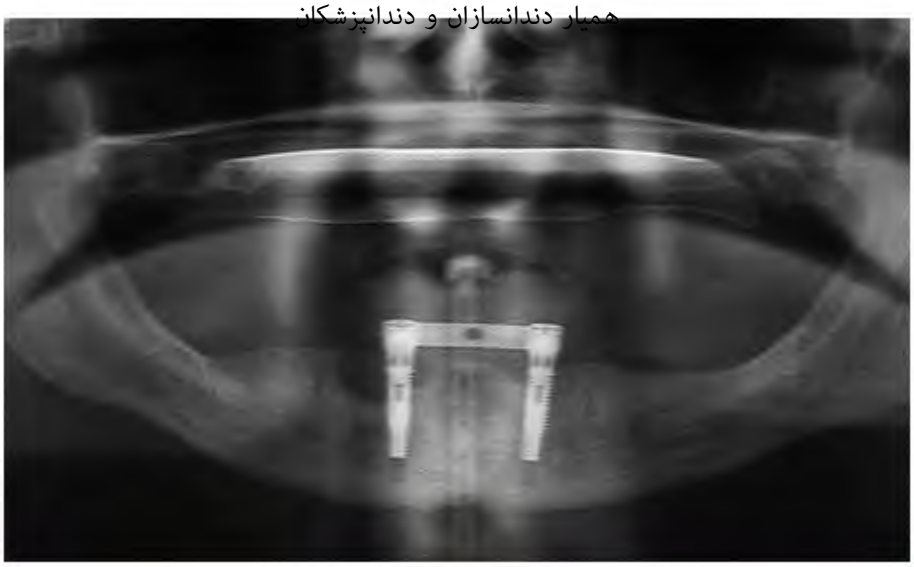


Fig 3-9u Follow-up panoramic radiograph.



Fig 3-9v Clinical situation after 8 months.

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Treatment course

- Single-session procedure (2012)

Treatment

Surgery and prosthetics:	Dominika Sliwowska, DDS, Dr Christoph T. Sliwowski
Dental technology:	Dental Technician Ludger Jansen, DentaLab

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Note on impression taking



Fig 3-10a The impression material used for the impression taking has escaped and is adhering to the bar.



Fig 3-10b Retention points for the impression material in the prosthesis.

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Fig 3-10c The undercuts have been blocked out.



Fig 3-10d A fragment of impression material has escaped into the wound.



Fig 3-10e Impregum fragment following removal.

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Fig 3-10f The impression material has been forced into the entire horizontal canal.

Usually, the impression is taken with the prepared prosthesis directly after implant placement, using Impregum impression material (3M ESPE). A few points need to be noted to ensure that the impression is successful first time and that the Impregum material stays in the impression rather than on the bar (Fig 3-10a). Retention points, in the form of perforations, should be created on the prosthesis to ensure that the impression material is joined to it not only by its adhesive force, but also mechanically (Fig 3-10b). If there is a cleft between the bar and the residual ridge, it will have to be blocked out with, eg, wax or modeling clay to prevent the bar from becoming embedded or the impression material from escaping (Fig 3-10c). Once the impression is removed, the operation site needs to be meticulously inspected to ensure that no Impregum residues remain in the wound (Fig 3-10d). Should this be the case, they will have to be carefully removed (Fig 3-10e). Sometimes, the material is forced into the entire drill canal and leaving such fragments in situ can lead to inflammation that is difficult to trace to its source (Fig 3-10f).

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Removable prostheses on several implants

Typical treatment course

Immediate fixed bridge on five implants and definitive bar-retained restoration

The treatment follows on from the 3D diagnosis on page 112.

Baseline situation

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A 79-year-old woman still had four anterior teeth in her mandible, which were not preservable in the long term; to date, her frame partial denture has been stabilized on these teeth. The plan was to extract the anterior teeth (Fig 3-11a), followed by the direct insertion of five implants for an immediate fixed bridge (see Diagnosis section, page 112). Augmentation of the maxilla (bilateral sinus elevation) was planned concomitantly with implant placement in the mandible.

Diagnostic tools

- Clinical examination
- CBCT scan and SimPlant planning
- Dental cast analysis

Treatment plan

1. Insertion of five implants and an immediate fixed bridge
2. Removable denture with bar and locking attachment on five implants

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Fig 3-11a Baseline situation. The patient had four remaining incisors.

Implant placement and augmentation

Because of the augmentation in the maxilla, extraction and implant placement in the mandible was performed under general anesthesia with intubation. Following extraction of the anterior teeth and smoothing of the mandible, five implants were inserted into the interforaminal region in accordance with the SimPlant planning.

Provisional cylinders were screwed onto the implants directly after their insertion (Fig 3-

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11b). As was feared during the planning process, almost half of implant 41 was exposed on the labial side. The prepared provisional restoration was fitted onto the provisional cylinders (Fig 3-11c). Space was left around each cylinder in the provisional bridge; these gaps were filled with a polymer (Fig 3-11d). The provisional was polymerized on the cylinders in a position adjusted to the patient's occlusion (Fig 3-11e). It was taken out for shaping and healing abutments were screwed onto the implants in the interim. The mandibular defects were augmented with the harvested bone chips and covered with membranes. After the gum was sutured, the healing abutments were unscrewed and the shaped provisional fitted directly onto the implants (Fig 3-11f). The postoperative panoramic radiograph shows the position of the implants in the mandible and the augmentation of the maxilla, with small titanium pins acting as vertical supports for the membrane (Fig 3-11g). Unfortunately, the lead apron was positioned too high up while the radiograph was being taken, producing a shadow over the anterior teeth. The provisional was unscrewed for the definitive removal of the sutures after 2 weeks (Fig 3-11h). At this point, a dehiscence around implant 41 was apparent despite the augmentation.

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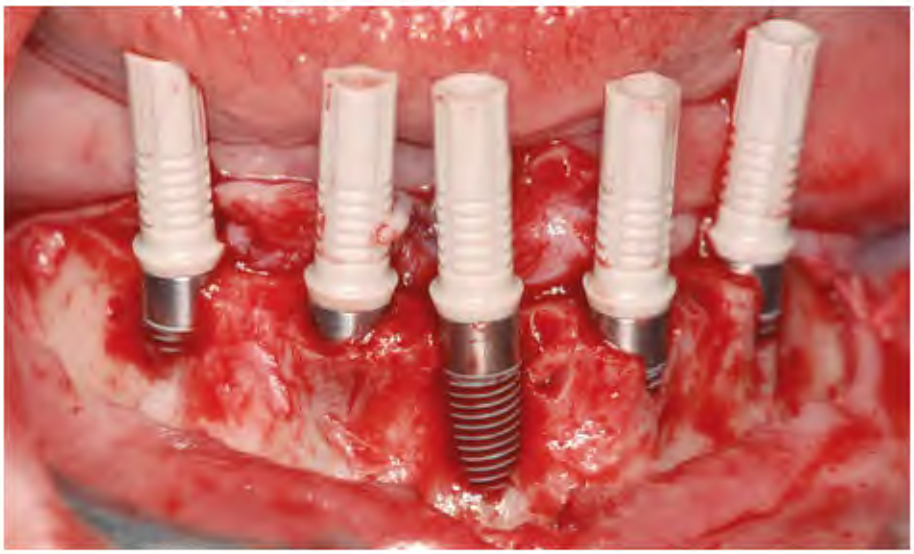


Fig 3-11b Inserted implants with provisional cylinders screwed onto them.



Fig 3-11c Try-in of the provisional denture.

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Fig 3-11d Gaps were left around the provisional cylinders.



Fig 3-11e The cylinders have been polymerized in.



Fig 3-11f Provisional denture screwed on directly after implant placement.

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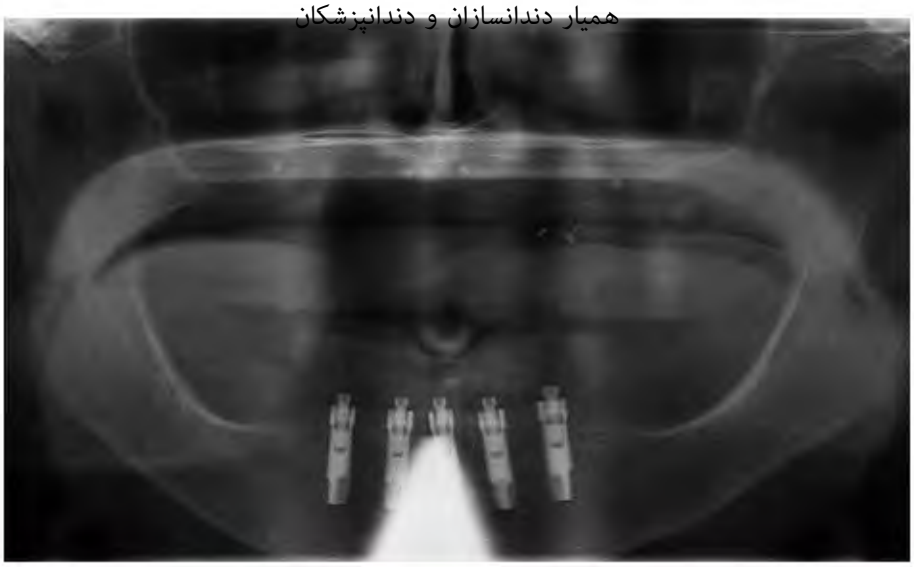


Fig 3-11g Postoperative panoramic radiograph.

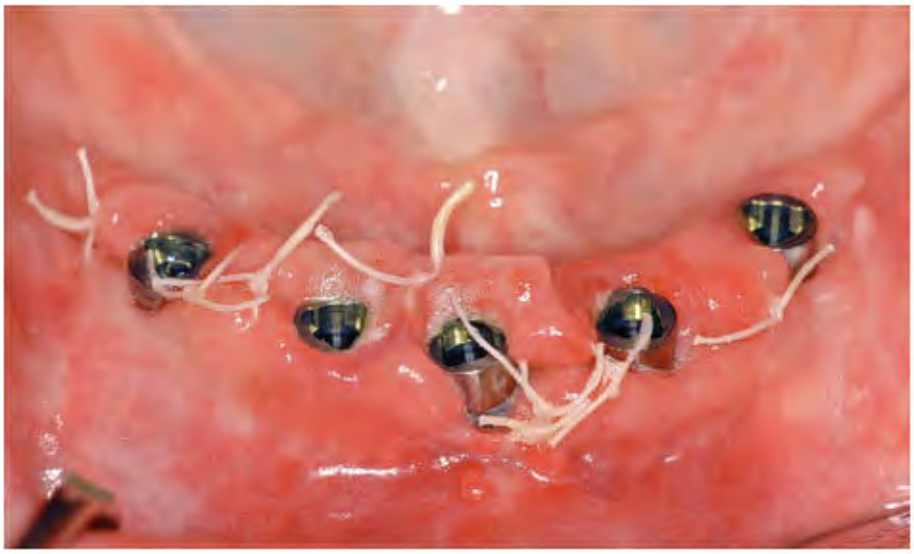


Fig 3-11h Dehiscence around implant 41 already apparent at the time of removal of the sutures.



Fig 3-11i Long-term provisional after 5 months.

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Fig 3-11j The impression copings screwed into place.



Fig 3-11k Taking an impression with Impregum.



Fig 3-11l Bar with two locking attachments, milled with the aid of CAD/CAM.

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Fig 3-11m The removable partial denture with two locking attachments.



Fig 3-11n Underside of the partial denture with electroplated gold framework.

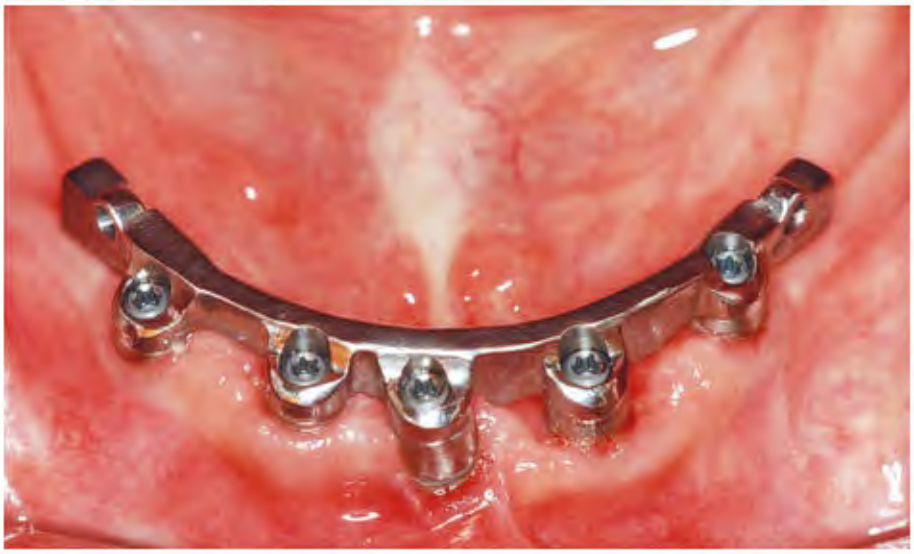


Fig 3-11o The bar has been screwed into place.

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Fig 3-11p Finished removable denture in the patient's mouth.

Prosthetic loading

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The long-term provisional denture was worn for 5 months before the definitive prosthesis was made. (Fig 3-11i). The impression was taken with the aid of two-part impression copings (Fig 3-11j) and an upward opening impression tray containing Impregum (Fig 3-11k). The definitive cast was scanned in the laboratory and a mesostructure bar planned virtually; the bar was then milled at a milling center according to this plan. The bar fabricated in this fashion fits with a precision that is virtually unattainable when using conventional methods (Fig 3-11l). A removable denture was fabricated to fit onto the bar, with two locking attachments to provide stable and secure anchoring (Fig 3-11m). To ensure a perfect fit, the framework of the denture was made with the aid of gold electroplating (Fig 3-11n). The bar was fitted into the mouth and the screws tightened with a 20 N/cm torque (Fig 3-11o). The removable denture was anchored onto the bar with both locking attachments and the occlusion finely adjusted (Fig 3-11p).

Treatment course

- Implant placement, immediate loading with a fixed partial denture (2011)
- 5 months to the definitive prosthetic loading

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental Technician Ludger Jansen, DentaLab

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Note

Connecting bar with a locking mechanism

Two locking bolt attachments are integrated into the prosthesis as additional retaining components (Fig 3-12a). For static and esthetic reasons, it is a good idea to position the bolt attachments as close to the gum as possible (Fig 3-12b). When locked, the bolt attachments are held in place in their slot in the bar, holding the prosthesis in place with absolute security. The prosthesis can only be removed if the bolt attachments are fully open (Fig 3-12c). The attachments are unlocked using a thin key inserted into a small buccal access (Fig 3-12d). Most patients quickly master the skill of opening this mechanism without the aid of a mirror. The original key is included in the locking attachment pack (Fig 3-12e). If necessary, however, a new key can be quickly fashioned out of 1-mm diameter dental wire or even with a straightened paperclip (Fig 3-12f).

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Fig 3-12a Basal view of the bar prosthesis with locking bolt attachments.

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Fig 3-12b Bar with perforations for the locking bolt attachments.

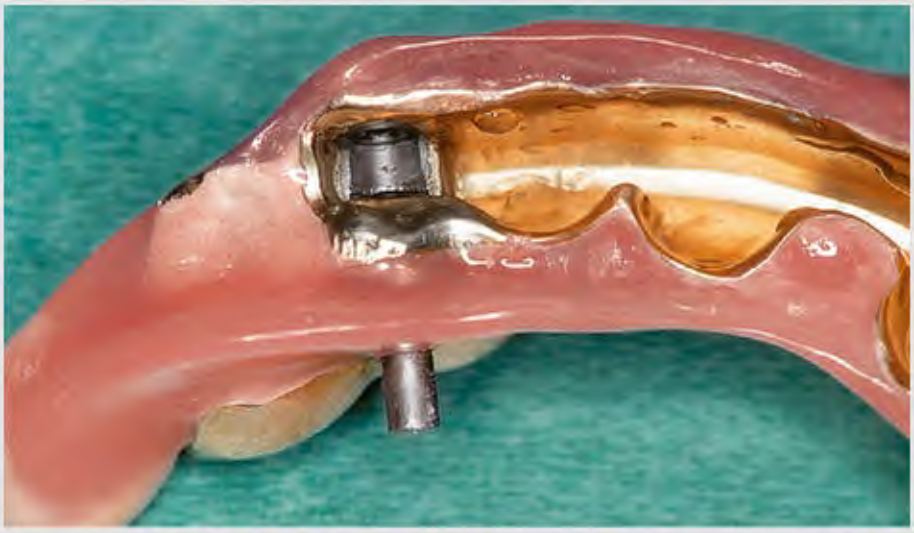


Fig 3-12c Detailed view of the prosthesis with the locking mechanism open.



Fig 3-12d Buccal access to the locking mechanism.

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Fig 3-12e Original key for the locking mechanism.



Fig 3-12f DIY key for the locking mechanism.

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Atypical treatment course – problematic baseline situation

Immediate loading with a provisional bar and an age-appropriate, definitive telescopic crown-retained prosthesis

Baseline situation

This female patient, aged 93 years, leads a full, active social life and sings in the church choir, so she sets great store by a well-fitting, securely anchored dental prosthesis (Fig 3-13a). Following the recent need to extract tooth 33, the denture was no longer properly anchored, so that the patient wanted her prosthesis to be stabilized further with the aid of implants (Fig 3-13b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph with template
- Dental cast analysis

Treatment plan

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1. Insertion of four implants, immediate bar and adjustment of the old prosthesis
2. Definitive prosthetic restoration with a telescopic, crown-retained overdenture on four implants and two natural teeth



Fig 3-13a Existing dental prosthesis.

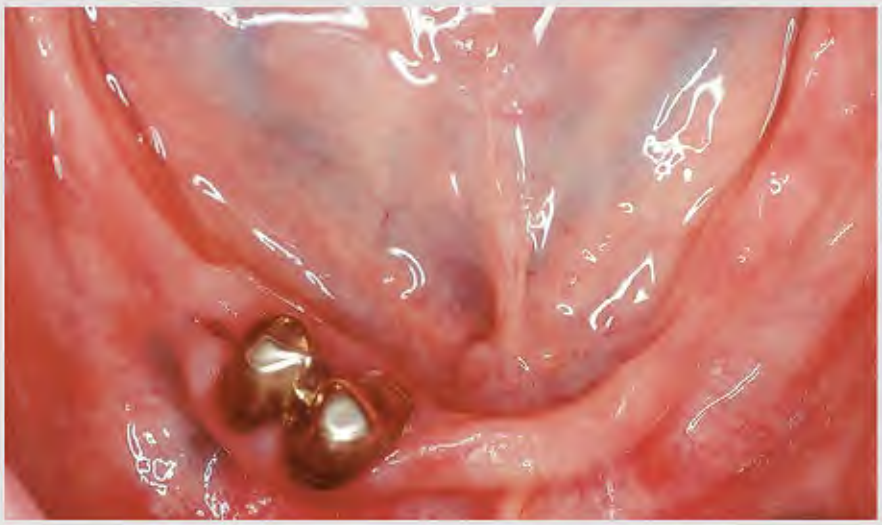


Fig 3-13b Lack of support in the third quadrant.

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Implant placement and impression taking

To ensure better positioning of the implants from the prosthetic point of view, the patient's existing prosthesis was duplicated and a surgical drill template prepared (Fig 3-13c).

The remaining telescope teeth provided stable retention for the template during the operation. Four implant beds were prepared in the mandible according to the template (Fig 3-13d). Four 18-mm long MK-III implants with a TiUnite surface (Nobel Biocare) were inserted for immediate loading (Fig 3-13e). Directly after insertion, impression copings were screwed

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onto the implants and an impression was taken (Fig 3-13f). Healing abutments were screwed on while the bar was being prepared in the laboratory (Fig 3-13g) and the wound was tightly sutured (Fig 3-13h).



Fig 3-13c Surgical drilling template.

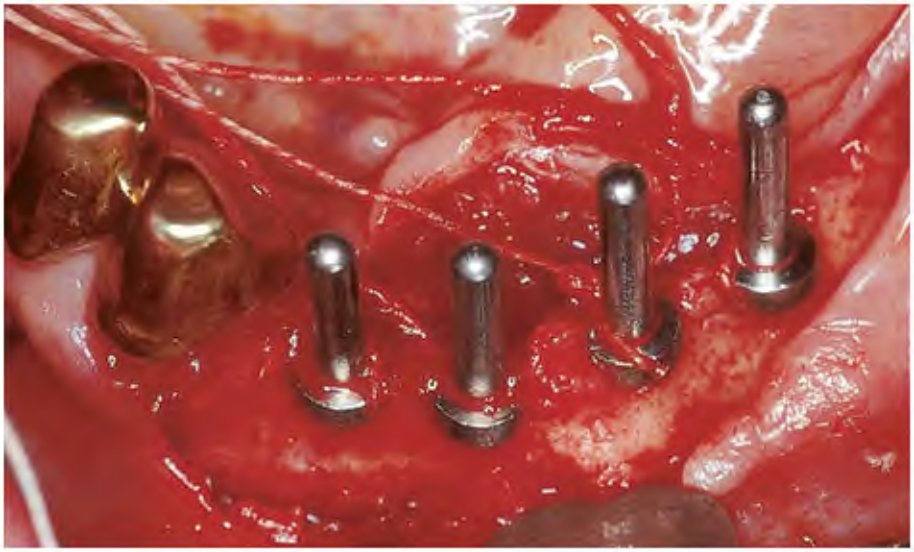


Fig 3-13d Aligning the implants.

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Fig 3-13e Inserted definitive implants.



Fig 3-13f The impression copings have been screwed into place.



Fig 3-13g Healing abutments in situ.

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Fig 3-13h Tight closure with sutures.



Fig 3-13i Incorporated provisional bar.



Fig 3-13j Directly relined prosthesis.

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Fig 3-13k Hygiene-friendly telescopic crowns.



Fig 3-13l Prosthesis with secondary telescopes.



Fig 3-13m Completed dental prosthesis: maxilla and mandible.

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Provisional bar and adaptation of the prosthesis

Two days later, a provisional bar was incorporated for primary interlocking of the implants (Fig 3-13i). The existing prosthesis was ground to shape and lined directly in the mouth with a soft lining material (eg, Viscogel; Fig 3-13j). The provisional bar remained in situ until the implants healed properly, already providing a secure hold for the prosthesis.

Definitive prosthesis

Because of the patient's advanced age and to keep the hygiene of the structure as simple as possible, the implants and remaining teeth were fitted with individual telescopic crowns (Fig 3-13k). The secondary telescopes were incorporated into the prosthesis (Fig 3-13l) and a new maxillary denture fabricated together with the mandibular one (Fig 3-13m). Six years after the treatment, the patient is still happy, as she can sing in the choir again without any problems, and was preparing to celebrate her 100th birthday (Fig 3-13n). The clinical and radiologic situation after 6 years of functional use remains stable (Figs 3-13o to 3-13q).

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Fig 3-13n The happy patient.

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Fig 3-13o Stable mucosal situation after 6 years.

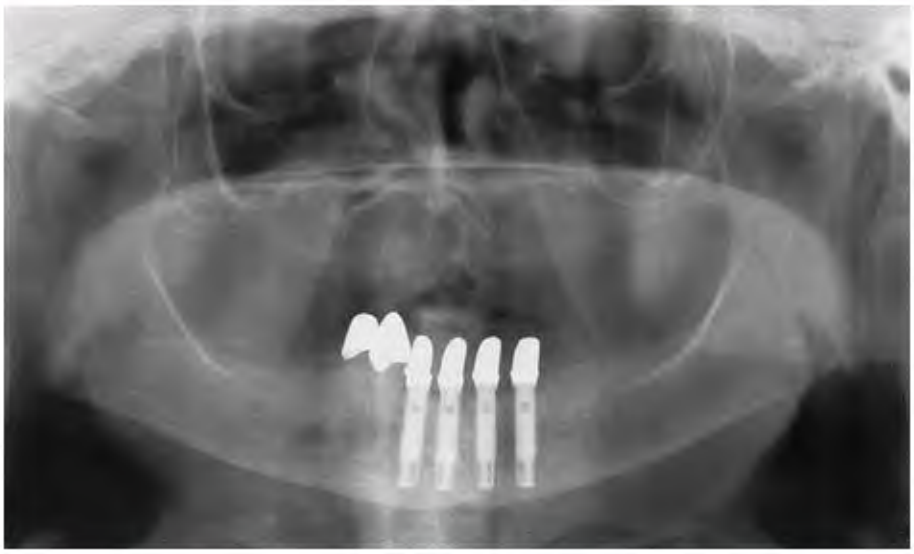


Fig 3-13p Stable bone situation after 6 years.



Fig 3-13q Maxillary prosthesis after 6 years of functional use.

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Treatment course

- Implant placement and immediate loading (2002)
- 4 months to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Roland Althoff
Dental technology:	Ivonne Lewik

Problems and complications

Inadequate dental prosthesis on two non-preservable implants – implant re-insertion and immediate loading

Baseline situation

A 66-year-old woman was having problems with her implants, inserted 2 years previously at another center (Fig 3-14a). Clinically, both implants were stable, but the prosthesis was wobbly: the implant abutments were loose and could not be screwed in tightly. The gum around the implants was painful to any touch. An additional problem lied in the fact that the cement retention did not allow the retaining screws to be accessed without damaging the telescopic crowns.

The panoramic radiograph showed that the two implants were barely anchored in the mandible and that their long-term prognosis was doubtful (Fig 3-14b). Therefore, they would need to be removed as part of the new prosthetic restoration. The patient did not want a full removable denture, even for the interim period, but instead wanted a stable immediate restoration.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

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Treatment plan

1. Implant removal and immediate implant placement with augmentation and immediate bar



Fig 3-14a Loose abutments and peri-implantitis.



Fig 3-14b Only about 5 mm of each implant is anchored in the bone.

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Fig 3-14c Exposed residual ridge around the implants.

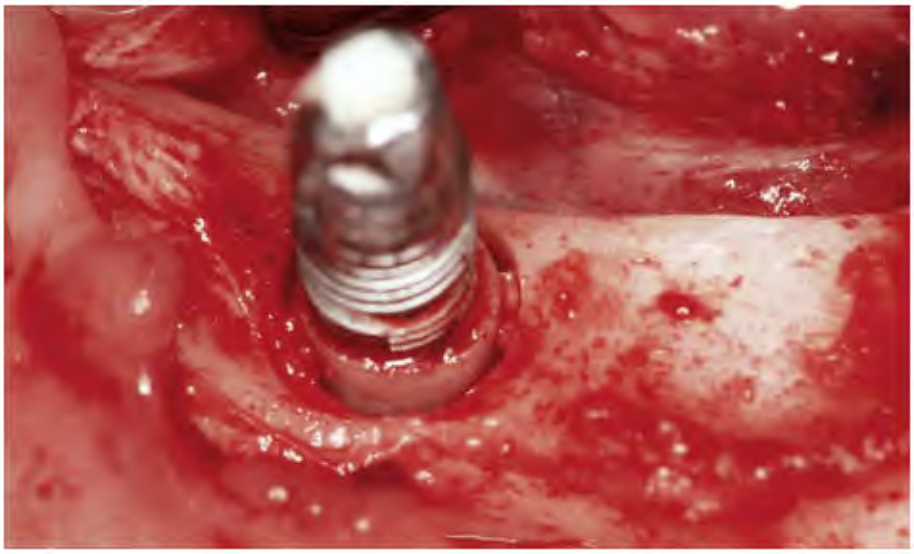


Fig 3-14d The implants are being explanted with a trephine.

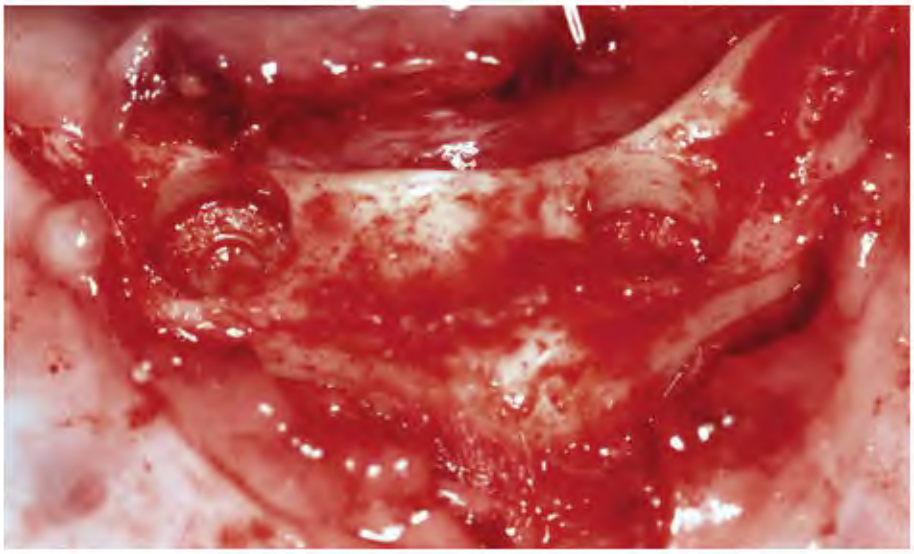


Fig 3-14e After implant removal.

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Fig 3-14f Preparation of the implant beds.

Implant removal and implant placement with immediate bar

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The incision for surgical access was made on the residual ridge with a relieving incision on the midline. The implants and the residual ridge were exposed, allowing both implants to be carefully removed (Fig 3-14c). To minimize bone loss during implant removal, both implants were reamed out to the tips with a trephine (Fig 3-14d), then carefully loosened with a Bein elevator and removed. Since the implants had not been inserted very deep in the bone, there was sufficient space beyond the apex to ensure stable anchoring for the new implants (Fig 3-14e).

Originally, the explanted implants had been inserted at positions 44 and 32, so that the intact residual ridge in regions 42 and 34 was available for two further implants (Fig 3-14f). Following implant removal, the bone adhering to the implants showed that they had only been anchored in the jaw to a depth of 5 mm (Fig 3-14g). Four 17-mm long Neoss implants, with a diameter of 4.0 mm in the intact jaw and 4.5 mm at the removal sites, were inserted to reduce the discrepancy relative to the latter sites (Fig 3-14h). Despite this, there was still space between the implants and their beds, which was to be filled by bone augmentation (Fig 3-14i). After the operation, the implants were to be interlocked with an immediate bar. For this reason, healing abutments were screwed on to act as spacers while the bar was being fabricated (Fig 3-14j). Before suturing, the bone defects were filled up with the harvested bone chips (Fig 3-14k). The impression copings were screwed onto the implants and the wound sutured (Fig 3-14l). The healing abutments were screwed back on immediately after the impression was taken (Fig 3-14m). The bar was incorporated 2 h later and left in situ for the next 3 months (Fig 3-14n). The postoperative panoramic radiograph shows the positioning of the implants in the mandible, securely anchored within the caudal cortical bone (Fig 3-14o). The denture was adjusted for the new bar, allowing the patient to continue using the implant-supported dental prosthesis without interruption, as requested by her.

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Fig 3-14g Removed implants.

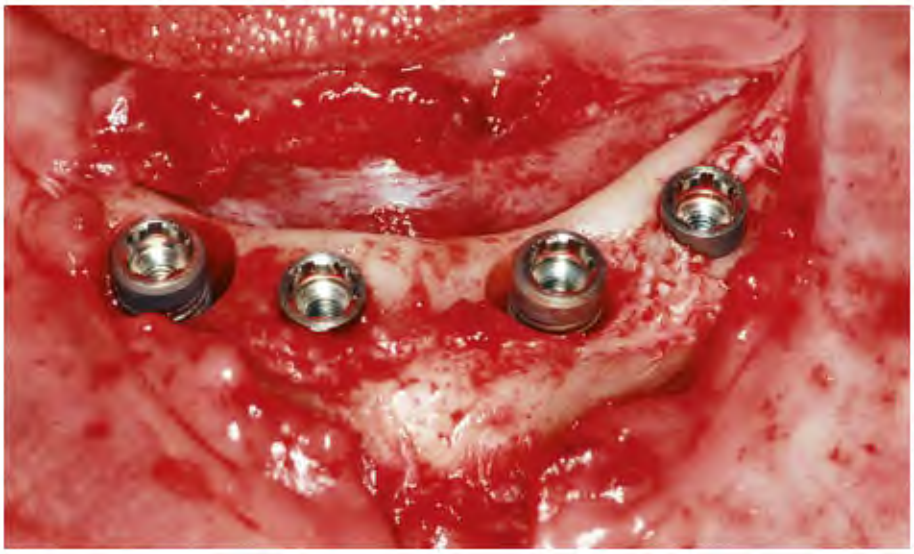


Fig 3-14h Inserted new implants.

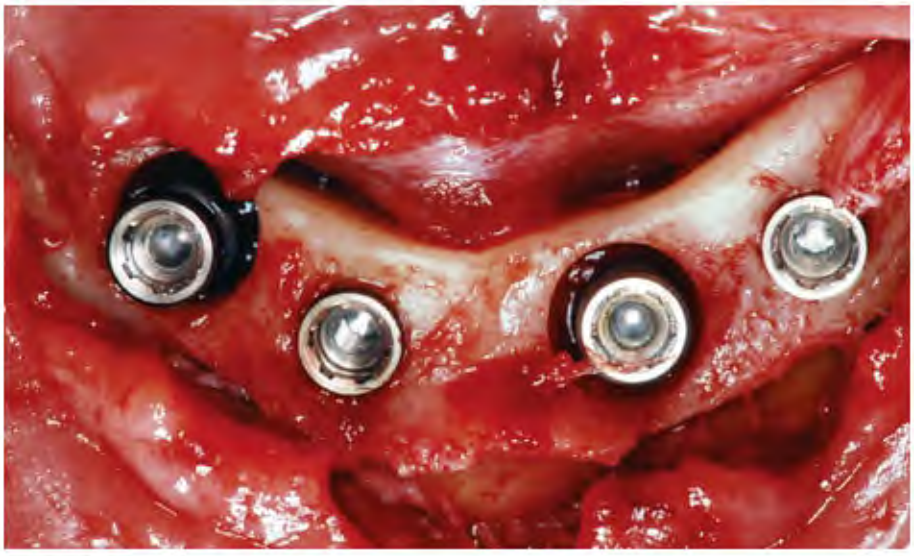


Fig 3-14i Gaps around the implants at the removal sites.

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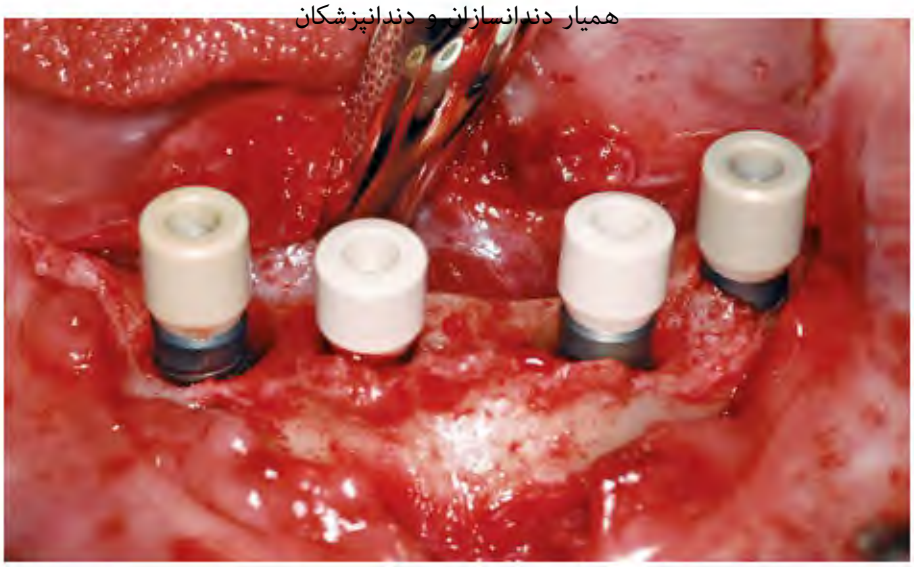


Fig 3-14j Healing abutments screwed into place.

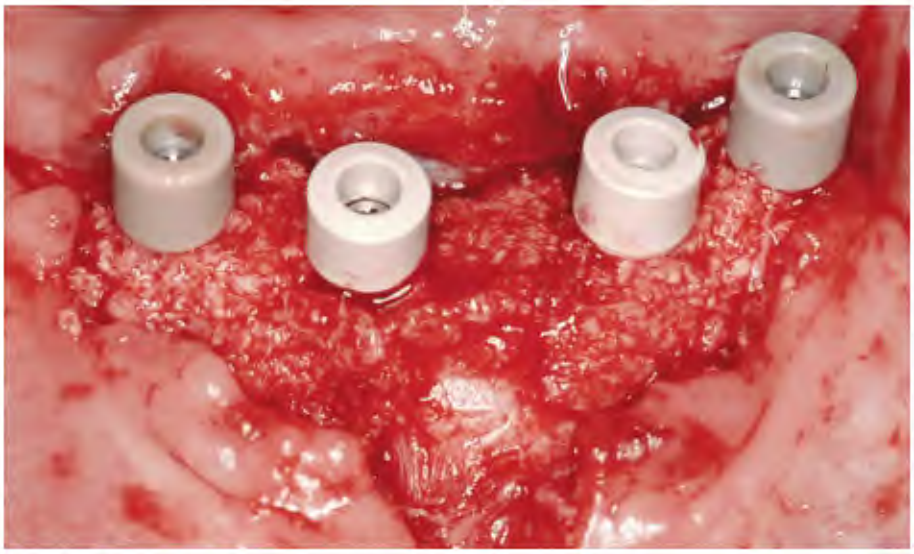


Fig 3-14k Augmentation.

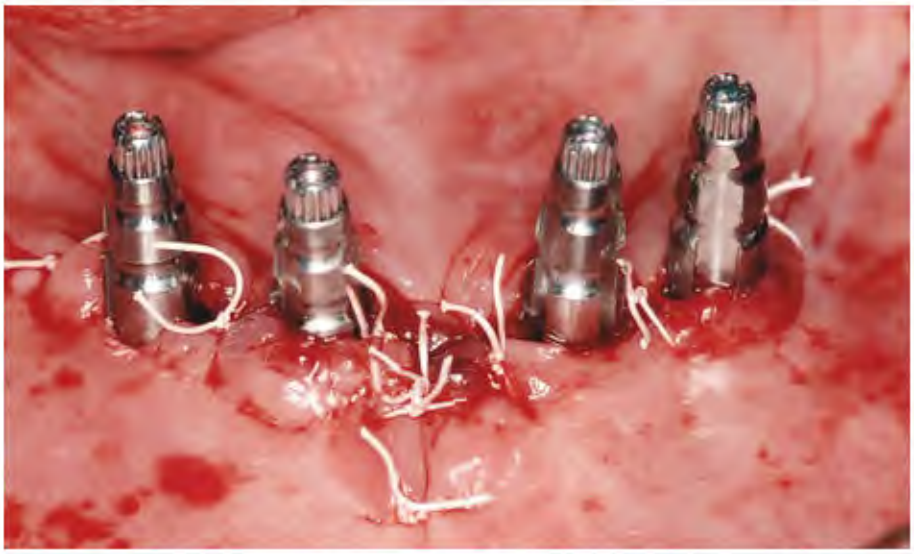


Fig 3-14l Impression taking and wound suturing.

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Fig 3-14m Waiting for the bar.



Fig 3-14n The bar in situ.

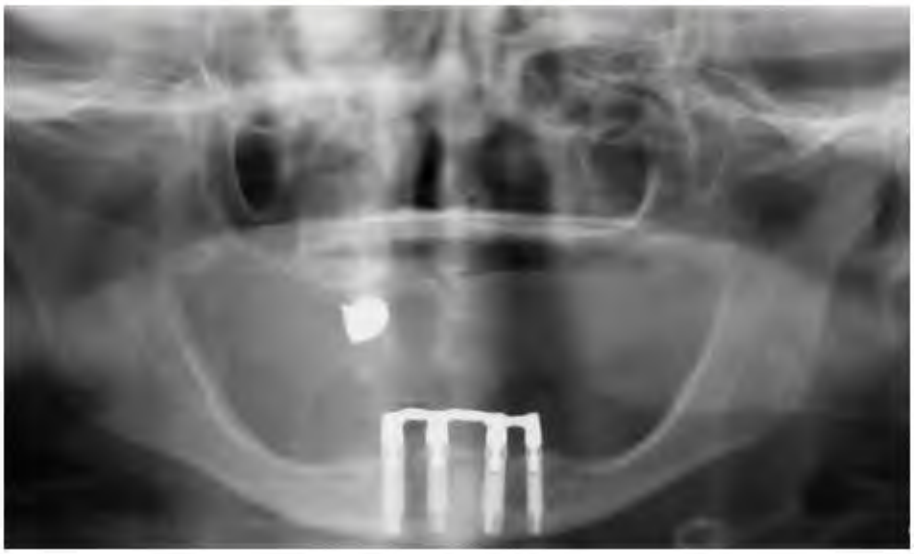


Fig 3-14o Follow-up panoramic radiograph.

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Treatment course

- Implant removal, implant placement and augmentation with immediate loading (2006)
- 4 months to definitive loading with a prosthesis

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Hubertus Klaus
Dental technology:	Dental technician Ludger Jansen, DentaLab

Fixed bridges on several implants

Typical treatment course

Fixed immediate bridge – implant placement with a 3D template

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Baseline situation

A relatively young, 48-year-old man had been suffering greatly from his complete toothlessness. He wanted a fixed prosthetic restoration for both mandibular and maxillary jaws. The loose lower complete denture was a particular problem for him, and stabilizing it would mean a great improvement (Fig 3-15a). The maxilla needed augmentation before implant placement (with bilateral sinus elevation), but the mandible already appeared suitable for implant placement (Fig 3-15b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- coDiagnostiX planning
- Dental cast analysis
- 3D template

Treatment plan

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1. Immediate implant placement with a screw-retained, immediate fixed implant bridge
2. Definitive fixed cantilever bridge once the implants had healed

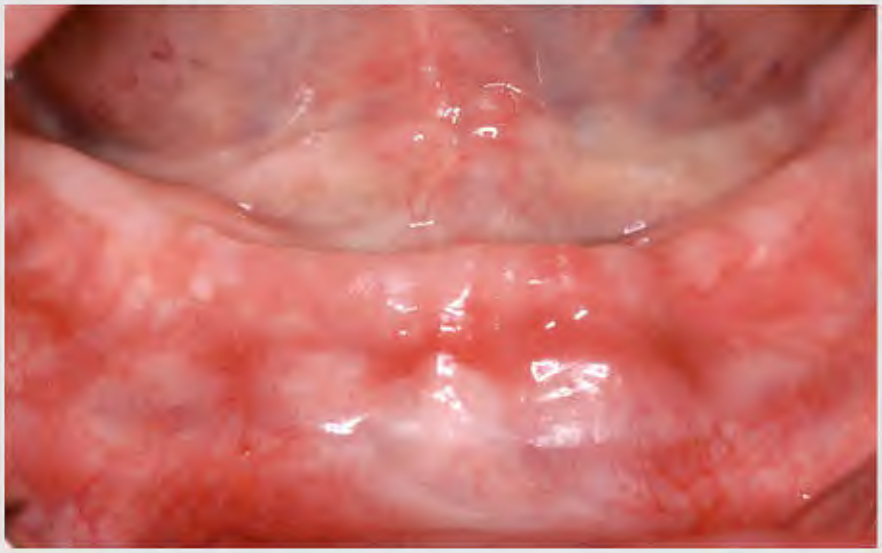


Fig 3-15a Edentulous mandible before the treatment.

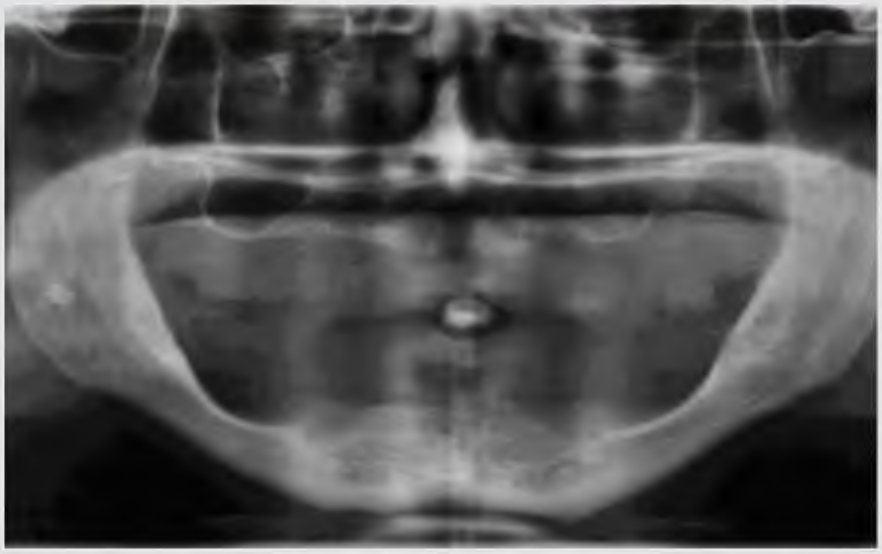


Fig 3-15b Panoramic radiograph.

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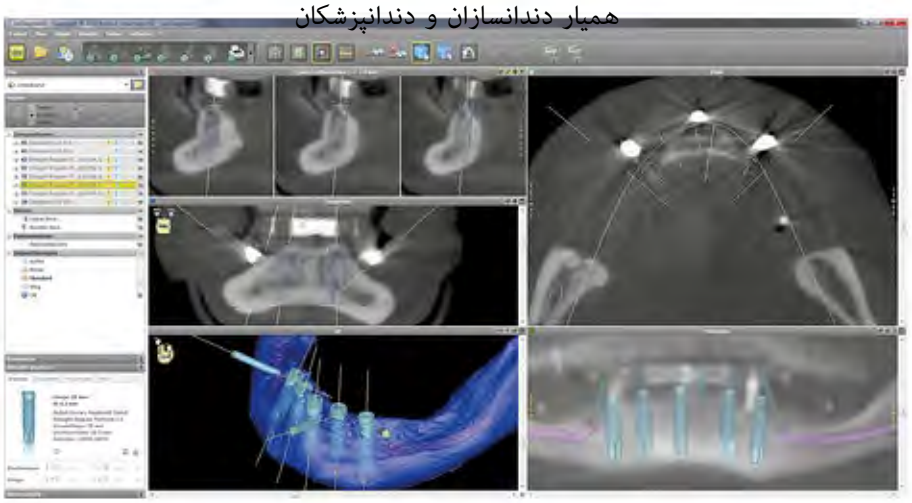


Fig 3-15c CBCT with template and coDiagnostiX planning.

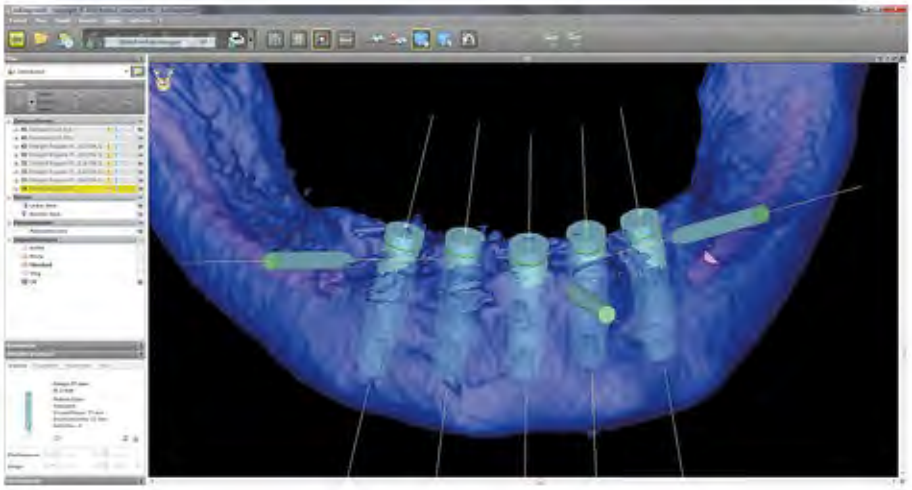


Fig 3-15d Five implants and three stabilization pins on the planning screen.



Fig 3-15e Transferring the implant positions from template to cast.

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Fig 3-15f Position of the implants for the provisional restoration.

Preparing the template and the provisional restoration

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First, the mandibular prosthesis was duplicated to allow a radiologic template to be fabricated for the coDiagnostiX planning. At this point, since it was not yet clear what type of restoration we should be aiming for (either an SOS prosthesis or a fixed bridge on five to six implants were being considered for financial and anatomical reasons), a bar casing replica for the SOS was also integrated into the template along with the necessary pins. A CBCT scan was taken together with the template and loaded into the coDiagnostiX software (Fig 3-15c). Following approval from the insurance provider and assessment of the mandibular anatomy, five interforaminal implants were planned for a screw-retained, cantilever fixed bridge. The dentist and technician discussed the planning procedure, checked it and approved it for the fabrication of the 3D template (Figs 3-15c and 3-15d). In the laboratory, the template was fabricated according to the plan, using the gonyX table (IVS Solutions) for the production of surgical guides. The positions of the planned implants were transferred to the definitive cast (Fig 3-15e). The plastic provisional restoration could then be prepared on the modified definitive cast (Fig 3-15f).

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Fig 3-15g Template positioned in the mouth before the implant placement.



Fig 3-15h Template secured to the jaw with three pins.

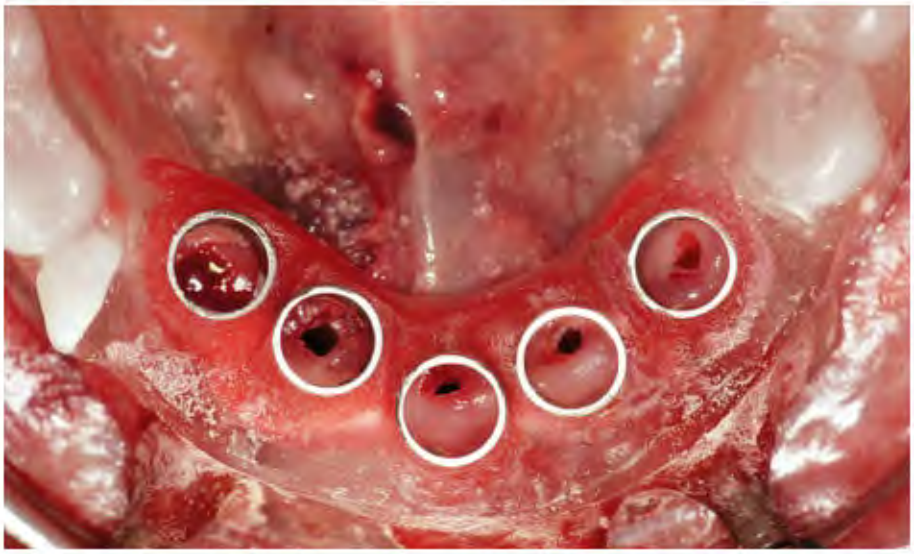


Fig 3-15i Bores drilled through the template.

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Fig 3-15j Checking the location of the bores following removal of the template.

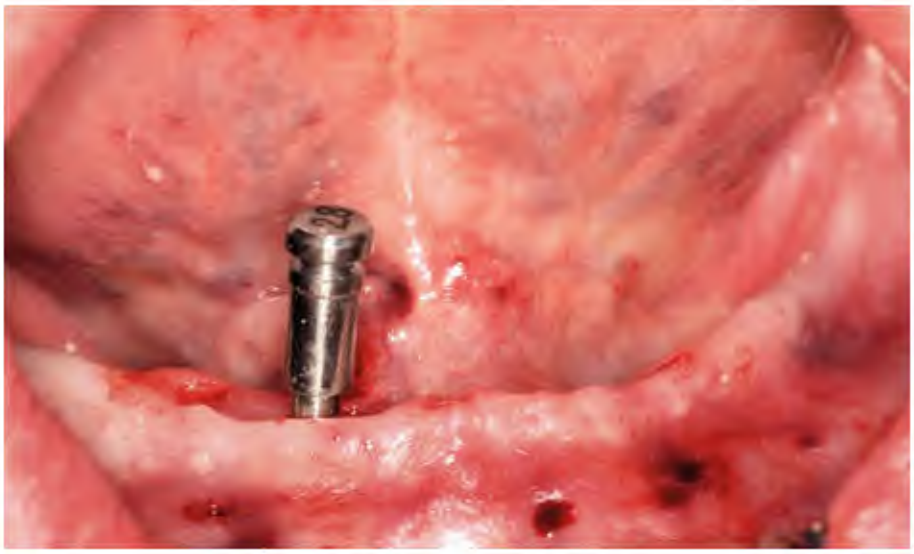


Fig 3-15k Using a pin to check the implant beds for stability.

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Implant placement and immediate loading

Implant placement was performed under local anesthesia (conduction and infiltration anesthesia). The prepared 3D template was positioned onto the mandible and held in place by the maxillary prosthesis while three horizontal bores were prepared (Fig 3-15g). The pins were inserted into these bores, thus fixing the template securely onto the jaw (Fig 3-15h). A 2-mm spiral drill was used to prepare bores in the mandible, with the aid of the NobelGuide guided sleeves (Fig 3-15i). To decide if a flap had to be created or whether flapless surgery would be possible, the template was removed and the locations of the bores checked (Fig 3-15j). If the bores are too far from the center of the residual ridge (particularly if they are too far in the labial or buccal direction), the recommended option is to open the operation site with augmentation and a sliding flap procedure. A vertical pin was used to check all the prepared

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beds for stability, one after the other (Fig 3-15k). If a bore lies outside the bone, the movement of the pin will indicate a lack of stability. In this case, exposure of the residual ridge and creation of a flap are unavoidable.

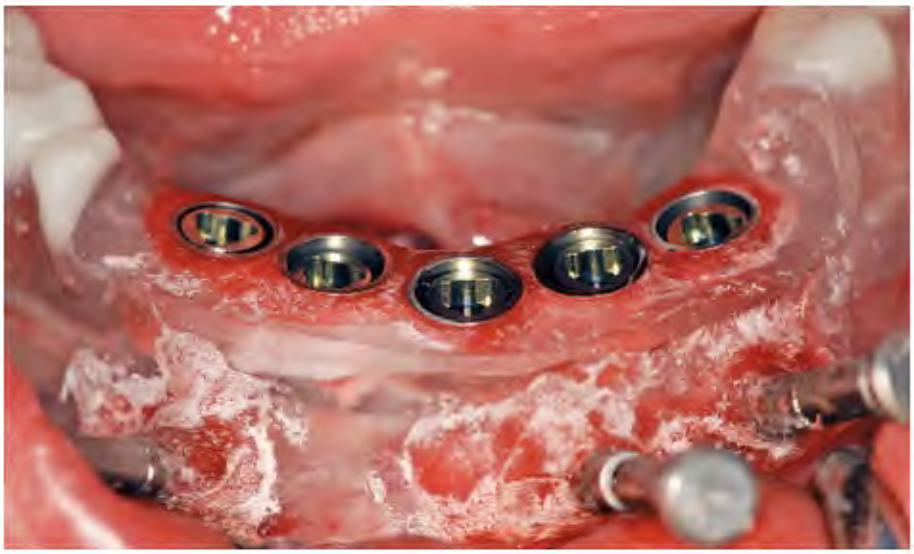


Fig 3-15l Reincorporation of the template and insertion of the implants.

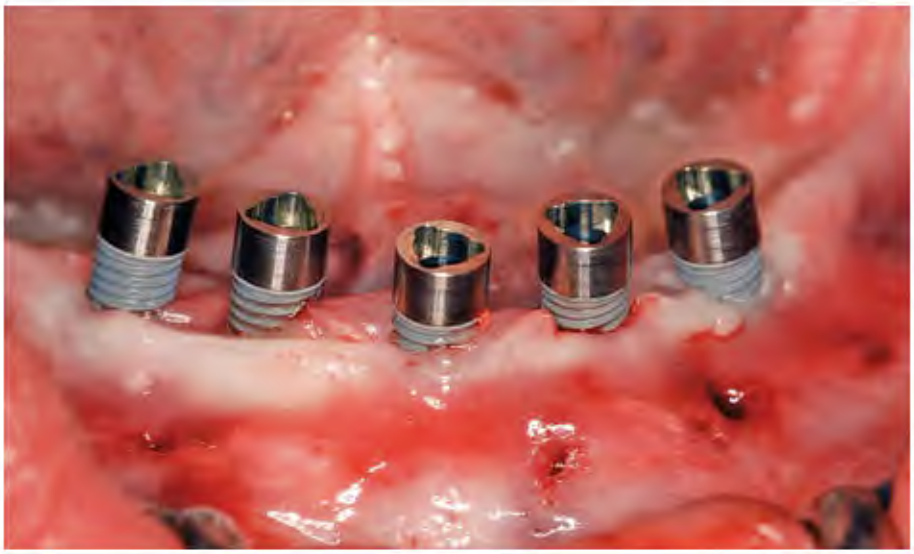


Fig 3-15m The template has been removed; the implants need to be inserted further.

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Fig 3-15n Vertical positioning of the implants.

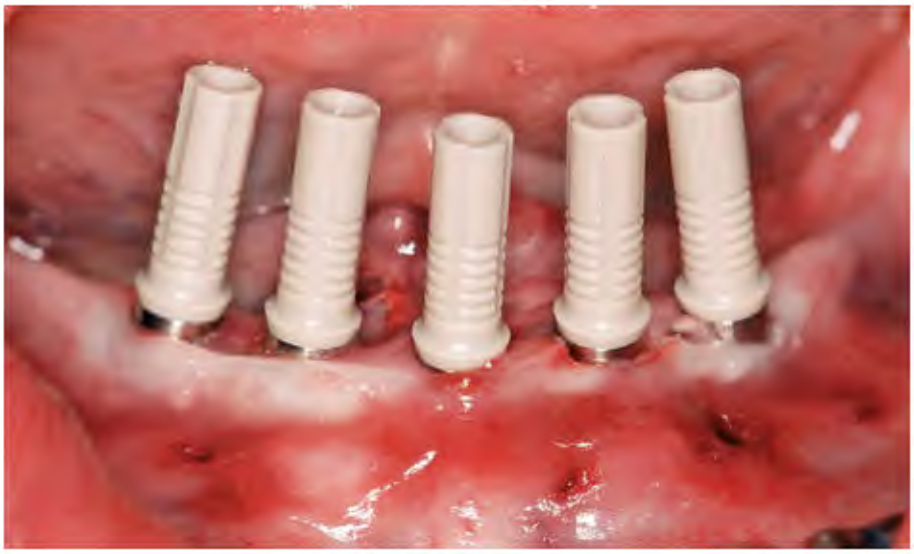


Fig 3-15o The provisional cylinders screwed into place.



Fig 3-15p Try-in of the prepared provisional.

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Fig 3-15q Fixing the provisional onto the cylinders with a dual-cured resin cement.

With the aid of the template, all the implant beds were prepared with drills of increasing size up to a diameter of 3.2 mm and the implants inserted transmucosally (Fig 3-15l). The template was removed and, working under visual control, all the implants were inserted to a depth that seemed clinically reasonable, with the margins just proud of the gingiva and all at the same level, if at all possible (Figs 3-15m and 3-15n).

Provisional cylinders were screwed onto the implants to make up the provisional restoration (Fig 3-15o). The prepared provisional fixed partial bridge replacing teeth 35 to 45 was fitted onto the cylinders without tension and ground to shape where necessary (Fig 3-15p). The cylinders were fixed to the provisional using a light-curing material, in such a way as to ensure the best possible occlusal fit as well (Fig 3-15q). The provisional was then removed from the mouth and reshaped, polished and then reincorporated (Fig 3-15r). The postoperative panoramic radiograph shows the position of the implants (Fig 3-15s). Four months after implant placement, the clinical situation was stable, although the patient needed to be remotivated with regard to hygiene, due to the deposits of dental calculus (Fig 3-15t).

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Fig 3-15r Long-term provisional incorporated after implant placement.

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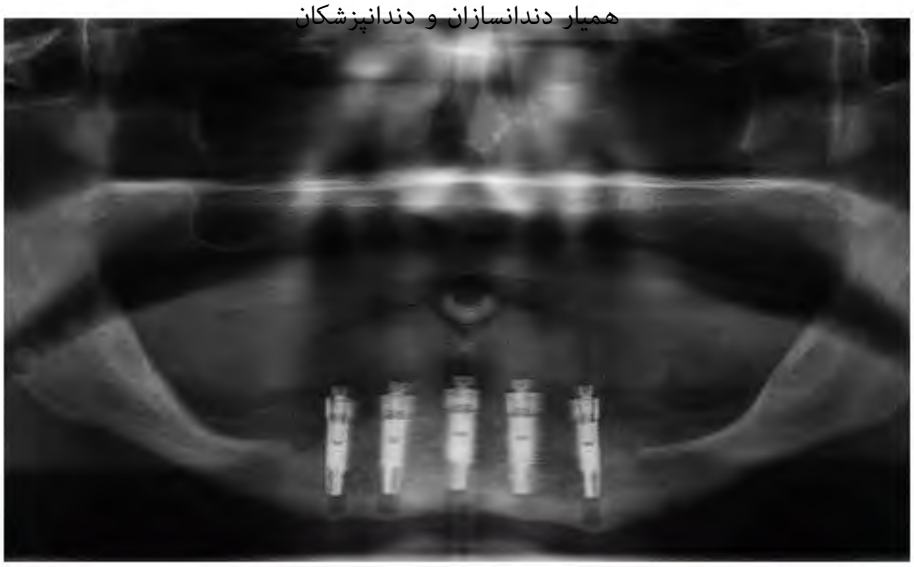


Fig 3-15s Postoperative panoramic radiograph.



Fig 3-15t Provisional after 5 months. Deposits of dental calculus.



Fig 3-15u The provisional has been removed.

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Fig 3-15v Labial/buccal view of the finished cantilever implant bridge.

Definitive prosthetic restoration

Five months after implant placement, the provisional was removed for impression taking (Fig 3-15u). Because of the risk of bleeding, the deposits on the implants were cleaned off only after the photograph was taken. The Impregum impression, taken on a custom tray, was sent to the laboratory for the fabrication of the screw-retained, metal-ceramic, cantilever bridge (Fig 3-15v).

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Fig 3-15w Occlusal view of the cantilever bridge.

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Fig 3-15x Screw-retained cantilever bridge on five implants.

The screw access holes are on the lingual side by the anterior teeth and the distal extensions are limited to three premolar widths (Fig 3-15w). The definitive restoration was incorporated into the mouth and blends in well with the overall appearance of the mouth (Fig 3-15x).

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Treatment course

- Implant placement and immediate loading with a denture replacing teeth 35 to 45 (2011)
- 5 months to the definitive cantilever bridge

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental technician Ludger Jansen, DentaLab

Atypical treatment course – problematic baseline situation

Extraction, immediate implant placement and immediate fixed bridge

Baseline situation

A 49-year-old woman still had five anterior teeth in the maxilla, fitted with telescopic crowns (Fig 3-16a). To date, these telescopic crowns have acted as anchors for the

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prosthesis, but cannot be preserved in the long term.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction of the anterior teeth
2. Immediate implant placement with immediate loading
3. Screw-retained, cantilever bridge



Fig 3-16a Five telescopic crowns used to anchor the prosthesis.

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Fig 3-16b CBCT scan images and 3D SimPlant planning of six implants.

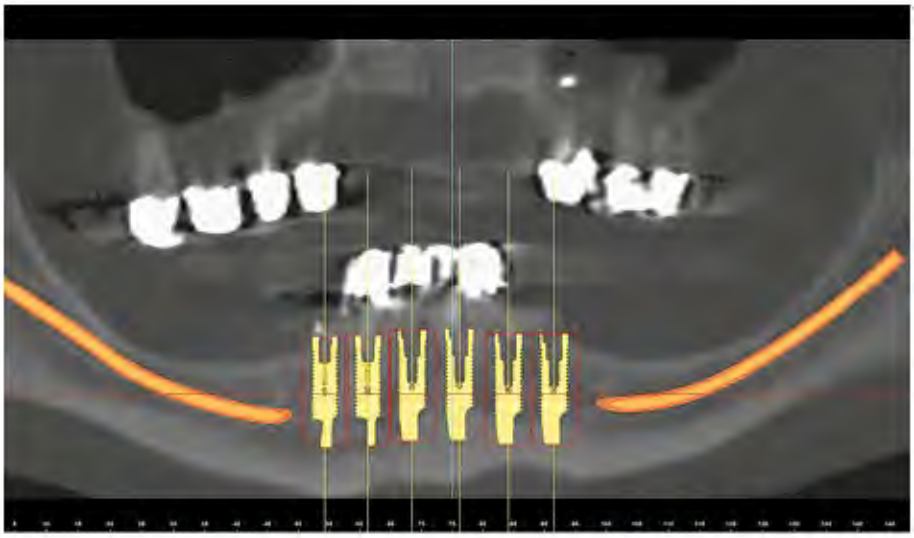


Fig 3-16c Six implants planned for the interforaminal region in the panoramic section view.

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Diagnosis and planning

A CBCT scan was taken and exported to the SimPlant program (Fig 3-16b). Six Replace Select implants (Nobel Biocare) were planned in the interforaminal region directly after extraction of the anterior teeth (Fig 3-16c). The six implants were uniformly distributed between the mental foramina (Fig 3-16d). During planning, it is important to position the implants centrally in the extraction sockets, as they would otherwise be displaced by the cortical structures (Fig 3-16e).

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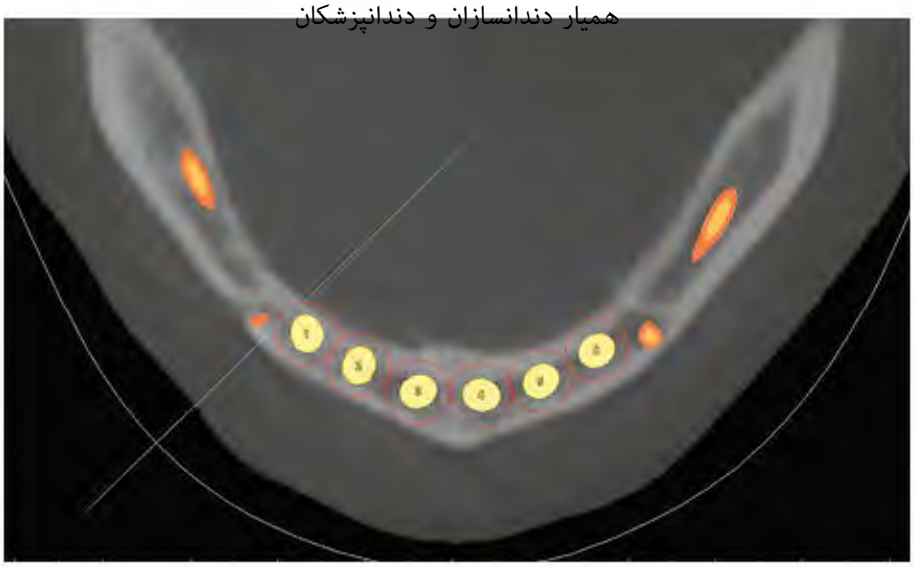


Fig 3-16d Uniform distribution of the implants in the axial slice.

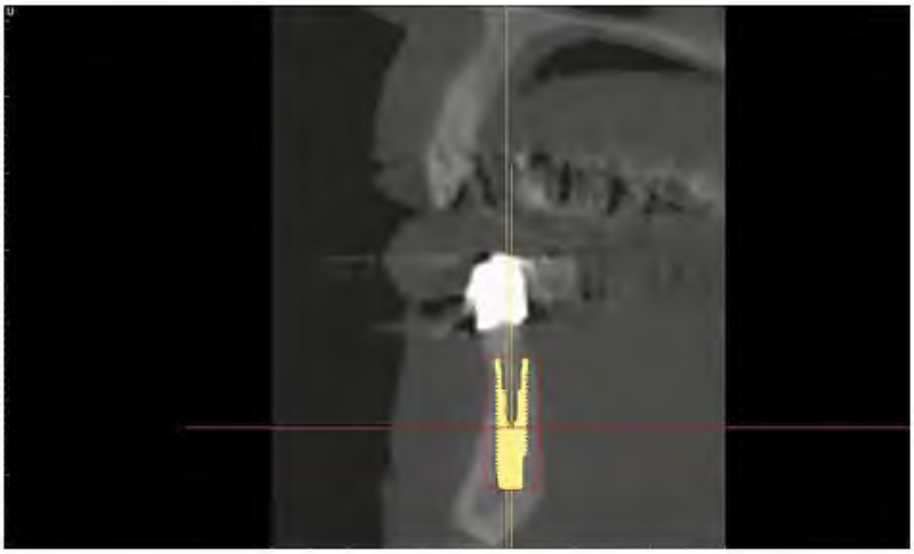


Fig 3-16e Alignment of the implants in the cross-sectional view.

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Extraction, implant placement and immediate loading

Working under bilateral conduction and infiltration anesthesia, the teeth were extracted, flaps created and the residual ridge smoothed. Six implant beds were prepared in accordance with the planning (Fig 3-16f). The position of the distal implant relative to the foramen was checked with an intraoperative radiograph (Fig 3-16g). Six 4.3 × 18 mm Replace Select implants were inserted. A few were partially exposed on the labial/buccal side, particularly in the third quadrant, and needed augmentation (Fig 3-16h). The bone chips collected by the filter during preparation served as the augmentation material (Fig 3-16i). The augmentation was protected from resorption with two Bio-Gide membranes (Fig 3-16j). Suturing followed, made more difficult by the prominent provisional cylinders (Fig 3-16k). A prepared provisional prosthesis was polymerized onto the provisional cylinders, after which it was shaped and given a high

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polish outside the mouth (Fig 3-16l). The shaped provisional was screwed firmly into place on the implants and the screw access holes provisionally filled in (Fig 3-16m). This provisional was worn during the 5-month implant healing period (Fig 3-16n).

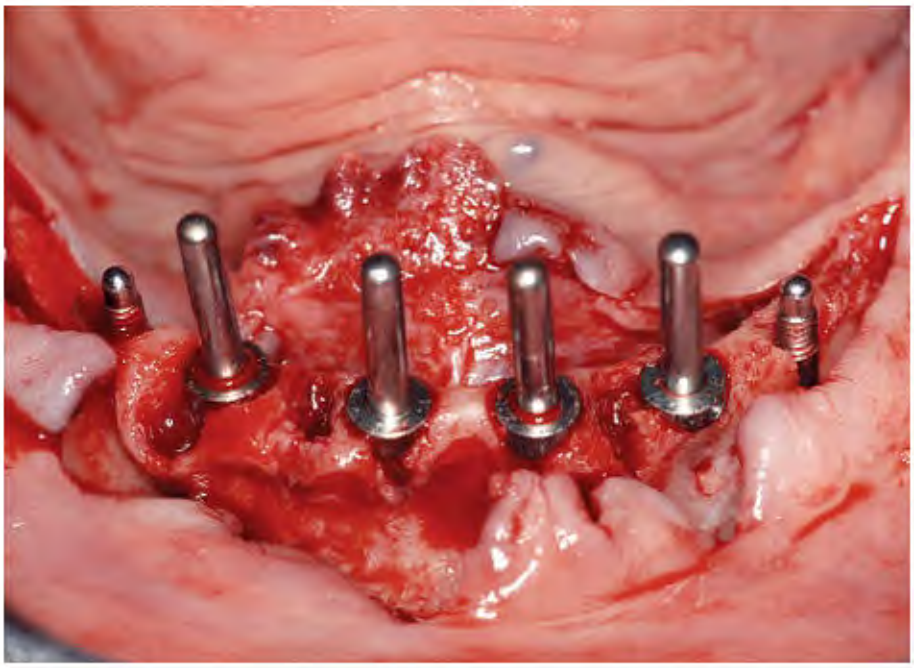


Fig 3-16f Extraction of the teeth, smoothing of the residual ridge and preparation of the implant beds.

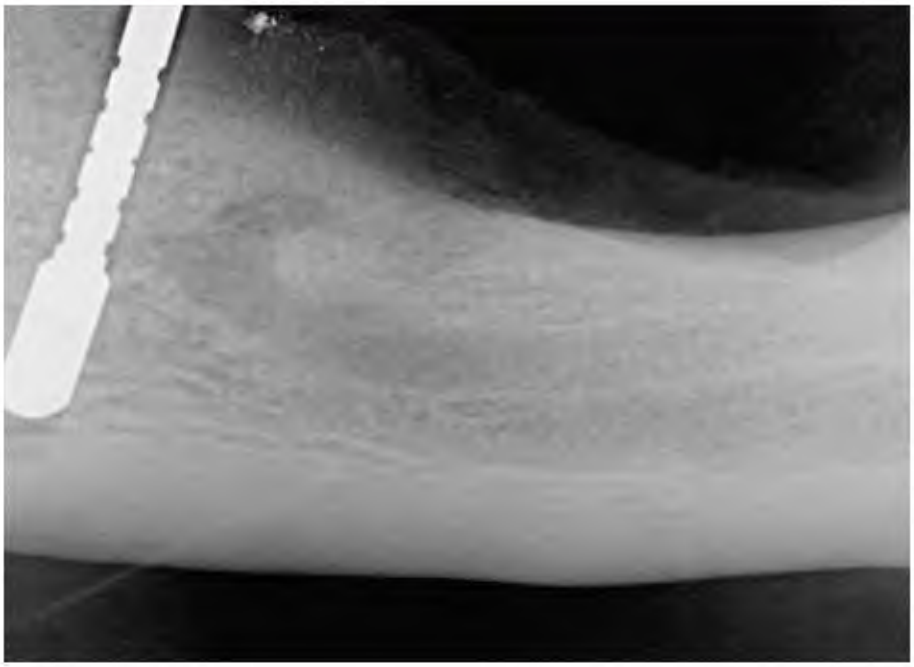


Fig 3-16g Intraoral radiograph taken during the procedure to check the position of the distal implants relative to the nerve.

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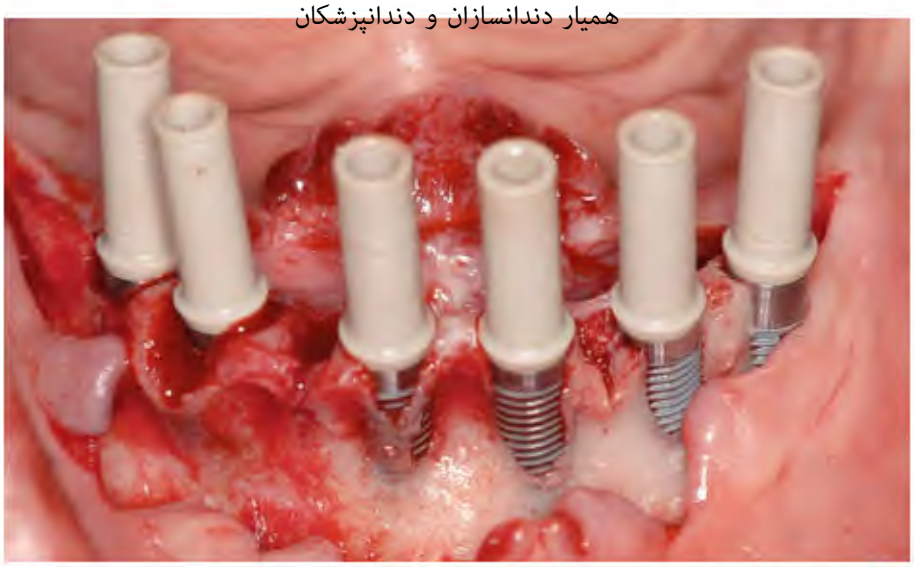


Fig 3-16h Inserted implants with provisional cylinders screwed on.

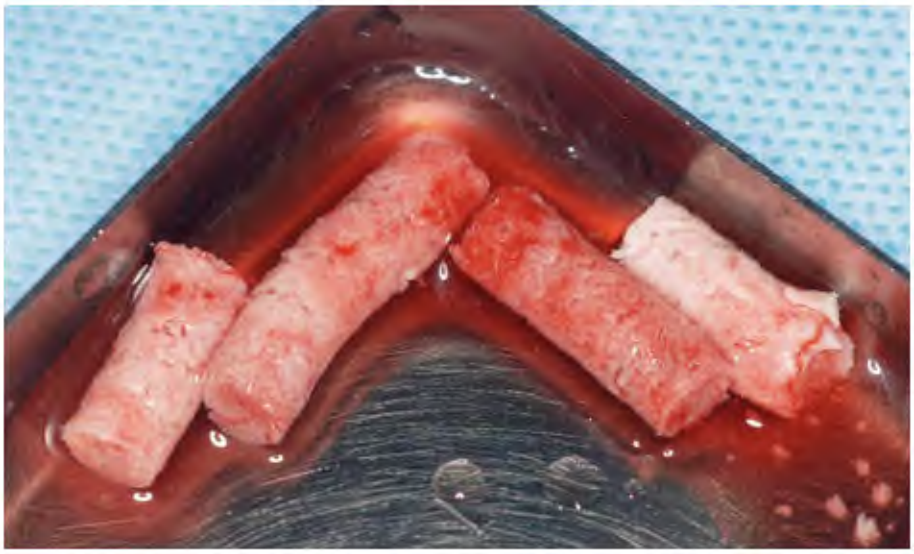


Fig 3-16i Bone chips harvested during preparation.

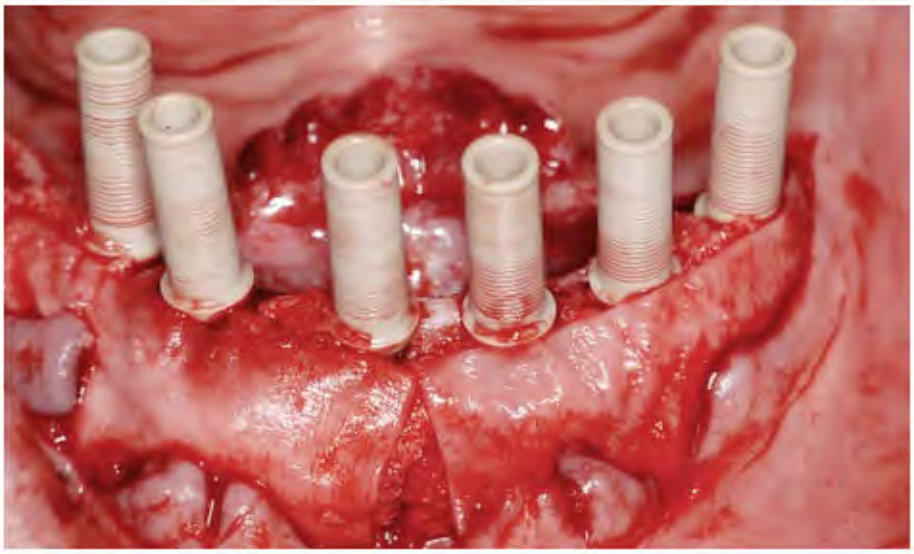


Fig 3-16j Augmentation with bone chips and membranes.

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Fig 3-16k The wound has been sutured as tightly as possible around the provisional cylinders.



Fig 3-16l Shaped fixed long-term provisional restoration.



Fig 3-16m The provisional restoration has been incorporated after implant placement.

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Fig 3-16n Provisional after 5 months.



Fig 3-16o Implants with the provisional removed for the impression taking.



Fig 3-16p Impression copings screwed into place.

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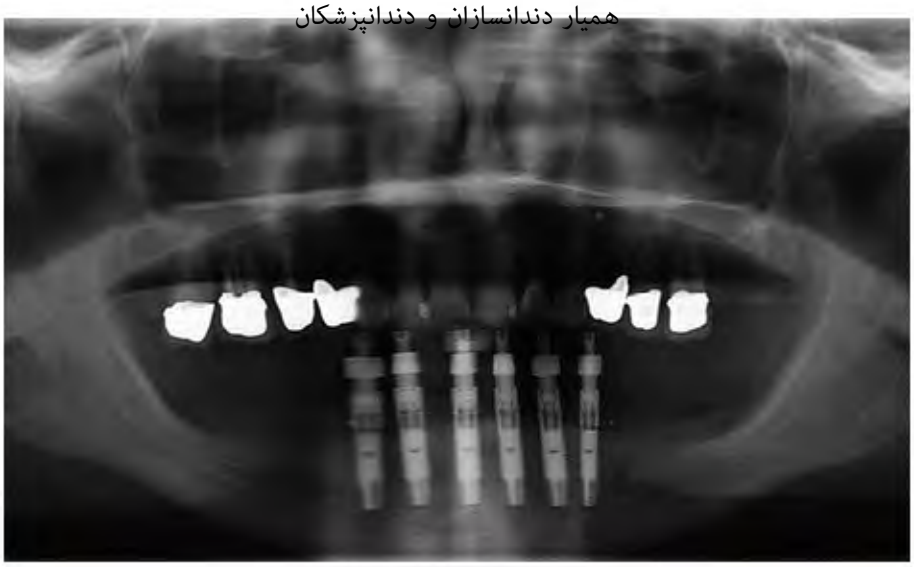


Fig 3-16q Panoramic radiograph taken to check the position of the impression copings.



Fig 3-16r First interocclusal record with impression copings, taken for guidance purposes.



Fig 3-16s Impression taken with Impregum using a custom tray.

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Fig 3-16t Precision check of the definitive cast with the index.

Prosthetic restoration

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After 5 months, the provisional prosthesis was unscrewed and the stability of the implants tested (Fig 3-16o). Impression copings were fitted onto the implants for impression taking (Fig 3-16p). A panoramic radiograph was taken to check accurate positioning of the impression copings (Fig 3-16q). A rough interocclusal record was also taken for guidance, using a plastic putty on the impression copings, to aid the technician in the fabrication of the occlusion rim (Fig 3-16r). The impression was taken with Impregum using a custom tray (Fig 3-16s). Two accessories were prepared in the laboratory for the next treatment appointment. First, a tooth position index made out of plastic was screwed onto the implants to check the precision of the impression (Fig 3-16t).



Fig 3-16u Screw-retained occlusion record with the anterior teeth set up.

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Fig 3-16v Incorporated definitive cantilever implant bridge.



Fig 3-16w Overall appearance following incorporation. Zones of dehiscence can be seen around the anterior implants.

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Attention: ***If any tension is detected when tightening the screws (more than ¼ of a rotation from the first point of resistance to the endpoint), the index will need to be detached and reassembled, or a new impression taken. If there is no tension, this means that the definitive cast is precise. In that case, the framework try-in stage can be skipped, proceeding either to ordering a bisque bake or directly to the fabrication of the fixed bridge itself.***

The second component that was delivered was a screw-retained interocclusal record with provisionally set up anterior teeth (Fig 3-16u). To be on the safe side, the whole wax-up could be tried in one more time before proceeding to the fabrication stage. If both the patient and the dentist are happy with the result, the fixed partial denture can be fabricated and incorporated (Fig 3-16v).

The metal-ceramic cantilever implant bridge has blended in well with the overall

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appearance of the mouth (Fig 3-16w). Despite the extensive augmentation, there is some recession of the labial gingiva around two mesial implants.

Treatment course

- Extraction, implant placement and immediate loading with a provisional in regions 35 to 45 (2010)
- 5 months to the definitive fixed cantilever bridge replacing teeth 36 to 46

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental technician Ludger Jansen, DentaLab

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Atypical treatment course – problematic baseline situation

Immediate fixed bridge loaded onto provisional implants

Baseline situation

This female patient, with a residual dentition consisting of four incisors that were not worth preserving, wanted a fixed prosthetic restoration to be fitted immediately after implant placement if at all possible (Fig 3-17a). The panoramic radiograph taken with a planning template shows good bone availability in the interforaminal region (Fig 3-17b). To ensure safe and undisturbed osseous integration of the definitive implants, provisional implants were planned as supports for the interim fixed denture.

Diagnostic tools

- Clinical examination
- Panoramic radiograph with template
- Dental cast analysis

Treatment plan

1. Insertion of six definitive and five provisional implants, immediate loading of a prosthesis onto the provisional implants, submerged healing
2. Exposure

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3. Screw-retained cantilever fixed bridge on six implants



Fig 3-17a Incisors that are not worth preserving.



Fig 3-17b Planning panoramic radiograph with template.

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Extraction, implant placement and immediate loading with a provisional restoration

Following extraction of the remaining teeth, implant beds were first prepared for the definitive implants, with the implant in region 35 lying directly over the nerve. Direction indicators were used to check for correct alignment (Fig 3-17c). Once the definitive implants were inserted, the direction indicators were screwed onto them (impression post screws can also be used for this), to show the positions of the implants in the mandible. The provisional implants (K.S.I. Bauer screws) were inserted into the remaining spaces (Fig 3-17d). The definitive implants

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were closed off with cover screws (Fig 3-17e) and the operation area sutured to ensure that only the provisional implants protruded from the gum. For the immediate prosthetic restoration, customized gold denture caps were fitted onto the provisional implants and an impression taken with them. Within 2 h, a long-term provisional prosthesis made of acrylic was fabricated on these caps in the laboratory; this prosthesis was suitable for use until the definitive restoration could be incorporated (Fig 3-17f).

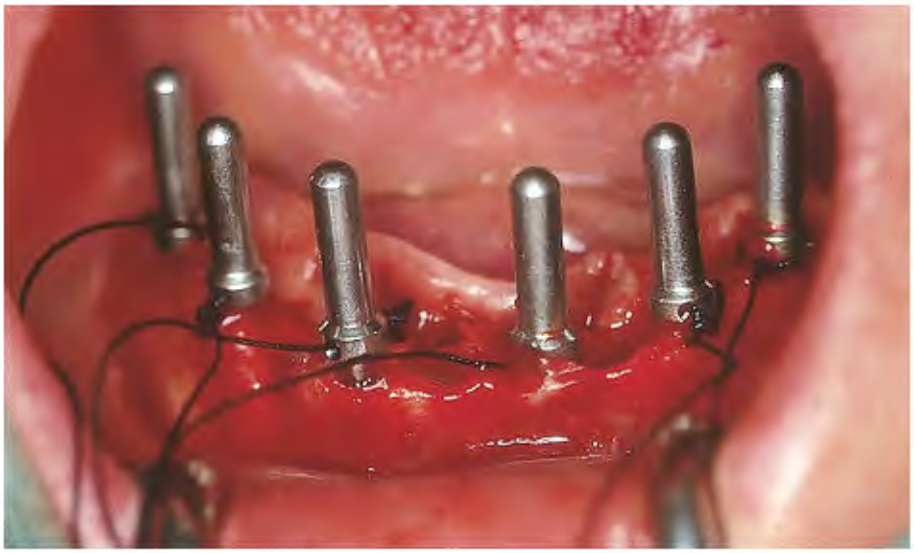


Fig 3-17c Checking the implant beds.

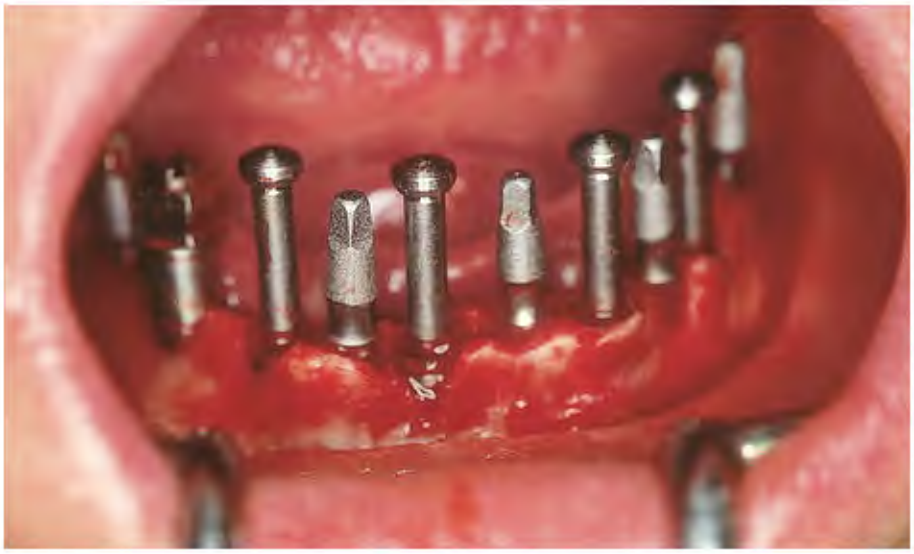


Fig 3-17d Alignment of the provisional implants.

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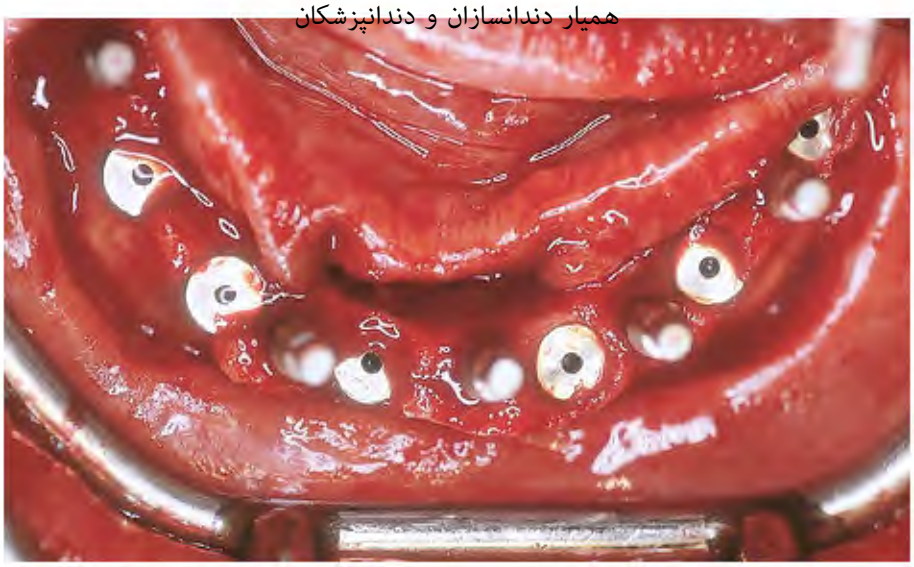


Fig 3-17e Cover screws fitted into place.



Fig 3-17f Provisional fixed partial denture with gold denture caps.



Fig 3-17g Postoperative panoramic radiograph.

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The good frictional properties of the gold caps meant that retention with provisional cement was unnecessary. The postoperative radiograph shows the position of the permanent and provisional implants and their relationship to the nerves (Fig 3-17g).



Fig 3-17h EsthetiCone abutments (Nobel Biocare) screwed into place.

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Fig 3-17i Before the impression taking.

Exposure

An undisturbed 6-month healing phase was to be expected due to the high level of comfort of the provisional fixed partial denture. With a few small modifications, the patient could continue wearing this even after the implants were exposed (Fig 3-17h). Once the soft tissue had stabilized, an impression was taken for fabrication of the definitive fixed implant bridge in the laboratory. The high-precision impression was taken with a custom tray and with impression copings screwed onto the definitive implants (Fig 3-17i). To allow the definitive restoration to be tried in, the master cast needed to reproduce not only the definitive implants

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(Brånemark System) but also the provisional ones (K.S.I. Bauer screws).

Laboratory technique

To fabricate the definitive cast, the model implants were screwed onto the impression copings embedded in the Impregum and corresponding analogs of the K.S.I. Bauer screws inserted into the impressions of the provisional implants (Fig 3-17j). Pouring resulted in a master cast that took all the implants into account (Fig 3-17k). The metal framework was cast in two parts and tried in to check for exact fit. The try-in showed a lack of tension-free fit in the third quadrant, with “wobbling” of the framework.

Therefore, it needed to be taken apart and reassembled in the mouth with Pattern Resin (GC America), followed by laser welding in the laboratory (Fig 3-17l). After another try-in of the framework, it was faced with acrylic resin and prefabricated prosthesis teeth. The gaps created for the provisional implants were left unfilled (Fig 3-17m), to allow occlusion and articulation to be checked in the mouth while the provisional implants were still in situ (Fig 3-17n).

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Prosthetic restoration

Following occlusal adjustment in the mouth, the two halves of the partial denture were interlocked with Pattern Resin and a stabilizing metal strut (a used drill can be used for this) in the dorsal region (Fig 3-17o). In the laboratory, the two parts were now joined with acrylic resin, to provide a controlled fracture site in case of tension caused by deformation of the mandible when the patient opened her mouth wide or bit down hard. Moreover, the spaces left for the provisional implants, needed until then for try-ins, were now filled to allow the fixed partial denture to be fabricated. In general, it takes only a few minutes to unscrew the provisional implants to allow the definitive prosthesis to be incorporated, and the process is virtually pain-free and almost bloodless (Fig 3-17p). After only a few days, hardly any trace remained of the removal sites of the provisional implants. The entire provisional restoration, including the removed implants, may be seen in Figure 3-17q. Finally, the completed fixed cantilever implant bridge (Fig 3-17r) was also checked radiologically for a perfect fit (Fig 3-17s). During the implant treatment of the maxilla (insertion of eight Replace Select implants), the clinical and radiologic situation in the mandible is stable after 10 years of functional use (Figs 3-17t ad 3-17u). To date, there has been no fracture of the acrylic resin joint, which had been incorporated as a safety feature to compensate for torsion of the mandible.

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Fig 3-17j Impregum impression with model implants from both systems.



Fig 3-17k Master cast.



Fig 3-17l Framework try-in.

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Fig 3-17m Framework with facing.



Fig 3-17n Last try-in of the superstructure, still in two separate sections.



Fig 3-17o Joining up the two parts.

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Fig 3-17p View following removal of the provisional implants.



Fig 3-17q Provisional restoration with removed K.S.I. Bauer screws.



Fig 3-17r Incorporated superstructure.

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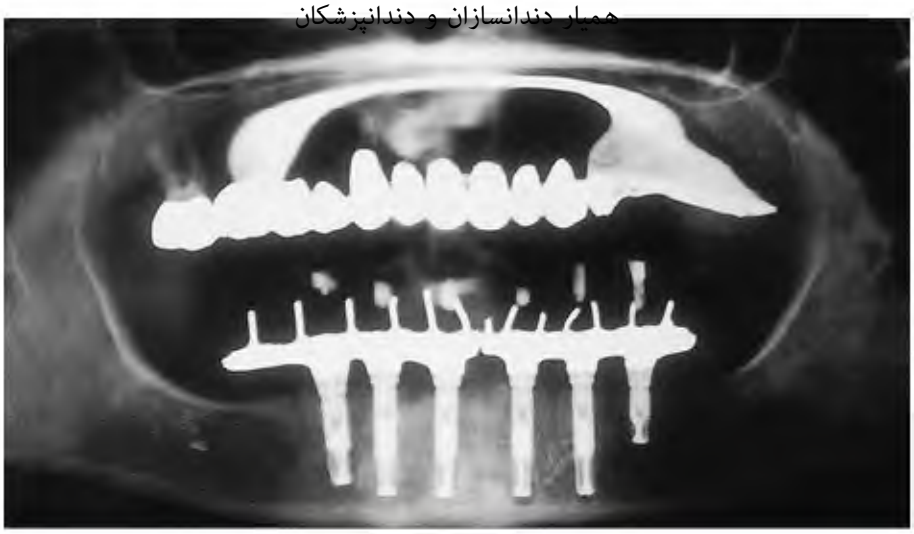


Fig 3-17s Post-procedure radiograph.



Fig 3-17t Clinical situation after 10 years.



Fig 3-17u Follow-up panoramic radiograph after 10 years.

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Treatment course

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- Extraction and implant placement with immediate loading (1995)
- 6 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery and prosthetics:	Dr Christoph T. Sliwowski
Dental technology:	Horst Mosch

Problems and complications

Destruction of the residual ridge due to peri-implantitis

Baseline situation

Three years earlier, this male patient had undergone surgical treatment at another center, involving the placement of four implants in the interforaminal region. One implant in region 42 had been lost shortly afterwards, while the rest had never been loaded with a prosthesis because of a loss of confidence between the patient and the original treatment provider (Fig 3-18a). Since the remaining implants showed large bone defects due to peri-implantitis, it was decided to remove them, augment the defects and place new implants (Figs 3-18b, 3-18c and 3-18d).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Implant removal, insertion of six implants in the interforaminal region, augmentation, submerged healing
2. Exposure
3. Loading with a fixed cantilever implant bridge

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Fig 3-18a Implants that have not been loaded.

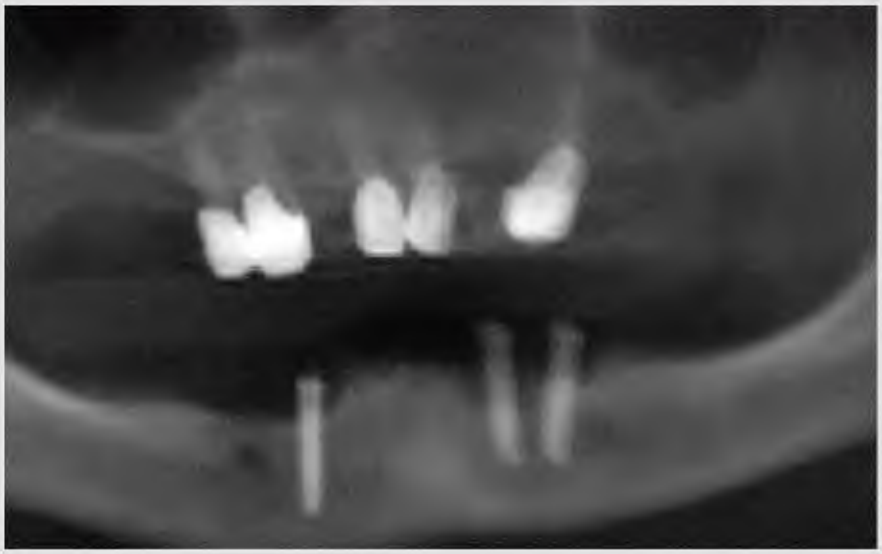


Fig 3-18b Baseline panoramic radiograph.



Fig 3-18c Cross section (CBCT) through implant 33.

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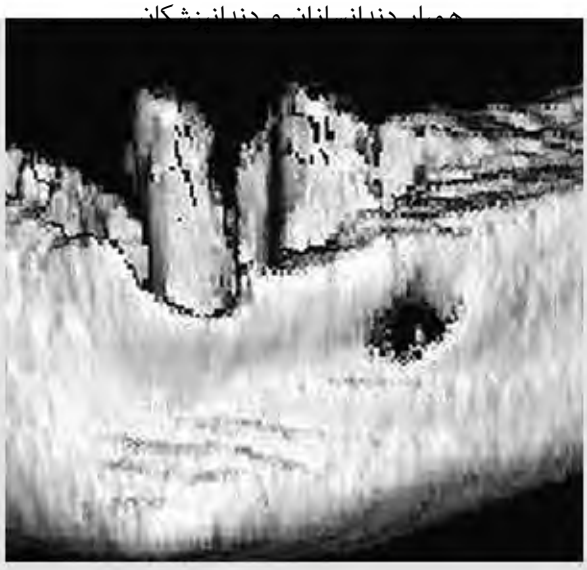


Fig 3-18d 3D visualization of the defects.

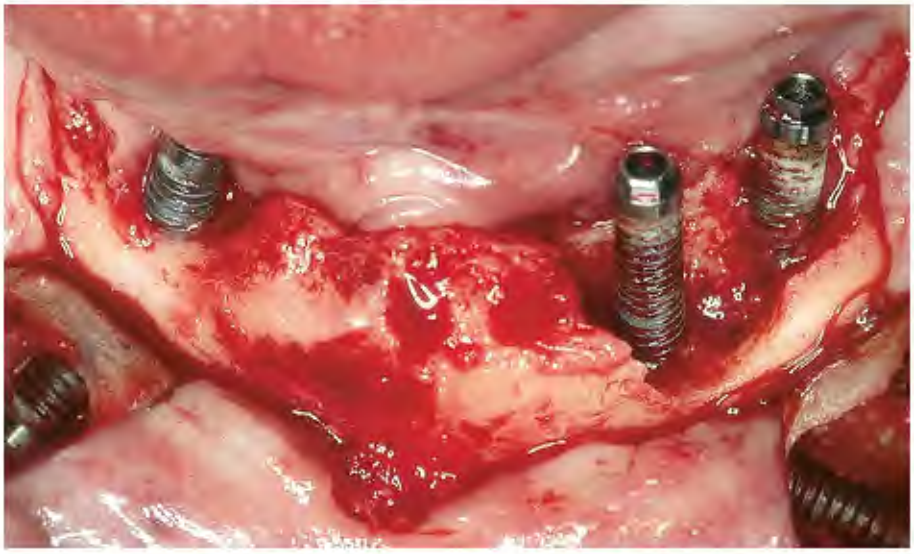


Fig 3-18e Peri-implant bone defects.

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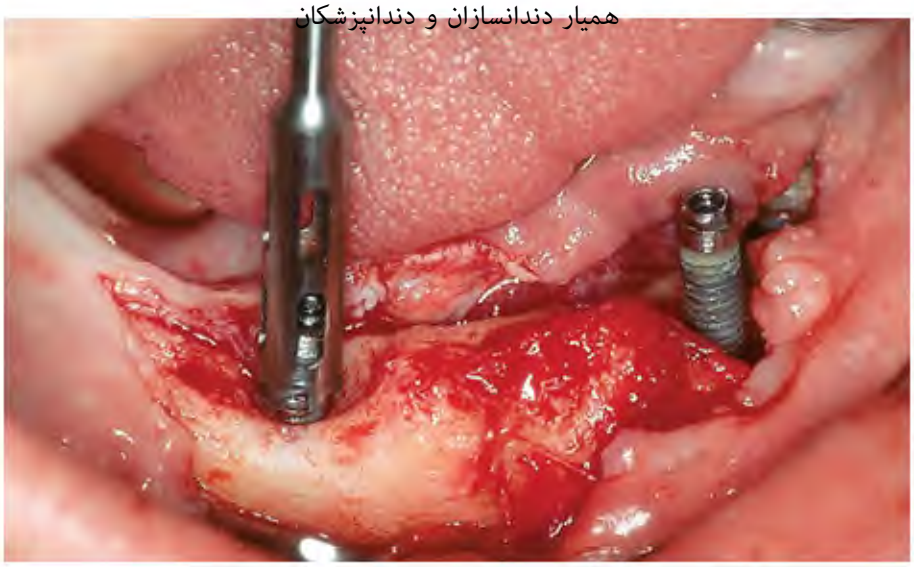


Fig 3-18f Implant removal with the trephine.

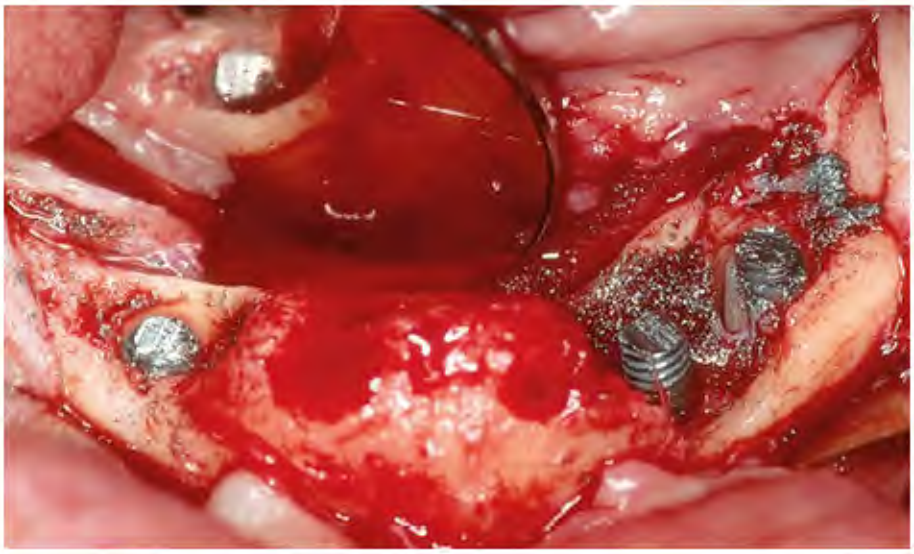


Fig 3-18g Shortening the implants.



Fig 3-18h Removed implants.

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Attention: ***Since the trephine is only 15-mm long, it cannot fully ream out an implant that is 18-mm long. Levering it out carries the risk of fracturing the implant apex, particularly with implants that exhibit apical perforations. To avert this risk, an implant may be shorted cranially by a few millimeters, allowing the trephine to ream out the bone around its full length (Fig 3-18g).***

Making the incision clearly revealed the bone defects caused by peri-implantitis (Fig 3-18e). The implants were reamed out with a trephine of standardized diameter (Fig 3-18f). Inspection showed good osseous integration of all the implants in the apical region (Fig 3-18h). Following implant removal, granulation tissue was removed from the bone defects, which were then carefully cleaned (also removing any titanium chips; Fig 3-18i).

Due to this patient's predisposition to peri-implantitis, six machined-surface MK-III Brånemark System implants were inserted into the interforaminal region (Fig 3-18j), and the large bone defect in region 32 to 34 was filled with bone chips and Bio-Oss (Fig 3-18k). The augmentation material was protected with a Bio-Gide membrane fixed into place with titanium pins (Fig 3-18l). The bone defect in region 44 was augmented in the same way (Fig 3-18m) and the wound tightly closed with Gore-Tex sutures (Fig 3-18n). The postoperative radiograph shows the positions of the newly inserted implants relative to each other and to the mental foramina (Fig 3-18o).

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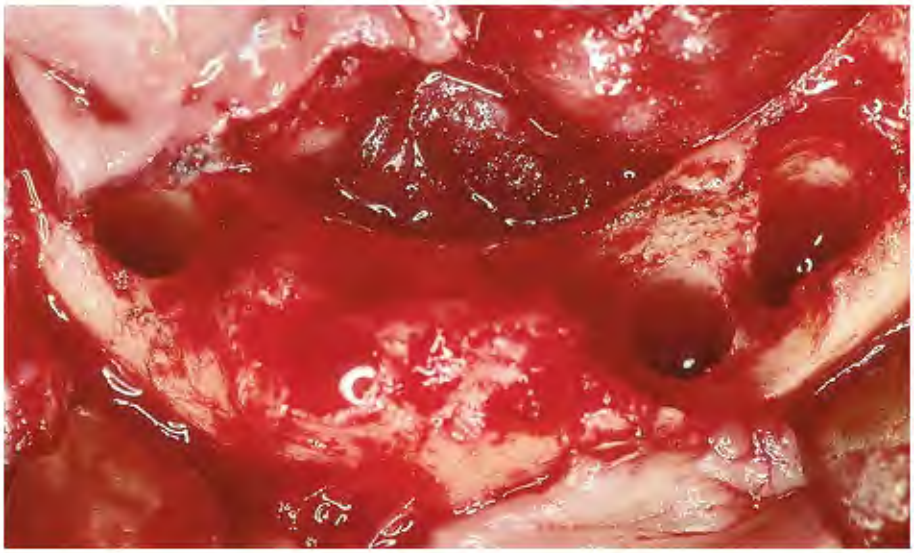


Fig 3-18i Bone defects following implant removal.

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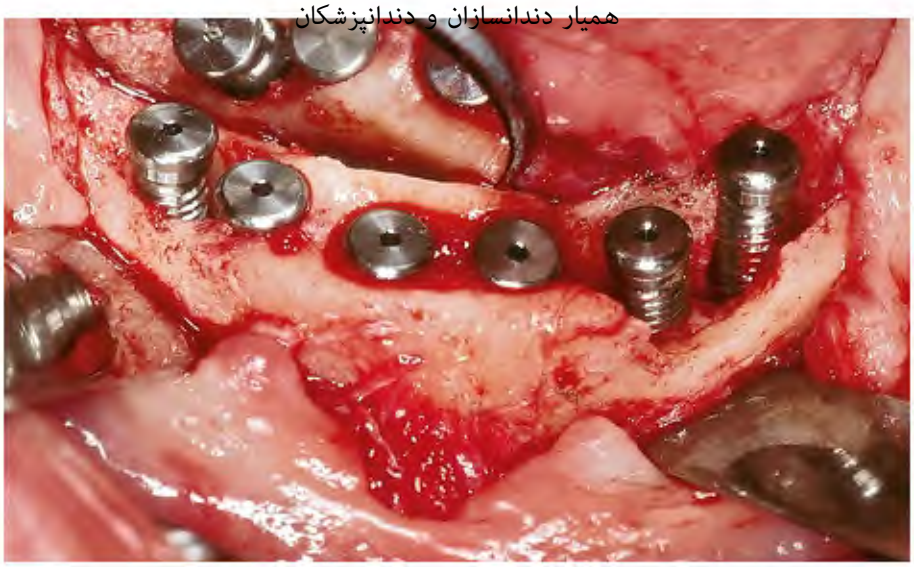


Fig 3-18j Six inserted Brånemark System implants.

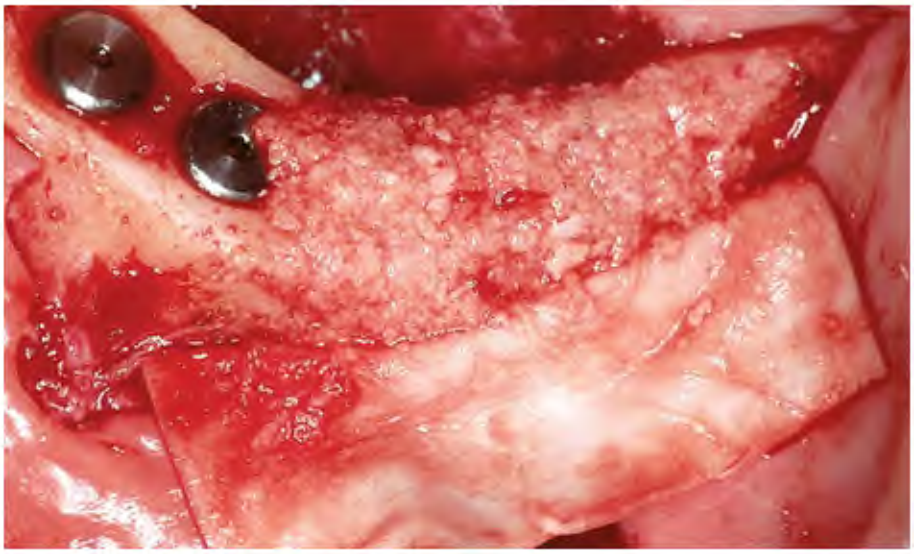


Fig 3-18k Augmentation with autologous bone.



Fig 3-18l Membrane attached with titanium pins.

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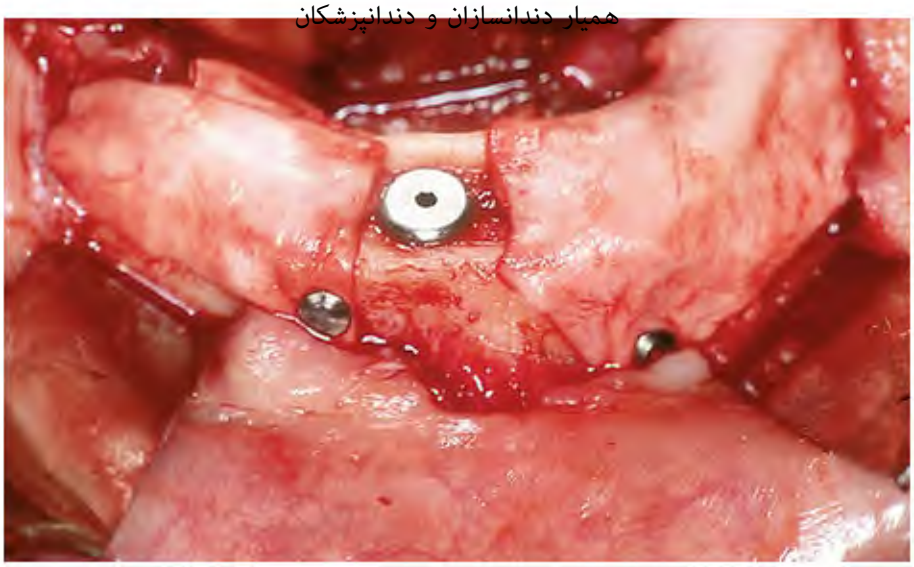


Fig 3-18m Completed augmentation.

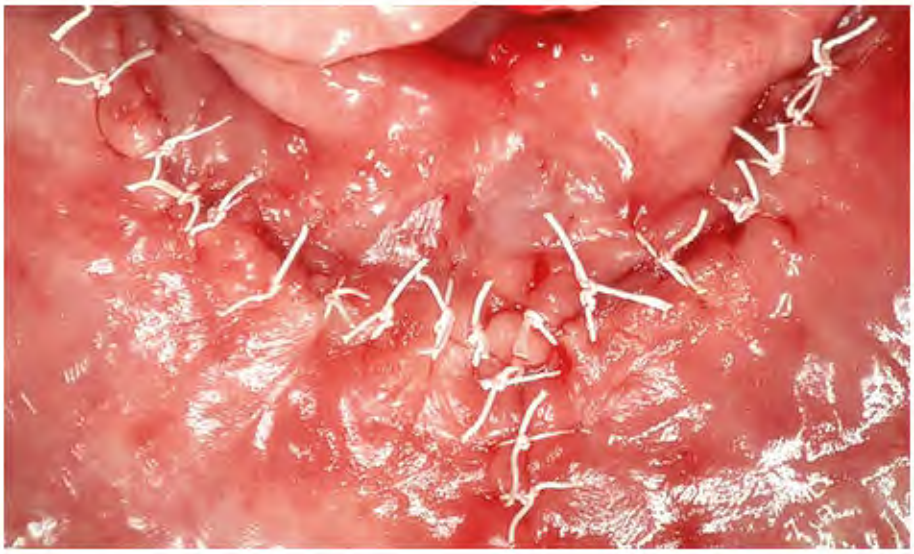


Fig 3-18n Tightly sutured wound.



Fig 3-18o CBCT panoramic view after implant placement.

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Fig 3-18p Exposure.



Fig 3-18q Impression copings screwed into place.



Fig 3-18r Fixed cantilever implant bridge with ceramic facing.

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Fig 3-18s Follow-up panoramic radiograph after 1 year.

Exposure and prosthetic restoration

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After 6 months, the implants were exposed and healing abutments screwed onto them (Fig 3-18p). Three weeks later, an impression was taken with impression copings screwed into place (Fig 3-18q). For the prosthetic restoration, a screw-retained, cantilever bridge with ceramic facing replacing teeth 36 to 46 was fabricated (Fig 3-18r). The follow-up panoramic radiograph after 1 year shows a stable osseous situation (Fig 3-18s). After such a prolonged treatment, the patient was happy to have got the fixed "teeth" that he wanted (Fig 3-18t).



Fig 3-18t Patient with his new prosthesis.

Treatment course

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- Implant placement and augmentation (2002)
- 6 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Problems and complications

Removal of an incorrectly placed implant

Baseline situation

A year before presenting to our clinic, this female patient had undergone implant treatment at another center. She declined to accept the results of this treatment due to the poor esthetic result and lack of stability of the prosthesis (Fig 3-19a). Despite their suboptimal placement, the Straumann implants in the left half of the mandible were suitable for inclusion into the planning for the new prosthetic restoration, whereas implant 44 needed to be removed due to its extremely faulty placement, so that a new implant could be inserted in the right position and at the correct angle (Fig 3-19b). Teeth 41 and 42 had to be extracted beforehand due to acute pain.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Removal of the implant in region 44, insertion of three new implants in regions 41, 43 and 44, augmentation
2. Exposure
3. Loading with a fixed cantilever implant bridge supported on all six implants

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Fig 3-19a Implants inserted at another center.



Fig 3-19b Radiologic baseline situation.

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Fig 3-19c View of the operation site.



Fig 3-19d Buccal exposure and implant removal.

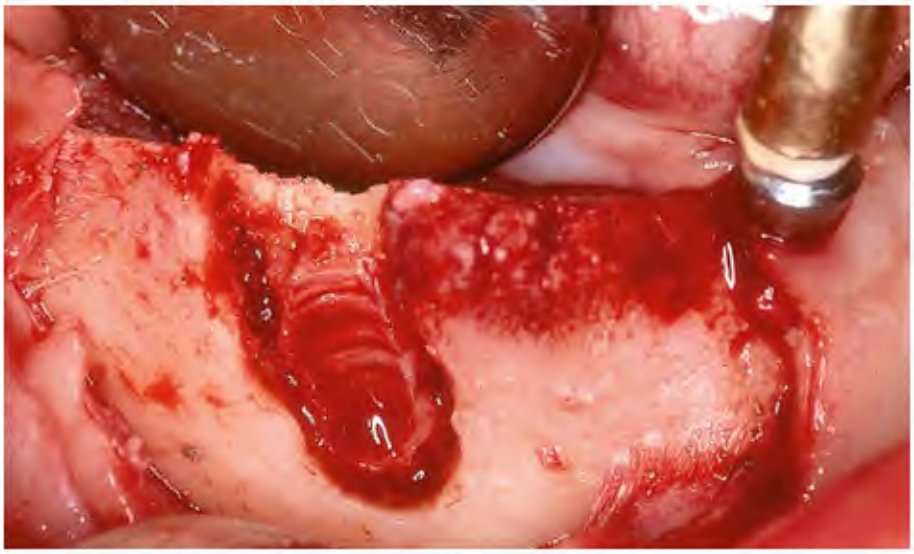


Fig 3-19e Post-implant removal defect.

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Fig 3-19f Three Brånemark implants have been inserted.

Implant removal, Implant placement and augmentation

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A good view of the operation area was achieved by creating a buccal trapezius flap (Fig 3-19c).

The bone around the implant was cut away with a bud bur and a Lindemann's cutting bur (Fig 3-19d); the implant was then carefully levered out without causing fracture of the implant or loss of the lingual bone wall (Fig 3-19e).

Attention: ***Narrow implants are usually explanted by reaming the bone around them with a trephine. When dealing with implants with a wider head, this will need to be cut off before using the trephine. If the residual ridge is very narrow, and especially if the implant is already shimmering through the bone, it should be exposed on the labial/buccal side and explanted laterally. This causes loss of the labial/buccal cortical bone in this region, which will require augmentation.***

Three Brånemark System implants (MK III, diameter 3.75 mm, length 18 mm) were inserted around the resultant bone defect (Fig 3-19f). The bone defect was filled with the harvested bone chips (Fig 3-19g) and the augmentation material covered with a Bio-Gide membrane attached with titanium pins (Fig 3-19h). This was followed by saliva-proof closure of the wound with Gore-Tex sutures (Fig 3-19i). The good osseous integration of the removed implants is apparent from the firmly adhering bone fragments post-removal (Fig 3-19j). After some minor adjustments, the patient was able to wear her existing prosthesis during the 5-month submerged healing phase of the implants (Fig 3-19k).

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Fig 3-19g Augmentation.

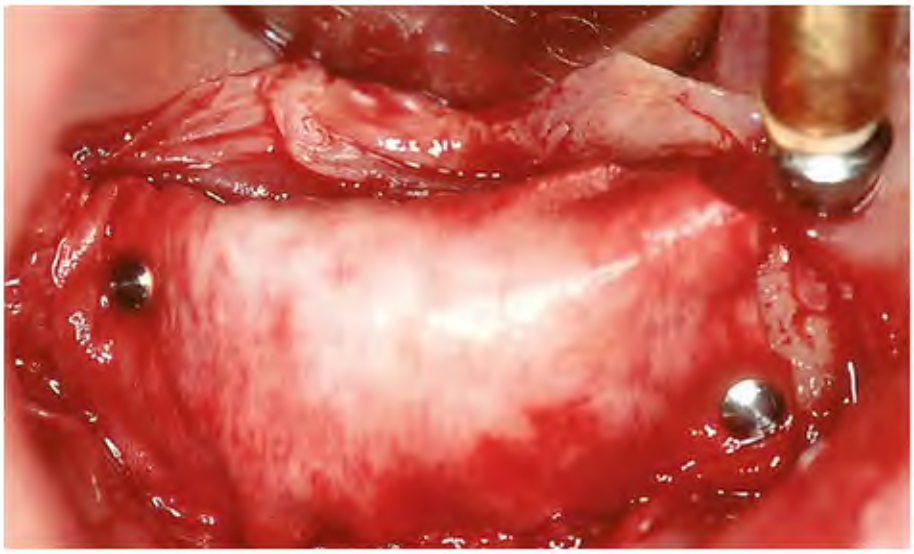


Fig 3-19h Attached membrane.

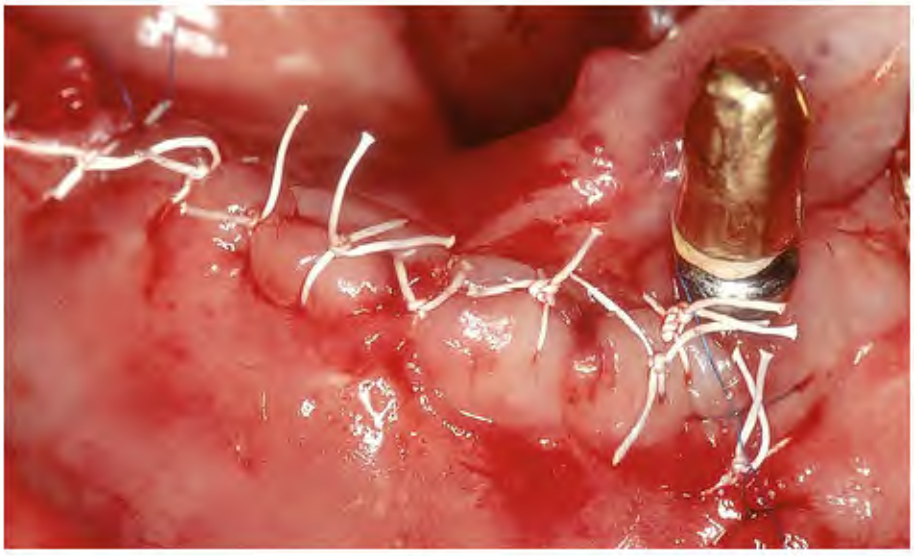


Fig 3-19i Sutured wound.

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Fig 3-19j Explanted Straumann implant.



Fig 3-19k Healing period.

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Fig 3-19l Healing abutments screwed into place.



Fig 3-19m Modified provisional denture.



Fig 3-19n Postoperative panoramic radiograph.

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Fig 3-19o Ceramic conditionally removable denture.

Exposure and prosthetic restoration

In the exposure phase, the implants were uncovered with a residual ridge incision. After the cover screws were replaced with healing abutments, the wound was adapted and closed with 6-0 sutures (Fig 3-19l). Further modification of the prosthesis was necessary to adjust it to the height of the abutments (Fig 3-19m). A conditionally removable denture was attached to the customized abutments with provisional cement (TempBond; Figs 3-19n and 3-19o).

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Treatment course

- Implant removal, implant placement and augmentation (2003)
- 5 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Dental Technician Willi Knepper

Full rehabilitation including implant placement in the posterior mandible

Implant placement in the posterior mandible, distally of the mental foramen, requires

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particularly careful preoperative diagnosis. The alveolar nerve limits the caudal bone supply, which can be utilized for implant placement. Damage to the nerve must be avoided at all costs, as it provides sensory innervation not only to the teeth in this region but, most importantly, to the lower lip and chin on that side. Any hypoesthesia, anesthesia or paresthesia that results if this nerve is damaged is extremely uncomfortable for the patient and represents a serious iatrogenic complication. A distance of 2 mm from the nerve should generally be maintained as a safety margin when planning implants.

The transverse configuration of the residual ridge is also of key significance. On the one hand, the transverse bone supply needs to be adequate if additional augmentative measures are not to be performed; and, on the other, the implant surgeon has to take into account the frequently very pronounced lingual undercuts and retractions of the residual ridge, particularly at the distal end. The vertical bone supply and the course of the inferior alveolar nerve can be very readily determined with a panoramic radiograph, especially if taken using a measuring template with incorporated titanium sleeves. However, this radiograph provides no information about the transverse bone supply or the 3D configuration of the alveolar process. In addition to clinical examination by palpation, which becomes progressively more difficult and more uncomfortable for the patient in the more distal regions, diagnostic CT or CBCT imaging combined with special implant planning software (eg, SimPlant) facilitates precise preoperative planning.

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Typical treatment course

Fixed bridges for prosthetic restoration of the entire mandible

Baseline situation

The 65-year-old man with an edentulous mandible wanted full rehabilitation of his mandibular dental arch including the molars (Fig 3-20a). The preoperative clinical and radiological diagnostic investigations showed a primarily adequate bone supply, which also extended to the posterior mandible, so the plan was to fit him with fixed implant bridges on nine implants.

Diagnostic tools

- Clinical examination
- Panoramic radiograph with template
- Dental cast analysis

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Treatment plan

1. Insertion of nine implants and augmentation
2. Secondary exposure
3. Screw-retained, metal-ceramic implant bridges



Fig 3-20a Baseline situation: edentulous mandible.

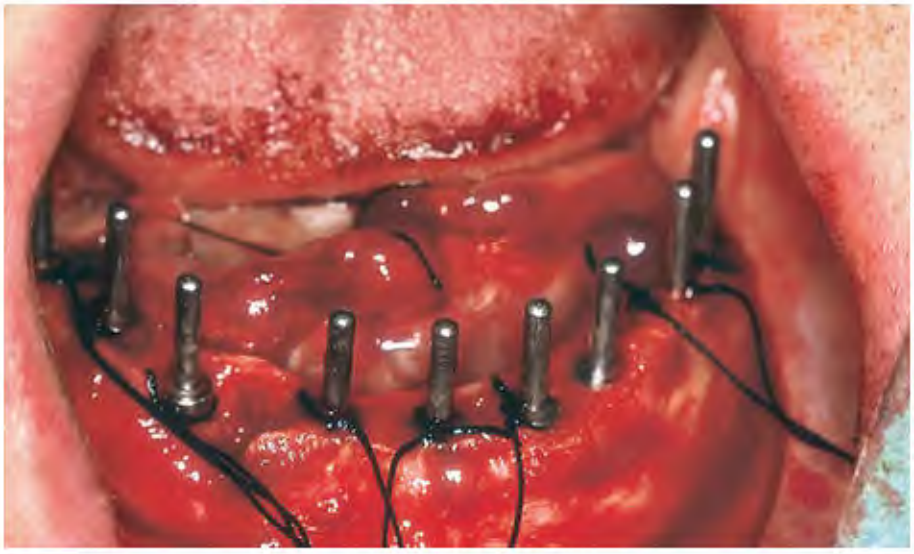


Fig 3-20b Checking the nine implant beds with direction indicators.

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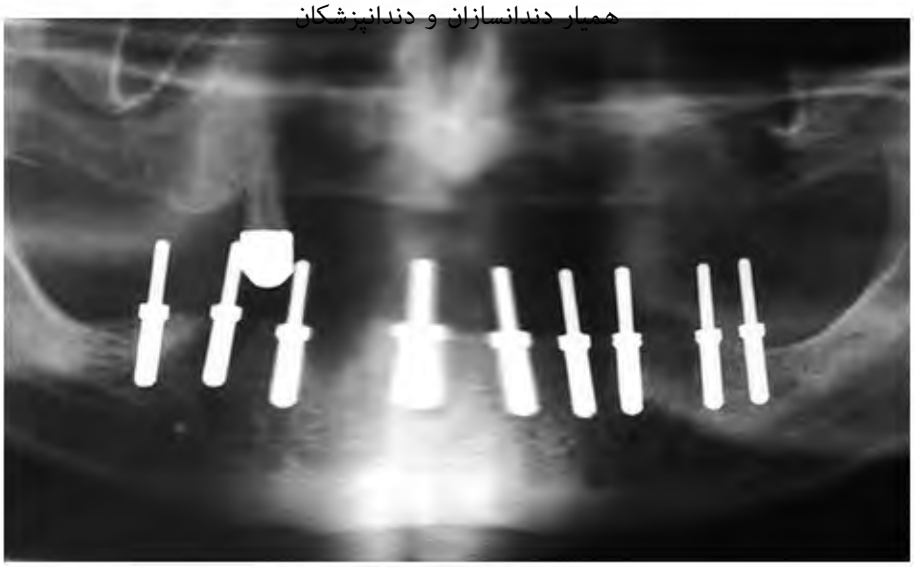


Fig 3-20c Intraoperative check radiograph.

Implant placement

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After the incision, five implant beds were prepared in the interforaminal region, along with two on each side at the distal ends (Fig 3-20b). To be on the safe side, an intraoperative radiograph was taken with direction indicators in situ, to check the positions of the implants and, above all, their distance from the inferior alveolar nerve (Fig 3-20c). Regular platform implants (18 mm long) were placed in the interforaminal region, while 8.5- and 10-mm long wide platform implants were inserted at the sides (Fig 3-20d). The existing bone defects were augmented directly after insertion. A Bio-Gide membrane was used in region 43 to stabilize the augmentation and as a guided bone regeneration barrier (Fig 3-20e). The postoperative panoramic radiograph shows the uniformly spaced implants, placed at a sufficient distance from the mandibular canal (Fig 3-20f).

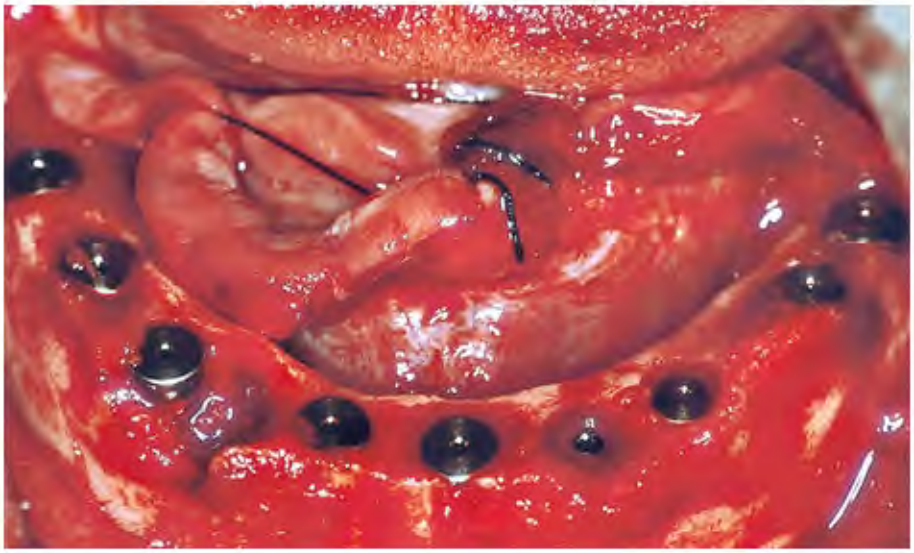


Fig 3-20d Inserted implants.

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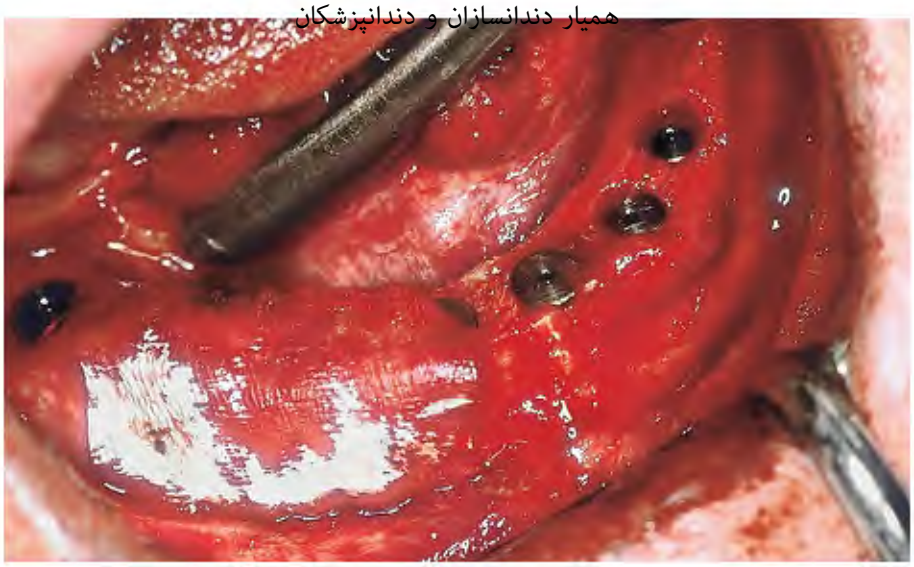


Fig 3-20e Augmentation covered with a membrane.

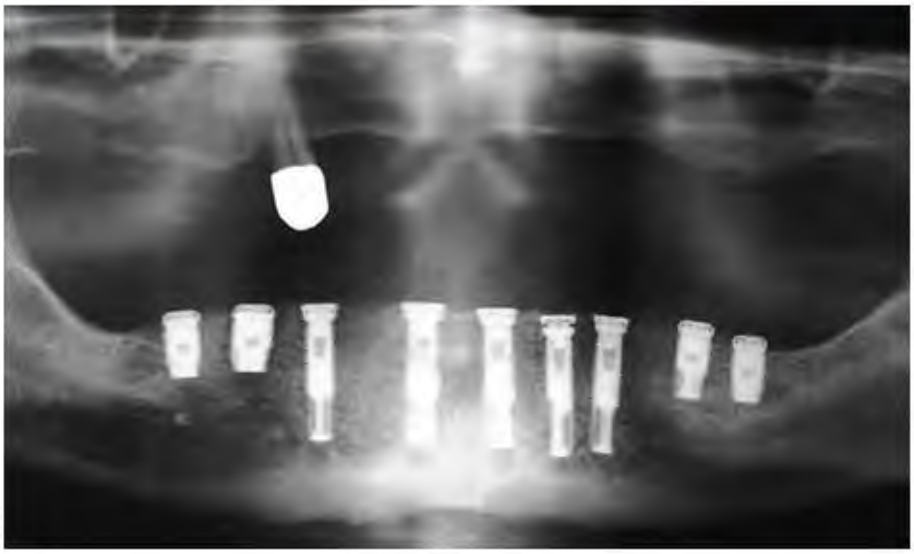


Fig 3-20f Postoperative radiograph.

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Attention: ***To be on the safe side, the position of the implant beds relative to important anatomical structures (eg, the inferior alveolar nerve) can be determined with an intraoperative radiograph (see Fig 3-20c). After this radiograph check, any necessary corrections regarding alignment and insertion depth can be made with greater precision, thus making optimal use of the available bone supply.***

Exposure and prosthetic restoration

Five months were factored in to allow the implants to heal (Fig 3-20g). In the exposure phase, the cover screws were removed and healing abutments screwed into place (Fig 3-20h). The definitive prosthetic restoration consisted of three metal bridges faced with ceramic, each screwed onto three implants. The final photograph shows the clinical situation 10 years following incorporation of the fixed restoration (Fig 3-20i).

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Fig 3-20g Situation prior to exposure.



Fig 3-20h Healing abutments screwed into place.



Fig 3-20i Three definitive metal-ceramic bridges.

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Treatment course

- Implant placement (1996)
- 5 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Eberhard Helbig

Typical treatment course

Immediate mandibular prosthetic restoration loaded onto provisional implants

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Baseline situation

This 51-year-old man with a dentition requiring urgent attention had delayed the necessary dental treatment for a long time (Figs 3-21a to 3-21d). Since the patient adamantly refused to have a removable denture, the only treatment option for him was an implant-supported dental prosthesis. The plan was to fit him with a fixed implant bridge on eight implants as the definitive restoration. An interim restoration loaded onto provisional implants was planned to ensure he also had a fixed prosthesis during the healing phase.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Insertion of eight definitive implants and immediate interim prosthesis loaded onto provisional implants
2. Secondary exposure

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3. Screw-retained, metal-ceramic implant bridge



Fig 3-21a Clinical baseline situation.

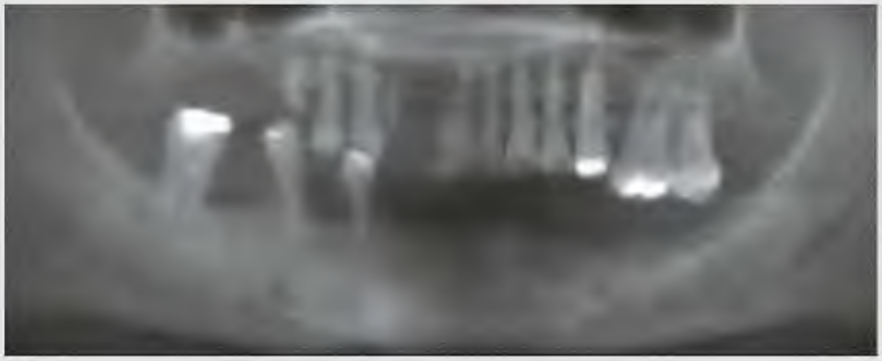


Fig 3-21b Panoramic radiograph. Non-preservable residual teeth in the maxilla and mandible.



Fig 3-21c 3D reconstruction. Frontal view.

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Fig 3-21d 3D reconstruction. Side view from the right.

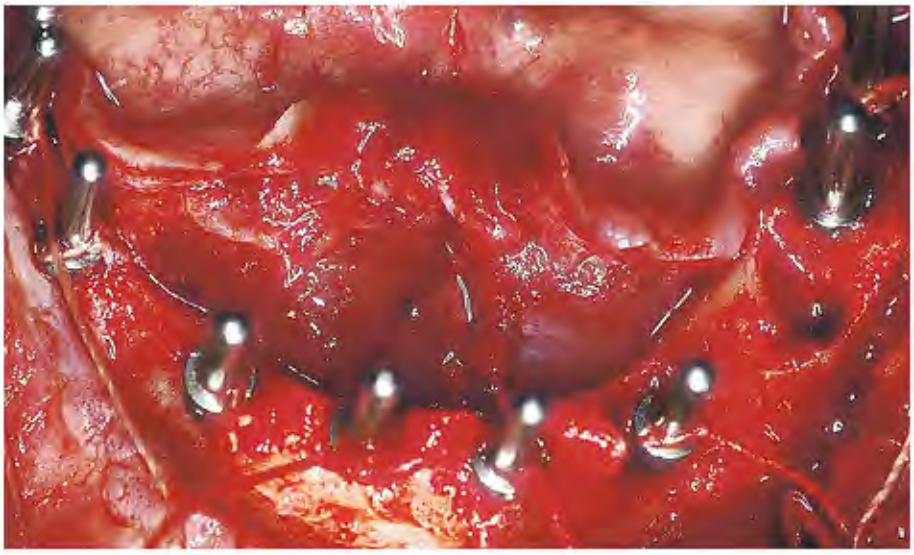


Fig 3-21e Checking the eight implant beds with direction indicators.

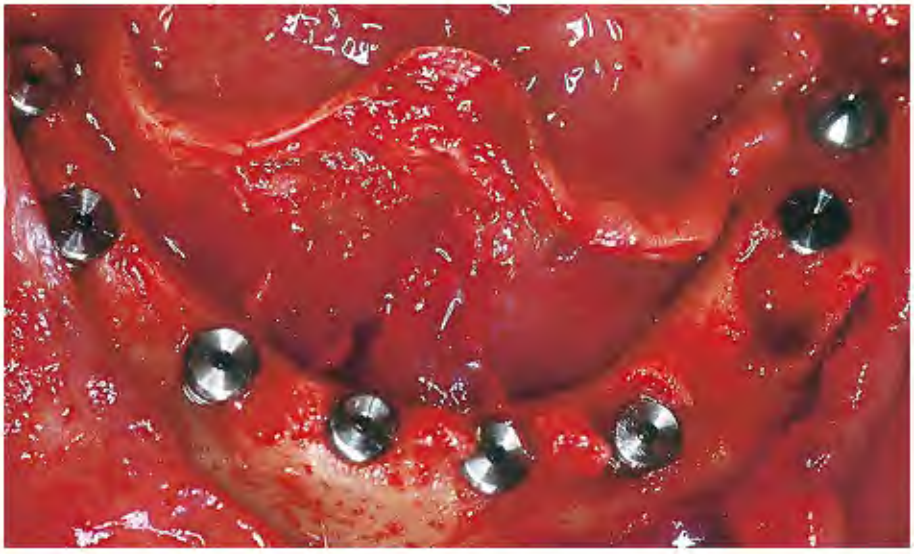


Fig 3-21f The definitive Brånemark implants have been inserted.

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Fig 3-21g The Immediate Provisional Implants (IPIs) have been inserted.

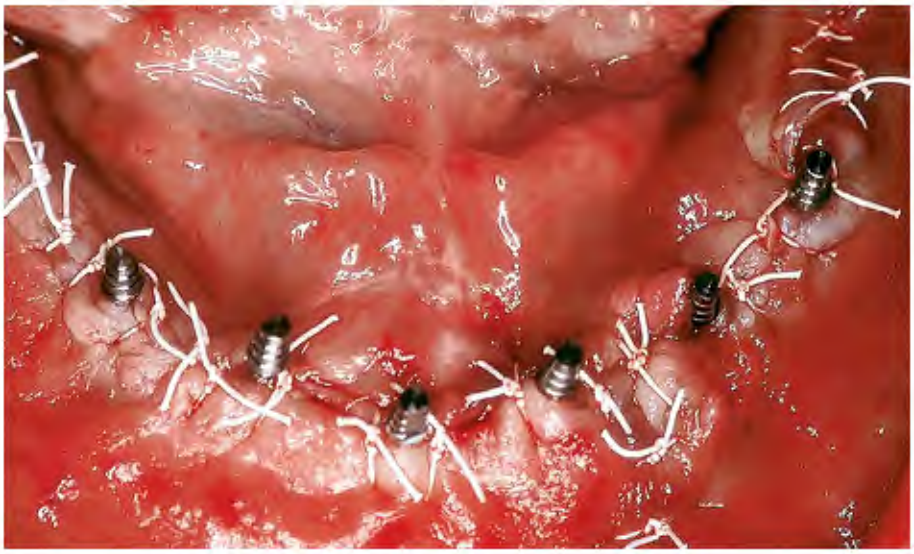


Fig 3-21h Tightly sutured wound.



Fig 3-21i Incorporated long-term provisional restoration.

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Extraction and implant placement

Eight implant beds were prepared in the mandible directly after the extraction (Fig 3-21e). Four implants were inserted in the interforaminal region, with two implants each in the posterior regions (Fig 3-21f). Six Immediate Provisional Implants (IPIs; Nobel Biocare) were placed between the permanent implants to ensure that the patient could have a fixed interim denture allowing undisturbed healing of the definitive implants (Fig 3-21g). The wound was tightly sutured and the provisional implants parallelized relative to one another (Fig 3-21h). After the quick immediate provisional restoration was made, an impression of the provisional implants was taken, allowing the long-term provisional prosthesis, fabricated by the laboratory in the interim, to be fitted when the patient returned to have his sutures removed (Fig 3-21i).

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Fig 3-21j Exposing the implants.



Fig 3-21k The long-term provisional has been ground down at the base.

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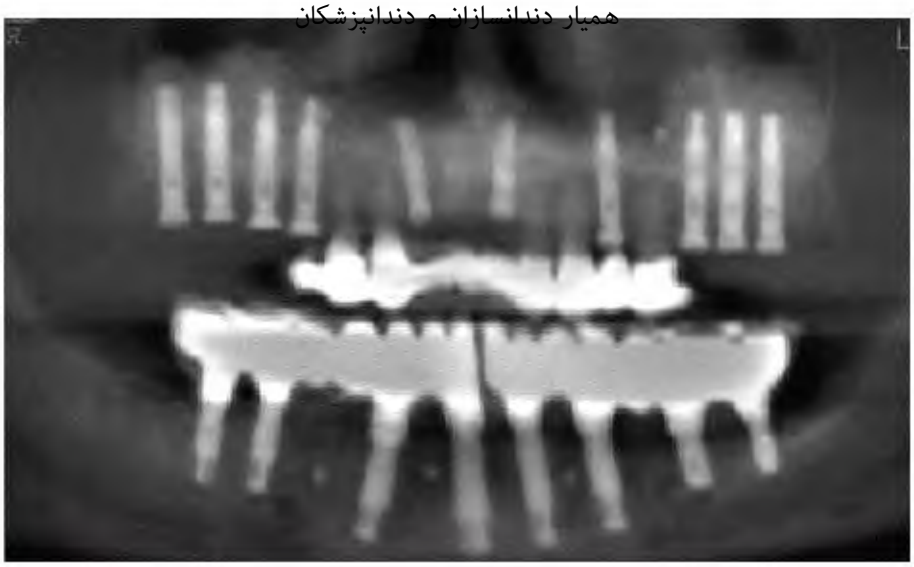


Fig 3-21l Follow-up radiograph following fabrication of the implant bridge.



Fig 3-21m Final photograph of the mandibular restoration.

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Exposure and prosthetic loading

After 5 months, the permanent implants were exposed and healing abutments screwed on (Fig 3-21j). The long-term provisional denture was ground down at the base, so that it could still be worn without colliding with the healing abutments (Fig 3-21k). The impression was taken and the definitive metal-ceramic fixed bridge fabricated. The superstructure, which spanned the regions of teeth 37 to 47, was constructed in two halves, each half supported by four implants and retained with transocclusal screws. The prosthetic restoration of the mandible was completed around the time of insertion with 10 Brånemark System implants in the maxilla (with bilateral sinus elevation). The correct, snug fit of the superstructure was checked radiologically following insertion (Fig 3-21l). The final photograph shows the clinical situation after completion of the mandibular restoration and before exposure of the implants in the maxilla (Fig 3-21m).

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Treatment course

- Implant placement and immediate loading of a prosthesis on provisional implants (2002)
- 5 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Atypical treatment course – problematic baseline situation

Fixed immediate prosthesis following extensive dental treatment and augmentation

Baseline situation

A male patient's extensive mandibular prosthetic restoration required attention due to the loosening of the abutment teeth. The existing three bridges could no longer be preserved because of severe periodontal damage affecting the abutment teeth (Figs 3-22a to 3-22e). The aim of the treatment was to fit the patient with a purely implant-supported, fixed reconstruction. To keep the number of treatment steps to a minimum, the plan was to perform the surgical dental treatment and implant placement under general anesthetic in a single session. Moreover, the patient refused to have a removable provisional restoration even during the implant healing phase, so that provisional implants were to be inserted and loaded with a fixed interim prosthetic restoration.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

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Treatment plan

1. Insertion of eight definitive implants and augmentation, immediate interim restoration on provisional implants
2. Secondary exposure
3. Cement-retained, metal-ceramic fixed implant bridge on customized abutments



Fig 3-22a Non-preservable residual teeth in the mandible.

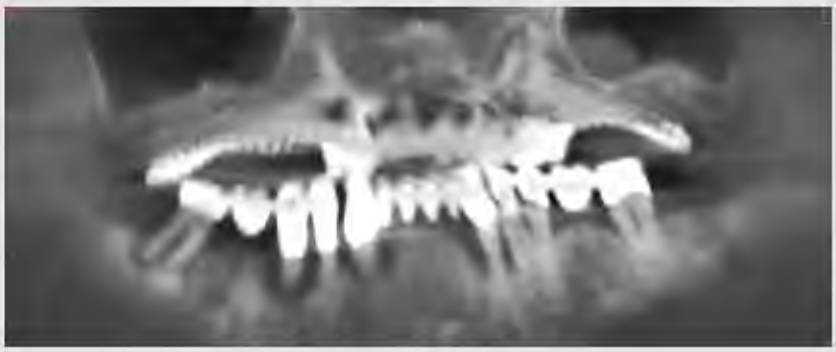


Fig 3-22b Radiological baseline situation – panoramic view.

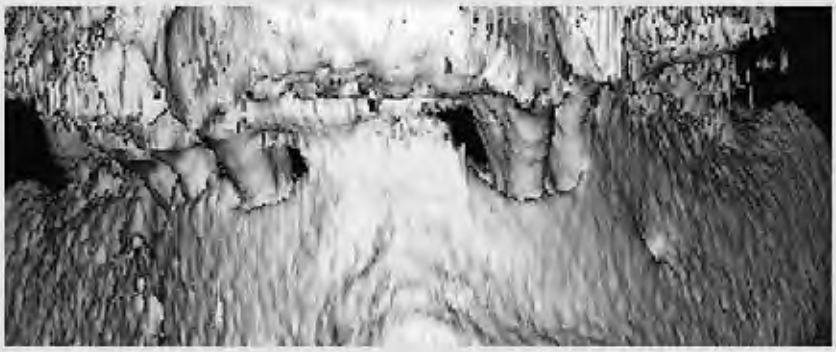


Fig 3-22c 3D reconstruction – frontal view.

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Fig 3-22d Side view, right side.

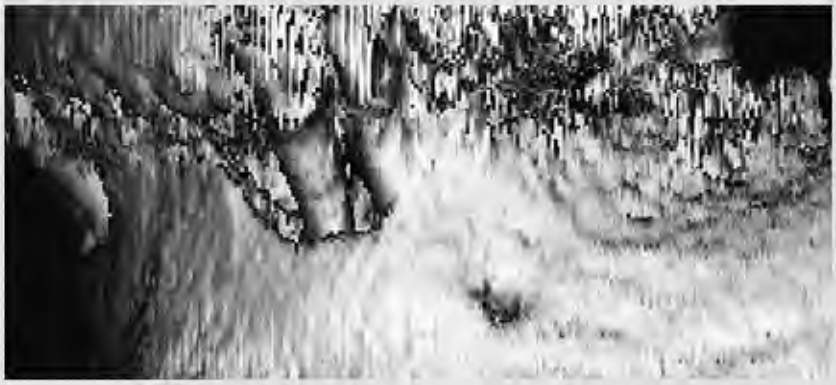


Fig 3-22e Side view, left side.

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Fig 3-22f Mandible following the necessary dental treatment with tooth 35 initially left in place.

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Fig 3-22g Definitive Brånemark implants inserted according to the prosthetic requirements.

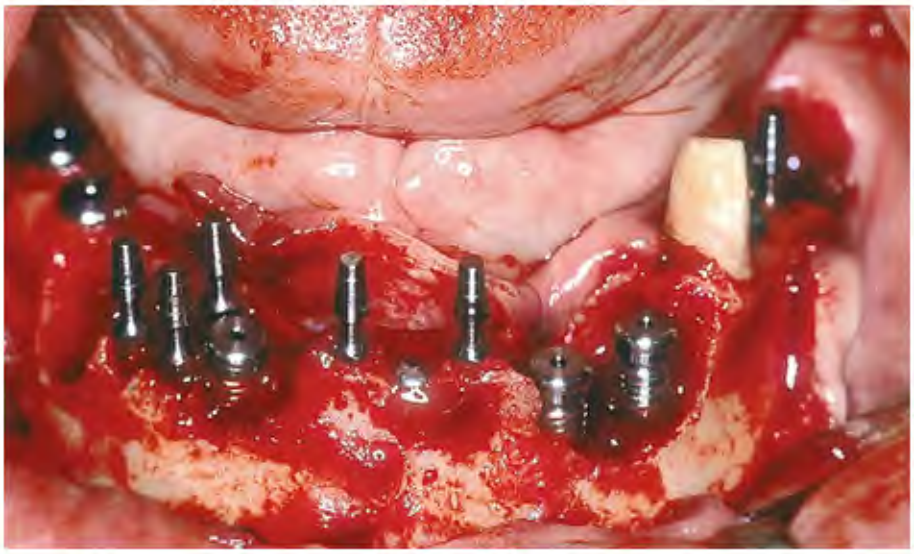


Fig 3-22h Inserted provisional implants.

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Dental treatment and implant placement

Removal of the fixed partial dentures showed that only tooth 35 was still stable and could be used as a retention element for a provisional restoration (Fig 3-22f). In spite of extensive bone defects, the local bone supply was still sufficient for the placement of eight definitive implants. Four definitive implants were inserted in the interforaminal region, with two on each side in the molar region (Fig 3-22g). The bone areas that were still intact and not affected by resorption were used to anchor the provisional IPIs (Fig 3-22h).

Augmentation

On the right side, there were two extensive defects in the region of former abutment teeth 43

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and 45 (Fig 3-22i and compare with Fig 3-22g). All the defects were filled with a mixture of harvested bone chips and the regenerative alloplastic bone substitute Cerasorb (curasan) and covered with Bio-Gide resorbable collagen membranes (Fig 3-22j). The membranes were attached to the residual ridge with titanium pins (Fig 3-22k). To enable tension-free wound closure over the augmented areas, the mucoperiosteal flap was mobilized by periosteal slitting, followed by saliva-tight wound closure with Gore-Tex sutures (Fig 3-22l).

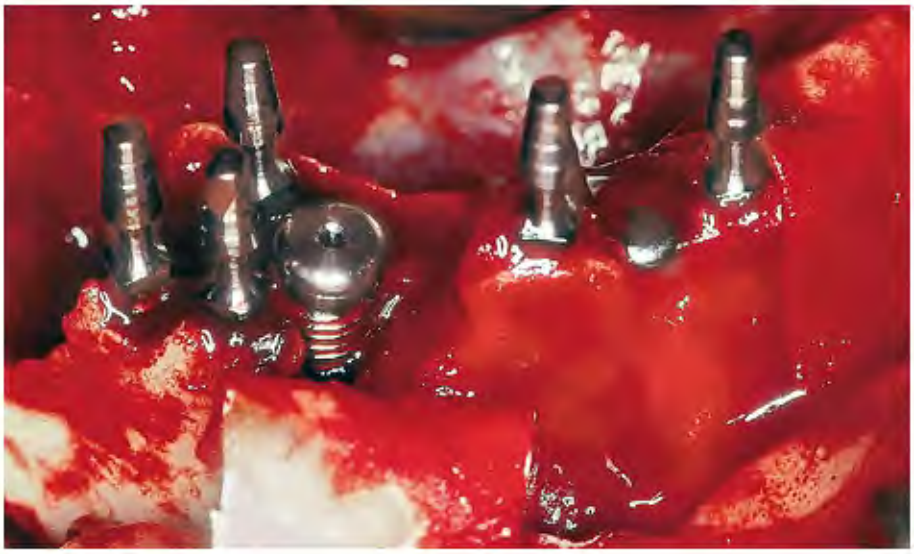


Fig 3-22i Bone defects prior to augmentation.



Fig 3-22j Augmentation with bone chips and Cerasorb.

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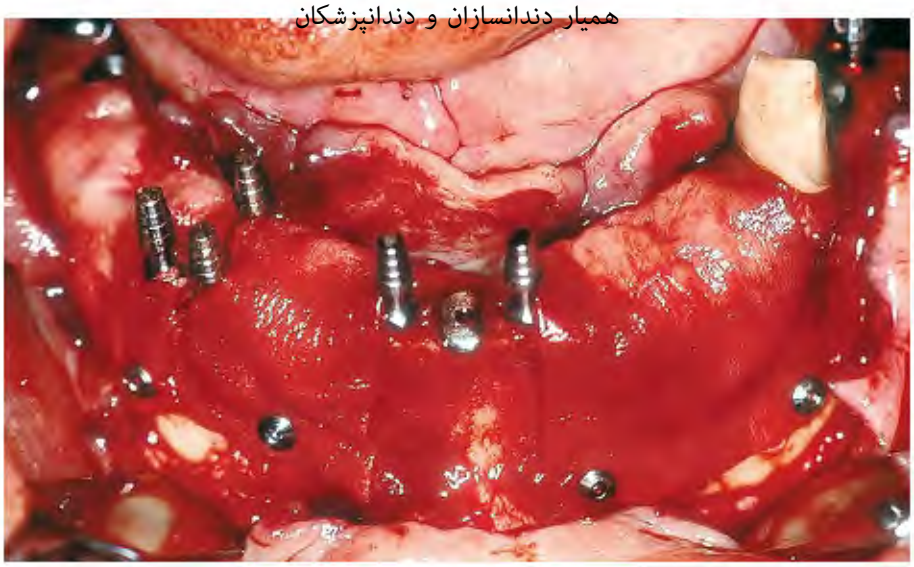


Fig 3-22k Bio-Gide membranes attached with pins.

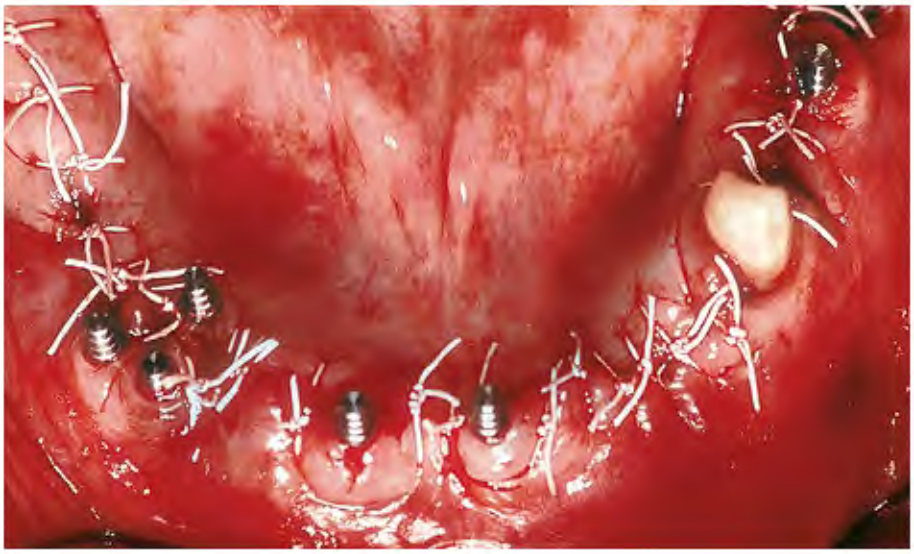


Fig 3-22l Saliva-proof wound suturing.



Fig 3-22m Immediate provisional restoration.

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Fig 3-22n Long-term provisional.

Provisional restoration

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The six IPIs needed to be aligned parallel to tooth 35 to ensure the same direction of insertion for the provisional fixed partial denture. The surgical procedure ended with impression taking and an interocclusal record for a laboratory-fabricated long-term provisional and the fabrication of the first immediate provisional (Fig 3-22m). When the patient came in for removal of the sutures, the immediate provisional was switched for a long-term one made in the laboratory. Due to the extensive augmentation, the healing time was approximately 6 months, during which the long-term provisional restoration was not removed (Fig 3-22n).

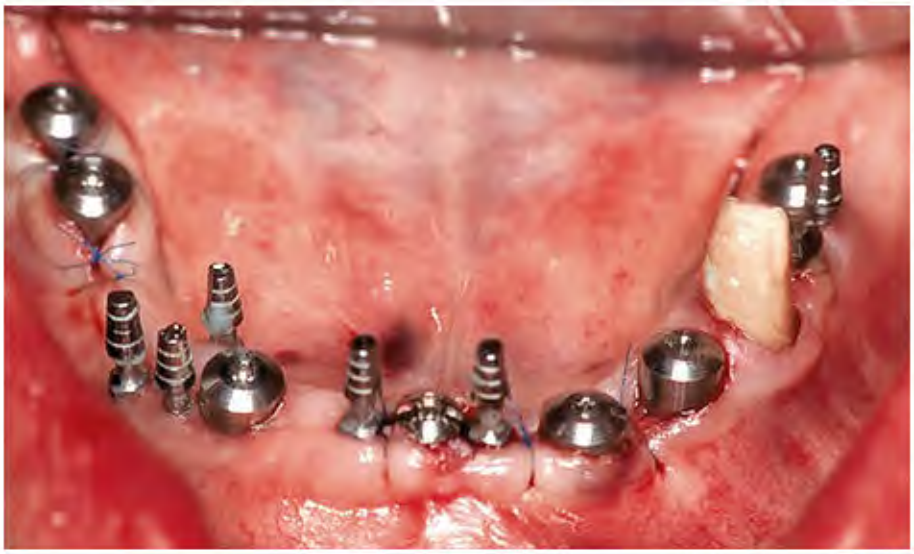


Fig 3-22o Healing abutments fitted following exposure.

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Fig 3-22p Radiological check of the fit of the customized abutments.



Fig 3-22q Labial/buccal view of the incorporated metal-ceramic fixed restoration.



Fig 3-22r Satisfied patient after the treatment.

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Exposure and prosthetic restoration

In the exposure operation, healing abutments were screwed onto the definitive implants (Fig 3-22o). After some minor adjustments to its underside, the provisional was reinserted and worn until the definitive one was fabricated. To ensure a continuous fixed prosthetic restoration for the patient, the provisional implants were removed by unscrewing only once the definitive bridge was fabricated. A cement-retained fixed restoration, divided between teeth 31 and 32, was planned as the definitive prosthesis. Before it was inserted, the snug fit of the cementing posts was double-checked by means of a panoramic radiograph (Fig 3-22p). A small gap was left between the lower edge of the restoration and the residual ridge to allow access for cleaning (Fig 3-22q). The patient feels much more confident following treatment completion (Fig 3-22r).

Treatment course

- Implant placement, augmentation and immediate loading (2002)
- 6 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Fernando Abrantes

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Atypical treatment course – problematic baseline situation

Selective extractions for the optimal positioning of definitive implants

Baseline situation

To date, this 40-year-old man, whose residual maxillary and mandibular dentition requires urgent attention (Fig 3-23a), has been unable to make up his mind to have dental treatment for two important reasons. Firstly, he suffers from a general dental phobia and, secondly, the only previous treatment recommendation he had been offered was removal of all the teeth from the maxilla and mandible and the fitting of full dentures. However, the

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patient categorically refused to be toothless, even for a temporary period. Thus, the treatment concept needs to be designed with the aim of providing the patient with a fixed restoration throughout the whole treatment phase. Initially, the purpose of the precise clinical and radiologic diagnostic investigations was to evaluate the value of the residual teeth as retaining elements for a provisional restoration until the whole treatment was completed (Figs 3-23b to 3-23e).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Selective extractions, immediate implant placement in the anterior region, provisional implants with immediate loading
2. Delayed implant placement in the posterior mandible
3. Secondary exposure
4. Cement-retained and lingual screw-retained, implant-supported fixed bridges



Fig 3-23a Clinical baseline situation. Dentition requiring dental treatment.

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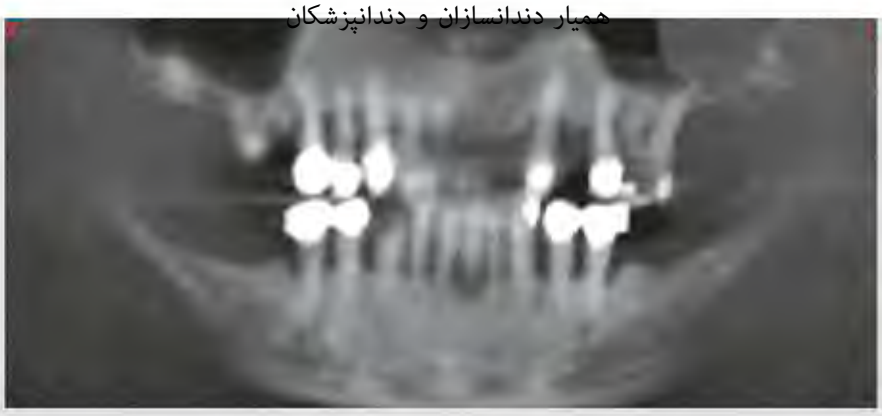


Fig 3-23b CBCT panoramic view.

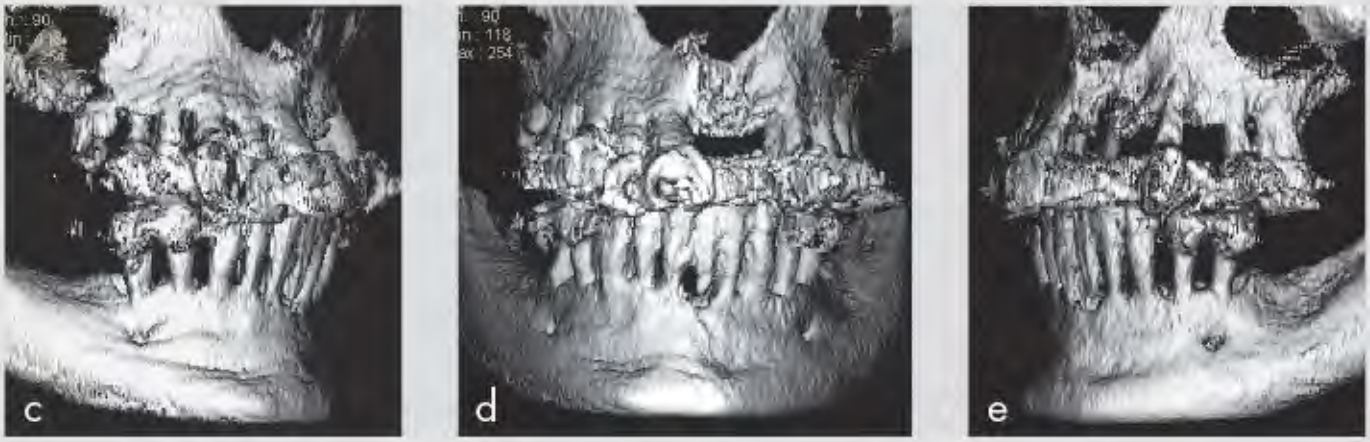


Fig 3-23c to e 3D reconstructions. (c) View from the right; (d) frontal view; and (e) view from the left.

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Fig 3-23f Mandible before the extractions.

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Fig 3-23g A few teeth have been left in place temporarily.

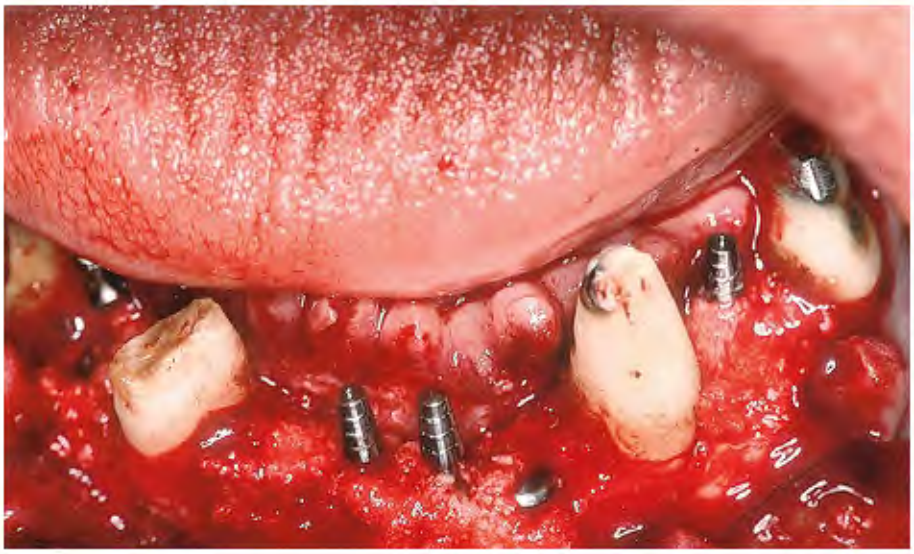


Fig 3-23h Insertion of four definitive Brånemark System implants and four provisional implants in the anterior mandible.



Fig 3-23i Postoperative radiograph after the implant placement.

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Extractions, implant placement and augmentation

Initially, teeth 35, 33 and 43, 45 were to be left in place in the mandible so that they could be used as retaining elements for a provisional restoration, while not standing in the way of strategic and prosthetically optimal implant placement (Fig 3-23f). If the patient was to be fitted with a fixed provisional restoration, it was still necessary to insert additional interim implants to cover the osseous integration phase of the definitive implants. The first step in the operation, performed under general anesthesia with intubation, was to take out the fixed partial dentures and extract the non-preservable teeth (Fig 3-23g). Meticulous removal of the granulation tissue was followed by the interforaminal placement of the permanent Brånemark System implants in regions 32, 34 and 42, 44, in accordance with the prosthetic requirements. After this, the local bone supply was utilized for the placement of four further provisional IPIs to provide additional stabilization for the provisional restoration (Fig 3-23h). Smaller defects were filled with the harvested bone chips. Following wound closure in the mandible, the non-preservable teeth were removed from the maxilla; bilateral sinus elevation procedures were performed during the same operation (Fig 3-23i). To enable a provisional to be fitted in the maxilla as well, six IPIs were inserted here analogously to the concept employed for the mandible. Immediate provisional prostheses were fabricated for both jaws.

Long-term provisional

Approximately 10 days postoperatively, at the time of suture removal (Fig 3-23j), the metal-reinforced fixed provisionals, fabricated in the laboratory according to the postoperative impression, were incorporated into the patient's mouth (Fig 3-23k). The fixed, esthetic interim prosthesis supported on the provisional implants and the residual teeth left in situ assured an undisturbed wait while the 9-month bone consolidation of the sinus augmentations took place (Fig 3-23l).

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Fig 3-23j Clinical situation at the time of suture removal.



Fig 3-23k Long-term provisional in the mandible.



Fig 3-23l Situation after 9 months with the long-term provisional.

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Fig 3-23m Clinical situation following removal of the provisionals.

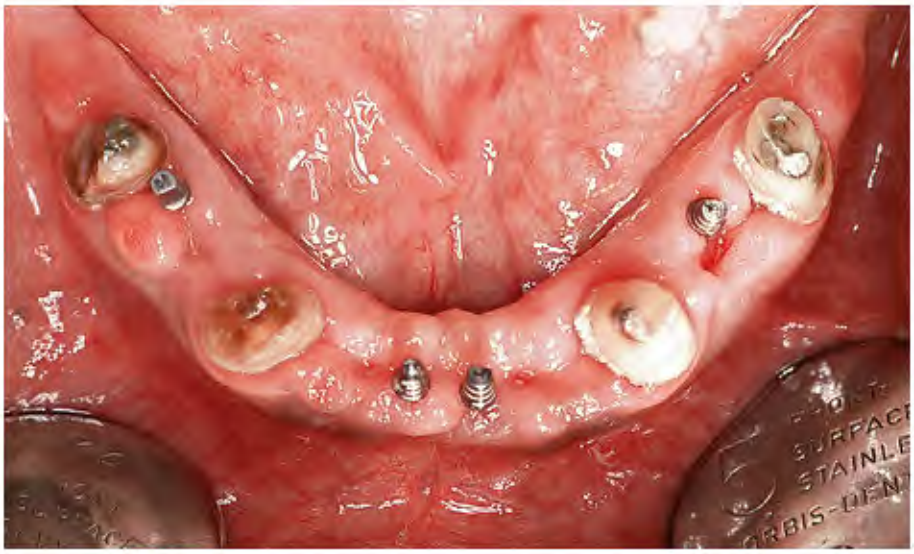


Fig 3-23n Provisional abutments in the mandible.

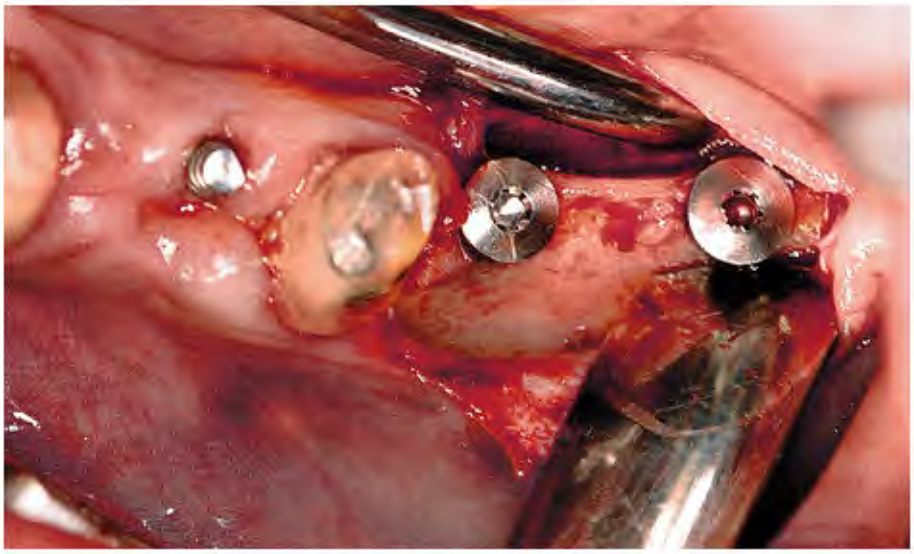


Fig 3-23o Two Neoss implants in regions 36 and 37 following insertion.

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In the second operation, which took place after 9 months, the fixed provisionals in the maxilla and mandible were first removed and the stability of the provisional implants was checked (Fig 3-23m). The actual implant placement of the definitive implants was performed quadrant by quadrant in a single session, starting in the maxilla with the insertion of 10 Neoss implants. Once the implants were placed in the maxilla, implant placement was continued in the mandible (Fig 3-23n). The insertion of two Neoss implants on each side also took place quadrant by quadrant (Figs 3-23o and 3-23p). It was not necessary to reopen the interforaminal region, as the definitive implants had already been inserted here in the first operation. Saliva-tight wound closure was followed by reincorporation of the provisionals, to ensure that the patient could continue using it during the 6-month healing phase.

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Fig 3-23p Two Neoss implants were inserted into regions 46 and 47.

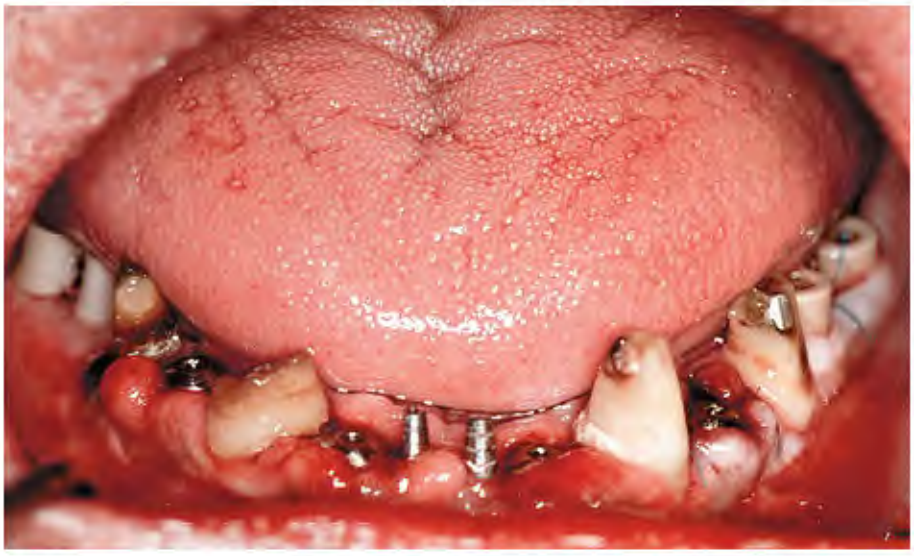


Fig 3-23q Exposure of the mandibular implants.

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Fig 3-23r Panoramic radiograph following exposure.

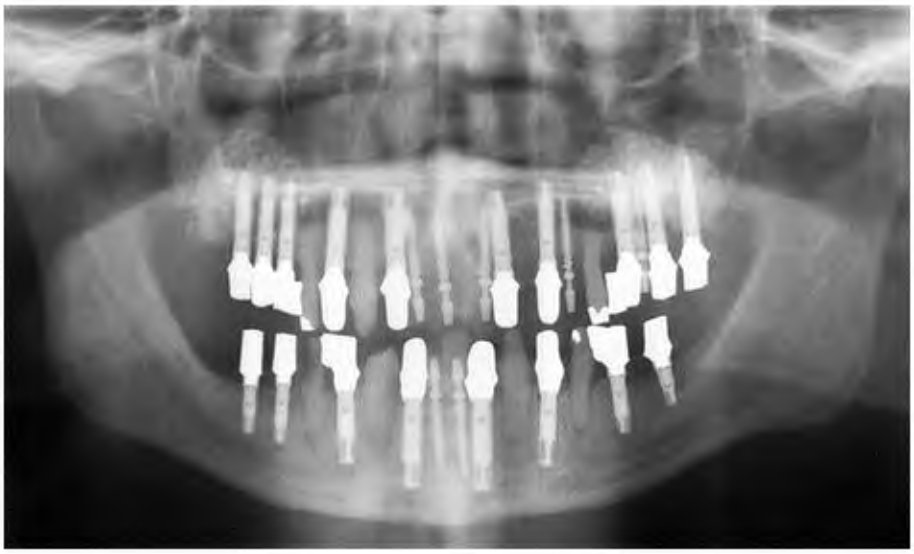


Fig 3-23s Radiologic check of the positions of the customized abutments.

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Exposure

The exposure of the implants took place after 6 months, starting in the mandible by means of a crestal incision over the implants. Titanium healing abutments were screwed onto the four Brånemark implants in the anterior region, while plastic abutments made of polyetheretherketone (PEEK) were screwed onto the four posterior Neoss implants (Fig 3-23q). In this case, two different implant systems were used in one patient's jaw, but the compatibility of their components ensures that the Neoss and Brånemark systems can be combined without any problems. After this, the maxillary implants were also exposed by means of a residual ridge incision made over the implantation sites and the PEEK healing abutments were fitted (Fig 3-23r).

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Prosthetic restoration

The impression for the definitive prosthesis was taken once the peri-implant soft tissues had healed completely. Prostheses were fitted in both jaws at the same time, as this was easier with the design of the occlusal surfaces. Impression taking with custom trays was followed by the construction of the definitive casts, with customized gold abutments fabricated for all 18 implants using the cast coping technique (Fig 3-23s). To allow the frameworks to be tried in before making the definitive restoration, it was necessary to incorporate spaces for the provisional implants and for the natural teeth that would no longer be included in the definitive prosthetic restoration. As a way of eliminating impression and cast inaccuracies, electroplated gold caps were fabricated to fit onto the customized primary components and cemented into the bridge framework inside the mouth. This guaranteed the totally passive fit of the partial denture structure. Immediately before the completed restorations were incorporated into the maxilla and mandible, the provisional implants and remaining teeth were removed and the bridges cemented together inside the mouth (Fig 3-23t). The restorations were placed onto the primary components and stabilized against unwanted transverse loosening with mini-screws inserted from the lingual and palatal side respectively, so that no screw access holes were visible on the occlusal surfaces (Fig 3-23u).

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Fig 3-23t Metal-ceramic fixed implant bridges in both maxilla and mandible directly following incorporation.

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Fig 3-23u Divided fixed restoration replacing teeth 37 to 47 on eight implants.



Fig 3-23v Clinical situation after 1 year.



Fig 3-23w The patient's smile.

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Direct comparison between the baseline situation and the final results indicates not only a better dentition but, above all, an improvement in the patient's quality of life (compare Figs 3-23a and 3-23t). One year after the fitting, the clinical situation appears stable (Fig 3-23v). The secure fit and the successful esthetic result made the patient smile in delight at his new prosthesis, saying "This has been the best investment of my life so far" (Fig 3-23w).

Treatment course

- Implant placement, augmentation and immediate loading (2003)
- 6 (posterior region) and 15 (anterior region) months, respectively, to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Problems and complications

Premature loosening of provisional implants

Baseline situation

This male patient (strong build, more than 2 meters tall), with anterior mandibular teeth not worth preserving, wanted a new fixed prosthetic restoration in the lower jaw, and also wanted to be fitted with a fixed provisional restoration during the healing phase of the definitive implants (Figs 3-24a and 3-24b). The treatment concept envisaged a final restoration consisting of a fixed implant bridge on ten definitive implants, distributed according to static principles. An interim fixed denture on provisional implants had been planned so that he could also have a fixed restoration during the osseointegration phase.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT

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- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction of the non-preservable teeth, immediate implant placement with augmentation, provisional implants with immediate loading
2. Secondary exposure
3. Transocclusal, screw-retained Procera fixed bridge with ceramic facing



Fig 3-24a Baseline situation.



Fig 3-24b Panoramic radiograph with the planned implants.

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Extraction and implant placement

Extraction of the teeth was followed by the placement of ten implants, four at the front and three each in the molar region, distally of the foramina. A further four provisional implants were inserted in the interforaminal region (Fig 3-24c).

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The stronger K.S.I. Bauer screws were used as provisional implants in the distal region, while IPIs were used further mesially (Fig 3-24d). Following implant placement, the bone defects were filled with bone chips mixed with a bone substitute (Cerasorb; Fig 3-24e) and the wound margins tightly sutured (Fig 3-24f).

Immediate provisional loading

Prosthetic caps were placed on the IPIs and interlinked with a ligature for stabilization of the immediate provisional restoration (Fig 3-24g).



Fig 3-24c Insertion of 10 definitive Brånemark System and four provisional implants.

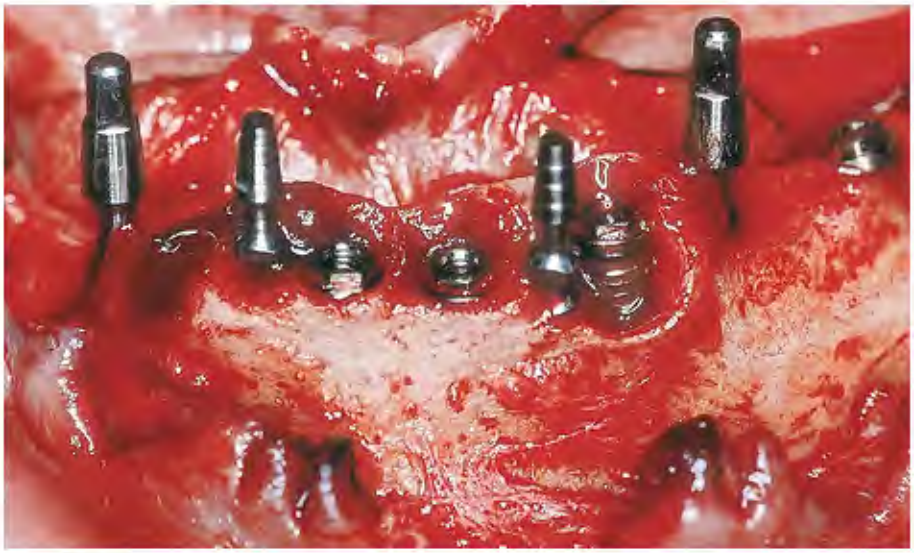


Fig 3-24d Different types of provisional implant: IPIs and K.S.I. Bauer screws.

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Fig 3-24e Augmentation.

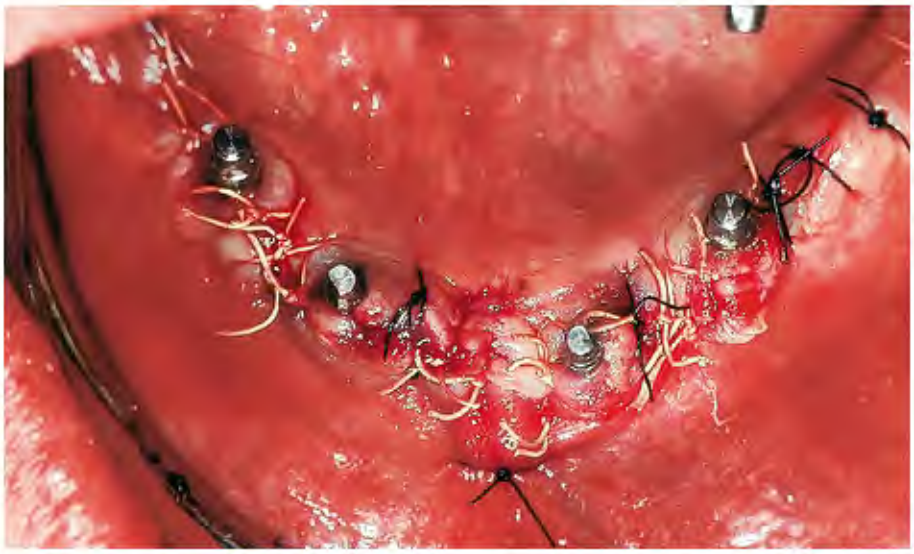


Fig 3-24f Saliva-tight wound suturing.

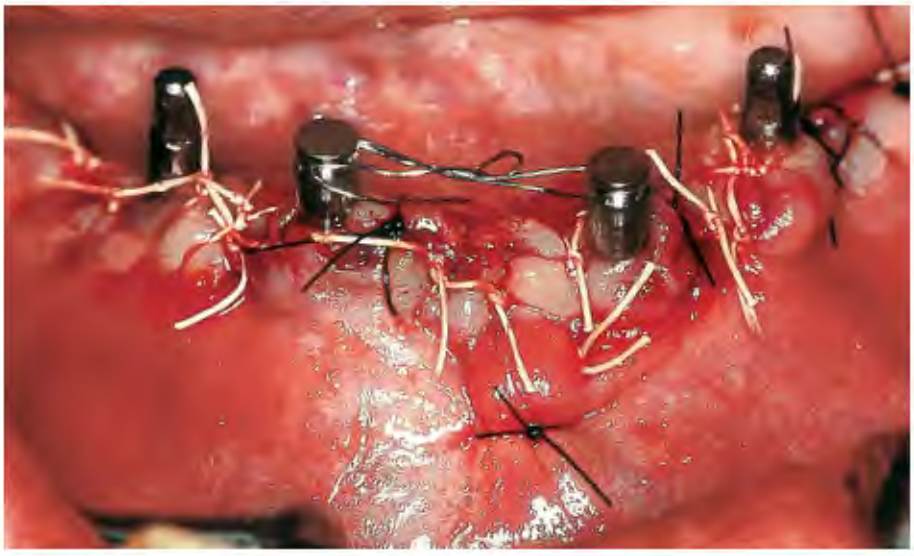


Fig 3-24g IPIs with prosthetic caps fitted into place.

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Fig 3-24h Immediate provisional restoration.

Custom-made caps were positioned onto the K.S.I. Bauer screws. A quick immediate provisional was produced with the aid of a prepared thermoplastic foil and incorporated (Fig 3-24h), then switched for a long-term provisional fabricated in the laboratory when the patient came in to have his sutures removed (Fig 3-24i). This provisional replaced only 10 teeth (35 to 45), with virtually no distal extension beyond the implants.

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Fig 3-24i Long-term provisional.

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Fig 3-24j Loosening of provisional implants 32 and 44.

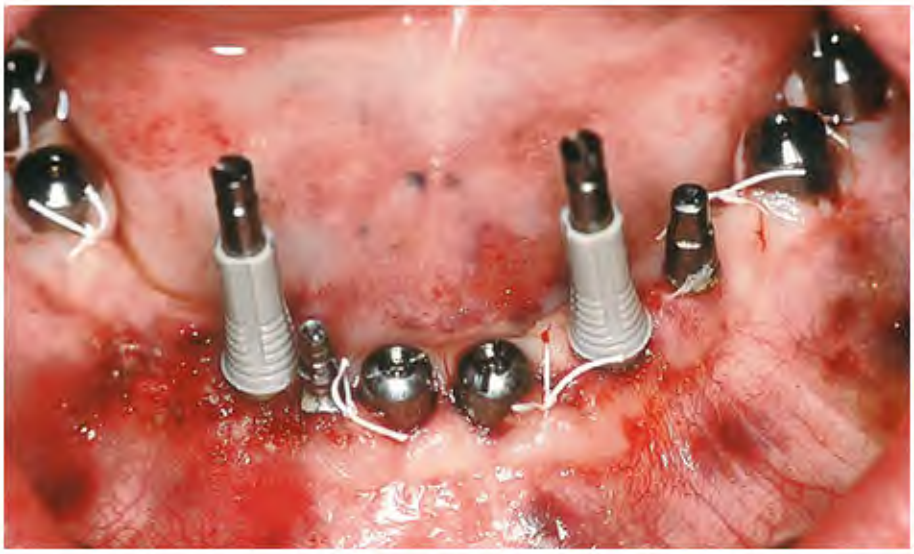


Fig 3-24k Provisional cylinders 33 and 43 being screwed into place.



Fig 3-24l Perforations in the provisional in regions 33 and 43.

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Fig 3-24m Plastic cylinders being polymerized into the long-term provisional.

Exposure and complication

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Loosening of provisional implants 32 and 44 was found at the exposure operation after 5 months, meaning that these had to be removed (Fig 3-24j). The remaining provisional implants were no longer sufficient to hold the interim fixed denture in place; therefore, two definitive implants needed to be included into the provisional restoration. To rescue the existing long-term provisional denture so that the patient could continue to use it, provisional plastic cylinders were screwed onto implants 33 and 43 (Fig 3-24k). In the laboratory, the metal-reinforced long-term provisional was hollowed out at the places marked in the mouth to ensure that the provisional would not come into contact with the cylinders when put back into place (Fig 3-24l). The remaining provisional implants ensured correct positioning of the interim denture. The plastic cylinders were then polymerized into the provisional denture inside the mouth, the denture shaped in the laboratory and then reattached to the definitive and provisional implants (Fig 3-24m).

The patient was able to wear the thus reshaped long-term provisional until the final implant superstructure was fabricated.

Prosthetic restoration

The definitive superstructure consisted of a ceramic-faced, Procera titanium fixed implant bridge extending from teeth 37 to 47 (Fig 3-24n). Seven years after the prosthetic restoration of the mandible, the clinical and radiologic situation, the latter recorded in the form of a follow-up panoramic radiograph (following the insertion of 10 Neoss implants in the maxilla reconstructed by sinus elevation), is stable (Fig 3-24o and 3-24p).

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Fig 3-24n Procera titanium fixed implant bridge from 37 to 47.



Fig 3-24o Clinical situation after 7 years of functional use.



Fig 3-24p Follow-up panoramic radiograph after 7 years.

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Treatment course

- Implant placement, augmentation and immediate loading (1999)
- 5 months to exposure
- 3 weeks to impression taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Dental Technician Olaf van Iperen

Problems and complications

Iatrogenic complication during the removal of provisional implants and peri-implantitis after 10 years of functional use

Baseline situation

This male patient, who has a denture phobia, put off the dental treatment he needed as long as possible due to the threat of toothlessness (Figs 3-25a and 3-25b). In previous consultations at another center, the treatment concept envisaged there consisted of extracting all of his teeth and initially fitting him with a removable complete denture. A decision with regard to a definitive restoration, possibly including implants, was to be made later.

However, the patient was very much against this treatment concept because of his denture phobia. The patient is a heavy smoker, smoking 30 to 40 cigarettes a day. It was therefore decided to perform the necessary dental treatment and to place the definitive implants into the mandible in a single session under general anesthesia. A fixed interim restoration was to be provided with the aid of provisional implants in the mandible and maxilla. Apart from the insertion of the provisional implants, this first session was to include bilateral sinus elevation with the autologous BioSeed (Oral Bone) graft cultivated from the patient's own bone cells.

Diagnostic tools

- Clinical examination

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- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Selective extraction of the non-preservable teeth, immediate placement of eight implants with augmentation, provisional implants with immediate loading
2. Secondary exposure
3. Cement-retained, ceramic-faced fixed implant bridge on customized abutments



Fig 3-25a Baseline situation: residual dentition requiring dental treatment.

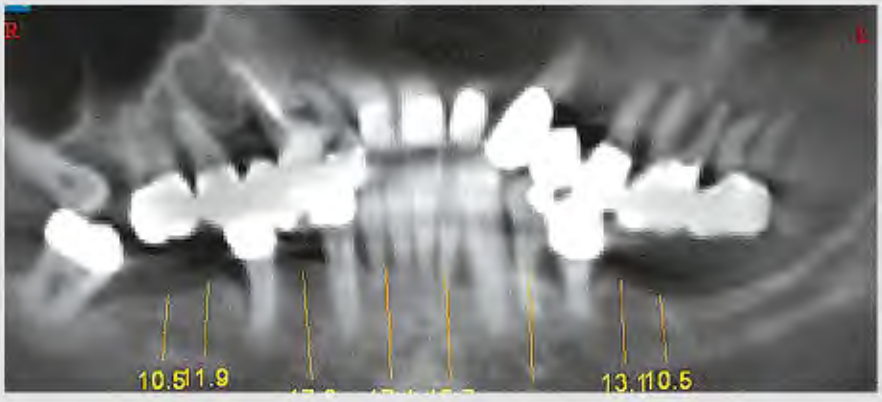


Fig 3-25b Baseline radiologic situation (CBCT panoramic view).

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Dental treatment and implant placement

Following preoperative antibiotic prophylaxis, the non-preservable mandibular teeth were all

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removed, except for the canines. Flaps were created on both the labial/buccal and lingual side, granulation tissue cleared from the extraction sockets and the implant beds prepared (Fig 3-25c). Eight permanent Brånemark implants were inserted at the planned sites and the remaining bone supply utilized for the incorporation of five provisional implants (Fig 3-25d). In regions 35 and 45, IPIs were inserted in pairs, one each on the lingual and buccal side (Fig 3-25e).

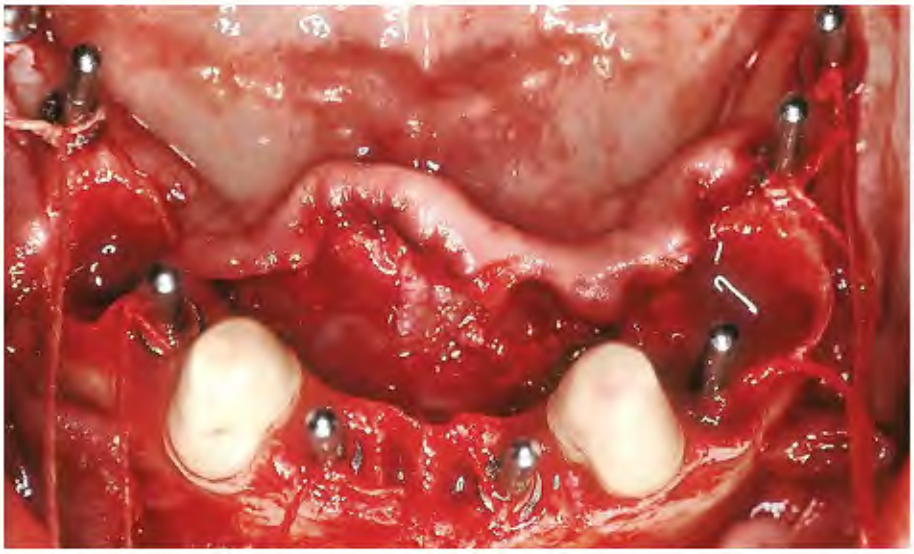


Fig 3-25c Alignment check of the eight implant beds.

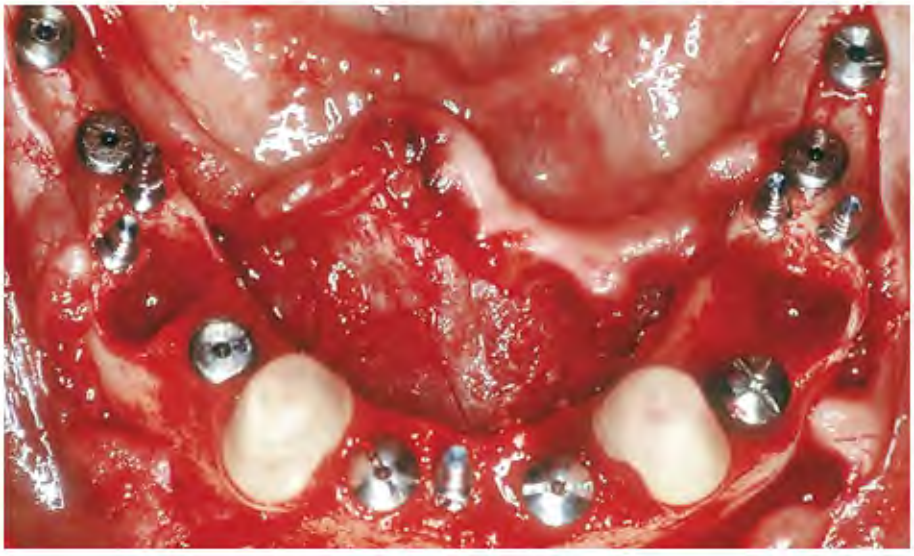


Fig 3-25d Eight definitive and five provisional implants following insertion.

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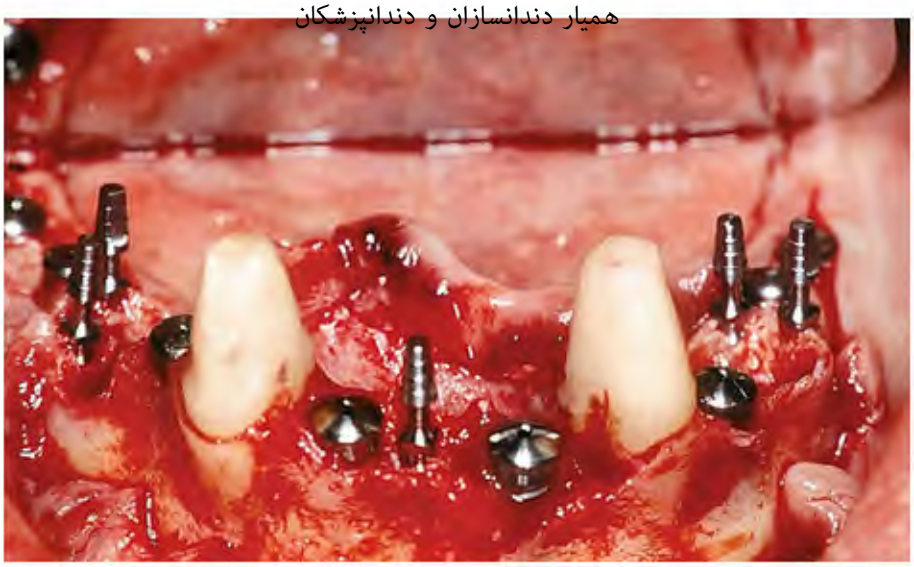


Fig 3-25e IPIs inserted in pairs in regions 35 and 45.

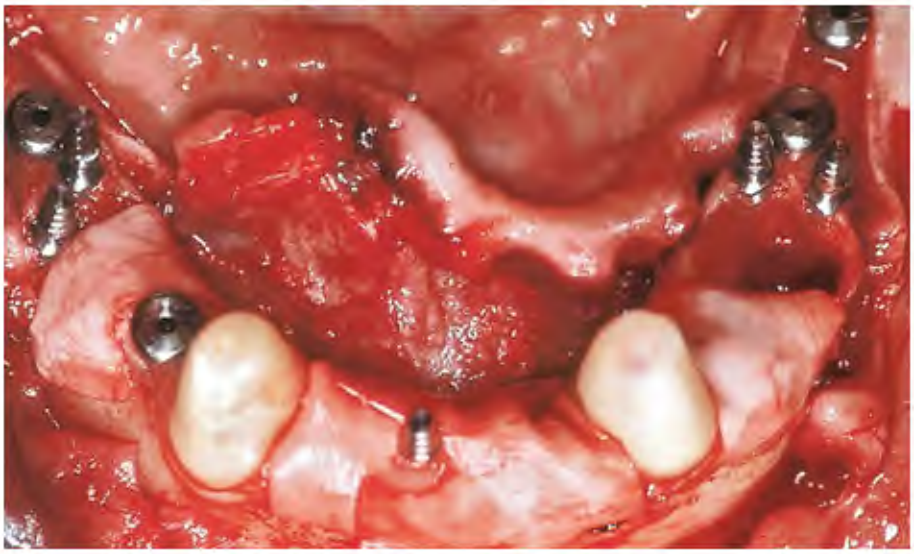


Fig 3-25f Augmentation.

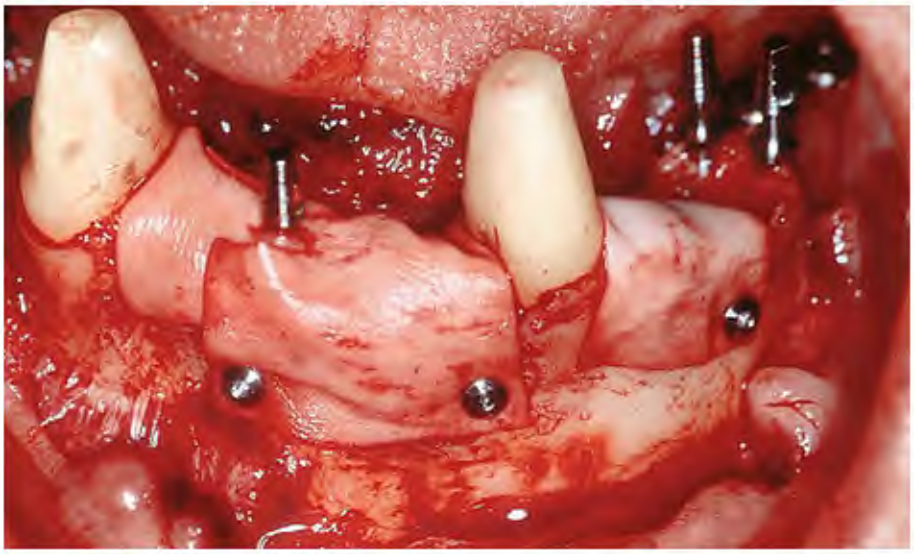


Fig 3-25g Membranes attached with titanium pins.

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The bone defects were filled with the harvested bone chips, covered with Bio-Gide membranes (Fig 3-25f) and the membranes attached with titanium pins on the labial/buccal side (Fig 3-25g). The wound margins were adapted and tightly sutured with Gore-Tex thread (Fig 3-25h). The prepared eggshell provisionals were adjusted in situ to the situation in both the mandible and maxilla, relined with self-curing polymer and incorporated immediately after the operation (Fig 3-25i). These provisionals were later switched for the metal-reinforced long-term provisionals fabricated in the laboratory (Fig 3-25j).

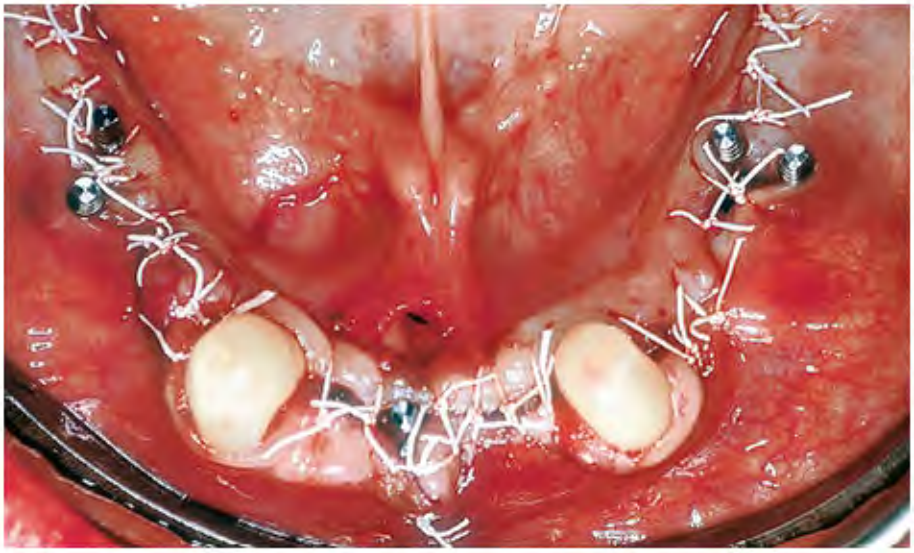


Fig 3-25h Tight suturing of the gum.



Fig 3-25i Relined eggshell provisional denture.

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Fig 3-25j Long-term provisional restoration on a metal base.

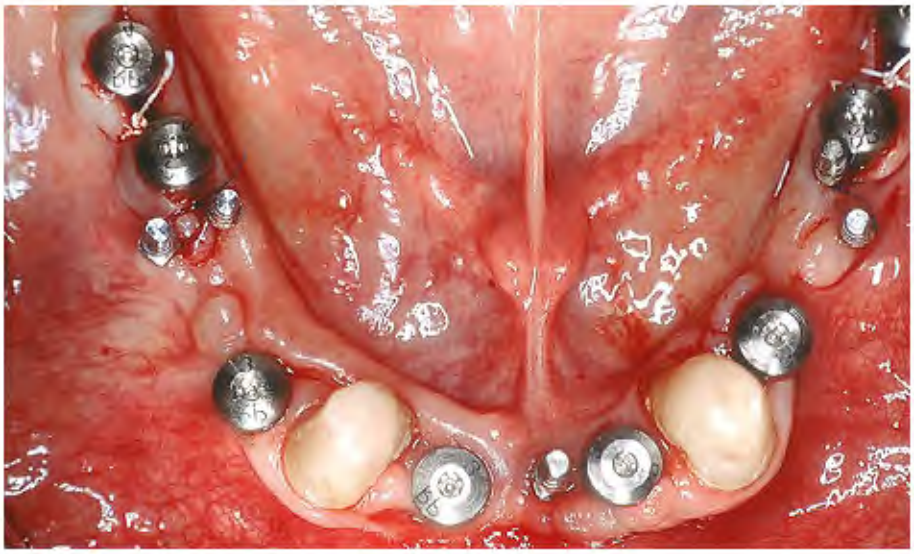


Fig 3-25k Exposure in the mandible.



Fig 3-25l Panoramic radiograph before the impression taking.

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Exposure and prosthetic restoration

The implants in the mandible were exposed even before implant placement in the maxilla (after the sinus elevation procedure; Fig 3-25k). In this case, a transverse, screw-retained, fixed cross arch bridge on customized abutments was selected as the superstructure. When taking the impression, the precise placement of the impression copings was checked with a panoramic radiograph (Fig 3-25l). Healing abutments were unscrewed before the try-in of the customized abutments (Fig 3-25m). A transfer key, with gaps left for the teeth and provisional implants, was prepared to ensure correct positioning of the abutments (Fig 3-25n). The remaining teeth and the provisional implants needed to be removed before the superstructure was completed. Since the prosthodontist attending the patient was on vacation at that particular point in time and the patient was in a big hurry, this step was performed by a different dentist. However, this colleague was not familiar with provisional implants and, instead of unscrewing them, he simply cut them all off so that they were flush with the gum. Implants which have been shortened in this way, even if not yet firmly integrated, cannot be unscrewed without a great deal of surgical time and effort (Fig 3-25o). To ensure that the mucosa closed over the remaining stumps, they were later reduced even further to bone level (Fig 3-25p). However, the treatment aim of a fixed implant bridge, without the need for an interim set of removable dentures, was still achieved.

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Fig 3-25m The healing abutments have been unscrewed.

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Fig 3-25n Customized abutments positioned with a transfer key.



Fig 3-25o Cut off IPIs in situ.



Fig 3-25p Stable gingival situation after the IPIs have been leveled.

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Fig 3-25q Basal view of the cross arch bridge with prosthetically favorable implant positions.

The fixed restoration was fabricated in one piece and faced with ceramic. Electroplated gold caps were cemented into the superstructure as secondary telescopic components and a secure fit was assured by transverse mini-screws inserted lingually in the molar region (Fig 3-25q). The advantage of this type of structure is that no screw access holes are visible from occlusally, but the restoration can be removed if required via the transverse screw retention (Fig 3-25r). The panoramic radiograph taken 6 months later when taking impressions of the ten Neoss implants in the maxilla showed a precisely fitted superstructure, along with the titanium residues remaining in the jaw from the IPIs and titanium pins (Fig 3-25s). Since titanium is involved, as with definitive implants, no complications are likely to result from these residues. Nevertheless, this “method” is not to be recommended for future use. The final photograph shows the clinical situation 3 years after the restoration was fitted (Fig 3-25t).

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Fig 3-25r Esthetic occlusal surface design with no perforations.

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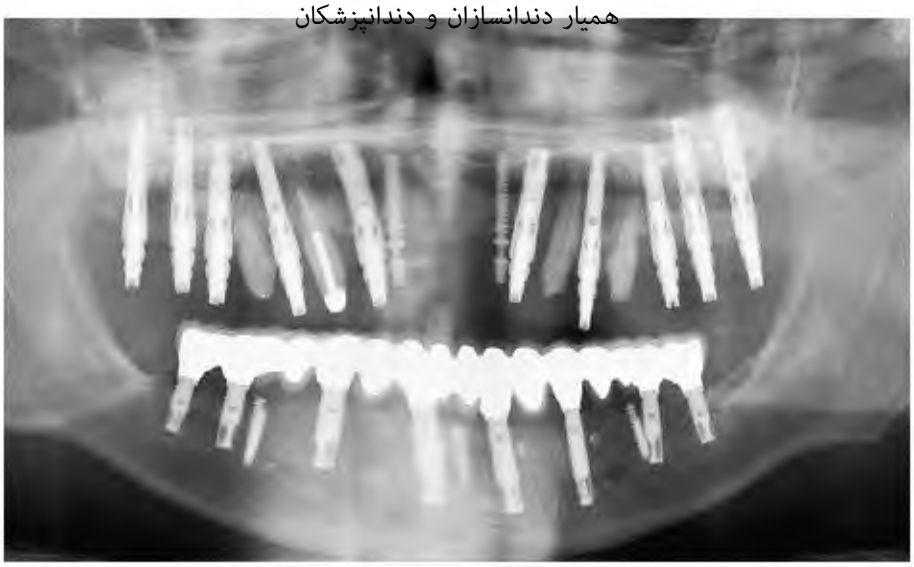


Fig 3-25s Follow-up panoramic radiograph with the titanium residues (the provisional implants and pins).



Fig 3-25t Peri-implant situation 3 years after the incorporation.

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Continued follow-up – detection of peri-implantitis

Ten years after the implantation treatment, the patient presented to the practice again after a long period, with pain and swelling in the mandible. He had never given up his tobacco habit and admits to smoking 30 cigarettes a day. After 10 years in functional use, the prosthetic restoration, particularly in the maxilla, showed signs of wear and the anterior teeth have become discolored (Fig 3-25u). The swelling in the fourth quadrant is so severe and painful as to make it very difficult to position a mirror for the photograph (Fig 3-25v). Clinical signs of peri-implantitis are apparent around virtually all of the implants in the mandible (Fig 3-25w). The panoramic radiograph shows extensive bone defects around the mandibular implants, along with the titanium residues from the IPIs and pins which still remain in situ (Fig 3-25x). A CBCT scan confirms the severe bone loss around the implants (Fig 3-25y). The extent of this

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bone loss is clearly apparent in the cross sections, especially around implants 34 (Fig 3-25z), 32 (Fig 3-25aa) and 47 (Fig 3-25bb). Probably the only reason why the structure is still in situ and functional is because long implants (18 mm in the anterior region) had been used. Whether this is an advantage or a disadvantage to the patient remains to be seen and is a matter for continued discussion. The massive loss of height in the residual ridge is clearly visible when one compares the positions of the titanium pins at the time of the augmentation (Fig 3-25g) and 10 years later on the 3D reconstruction (Fig 3-25cc).



Fig 3-25u Clinical situation after 10 years.



Fig 3-25v Severe swelling in the fourth quadrant.

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Fig 3-25w Peri-implantitis around almost all the implants in the mandible.

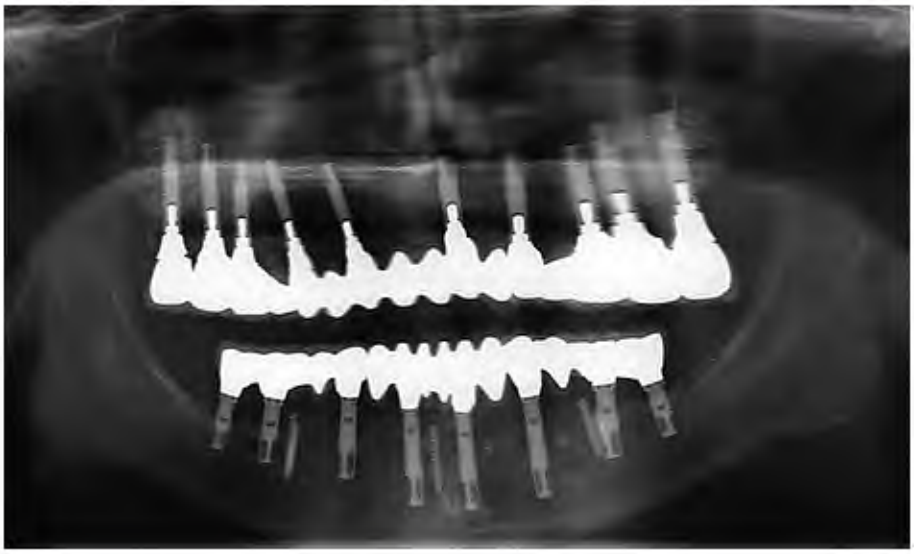


Fig 3-25x Panoramic radiograph after 10 years of functional use with bone defects and titanium residues.

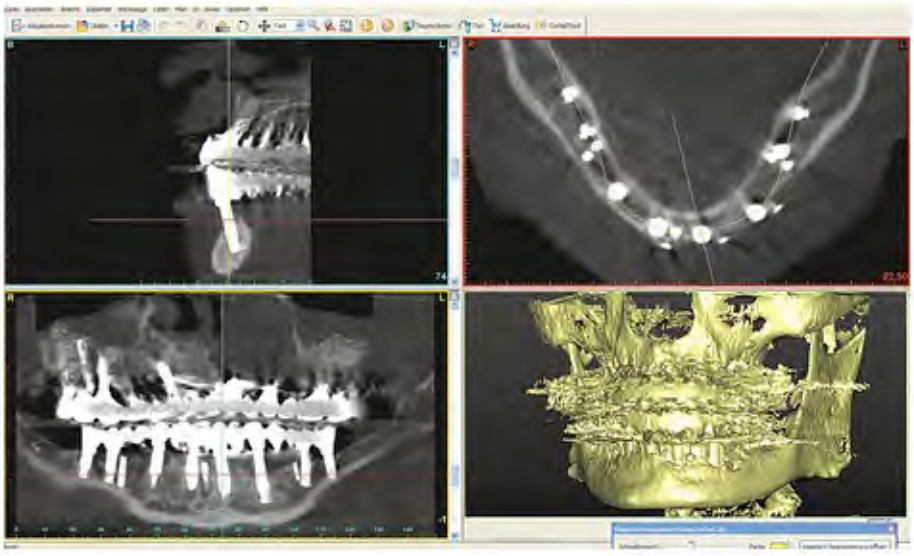


Fig 3-25y CBCT scan images with the same findings.

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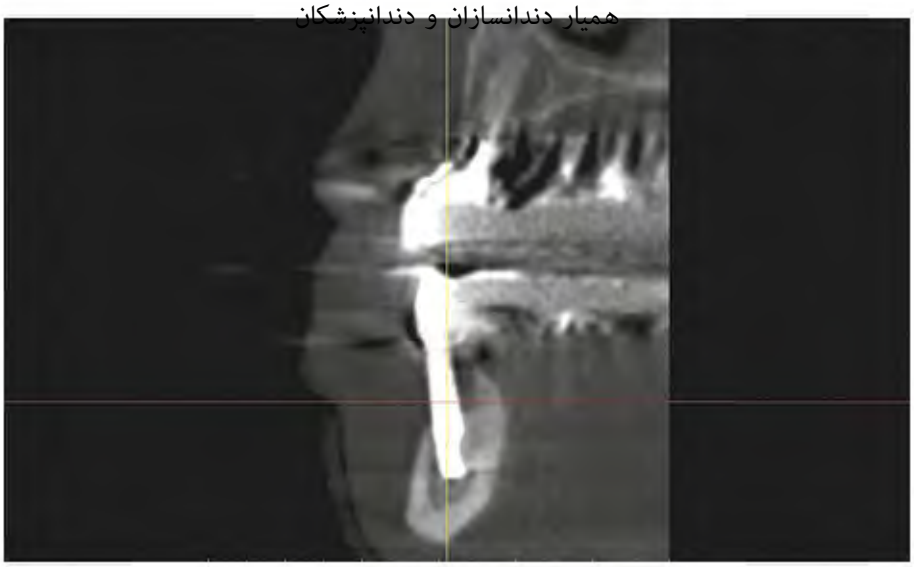


Fig 3-25z Bone loss around implant 34.



Fig 3-25aa Bone loss around implant 32.

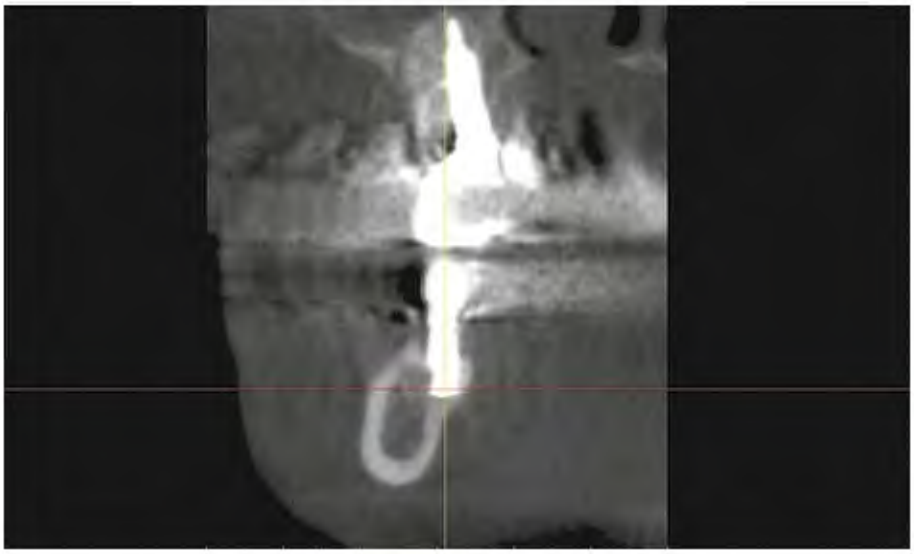


Fig 3-25bb Bone loss around implant 47.

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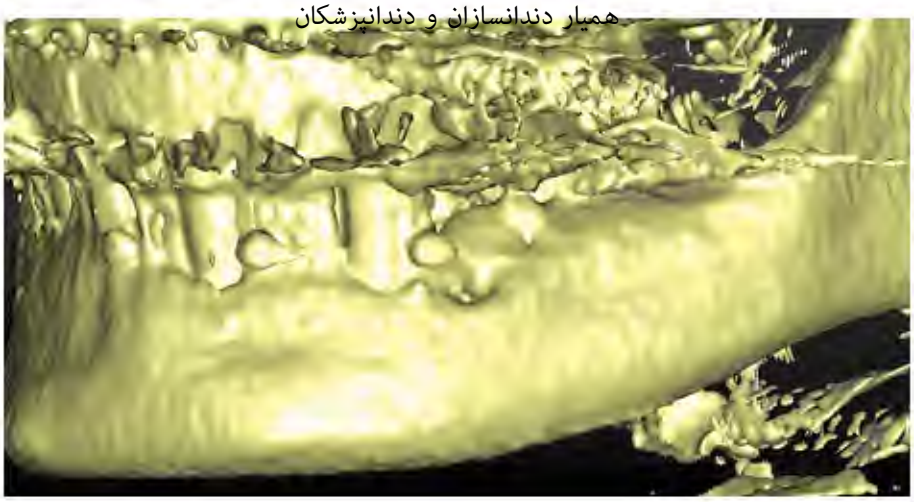


Fig 3-25cc Marked loss of height of the residual ridge around the titanium pins compared to Fig 3-25g.

Treatment course

- Implant placement, augmentation and immediate loading (2002)
- 8 months to exposure
- 3 weeks to impression taking and fabrication
- 10 years up to the detection of extensive, severe peri-implantitis

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Immediate loading of definitive implants

Immediate loading of permanent implants with a fixed bridge

Baseline situation

This male patient, who still had two crowned canines in the mandible, wanted a fixed prosthetic restoration (Fig 3-26a). As he was on anticoagulation treatment with a warfarin-type drug due to a cardiac disorder, and his medication required complex adjustment for any surgical procedure, the plan was to perform single-session implant placement with transmucosal healing, even though the need for augmentation in the

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posterior mandible was already apparent at the planning stage. The residual ridge was very well preserved in the anterior area, but was already severely atrophied in the posterior region (Figs 3-26b and 3-26c). If the implants were to be placed at the same level, the anterior residual ridge needed to be reduced, while its distal segments required augmentation.

Diagnostic tools

- Clinical examination
- Consultation with an internist
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Reducing the level of the bone in the anterior mandible, implant placement in the anterior and posterior mandible with posterior augmentation, immediate provisional restoration supported by anterior implants and canines
2. Definitive prosthetic restoration consisting of a transocclusal, screw-retained, ceramic-faced fixed implant bridge



Fig 3-26a Baseline clinical situation.

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Fig 3-26b Large discrepancy in height between the anterior and posterior mandible – CBCT panoramic view.



Fig 3-26c 3D reconstruction.

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Implant placement and augmentation

In the operation, performed under general anesthesia with intubation, reduction of the height of the residual ridge was followed by the placement of two Neoss implants in regions 32 and 42, plus three further implants distally of the canine in the third quadrant (Fig 3-26d). The distal implants were inserted approximately 2 mm supracrestally (Fig 3-26e). The cortical bone was perforated in several places for more rapid revascularization of the augmentation. Healing abutments were screwed onto the implants and augmentation carried out with a mixture of autologous bone and Bio-Oss. To stabilize the augmentation material prior to the saliva-proof wound closure, it was covered with a Bio-Gide membrane, held in place by the abutments and one titanium pin (Fig 3-26f). The wound was then closed, followed by implant placement on the opposite side performed in the same way. Since the atrophy here was even more advanced with more implant threads exposed, this region required an even greater augmentation volume (Fig 3-26g). Once again, the membrane was held in place with the healing abutments and an additional pin (Fig 3-26h).

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Fig 3-26d Insertion of Neoss implants in regions 32, 34, 36 and 37.

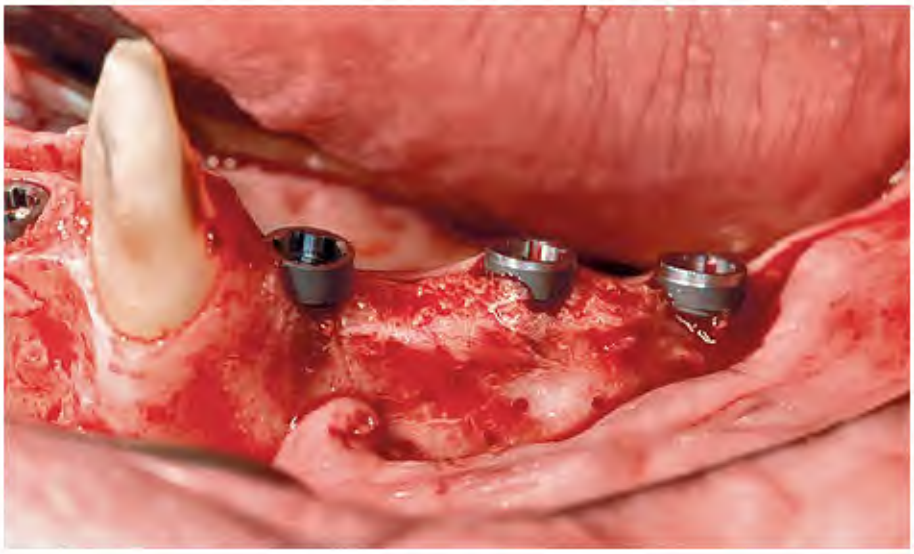


Fig 3-26e Supracrestal placement of the implants.

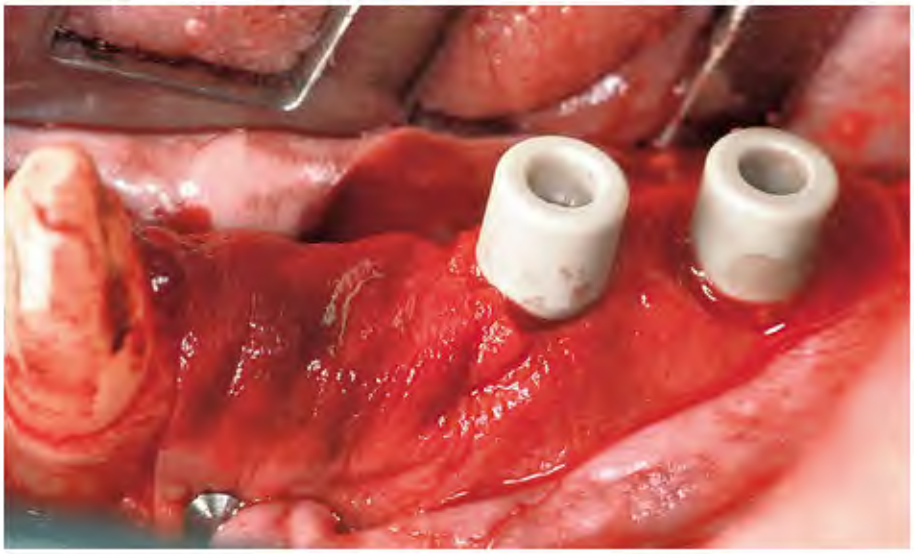


Fig 3-26f PEEK healing abutments screwed into place, stabilizing the membrane and augmentation material.

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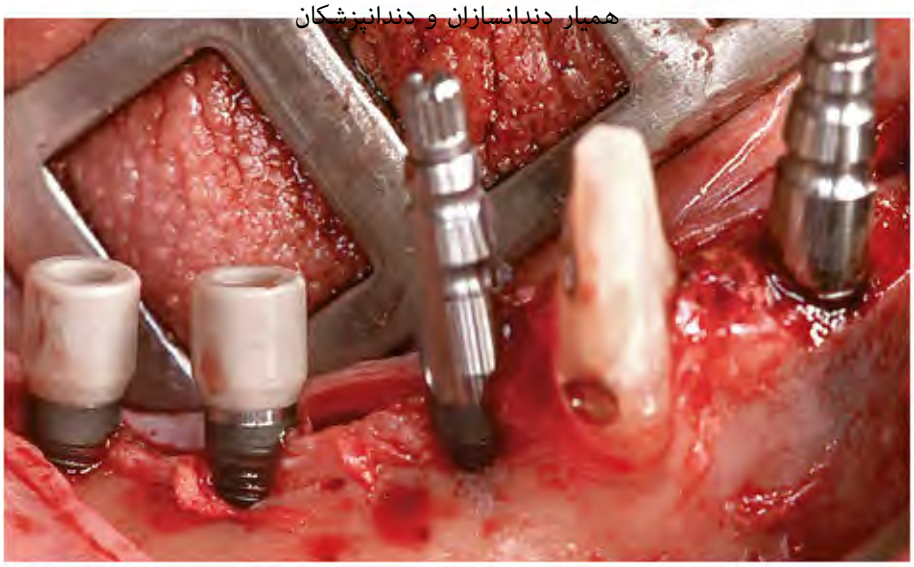


Fig 3-26g Implant placement on the opposite side. Perforated cortical bone.

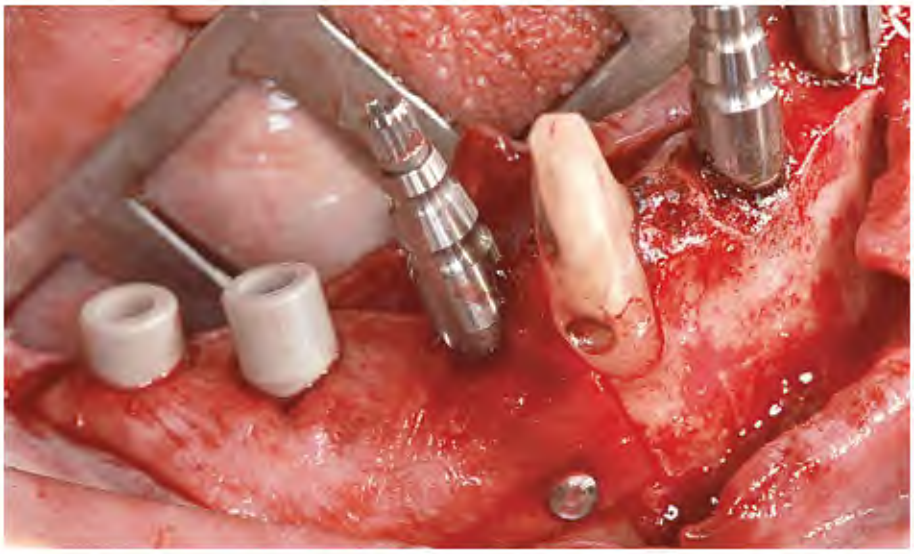


Fig 3-26h Augmentation with attached membrane.

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Provisional immediate loading

For the impression taking for a long-term provisional restoration to be fabricated in the laboratory, impression copings were screwed onto the four anterior implants even before the wound was sutured (Fig 3-26i). The impression was taken with the "pick-up" technique, using an open custom tray through which the impression copings could be unscrewed. Once the impression was taken, the healing abutments were screwed on (Fig 3-26j) and a quick immediate provisional denture prepared with the aid of a thermoplastic foil over all eight implants and the two canines (Fig 3-26k). The provisional extended from teeth 36 to 46, but with occlusal contacts from 34 to 44 only. The distribution of the implants in the jaw and their positions in relation to each other and to the mandibular canal are evident from the postoperative radiograph (Fig 3-26l).

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Fig 3-26i Impression copings on the anterior implants.

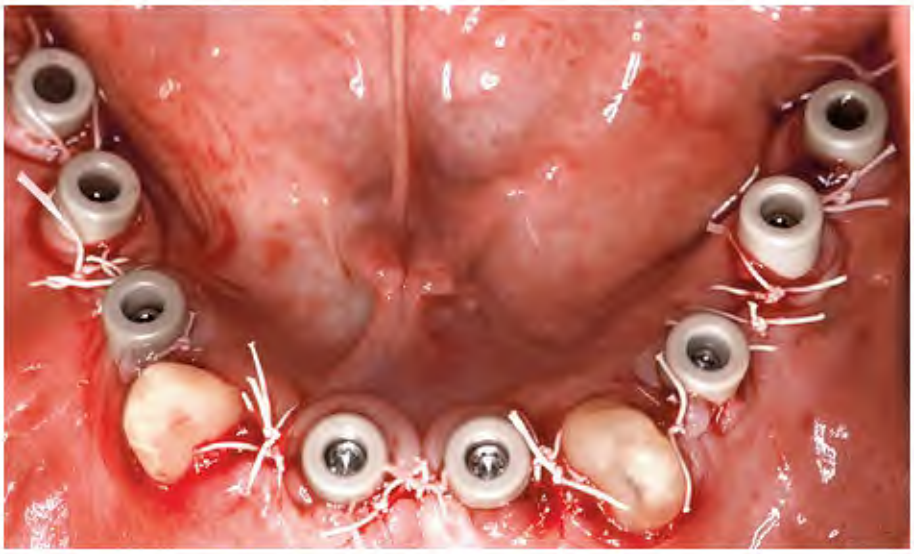


Fig 3-26j Wound suturing.



Fig 3-26k Immediate provisional restoration.

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Fig 3-26l Postoperative panoramic radiograph.



Fig 3-26m Customized provisional cylinders.

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Laboratory method

Once the cast was made, provisional cylinders were screwed onto the model implants in the laboratory and customized (Fig 3-26m). A metal-reinforced provisional fixed partial denture was made up over these, allowing it to be connected to the provisional abutments inside the mouth (Fig 3-26n). The screw holes over the implants were left unfilled, allowing access to the abutment screws even after the prosthesis was polymerized in (Fig 3-26o).

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Fig 3-26n Metal-reinforced long-term provisional.



Fig 3-26o Access to the screws.



Fig 3-26p Finished long-term provisional.

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Fig 3-26q Long-term provisional in situ.

Long-term provisional and prosthetic restoration

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After the initial stabilization of the gingival situation was achieved approximately 10 days postoperatively, the long-term provisional was inserted and the prepared structural components affixed to each other in the mouth and then shaped in the laboratory (Fig 3-26p).

The long-term provisional was cemented onto the canines with TempBond and screwed onto the implants (Fig 3-26q). This provisional extended from teeth 35 to 45, allowing the four short distal implants to heal transmucosally, but without disturbance. A screw-retained fixed cross-arch bridge spanning teeth 37 to 47 was fabricated 6 months after implant placement (Fig 3-26r). Thanks to the combination of residual ridge augmentation and leveling methods, the differences in height between the anterior and posterior mandibular region were at least partly evened out (Fig 3-26s). While the selected single-session method carries a greater risk of complications, it can spare the patient on long-term anticoagulation the need for an additional operation (Fig 3-26t).

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Fig 3-26r Transocclusal, screw-retained, metal-ceramic bridge as the definitive prosthetic restoration.



Fig 3-26s Stable and harmonious mandibular and gingival situation following the augmentation.



Fig 3-26t Patient following treatment completion.

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Treatment course

- Implant placement, augmentation and immediate loading (2005)
- 6 months to impression taking and fabrication

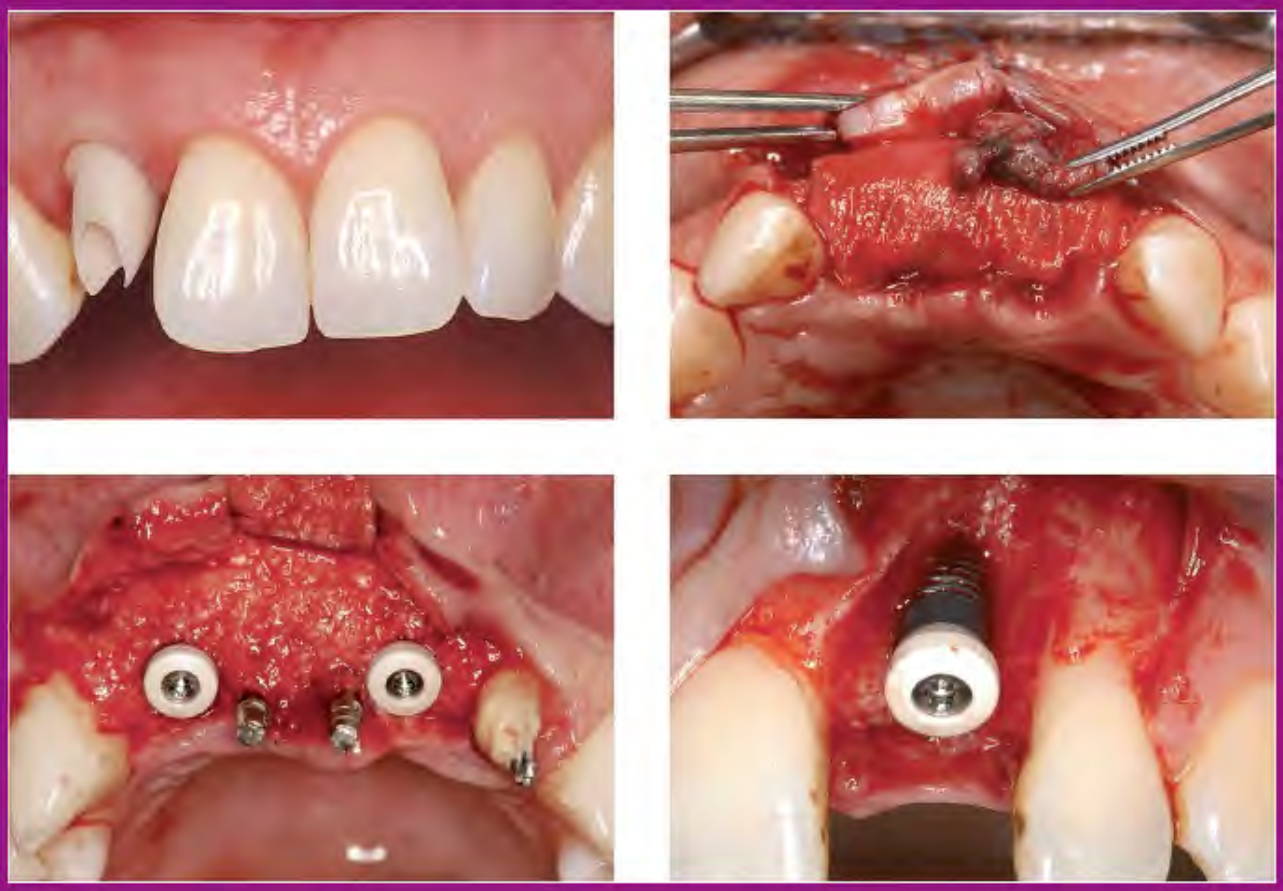
Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Ute Olbers

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4
The Anterior Maxilla



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Esthetics play an important role in any prosthodontic treatment. However, it is at its most significant when it involves the teeth of the anterior maxilla. If the best possible final result is to be achieved, it is not only the anatomical aspects but also – and above all – the esthetic ones that need to be considered from the outset, ie, at the diagnostic stage.

Diagnosis with esthetic considerations

The length of the upper lip is the most significant factor in the anterior maxilla. If the smile line is high, even the smallest irregularities in the red or white esthetic components of a restoration can result in esthetic failure (Figs 4-1a and 4-1b).

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Extensive diagnostic investigations with the aid of a wax-up or set-up on articulated study casts are recommended before any implant placement. Knowledge of the spatial relationships in the gap that needs to be filled, along with the desired height-to-width ratio of the future crown, are key factors determining the final result.

When it comes to the technological planning involved in replacing a tooth, comparison with its counterpart on the opposite side delivers very important information for the subsequent prosthetic restoration. The height of the tooth, determined by the course of the cementoenamel junction (CEJ) of the contralateral and neighboring teeth, needs to be taken into account in the planning stages. If the vertical measurement from the ideal position of the incisal edge to the residual ridge exceeds the optimal crown height, then it will be necessary to carry out bone or soft tissue augmentation procedures.

This becomes apparent on the diagnostic cast when the ideal position of the dental crown is fixed and the result is a gap between the tooth and the residual ridge at the cervical end (Fig 4-1c). If the labial resorption is not particularly pronounced, augmentation can normally be performed in a single session with implant placement.

The planned shape of the tooth and the information obtained from this diagnostic step should be transposed to the operation area by means of a surgical guide template. This needs to fully reproduce the extent of the set-up tooth in the gap (Fig 4-1d). The template is made of transparent plastic and stabilized on the incisal edges of the neighboring teeth with plastic occlusal rests. For better orientation, the desired position of the implant is marked on the cast (Fig 4-1e). It is best if the implant can be placed at the center of the gap and along the course of the dental arch.

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Attention: ***Placing implants too far palatally may result in crown deformity, either vertical or with a vestibular overlap in the form of a "balcony," which interferes with occlusion. This can cause difficulties when cleaning the teeth. Positioning the crown too far in the labial direction displaces the soft tissue and leads to its atrophy. This results in a crown that is, or appears, too long.***

The longitudinal axis of the crown, which ideally also determines the longitudinal axis of the implant, is set by drilling a hole 3 mm in diameter (Fig 4-1f). For a better view, the drill hole can be exposed by cutting away the labial side of the template. The cervical margin of the set-up tooth should still be clearly identifiable (Fig 4-1g). Later, during the surgical procedure, a direction indicator is used to check the axis of the tooth or implant.

If the patient is using an interim prosthesis, this can also deliver important information during the diagnostic phase. It can be used to try out the position of the crown, and to test static and dynamic occlusion. Moreover, any residual ridge defects are shown up by the pink acrylic part of the prosthesis in the region of the defect (Fig 4-1h).

Radiographs (a panoramic radiograph and dental films at least) are also needed for diagnostic purposes (Fig 4-1i). In cases where atrophy has already occurred, an additional computed tomography (CT) or cone beam computed tomography (CBCT) scan will be required (see 3D diagnosis, p. 230).

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The planned position of the implant is determined on the radiograph. A radiographic template with integrated titanium sleeves is recommended to determine the magnification factor of the panoramic radiograph. In contrast to the posterior region, the bone supply in the anterior maxilla is generally sufficient for an implant length of 13 to 18 mm. If the “Simpler in Practice” method is to be used, it is advisable to fashion a stable baseplate on the diagnostic cast (Fig 4-1j).



Fig 4-1a Long upper lip – normal smile line.



Fig 4-1b Short upper lip – high smile line.

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Fig 4-1c Gap between the edge of the crown and the residual ridge.



Fig 4-1d Duplicated tooth in the template.

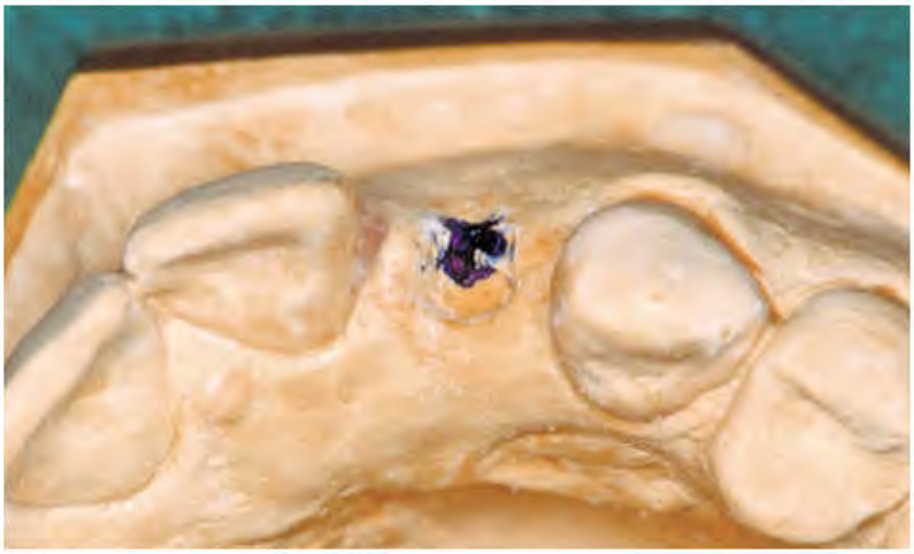


Fig 4-1e Marked implant position.

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Fig 4-1f Hole drilled along the axis of the tooth.



Fig 4-1g The drill hole has been exposed on the labial side.



Fig 4-1h Pink acrylic shows the extent of the defect.

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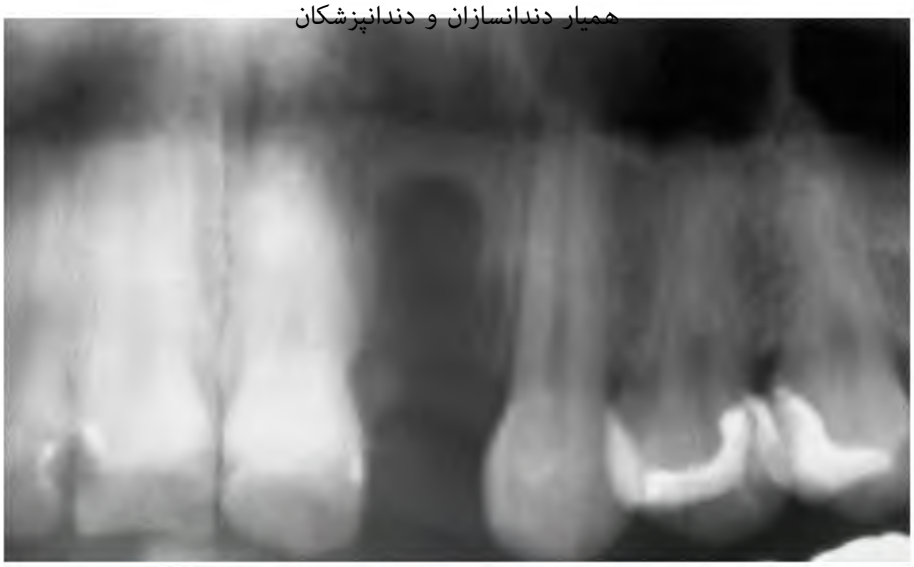


Fig 4-1i Section from a panoramic radiograph.

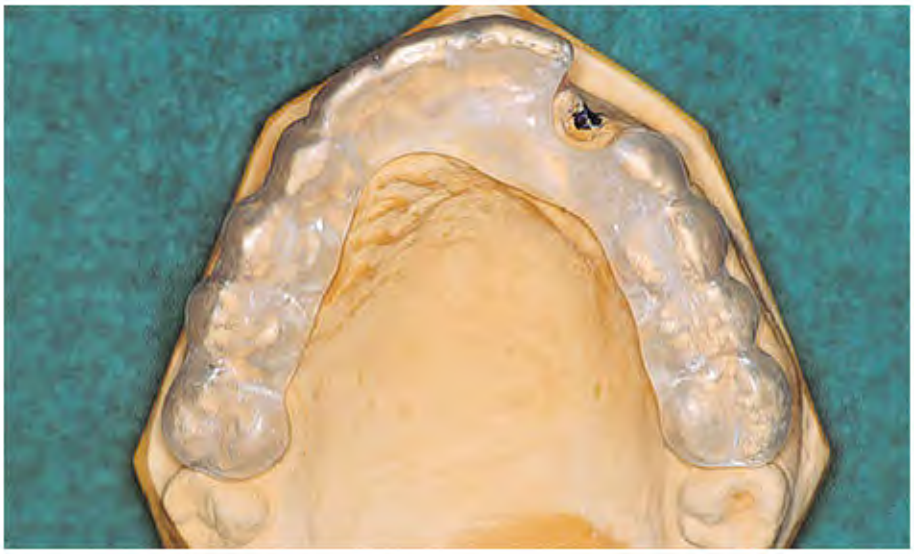


Fig 4-1j The baseplate.

See page 237 for the continued procedure.

3D diagnosis and SimPlant planning

Three-dimensional (3D) diagnosis is continually gaining in significance and is indicated in most cases when planning a single-tooth implant in the anterior maxilla. It is particularly important in immediate implant placement where immediate loading is planned.

A planning program, such as SimPlant in this case (Dentsply), is normally used for this. The data obtained from the CBCT or CT scan are transferred into the planning program in Digital Imaging and Communications in Medicine (DICOM) format (Fig 4-2a). The data set includes the panoramic section, which provides an overview of the whole situation (Fig 4-2b). In the case presented here, tooth 22 needs to be extracted, with immediate loading of the implant (see

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the “Immediate loading” case, page 270). However, the cross-sectional view is the most significant when it comes to detailed implant planning (Fig 4-2c). The planned implant, taken from the library, is placed virtually into this projection (Fig 4-2d). The exact position of the implant is then checked further in all planes and projections (Fig 4-2e). Bone densitometry around the implant can be used to assess bone quality, another important factor for immediate loading of the implant (Fig 4-2f). In this case, the very high bone density in the coronal region of the implant is falsified by the projection of the tooth that still remains here. Superimposition of the long axis of the implant facilitates the planning and fabrication of a surgical drill guide, which allows precise drilling and placement of the implant (see the “Immediate loading” case, page 271, Figs 4-14c and 4-14d). Visualization of the long axis of the implant also shows where the access hole for the retaining screw is to be located (Fig 4-2g). This information is important when choosing a suitable abutment. The selected abutment (angled by 22 degrees in this case) can also be planned three-dimensionally and virtually placed (Fig 4-2h).

It is only thanks to 3D planning that the surgical guide template can be fabricated and the immediate provisional restoration can be prepared before the operation.

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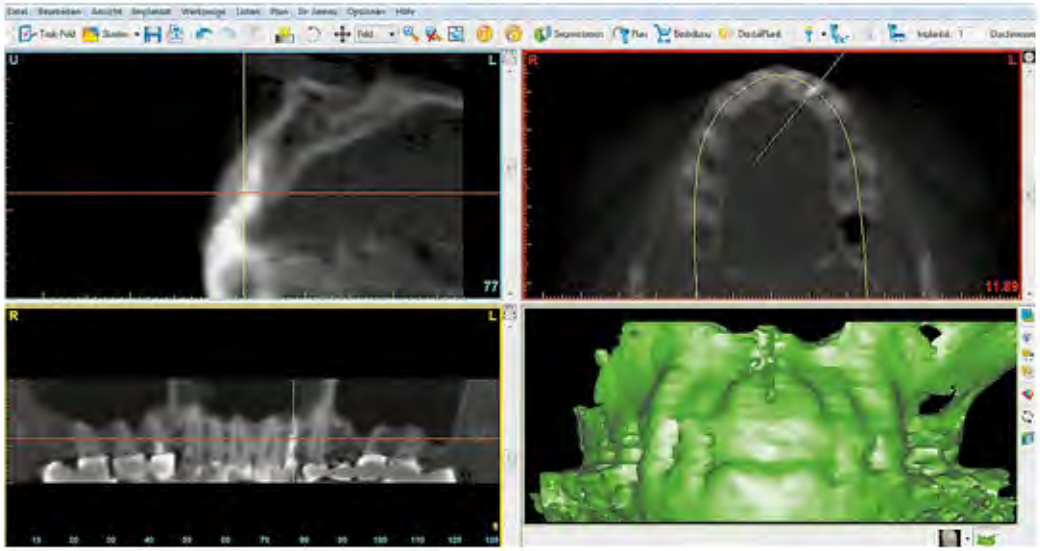


Fig 4-2a CBCT scan images for the planning process.

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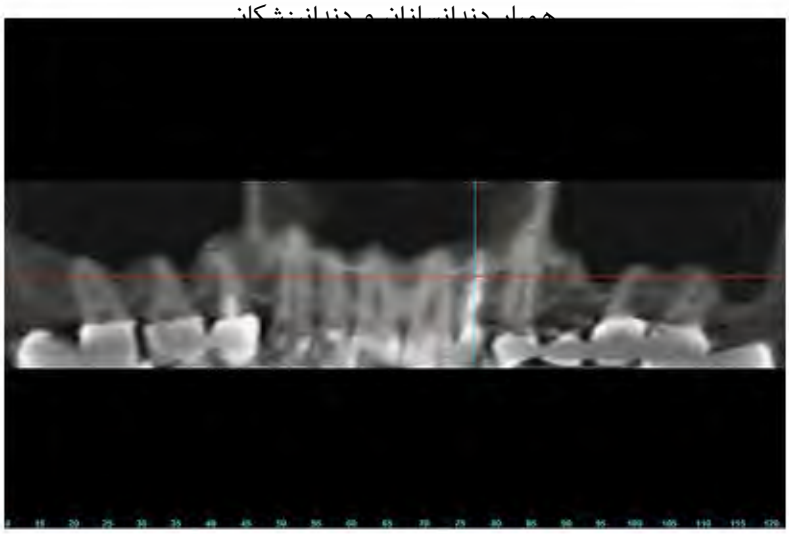


Fig 4-2b Overview on the panoramic section.

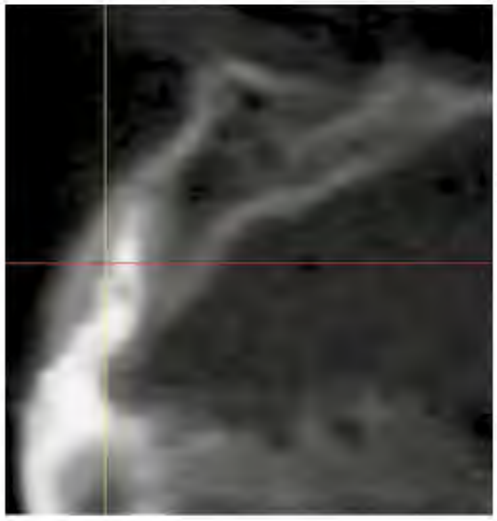


Fig 4-2c Cross section.

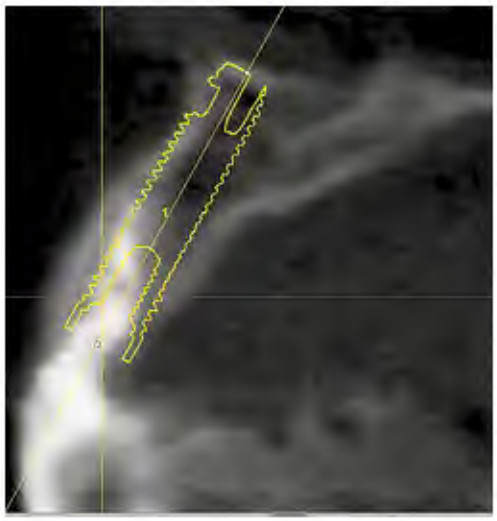


Fig 4-2d Positioning of the implant.

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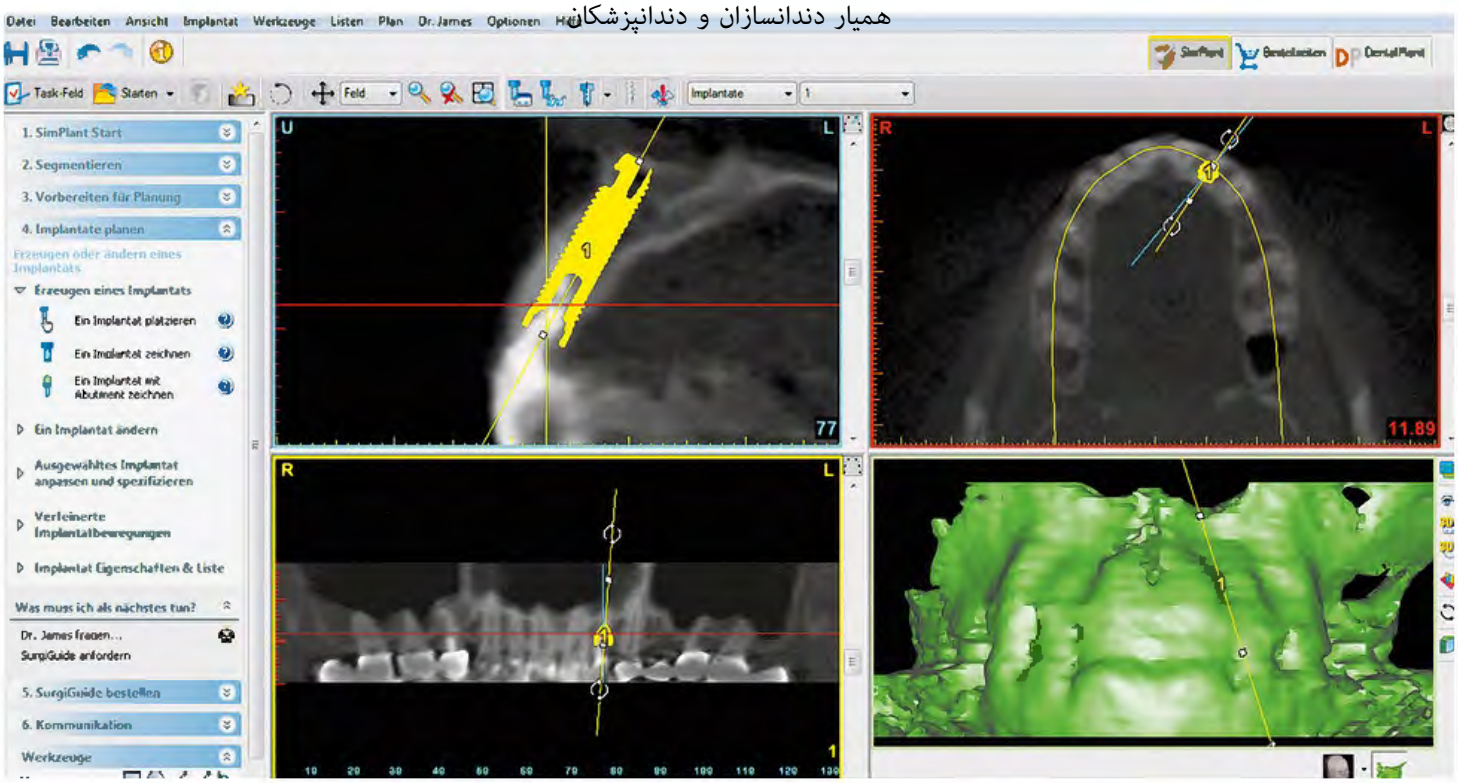


Fig 4-2e Position of the implant in all planes.

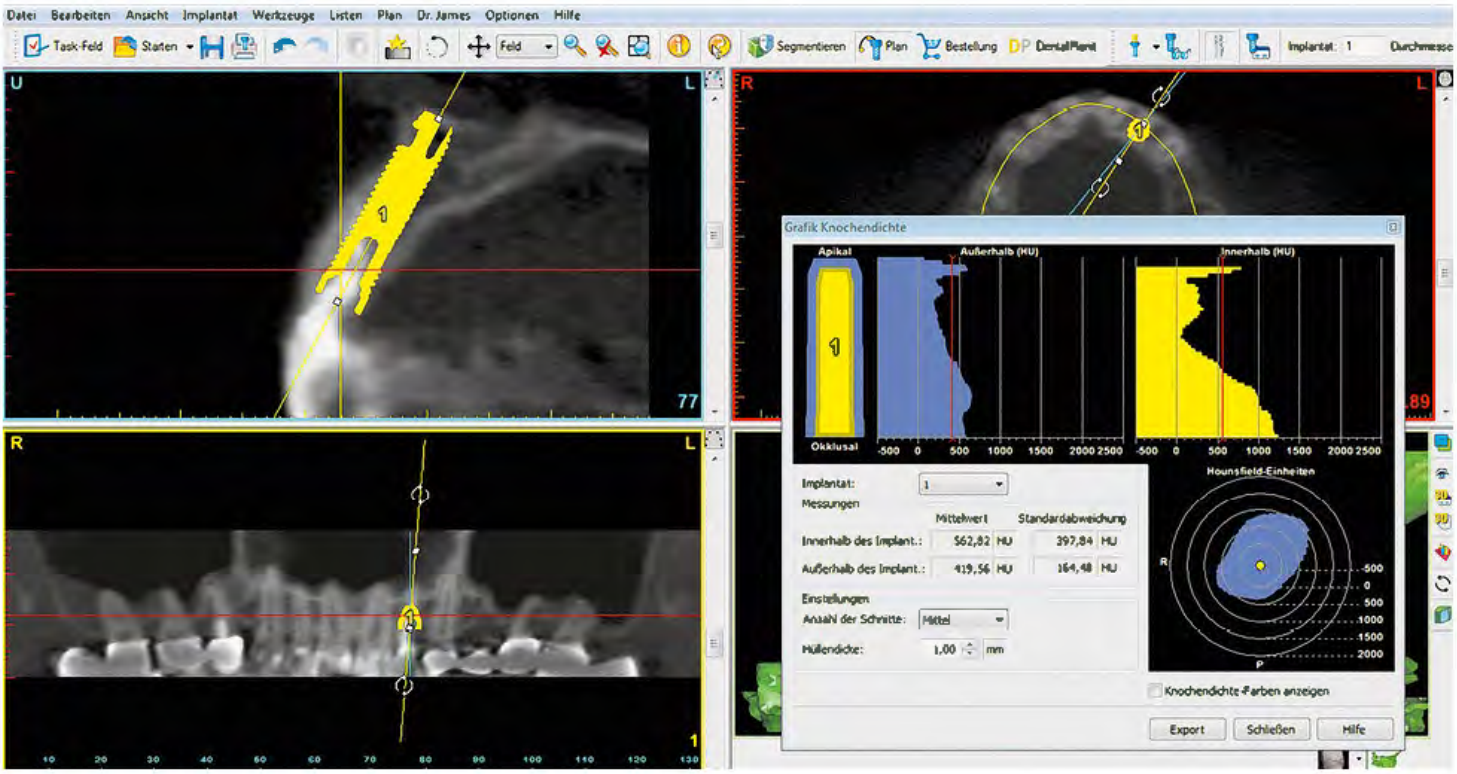


Fig 4-2f Bone densitometry around the implant.

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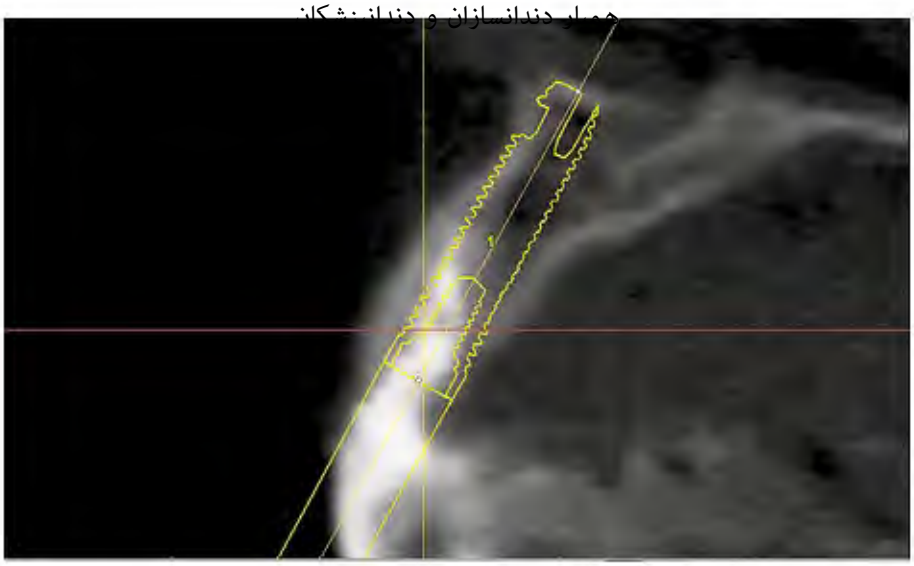


Fig 4-2g Access hole for the retaining screw.

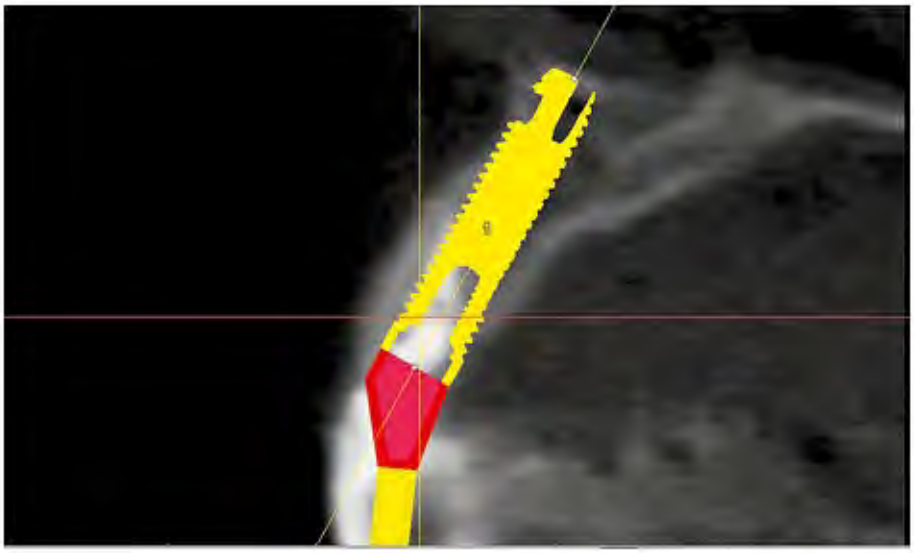


Fig 4-2h Positioning the angled abutment.

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Single-tooth replacement

Implants can be used for a particularly natural and atraumatic restoration of single-tooth gaps in the anterior maxilla. Esthetically unacceptable clips are just as redundant as preparing neighboring teeth for a bridge, which are usually completely healthy. Another advantage of single-tooth implants is that they allow optimal cleaning of the interdental spaces.

Apart from the high esthetic requirements that apply to anterior teeth, single-tooth implant placement is usually unproblematic. Bone defects and the loss of interdental papillae are generally less serious than with larger gaps involving several teeth. Tissue reconstruction achieves good and, above all, predictable results in most cases.

After an average implant healing phase of 6 months, the question that often presents itself is how to make sure that the patient is fitted with an esthetically satisfactory restoration as soon after exposure of the implant as possible. The implantological protocol dictates that a healing

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abutment of appropriate length be incorporated during the exposure operation. This abutment should be at least 1 to 2 mm proud of the gingiva, so that it does not become overgrown by it. However, a protruding titanium abutment can be unsightly in the anterior part of the dental arch. In addition, the incorporation of the previously worn provisional prosthesis, especially one fabricated by casting, can be problematic in some cases due to lack of space. The healing abutment should stay in situ until the gingival situation has stabilized.

Following gingival stabilization, the healing abutment is replaced by the definitive abutment. After the latter (eg, CeraOne for a single-tooth implant; Nobel Biocare) has been incorporated, an impression is taken and the prosthetic crown fabricated. In contrast to the conventional protocol, the Simpler in Practice technique allows the patient to be offered an esthetically pleasing provisional restoration immediately. Furthermore, it offers the option of shaping the contour and course of the gingival margin around the implant and also to influence the continued development of the papilla by appropriate configuration of the interdental space.

Typical treatment course

Single-tooth implant – Simpler in Practice technique

This case follows on seamlessly from the standard diagnostic procedure.

Baseline situation

This young, 30-year-old woman lost tooth 22 due to apical and periodontal inflammation. She had been fitted with a removable provisional prosthesis by her dentist (see Diagnosis, Fig 4-1h, page 229). The ridge defect that developed after the extraction (Fig 4-3a and see Diagnosis, Fig 4-1i) would have resulted in considerable esthetic as well as functional restrictions, had she been provided with a conventional prosthetic restoration with no augmentative measures. Therefore, an implant-based solution was the preferred option to protect the neighboring teeth.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Implant placement and augmentation, recording the implant position
2. Fabrication of the provisional restoration – Simpler in Practice technique

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3. Exposure and incorporation of the provisional
4. Definitive ceramic crown



Fig 4-3a Clinical situation before treatment.



Fig 4-3b Bone defect with apical fenestration.

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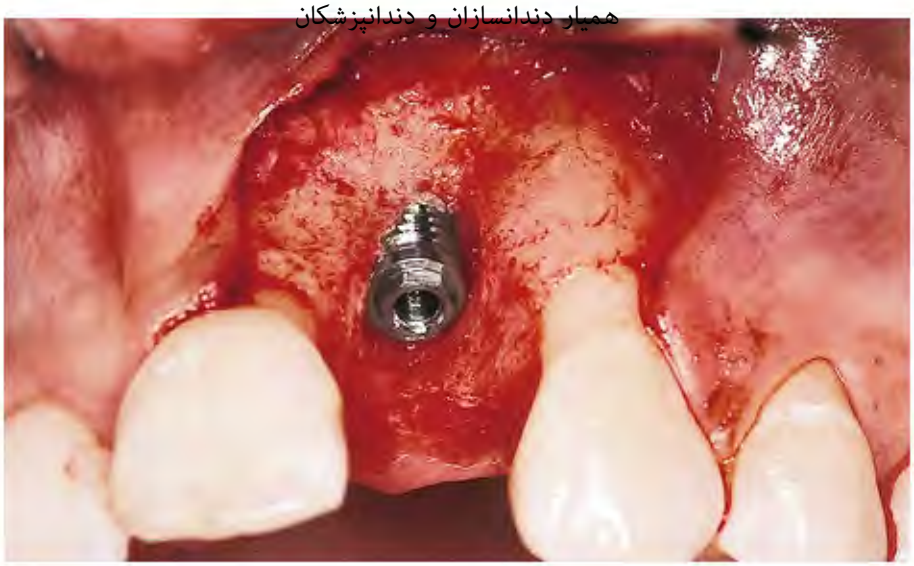


Fig 4-3c The implant in situ.

Implant placement, recording the fixture position and augmentation

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The bone defect between teeth 21 and 23 was revealed following dissection of the mucoperiosteal flap. There was only a thin palatal bone lamella with apical fenestration at this location (Fig 4-3b). Once the implant was placed (Fig 4-3c), an impression coping was screwed onto it and a prepared baseplate incorporated (Fig 4-3d and Diagnosis, Fig 4-1j). The impression coping was fixed into the baseplate with a self-curing polymer (Pattern Resin, GC America; Fig 4-3e).

Once the self-curing polymer had hardened, the impression coping was unscrewed from the implant and the impression coping/baseplate complex removed. A healing abutment was then screwed on to act as a spacer (Fig 4-3f) and bone augmentation performed with the bone substitute Bio-Oss and a Bio-Gide membrane (Geistlich; Fig 4-3g). The membrane needed to be securely attached (eg, with a titanium pin or preferably a resorbable Resor-Pin [Geistlich] on the labial side and with a mattress stitch suture on the palatal side) to ensure that the augmentation material remained in place on the bone. The mucoperiosteal flap was repositioned following periosteal slitting and the wound then closed by suturing. The 7-month healing phase was uncomplicated (Fig 4-3h).

Exposure and provisional loading

After the 7-month healing phase, the implant was exposed with an incision on the palatal side and the healing abutment unscrewed. This revealed good regeneration of the hard tissues (Fig 4-3i). Osseous support for the papillae was now in place.

The sterilized CerAdapt abutment (Nobel Biocare) was screwed on (Fig 4-3j) and the retaining screw tightened with the aid of a torque controller (32 N/cm). The provisional crown

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was cemented on with TempBond (Kerr). This was followed by gingival adaptation and suturing (Fig 4-3k).

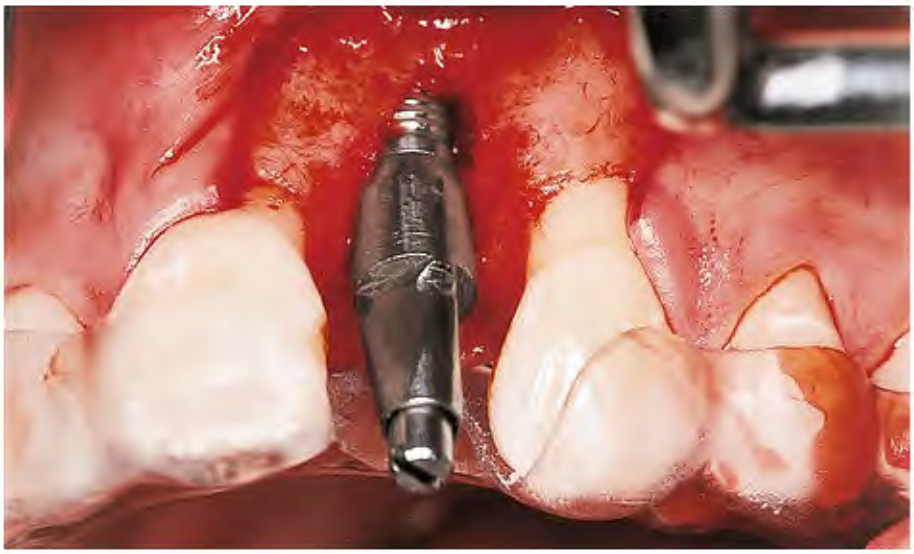


Fig 4-3d Impression coping screwed onto the implant and the baseplate stabilized on the teeth.

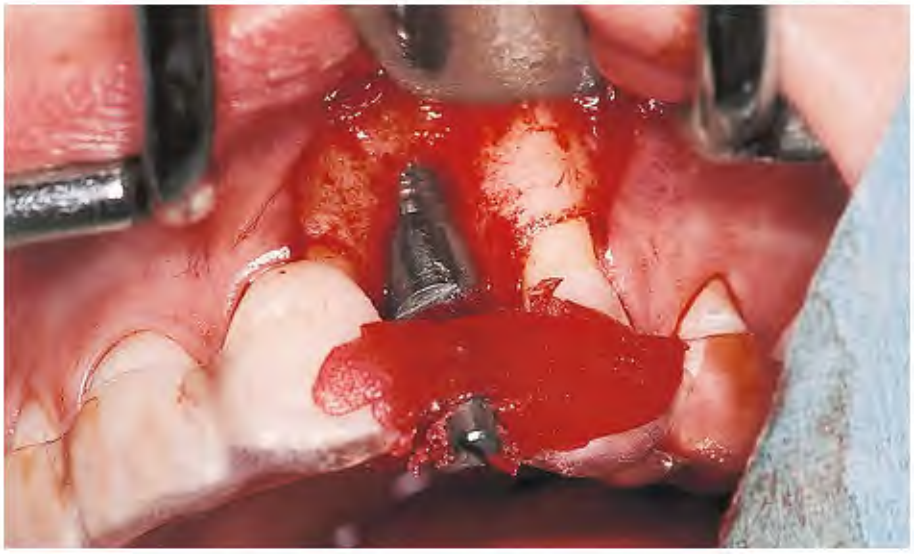


Fig 4-3e The impression coping has been integrated into the baseplate.

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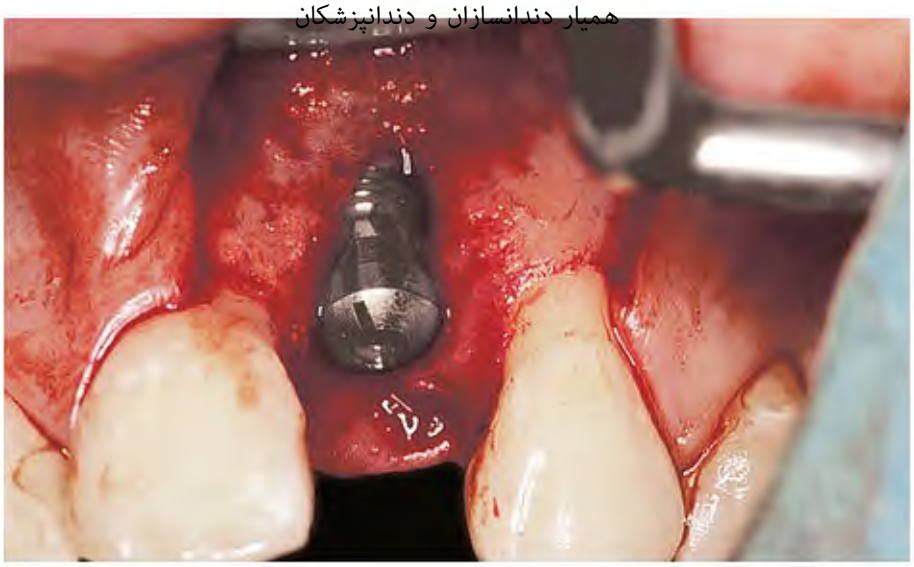


Fig 4-3f Healing abutment as spacer.

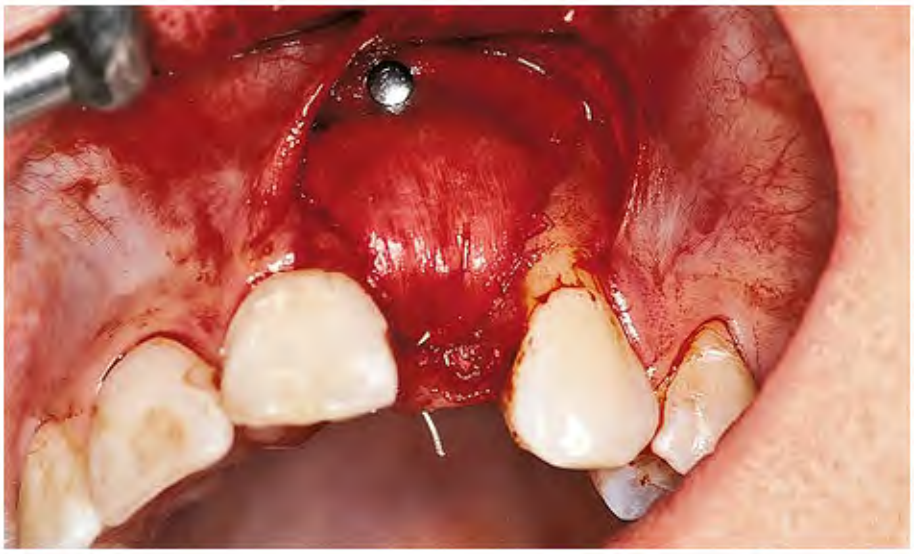


Fig 4-3g Bone augmentation with Bio-Oss and Bio-Gide.



Fig 4-3h Healing phase.

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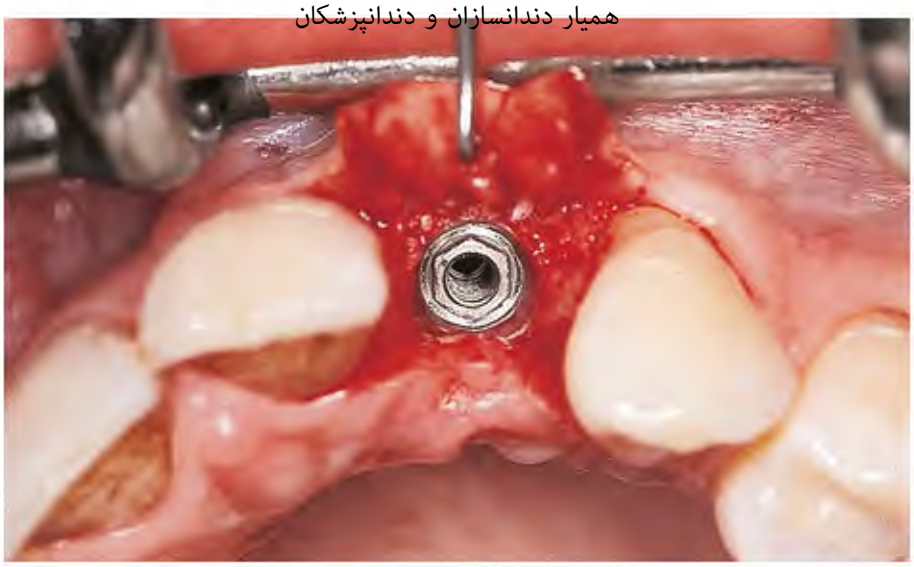


Fig 4-3i Exposure of the implant.

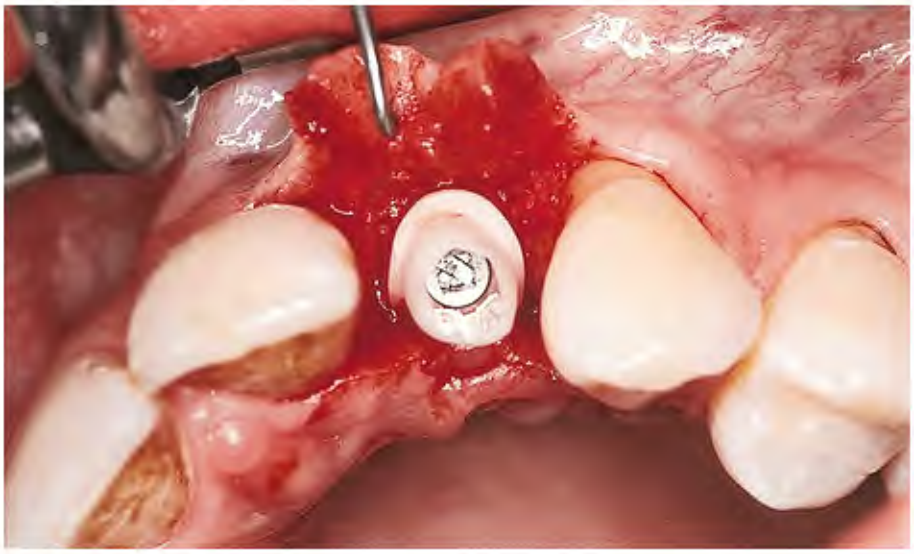


Fig 4-3j Fitted CerAdapt abutment.



Fig 4-3k Provisional crown.

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Fig 4-3l Regeneration of the bone defect.



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Fig 4-3m Definitive ceramic crown.

Attention: ***During the exposure operation, it may turn out that the bone margin makes fitting the abutment difficult or impossible. If this is the case, the diameter of the abutment needs to be reduced or the bone reamed out.***

The postoperative radiograph should confirm the optimal positioning of the implant components. If this is not the case, the fit of the abutment will need to be corrected. Here, the radiograph showed not only that a good fit has been achieved, but also that the former bone defect has regenerated (Fig 4-3l; cf. Diagnosis, Fig 4-1i).

Definitive restoration

A few months later, following gingival stabilization, the CerAdapt abutment was reshaped in the mouth and thus adjusted to the final soft tissue contours. Once this shaping was complete

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(as with a tooth stump), the full ceramic crown could be fabricated in the laboratory. Figure 4-3m shows the cement-retained ceramic crown 8 months after exposure of the implant.

Treatment course

- Implant placement and augmentation (1996)
- 7 months to exposure
- 3 months to the definitive crown

Treatment

Surgery and provisional restoration:	Dr Christoph T. Sliwowski
Ceramic crown:	Dr Eberhard Helbig

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Note

Simpler in Practice Technique

Simpler in Practice is a method of fabricating a provisional restoration on implants before they are exposed. For a working cast to be created with this technique, the position of the inserted implants has to be recorded intraoperatively and transferred to a situational cast. The model implants also need to be incorporated secondarily into the working cast. This is done with the aid of a preoperatively fabricated baseplate onto which the impression copings are attached during implant placement.

Fabrication of the provisional restoration – Simpler in Practice

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Fig 4-4a Baseplate on the reamed-out cast.

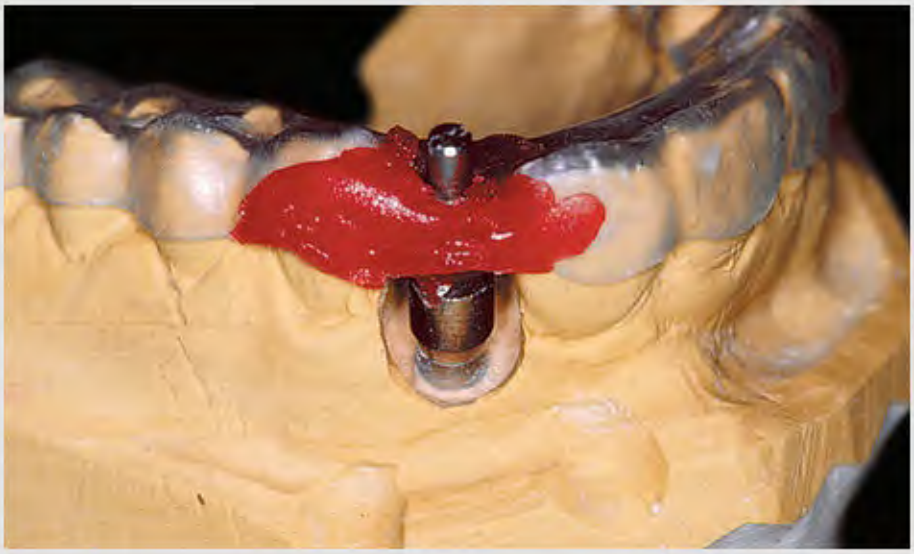


Fig 4-4b Secondarily incorporated model implant.

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Producing a definitive cast

The provisional restoration can be fabricated without delay on the original cast on which the baseplate was produced.

Attention: ***However, consideration will need to be given to the fact that the positions of the teeth or the gingival situation could have changed during the several months of the healing period.***

The implant position as recorded in the mouth is transferred to a working cast with the aid of the existing baseplate. After the plaster cast is reamed out in the implant region, the model implant is screwed onto the fixed impression coping and the baseplate placed onto the reamed-out cast (Fig 4-4a). Once the correct fit of the baseplate on the cast has been

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ascertained, the model implant is fixed into the working cast with plaster (Fig 4-4b).

Attention: ***The model implant must not touch the plaster cast while the baseplate is being put into place.***

Preparation of the CerAdapt abutment

The gingival line acts as a reference when preparing the CerAdapt abutment at the cervical end (Fig 4-4c). Preparation of the abutment is also determined by the inclination of the adjoining teeth and an analysis of the local spatial relationships (Fig 4-4d).



Fig 4-4c CerAdapt abutment with the gingival line marked in.



Fig 4-4d Occlusal relationships marked in the articulator.

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Fig 4-4e CerAdapt on the holder.



Fig 4-4f Prepared abutment.

Attention: ***Presently, most abutments are fabricated from zirconia using the computer-aided design and manufacturing (CAD-CAM) technique.***

Before milling starts, the desired shape is drawn in with a permanent marker (Fig 4-4e). The CerAdapt abutment is prepared with the aid of a water-cooled turbine handpiece. During preparation, care must be taken to ensure that enough space is left for the papillae at the proximal ends. The preparation should not extend more than 1.5 mm subgingivally. It is vital to adhere to the minimum thicknesses recommended by the manufacturers due to the risk of fracture (Fig 4-4f; see also page 258).

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Fig 4-4g Plastic transfer used to position the abutment.



Fig 4-4h Prosthetic implant superstructure imitating the tooth (with space left for the papillae at the proximal ends).

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Fabrication of the transfer and provisional crown

The exact position of the abutment on the hexagonal base of the model implant is fixed with the aid of a plastic transfer made of, eg, Pattern Resin (Fig 4-4g). Its function is to ensure torsion-free transfer of the CerAdapt abutment from the cast to the patient's mouth.

After the transfer is made up, a provisional crown is fabricated on the abutment. The general rule is that, ideally, the prepared abutment with the provisional crown attached to it corresponds to the natural tooth that is being replaced (Fig 4-4h). The mesiodistal position of the implant determines the spatial relationships of the proximal surfaces and the shapes of the interdental papillae. It is best to place the implant at the center of the gap. The provisional crown should be in static occlusion with slight infraocclusion. Occlusal contacts should be avoided in articulation (laterotrusion and protrusion movements).

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Fabrication of the provisional restoration delivers a wealth of information, which is of significance to the optimal appearance (shape and color) of the definitive, metal-free ceramic crown. The latter is fabricated a few months later, once the gingival situation has stabilized.

Typical treatment course

Esthetic requirements dictated by a high smile line

If the upper lip is short or the smile line high, implant placement needs to be very carefully planned and performed. The anterior teeth are so exposed that even the tiniest irregularities catch the eye straight away.

Baseline situation

This female patient lost tooth 12 due to apical periodontitis. While the atrophy of the residual ridge is moderately advanced, the prognosis for a conventional prosthetic restoration is on the unfavorable side due to the short upper lip (Fig 4-5a; also see the standard diagnosis section on page 229 and Fig 4-1b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Implant placement and augmentation, recording of implant position
2. Fabrication of the provisional restoration – Simpler in Practice
3. Exposure and incorporation of the provisional
4. Definitive ceramic crown

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Fig 4-5a Situation after the loss of tooth 12.

Implant placement

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An incision was made in the sulcus along teeth 15 to 21 to avoid vertical releasing incisions around the anterior teeth, which carry the risk of scarring. The mucoperiosteal flap along with the papillae was carefully dissected and lifted and an 18-mm long MK II implant inserted (Brånemark System; Fig 4-5b). The implant position was recorded by polymerizing a plastic impression post into the baseplate with Pattern Resin (Fig 4-5c). This impression post (of the "snap-on" type) is more user-friendly than screw-retained impression copings, but less precise. The papillae needed to be augmented up to the black mark. For this purpose, a healing abutment of appropriate height (3 mm) was used as a "supporting column" (Fig 4-5d). Following periosteal slitting, the flap and papillae were repositioned without tension and secured with mattress sutures (Fig 4-5e). This ensured that the desired gingiva height was achieved at the end of the operation.

The interim restoration was produced using the thermoplastic foil splint technique (Fig 4-5f). As it is supported by the teeth alone, the restoration exerts no pressure on the mucosa so that the healing process is not impaired.

Laboratory method

The position of the implant was reproduced according to the baseplate (Fig 4-5g). A provisional cylinder, which needed shortening in accordance with the spatial relationships, was selected as the first provisional restoration. To maintain and shape the soft tissues in the interproximal spaces, a provisional crown of reduced diameter was built up on the plastic cylinder, starting from the head of the implant, and then finished (Fig 4-5h).

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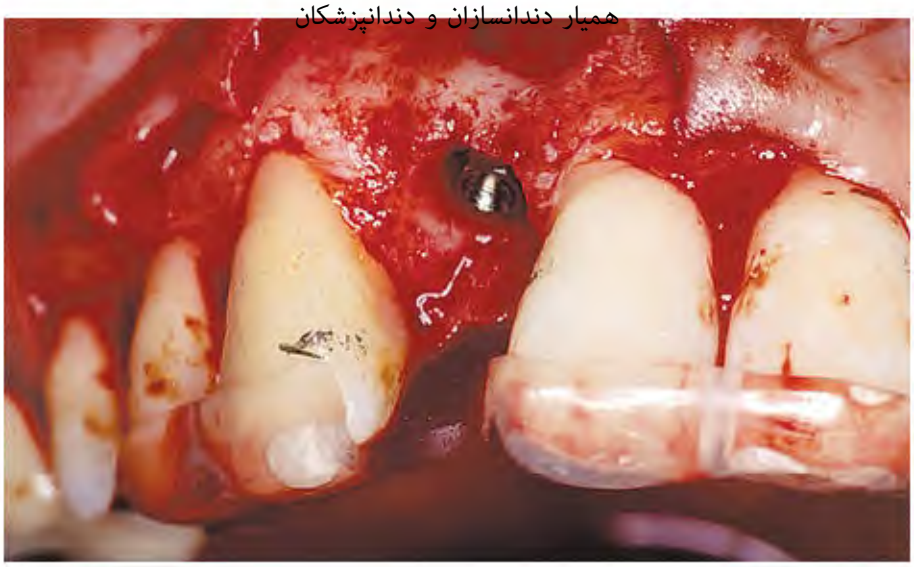


Fig 4-5b Insertion of the implant.

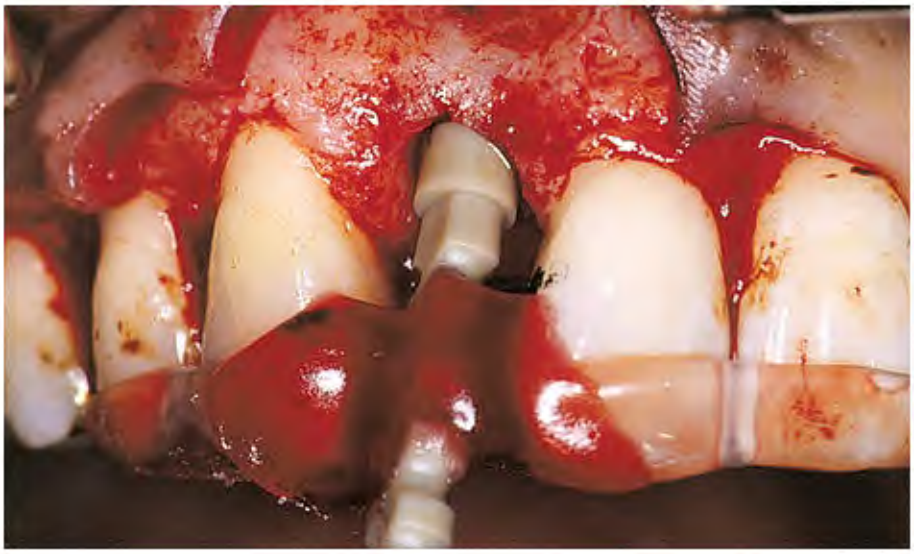


Fig 4-5c Recording the position of the implant.



Fig 4-5d Healing abutment as “supporting column” for the gingiva.

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Fig 4-5e Mobilization of the flap by periosteal slitting.



Fig 4-5f Provisional restoration based on a thermoplastic splint.

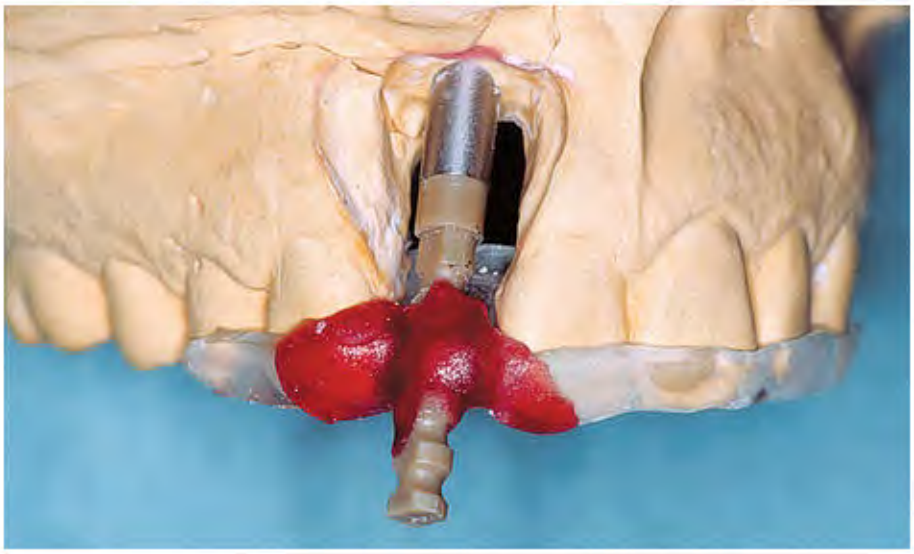


Fig 4-5g Secondary placement of the model implant.

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Fig 4-5h Provisional crown on the plastic cylinder.



Fig 4-5i Clinical situation before exposure.



Fig 4-5j Incision.

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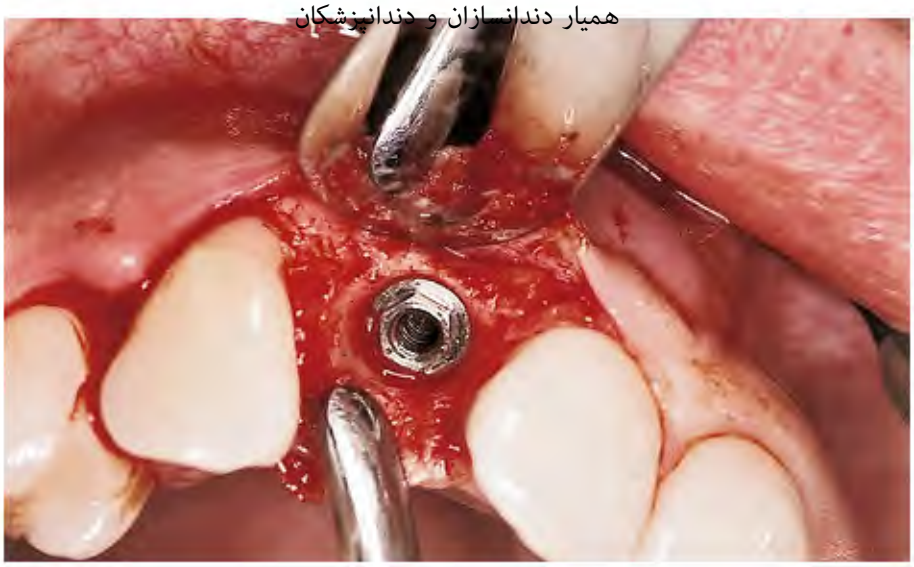


Fig 4-5k Removing the healing abutment.

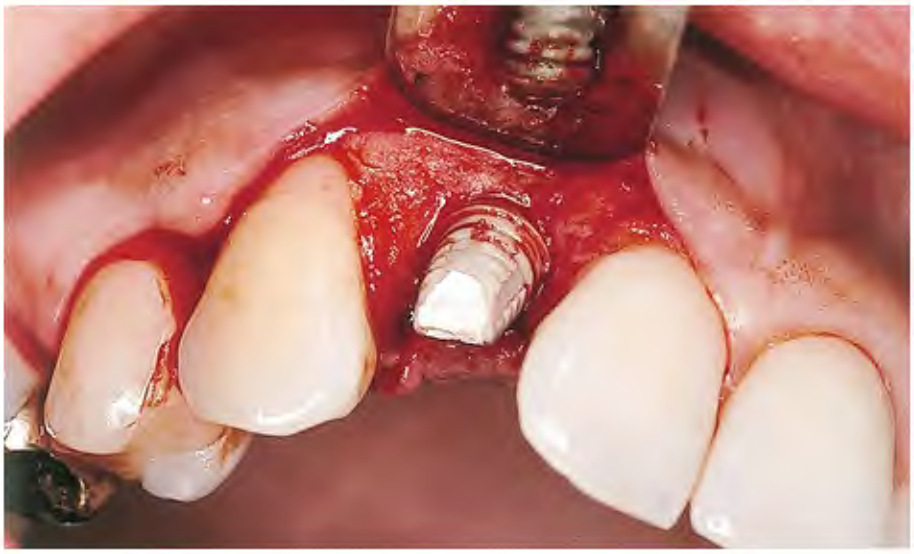


Fig 4-5l Provisional cylinder screwed into place.

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Exposure

The 6-month healing phase was uncomplicated and the height of the soft tissues remained largely stable. Since augmentation had been decided against at the time of implant placement due to the incomplete healing of the apical periodontitis, the horizontal shaping of the residual ridge remained incomplete. The lack of bone support contributed to the fact that the metallic healing abutment shimmered through the slightly receded mucosa (Fig 4-5i).

To improve the esthetic situation, the bone augmentation was performed in the same session as the implant exposure.

The incision for this was made on the labial side in the sulcus of teeth 14, 13 and 11, shifting it slightly in the palatal direction around the implant. Only one papilla between teeth 14 and 13 was lifted (Fig 4-5j). Gentle lifting of the flap revealed that the bone loss had remained moderate due to the supporting function of the healing abutment. After removing the healing

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abutment (Fig 4-5k), the prepared provisional cylinder was screwed on first. The screw access hole was filled with gutta-percha (Fig 4-5l) and the provisional crown secured into place with TempBond; any excess of the latter can be removed under visual control (Fig 4-5m).

To ensure good spatial relationships when shaping the papillae, the interproximal spaces between the implant and the neighboring teeth were kept as clear as possible. In order to provide bone support for the papilla, which is a prerequisite for its regeneration; the gaps and the thin labial bone wall were augmented with the bone substitute Biogran (Biomet 3i), without using a membrane. After this, the flap and papilla 13 to 14 were secured with mattress sutures (Fig 4-5n).



Fig 4-5m Provisional crown – space for the bone augmentation.



Fig 4-5n Stabilization of the flap with mattress sutures.

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Fig 4-5o First phase of healing.



Fig 4-5p The provisional crown has been widened.



Fig 4-5q Stabilization of the gingival situation.

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Fig 4-5r CerAdapt abutment screwed into place.

Prosthetic restoration

The patient wore the first provisional restoration during a regeneration phase lasting several months (Fig 4-5o). After approximately 6 to 8 weeks, it was possible to widen the existing resin crown slightly in the subgingival region for the first time and force the soft tissue in the proximal and labial directions (Fig 4-5p). This procedure was repeated until a satisfactory result was achieved after 6 months (Fig 4-5q). The provisional was replaced with an anatomically adapted CerAdapt abutment (Fig 4-5r). If the abutment appears too narrow at the apex in similar situations, it can be widened by adding on ceramic. When a restoration of increased diameter is first incorporated, it causes blanching of the gingiva. This should last only a few minutes; if it lasts longer, it may result in gingival damage.

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Fig 4-5s Try-in of the Procera cap.

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Fig 4-5t Replacement of tooth 12 after 1 year of functional use.



Fig 4-5u Esthetically integrated dental prosthesis.

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Fig 4-5v The patient can laugh again.

After the CerAdapt abutment was fixed into place with a gold screw at 32 N/cm, the screw access hole was filled with gutta-percha, the provisional relined and then provisionally cemented into place. Following a 14-day gingival stabilization phase, the CerAdapt abutment was slightly reworked and shaped in the same way as a prepared tooth. An all-ceramic Al2O3 cap can be fabricated with the aid of the Procera method. This cap is checked for fit inside the mouth (Fig 4-5s). Once the Procera cap is faced with AllCeram ceramic (Procera), the finished crown can be fixed into place with adhesive (Fig 4-5t).

Figures 4-5t, 4-5u and 4-5v show the restoration 1 year after the surgical procedure.

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Treatment course

- Implant placement (1997)
- 6 months to exposure
- 6 months to definitive prosthetic loading

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski
Dental technology: Horst Mosch

Atypical treatment course – problematic baseline situation

In patients presenting with malformations – such as dental agenesis, particularly of the lateral incisors – the gaps are often very narrow due to the accompanying maxillary

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hypoplasia. For this reason, implants now represent the best long-term restoration for this problem, both esthetically and functionally. An implant-based restoration means that healthy teeth do not need to be prepared for a bridge. Moreover, it is often possible to reconstruct atrophied segments of the residual ridge during the operation. In a few cases, the gap between the central incisor and the canine is too small for the insertion of a standard Brånemark implant (regular platform [RP], diameter 3.75 mm). Implants of reduced diameter have been developed for cases like these. An implant of this type (narrow platform [NP], diameter 3.3 mm) made it possible to perform an implant-based restoration in the following case.

Single-tooth implants in an adolescent girl presenting with shortage of space

Baseline situation

A 17-year-old girl presented with agenesis of teeth 12 and 22. Teeth 13, 11, 21 and 23 were free of caries (Fig 4-6a). The gap in region 12 was 4.5 mm wide, while the gap in region 22 was narrower than 4 mm. Gaps at least 6- to 7-mm wide should be available for the placement of a standard implant. Therefore, the plan was to use two NP implants for the restoration of the gaps (see radiograph with measuring template, Fig 4-6b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph with reference objects
- Dental cast analysis

Treatment plan

1. Implant placement and augmentation, recording the positions of the implants
2. Fabrication of provisional restorations – Simpler in Practice
3. Exposure and incorporation of the provisionals
4. Definitive ceramic crowns

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Fig 4-6a Clinical baseline situation.



Fig 4-6b Panoramic measuring radiograph with template.

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Fig 4-6c Recording the positions of the implants.



Fig 4-6d Residual ridge before augmentation/Implant placement.

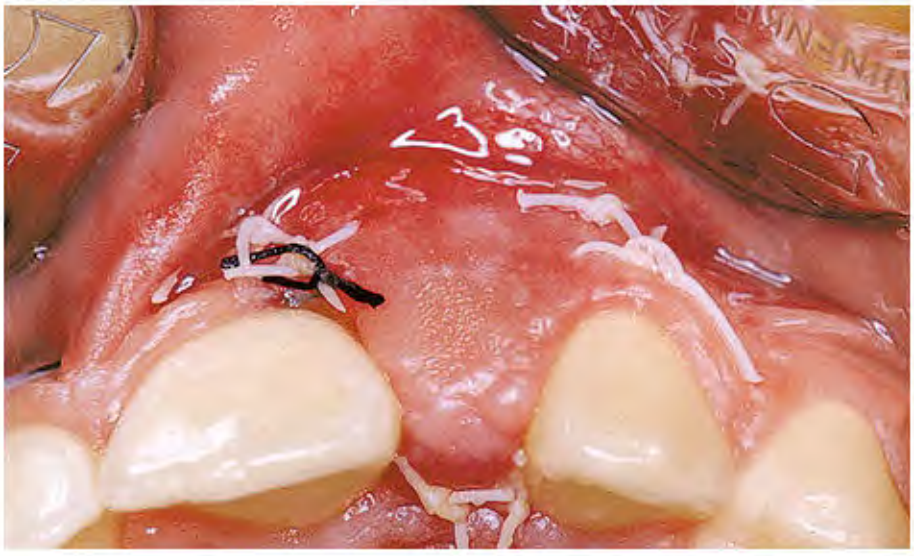


Fig 4-6e Overcontouring shortly after augmentation.

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Implant placement

Before implant placement, the missing teeth were waxed up onto the situational cast for diagnostic purposes. Two 15-mm long NP implants were inserted following the appropriate diagnostic process. Immediately after the implants were inserted, their positions were recorded by fixing impression copings onto the baseplate (Fig 4-6c).

For improved esthetics, the atrophied alveolar bone was augmented during the same procedure using the bone substitute Bio-Oss and the guided bone regeneration (GBR) membrane Bio-Gide (Figs 4-6d, 4-6e and 4-6f). To achieve normal residual ridge contours (Fig 4-6f), a bone substitute loss of approximately 30% needed to be taken into account in the augmentation. This meant that overcontouring was necessary when augmenting the alveolar process (Fig 4-6e). The small diastema between teeth 11 and 21 had already closed up spontaneously at the time of exposure (compare Figs 4-6a and 4-6l). Because of this change in position of the teeth, the missing teeth were once again waxed up on the updated situational cast (Fig 4-6g). To ensure symmetry of the teeth, tooth 21 had to be stripped on the distal side to make it approx 0.2 mm narrower. In the laboratory, the positions of the implants were transferred from the baseplate to the cast (Fig 4-6h). At the time of this patient's treatment, the single tooth replacement (STR) abutment with its thin walls and minimal diameter represented the abutment of choice in situations with very limited space.

STR abutments with a height of 2 mm were chosen in this case (Fig 4-6i). The abutments were shortened as required and prepared for prosthetic purposes (Fig 4-6j). Provisional plastic crowns were initially fabricated on the abutments (Fig 4-6k).

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Exposure

The 7-month healing period was uncomplicated (Fig 4-6l). For the exposure, the incision was made slightly toward palatally, to displace the gingiva in the labial direction for better esthetics.

STR abutments (2 mm high) were fitted into place and tightened with a torque controller (20 N/cm). Before the wound was sutured, the screw access holes were filled with gutta-percha (Fig 4-6m) and the provisional crowns put into place with TempBond (Fig 4-6n). This sequence ensured that any excess cement could be removed under visual control. The follow-up radiograph shows the precise fit of the implant components (Fig 4-6o) with minimal interproximal spaces between the implants and the neighboring teeth. Two months after exposure, the gingival situation was largely stable (Fig 4-6p), allowing the definitive ceramic crowns to be fabricated and also fixed into place with provisional cement. The photos 6 years after implant placement show a stable gingival situation and the natural appearance of the anterior teeth in the maxilla (Figs 4-6q and 4-6r).

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Fig 4-6f Stabilization of the gingival situation.



Fig 4-6g Wax-up.

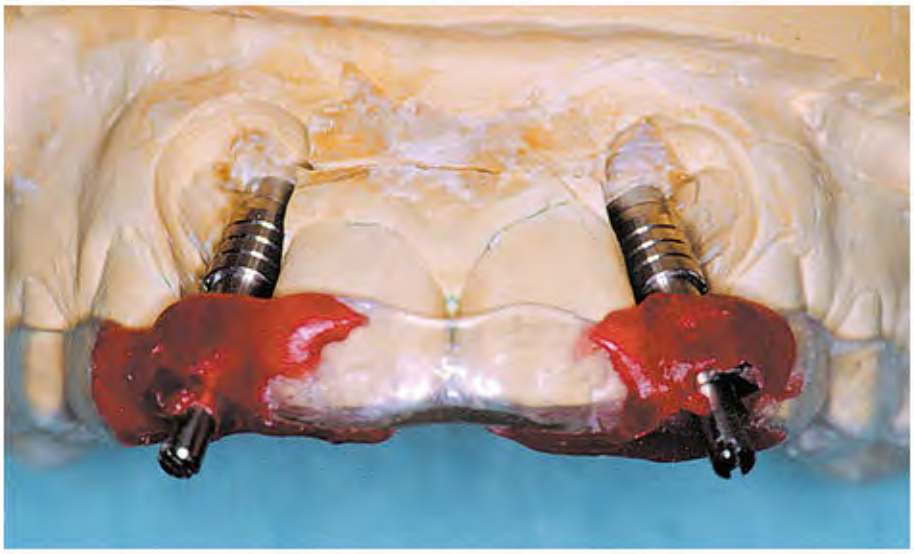


Fig 4-6h Transferring the positions of the implants to the cast.

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Fig 4-6i STR abutments screwed into place.



Fig 4-6j Customizing the STR abutments.



Fig 4-6k Provisional crowns.

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Fig 4-6l Clinical situation prior to exposure.



Fig 4-6m STR abutments fitted into place.



Fig 4-6n Provisional crowns.

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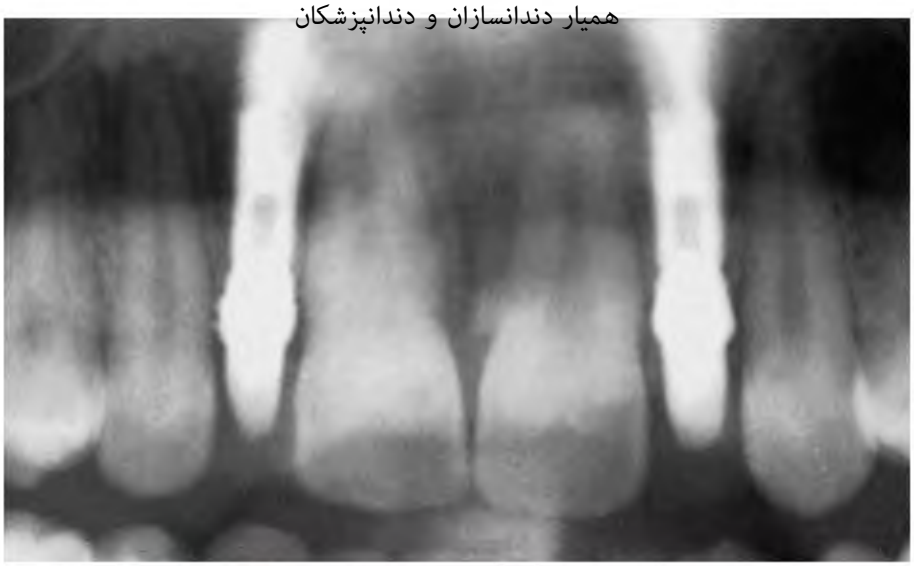


Fig 4-6o Follow-up panoramic radiograph.



Fig 4-6p Stable gingival situation.



Fig 4-6q Prosthetic restoration after 6 years of functional use.

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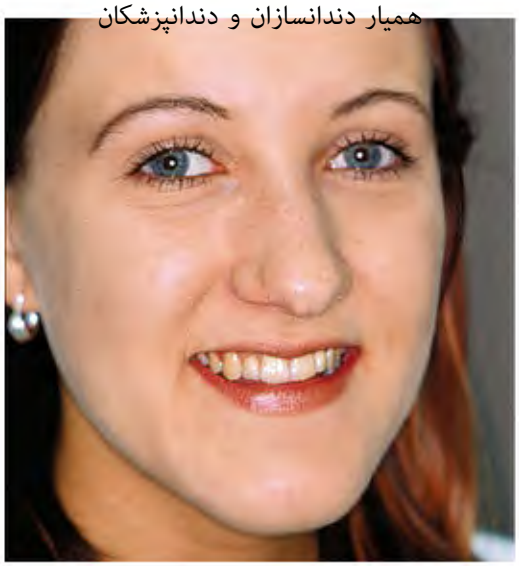


Fig 4-6r The patient is satisfied with her treatment.



Fig 4-6s Clinical situation after 14 years with implant crowns that are now too short.



Fig 4-6t Follow-up panoramic radiograph after 14 years.

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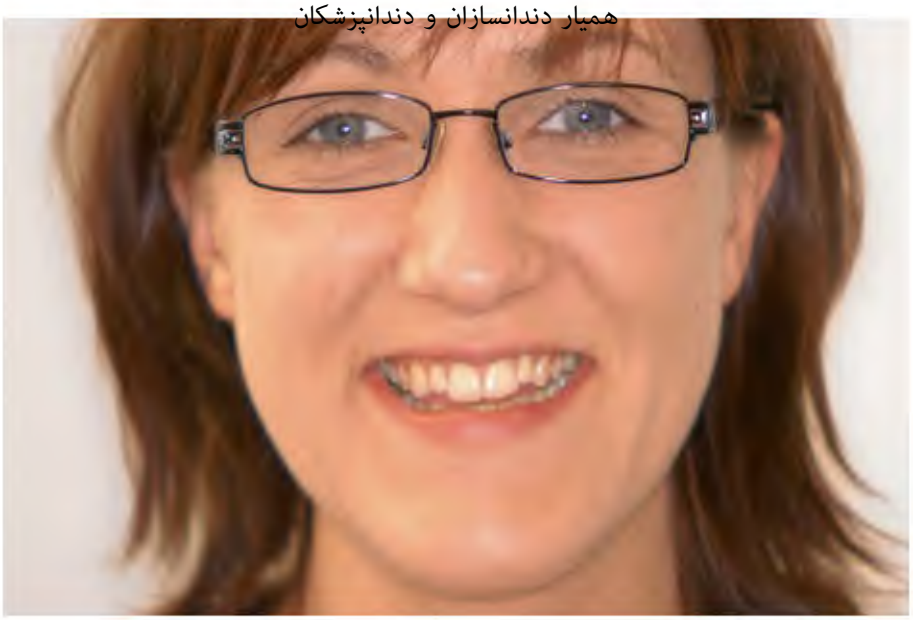


Fig 4-6u In the interim, the adolescent patient has grown into an adult woman.

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Continued follow-up

A check-up after 14 years shows that the jaw did continue to grow during this period and that the implant crowns are now visibly too short (Fig 4-6s; see also Note on page 250). However, the follow-up panoramic radiograph after 14 years shows a stable osseous situation around the implants and confirms the success of the implant treatment (Fig 4-6t). The adolescent patient has now become a businesswoman, has children of her own and is still satisfied with the final result of her treatment (Fig 4-6u). Moreover, she expresses little interest in replacing her old crowns, which are now too short with new, longer ones.

Treatment course

- Implant placement and augmentation (1996)
- 7 months to exposure
- 2 months to definitive loading

Treatment

Surgery and Prosthetics: Dr Christoph T. Sliwowski
Dental technology: Horst Mosch

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Note

Implants in adolescents



Fig 4-7a Crown 12 after insertion.



Fig 4-7b Crown 12 after 2 years.



Fig 4-7c Crown 12 is now visibly too short after 14 years.

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Fig 4-7d Crown 22 after insertion.



Fig 4-7e Crown 22 after 2 years.



Fig 4-7f Crown 22 after 14 years with the gingival margin running too far in the apical direction.

As a matter of principle, when providing adolescent patients with an implant-based restoration, it will be necessary to establish whether bone growth is complete (for example, by means of a hand-wrist radiograph). If implant placement is performed too early, it can inhibit growth locally in the maxilla, possibly resulting in esthetic and functional defects. If doubts still remain in spite of extensive diagnostic investigations confirming that bone growth is complete, the provisional retention of implant crowns offers the option of subsequent correction. In the present case, both the hand-wrist radiograph and the patient's age of 17 years indicated that bone growth had largely been completed. The experiences of several authors in the treatment of adolescents, which made up the topic of the Consensus Conference in Jönköping in Sweden in November 1995, along with the experiences of the present author, suggest that minor signs of growth can continue to occur up to the age of 23 years, ie, long after the statistic completion of growth.

Changes in tooth length were also still apparent in this case. Figure 4-7a, a photograph

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taken during the surgical correction of the mesial papilla a few weeks after exposure, shows a well-balanced course of the incisal edges of teeth 13, 12 and 11. Figure 4-7b, taken 2 years later, shows that teeth 13 and 11 have continued to "grow" (as a result of appositional growth of the maxilla), while the incisal edge of implant crown 12 has not followed those of the neighboring teeth. A similar situation can be seen on the left side in implant 22 (Figs 4-7d and 4-7e). Since the implant crown had only been provisionally cemented on, it could be removed at any time without causing any damage and elongated by adding on ceramic (see Fig 4-6q, p. 248).

Continued follow-up

Examination of the patient 14 years after the implant placement provides interesting information. The completed bone growth, as diagnosed previously, had not been confirmed and implant crowns 12 and 22 are now considerably shorter than the patient's own teeth, especially 11 and 21. Compared to Fig 4-7b, crown 12 is still too short, but the gingival margin blends in harmoniously with the overall appearance of the mouth (Fig 4-7c). Crown 22, however, is not only too short, but the gingival margin, which runs too far in the apical direction, disrupts the harmony of the anterior teeth (Fig 4-7f).

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Atypical treatment course – problematic baseline situation

Emergency implant placement following traumatic loss of an anterior tooth

Baseline situation

A female patient, working as an assistant at a prosthodontic practice, had been dissatisfied with the esthetic appearance of tooth 21 for many years: the crown, fitted onto a post and core, was too short and part of the root showed as a dark margin at the cervical end (Fig 4-8a). A new restoration had been planned for some time, but not yet realized. The tooth itself had acted as a trigger for the treatment, having fractured along its root (Fig 4-8b). There could be no further delay now, and quick action was needed. While inflammation around the root of tooth 21 is clearly visible in all planes in the CBCT scan, it is also apparent that there is sufficient bone at the apex to provide a stable anchor for an implant (Fig 4-8c). A 17-mm long implant (4 mm in diameter) was planned in the SimPlant program (Fig 4-8d).

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- Dental film
- CBCT and SimPlant planning

Treatment plan

1. Extraction of the root residue of tooth 21 and immediate implant placement with augmentation
2. Exposure with gingival correction
3. Prosthetic loading



Fig 4-8a Esthetically displeasing restoration of tooth 21.

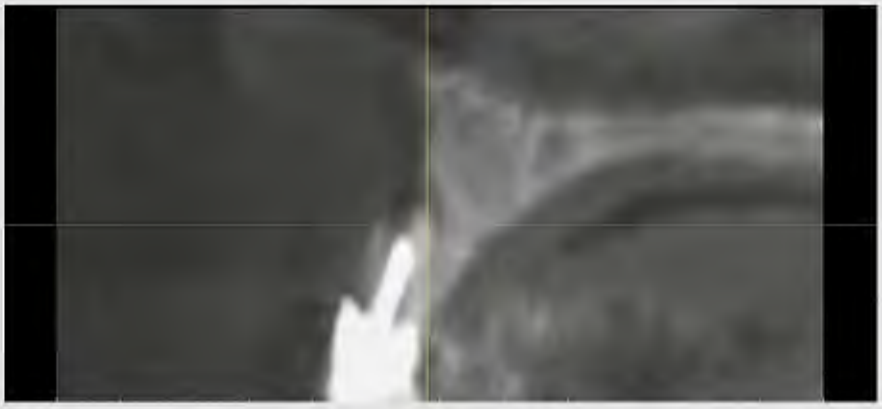


Fig 4-8b Split root of tooth 21 in cross section.

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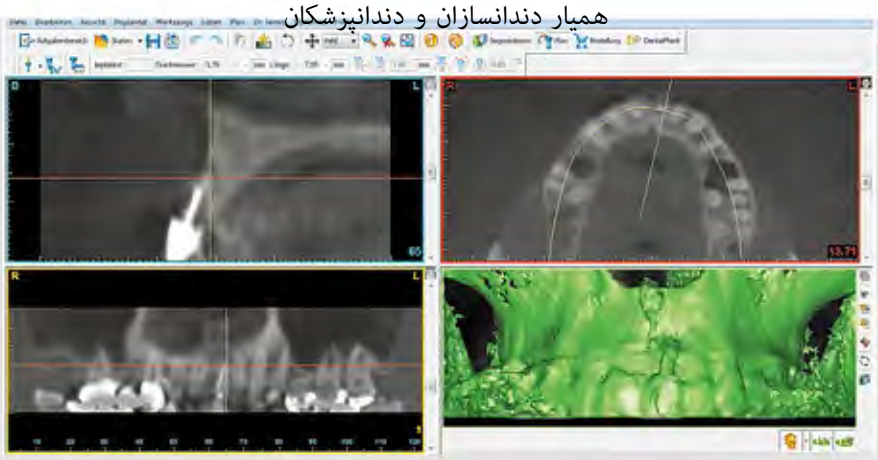


Fig 4-8c CBCT before the extraction.

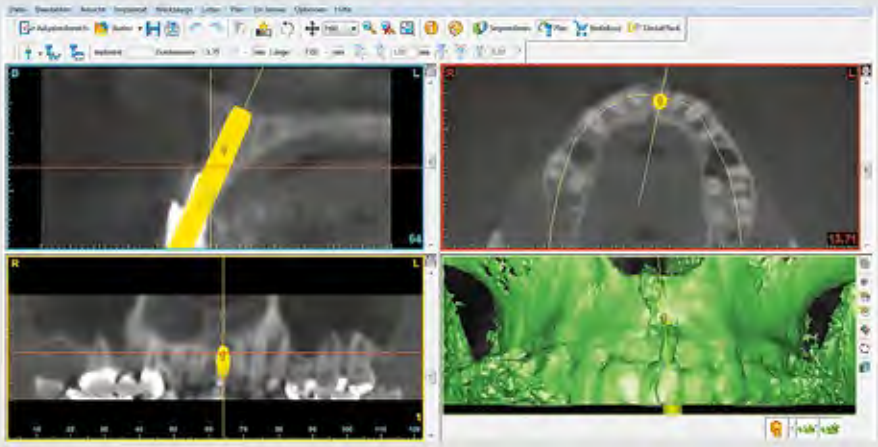


Fig 4-8d SimPlant planning of the immediate implant placement in region 21.

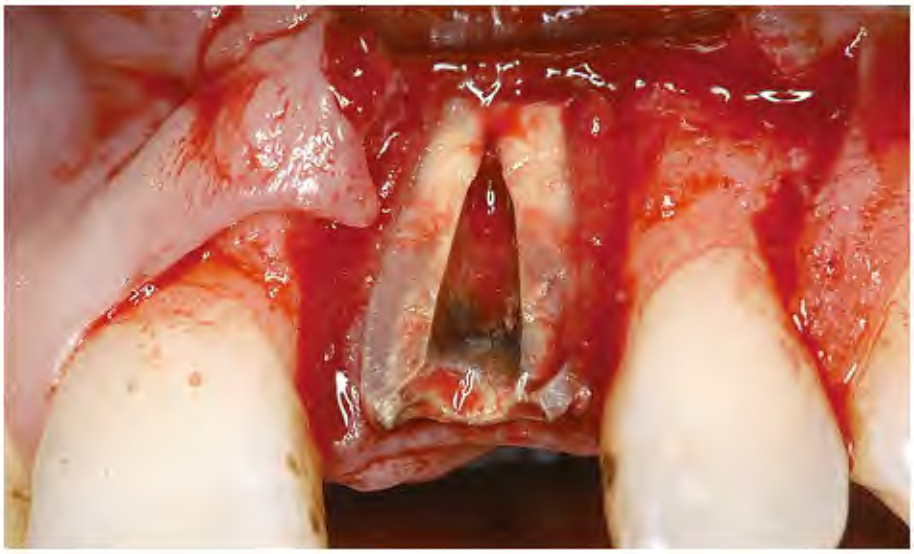


Fig 4-8e Split root of tooth 21 following flap reflection.

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Fig 4-8f Inserted implant with healing abutment.

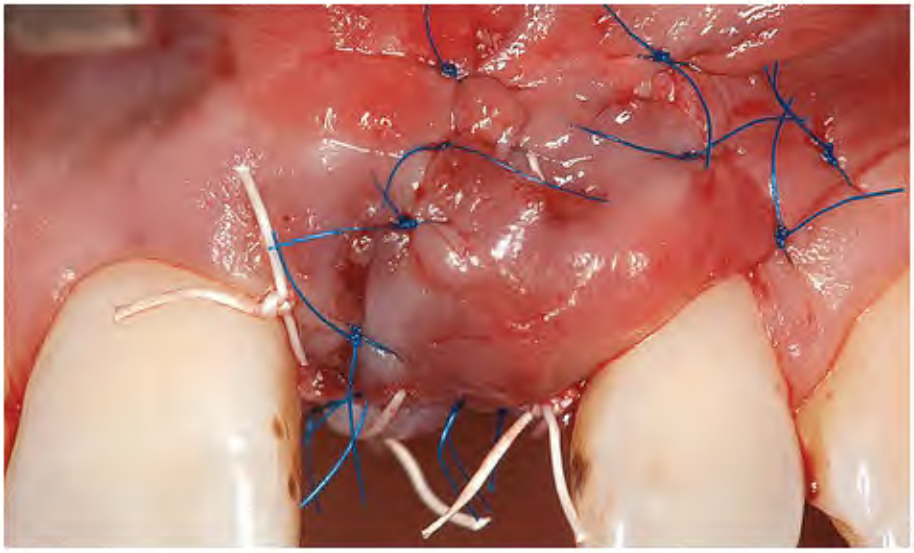


Fig 4-8g Laterally transposed split flap, pedunculated at the coronal end, secured into place with sutures.



Fig 4-8h Clinical situation 4 weeks after implant placement.

Extraction and implant placement

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Following conduction and infiltration anesthesia, the crown was first removed with the root pin. The gingival bridges in the interproximal spaces were cut and a releasing incision made distally of tooth 22 (Fig 4-8e). The palatal half of the root was removed with the granulation tissue and the bone bed refreshed. A 17-mm long Neoss implant (4 mm wide) was inserted into the extraction socket in accordance with the SimPlant planning. There was a total absence of bone on the labial side. A 2.7-mm long healing abutment was screwed onto the implant for better support of the augmentation materials (Fig 4-8f). First, the harvested bone chips were packed on the labial side of the implant and in the interapproximal spaces, followed by the regenerative bone substitute Bio-Oss. The augmented area was covered with a resorbable membrane (Tutodent, Tutogen; 15 × 20 mm), attached at the apical end with two titanium pins. Following the augmentation, saliva-tight suturing presented a great challenge in this situation. To do this, a split flap, pedunculated at the coronal end, was created and mobilized in its entirety. However, this was not sufficient to cover the wound, so that the flap also had to be transposed from distally to mesially. The flap was secured into place in this position with Gore-Tex (W. L. Gore and Associates) and 6-0 sutures (Fig 4-8g). However, the lateral transposition caused unwanted coverage of tooth 22 with unattached mucosa. The sutures were removed in three stages after 1, 2 and 4 weeks (Fig 4-8h).

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Fig 4-8i Gingival situation prior to exposure.

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Fig 4-8j Loop suture for apical fixation of the flap.

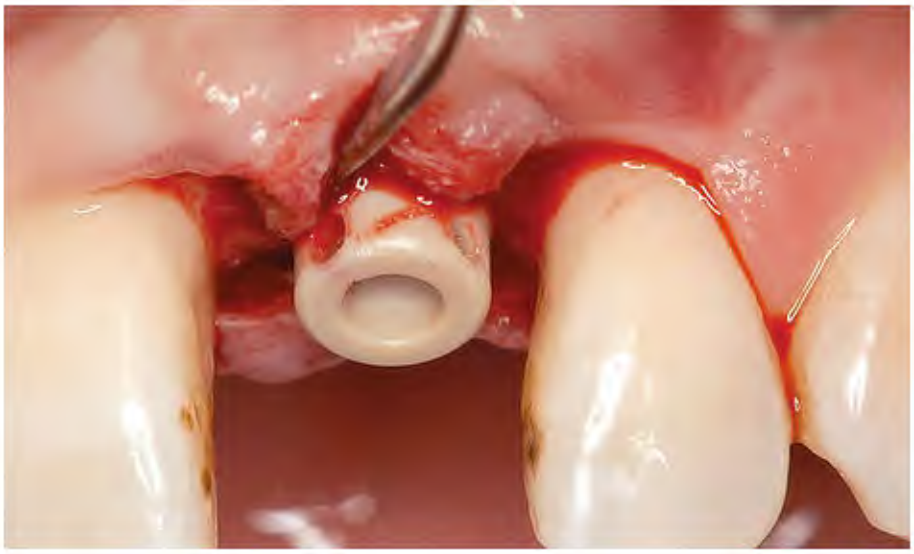


Fig 4-8k Perforations in the healing abutment.

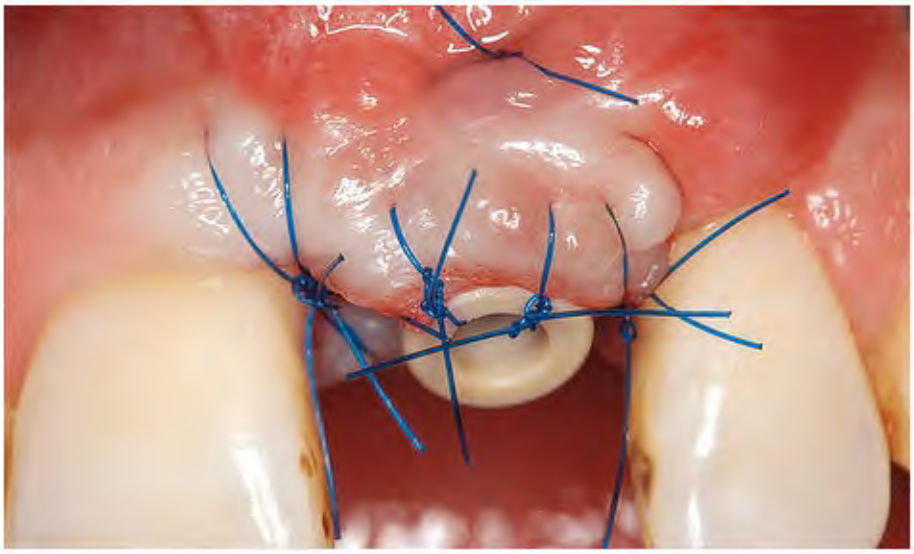


Fig 4-8l Mucosal distraction.

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Fig 4-8m Long-term provisional restoration.

Exposure with vertical mucosal distraction

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Implant 21 was exposed after 7 months' healing (Fig 4-8i). The incision was made palatally of the implant and the flap mobilized slightly toward the labial side without release. A loop suture was made around the implant to secure the flap and to force the gingiva back in the apical direction (Fig 4-8j). Two small perforations were made in the new, 5-mm high polyetheretherketone (PEEK) healing abutment to hold the sutures in place (Fig 4-8k). This allows the flap to be securely attached to the implant. Adaptation in the interproximal spaces was also performed using microsurgical sutures (Fig 4-8l). Two months after exposure, a crown was fabricated on the provisional abutment and incorporated as the long-term provisional restoration (Fig 4-8m).

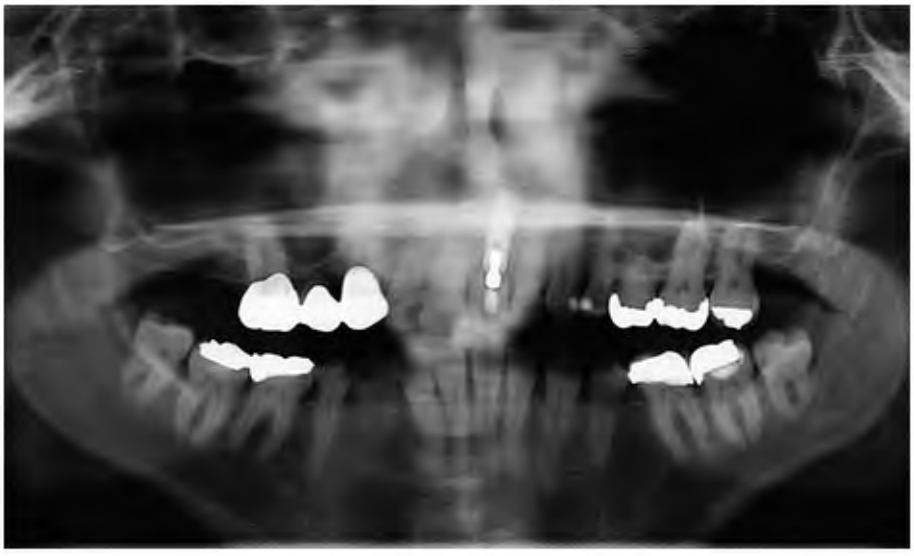


Fig 4-8n Panoramic radiograph after 5 years.

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Fig 4-8o Provisional implant crown 21 after 5 years of functional use.



Fig 4-8p Satisfied patient.

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Continued follow-up

Figures 4-8n and 4-8o show the follow-up panoramic radiograph and the restoration, still only provisional, with the labial screw access hole after 5 years in functional use. The patient is very happy with the long-term provisional and is not interested in having a definitive ceramic crown fabricated (Fig 4-8p).

Treatment course

- Extraction and immediate implant placement with augmentation (2007)

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- 7 months to exposure with vertical mucosal distraction
- 2 months to provision of the long-term provisional

Treatment

Surgery and provisional crown: Dr Christoph T. Sliwowski
Dental technology: Horst Mosch

Problems and complications

If no preventive measures are taken, the loss of teeth is always followed by residual ridge atrophy in this region. When the atrophy is mild, an esthetically pleasing result can also be achieved without bone augmentation. If the osseous situation at baseline is poor, failure to carry out augmentation almost always causes problems later on. Provided that the mucosa is not perforated, augmentation can be left until the time of implant exposure. Mucogingival surgery techniques are also available where esthetic improvements are needed.

Spontaneous perforation of the mucosa

Baseline situation

This 19-year-old woman has lost tooth 12 due to apical periodontitis associated with chronic fistulation. A single-tooth implant was inserted after a waiting period of 3 months. Augmentation was not performed at the patient's request (Fig 4-9b). In this case, simple exposure by mucosal punching would have caused irreversible damage – the head of the implant and the screw threads would have been exposed. Because of the perforation, direct correction by packing bone onto the defect appeared too risky at the time. A mucosal graft offered itself as the treatment of choice in this situation. This allows the visible metal components to be covered by mucogingival surgery. These regenerative measures were to take place, at the time of implant exposure.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental film

Treatment plan

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1. Implant placement without augmentation
2. Exposure
3. Prosthetic loading



Fig 4-9a Healing phase following the insertion of implant 12 (no bone augmentation).



Fig 4-9b Spontaneous perforation of the mucosa over the implant.

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Fig 4-9c Superficial incision into the mucosa.



Fig 4-9d Split-flap technique with the connective tissue cut as far palatally as possible.

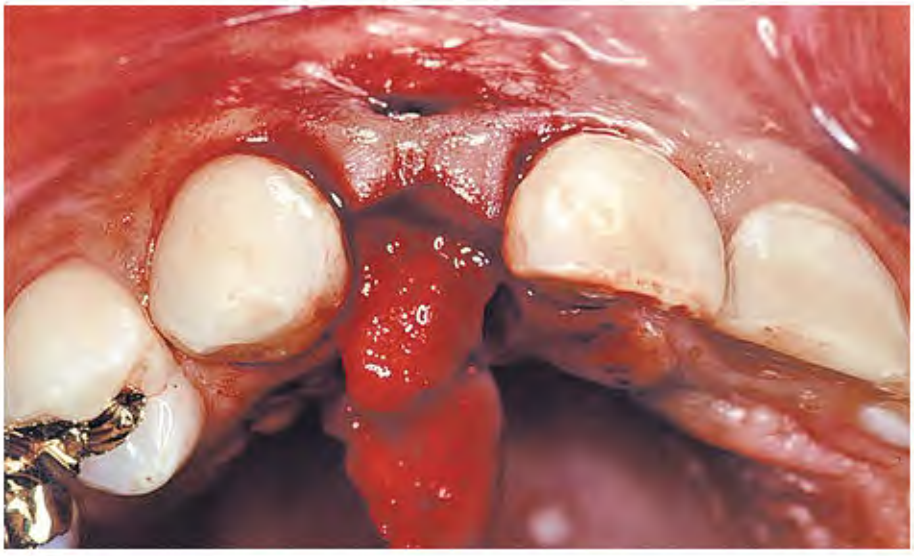


Fig 4-9e Mobilization of the connective tissue flap from the palate.

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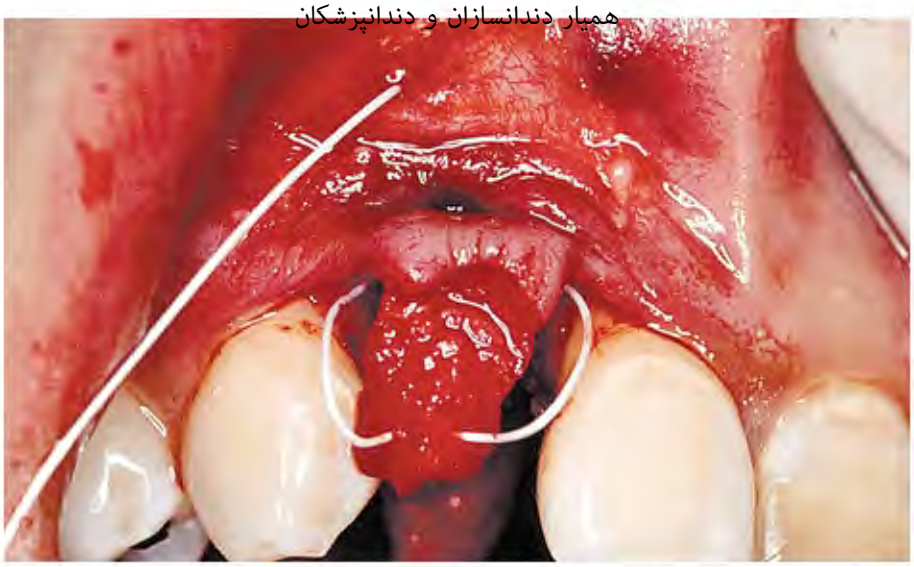


Fig 4-9f The flap is being pulled into the labial vestibule with the aid of the “reins” (roll flap technique).

Mucosal graft and implant exposure

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The incision was made on the palatal side, in the mucosa only. The underlying subepithelial connective tissue was not cut (split-flap technique; Fig 4-9c). A mucoepithelial flap approximately 10 mm long was dissected away in the palatal direction and the underlying layer cut through completely at the end of the dissection (Fig 4-9d). The connective tissue on the palatal side, still pedunculated, was mobilized away from the bone, working apically to coronally (Fig 4-9e).

Continuing the microsurgical procedure, the the labial full-thickness mucoperiosteal flap, together with the pedunculated palatal connective tissue, was dissected away from the bone. A back-stitch suture starting deep in the labial vestibule was taken over the pedunculated, palatal tissue to form “reins,” and then pulled back out in the vestibule (Fig 4-9f). Tightening the suture (the “reins”) pulled the palatal connective tissue under the labial flap, fixing it into this position (the roll flap technique; Fig 4-9g). At the same time, the cover screw was replaced with the healing abutment. The perforation was completely covered. This was followed by adaptation of the papillae and secure closure by suturing (Fig 4-9h). The sutures remained in situ for 2 to 3 weeks, until gingival stabilization first became apparent. When compared with Fig 4-9b, the excess gingiva on the labial side following removal of the sutures (Fig 4-9i) looks like a conspicuous gain in tissue. However, some subsequent atrophy is to be expected.

Prosthetic loading

If a gingiva deficit has developed around the head of an implant, an all-ceramic abutment is the device of choice. In the present case, the implant was also loaded with an all-ceramic abutment (CerAdapt; Fig 4-9j). After the gingival situation has stabilized completely, an all-

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ceramic crown can be incorporated using the adhesive technique. The final photo shows the clinical situation 2 years after the implant was loaded with the prosthesis (Fig 4-9k).

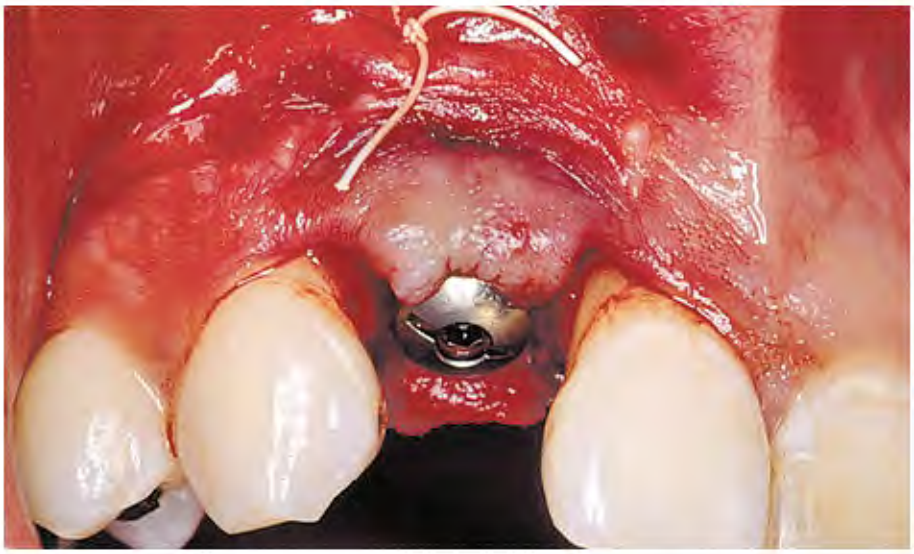


Fig 4-9g Tightening the “reins.”

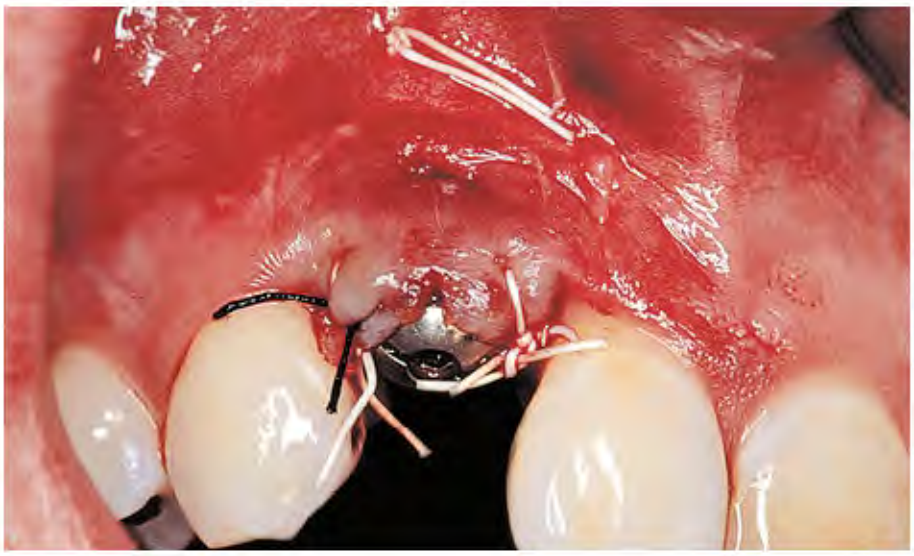


Fig 4-9h Secure closure via additional suturing.

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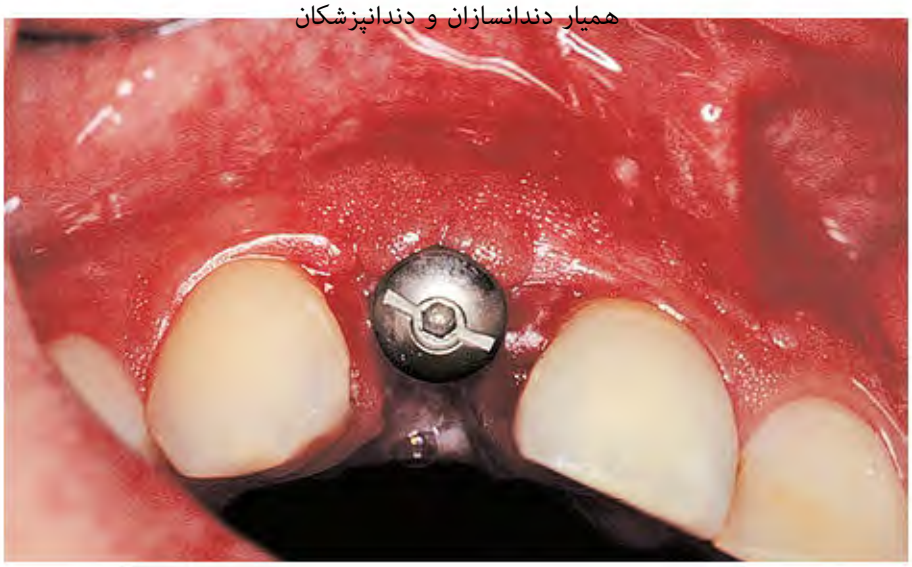


Fig 4-9i Excess gingiva.



Fig 4-9j The CerAdapt abutment screwed into place.



Fig 4-9k Clinical situation after 2 years.

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Treatment course

- Extraction (1997)
- 3 months to implant placement
- 7 months to exposure
- 6 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Note

Fracture risk of ceramic abutments



Fig 4-10a Fractured CerAdapt abutment.

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Fig 4-10b Fracture site at screw level.

Grinding a ceramic abutment to shape requires not only experience, but also a lot of care. If an abutment is ground away too much, it can be weakened to such an extent that it fractures when tightened with a torque controller (Fig 4-10a). It is particularly prone to fracturing if the preparation extends so far as to be exactly flush with the upper edge of the retaining screw (Fig 4-10b). It is therefore essential to adhere to the minimum thicknesses recommended by the manufacturer.

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Problems and complications

Biological and mechanical complications: suture dehiscence and loosening of the screw retention

Baseline situation

This female patient was not satisfied with her present replacement of tooth 11 with a fixed partial denture spanning teeth 12 to 22, due to its poor esthetics. She was bothered by the added on pink ceramic at the cervical end and the absence of interdental spaces between the anterior teeth (Fig 4-11a). Tooth 11 should be replaced by a single-tooth implant. The use of pink ceramic in the present restoration suggested a hard and soft tissue deficit and indicated a need for regeneration.

Diagnostic tools

- Clinical examination
- Panoramic radiograph

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- Dental film

Treatment plan

1. Implant placement with augmentation
2. Exposure with gingival correction
3. Prosthetic loading



Fig 4-11a Baseline situation.

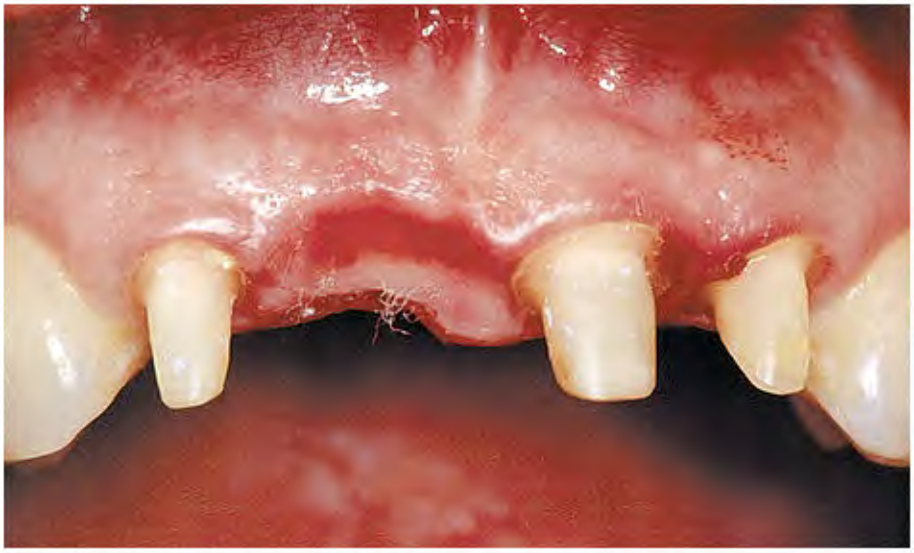


Fig 4-11b Residual ridge atrophy.

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Fig 4-11c Overcontouring of the augmentation.

Implant placement, augmentation and suture dehiscence

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Removal of the fixed partial denture confirmed the need for augmentation (Fig 4-11b). A 15-mm long MK-III RP implant (Brånemark) long was inserted in region 11 and loaded with a 3-mm healing abutment for soft tissue support. Bone augmentation was performed with autologous bone, Bio-Oss material and a resorbable Osseoquest membrane (Gore Medical). To compensate for shrinkage of the augmentation material, it was overcontoured by approx 30% (Fig 4-11c). Flap mobilization was required to ensure full, tension-free coverage of the augmentation materials. The pontic was extensively reduced from the apical end, to ensure that it did not exert pressure on the augmentation, putting its healing at risk (Fig 4-11d). The negative factor that could impair the healing process was the patient's smoking habit. Wound dehiscence did occur after 2 weeks (Fig 4-11e). For this reason, the result of the augmentation was somewhat poorer than expected (Fig 4-11f).

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Fig 4-11d Mobilization of the flap and reduction of the pontic.

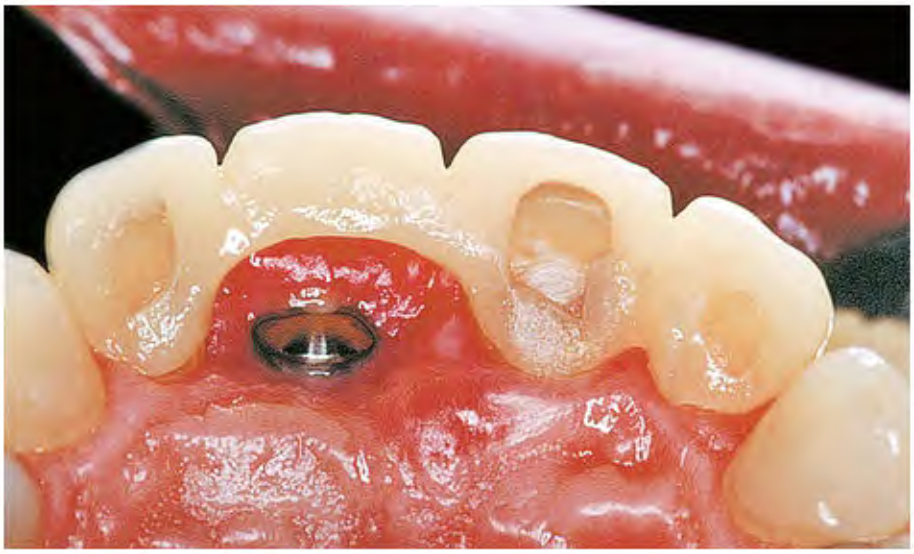


Fig 4-11e Suture dehiscence.



Fig 4-11f Partial loss of the augmentation material.

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Following gingival stabilization after exposure (Fig 4-11f), an impression of the implant head was taken and an all-ceramic crown fabricated on the CerAdapt abutment. At the same time, the individual ceramic crowns on teeth 12, 21 and 22 were prepared and cemented on. The CerAdapt abutment was fixed into place with the gold screw tightened by hand. The ceramic crown was fitted onto the abutment using the adhesive technique.

Six months after the crowns were incorporated, the patient noticed slight mobility of crown 11 on the implant. Clinical examination showed only minimal mobility of the crown and a mild inflammatory reaction around the implant (Figs 4-11g and 4-11h).

The abutment's retaining screw had loosened and needed tightening again. Access to the screw was blocked by the crown, which was held in place with adhesive. An added difficulty lay in the axis of the implant, namely that the screw channel was aligned with the labial surface and the incisal edge of the crown. A narrow channel was drilled on the palatal side to open up access to the screw without destroying the entire restoration (Fig 4-11h).

However, the driver that fitted the screw could not be placed there due to the altered axis, which meant that it could only be loosened with other instruments of smaller diameter. Once the abutment, including the crown (Fig 4-11i), was unscrewed, all the components were rinsed with 3% H_2O_2 and dried. Since the existing prosthetic restoration was not destroyed during removal, it could be used as a provisional until a new all-ceramic crown was fabricated (Fig 4-11j).

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Fig 4-11g Signs of mild inflammation caused by mobility of the crown.

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Fig 4-11h Perforation of the crown and access to the screw.



Fig 4-11i Dental prosthesis following removal.



Fig 4-11j Patient following treatment completion.

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Treatment course

- Implant placement with augmentation (1996)
- 6 months to exposure
- 6 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Gregor Cwajgart
Dental technology:	Gerhard Makowski

Problems and complications

Development of an apical cyst at an anterior dental implant

Baseline situation

This 45-year-old woman's tooth 11, already elongated, needed to be extracted due to loosening (Fig 4-12a). Since the bone supply above the tooth appeared adequate, immediate implant placement was planned at this site to prevent atrophy following extraction of the tooth (Fig 4-12b). Sinus floor augmentation was to be performed at the same time as implant placement in two quadrants.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT scan
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Sinus lift and implant placement at 24, 25 and 26; extraction and immediate implantation at 11 with augmentation
2. 6 to 9 months to exposure

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3. 6 weeks to prosthetic loading



Fig 4-12a Loose tooth 11.



Fig 4-12b Extraction of tooth 11.

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Extraction and implant placement

The sinus elevation and insertion of three implants in the posterior area, performed under full general anesthesia, was followed by the extraction of tooth 11 and cleansing of the extraction socket (Fig 4-12b). Without incision or dissection of a flap, a Biomet 3i implant 18-mm long and 3.75-mm in diameter was inserted directly into the extraction socket in accordance with the 3D SimPlant planning (Fig 4-12c). The impression for the immediate provisional restoration of tooth 11 was taken with the aid of an impression coping. Instead of a cover screw, a 5-mm high healing abutment was screwed onto the implant to provide soft tissue

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support, and the prepared plastic clip-on prosthesis was incorporated as a provisional for a short time (Fig 4-12d). The laboratory-fabricated provisional crown with no occlusal contact was incorporated a few days later and worn until the patient was fitted with her definitive restoration (Fig 4-12e).



Fig 4-12c Osseotite implant with the fixture mount still in place.



Fig 4-12d Healing abutment screwed into place.

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Fig 4-12e A provisional crown was worn during the healing phase.

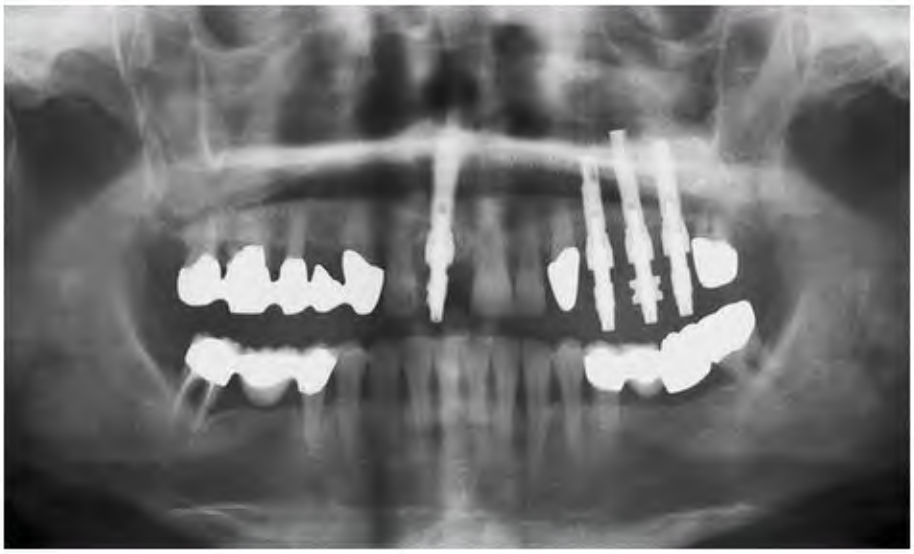


Fig 4-12f Panoramic radiograph taken during the impression taking.



Fig 4-12g Single ceramic crown 11 after 6 years in functional use.

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The posterior dental implants were exposed 9 months later. Impression copings were screwed onto all fourw implants. The impression was then taken following a check radiograph (Fig 4-12f). The three implants in the second quadrant were loaded with metal-ceramic compound crowns and implant 11 with a single ceramic crown. The clinical situation remained stable over a period of 6 years (Fig 4-12g).



Fig 4-12h Swelling of the palate.

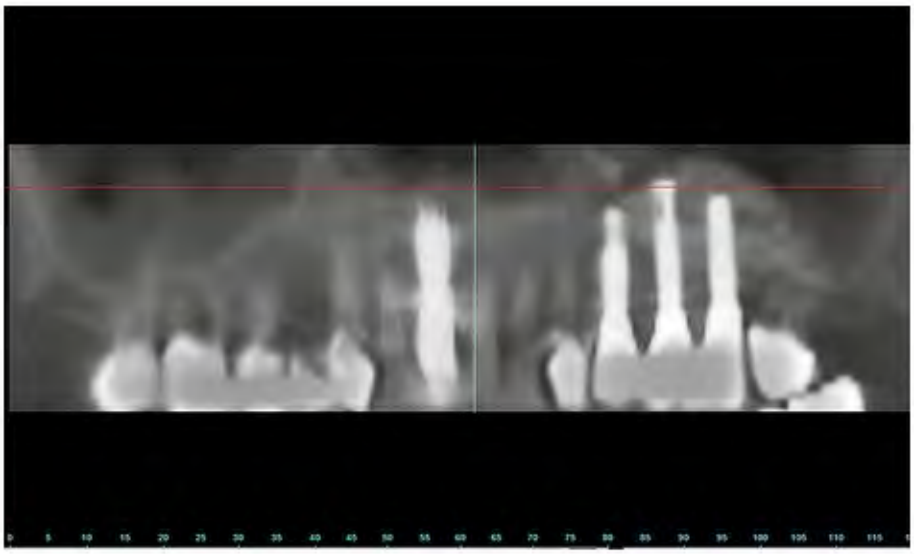


Fig 4-12i Radiolucency around implant 11.

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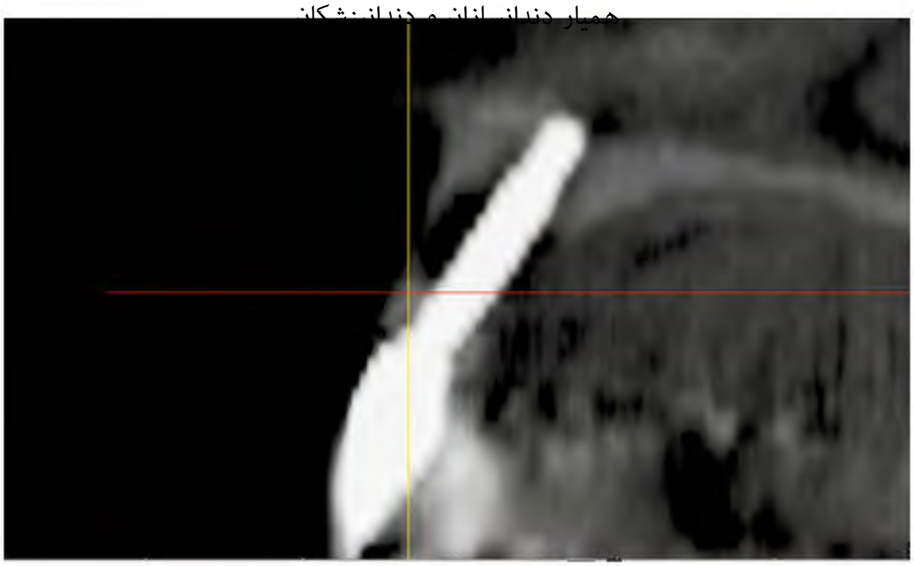


Fig 4-12j Cross-sectional view.



Fig 4-12k L-shaped access incision.

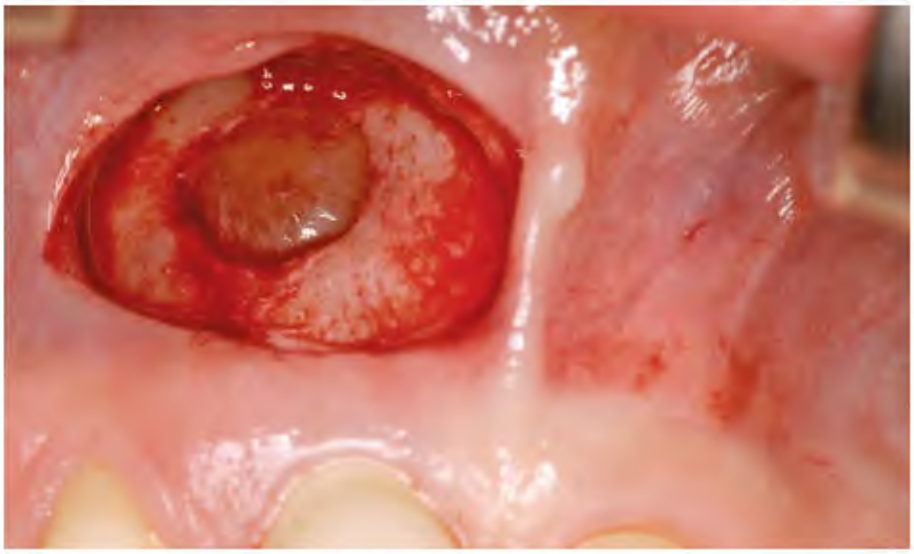


Fig 4-12l Cystic lesion.

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Fig 4-12m Removal of the cyst.



Fig 4-12n Refreshing the bone.

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Complication

Six years after implant placement, the patient complained of swelling of the palate in the region of teeth 11 and 12 (Fig 4-12h). Clinical inspection confirmed the suspected pathology. The radiograph showed a radiolucency around implant 11 (Fig 4-12i), with the cross section revealing a cystic lesion extending from the labial side to the palate and taking in approximately half the length of implant 11 (Fig 4-12j). A revision under local anesthesia was planned, although implant removal was likely to be required. However, the patient insisted on keeping the implant at any cost.

Revision

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The horizontal arm of the L-shaped access ran approximately 5 mm apically of the cervical region of 11 and 12, while the vertical arm ran along the midline. The mucoperiosteal flap was dissected away in a distal and apical direction (Fig 4-12k). A cystic lesion approximately 7 to 8 mm in diameter was revealed about 10 mm from the crown 11 (Fig 4-12l). The cyst was carefully removed, the bone walls refreshed and the implant cleaned (Fig 4-12m). The resultant cavity was generously irrigated with chlorhexidine and saline (Fig 4-12n), after which it was tightly packed with regenerative bone substitute (Bio-Oss, small particle size) saturated with gentamicin (Fig 4-12o). No membrane was used to cover the augmentation and the wound was tightly sutured with 6-0 Mopylen sutures (Resorba; Fig 4-12p). The sutures were removed after 2 weeks. Two years after the revision, the clinical situation remains stable and the patient is symptom-free (Fig 4-12q).



Fig 4-12o Filling the defect with Bio-Oss.

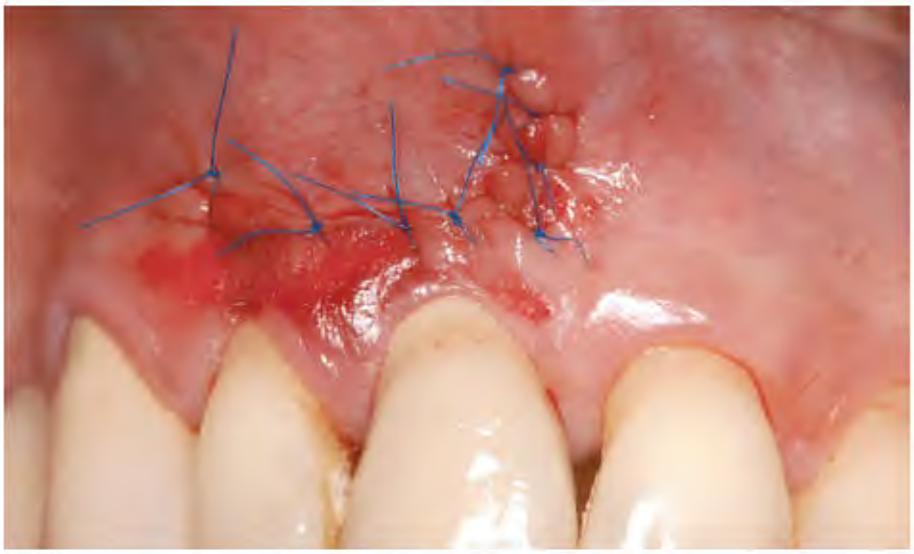


Fig 4-12p Wound closure by suturing.

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Fig 4-12q Clinical situation after another 2 years.

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Treatment course

- Left-sided sinus elevation with the insertion of three implants and extraction of tooth 11 with immediate implant placement (2002)
- 9 months to exposure and prosthetic loading
- 6 years to formation of the cyst and revision

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Immediate loading of a single-tooth implant in the presence of a well-preserved residual ridge

In cases where the gap between teeth is more extensive and more than one tooth needs to be replaced, the placement of definitive implants can also be supplemented with provisional ones. The latter provide a stable support for the provisional restoration directly after the procedure. This option is not available for single-tooth implants. In this case, immediate provisional loading of the implant represents the only chance of a fixed prosthesis, which is not dependent on other teeth. An adequate bone supply for stable anchoring of the implant is absolutely essential, and both patient and dentist need to be aware that the risk of implant loss is greater than with the conventional procedure.

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Immediate implant placement and immediate loading following extraction of the primary canines

Baseline situation

A 21-year-old woman showed agenesis of both maxillary canines. Her persistent primary teeth 53 and 63 had become very loose as a result of advanced root resorption and needed to be extracted. The neighboring teeth were free of caries and the anatomical structures, such as the interdental papillae and the gingiva line, were well preserved (Fig 4-13a). Following precise analysis of the situation in the mouth and of the study casts, implant treatment with immediate loading appeared a reasonable option. The vertical bone supply, as seen in the panoramic radiograph, allowed two 18-mm implants to be inserted (Fig 4-13b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental films

Treatment plan

1. Extraction of primary teeth 53 and 63 and immediate implant placement
2. Immediate provisional restoration
3. Definitive prosthetic loading



Fig 4-13a Baseline situation (very loose canines).

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Fig 4-13b Panoramic radiograph.



Fig 4-13c Distal releasing incision.



Fig 4-13d Advanced root resorption.

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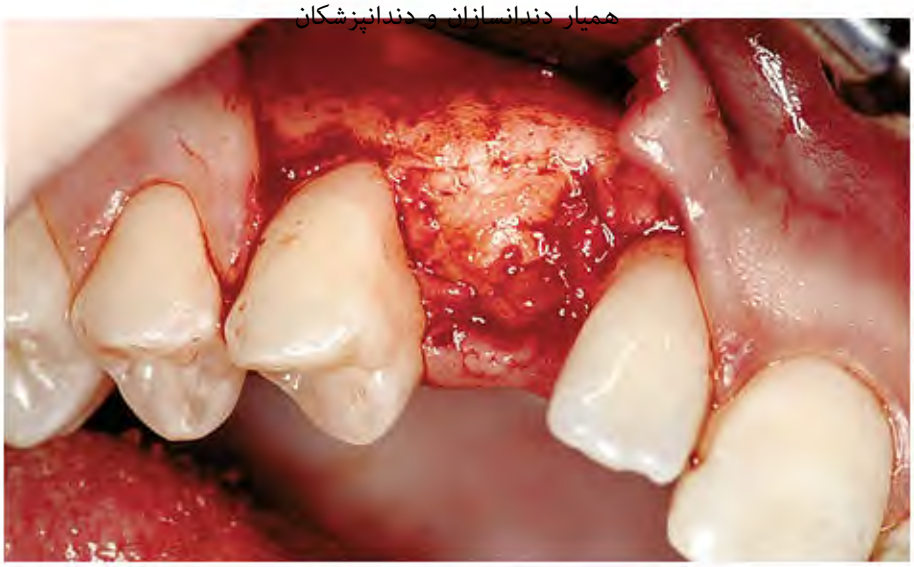


Fig 4-13e The preventive effect of primary tooth retention on the residual ridge.

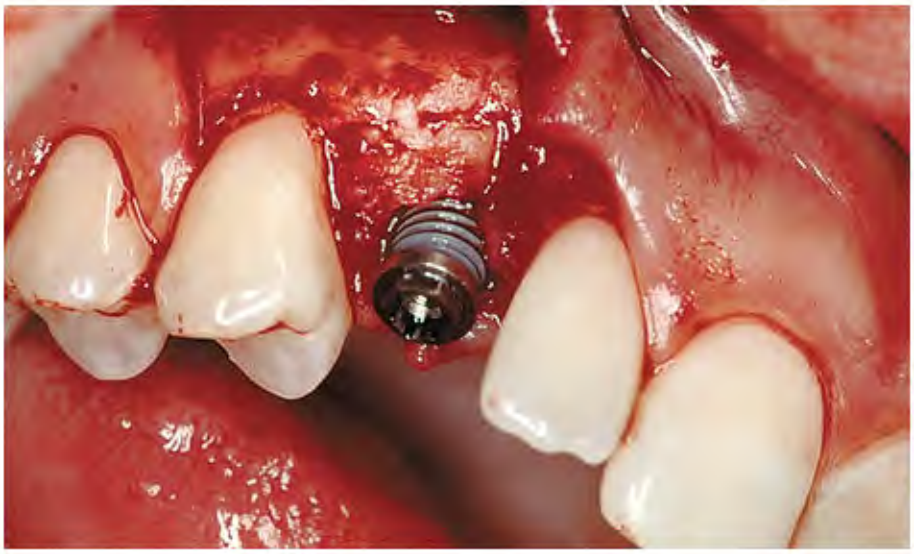


Fig 4-13f Insertion of TiUnite implants.

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Extraction, implant placement and immediate provisionals

At the patient's request, the procedure was to take place under full general anesthesia. To ensure maximum patient comfort and to preserve the soft tissue contours, the plan was to perform the extraction and implant placement in a single session. A vertical releasing incision was made at the height of the first premolar (Fig 4-13c). The mucoperiosteal flap with both papillae was cleanly separated from the necks of the teeth and dissected away. The palatal gum line was cut away and primary tooth 53 was extracted. Resorption of the root was already highly advanced (Fig 4-13d). Thanks to preservation of the primary teeth up to the time of implant placement, the residual ridge had remained very well preserved, both vertically and horizontally (Fig 4-13e). A 18-mm long MK III implant with the rough TiUnite implant surface (Nobel Biocare) was inserted to increase the likelihood of successful treatment (Fig 4-13f).

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Insertion of the implant (placed at the optimal depth of 2.5 mm below the CEJ for esthetic reasons) was followed by the incorporation of a 2-mm high CeraOne abutment (Fig 4-13g). This procedure was repeated on the other side. The provisional plastic caps were fitted onto the CeraOne abutments, the flaps repositioned and adapted around the teeth and the implants were secured with 6-0 sutures (Fig 4-13h). The papillae were stabilized further with mattress stitches. The provisional caps were cut to shape and the first provisional crowns 13 and 23 fabricated on them with the aid of a fast-curing resin and a previously prepared thermoplastic foil (Fig 4-13i). This process was made more difficult by the lack of chemical bonding between the caps and the resin. The postoperative radiograph confirms good anchoring of the implants in the bone and the precise fit of the implant components (Fig 4-13j). Impression taking during implant placement allowed the long-term provisional restorations to be fabricated in the laboratory and incorporated following suture removal (Fig 4-13k). It is important for the provisionals (both the first and the second) to be placed totally out of occlusion and to have no function in any articulation movements, whether protrusion or laterotrusion. The definitive ceramic crowns were incorporated after 6 months. The final photo shows the happy patient after the treatment (Fig 4-13l).

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Fig 4-13g CeraOne abutment screwed into place.

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Fig 4-13h Provisional plastic caps.



Fig 4-13i Immediate provisionals.

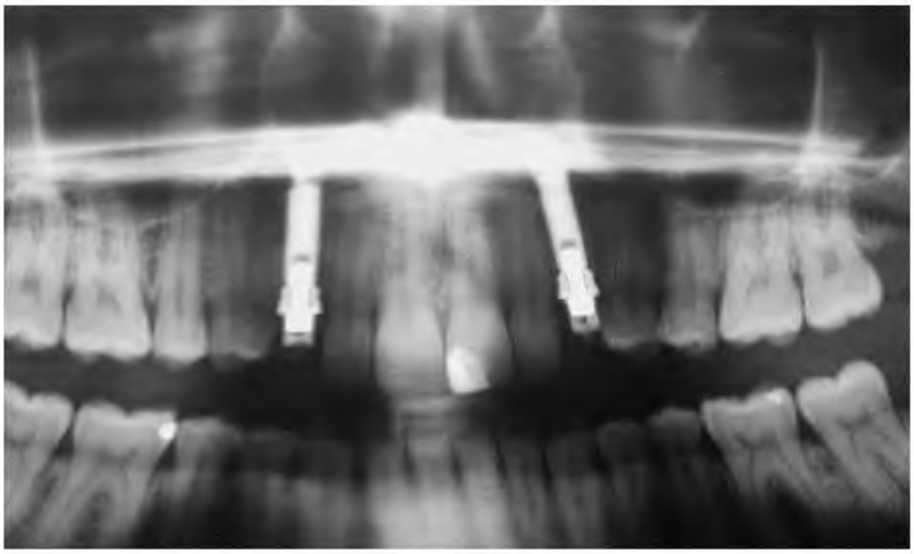


Fig 4-13j Postoperative panoramic radiograph.

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Fig 4-13k Long-term provisional restorations.



Fig 4-13l Satisfied patient.

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Continued follow-up

Nine years later, the clinical situation remains stable (Fig 4-13m). Implant 13 even shows excess gingiva, so that its crown is shorter than those of the neighboring teeth (Fig 4-13n). Implant 23 blends in harmoniously with the dental arch (Fig 4-13o). The follow-up panoramic radiograph shows a stable osseous situation around the implants after 9 years (Fig 4-13p). The patient continues to be satisfied with her implant-based restoration (Fig 4-13q).

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Fig 4-13m Definitive crowns after 9 years of functional use.



Fig 4-13n Excess gingiva around crown 13 after 9 years.



Fig 4-13o Crown 23 after 9 years.

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Fig 4-13p Panoramic radiograph after 9 years.



Fig 4-13q The patient is still satisfied with the treatment.

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Treatment course

- Extraction of primary teeth, implant placement and immediate provisionals (2001)
- 6 months to definitive loading

Treatment

Surgery and provisional crowns:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Immediate implant placement following an inflammatory process around tooth 22

This case follows on seamlessly from the 3D diagnosis on page 230.

Baseline situation

This female patient had problems with tooth 22, which had had root canal treatment. Clinical examination revealed mobility of the crown and fistulation above tooth 22 (Fig 4-14a). The radiograph showed a transverse fracture of the root at bone level (see 3D diagnosis, page 230). The tooth had to be extracted and the patient wanted a prosthetic restoration immediately after implant placement.

Diagnostic tools

- Clinical examination
- Panoramic radiograph, intraoral radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Preparation of the template and provisional restoration in the laboratory
2. Extraction and implant placement with immediate provisional, augmentation
3. Definitive prosthetic loading

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Fig 4-14a Fistulation above tooth 22.

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Preparatory work in the laboratory

Based on the SimPlant planning and the virtual, 3D placement of the implant (see the 3D diagnosis, page 230), an individual surgical drill guide and a master cast were fabricated in the laboratory. A titanium abutment and a provisional crown were prepared on the model implants in the specified position; both were to be incorporated directly after implant placement.

Extraction, implant placement and augmentation

Conduction and infiltration anesthesia were induced, after which the fractured crown was removed. The incision was made in the interproximal spaces, with a releasing incision distally of tooth 23 (Fig 4-14b). The root, which was firmly attached to the bone, was very carefully extracted to ensure that the labial bone lamella – apart from the existing apical fenestration – remained as intact as possible. The socket was checked and cleaned and the surgical template tried in (Fig 4-14c). The individual template allowed accurate guidance of the 2-mm spiral drill (Fig 4-14d). Preparation continued with drills of increasing size up to 3.2 mm, drilling in the same position and direction, but without using the template (Fig 4-14e). The 17-mm long and 4-mm wide Neoss implant was securely inserted into the jaw with no prior thread cutting (Fig 4-14f). The depth of insertion was also determined by the template, so that the prepared rotation-proof abutment could be transferred to the implant in the same position, as far as possible (Fig 4-14g). The provisional crown was sealed off with fast-curing resin, polished and fitted on the abutment with TempBond (Fig 4-14h). The cement residues were removed

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under visual control. This was followed by bone augmentation. The harvested bone chips were packed in as the first layer, followed by a second layer of a xenogeneic cancellous/cortical bone substitute (Bio-Gen Mix; Bioteck), with some overcontouring on the labial side of the implant, and covered with a resorbable membrane (Tutodent, 15 × 20 mm). The flap was repositioned over the membrane and fixed into place with 6-0 sutures (Fig 4-14i).

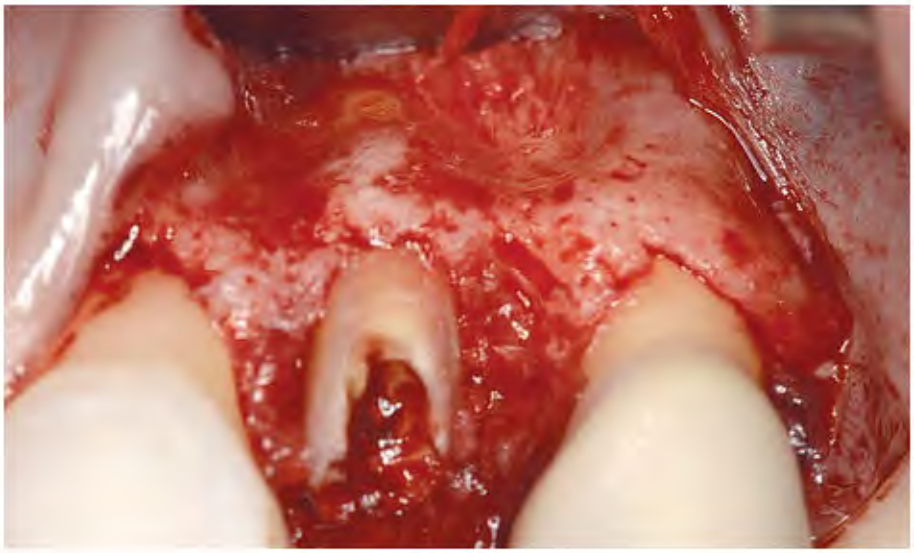


Fig 4-14b Root 22 following flap reflection.

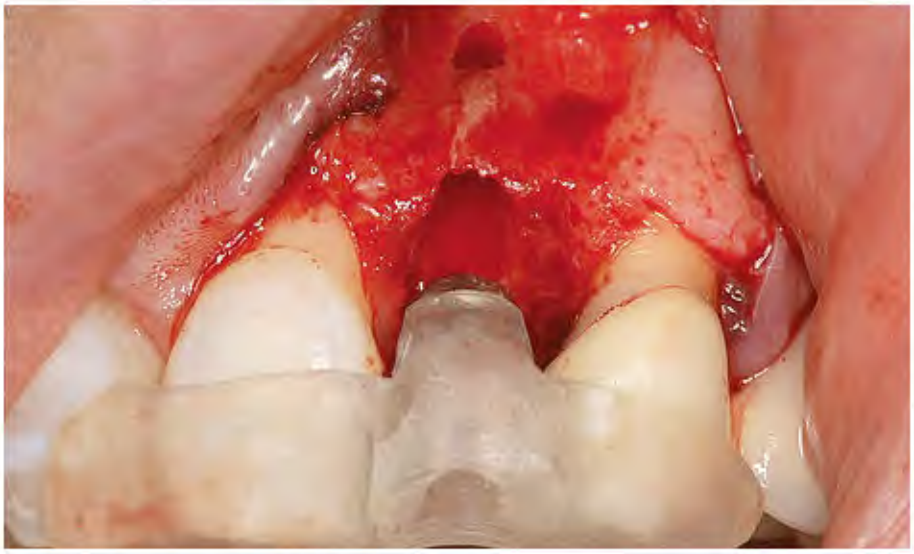


Fig 4-14c Surgical template in situ.

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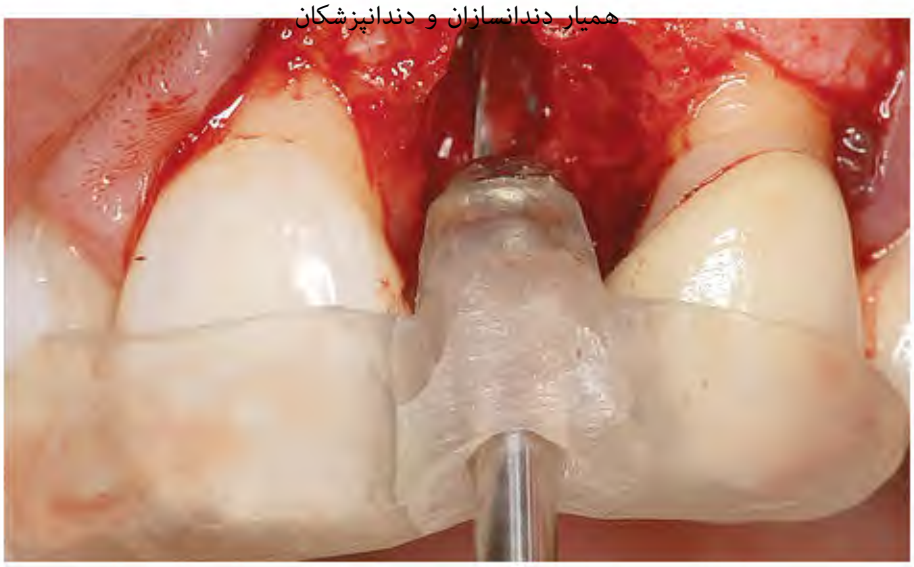


Fig 4-14d Guided insertion of the spiral drill through the template.

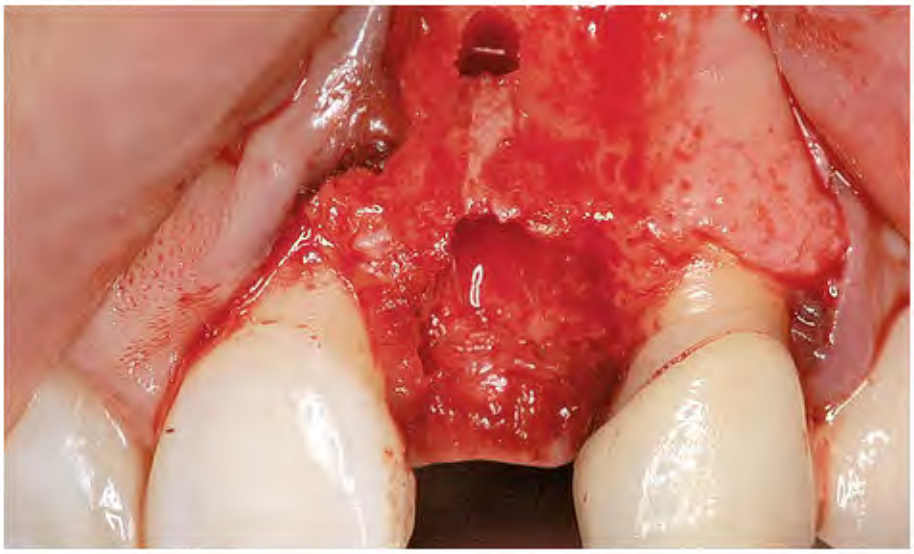


Fig 4-14e Fenestration in the apical region.

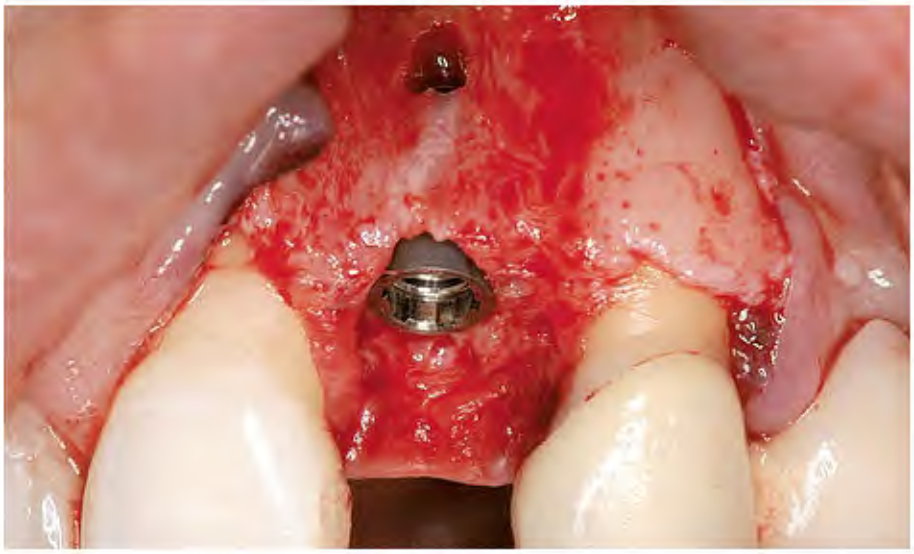


Fig 4-14f Inserted implant.

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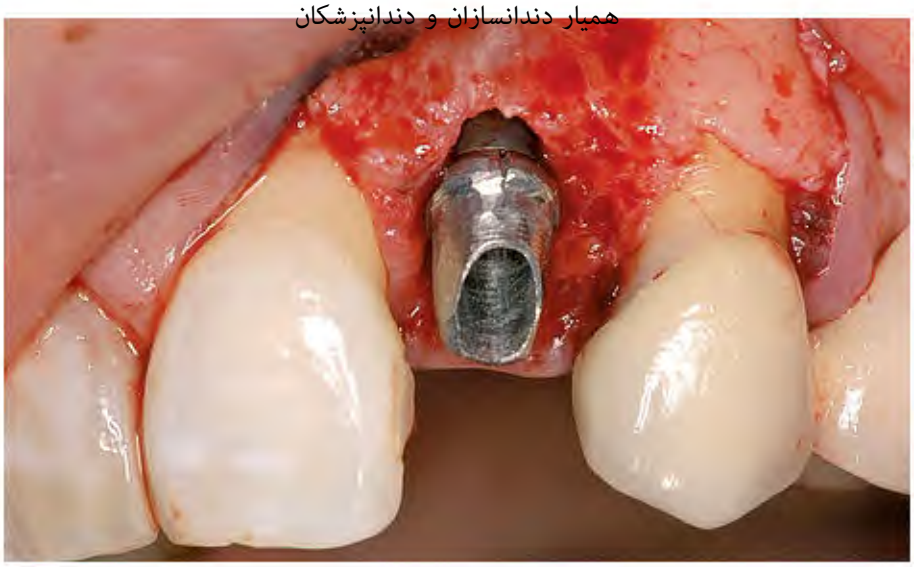


Fig 4-14g Abutment screwed into place.

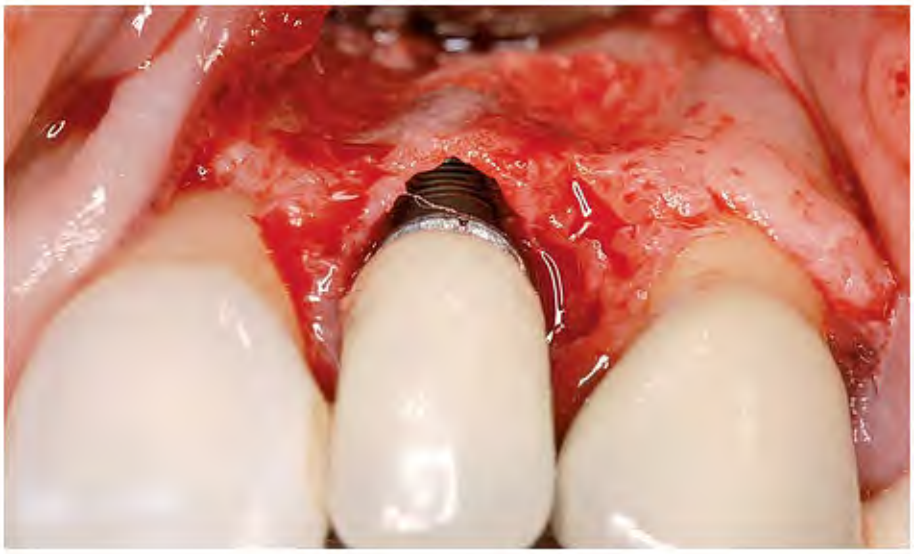


Fig 4-14h Provisional crown secured with TempBond.

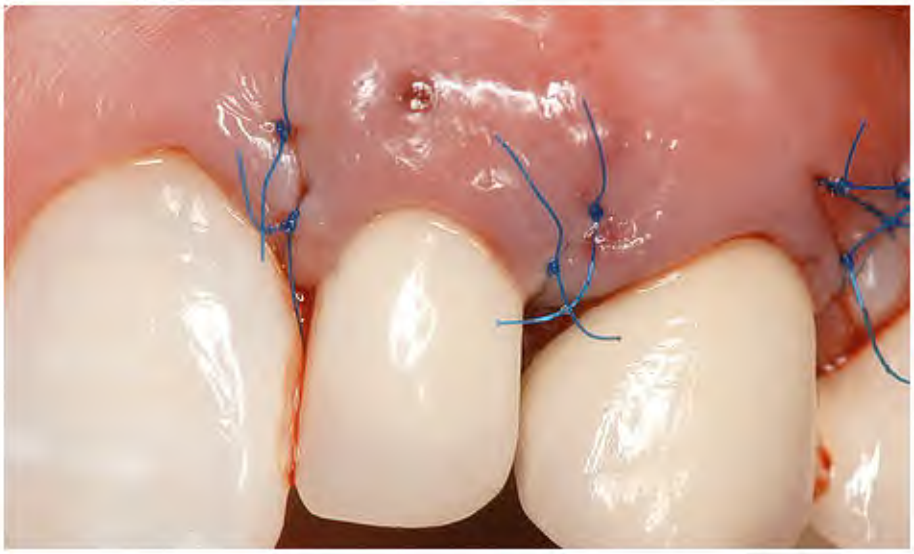


Fig 4-14i Wound closure by suturing.

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Fig 4-14j Clinical situation after 3 months.



Fig 4-14k Gingival situation 6 months after implant placement.

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Prosthetic restoration

Three months after implant placement, the gingival situation had stabilized and regeneration of the interdental papillae was apparent (Fig 4-14j). After another 3 months, it was possible to take an impression for the definitive crown (Fig 4-14k). Four years after implant placement, the bone situation on the follow-up panoramic radiograph is stable (Fig 4-14l). The esthetic situation after 4 years of functional use is more than satisfactory for the patient, but not necessarily ideal from the expert's point of view (Fig 4-14m). While the gingival margin above implant 22 and tooth 23 is stable; it is slightly higher than before the operation and also higher than the gum line on the opposite side, probably as a result of the surgical procedure and the immediate restoration of the implant.

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Fig 4-14l Follow-up panoramic radiograph after 4 years.



Fig 4-14m Prosthetic restoration after 4 years.

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Treatment course

- Extraction, implant placement with immediate restoration and augmentation (2006)
- 6 months to definitive loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Roland Althoff
Dental technology:	Angela Althoff

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Premolar implant in a patient with a high smile line

In most classification systems, the premolars are considered to be posterior teeth. Currently now, when the esthetic component is increasing in importance, it would be more accurate to group them together with the anterior teeth. The reason is that it is not just the first premolars that are usually presented to public view, but also the second premolars and sometimes even the 6-year molars; this is particularly true in patients with a high smile line.

Baseline situation

This female patient lost tooth 24 due to apical periodontitis. The residual ridge atrophy was moderate in the horizontal plane and only slight in the vertical direction (Fig 4-15a).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Dental cast analysis

Treatment plan

1. Implant placement
2. Exposure and prosthetic loading



Fig 4-15a Loss of tooth 24.

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Fig 4-15b Inserted implant.



Fig 4-15c Improving the shape of the residual ridge with a high cover screw.

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Implant placement

After lifting the mucoperiosteal flap with only one releasing incision by tooth 25, a standard 15-mm long implant was inserted fully into the bone (Fig 4-15b). Augmentation measures were not necessary. The use of a high cover screw improved the soft tissue contours in the long term (Fig 4-15c).

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Fig 4-15d Palatal incision.



Fig 4-15e Displacing the tissue in the buccal direction.

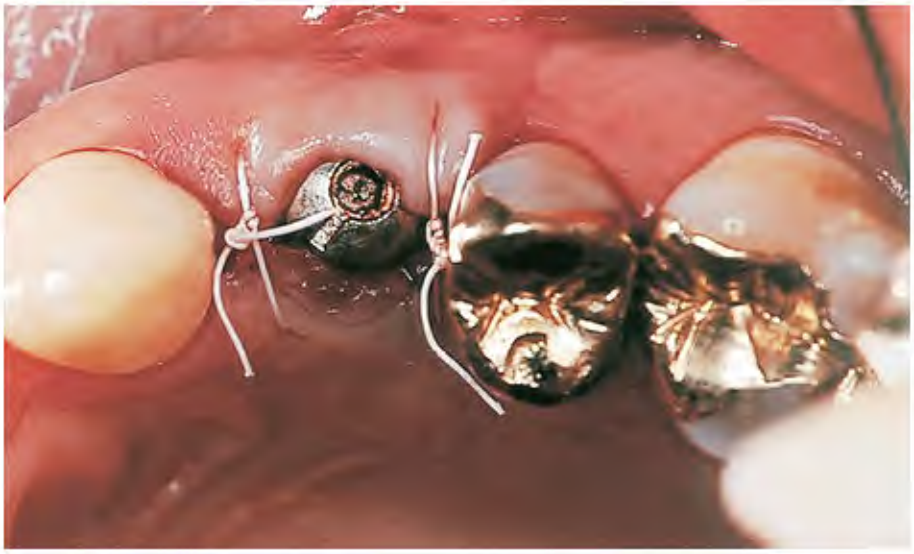


Fig 4-15f Supporting the gingiva on the abutment.

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Fig 4-15g Improving the residual ridge contours without bone augmentation.

Attention: ***Support for the gingival contours can be achieved with the use of various components. If the implant is only to be countersunk slightly, the small "Version A" screw offers minimal support. More support can be achieved with the higher slotted screw. A further increase is possible by using 2- or 3-mm high healing abutments.***

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Exposure and prosthetic loading

Exposure of the implant with a palatal incision took place after 6 months (Fig 4-15d). A minimally invasive exposure technique allowed the fixed gingiva to be displaced in the buccal direction with no loss of tissue (Fig 4-15e). A healing abutment height of 1 to 2 mm below gingiva level was now deliberately chosen to prevent apical shrinkage of the gingival margin. The flap was held in place with a fixing suture (Fig 4-15f). The papillae were preserved. In this case, the implant was loaded with a TiAdapt abutment (Nobel Biocare) and a cement-retained, all-ceramic crown (Figs 4-15g and 4-15h). A satisfactory implant-supported restoration of the visible premolar region was achieved despite the high smile line (Figs 4-15i and 4-15j).

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Fig 4-15h Harmonious gingival line and restored papillae.



Fig 4-15i High smile line.

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Fig 4-15j Satisfied patient.

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Attention: ***The height of the abutment can affect the subsequent course of the gum. If a long abutment is used, the gum will stabilize around it at the prevailing level. If using a shorter abutment, which ends approximately 1 to 2 cm below gingiva level, the soft tissue may grow over the abutment. The resultant gingival excess is forced in the labial/buccal direction when the superstructure is fitted. In rare cases, this may lead to inflammatory reactions in the hyperplastic gingiva, which needs to be treated with excision.***

Treatment course

- Implant placement (2000)
- 6 months to exposure
- 4 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Uwe Hildebrand
Dental technology:	Horst Mosch

Premolar implants and several single-tooth implants

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Several single-tooth gaps following traumatic tooth loss

Baseline situation

This young female patient lost teeth 11 and 22 in a bicycling accident (Fig 4-16a). While teeth 12 and 21 were damaged, they could be restored using conventional methods. As a provisional restoration, the patient was wearing a thermoplastic foil splint, fabricated elsewhere, with resin replacements for teeth 11 and 22 (Fig 4-16b). A CBCT scan for the SimPlant planning was performed before implant placement (Fig 4-16c). The plan for implant 11 was to insert it at a relatively steep angle to avoid collision with the incisal canal (Fig 4-16d). Implant 22 needed to be inclined considerably more to minimize labial fenestration (Fig 4-16e). The virtual placement of the implants and their inclinations, together with the visualized restorative spaces, can be seen in all the imaging planes (Fig 4-16f).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Implant placement and augmentation
2. Exposure and long-term provisional restoration



Fig 4-16a Clinical baseline situation.

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Fig 4-16b Provisional prosthesis on the thermoplastic foil splint.

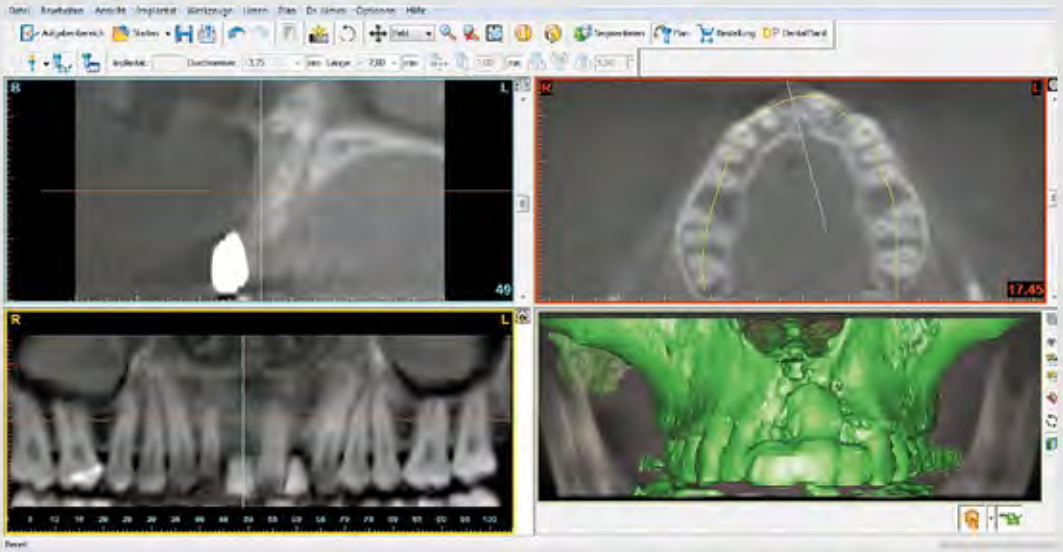


Fig 4-16c CBCT scan images for the SimPlant planning.

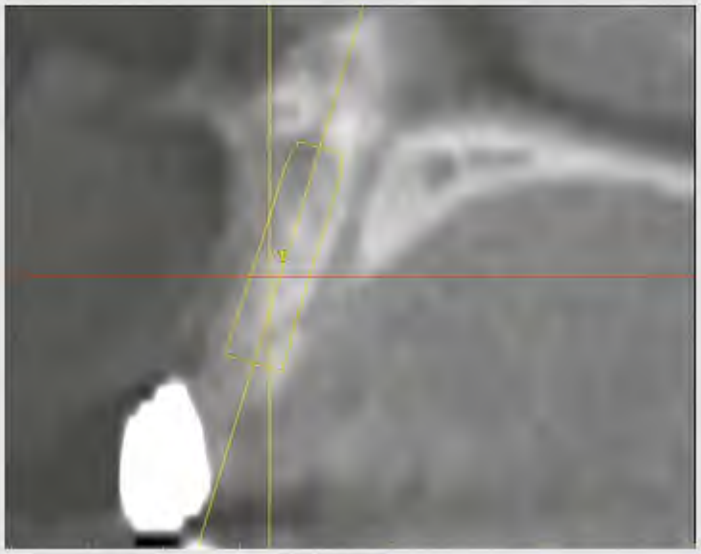


Fig 4-16d Steeply inclined placement of implant 11.

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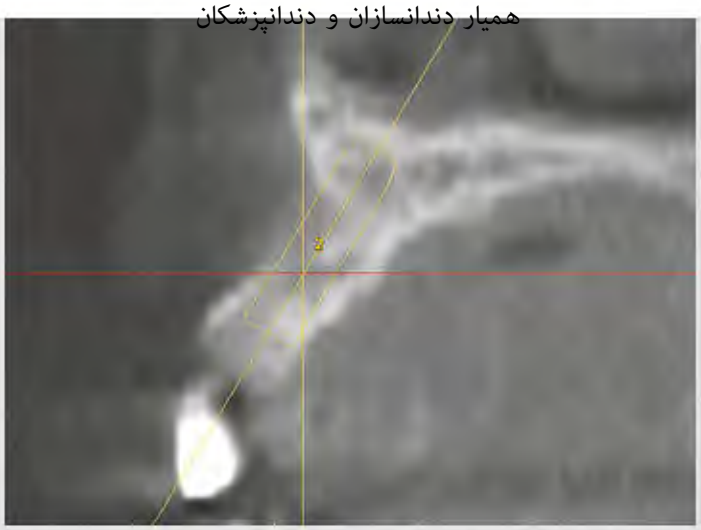


Fig 4-16e Unavoidable fenestration around implant 22.

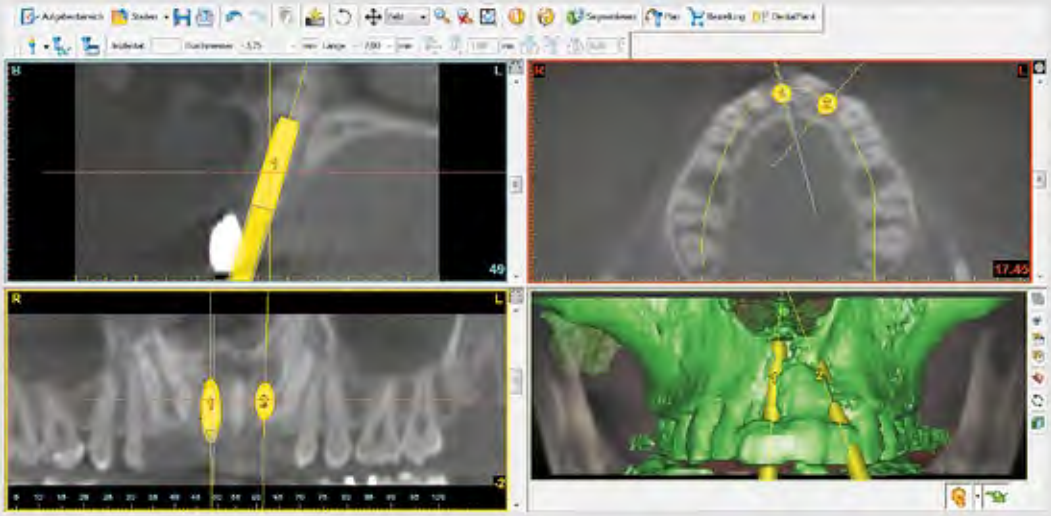


Fig 4-16f Completed planning for both implants.



Fig 4-16g Insertion of the implants.

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Fig 4-16h Apical fenestration around implant 22.

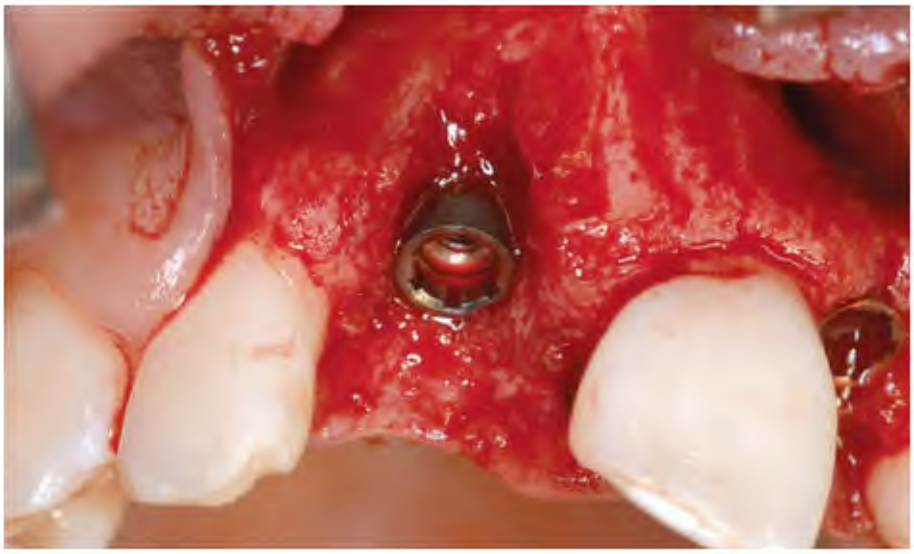


Fig 4-16i Cervical bone dehiscence around implant 11.

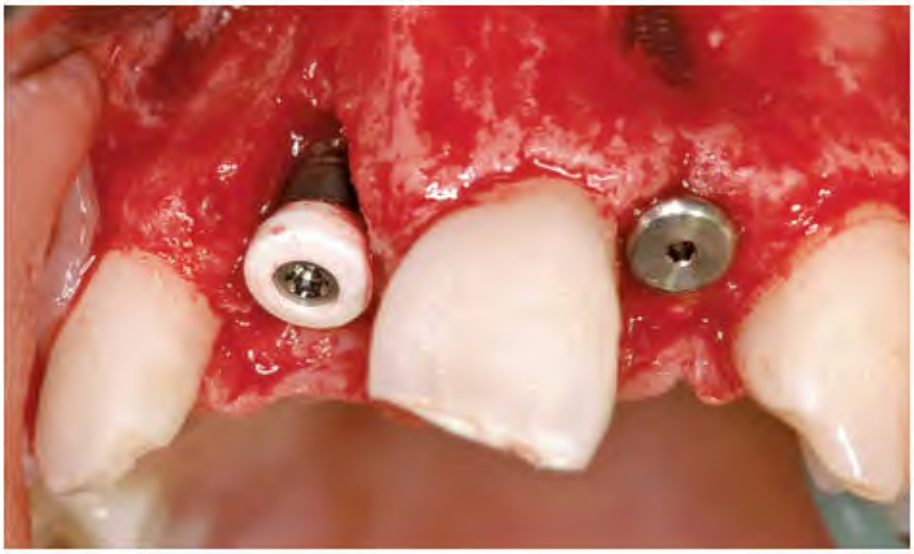


Fig 4-16j Healing abutment 11 as a support for the membrane.

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The incision was made on the residual ridge, on the palatal side of the planned implants. A mucoperiosteal flap was created from teeth 12 to 23 with a releasing incision distally of tooth 23. Two Neoss implants (length: 17 mm; diameter: 4.0 mm) were inserted at the sites of teeth 11 and 22 (Fig 4-16g). After the insertion, an apical fenestration was apparent around implant 22 (Fig 4-16h) and bone dehiscence in the cervical region around implant 11 (Fig 4-16i). To allow this defect to regenerate both vertically and horizontally, a short, 2.7-mm high healing abutment was screwed onto implant 11, to act as a support for the membrane (Fig 4-16j). Only slight augmentation was required around implant 22, so that the Brånemark System cover screw, barely 1 mm in height, offered adequate support in this region.

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Fig 4-16k Membranes cut to shape.



Fig 4-16l Attaching the membranes with pins.

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Fig 4-16m Suturing the wound.

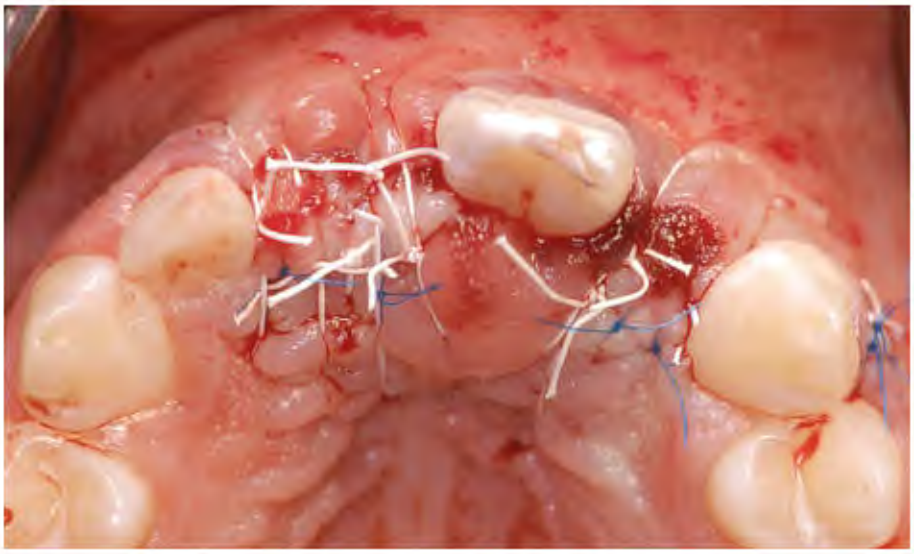


Fig 4-16n Extra-large backstitch sutures.



Fig 4-16o Adjusted provisional.

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Fig 4-16p Postoperative panoramic radiograph.

A mixture of autologous bone and Bio-Oss was applied over both implants, with an excess of material, and covered with resorbable membranes (Bio-Gide) (Fig 4-16k). The membranes were stabilized apically with titanium pins (Fig 4-16l). Periosteal slitting was followed by saliva-proof wound closure with Gore-Tex and Mopylen sutures (6-0; Fig 4-16m). To increase the stability of wound closure, extra-large backstitch sutures were placed over the implants from far inside the labial vestibule to deep into the palate (Fig 4-16n). The existing splint was adapted to the new situation to ensure that it did not exert pressure anywhere on the augmentation (Fig 4-16o). The postoperative radiograph shows the positioning of both implants (Fig 4-16p).

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Fig 4-16q Healing phase.

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Fig 4-16r Provisional fixed partial denture.



Fig 4-16s Residual ridge prior to exposure.

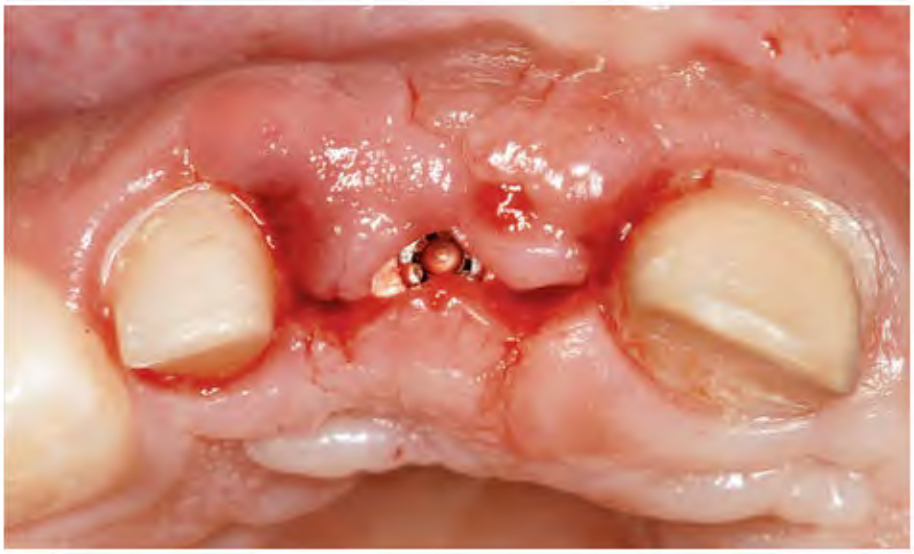


Fig 4-16t Cosine curve technique.

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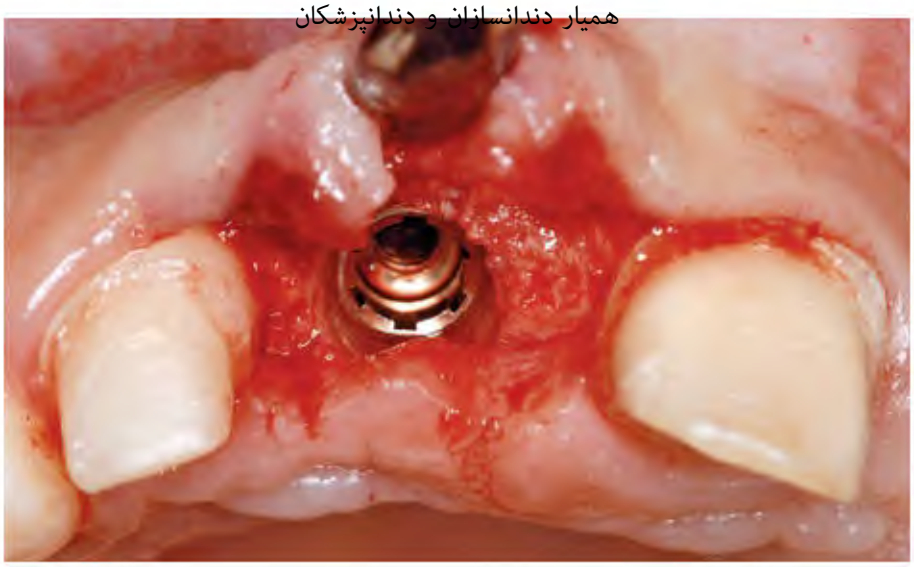


Fig 4-16u Augmentation result.



Fig 4-16v Incision around implant 22.

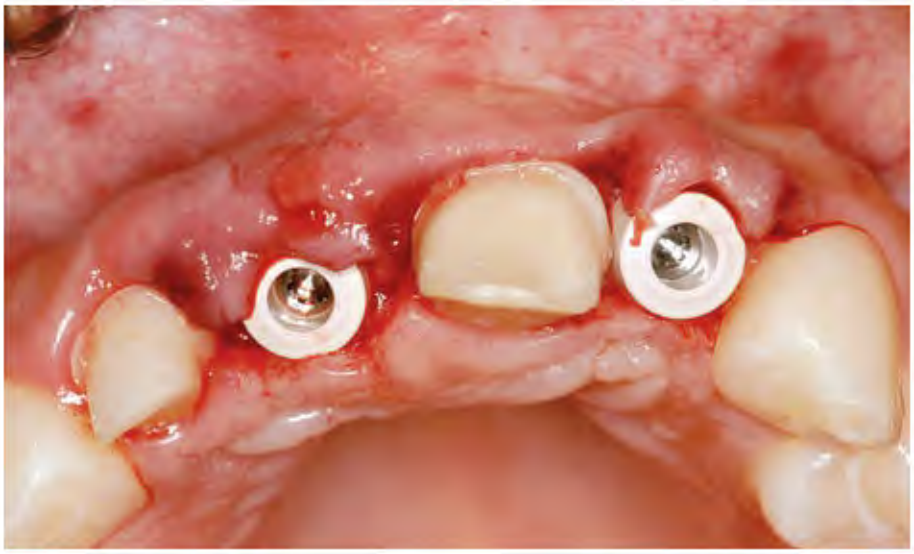


Fig 4-16w Healing abutments screwed into place.

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Fig 4-16x The abutment has been ground to shape.

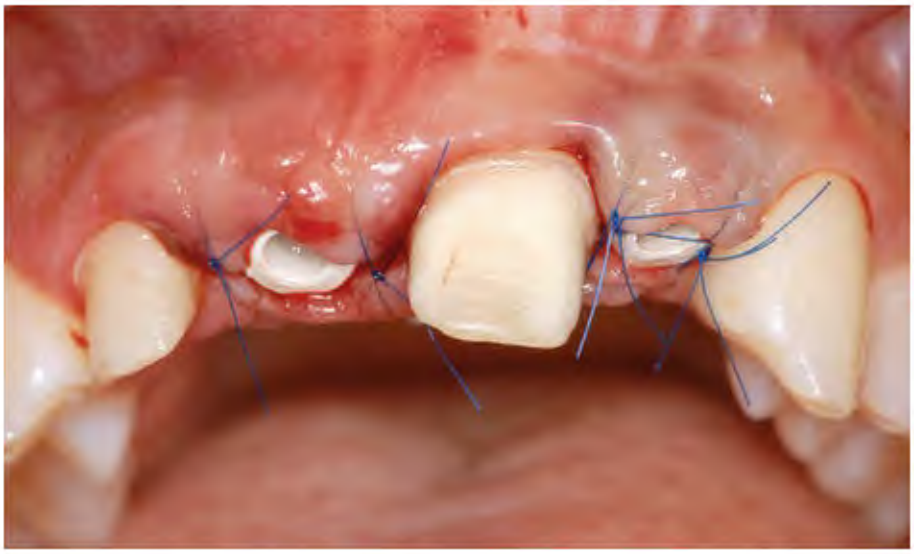


Fig 4-16y Stabilization with sutures.



Fig 4-16z Modified provisional.

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Exposure

The 8-month healing period was uncomplicated (Fig 4-16q). Since a prosthetic restoration was planned for teeth 12 and 21, they were prepared in the interim and used as abutments for a long-term provisional restoration (Fig 4-16r). Removal of the fixed provisional revealed an adequately regenerated residual ridge (Fig 4-16s). The incision to expose implant 11 was made using the cosine curve technique (Fig 4-16t). The short healing abutment was unscrewed, revealing a positive augmentation result (Fig 4-16u). Implant 22 was also exposed using the cosine curve technique (Fig 4-16v). Healing abutments (5-mm high) were screwed onto both implants (Fig 4-16w). The PEEK abutment on implant 22 was in slight collision with tooth 21 and needed to be ground to shape (Fig 4-16x). Both mucoperiosteal flaps were stabilized with Mopylen sutures (6-0) (Fig 4-16y). The provisional resin fixed bridge was modified on the gingival side and incorporated immediately after exposure (Fig 4-16z).

Treatment course

- Traumatic loss of teeth
- 6 months to implant placement and augmentation (2007)
- 8 months to exposure and prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Hubertus Klaus
Dental technology:	Horst Mosch

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Premolar implants and several single-tooth implants

Restoration of several single-tooth gaps

Diagnosis and treatment planning for several single-tooth gaps resembles that which is involved in a single-tooth implant. The placement of several single-tooth implants normally occurs sequentially, or quadrant by quadrant. It is best to open one quadrant first, carry out the implant treatment there and close it up before treating the next quadrant.

Baseline situation

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A patient was unhappy with her restoration following prosthetic treatment of missing teeth 17, 15, 14, 22, 24 and 25. Her own dentist had decided that this restoration should consist of an overdenture (Fig 4-17a). Teeth 13 and 23, which did not require crowning, were prepared to be fitted with telescopic crowns for prosthesis retention. Since it had already closed up partially, gap 24 to 25 provided enough space for only one premolar. Although the overdenture was light and delicate in design, the patient could not manage with it. She therefore decided to be fitted with a new, fixed restoration.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- Dental cast analysis

Treatment plan

1. Implant placement
2. Exposure
3. Prosthetic loading



Fig 4-17a Clinical situation following completion of the prosthetic treatment.

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Implant placement and exposure

Despite the horizontal atrophy, the residual ridge was wide enough to take the implants without augmentation. Four MK-II implants were inserted: three 18-mm long implants (3.75 mm in

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diameter) in regions 14, 22 and 24, plus one 10-mm long implant (4 mm diameter) in region 15 (Fig 4-17b). Since no bone augmentation was performed at the time of implant placement, the gingival situation needed correcting with an appropriate incision and suturing technique at the time of exposure. The incision over implants 15 and 14 was made slightly palatally, using the cosine curve technique (Fig 4-17c; see also page 330). The soft tissues can also be shaped with the use of healing abutments or gingival contouring devices.

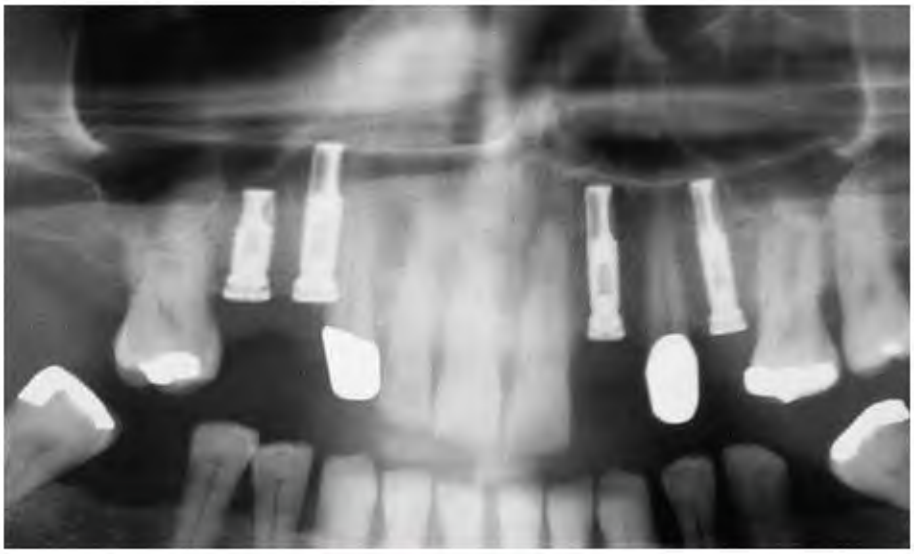


Fig 4-17b Panoramic radiograph following implant placement.

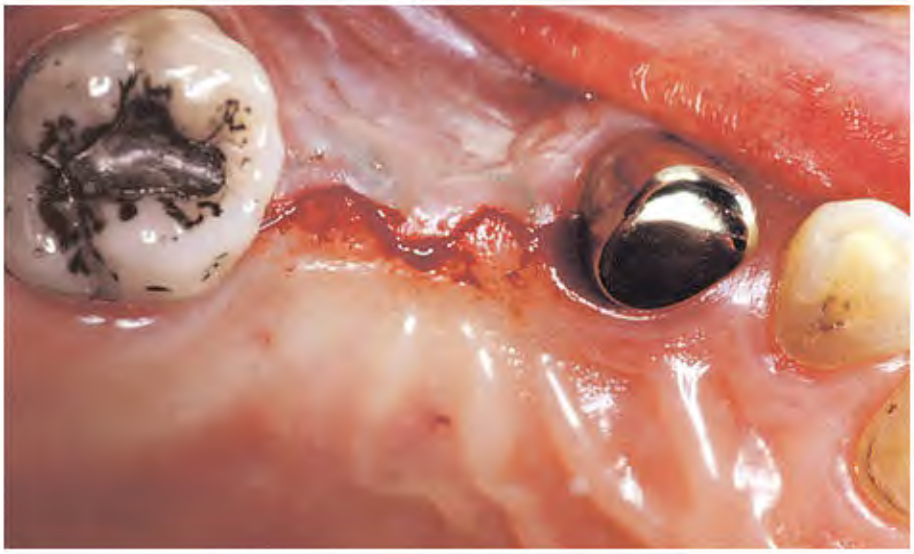


Fig 4-17c Incision made with the cosine curve technique.

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Fig 4-17d Bio-Esthetic healing abutments.



Fig 4-17e Exposure of single-tooth implant 22.

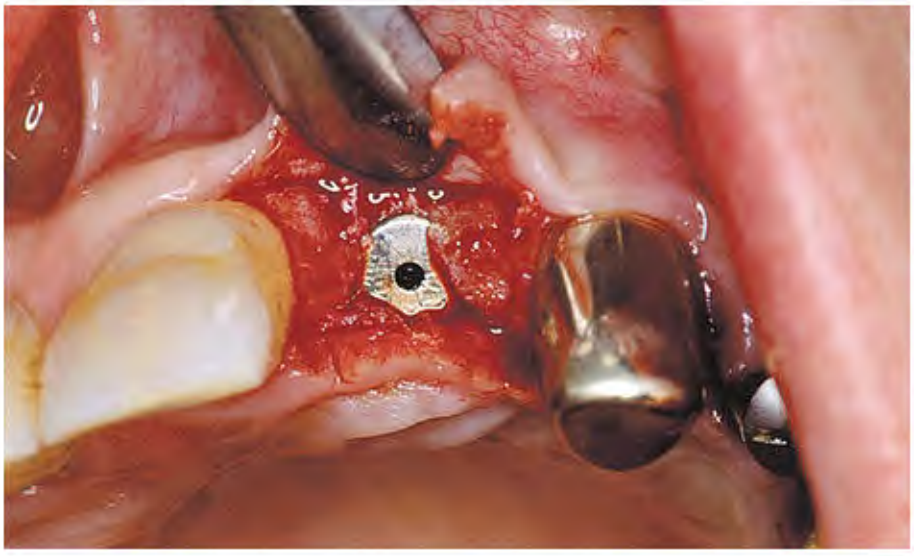


Fig 4-17f Splitting the palatal flap.

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Fig 4-17g Bio-Esthetic abutment for the anterior teeth (implant 22) and standard abutment (implant 24).

Soft tissue contouring devices from the Bio-Esthetic premolar range (Biomet 3i) were used for implants 15 and 14 (Fig 4-17d; see note on page 284). The incision in region 22 was made further palatally, to include palatal connective tissue that was to be used to shape the papillae (Fig 4-17e). Subepithelial connective tissue was also obtained by splitting and relocating the flap in the mesial and distal interproximal directions (Fig 4-17f). To support papillary shaping, a tissue contouring device for anterior teeth from the Bio-Esthetic range was used for implant 22 (Fig 4-17g). A Brånemark System healing abutment was selected for implant 24 (Fig 4-17g). The gingival healing process was uncomplicated on both sides.

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Fig 4-17h Impression posts corresponding to the shape of the gingiva.

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Fig 4-17i Prefabricated abutments on the cast.

Laboratory method

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The impressions for implants 15, 14 and 22 were taken with the aid of impression copings fitting the gingival shapers. A rotationally symmetrical impression coping was used for implant 24 (Fig 4-17h). Impressions of the teeth to be crowned were taken at the same time. System-specific components were used for the prosthetic loading of the implants. Straight, customizable Bio-Esthetic abutments for premolars were used for implants 14 and 15, while an angled abutment for anterior teeth was used for implant 22 (Fig 4-17i). A customized abutment was cast in gold for the restoration of tooth 24 with the aid of a wax-up, burn-out plastic cylinder (Subtec 2; BEGO Implant Systems).

Prosthetic restoration

Individual metal-ceramic crowns were provisionally cemented onto all the abutments. Six months later, the gingival situation was stable, presenting as follows: on the right side, the gum around the canine and around implant 14 showed nothing of note; crown 15 appeared a bit too long and the implant's titanium components shimmered through the mucosa (Fig 4-17j). The cervical fillings in the incisors were not modified at the patient's request, so that crown 22 had to be adapted to the existing situation.

In the second quadrant, one can compare the contouring of the gingiva by different implant superstructure components. Crown 22 has at its basis prefabricated components from the Bio-Esthetic system. It shows a better gum line than crown 24, which has an individually cast abutment (Fig 4-17k). A final photograph approximately 2 years following incorporation of the prosthetic restoration shows a harmonious gingival line (Fig 4-17l). The follow-up radiograph confirms a stable bone line (Fig 4-17m). The gaps between the posterior teeth of the mandible

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have remained unrestored in accordance with the patient's wishes.

Attention: ***The Bio-Esthetic range (Biomet 3i) includes five types of tissue contouring devices with different cross sections, designated A, B, C, D and E (corresponding to tooth diameters). In this way, the contour of the gingiva is adjusted to the desired tooth shape at the time of exposure. Customized CAD-CAM or customizable abutments can also be used to shape the gingiva.***



Fig 4-17j Single-tooth crowns on the right side.



Fig 4-17k Crown 22 visually adjusted to the fillings in the incisors.

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Fig 4-17l Clinical situation 2 years following treatment completion.

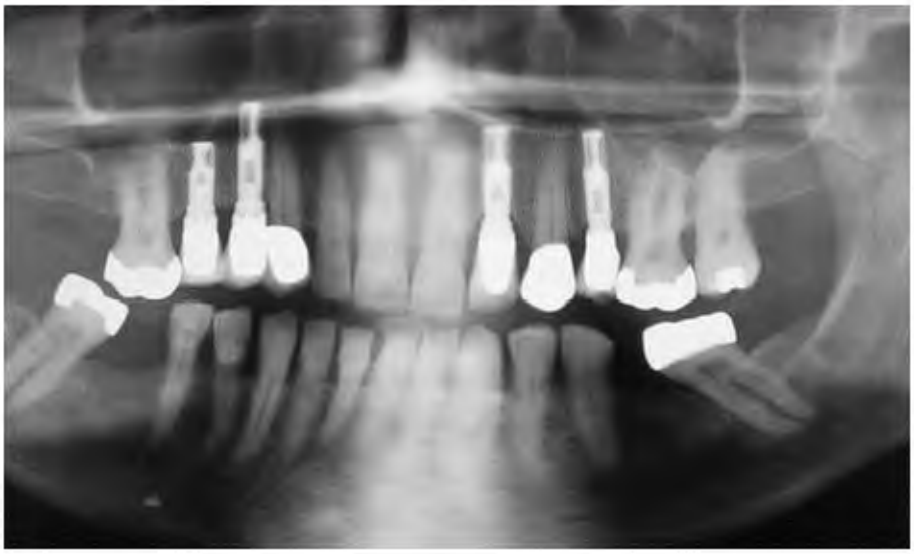


Fig 4-17m Stable osseous situation after 2 years.

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Treatment course

- Implant placement (1999)
- 6 months to exposure
- 3 weeks to impression taking

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Restoration of multi-tooth gaps

An implant-supported restoration of a multi-tooth gap is much more difficult to accomplish than one involving a single-tooth gap. Its esthetic prognosis is also significantly poorer. One reason for that is the more rapid and pronounced residual ridge atrophy, which often requires extensive augmentation measures. The other is that the interdental papillae atrophy much more rapidly, their reconstruction between two implants being much more problematic that between an implant and a natural tooth.

Typical treatment course

Replacement of four missing incisors on four implants

Baseline situation

This male patient presented with four missing incisors and a free-end situation on the left side (Fig 4-18a). While the free-end situation in the left maxilla should also be treated with implants, this was to be done independently from the treatment of the anterior gap.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- Dental cast analysis

Treatment plan

1. Insertion of four implants and augmentation
2. Exposure and prosthetic loading

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Fig 4-18a Baseline situation.

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Implant placement

The implant positions were established on the basis of the, as yet, incompletely healed tooth sockets (Fig 4-18b). To regenerate the natural gingival line over the anterior teeth, the mesial implants were inserted 1-mm deeper than the lateral ones. Different cover screws were used for the soft tissue conditioning (Fig 4-18c). The mesial implants were fitted with higher, thicker slotted screws to support horizontal and vertical bone regeneration. The distal implants were fitted with small screws of reduced diameter to leave space for bone augmentation. This was performed with bone chips collected in the bone filter and with the liquid membrane ATRISORB (TOLMAR) (Fig 4-18d). The 8-month healing period was uncomplicated (Fig 4-18e).

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Fig 4-18b Implant beds prepared in the still existing sockets.

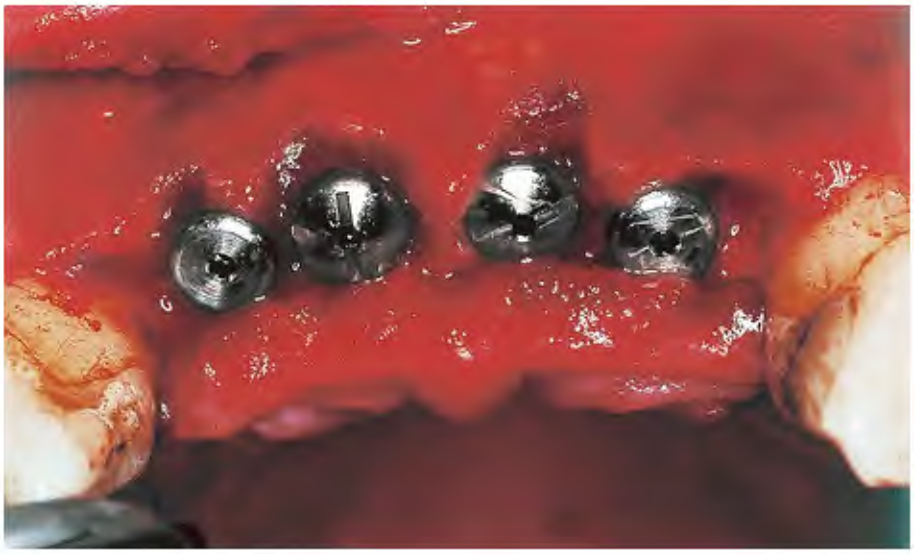


Fig 4-18c Inserted implants with different cover screws.



Fig 4-18d Bone augmentation.

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Fig 4-18e Healing phase.

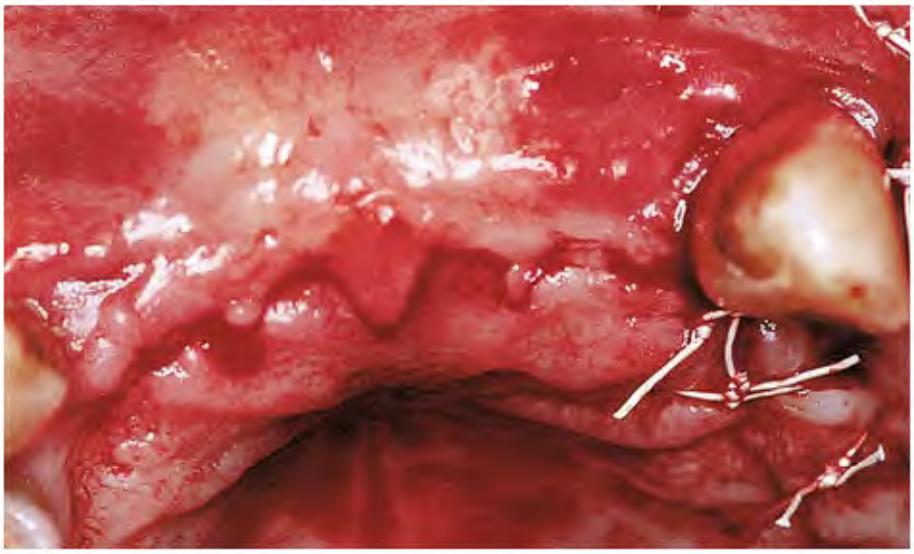


Fig 4-18f Incision made using the cosine curve technique.

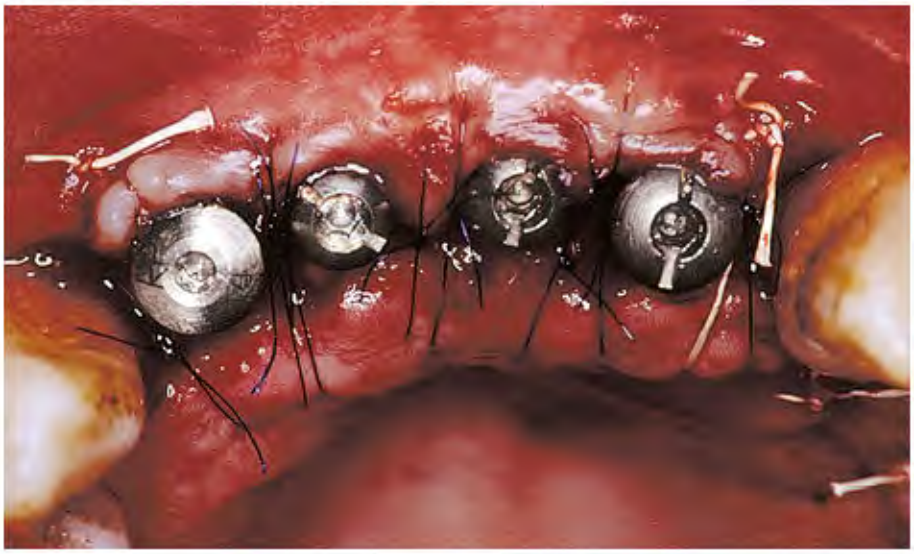


Fig 4-18g Adaptation of the flap and fixation with microsurgical sutures.

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Exposure and prosthetic restoration

The incision to expose the implants was made using the cosine curve technique (see page 330). More tissue was prepared for the papilla between teeth 11 and 12 (Fig 4-18f). When the flap was lifted, it was already clear that it would not be wide enough to cover all the healing abutments on the labial side (see page 288). To reduce the tension, reduced-diameter abutments were used for the more outwardly inclined mesial implants. The flap was gently adapted over the abutments and fixed into place with microsurgical 6-0 sutures (Fig 4-18g). During the first phase, the prosthetic restoration, in the form of compound crowns, was temporarily cemented onto the customized abutments (Figs 4-18h and 4-18i). The free-end situation was restored on three implants inserted following a sinus floor elevation, with a screw-retained fixed implant bridge on multi-unit abutments (Fig 4-18j). Figure 4-18k shows the satisfied patient following completion of his implant treatment.

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Fig 4-18h Ceramic compound crowns.

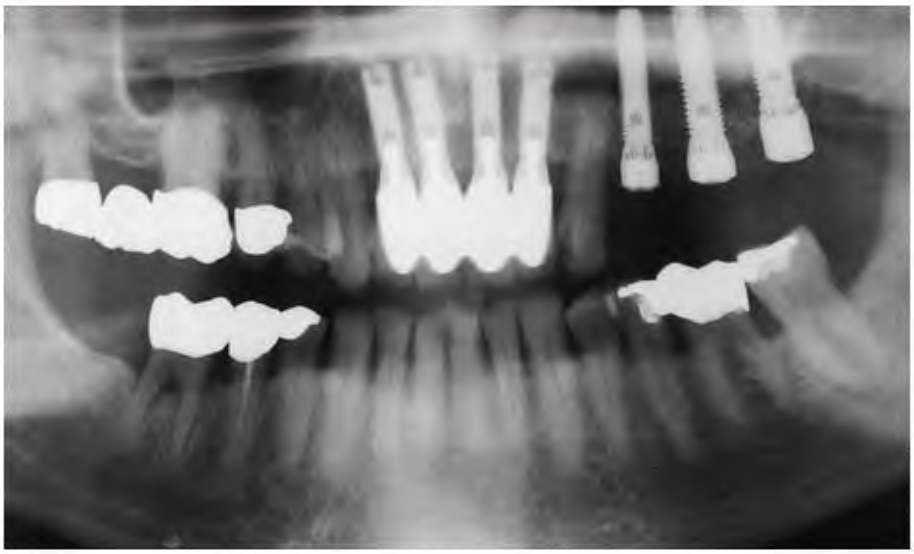


Fig 4-18i Postoperative panoramic radiograph.

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Fig 4-18j Independent restoration of the anterior and posterior teeth.



Fig 4-18k Patient following completion of his treatment.

Attention: ***When mucosa is transplanted from the palate to the labial or buccal vestibule, the flap is rarely wide enough to provide full coverage of the healing abutments. In cases where the radius of the jaw curvature is to small and narrow, coverage is even more problematic. The flap can only be stretched to a very limited extent. Additional widening of the flap can be achieved with vertical releasing incisions into the periosteum.***

Treatment course

- Implant placement and augmentation (2000)
- 9 months to exposure
- 6 weeks to prosthetic loading

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Treatment

Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Uwe Hildebrand
Dental technology: Horst Mosch

Typical treatment course

Replacement of four missing incisors on two implants

Baseline situation

A 62-year-old man lost four incisors after they became loose, and was fitted with a provisional restoration consisting of a cast removable prosthesis for the transitional period. On clinical inspection, the residual ridge was still well preserved and seemed to indicate a good prognosis for implant placement (Fig 4-19a). The panoramic radiograph confirmed this diagnosis. Only the CT showed that, while the residual ridge really was wide enough at positions 12 and 21, it appeared to be too narrow in regions 11 and 22 and also showed bone deficits.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT with SimPlant planning
- Dental cast analysis

Treatment plan

1. Insertion of two implants and augmentation
2. Exposure and prosthetic loading

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Fig 4-19a Four missing incisors.

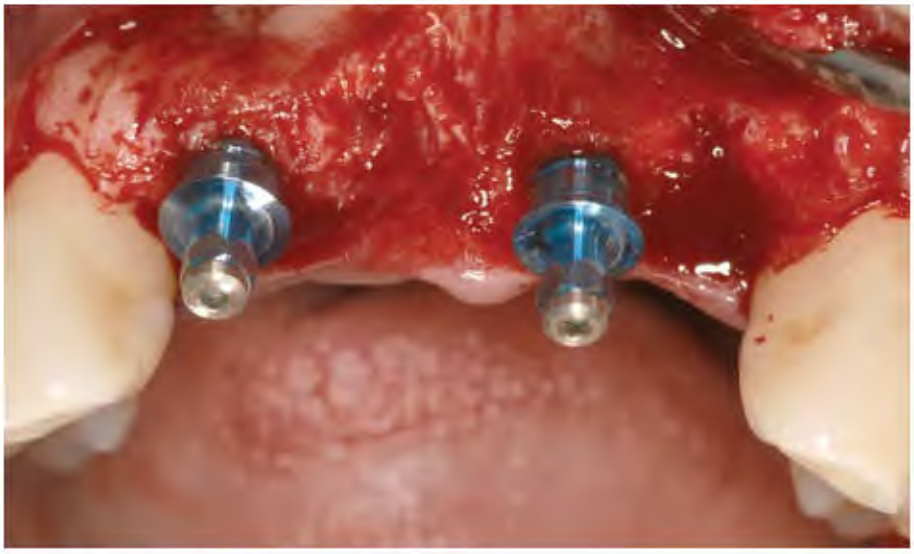


Fig 4-19b Implants in regions 12 and 21.

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Fig 4-19c Augmentation.

Implant placement and augmentation

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Implant placement was performed under full general anesthesia, together with sinus elevation on the left side. The incision was made palatally on the residual ridge between teeth 13 and 23. According to the planning procedure, two Osseotite implants (Biomet 3i) (18-mm long and 3.75-mm in diameter) were inserted at positions 12 and 21 (Fig 4-19b). The insertion mounts were unscrewed from the implants and the cover screws put into place. For the augmentation in regions 11 and 22, a 25 × 25 mm Bio-Gide membrane was cut into two strips and attached to the defects at the apical end with titanium pins (Fig 4-19c). The defects were filled with the harvested bone chips and the membrane strips pushed under the periosteum toward the palatal direction (Fig 4-19d). Periosteal slitting was followed by tight closure with Gore-Tex and Mopylen 6-0 sutures. These were removed after 2 weeks (Fig 4-19e).

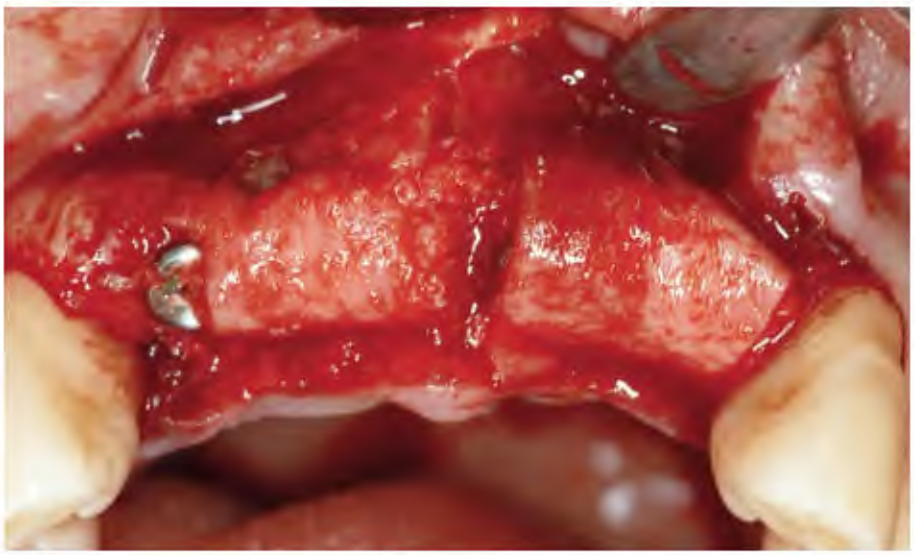


Fig 4-19d Attached membranes.

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Fig 4-19e Closure by suturing.



Fig 4-19f Fixed implant bridge after 5 years of functional use.

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Exposure and prosthetic restoration

After 9 months, implants 12 and 21 were exposed concomitantly with implant placement in the second quadrant. A screw-retained ceramic fixed bridge with pontics 11 and 22 was chosen as the prosthetic restoration. The final photograph shows the clinical situation after 5 years of functional use (Fig 4-19f).

Attention: ***A point of note in this case is the lack of symmetry between the crowns on the implants and the pontics. Here, the anatomical structure of the residual ridge determined the location of the implants. From an esthetic point of view, the most favorable option is to insert two implants into the lateral incisor positions. The esthetic appearance of the central incisors is best recreated by gingival conditioning with pontics.***

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Treatment course

- Implant placement and augmentation (2004)
- 9 months to exposure
- 6 weeks to prosthetic loading

Treatment

Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Michael Weber
Dental technology: Horst Mosch

Atypical treatment course – problematic baseline situation

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Reconstruction of the papillae between implants is difficult to accomplish when restoring multi-tooth gaps between anterior teeth. However, if these structures are present before implant placement, they can often be preserved. To ensure that the gingival margin and the interdental papillae do not atrophy, they will need support. This can be achieved with immediate implant placement following extraction of the teeth, if tooth-shaped superstructures are used. However, one prerequisite is that sufficient bone tissue is available to anchor the implants. Another option is offered by a provisional fixed bridge, in which specially shaped ovate pontics, which penetrate slightly into the extraction socket, provide support for the gingival margin.

Restoration of a multi-tooth gap with preservation of the anatomical structures

Baseline situation

This patient had had persistent problems in the anterior maxilla for a prolonged period. Repeated attempts by previous treatment providers to rescue the teeth by apicoectomy failed, so that extraction of the four incisors became unavoidable. An interim restoration in the form a fixed bridge was to be fabricated before the extraction.

Diagnostic tools

- Clinical examination
- Panoramic radiograph

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- CBCT with SimPlant planning
- Dental cast analysis

Treatment plan

1. Measures to preserve the bone and papillae
2. Extractions, insertion of four plus two implants and augmentation
3. Simpler in Practice recording of the implant positions
4. Exposure and immediate prosthetic restoration

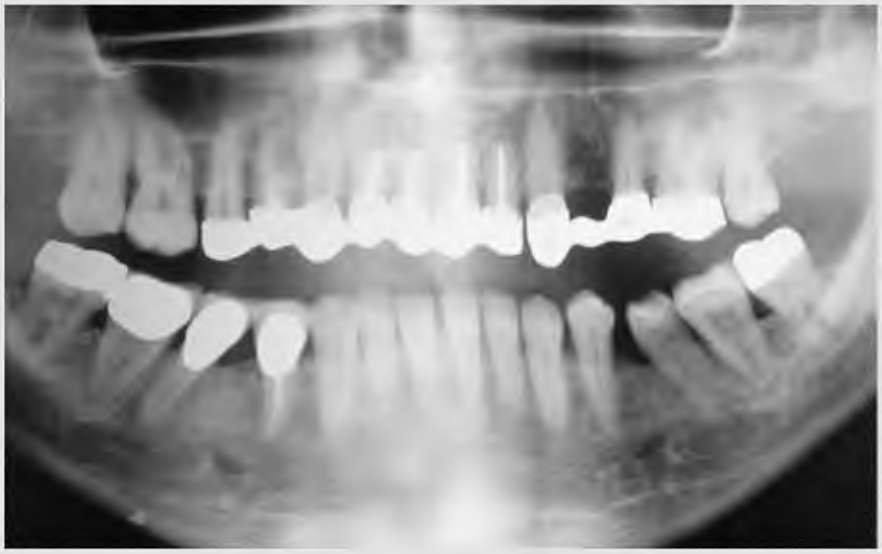


Fig 4-20a Panoramic radiograph before the treatment.

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Pre-implantation measures to preserve the bone and papillae

In the radiographs, the bone volume around the root apices of the teeth to be extracted (Fig 4-20a) was found to be adequate to anchor implants with primary stability.

The procedure was performed in several steps. In the first step, once the interim fixed partial denture was removed (Fig 4-20b), all four crown stumps were cut away and the roots shortened to approximately 2 mm subgingivally, so that the presence of the roots would protect the thin labial bone lamellae of the dental sockets from atrophy (Fig 4-20c). The aim of this was to preserve the external contours of the residual ridge up to the time of implant placement. An impression of the shape of the residual ridge was then taken for the relining of the provisional fixed bridge (Fig 4-20d).

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Fig 4-20b Situation following removal of the fixed bridge.

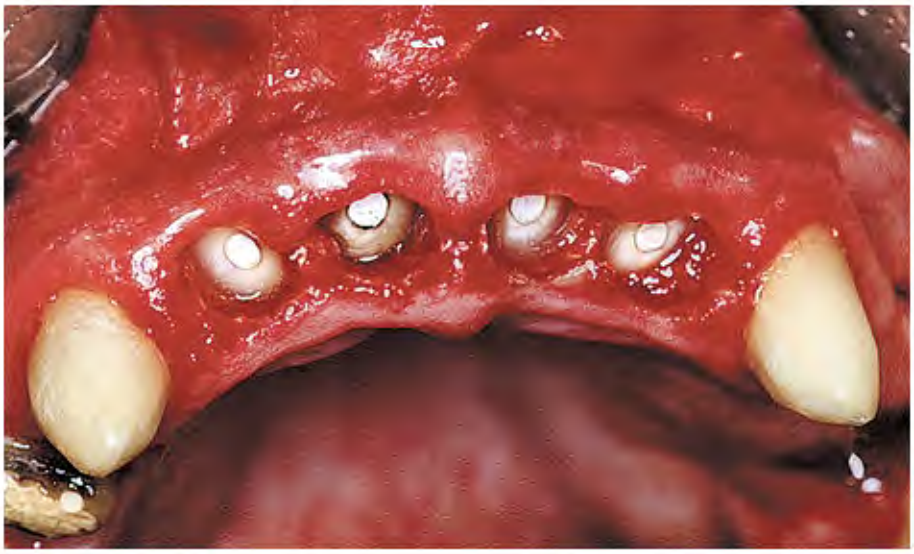


Fig 4-20c Subgingival reduction of the anterior teeth.



Fig 4-20d Relining impression.

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Fig 4-20e Ovate pontics.



Fig 4-20f Preserving the papillae before implant placement.

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Once a cast was made up, the fixed bridge was reworked: the crown parts were filled with composite and built up to the level of the shortened roots. These “pontics” were reduced by about 0.5 to 1 mm, worked into an ovate shape and then polished (Fig 4-20e). The provisional bridge in this form was tried into the anterior sockets for good fit and provisionally inserted with TempBond. After a 5-week healing phase, a thin mucosal layer had formed over the remaining roots (Fig 4-20f). The papillae and the gingival margin remained largely intact.

Attention: ***The task of the pontics is to offer mechanical protection to the gingival margin and, above all, to the interdental papillae (by taking over the function of the teeth). The 0.5-mm gap between the pontics and the roots should allow a thin mucosal layer to form over the root, so that a continuous covering layer of mucosa is present at the time of implant placement. The support for the papillae and gingival margin needs to be in place both before and after implant placement.***

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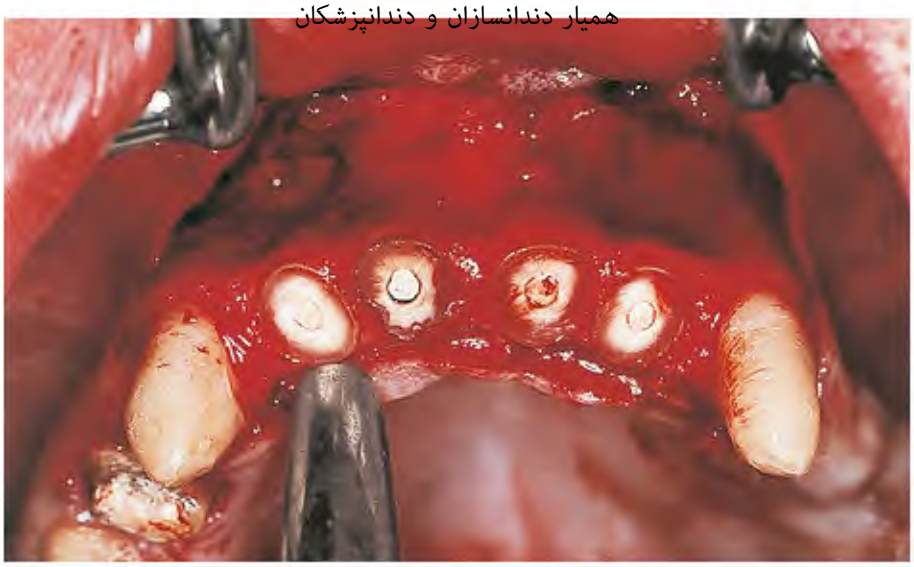


Fig 4-20g Creating the labial flap.

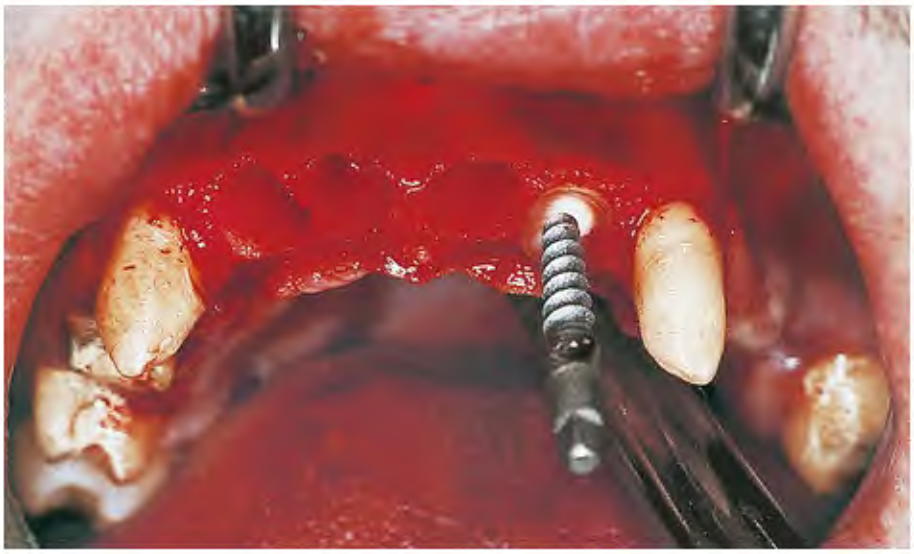


Fig 4-20h Root extraction using the “corkscrew technique.”

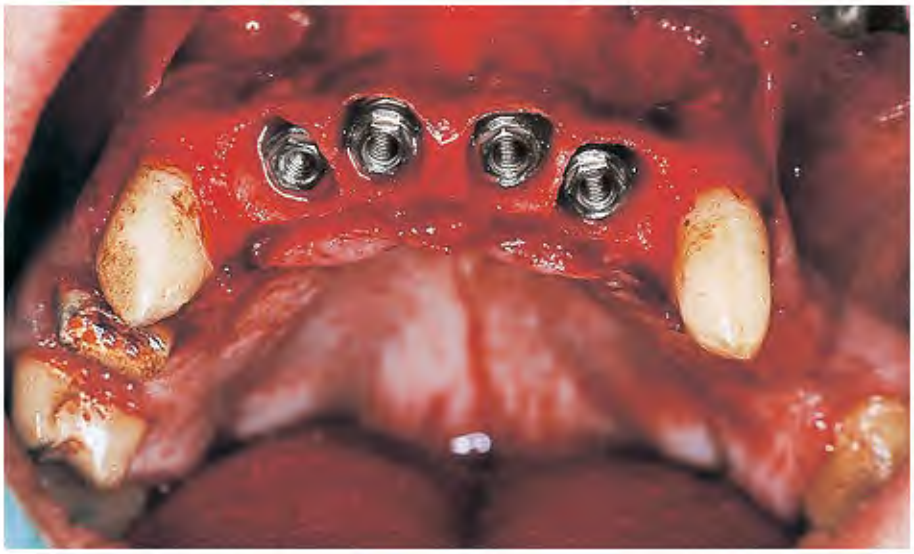


Fig 4-20i Inserted implants.

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Fig 4-20j Impression copings screwed into place.

Extraction and implant placement

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After the provisionally fitted fixed bridge was removed, the operation area was prepared for implant placement. An incision was made palatally of the remaining roots. The labial and palatal papillary prominences were included into the flap (Fig 4-20g). The root extraction needed to be performed with great care, so as not to damage the labial bone lamellae. This was achieved using the “corkscrew technique:” a compression screw was driven into the root canal and removed together with the root (Fig 4-20h).

Extraction was followed by preparation of the implant beds, the positions of the implants being accurately determined by the existing sockets.

Recording the position of the implants – the Simpler in Practice concept

Once the implants were placed (Fig 4-20i), impression copings were screwed onto the fixtures (Fig 4-20j). The positions of the implants were recorded by fixing the impression copings into a template using self-polymerizing Pattern Resin. The position of the impression copings needs accurate checking if the fixtures are sunk well below the level of the bone (often, this can only be done with a radiograph).

Note

The “corkscrew technique”

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Conventional tooth extraction with dental forceps is often associated with the traumatic loss of the thin labial or buccal lamella. If performed with care, the “corkscrew technique” is atraumatic and allows the local bone to be preserved. To anchor the “corkscrew,” the root canal will need deep preparation, eg, with a Lindemann bur. A compression screw of appropriate diameter is then driven in until it is securely anchored. Careful movement of the root with the screw destroys the periodontal fibers, and the root can then be pulled out like a cork from a bottle.

Measures accompanying implant placement

The residual ridge was augmented to improve the esthetic result. First, the gap in the socket around the implant was filled with autologous bone particles and the whole residual ridge was then augmented on the labial side with the bone substitute Bio-Oss and the guided bone regeneration (GBR) membrane Bio-Gide (Fig 4-20k).

The insertion of implants into the anterior maxilla was accompanied by implant placement in regions 24 and 25 – once again in conjunction with a bone augmentation procedure (Fig 4-20l). Removal of the sutures showed a clinically satisfactory gingival line. The papillae remained preserved and the labial/buccal soft tissue margin was also unchanged (Fig 4-20m). The pale Bio-Gide membrane could be seen shimmering through the thin mucosa (Fig 4-20n).

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Healing phase

Unfortunately, the measures to preserve the papillae could not be followed up until the time of implant exposure. The interim fixed bridge, provisionally cemented with TempBond, had worked itself loose from its abutments, so that the patient had to seek help from his local emergency dentistry service to have the denture reattached. The emergency dentists diagnosed pressure points, which were treated by filing away the points of the pontics (Fig 4-20o). When the patient presented for his check-up, the residual ridge had healed very well, but the papillae had leveled out (Fig 4-20p).

The 6-month implant healing phase was uncomplicated.

Fabrication of the provisional restoration – “Simpler in Practice” concept

The desired abutments were selected and adapted to the working cast; in this case, they consisted of four CerAdapt abutments. After marking the likely gingival line and checking the maxillomandibular relationship, the abutments were customized by a dental technician. To

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prevent debris from accumulating in the abutments' internal channels during the preparation, these were protected with special plastic rods (Fig 4-20q). Provisional crowns were fabricated on the finished abutments (Fig 4-20r). The relationship of the crowns relative to each other and to the abutments was fixed with the aid of a thermoplastic foil split, allowing it to be transferred to the situation inside the mouth (Fig 4-20s). A metal transfer was then produced in the laboratory, enabling the defined positions of the CerAdapt abutments to be accurately transferred to the mouth (Fig 4-20t). Immediately before exposure, all the components were cleaned and either sterilized or disinfected.

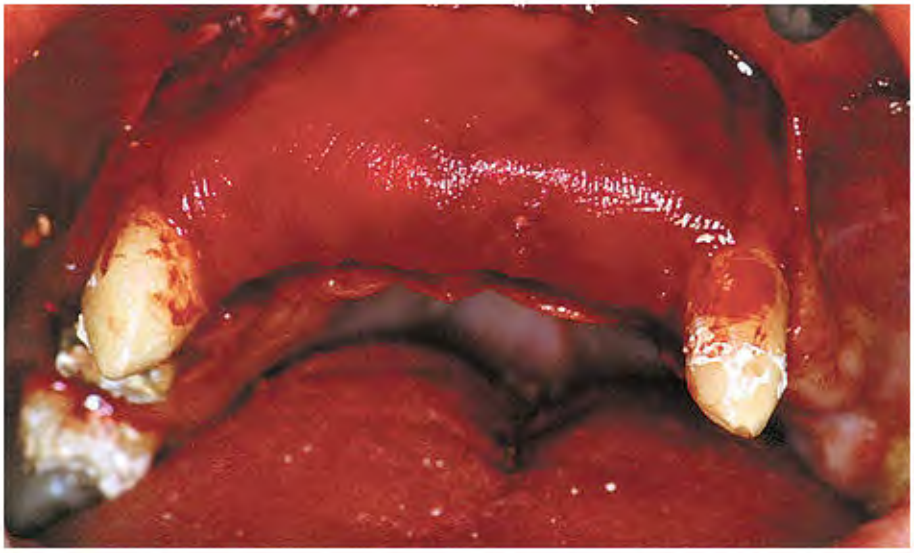


Fig 4-20k Augmentation.



Fig 4-20l Concomitant implant placement in regions 24 and 25.

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Fig 4-20m Preserved papillae and gingival margin.

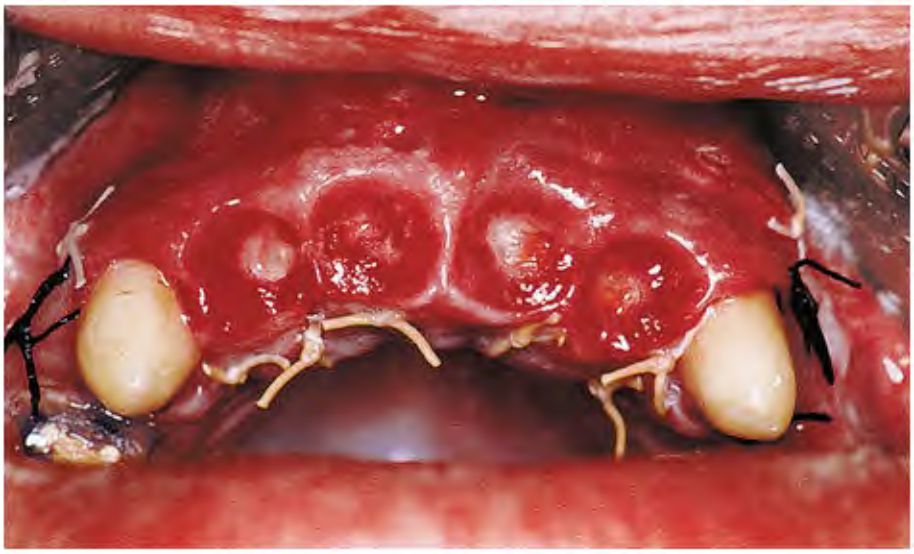


Fig 4-20n Following removal of the fixed partial denture.



Fig 4-20o “Pressure points” treated by leveling the pontics.

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Fig 4-20p “Healed pressure points.”



Fig 4-20q Preparation of the CerAdapt abutments.



Fig 4-20r Prepared abutments.

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Fig 4-20s Transfer for the crowns.



Fig 4-20t Metal transfer for the shaped abutments.



Fig 4-20u Fitting the abutments.

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Fig 4-20v Situation during removal of the sutures.



Fig 4-20w Normally shaped residual ridge.



Fig 4-20x Occlusal view after 3 years of functional use.

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Exposure operation – insertion of the provisional

In the exposure operation, the incision was made slightly toward the palatal aspect, to allow the mucosa to be pushed in the labial/buccal direction for better esthetic results. The CerAdapt abutments were screwed onto the implants with the aid of the transfer (Fig 4-20u) and the retaining screws tightened with 32 N/cm torque. The screw access holes were sealed off with gutta-percha. Using the thermoplastic foil splint as an aid, the provisional crowns were attached with TempBond and the cement residues carefully removed under visual control. This was followed by tight suturing of the wound. The sutures were removed 10 days after implant exposure (Fig 4-20v). The final photos show a satisfactorily contoured residual ridge (Fig 4-20w) and a harmonious dental arch (Fig 4-20x) 3 years after exposure.

Treatment course

- Measures to preserve bone and papillae (1999)
- 5 weeks to extraction, insertion and augmentation
- 6 months to exposure and immediate prosthetic loading
- 6 weeks to definitive restoration

Treatment

Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Roland Althoff
Dental technology:

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Atypical treatment course – problematic baseline situation

Simultaneous immediate and delayed implant placement to replace two central incisors

Baseline situation

After repeated apicoectomies on her two central incisors, this female patient had already lost tooth 11 and was wearing a plastic removable prosthesis as a replacement (Fig 4-21a). Tooth 21 also needed extracting due to persistent symptoms. The baseline situations for the two implants were different (Fig 4-21b). The residual ridge in region 11 already showed a soft tissue and bone deficit, so that the plan here was to perform delayed implant placement (Fig 4-21c). Tooth 21 was to be extracted, with immediate implant placement taking place during the same session (Fig 4-21d).

While the bone structures at the extraction site were still in place, a gingival deficit was likely over the socket. A CBCT scan was performed for the 3D planning (Fig 4-21e). A 17-mm long implant could be inserted in place of tooth 11 (Fig 4-21f). For implant placement in region 21, it was important for tooth extraction to be atraumatic to ensure that the labial bone lamella remained as intact as possible for the augmentation (Fig 4-21g). Hard and soft tissue needed to be reconstructed at both sites for optimal esthetic results (Fig 4-21h).

Diagnostic tools

- Clinical examination
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction of tooth 21 with immediate implant placement, delayed implant placement in region 11 and augmentation, mucosal graft
2. Exposure, two individual ceramic crowns on customized abutments

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Fig 4-21a Plastic prosthesis replacing tooth 11.



Fig 4-21b Different residual ridge contours in regions 11 and 21.



Fig 4-21c Horizontal bone deficit in region 11.

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Fig 4-21d Baseline situation before implant placement.

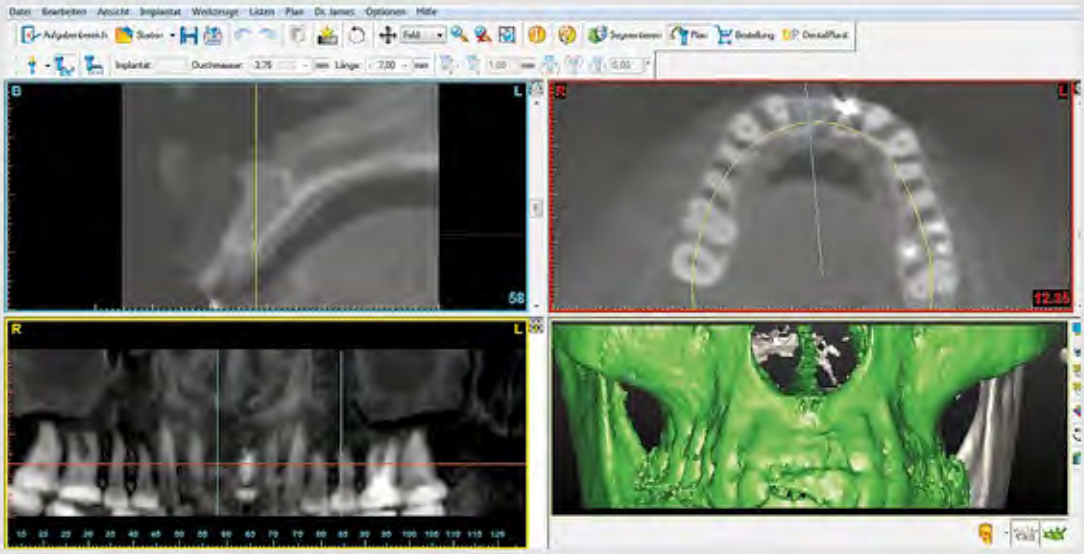


Fig 4-21e CBCT scan images for the SimPlant planning.

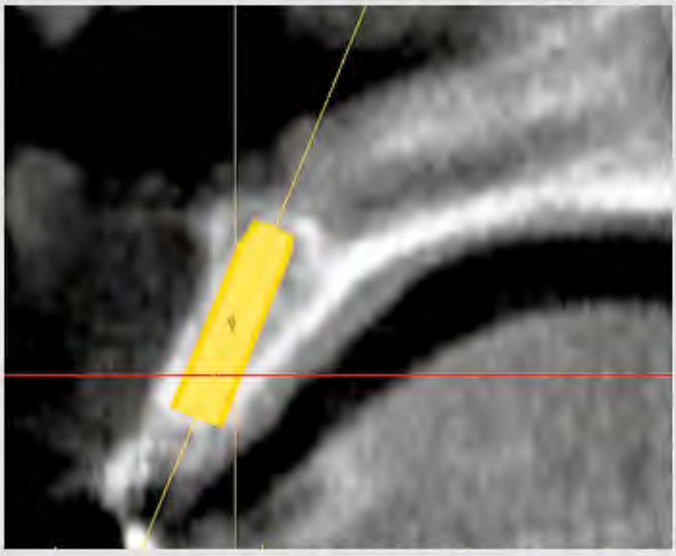


Fig 4-21f Positioning of the implant in region 11.

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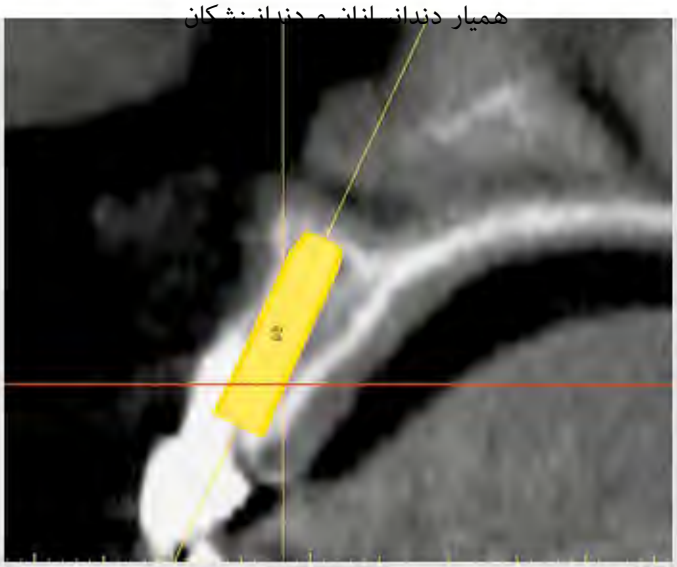


Fig 4-21g Immediate implant placement following extraction of tooth 21.

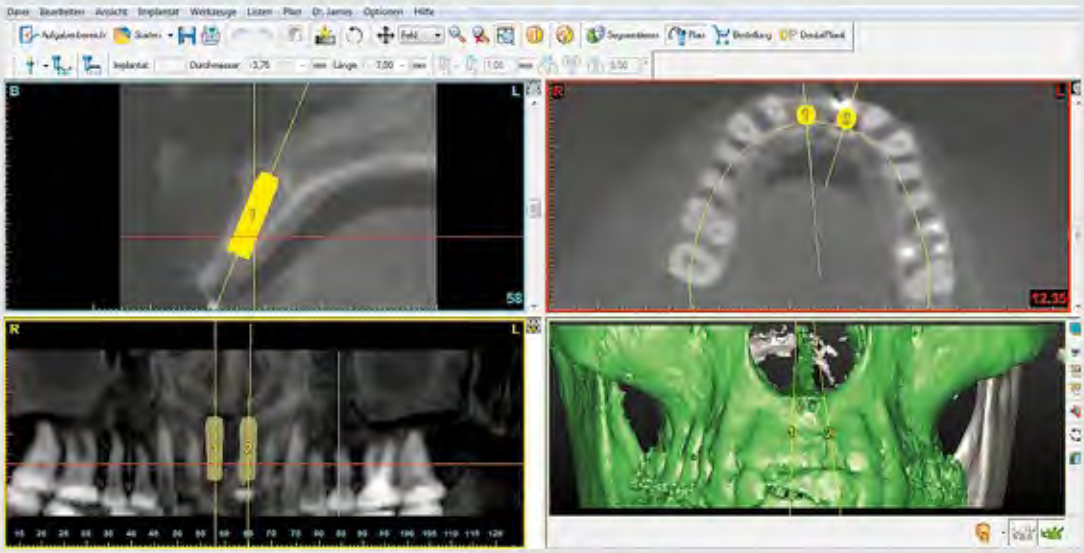


Fig 4-21h SimPlant planning of the two implants.

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Extraction, implant placement and augmentation

The palatal incision on the residual ridge was made after the atraumatic extraction of tooth 21. Implant 11 was inserted in the middle of the residual ridge, implant 21 close to the lingual wall of the extraction socket (Fig 4-21i). The shoulders of both implants were located at the same prosthetically favorable height; the missing bone had to be regenerated. Two 17-mm long Neoss implants (4-mm in diameter) were used. To achieve the desired bone height, 2.7-mm long healing abutments were screwed onto the implants (Fig 4-21j). The job of the healing abutments was to support the membrane and to retain the augmentation volume mechanically in both the vertical and horizontal direction (Fig 4-21k). The augmentation was performed with a

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mixture of harvested autologous bone and the regenerative bone substitute Bio-Oss, and stabilized with a resorbable membrane (Tutodent; Fig 4-21l).

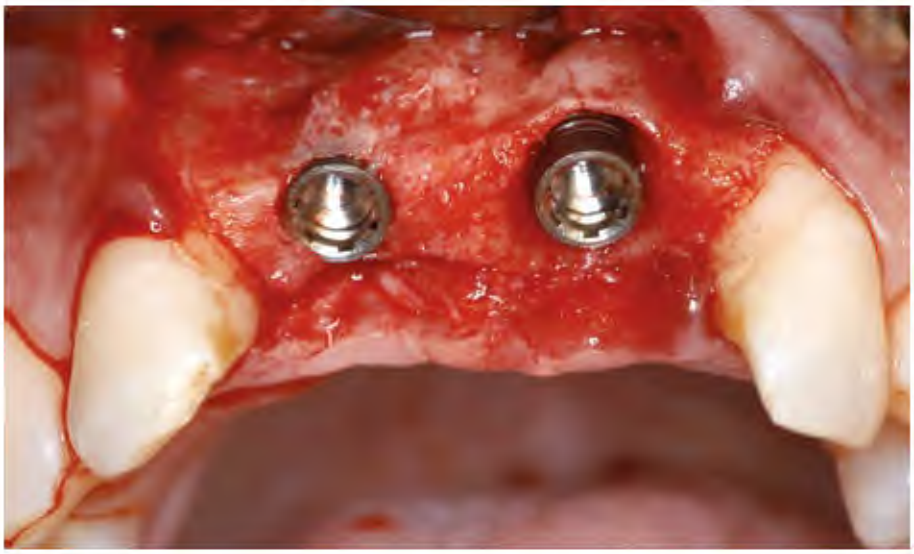


Fig 4-21i Inserted implants.

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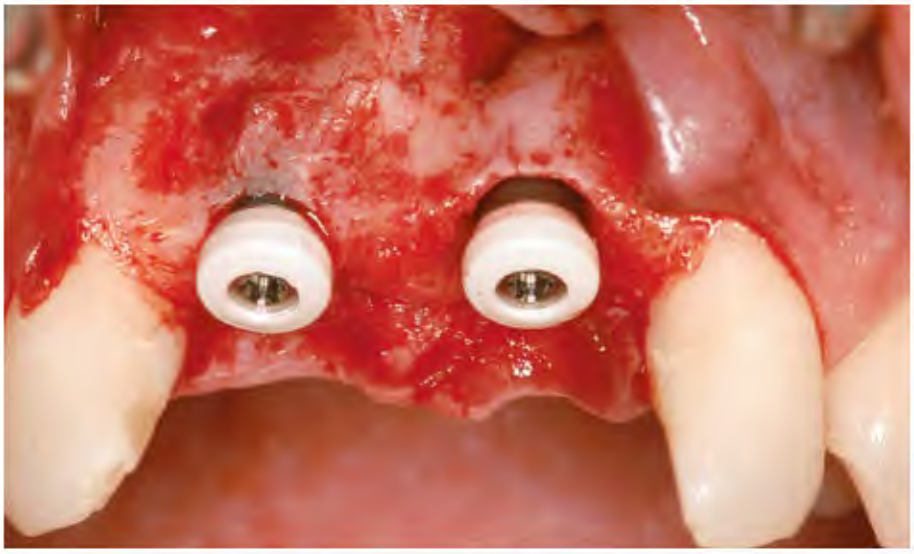


Fig 4-21j Short healing abutments screwed into place.

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Fig 4-21k Difference in residual ridge contours.

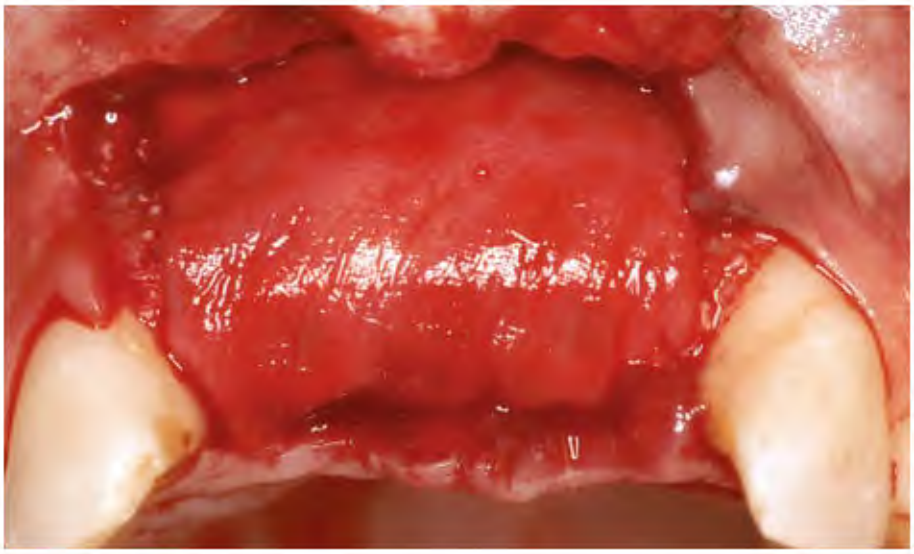


Fig 4-21l Augmentation with a membrane.

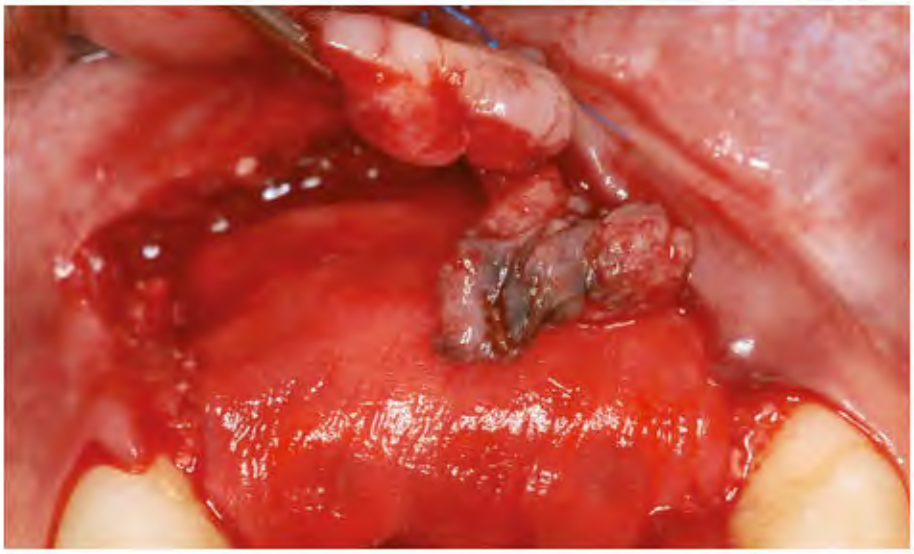


Fig 4-21m Creating the split flap.

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Fig 4-21n Adapting the split flap.

Periosteal slitting was performed to ensure saliva-proof suturing and that the mucoperiosteal flap was mobilized. However, there remained a soft tissue defecit after the extraction of tooth 21; this could be covered with a subepithelial graft. To do this, a split flap detached at the apical end and with a pedicle at the coronal end was created deep in the labial vestibule (Fig 4-21m) and adapted to the extraction socket (Figs 4-21n and 4-21o). A perforation of the mucosa that occurred during the dissection was repaired directly with microsurgical sutures (Fig 4-21p). The mucoperiosteal flap had to be mobilized sufficiently to allow it to be repositioned over the oversized augmentation without any tension (Fig 4-21q). During wound closure, the entire mucoperiosteal flap was first stabilized with three Gore-Tex sutures (one on each side and one in the middle) and the split flap was then fixed to the palatal mucosa with a microsurgical suture. The rest of the wound closure was performed with Gore-Tex and microsurgical suture material, using both ordinary and mattress backstitch sutures (Fig 4-21r). The sutures had to stay in place for at least 2 to 3 weeks (Fig 4-21s). The last Mopylen sutures (6-0) were removed once the soft tissue had regenerated fully over the implants (after approximately 4 to 6 weeks; Figs 4-21t and 4-21u). A postoperative panoramic radiograph was taken after implant placement (Fig 4-21v).

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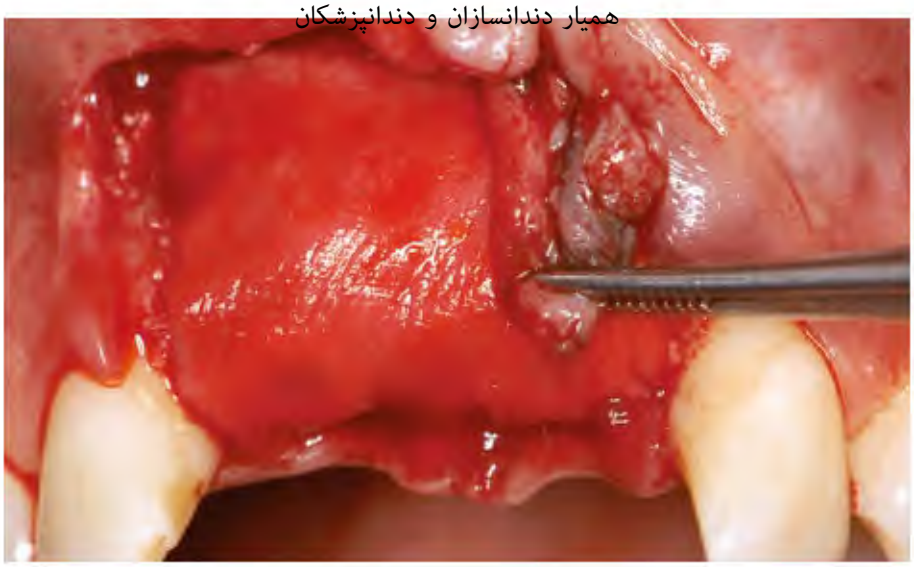


Fig 4-21o Mobilization of the split flap.

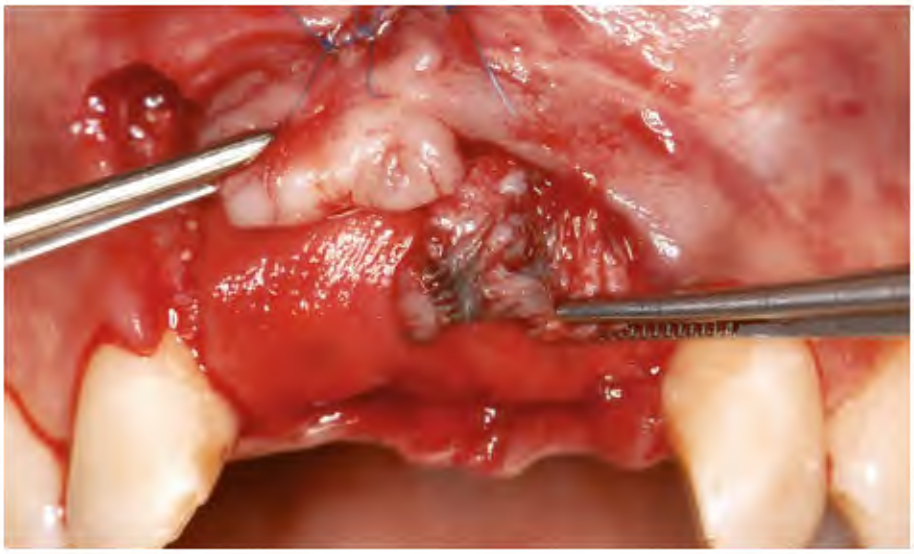


Fig 4-21p Sutured mucosal perforation.

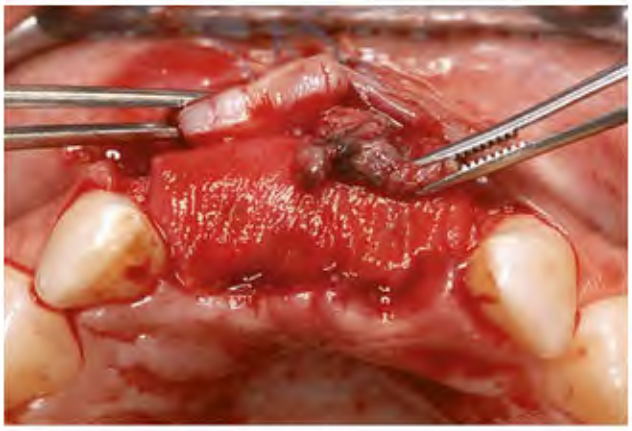


Fig 4-21q Mobilization of the whole flap.

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Fig 4-21r Sutured wound, including repair of the perforation.

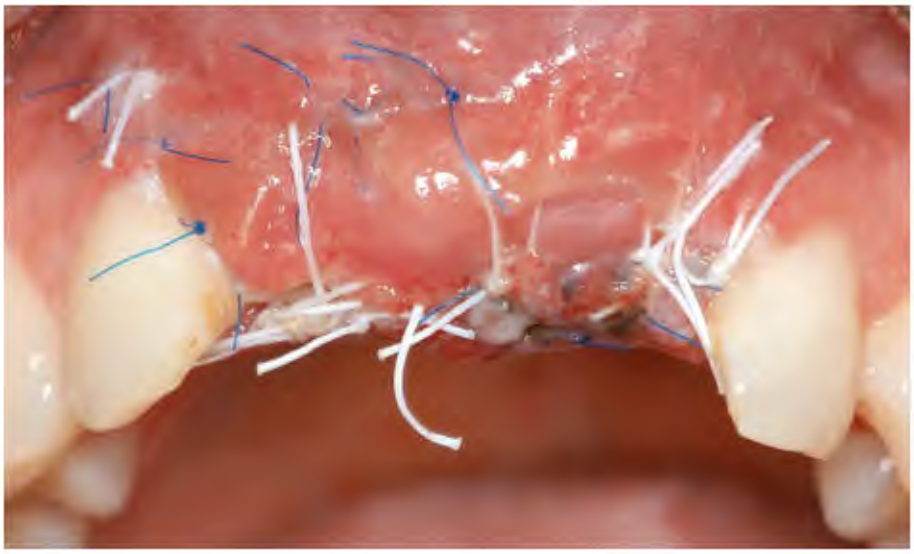


Fig 4-21s Clinical situation after 10 days.



Fig 4-21t After 4 weeks.

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Fig 4-21u Stable healing course.



Fig 4-21v Postoperative panoramic radiograph.



Fig 4-21w Resorption of the augmentation material under the prosthesis.

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Fig 4-21x Flattening of the residual ridge contour.

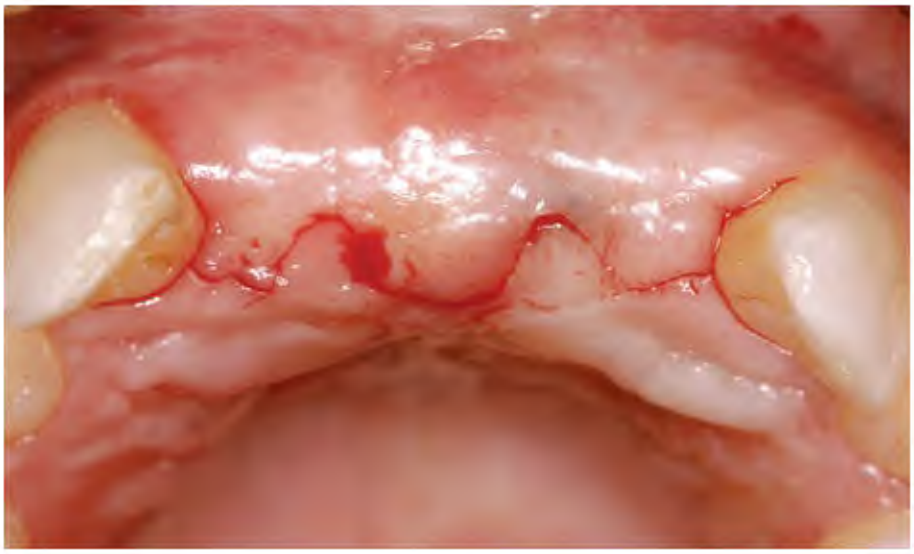


Fig 4-21y Incision made using the cosine curve technique.

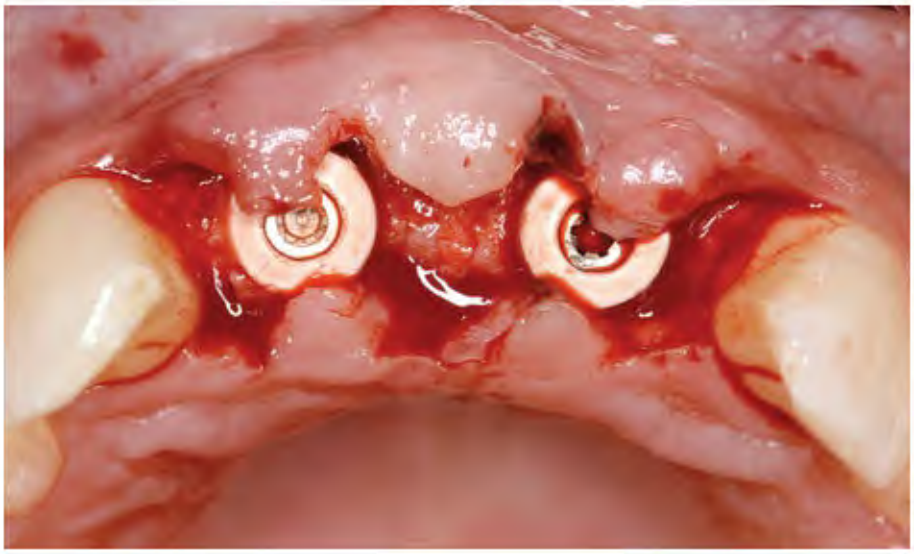


Fig 4-21z Outcome of the augmentation.

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Exposure and prosthetic loading

The 8-month healing period was uncomplicated, but there was slight resorption of the augmentation material, as made apparent by the shaped clasp prosthesis (Fig 4-21w). Implant exposure is the right time to improve the contour of the residual ridge slightly (Fig 4-21x). The incision for the exposure was made slightly palatally, using the principles of the cosine curve technique (Fig 4-21y; see also page 330). Slight raising of the mucoperiosteal flaps revealed good reorganization of the augmentation (Fig 4-21z). When the 2.7-mm long healing abutments were unscrewed, it was apparent how much new bone had formed around the implants (Fig 4-21aa). Healing abutments (5-mm long) were now screwed onto the implants. The palatal flap was first secured at the sides with two sutures (Fig 4-21bb), followed only then by full wound closure (Fig 4-21cc). To avoid flap compression, the prosthesis needed to be hollowed out (Fig 4-21dd). The sutures were removed after approximately 2 weeks (Fig 4-21ee). An impression for the prosthetic restoration in this esthetically sensitive region was not made until approx 6 weeks after the exposure. Two individual ceramic crowns were fabricated on the customized zirconium dioxide abutment and attached with adhesive (Fig 4-21ff). The patient is very satisfied with the final result (Fig 4-21gg).

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Fig 4-21aa Regenerated bone around the implants.

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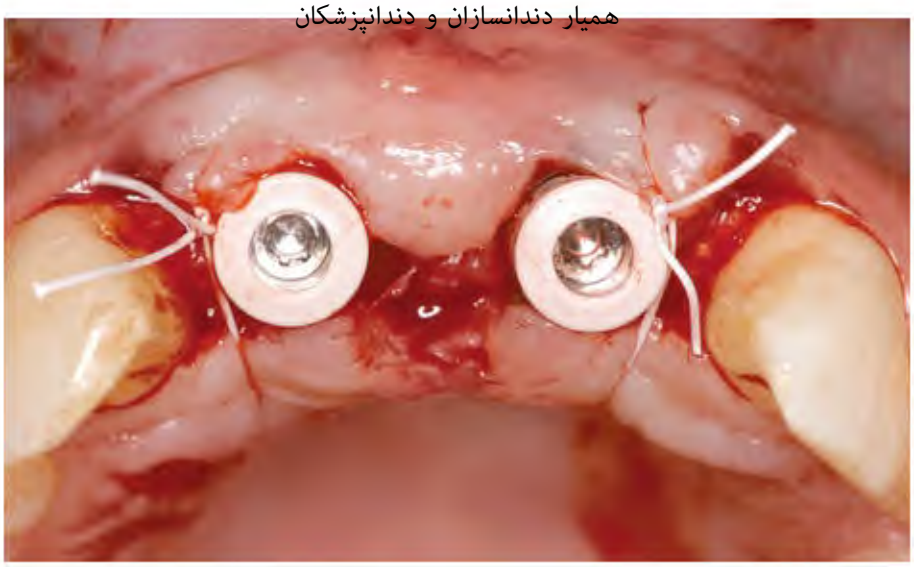


Fig 4-21bb Flap fixation.

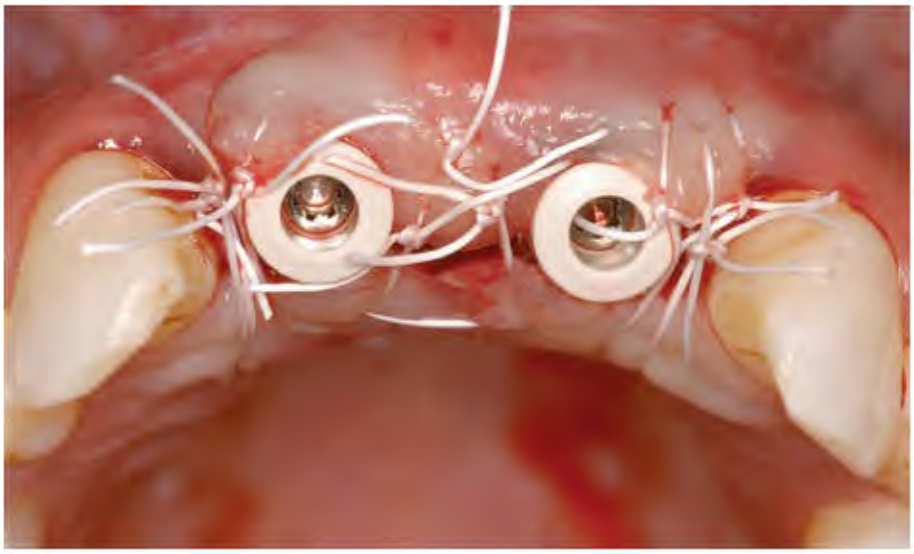


Fig 4-21cc Closure by suturing.



Fig 4-21dd Hollowed-out prosthesis.

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Fig 4-21ee Removal of the sutures.



Fig 4-21ff Individual crowns on zirconium dioxide abutments.

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Fig 4-21gg Satisfied patient.

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Treatment course

- Extraction, implant placement and augmentation 2007
- 8 months to exposure
- 6 weeks to impression-taking and fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Problems and complications

The loss of an implant is often associated with hard and soft tissue defects. For a new implant to be anchored, it is usually necessary to reconstruct the bone bed first (bone augmentation). The new implant can only be inserted once the healing phase of the augmentation has run its course.

Implant treatment following the loss of an implant-supported restoration

Baseline situation

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Following the traumatic loss of teeth approximately 15 years before, this female patient had two Tübinger immediate implants placed in regions 21 and 22 at another clinic. According to the patient, implant 22 had become loose approx 5 years before. It had been stabilized with a thermoplastic foil splint and interlocked with implant 22 by means of a superstructure. The patient first presented here with this superstructure (Fig 4-22a). Clinical inspection showed slight loosening of the implants; probing depths and the radiograph showed widening of the gap around the implants (Fig 4-22b). Removal of the superstructure showed a large gingival deficit (Fig 4-22c). The gingival margin lied approximately 8 mm apically of the cementoenamel junction (CEJ) at implant 21, and approximately 6 mm apically of it at implant 22. There is no attached gingiva left. Both implants had to be removed.

Diagnostic tools

- Clinical examination
- Panoramic radiograph, CT scan
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Removal of ceramic implants 21 and 22 with simultaneous augmentation and a mucosal graft
2. Implant placement
3. Exposure and prosthetic loading



Fig 4-22a Compound crowns on the two Tübinger implants.

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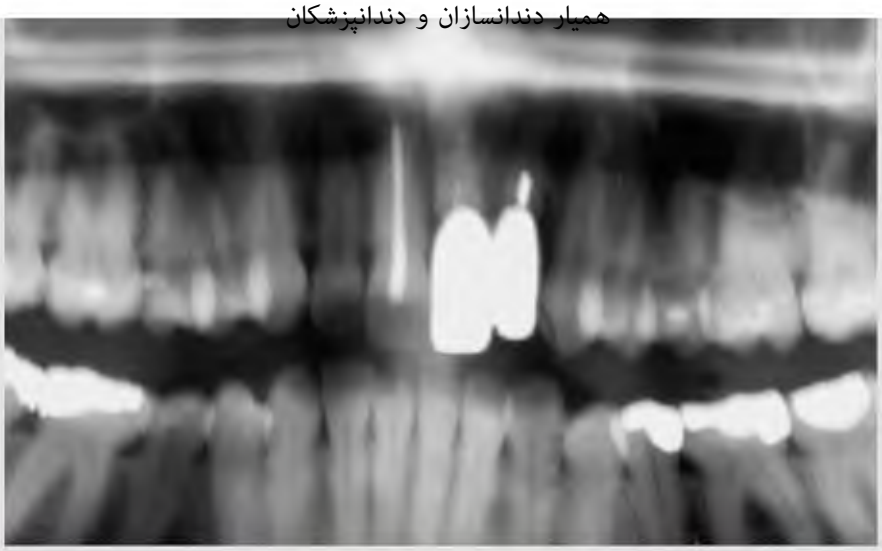


Fig 4-22b Panoramic radiograph.



Fig 4-22c Situation following removal of the compound crowns.

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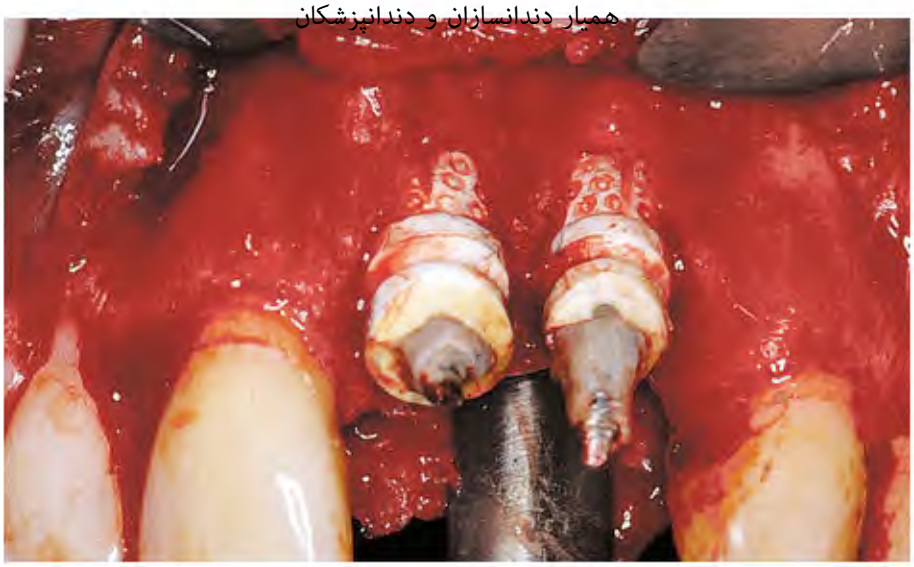


Fig 4-22d Extensive loss of the labial bone lamella.

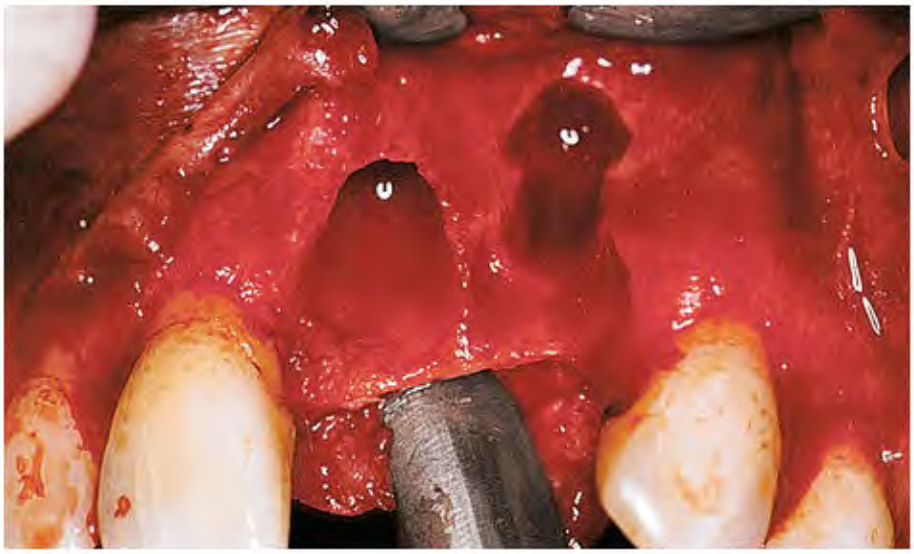


Fig 4-22e Bone defect following implant removal.



Fig 4-22f Titanium-reinforced Gore-Tex membrane attached with titanium pins.

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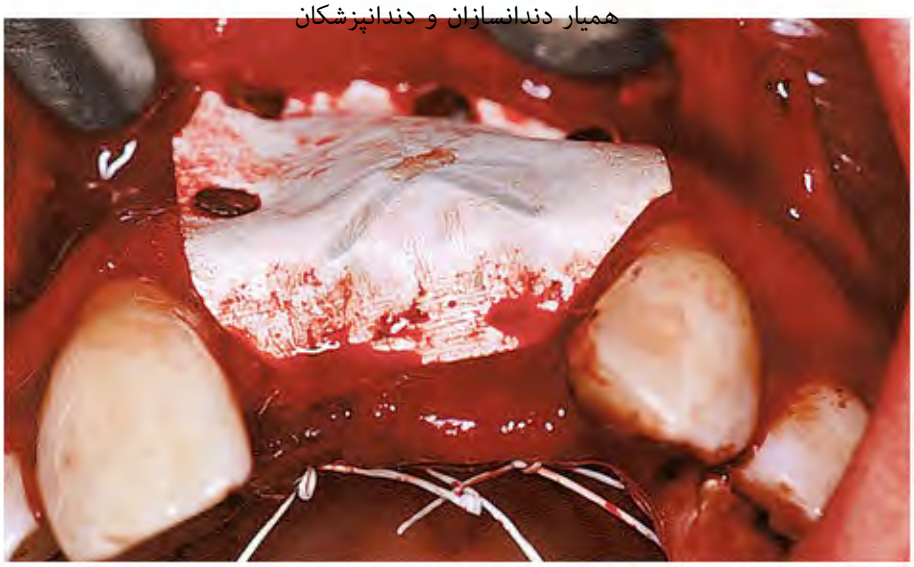


Fig 4-22g Palatal fixation of the membrane with sutures.

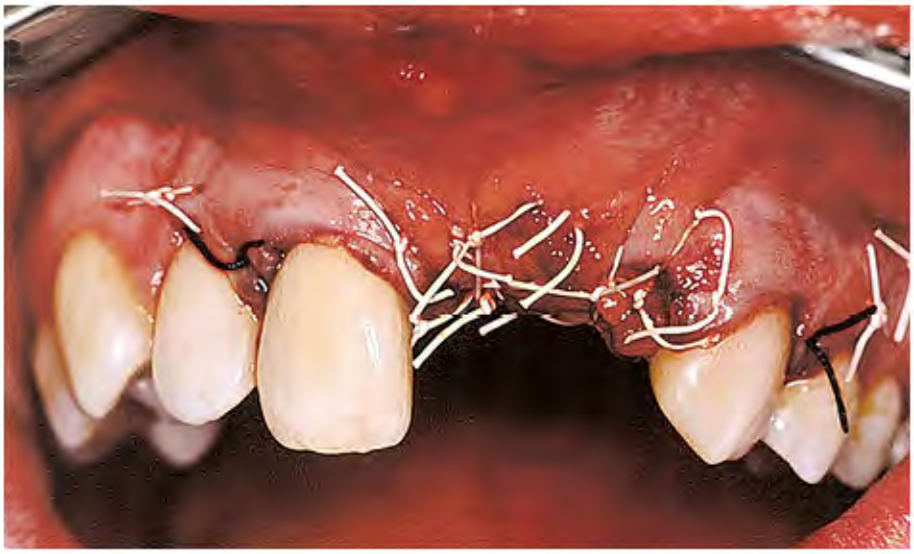


Fig 4-22h Free gingival graft from the palate.

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Implant removal and augmentation

A wide flap extending from tooth 12 to 24 was created to ensure the optimum supply of nutrients for the tissue after the augmentative measures. Flap reflection revealed the almost total absence of a labial bone wall around both implants (Fig 4-22d). Implant 21 was removed undamaged. Implant 22 showed a fracture in its upper segment and was removed in two pieces. Since both implants extended up to the floor of the nasal cavity, a bone defect of corresponding size was present here (Fig 4-22e). The bone defects were repaired with two Bio-Oss cancellous bone blocks and with small Bio-Oss particles. A large, titanium-reinforced Gore-Tex membrane was applied over this and attached with titanium pins (Fig 4-22f). At the palatal end, the membrane was stabilized following appropriate adaptation with three Gore-Tex sutures (Fig 4-22g). Since the gingival deficit was large (see Fig 4-22c) and the Gore-Tex membrane requires an intact mucosa, a free gingival graft was also taken from the palate and

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securely attached over the membrane (Fig 4-22h).



Fig 4-22i Gingival situation after 9 months.



Fig 4-22j Provisional restoration with thermoplastic foil.

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Fig 4-22k Insertion of the implants.

Implant placement

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After the 9-month healing period, the bone augmentation material was sufficiently stable to anchor the implants. Although an intact covering layer of mucosa was in place (Fig 4-22i), the height and width of the residual ridge were not yet adequate from an esthetic point of view and needed to be optimized with regenerative measures. The patient was fitted with a thermoplastic foil splint securely positioned onto the teeth as a long-term provisional restoration (Fig 4-22j). This ensured that the augmentation would not be put at risk, eg, by pressure from a clasp denture. As a result of the augmentation, the implants were inserted with primary stability. The implants were fully inserted in the bone, with implant 22 placed slightly deeper. To even out the difference in height between the implants and to offer additional support to the gingiva, a 3-mm healing abutment was screwed onto implant 22 (Fig 4-22k). Unfortunately, the regenerative capacity of the gingiva, which had been operated on several times, was insufficient, so that tissue perforation occurred over the support zone even before removal of the sutures (see Fig 4-22g). However, the gingival situation remained stable despite the perforation.

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Fig 4-22l Situation after the gingival graft and before implant exposure.

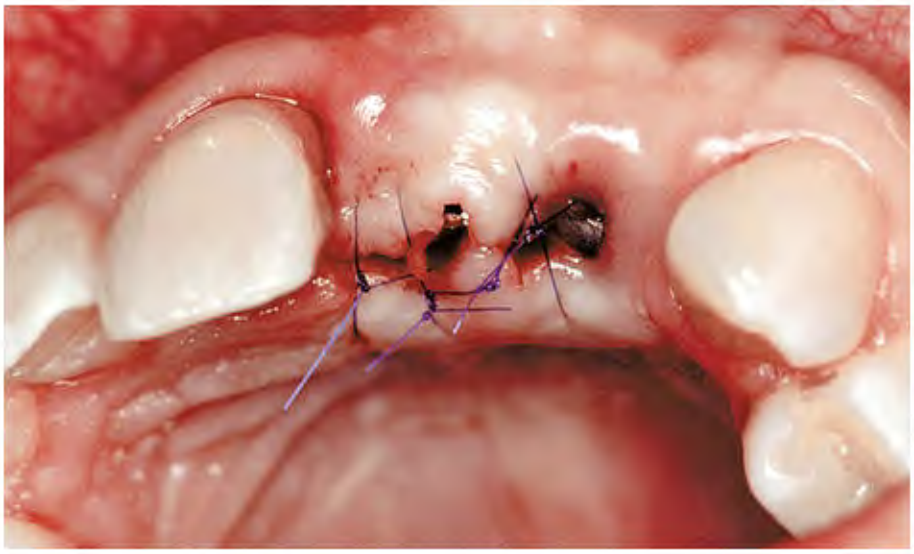


Fig 4-22m Exposed implant 21 and spontaneous perforation over implant 22.



Fig 4-22n Provisional plastic cylinders.

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Fig 4-22o Initial stage of the gingiva stretching process. Shortened provisional taken out of occlusion.



Fig 4-22p Final phase of the gingiva stretching process.



Fig 4-22q Fitting the customized abutments.

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Fig 4-22r Prosthetic loading after 18 months.

Exposure and provisional loading

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If at all possible, any gingival corrections that are needed should be performed a few weeks before exposure, or concomitantly with it at the very least. In the case presented here, the correction took place 6 weeks before the planned exposure, with the aid of a free connective tissue graft from the palate (see page 310). This allowed the soft tissue to be built up in the labial and coronal directions.



Fig 4-22s Radiograph after 12 years.

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Fig 4-22t Prosthetic restoration after 12 years.

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The exposure took place 6 weeks after the transplantation as planned. Even though the graft had initially provided full coverage, a perforation did develop over implant 22, fortunately this was very small (Fig 4-22l). For the exposure, the incision over implant 21 was made palatally, to include the access for implant 22. The cover screw was removed and the smallest healing abutment (3 mm high and 4.1 mm wide) was selected and screwed into place (Fig 4-22m). If there is a gingival deficit, it is advantageous for the flap to partially cover the healing abutment to form sufficient tissue for the subsequent stretching process (Fig 4-22m). Shaping of the gingiva with the provisional restoration was started only following primary soft tissue healing. The implants were loaded with a first provisional restoration on plastic cylinders (Fig 4-22n). Initially, the provisional crowns had to be made very narrow in the subgingival region to provide sufficient space for the soft tissue to consolidate. The provisional was placed out of occlusion and articulation (see Progressive Bone Loading, page 387) (Fig 4-22o). The gingival margins were shaped by gradually widening the subgingival segments of the crowns (Fig 4-22p). Once the stretching phase was completed, the definitive prosthetic restoration was incorporated on customized abutments (Fig 4-22q). Any remaining soft tissue defects could be compensated for with pink ceramic at the cervical end of the crown. Figure 4-22r shows the prosthetic restoration 18 months after its incorporation.

Continued follow-up

At a follow-up assessment 12 years later, moderate bone loss around the implants can be seen in the dental radiograph (Fig 4-22s). Despite the bone defect, there is a stable clinical situation around the implants with a satisfactory long-term esthetic result (Fig 4-22t).

Treatment course

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- Removal of the ceramic implants after 15 years and augmentation (1997)
- 9 months to implant placement
- 8 months to gingival graft
- 6 weeks to exposure
- 4 months to shape the gum
- Prosthetic restoration

Treatment

Surgery:	Dr Christoph T. Sliwowski
Dental technology:	Horst Mosch
Prosthetics:	Dr Uwe Hildebrand

Note

Mucosal graft technique

Harvesting the graft



Fig 4-23a Preparing the template.

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Fig 4-23b Placing the template onto the palate.



Fig 4-23c Incision guided by the template.



Fig 4-23d Dissection of the thin flap.



Fig 4-23e Template-sized graft.

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Fig 4-23f Fixation of the palatal flap.

To harvest a graft of the desired size, a template should be prepared before the procedure. This can be made out of sterile aluminum foil, cut to the size and shape of the recipient site (Fig 4-23a). The template is placed on the planned donor site on the palate approximately 3 to 4 mm over the second premolar and the first molar (Fig 4-23b). The superficial incision is made on three sides (coronal, mesial and distal; Fig 4-23c). Depending on the size of the template, a thin flap with a pedicle on the apical side is dissected out of the epithelium and the outermostw layer of the collagenous fiber network (Fig 4-23d). The underlying connective tissue is cut on all sides up to the periosteum and dissected away.

When removing the graft, care should be taken not to damage the palatine artery. The resultant connective tissue graft corresponds to the template and is exactly the required size (Fig 4-23e). It needs to be stored in physiologic saline or covered with moist swabs to protect it from drying out. The donor side is covered with the repositioned epithelial flap, which is attached with sutures (Fig 4-23f).

Graft placement



Fig 4-23g Recipient site before the graft.

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Fig 4-23h Incision made with the cosine curve technique.



Fig 4-23i Tunneling.



Fig 4-23j Pulling the graft in with two “reins.”



Fig 4-23k Suture fixation of the graft.

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Fig 4-23l “Gingival bridge” from the apices of the cosine curve.



Fig 4-23m Gingival situation after 3 weeks.



Fig 4-23n Healed donor site on the palate.

The incision at the recipient site (Fig 4-23g) should be made to ensure optimal blood supply to the graft and the best possible stabilization. Ideally, the site is exposed using the cosine curve technique (see page 332) (Fig 4-23h). Pockets are dissected under both sections of the flap and the graft is pushed in (Fig 4-23i). The graft can be pulled into the pocket with “reins” formed with sutures (purple suture on the left and white on the right in this case; Fig 4-23j). Both flaps and the graft must then be secured carefully with sutures (Fig 4-23k). The peaks of the cosine curves retain the graft in the middle like a mucous membrane bridge and supply it with nutrients (Fig 4-23l). The sutures are left in situ until the site has healed completely (at least 3 weeks; Fig 4-23m). The implants are exposed after 6 weeks (see page 308). At this time point, the donor site on the palate should have healed completely (Fig 4-

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23n).

Problems and complications

Immediate restoration loaded onto provisional implants following loss of the old implant-supported restoration

An increasing number of patients cannot manage with a removable prosthesis, even for the few months that it takes for the inserted implants to heal. Provisional implants can do a very good job in this group of patients. They are inserted into the bone between the permanent implants as an interim solution, to provide stable and secure retention of the provisional prosthesis from the outset. These accessory implants do not usually undergo osseous integration but merely become mechanically anchored in the bone; however, they can be loaded immediately as retention points for the provisional dental prosthesis. Because of the lack of osseous integration, their stability tends to decrease after a prolonged loading period.

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Baseline situation

A 48-year-old man presented with severe loosening of compound crowns 12, 11 and 21 accompanied by an inflammatory reaction around the abutment teeth (Fig 4-24a). A CBCT scan was taken for the 3D planning (Fig 4-24b). A zone of radiolucency can be seen in the radiograph around the hollow cylinder implant in region 12 (Fig 4-24c). This implant was very loose and was only held in place by the fixed bridge. While the transdental root pin in tooth 11 extended to the floor of the nasal cavity, the bone around it appeared to have undergone considerable resorption (Fig 4-24d). The transdental pin in tooth 21 had fractured and the broken fragment was still firmly embedded in the jaw bone (Fig 4-24e).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Removal of implant 12, extraction of teeth 11 and 21 with augmentation, immediate

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restoration loaded onto provisional implants

2. Implant placement and repeat augmentation
3. Exposure, long-term provisional restoration to shape the papillae
4. Prosthetic restoration



Fig 4-24a Baseline situation.

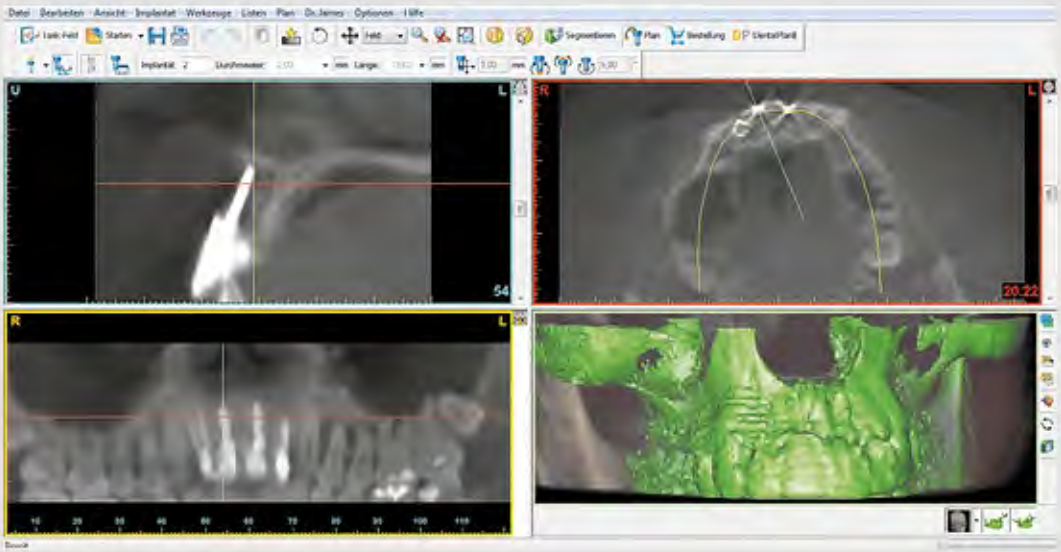


Fig 4-24b CBCT scan images.

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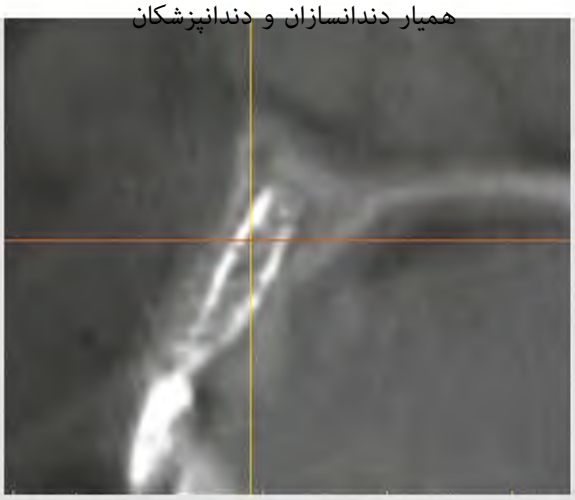


Fig 4-24c The loose hollow cylinder implant in region 12.

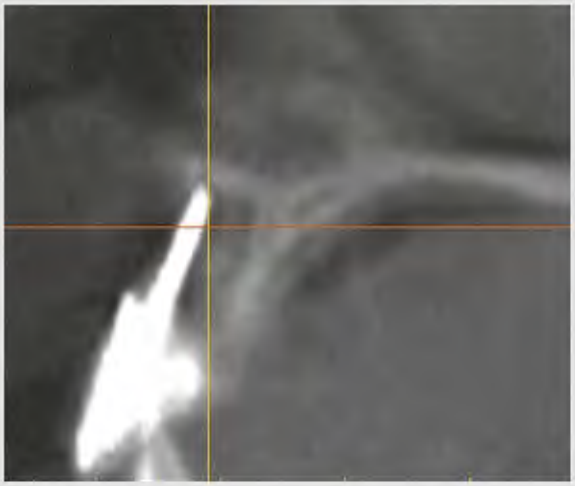


Fig 4-24d Transdental root pin in tooth 11.

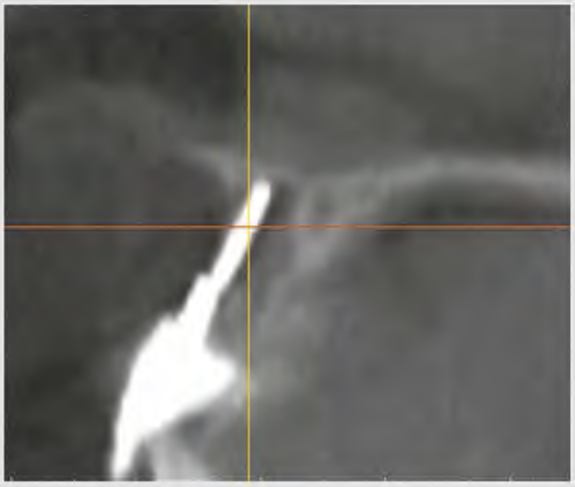


Fig 4-24e The broken root pin in tooth 21.

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Fig 4-24f Situation following removal of the fixed bridge.

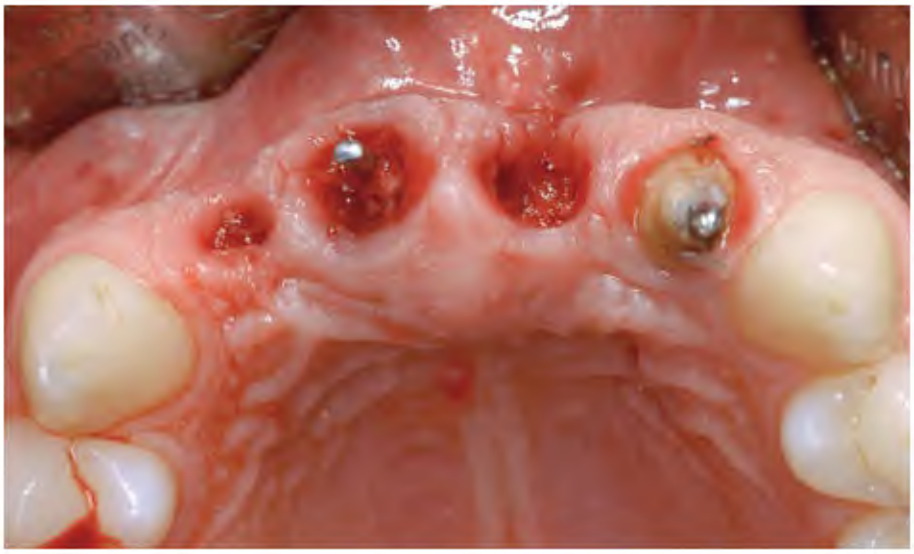


Fig 4-24g Horizontal residual ridge atrophy.

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Implant removal and augmentation

When the fixed bridge was removed, implant 12 and the transdental root pin in tooth 21 were automatically removed (Fig 4-24f). The transdental root pin in tooth 11 remained in the jaw. A chronic inflammatory reaction had caused severe horizontal and vertical atrophy of the residual ridge (Fig 4-24g). When the operation area was opened up, a deep bone defect was revealed in region 12, along with the pin in region 21, fractured at the apex (Fig 4-24h). A few threads of pin 11 were still firmly anchored in the bone. Both were removed by careful reaming. The removed structure offered only limited support for the loads placed on it (Fig 4-24i). Two Intermediate Provisional Implants (IPI; Nobel Biocare) were inserted in the remaining residual ridge in such a way as to ensure that they were not in the way of the planned definitive implants 12 and 21 (Fig 4-24j). Following meticulous cleaning to remove any inflamed tissue, the defective residual ridge was filled with the regenerative bone substitute

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Bio-Oss (Fig 4-24k). The augmentation was overcontoured both vertically and horizontally to counteract any future resorption (Fig 4-24l). It was then stabilized with a Bio-Gide membrane, which was attached with titanium pins.

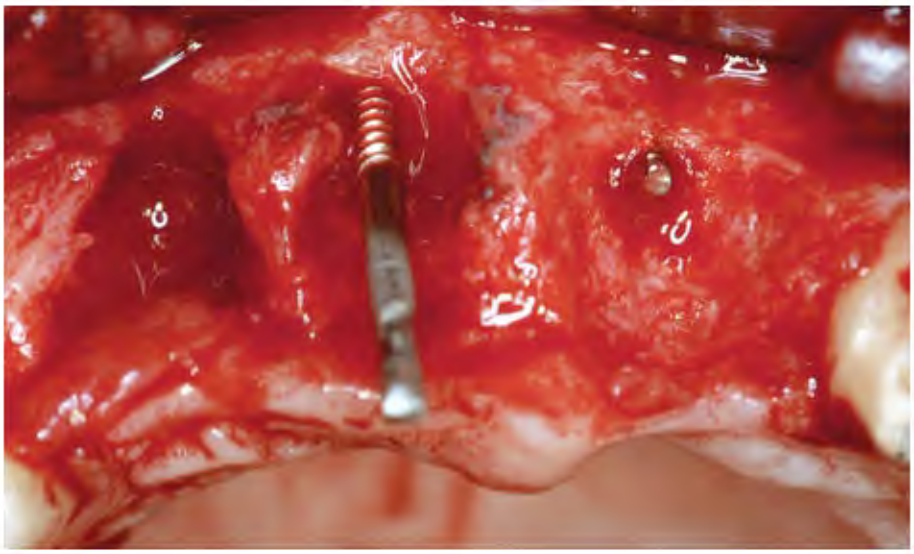


Fig 4-24h Residual ridge following flap reflection.



Fig 4-24i Removed implant and crown fragments.

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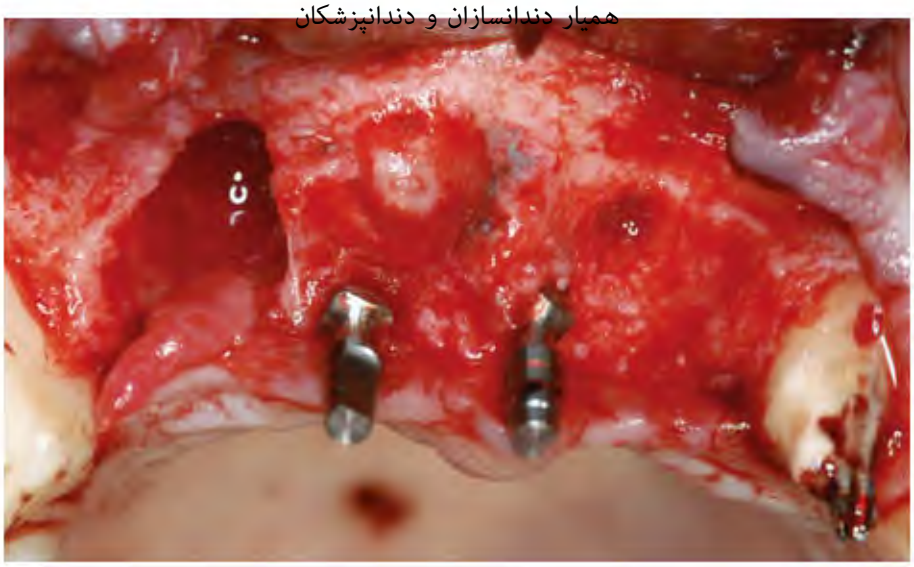


Fig 4-24j Provisional implants.



Fig 4-24k Augmentation with Bio-Oss.

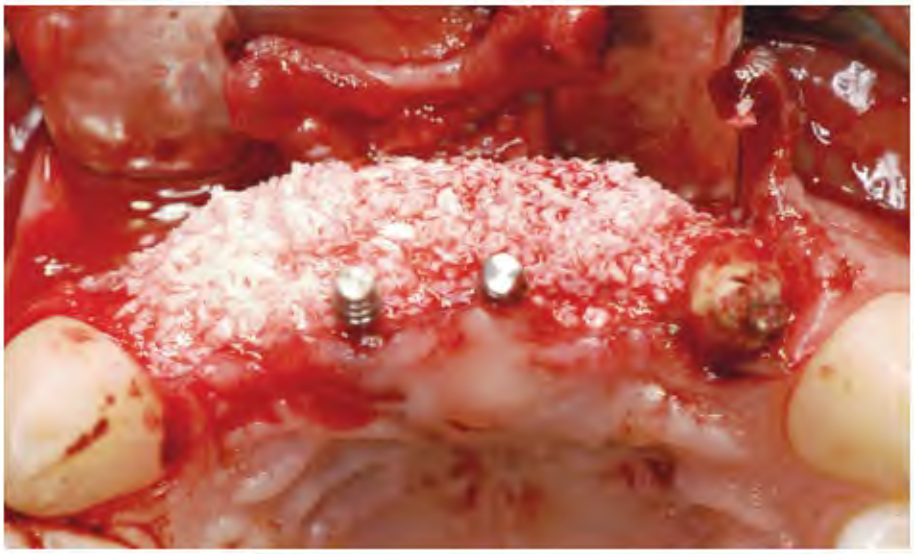


Fig 4-24l Overcontouring of the augmentation.

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Fig 4-24m Tight suturing of the wound.



Fig 4-24n First immediate provisional restoration.

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Extensive periosteal slitting followed to ensure that the overcontoured augmentation was covered completely with mucosa despite the extraction defects (Fig 4-24m). The two provisional implants and the stump of tooth 22 were used as abutments for the provisional restoration. The immediate provisional was fabricated directly with the aid of a thermoplastic foil and incorporated (Fig 4-24n). The immediate provisional was later replaced with a long-term one (Fig 4-24o).

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Fig 4-24o Long-term provisional.



Fig 4-24p Stable healing course.



Fig 4-24q Following removal of the provisional.

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Fig 4-24r Contour of the residual ridge.



Fig 4-24s Palatal incision.

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Implant placement

Eight months after the augmentation, the clinical situation appeared stable (Fig 4-24p) and the newly regenerated bone bed was of sufficient size to allow implant placement to take place. The long-term provisional restoration was removed and the stability of the provisional implants tested (Fig 4-24q). The gingiva had already been shaped to the desired structure by the overcontoured pontics (Fig 4-24r). Compared to the baseline situation, the residual ridge now looks far better suited for implant placement (see Figs 4-24r and 4-24g). The incision was made on the residual ridge, palatally of the provisional implants and tooth 22 (Fig 4-24s). A releasing incision was made by tooth 13, to allow the flap to be dissected away toward the labial aspect (Fig 4-24t).

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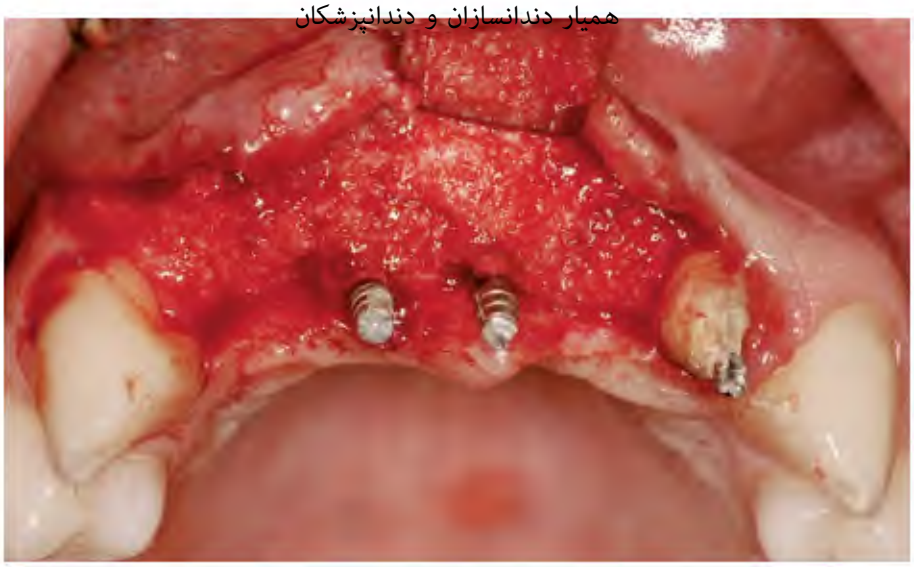


Fig 4-24t Result of the augmentation.



Fig 4-24u Preparation of the implant beds.



Fig 4-24v Healing abutments on the inserted implants as supports for the augmentation.

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Fig 4-24w Suturing of the wound.



Fig 4-24x Modified provisional.

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Implant beds were prepared in regions 12 and 21 and checked with direction indicators (Fig 4-24u). The provisional implants and tooth 22 remained undisturbed for the time being. Two 17-mm long Neoss implants (4 mm in diameter) were inserted at positions 12 and 21. To ensure improved conditions for further augmentation, 2.7-mm long healing abutments were screwed onto the implants instead of cover screws, to act as supports (Fig 4-24v). The augmentation was performed with the harvested bone chips and a bone substitute (Bio-Oss), without the use of a membrane. The mucoperiosteal flap was released by periosteal slitting and repositioned over the operation area. It was fixed into place with Gore-Tex and microsurgical sutures (Fig 4-24w). After some adjustment on the gingival side of the long-term provisional, the patient continued to wear it up to the time of implant exposure (Fig 4-24x).

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Fig 4-24y Situation before exposure.



Fig 4-24z Contour of the residual ridge.

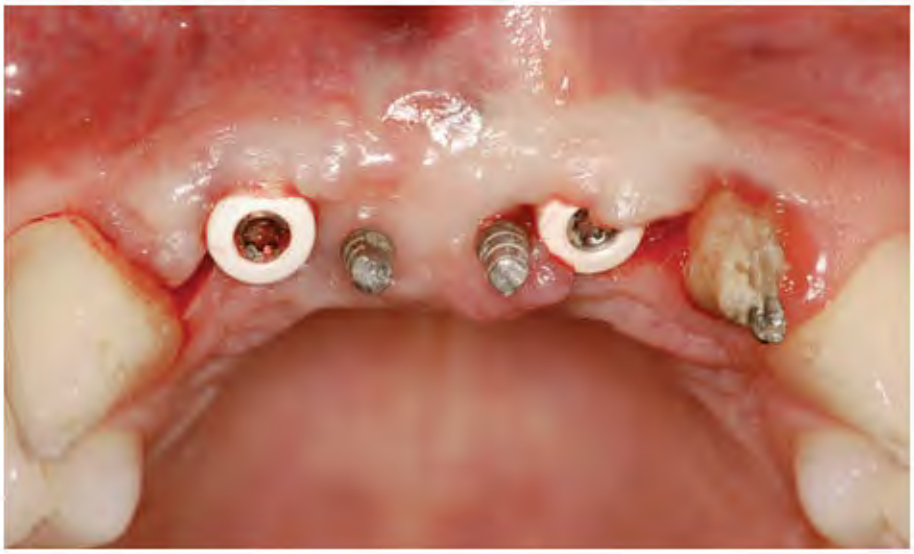


Fig 4-24aa Minimally invasive incision.

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Fig 4-24bb Suturing following the exposure.



Fig 4-24cc Postoperative panoramic radiograph at the time of impression taking.



Fig 4-24dd Long-term provisional on definitive implants.

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Exposure

The implants were exposed after another 7 months. The long-term provisional was removed, revealing that implant 12 was already partly exposed (Fig 4-24y). The contour of the residual ridge had improved markedly (Fig 4-24z). A minimally invasive incision was made over both implants, slightly in the palatal direction (Fig 4-24aa). The short abutments were switched for ones 5 mm in length. Both flaps were stabilized with Mopylen 6-0 sutures (Fig 4-24bb). The postoperative panoramic radiograph showed the positioning of the implants in the jaw (Fig 4-24cc). Until a new provisional on the definitive implants was fabricated, the patient could continue to wear the long-term provisional, shaped to allow place for the abutments. The new long-term provisional was made after approximately 6 weeks (Fig 4-24dd). The definitive prosthetic restoration was incorporated after another 3 months. A follow-up panoramic radiograph was taken 4 years after treatment completion, confirming a stable bone situation around the implants (Fig 4-24ee). When compared to baseline, the clinical situation after 4 years is more than satisfactory for both patient and dentist (Figs 4-24a and 4-24ff).

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Fig 4-24ee Follow-up panoramic radiograph after 4 years.

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Fig 4-24ff Definitive prosthetic restoration after 4 years of functional use.

Treatment course

- Dental treatment, implant removal and augmentation (2007)
- 8 months to implant placement
- 7 months to exposure
- 6 weeks to impression taking
- 3 months to the definitive restoration

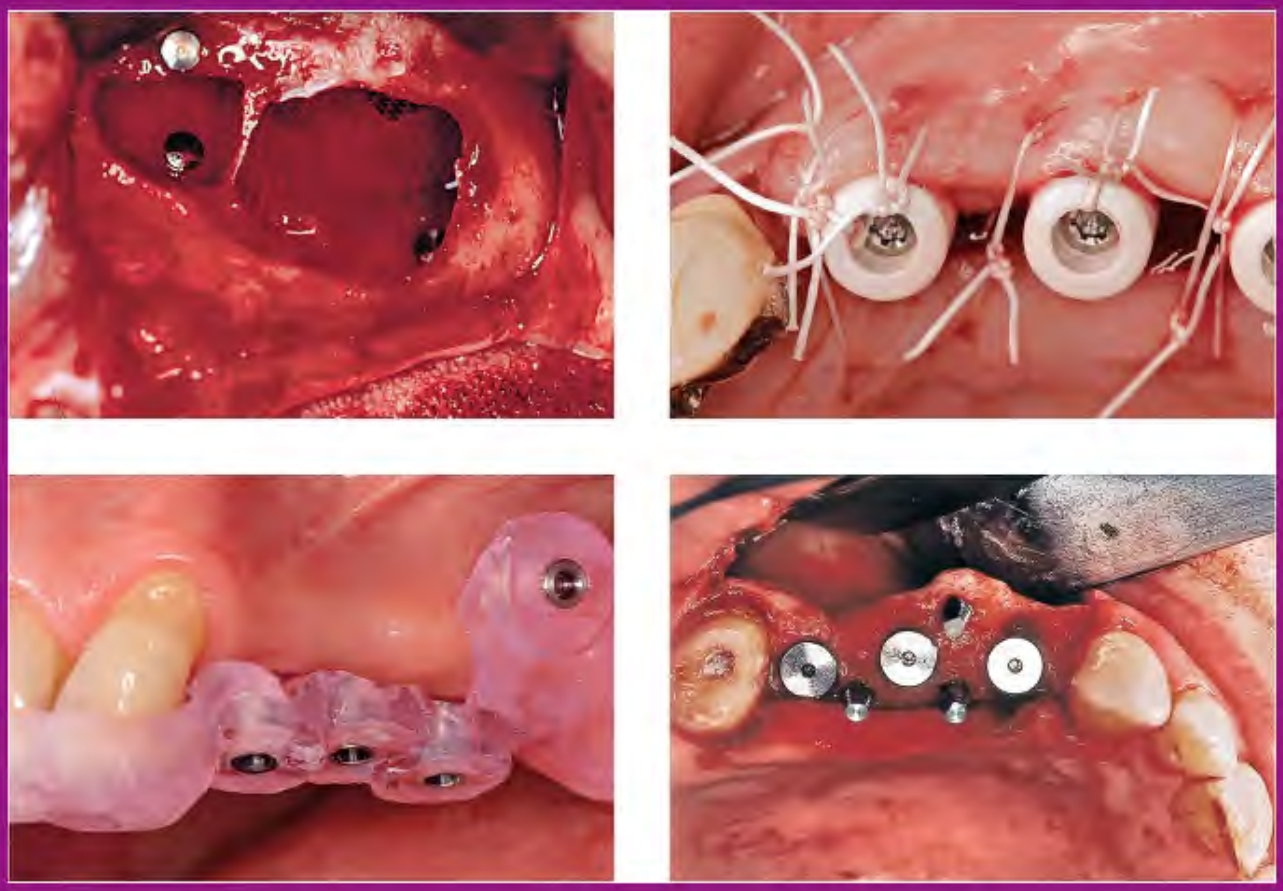
Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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5
The Posterior Maxilla



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Fig 5-1a Initial diagnostic cast with missing teeth.



Fig 5-1b Teeth set up onto the cast.



Fig 5-1c The duplicated cast.

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Fig 5-1d Thermoplastic foil on the starting casts with implant positions marked.

Even at the diagnostic stage, the factors that take priority in the posterior maxilla differ from those in the anterior maxilla. The esthetic component plays an important role here also, but the main focus is on the available bone supply and its quality. Typically, the loss of teeth brings with it a reduction in the bone bed, so that implant-based restorations of larger gaps or free-end situations are often possible only with the aid of augmentative measures. Single dental implant placement tends to be a rarity in the posterior maxilla; consequently, it will only be given brief consideration here. The failure risk of single implant placement is higher in the molar region, as the bone here is usually softer and subjected to greater physical forces than in the anterior maxilla.

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Diagnosis

Conventional diagnosis

The diagnostic stages involved in a multi-tooth gap and a free-end situation are virtually identical. For prosthetic reasons, the implants should be inserted exactly where the natural teeth were originally located, or would have been located in the ideal-case scenario. These positions are reconstructed by setting up prosthetic teeth onto the maxillary cast in articulation (Figs 5-1a and 5-1b). If ground-down abutment teeth are present, these must also be waxed up (Fig 5-1b).

Fabrication of a radiologic or surgical template

A surgical drill template is constructed from a transparent plastic to allow the implant

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positions as determined on the cast to be accurately transposed to the patient. Initially, the wax-up needs to be duplicated in plaster, so that a template base can be fabricated using a thermoplastic foil (Figs 5-1c and 5-1d); otherwise, the wax-up would be altered by the heat in the deep-drawing device. The desired implant positions are marked in with a marker pen (Fig 5-1d). The marked sites are drilled and the parallelization pins attached to both the cast and the thermoplastic foil in accordance with the desired implant axes (Fig 5-1e). The pins must be so securely attached to the cast that they remain aligned exactly as required when the thermoplastic foil is removed (Fig 5-1f). Titanium sleeves are incorporated into the template at the specified positions to allow the planned implant sites to be identified in the radiograph. The sleeves are placed onto the parallelization pins, so that the channel of the sleeve reproduces the ideal implant position (Fig 5-1f). Generous openings are cut into the occlusal side of the thermoplastic foil and the latter is placed on the model (Fig 5-1g). The spaces thus created are filled with cold-curing polymer, securely anchoring the titanium sleeves in the template. The resultant template is worked up for the radiologic diagnosis (Fig 5-1h). A panoramic radiograph is taken or a cone beam computed tomography (CBCT) scan prepared with the template (Fig 5-1i). Since the sleeves are made out of titanium rather than steel, the template can also be used for a CT scan.

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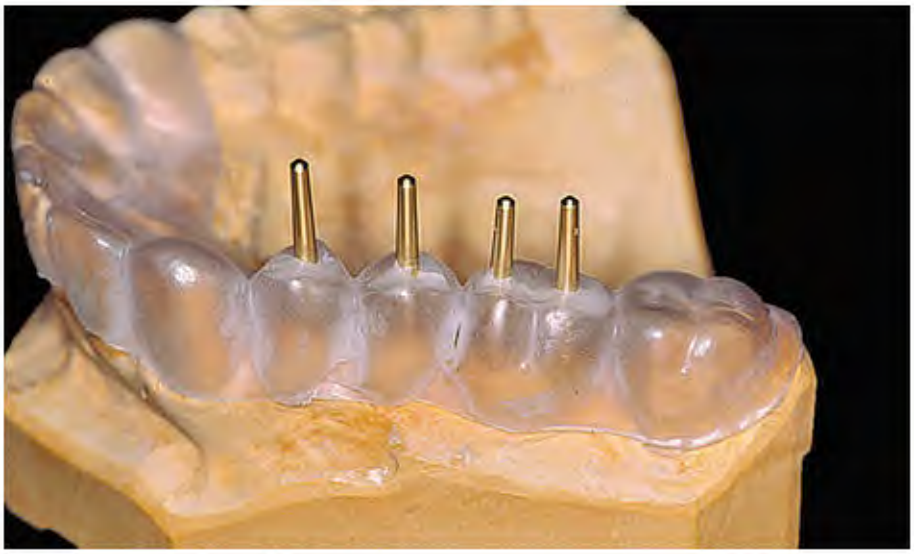


Fig 5-1e Guide pins fixed into the cast, showing the implant axes.

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Fig 5-1f Titanium sleeves placed onto the pins.

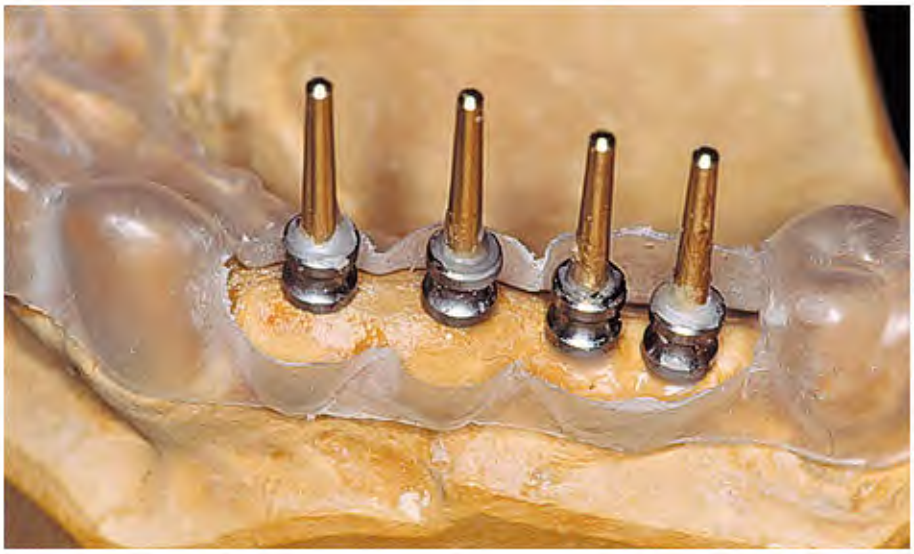


Fig 5-1g Thermoplastic foil with the occlusal surface reamed away.



Fig 5-1h Titanium sleeves polymerized into the template.

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Fig 5-1i Panoramic radiograph with the template.



Fig 5-1j Keeping the course of drilling in check.



Fig 5-1k The template following removal of the titanium sleeves.

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Fig 5-1l Completed surgical template.

The inserted sleeves restrict the drilling to a specific course (Fig 5-1j). However, the sleeves can be removed to allow a change in angle if the bone situation is unfavorable (Fig 5-1k). The entire buccal wall of the template should also be removed to give a better view of the operation area. The desired implant positions are still clearly determined by the notches in the palatal part of the template. During the course of implant placement, a template prepared in this way (Fig 5-1l) can be disinfected with, eg, alcohol or chlorhexidine, but must not be sterilized in the autoclave under any circumstances due to the risk of deformation.

For the treatment course, see page 327.

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Note

Shaping the surgical template

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Fig 5-2a Stabilizing the template with a denture clasp.



Fig 5-2b The palatal part of the template has been cut out.

The template can be anchored by supporting it on the incisal or occlusal surfaces of the remaining dentition. It is also possible to fasten the surgical template to the teeth with clasps, like a denture (Fig 5-2a). In cases of more extensive tooth loss, rests on the maxillary tuberosities and a transpalatal arch can help stabilize the template (Fig 5-2b). If a buccal incision is planned, space must be made for the palatal flap to be created, which requires the palatal part of the template to be cut out generously (Fig 5-2b).

3D diagnosis and planning

Three-dimensional (3D) diagnosis in the posterior maxilla is already of significance in the overall treatment plan. The first decision to be made is whether direct implant placement is possible or whether the bone bed must be augmented first (sinus floor elevation). In the latter

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case, two CT scans and two sets of 3D planning are likely to be needed: one of each before sinus elevation and one after the bone has been augmented, but before implant placement. In the case presented here, we concentrate on the implant planning following preparation of the bone bed, ie, after sinus elevation (Fig 5-3a). The extent of the augmentation is clearly apparent in the panoramic section (Fig 5-3b). The detailed planning for each individual implant begins on the cross-sectional images (Fig 5-3c). In this projection, the proposed implant is placed into the maxilla virtually, either as a solid image or in outline (Fig 5-3d). On the other hand, the placement and distribution of all the implants can be seen best in the panoramic section (Fig 5-3e). The planned positions of all the implants are then checked in other planes and projection over the entire image surface area (Fig 5-3f). The 3D reconstruction provides the most vivid visualization and is best suited for the patient information procedure (Fig 5-3g). For the purposes of accurate analysis and documentation, the bone quality around each individual implant should also be determined by bone densitometry (Figs 5-3h to 5-3l). Implant 1 (region 23) is to be anchored in the existing local bone and shows the highest density values in the central region (Fig 5-3h). As an approximation, implant 2 (region 24) is to be anchored half in existing and half in augmented bone (Fig 5-3i). The difference between existing local bone and the bone substitute Bio-Oss (Geistlich) in the sinus floor elevation area becomes even more marked around implant 3 (region 25; Fig 5-3j). According to the available calculations, the augmented new bone, rich in Bio-Oss, shows much higher bone density than the autologous bone. Implants 4 and 5 (regions 26 and 27) also show a continuing decrease in the quality of both local and augmented bone in the distal direction (Figs 5-3k and 5-3l). This tendency toward a distal decrease in bone density is confirmed clinically in most cases while the implant beds are being prepared.

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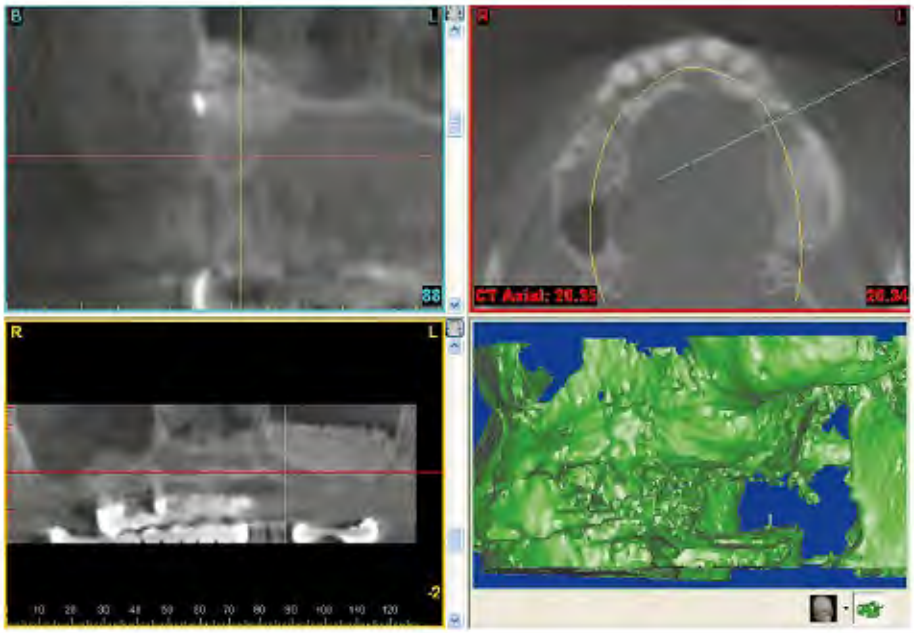


Fig 5-3a CBCT scan after the sinus floor elevation.

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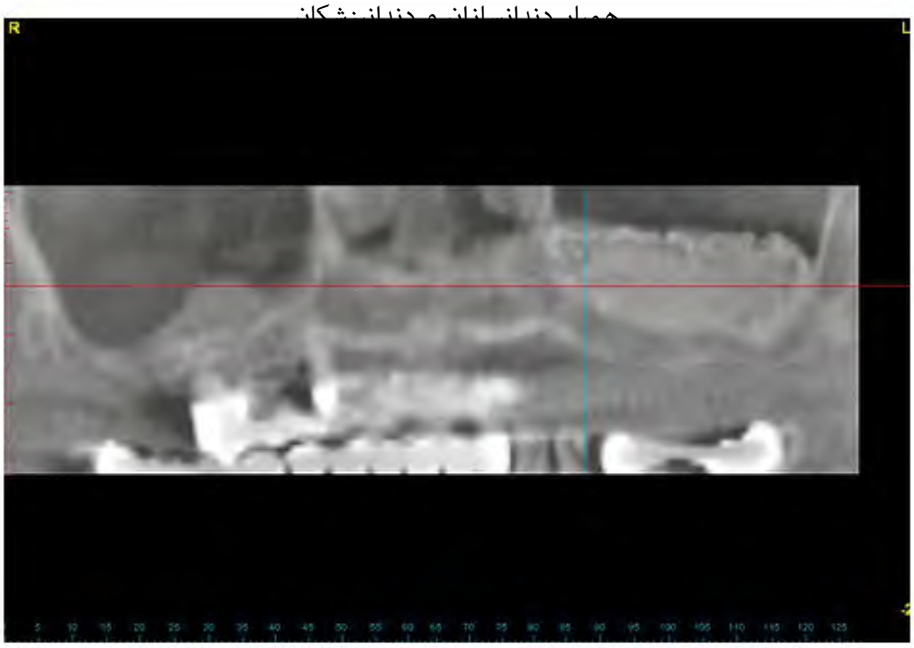


Fig 5-3b Left-sided sinus floor elevation in the panoramic section.

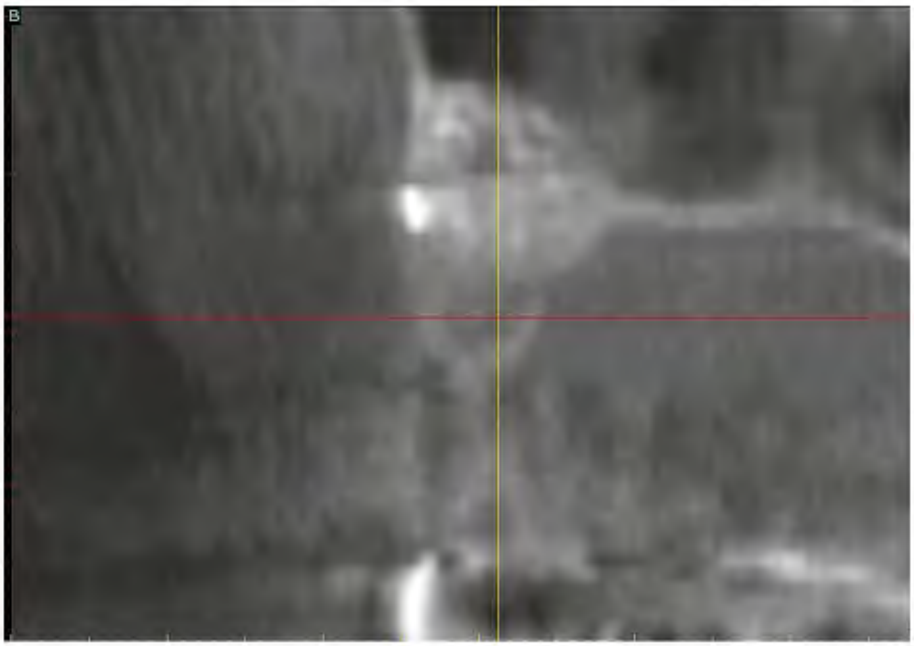


Fig 5-3c Cross section of the maxilla in region 24.

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Fig 5-3d Outline of implant 24.

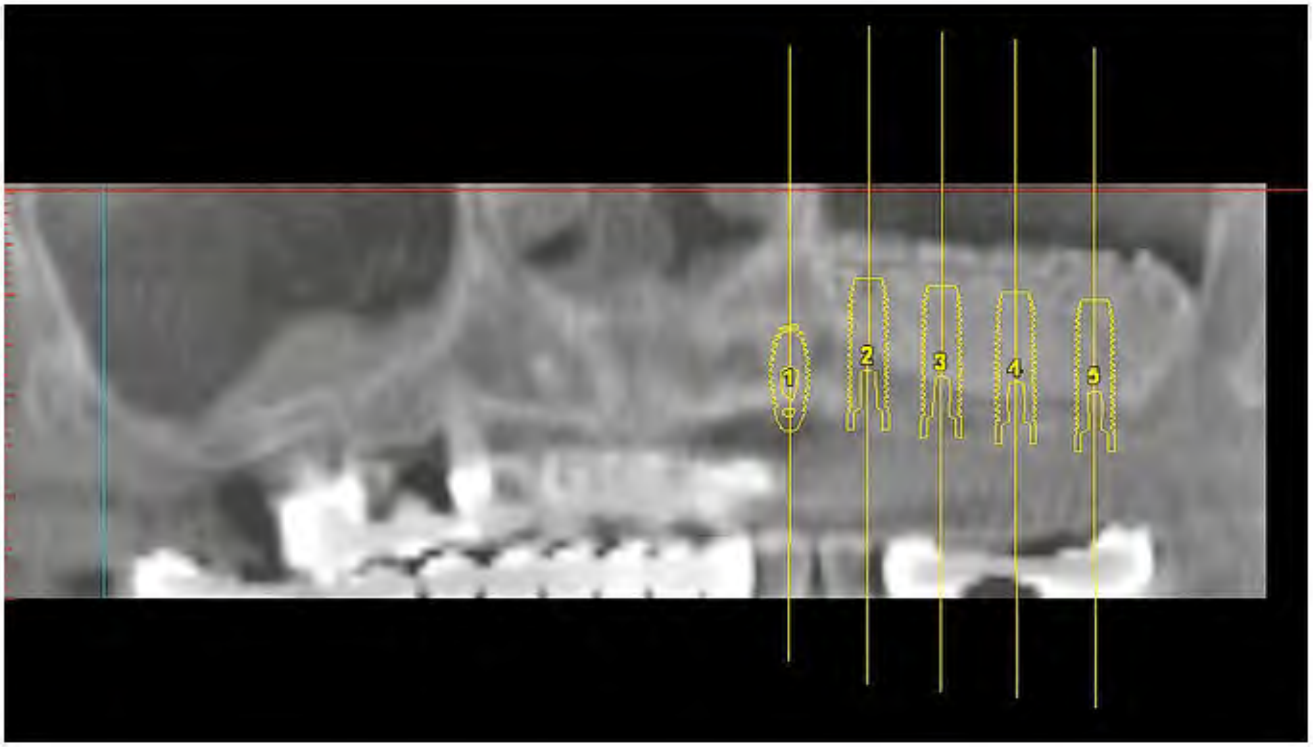


Fig 5-3e Distribution of the implants in the panoramic section.

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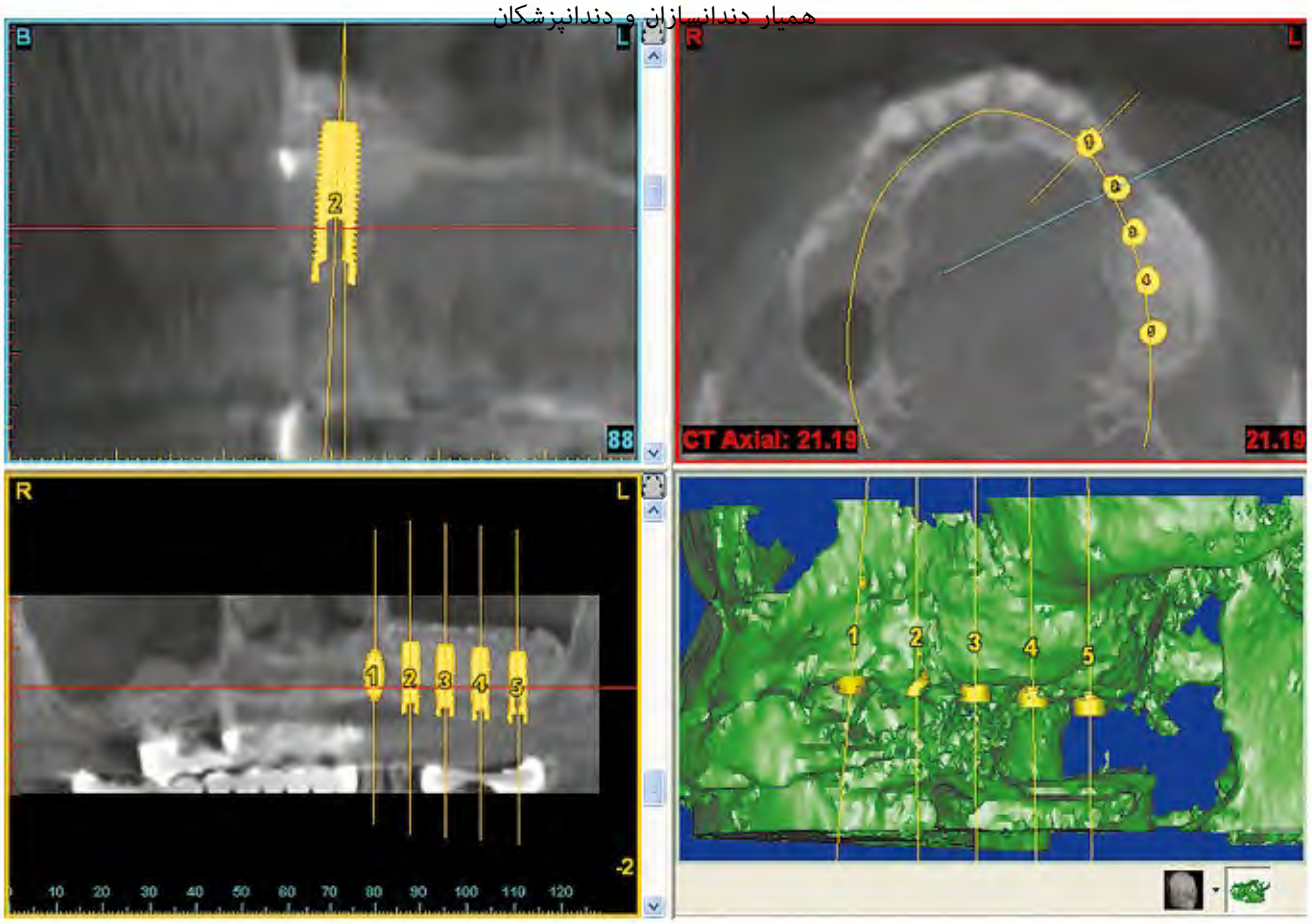


Fig 5-3f Overall planning in all the imaging planes.

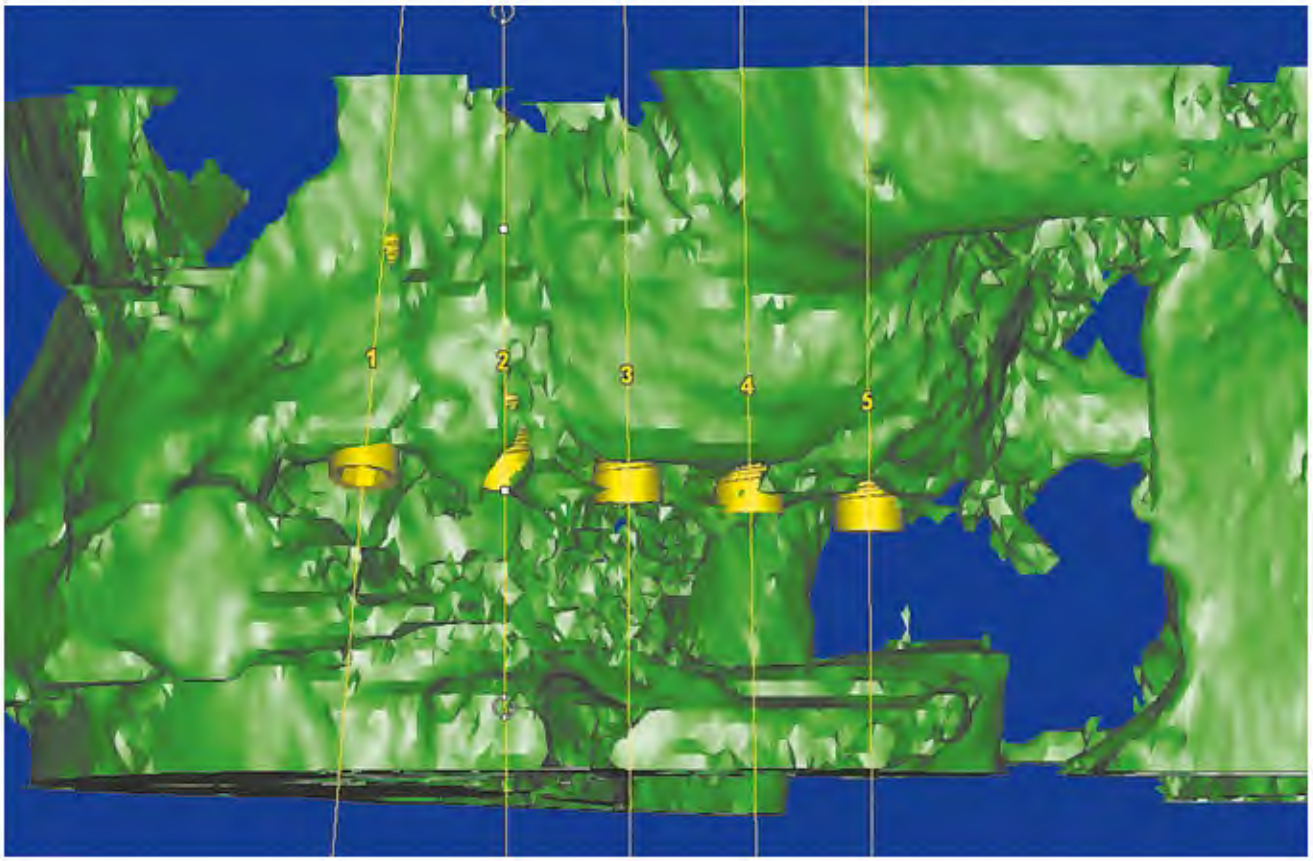


Fig 5-3g Vivid 3D reconstruction.

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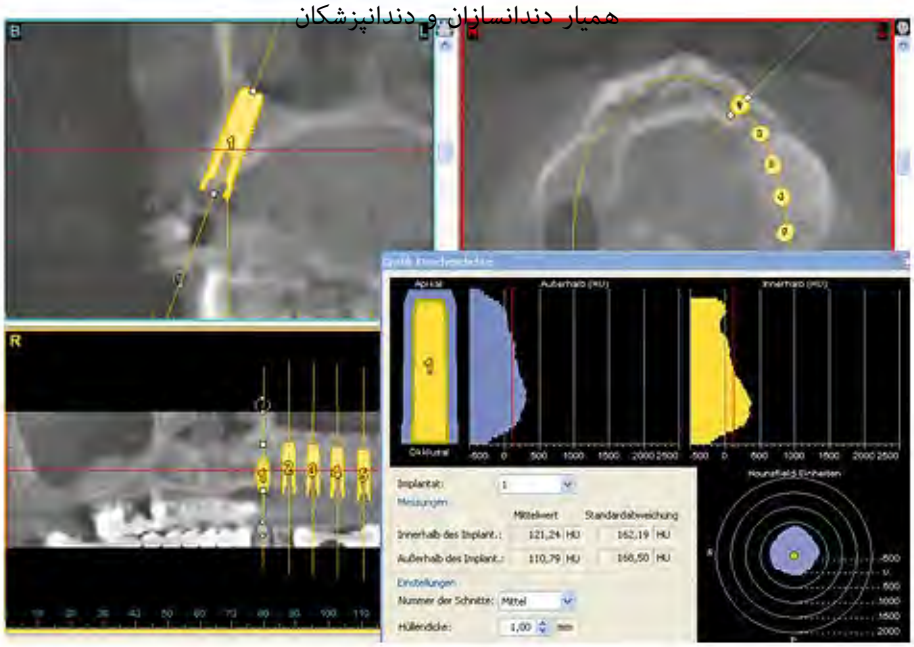


Fig 5-3h Bone densitometry around region 23.

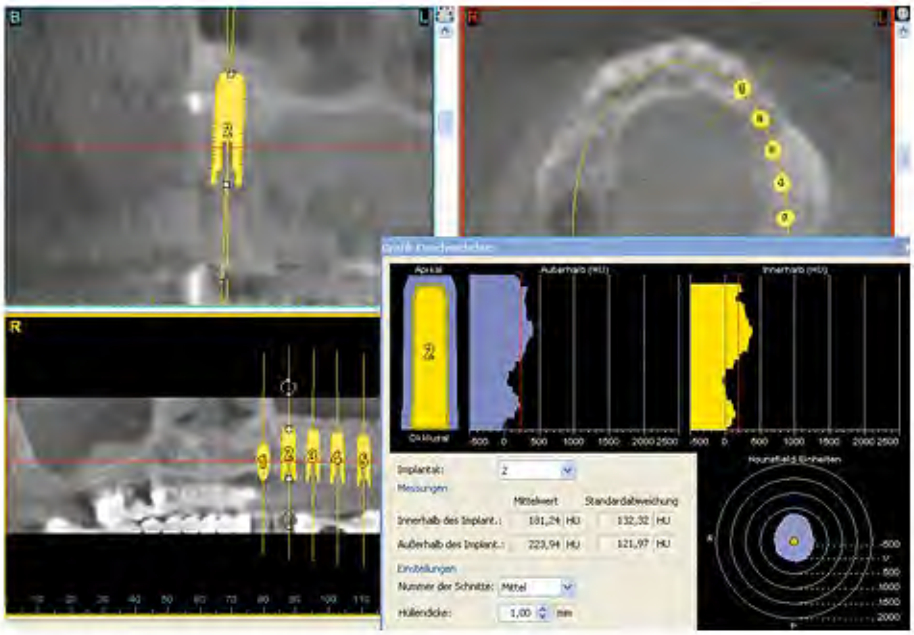


Fig 5-3i Bone densitometry around region 24.

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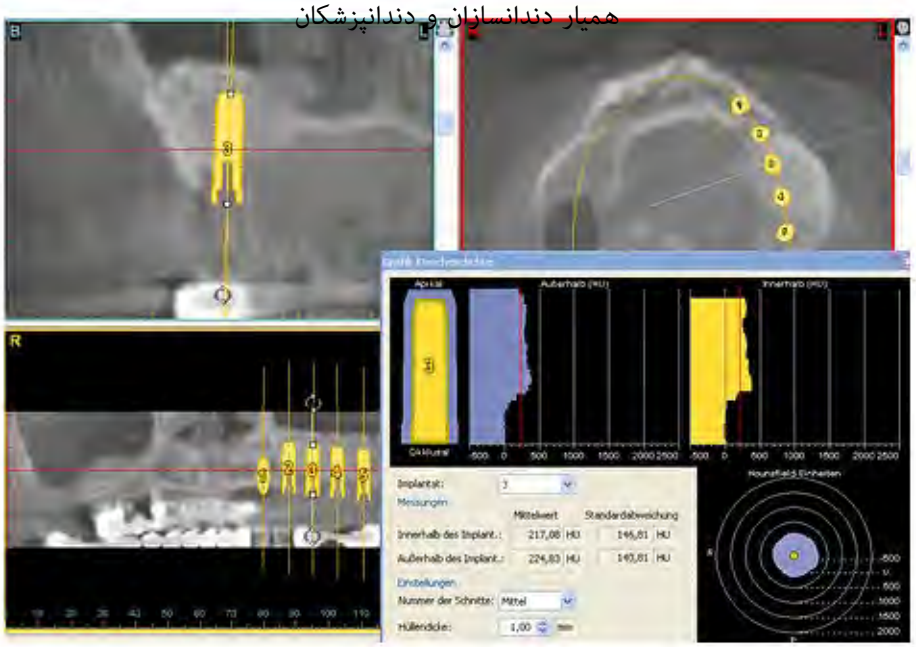


Fig 5-3j Bone densitometry around region 25.

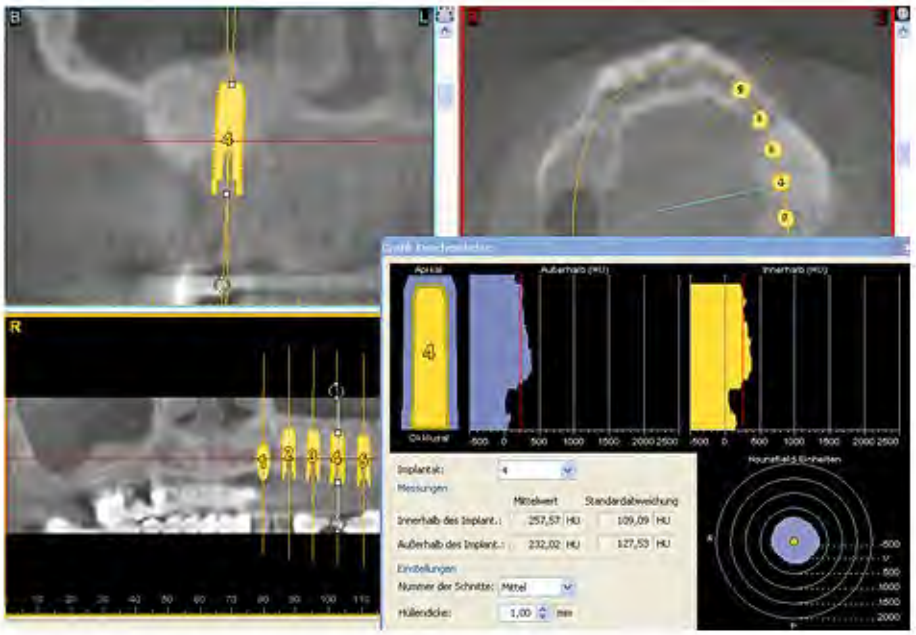


Fig 5-3k Bone densitometry around region 26.

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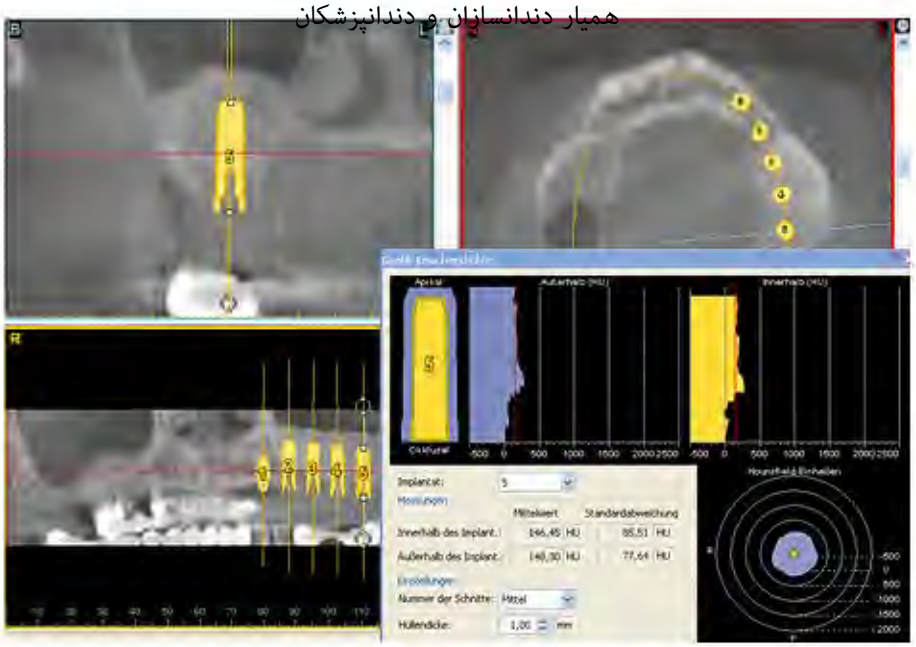


Fig 5-3l Bone densitometry around region 27.

For the treatment course, see page 378.

Restoration of single- and multi-tooth gaps

Typical treatment course

Fixed bridge with multiple abutments

The case report presented here is a continuation of the standard diagnostic investigations on pages 320–322.

Baseline situation

This female patient was to be provided with permanent replacements for teeth 12, 14, 15, 16 and 17. Her bridge 13 to 18 had a doubtful prognosis due to the root canal treatment on the canine and the periodontal weakening around the wisdom tooth (Fig 5-4a). In the edentulous segments – particularly distally – the residual ridge had already undergone extensive atrophy (Fig 5-4b). The panoramic radiograph showed that there was sufficient vertical space for implants 12, 14 and 15 (see Diagnosis on page 321; Fig 5-1i). Implant placement in regions 16 and 17 would require prior sinus floor elevation.

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- Dental cast analysis
- Template

Treatment plan

1. Implant placement
2. Exposure
3. Definitive prosthetic loading



Fig 5-4a Fixed bridge 13 to 18 is to be reconstructed.



Fig 5-4b Situation following removal of the bridge.

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Fig 5-4c Direction indicators show the axes of the implants.

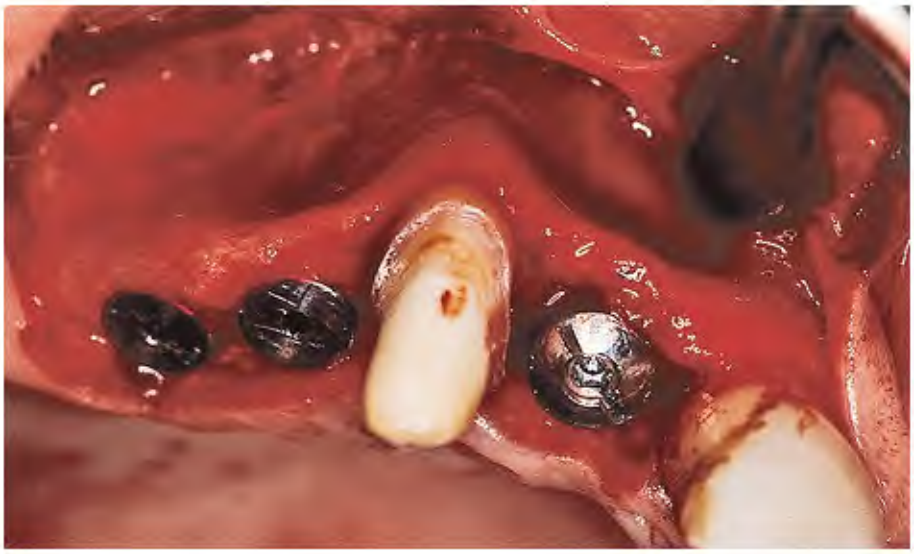


Fig 5-4d Inserted implants.

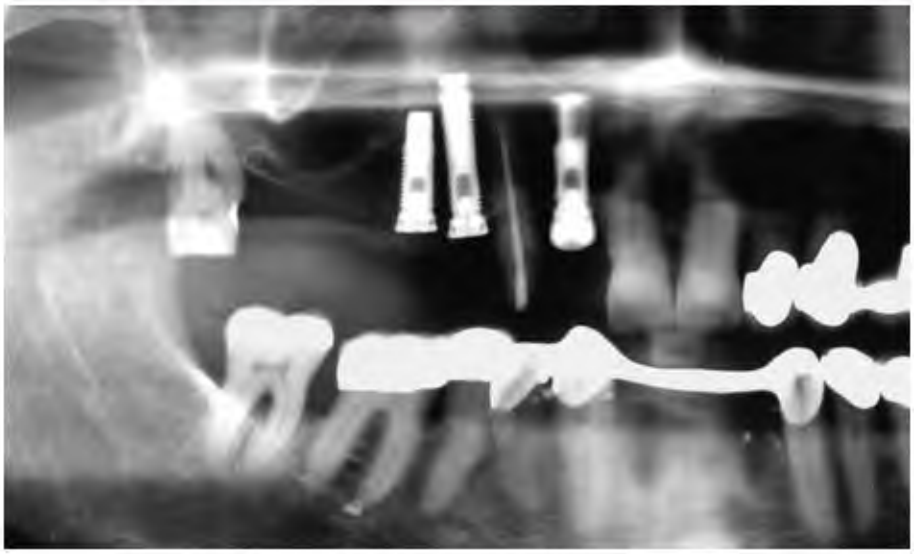


Fig 5-4e Three implant types to ensure optimal anchorage, dependent on bone quality.

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Since the patient did not agree to a sinus floor elevation due to the increased operation time and complexity and the prolonged healing time, it was necessary to find a compromise solution. Positions 12, 14 and 15 were chosen for implant placement. The implant axes were adjusted to the anatomical situation (especially the implant in region 15; Fig 5-4c). Implants 14 and 15 were fitted with cover screws; implant 12 was fitted with a healing abutment for better mucosal support (Fig 5-4d). The postoperative radiograph shows three different implant types (Fig 5-4e). In region 12, where the bone was at its hardest, a self-tapping Brånemark System MK II fixture (15-mm long, 3.75 mm in diameter) was inserted to extend into the cortical bone of the floor of the nasal cavity. In region 14, where the bone was somewhat softer, a standard fixture (18-mm long, 3.75-mm in diameter) was placed parallel to the canine and inserted, without prior thread-cutting, to extend into the cortical bone of the floor of the maxillary sinus. The Brånemark System MK IV fixture has been developed especially for soft bone. It is slightly conical in shape (apical diameter 3.75 mm, coronal diameter 4 mm), has a double thread and thus provides very high primary stability.

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Fig 5-4f Cement-retained telescopic crown on tooth 13.

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Fig 5-4g Customized abutments screwed onto the implants.



Fig 5-4h The fixed bridge has been provisionally cemented on.



Fig 5-4i Patient following treatment completion.

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Exposure and prosthetic restoration

The patient was able to wear a provisional fixed bridge, supported on teeth 13 and 18, throughout the healing period. The mucosal situation in region 12 was optimized further by the incision used during implant exposure and by the suturing technique (the cosine curve technique, see Note on page 330). The same cosine curve technique was used for the exposure of implants 14 and 15. Copings were fitted both onto the implants in region 12, 14 and 15 and onto natural teeth 13 and 18 (Fig 5-4f). Custom-cast abutments were screwed onto the implants, while copings were cemented onto the natural teeth (Fig 5-4g). The telescopic fixed bridge was now provisionally secured onto all five abutments with TempBond Kerr; Fig 5-4h. The pale veneer was applied to the denture at the express request of the patient (Fig 5-4i).

Treatment course

- Implant placement (1997)
- 6 months to exposure
- 4 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Note

Cosine curve technique to improve the gingival situation

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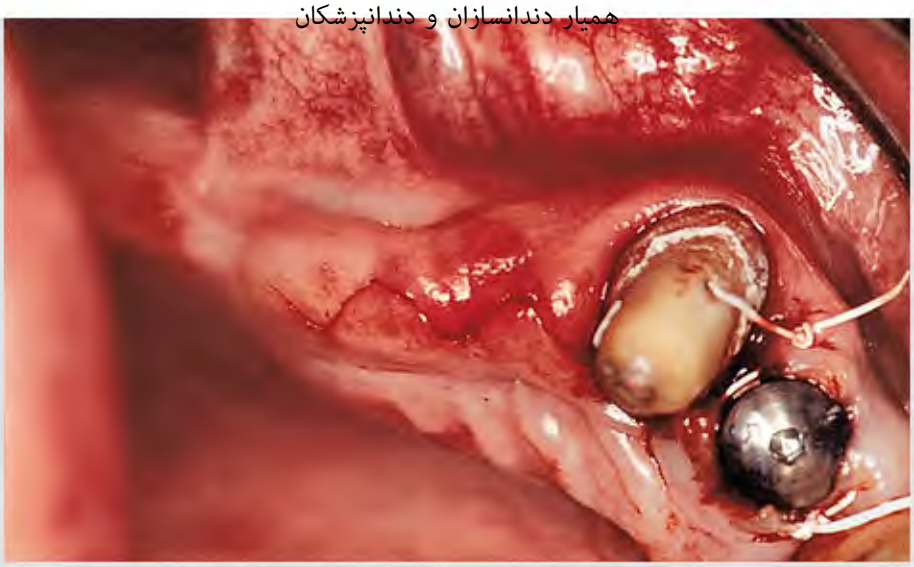


Fig 5-5a Incision shaped like a cosine curve.



Fig 5-5b Mobilization of the buccal and palatal flaps.

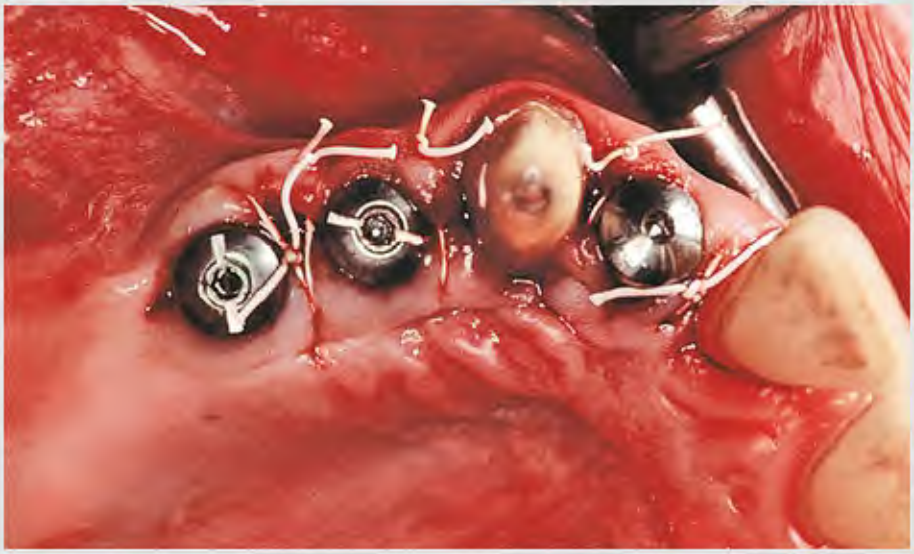


Fig 5-5c The peaks of the cosine curve have been adapted in the interdental spaces.

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The subsequent gingival situation around the implants is determined primarily by the incision made at the time of exposure. Punching out the soft tissue over the implants must be avoided at all costs, as this would negate the optimal requirements for correction. One way of improving the gingival situation at the time of exposure is to use the cosine curve technique. In this technique, the incision is made centrally on the residual ridge and centrally over the implants, as well as slightly toward a palatal direction. The incision is shaped like a cosine curve (Fig 5-5a). Both the palatal and the buccal flap should then be mobilized slightly (Fig 5-5b). Once the cover screws are removed, healing abutments of the desired height and diameter are screwed on in their place. After this, the peaks of the cosine curve of each of the mobilized flaps are adapted in the interdental spaces – as in the lateral sliding flap technique – and stabilized with sutures (Fig 5-5c). This procedure is virtually atraumatic and makes optimal use of the available soft tissue. The sutures can be removed once the initial gingival stabilization has taken place (after approximately 7 to 10 days).

Atypical treatment course – problematic baseline situation

Restoration in a case of pronounced, one-sided residual ridge atrophy

Baseline situation

This male patient was to be fitted with a fixed prosthetic restoration of a large gap, which extended from wisdom tooth 18, across the middle and up to lateral incisor 22. The residual dentition in the maxilla was as follows: teeth 18 and 28 are free-standing, while teeth 22, 24 and 26 had been fitted with a fixed partial denture with a distal cantilever extension (Fig 5-6a). The patient was wearing a simple clasp prosthesis, which was very prone to fracture. Rehabilitation with a fixed restoration was planned. The shape of the residual ridge in the first quadrant was no longer ideal due to the prolonged toothlessness and the associated bone atrophy. The baseplate with optimal implant positions, as determined during the diagnostic procedure, clearly demonstrates this problem (Fig 5-6b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- Dental cast analysis
- Surgical template and baseplate

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Treatment plan

1. Implant placement and recording of the implant positions
2. Exposure and incorporation of the provisional restoration
3. Definitive prosthetic loading



Fig 5-6a Atrophied residual ridge in the first quadrant.



Fig 5-6b Discrepancy between the baseplate and the residual ridge.

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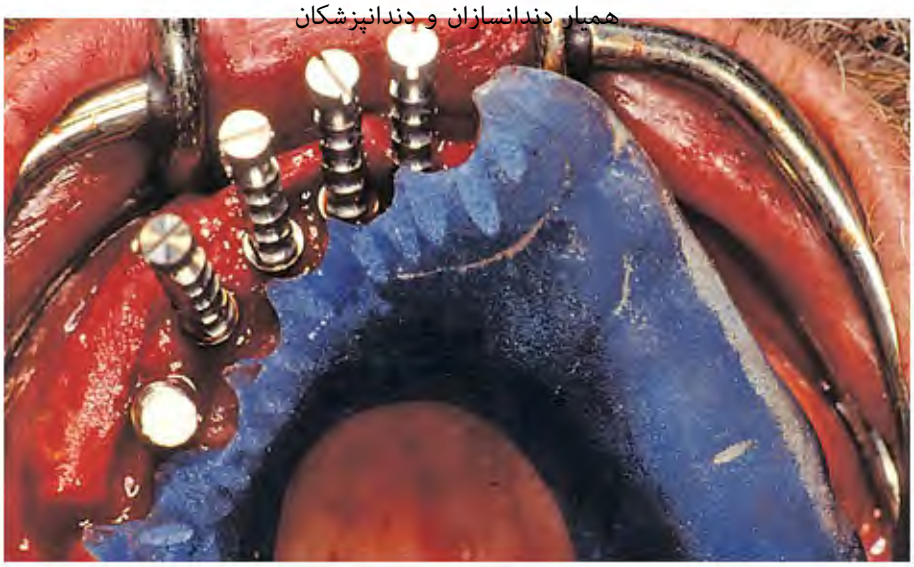


Fig 5-6c Modification of the baseplate.

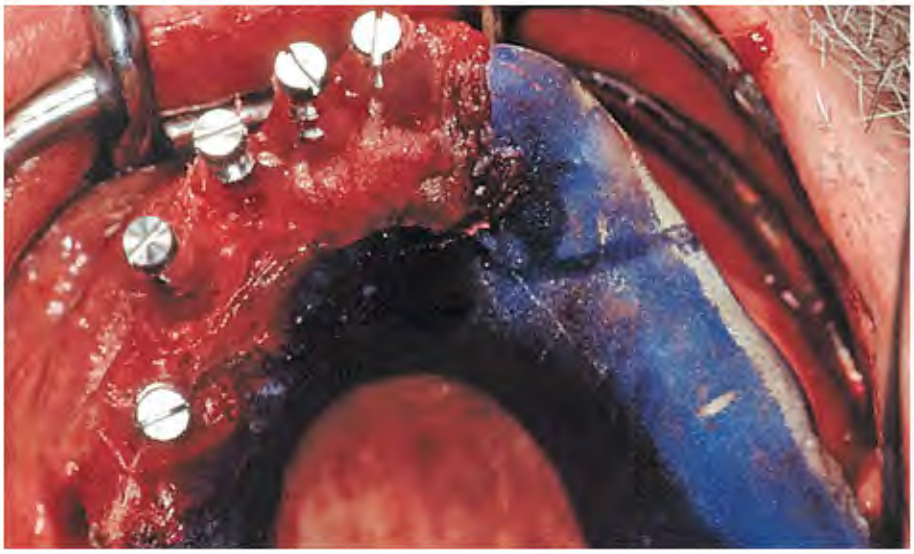


Fig 5-6d Impression copings, polymerized into the baseplate.

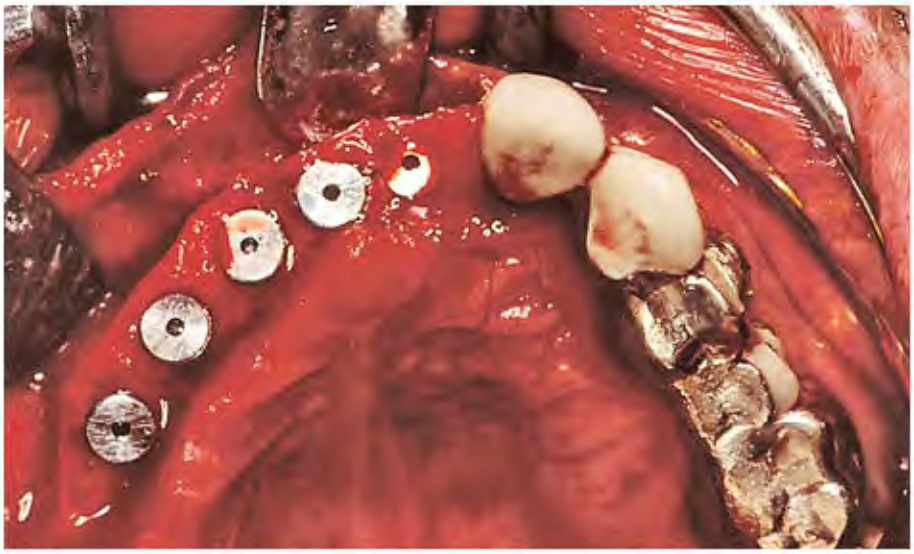


Fig 5-6e Inserted implants.

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Implant placement and recording of the implant positions

It proved possible to insert the implants in positions 14, 13, 12, 11 and 21 into the existing local bone. As the buccal and labial atrophy of the residual ridge could not be fully reconstructed, at the request of the patient, the implants were placed further palatally than planned from the prosthetic point of view. To allow the superstructure to be prepared before exposure, it was necessary to record exact the exact positions of the implants and their relationships to one another and to the residual dentition.

For this purpose, impression copings were screwed onto the implants after the latter were inserted. The prepared baseplate was corrected accordingly, due to the greater than expected residual ridge atrophy (Fig 5-6c). The impression copings were integrated into the template with Pattern Resin (GC America)(Fig 5-6d). Once the baseplate was removed, cover screws were screwed onto the implants (Fig 5-6e). The mucoperiosteal flap was mobilized by periosteal slitting. This was followed by tight closure of the wound by suturing. The provisional restoration was prepared during the healing phase (see Note on the laboratory method on page 338).

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Exposure with incorporation of the superstructure and gingival augmentation of the residual ridge

Very careful planning is needed for the exposure technique and the incision, especially in the anterior maxilla. The gum line over the future crowns is a key factor in the planning. The prosthesis teeth (without pink acrylic) show the buccal and labial course of the crowns (Fig 5-6f). In this case, all the implant penetration sites were located in the unattached mucosa of the buccal and labial vestibule. The exposure operation was used to gather more attached gingiva around the implants and to correct the mucosal situation.

On the palatal side of the implants, the incision extended only into the mucoepithelium. The epithelialized gingiva was dissected away from the connective tissue towards the palatal direction over a length of approximately 10 mm; this needs to be done without any perforations, if at all possible (split-flap technique). The periosteum was cut through at the end of the mucosal flap (approximately 10 mm palatally of the implants). The long flap extending toward the palatal direction had to be detached from the bone, working toward the labial and buccal vestibule (Fig 5-6g). Once the cover screws were removed, the prepared sterile inner crowns were screwed into place. The implant abutment lying furthest distally was screwed on first with the aid of the transfer (Fig 5-6h). The key could then be used to place the other abutments in any desired sequence. A method that has proved useful is to mark the components on the labial/buccal side so that they can be put into the correct order quickly during the procedure (Fig 5-6i). Once the screws were tightened, the provisional crowns were attached

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using a little TempBond with added Vaseline and the cement residues removed under visual control (Fig 5-6j).



Fig 5-6f Unattached mucosa in the cervical region of the future crowns.

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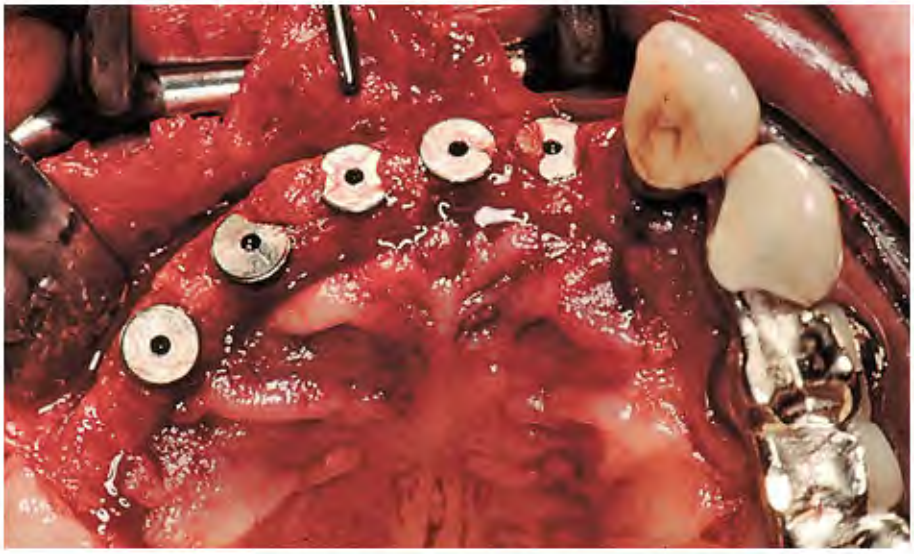


Fig 5-6g Split-flap technique.

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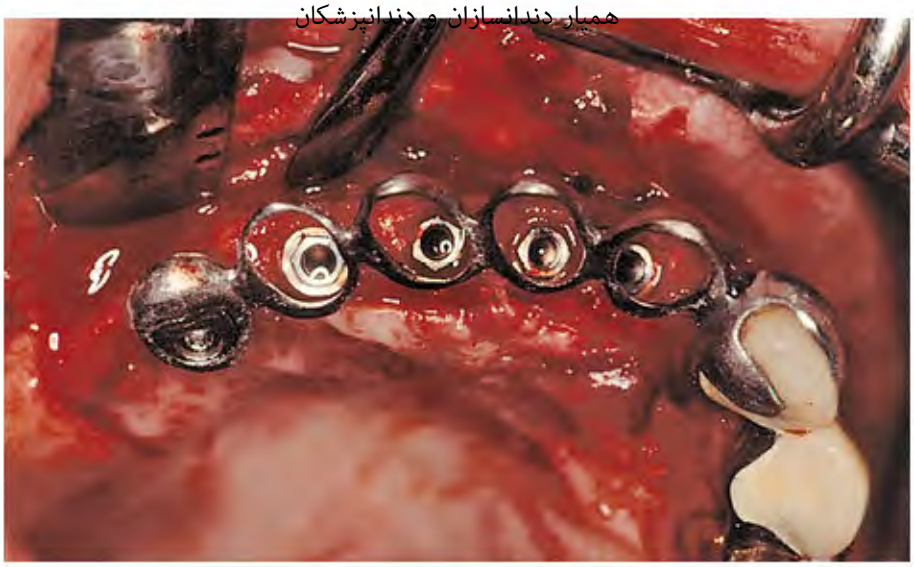


Fig 5-6h Fitting the abutments with the transfer key.

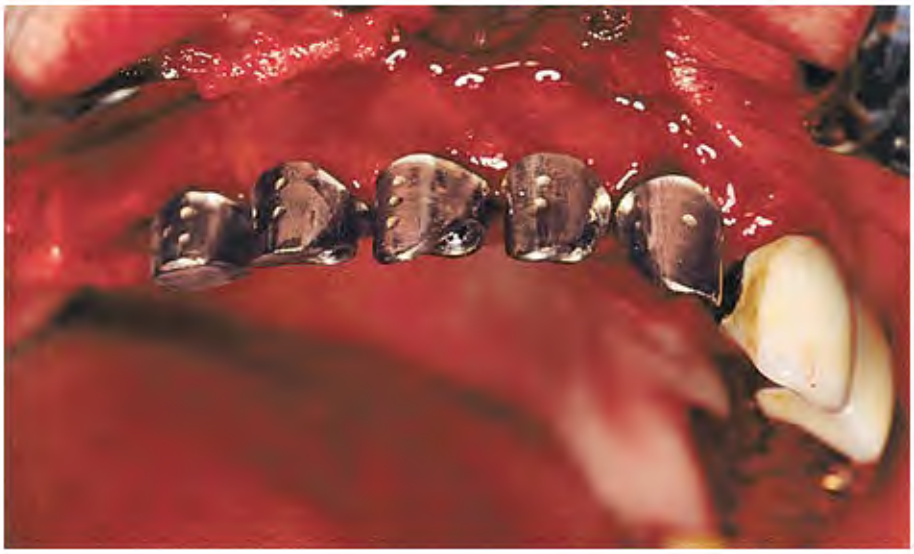


Fig 5-6i Markings on the abutments.



Fig 5-6j The long-term provisional implant bridge has been inserted.

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Fig 5-6k Stabilization of the pedunculated palatal flap.



Fig 5-6l Adaptation of the thinned-out palatal flap.



Fig 5-6m Dressing made of thermoplastic foil.

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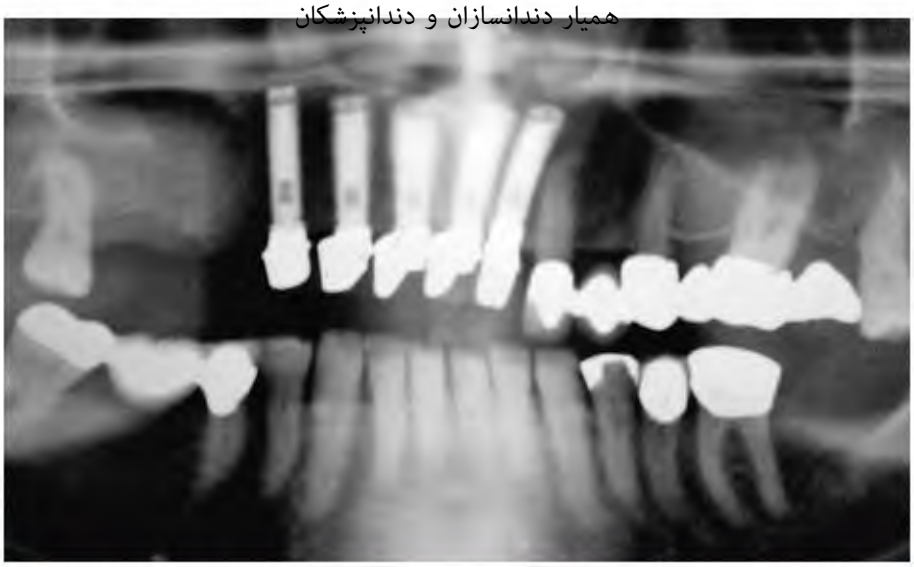


Fig 5-6n Postoperative panoramic radiograph.



Fig 5-6o Clinical situation following the healing phase.

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Attention: ***When tightening the retaining screws, it is essential to stop the abutments from twisting to the right on their own axes. Even the slightest twist causes tension, the result being that the transfer can only be removed with difficulty and that the superstructure no longer fits.***

On the buccal/labial side, the roll flap was adapted to the implant abutments and secured with sutures (roll flap technique; Fig 5-6k). When suturing, the thinned palatal mucosal flap also had to be securely adapted to the bone (Fig 5-6l). Solcoseryl dental adhesive paste was applied and a prepared thermoplastic foil with a palatal cover put into place to allow the tissues to heal undisturbed (Fig 5-6m). The postoperative panoramic radiograph shows the exact fit of the abutments on the implants (Fig 5-6n). The healing phase was uncomplicated (Fig 5-6o).

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Fig 5-6p Repeat preparation of the teeth.



Fig 5-6q Cement-retained fixed dental bridge and crown 18.



Fig 5-6r Securing the implant-supported section with mini-screws.

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Fig 5-6s Overall rehabilitation.

Prosthetic restoration

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More prosthetic steps followed once the situation had stabilized after about 6 to 8 weeks. For the overall rehabilitation, the bridge 22 to 27 was first removed (Fig 5-6p) and the abutment teeth prepared again. This was followed by impression taking. In the laboratory, the split structure was fabricated on the overall cast. The tooth-supported components that were to be cemented on were fitted with attachments for external screw retention. The implant-retained portion was to be cemented on provisionally and screwed onto the rest of the restoration.

The dental bridge 22-24-26-28 and crown 18 were inserted first and retained with Harvard cement (Harvard Dental; Fig 5-6q). After the provisional cement retention, the implant-supported part of the restoration was secured to the external attachments between 21 to 22 and 17 to 18 (Fig 5-6r). Some atrophy of the slightly overcontoured attached gingiva in regions 14 to 21 also had to be taken into account (Fig 5-6s).



Fig 5-6t Patient following treatment completion.

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The overall fixed maxillary rehabilitation from 18 to 28 was performed satisfactorily even without any bone augmentation (such as sinus floor elevation and posterior residual ridge augmentation). Figure 5-6t shows the patient after the treatment.



Fig 5-6u Follow-up panoramic radiograph taken after 14 years.



Fig 5-6v Clinical situation after 14 years.

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Fig 5-6w Excess attached gingiva over the implants.



Fig 5-6x Virtually unchanged situation in the occlusal view.

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Continued follow-up

The patient presented for a check-up 14 years after implant placement. A stable, virtually unchanged situation can be seen in the panoramic radiograph (Fig 5-6u). The fear expressed following incorporation of the restoration, namely that the roll flap on the buccal/labial side of the implants could degenerate, has not been realized even after many years (Fig 5-6v). The extent of the overcontoured attached gingiva, which has been preserved over the years, is particularly marked when compared to the course of the gingiva under the denture span in the molar region (Fig 5-6w). In the 14 years of use, there have been no complications, whether descent of the dental segment or damage to the screw-retained attachment (Fig 5-6x). The patient remains very satisfied with the outcome of the treatment and can laugh and smile freely at all times (Fig 5-6y).

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Fig 5-6y The patient can laugh freely with his securely fitting teeth.

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Treatment course

- Implant placement (1997)
- 6 months to exposure
- 8 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Note

The cast coping laboratory method (relating to the case history on page 331)

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Fig 5-7a Placing the template onto the reamed-out cast.



Fig 5-7b Embedded implant analogs.



Fig 5-7c Wax-up.



Fig 5-7d Preparing the matrix.

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Fig 5-7e Plastic cylinders as supports.

Up-to-date casts are made up after exposure has taken place. After checking the impression copings for a tight fit in the template, the model implants are screwed into place. The cast is reamed out until the model implants are no longer in any contact with it and the template can once more be positioned precisely onto the cast (Fig 5-7a). The model implants are fixed into plaster, slightly below gum level.

After the template is unscrewed, the model implants remain in the cast, positioned analogously to the implants placed in the jaw (Fig 5-7b). A gingival mask is then fabricated. The cast is articulated and the prosthesis teeth set up. The positions of the prosthesis teeth on the cast (Fig 5-7c) are recorded with a plaster matrix (Fig 5-7d). The prosthesis teeth and palatal plate are removed, and the gingival mask perforated at the implant penetration sites.

The implant abutments are fabricated using the cast coping technique. The method is not new and is based on the University of California, Los Angeles (UCLA) abutment idea. In this technique, an individual abutment is modeled in wax on a burnout plastic cylinder, so that it can be cast in metal. Burnout acrylic cylinders/sleeves (Sub-Tec 2; BEGO) are selected as supports for the cast coping components and screwed onto the model implants (Fig 5-7e). These cylinders are ground to shape to fit the matrix.



Fig 5-7f Shortened plastic cylinders.

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Fig 5-7g Modeled customized abutments.



Fig 5-7h The modeled transfer.



Fig 5-7i The cast metal transfer.



Fig 5-7j Provisional crowns on the customized abutments.

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All the cylinders are adjusted in sequence (Fig 5-7f) and the custom abutments, which correspond to the inner crowns, are modeled in wax. The modeling is guided by the matrix (Fig 5-7g) and the gingival situation. Any discrepancies between implant position and crown can be compensated for by custom modeling. The modeled inner crowns are cast in metal and checked on the plaster cast.

To fix the definitive positions of the inner crowns relative to each other and to transfer them to the operation site, a transfer is modeled and cast in metal (Figsw 5-7h and 5-7i). Provisional crowns are then fabricated on the basis of the prosthesis teeth (Fig 5-7j).

Atypical treatment course – problematic baseline situation

Sinus floor elevation with vertical and horizontal augmentation and single-tooth implant with orthodontic treatment

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Baseline situation

A 49-year-old woman required dental treatment in quadrants one to three, despite the good clinical appearance of her dentition (Fig 5-8a). Teeth 16, 22 and 28 needed to be extracted (Fig 5-8b). Tooth 22 had already received root canal treatment and developed an active fistula in the apical region (Fig 5-8c). The bone bed in the distal parts of the maxilla was not adequate for the stable, long-term anchoring of implants, so that bilateral sinus floor elevation needed to be performed first (Fig 5-8d).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Extraction, bilateral sinus floor elevation with vertical and horizontal augmentation
2. Implant placement
3. Exposure and horizontal widening of the gingiva
4. Orthodontic mesialization of tooth 15
5. Definitive prosthetic loading

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Fig 5-8a Clinical baseline situation.



Fig 5-8b Panoramic radiograph before the treatment.

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Fig 5-8c Fistula over tooth 22.

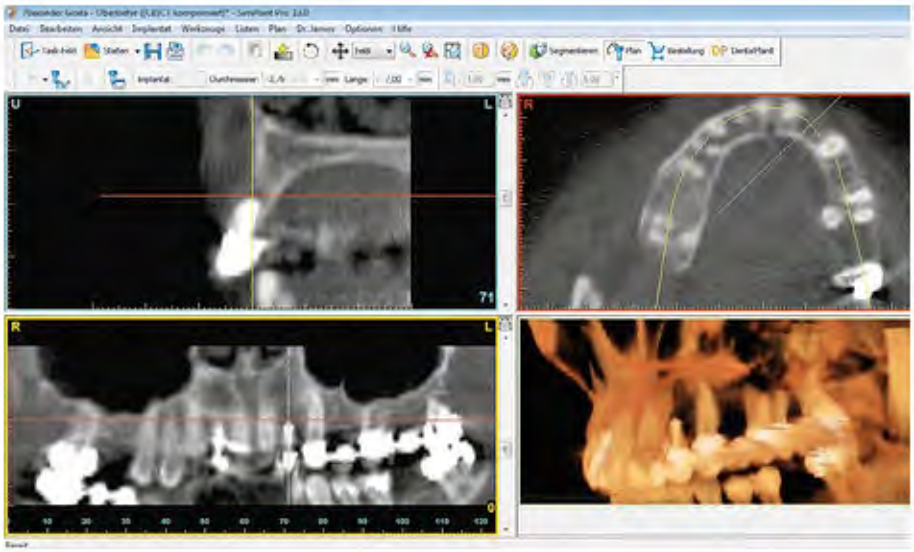


Fig 5-8d CBCT scan images before the sinus floor elevation.



Fig 5-8e Gap left by the loss of tooth 16. The premolars are starting to migrate distally.

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Fig 5-8f Fenestration over the root of tooth 26.



Fig 5-8g Extensive bone defect in region 22.

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Sinus floor elevation and lateral augmentation

Working under general anesthesia, the procedure began with removal of the bridge on teeth 23, 26 and 28. This was followed by the extraction of teeth 22 and 28. Tooth 16 had already been extracted on a prior occasion, to ensure an intact mucosal layer for coverage after the sinus floor elevation (Fig 5-8e). An incision was made along the palatal surfaces of the teeth with a releasing incision distally of tooth 21. The access window to the maxillary sinus was created cranially of the root apices of tooth 26, without damaging them (Fig 5-8f). The prolonged inflammation around tooth 22 had led to an extensive bone defect, making implant placement impossible without prior augmentation (Fig 5-8g). Both sinus elevation and lateral augmentation were performed with Bio-Oss (particle size 1 to 2 mm) and the harvested bone chips. A large Bio-Gide membrane (Geistlich) (30 × 40 mm) was divided into smaller

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fragments for the two windows and for lateral augmentation in region 22. These membrane fragments were attached with titanium pins (Fig 5-8h). After the periosteal slitting, the flap was mobilized in such a way as to provide tension-free coverage of the whole operation area. It was attached with Gore-Tex and Mopylen 6-0 sutures (W. L. Gore and Resorba, respectively) using the simple interrupted and mattress stitch techniques (Fig 5-8i). An immediate provisional was fabricated out of Protemp (3M ESPE) over the stumps of teeth 23 and 26 with the aid of thermoplastic foiland incorporated (Fig 5-8j).

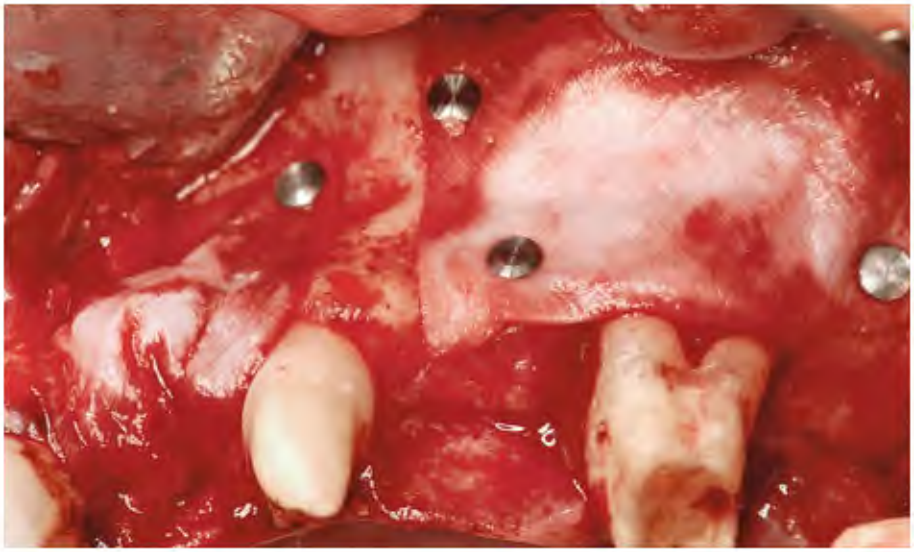


Fig 5-8h Augmentation.



Fig 5-8i Tension-free wound suturing.

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Fig 5-8j Short-term provisional restoration.



Fig 5-8k Stable healing course.



Fig 5-8l Long-term provisional

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After the sutures were removed, the short-term provisional was exchanged for a metal-reinforced, long-term provisional (Fig 5-8k). This provisional replaced teeth 22 and 24, where the implants were to be inserted. Two additional implants were planned in region 27 and one in region 36 (Fig 5-8l). Implant placement took place 10 months after augmentation. The single implant in region 16 was inserted first (Fig 5-8m). Further migration of tooth 15 toward a distal direction is apparent in the occlusal view; this was to be corrected orthodontically (see Figs 5-8e and 5-8m).

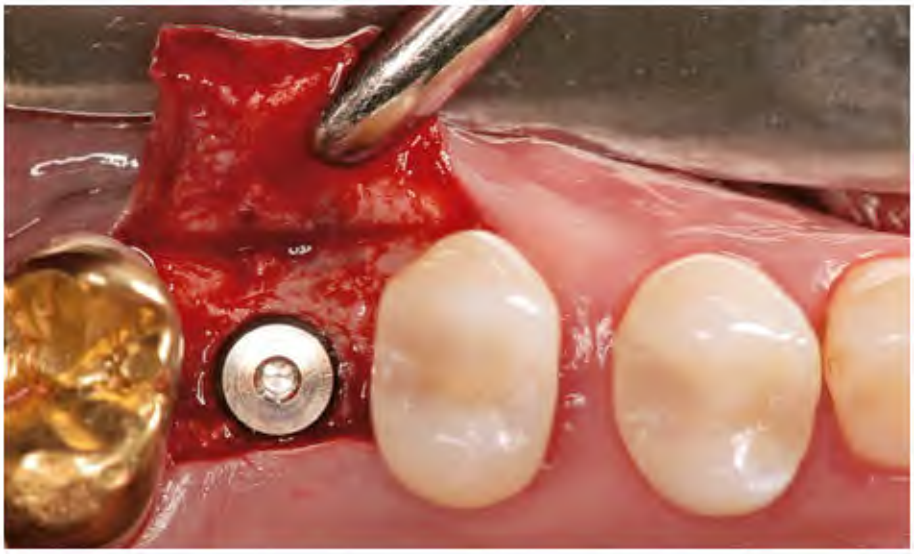


Fig 5-8m Inserted implant in region 16; distal migration of tooth 15.



Fig 5-8n Creating the flap.

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Fig 5-8o Result of the augmentation.

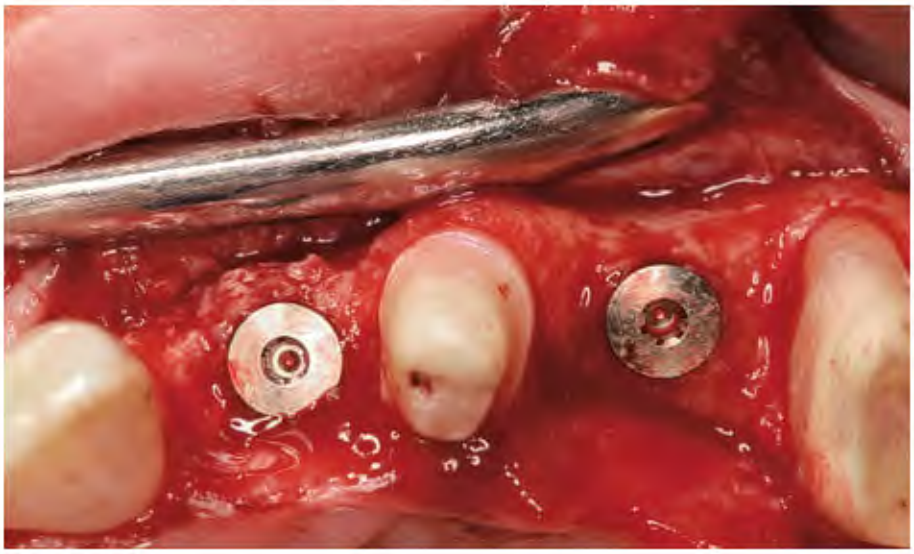


Fig 5-8p Bone spreading and insertion of implant 22.

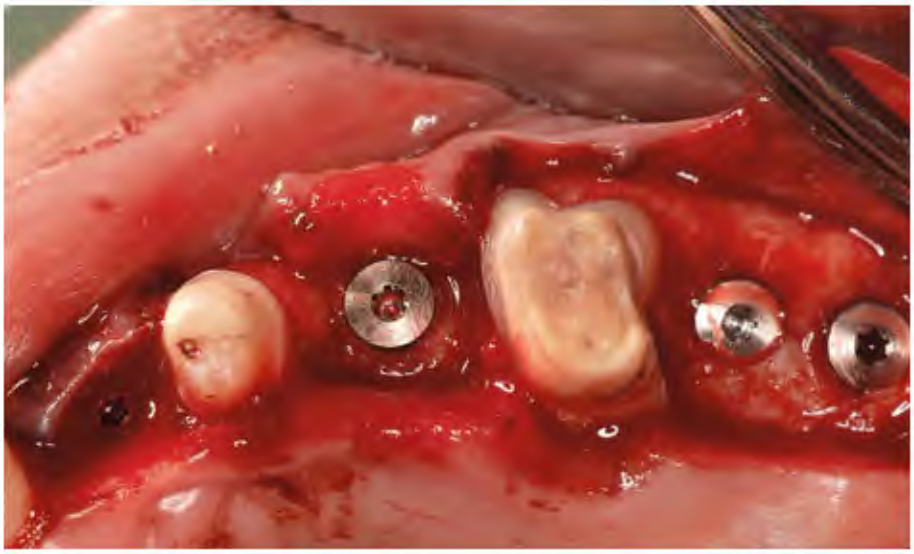


Fig 5-8q Insertion of further implants.

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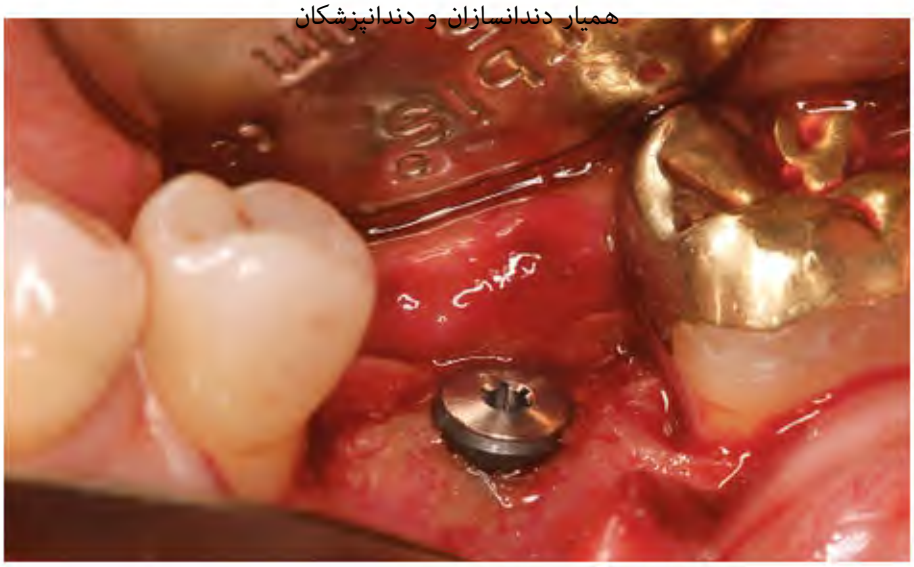


Fig 5-8r Concomitant insertion of implant 36.

On the left side, the incision was made along the palatal surface of the teeth. The releasing incision was made at the height of former tooth 28 (Fig 5-8n). Lateral augmentation in region 22 had also been very successful, and hardly any resorption of the augmentation material was apparent (Fig 5-8o). During preparation of implant bed 22, the bone bed was widened slightly by bone spreading and a 3.5-mm wide Neoss implant was inserted (Fig 5-8p). Further implants were inserted with primary stability in regions 24, 27 and 28 (Fig 5-8q). The single-tooth implant 11 mm in length and 4.5 mm in diameter was then inserted in the region of tooth 36 (Fig 5-8r).

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Fig 5-8s Clinical situation prior to exposure.

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Fig 5-8t Exposed implants.



Fig 5-8u Modified long-term provisional.



Fig 5-8v Distal migration of tooth 15.

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Fig 5-8w Periodontal defect on the mesial side of tooth 15 and its treatment.

Exposure and orthodontic treatment

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All the implants were exposed 1 year after insertion. The long-term provisional was still in use and was removed for the exposure (Fig 5-8s). The incision on the left side was shifted further palatally to widen the zone of keratinized gingiva. The cover screws were replaced with 5-mm high polyetheretherketone (PEEK) abutments and the flaps were adapted onto these (Fig 5-8t).

The long-term provisional needed to be adjusted to the new situation prior to incorporation (Fig 5-8u). On the right side, the gap between teeth 14 and 15 had grown because tooth 15 had migrated further distally. This condition needed to be corrected before the definitive restoration (Fig 5-8v). The large periodontal defect on the mesial surface of this tooth could have been a possible cause for the migration. In the exposure operation, the gingiva was reflected slightly more and this defect carefully cleansed by open curettage (Fig 5-8w). The surface of the root was mechanically cleaned and chemically decontaminated. The flap was fixed with Gore-Tex sutures without filling the defect (Fig 5-8x). The sutures were removed after 2 weeks (Fig 5-8y). After another 2 weeks, the healing abutment was replaced with a definitive titanium abutment, allowing the orthodontic straightening of tooth 15 to begin (Fig 5-8z). For the orthodontic treatment, a partial archwire on a ring was fitted around tooth 17, along with two brackets in regions 14 and 15. Abutment 16 was initially fitted with a provisional crown (Fig 5-8aa).

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Fig 5-8x The wound has been sutured after the exposure.

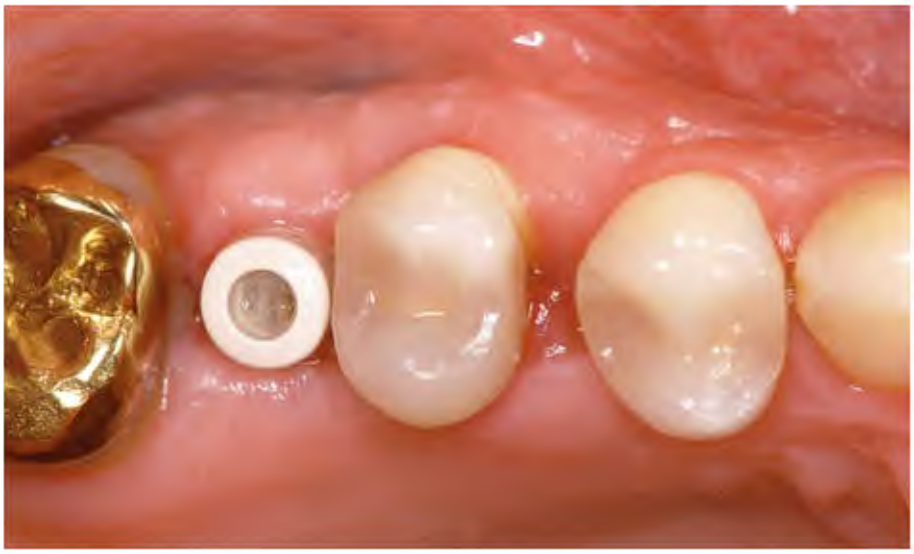


Fig 5-8y Healing on the right side.



Fig 5-8z Start of the orthodontic treatment.

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Fig 5-8aa Provisional crown on implant 16.



Fig 5-8bb The gap between teeth 14 and 15 has been closed by the orthodontic treatment.



Fig 5-8cc The orthodontic apparatus has been removed.

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Ten weeks later, the orthodontic straightening of tooth 15 was completed, allowing the definitive prosthetic restoration to start (Fig 5-8bb). The orthodontic apparatus was removed for this purpose (Fig 5-8cc) and an impression taken for definitive crown 16 (with the prefabricated framework). Until the incorporation of the crown on the following day (Fig 5-8dd), the position of tooth 15 was maintained with a simple spacer. An impression of the left side was taken 3 weeks after the exposure (Fig 5-8ee). Zirconia abutments were fabricated on implants 22 and 24, and titanium ones on implants 27 and 28 (Fig 5-8ff).



Fig 5-8dd Definitive crown on implant 16.

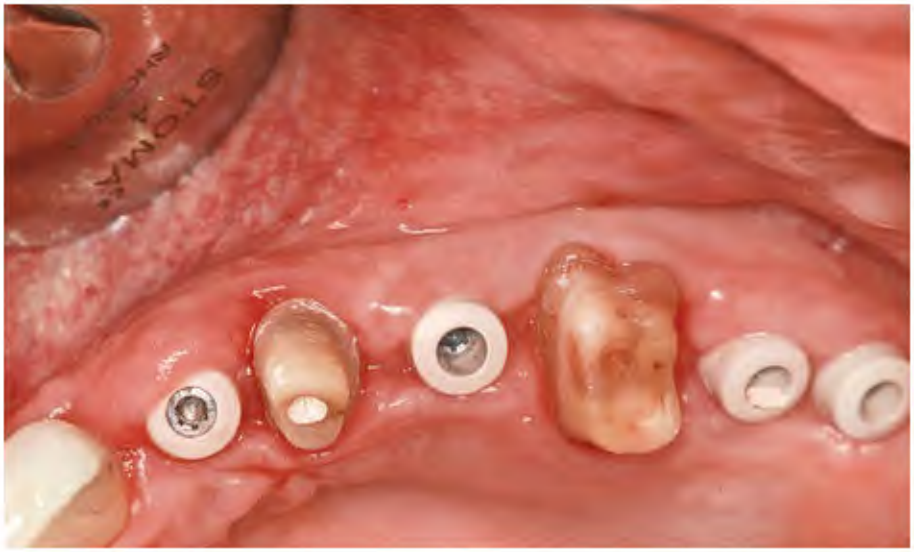


Fig 5-8ee The left side before impression taking.

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Fig 5-8ff Fitted abutments.



Fig 5-8gg Completion of the treatment.



Fig 5-8hh The patient can laugh again.

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The ceramic individual crowns baked onto the zirconia caps were cemented on after the abutment screws were tightened. Crown 36 was also definitively inserted (Fig 5-8gg). After the 2-year treatment, the patient is very satisfied with the final result (Fig 5-8hh).

Treatment course

- Extractions and bilateral sinus floor elevation with posterior augmentation (2006)
- 10 months to implant placement
- 1 year to exposure
- 3 months' orthodontic treatment before the definitive loading

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski
Orthodontic treatment: Dr Beata Sliwowska
Dental technology: Dental technician Ludger Jansen, DentaLab

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Problems and complications

Sinus floor elevation with reconstruction of the residual ridge and gingiva

Baseline situation

This female patient had to have teeth 22, 23 and 25 extracted due to periodontal disease (Fig 5-9a). Teeth 23 and 25 had been used as abutments for a bridge. The severe periodontal loosening had resulted in extensive bone and soft tissue loss, creating unfavorable conditions for an implant-supported restoration (Fig 5-9b). In addition to the vertical and horizontal bone loss, the maxillary sinus extended far toward a mesial direction, so that too little bone was available in the premolar region to anchor implants in the long term. After the CT analysis, it was decided to perform sinus floor elevation (see page 383) plus vertical and horizontal residual ridge augmentation concomitantly with implant placement.

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- CT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Implant placement, left-sided sinus floor elevation with vertical and horizontal augmentation
2. Exposure and horizontal widening of the gingiva
3. Definitive prosthetic loading



Fig 5-9a Panoramic radiograph before teeth were extracted.



Fig 5-9b Residual ridge atrophy following the extraction of teeth 22, 23 and 25.

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After the palatal ridge incision and the dissection of a mucoperiosteal flap, a small window was cut into the apical premolar region of the maxillary sinus (Fig 5-9c). The maxillary sinus mucosa was detached and the implant beds prepared (Fig 5-9d). The gradual augmentation of the sinus floor with a mixture of Bio-Oss, autologous bone and autologous blood took place alongside the insertion of four implants (Fig 5-9e). The implants were placed so that they protruded approximately 2 to 3 mm above bone level, so that they would offer vertical support to the bone augmentation. The higher cover screw on the canine implant was to act as a zone of support for the membrane, preferably in the titanium-reinforced region. The large titanium-reinforced Gore-Tex TR9W membrane was adjusted and attached on the apical side. The prepared mixture of Bio-Oss and bone was then packed under it (Fig 5-9f).

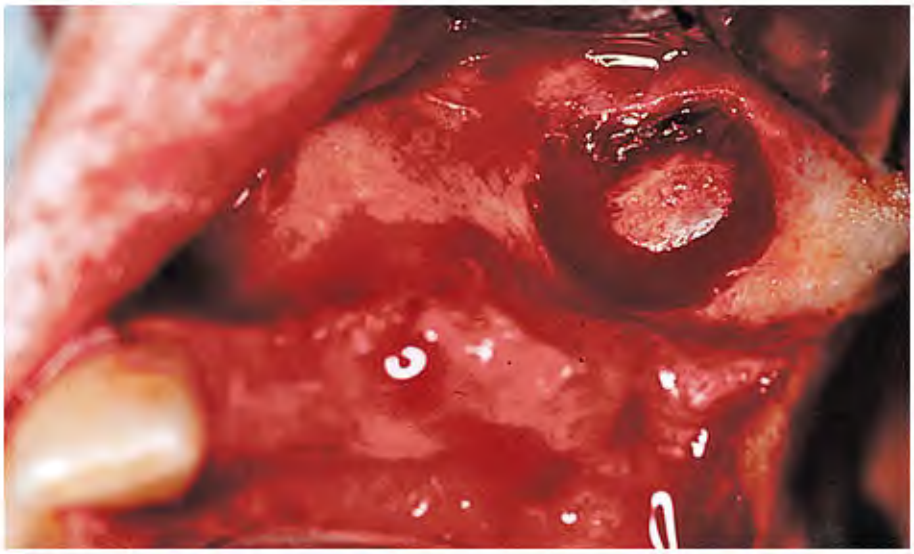


Fig 5-9c Fenestration of the maxillary sinus.



Fig 5-9d Preparation of the implant beds.

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Fig 5-9e The cavity in the maxillary sinus has been filled and the implants inserted.



Fig 5-9f Membrane attached with pins on the apical side.



Fig 5-9g Adapted and stabilized membrane.

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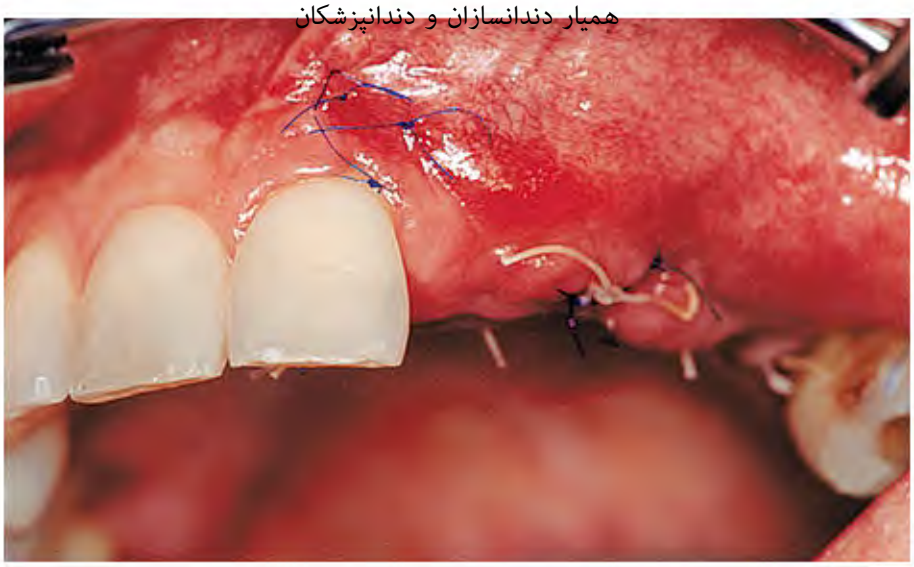


Fig 5-9h Mobilization of the buccal mucosa to cover the membrane.

Following shaping of the residual ridge, the membrane was adapted over the ridge to the palatal side and attached with titanium pins (Fig 5-9g). The flap needed to be repositioned by periosteal slitting without any tension and without exerting any pressure on the augmented area, before the wound was tightly closed with mattress and simple interrupted sutures (Fig 5-9h). The height of the implants above bone level is apparent on the panoramic radiograph, taken directly after the operation (Fig 5-9i). Since the vertical augmentation was undertaken with bone substitutes, a healing period of at least 9 months was required.

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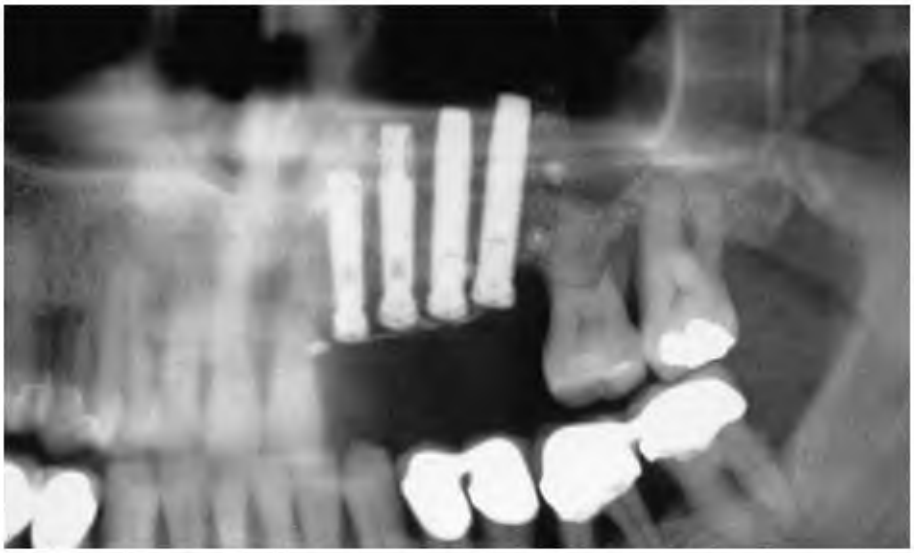


Fig 5-9i Panoramic radiograph after the procedure.

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Fig 5-9j Unattached mucosa on the residual ridge.

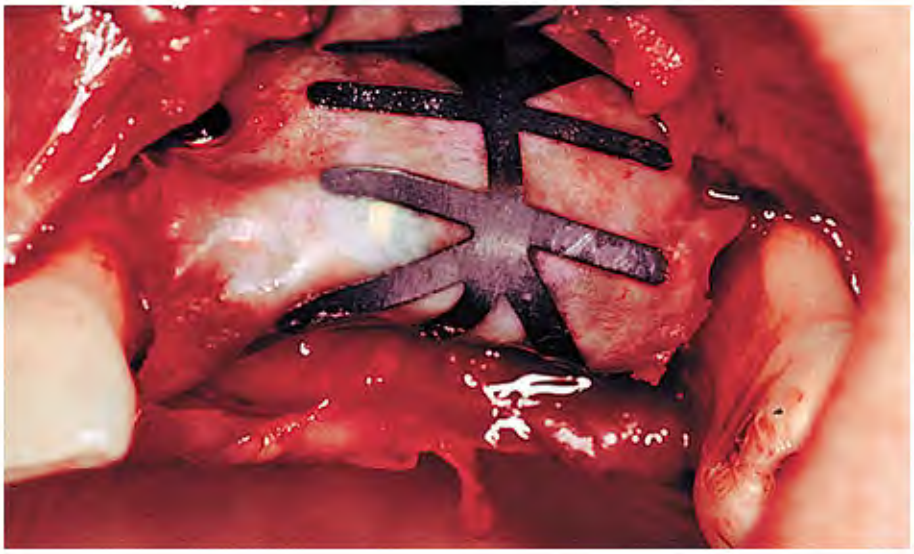


Fig 5-9k Exposure of the membrane.

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Exposure and prosthetic restoration

As a result of the periosteal slitting and the displacement of the unattached mucosa in the coronal direction, there was no keratinized gingiva in the implant region (Fig 5-9j). For this zone to be reconstructed, connective tissue needed to be moved from the palate toward the vestibule. This was achieved with a combination of two methods: the split flap and the roll flap techniques (see pages 528 and 529). Following dissection of the flap, an access to the membrane and to the pins attaching it was created (Fig 5-9k). All the pins were taken out first to allow the membrane to be removed without tearing. To be on the safe side, the membrane was checked for intactness following removal.

The newly formed hard bone tissue had grown over all the cover screws apart from the supporting one, so that it had to be cut away to allow access to the implants (Fig 5-9l).

It had even been possible to reconstruct a bony support for the inter-implant papillae (Fig 5-

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9m). Healing abutments of reduced diameter were screwed onto the exposed implants to allow the mucosa to regenerate in the spaces between the implants (Fig 5-9n). The roll flap on the buccal/labial side needed to be tightly adapted to the abutments (Fig 5-9o).

The epithelial flap, which had been thinned out on the palatal side, was stabilized on the bone base with overlapping sutures (Fig 5-9p). The sutures were removed gradually over a period of 3 weeks (Fig 5-9q). The impression was taken after 5 to 6 weeks. Implant 22 was loaded with a CerAdapt (Nobel Biocare) abutment and an all-ceramic crown. Implants 23, 24 and 25 were loaded with the aid of the cast coping technique (Fig 5-9r). The follow-up radiograph (Fig 5-9s) shows good mineralization of the augmented bone compared to the baseline findings at the time of implant placement (see Fig 5-9i). Comparison of the intraoral images before and after the treatment makes it clear that not only the teeth, but also the residual ridge and the attached gingiva had been successfully restored (Figs 5-9t and 5-9u). The patient is very happy with this improvement (Fig 5-9v).



Fig 5-9l Regenerated bone under the membrane.



Fig 5-9m Bone support for the papillae.

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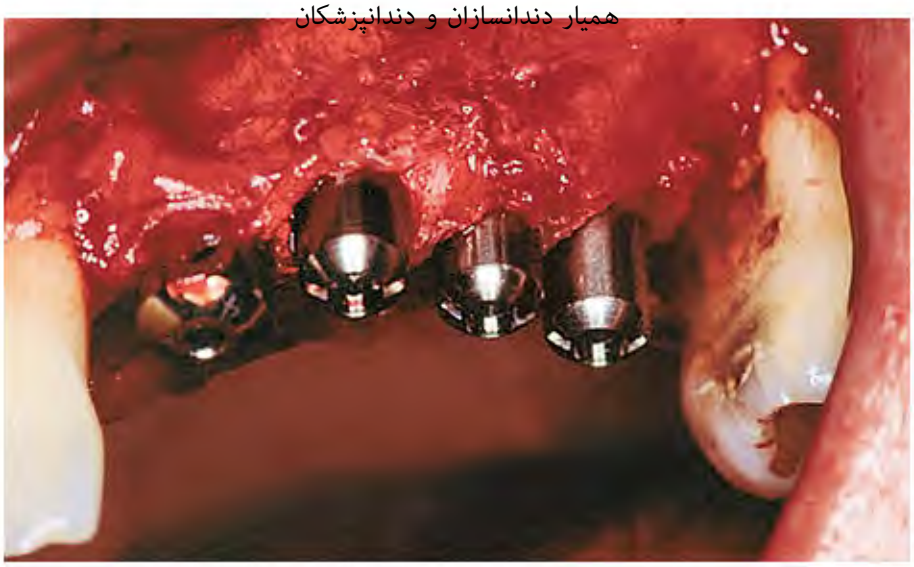


Fig 5-9n Healing abutments of reduced diameter.



Fig 5-9o Palatal graft stabilized on the healing abutments.



Fig 5-9p Adaptation of the thinned-out palatal flap.

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Fig 5-9q Clinical situation after 3 weeks.



Fig 5-9r Prosthetic restoration.

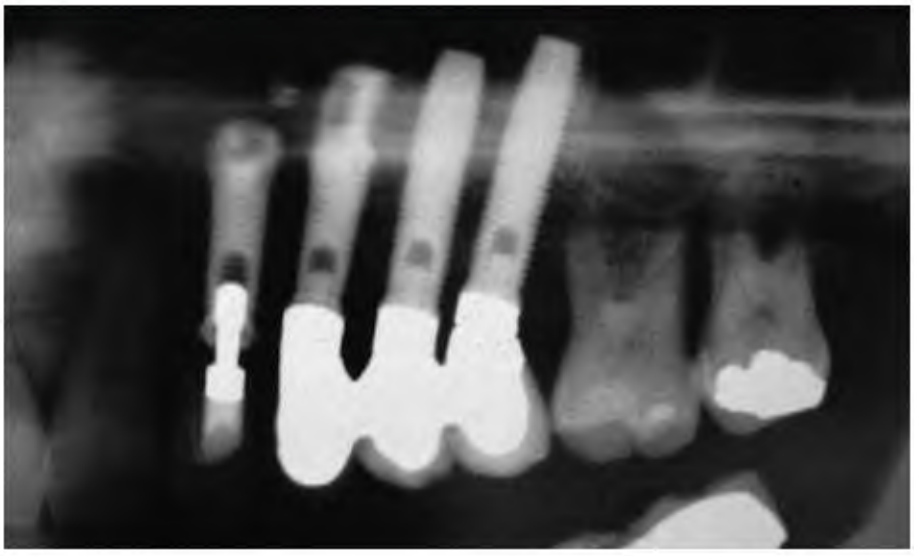


Fig 5-9s Check panoramic radiograph.

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Fig 5-9t Maxilla before the procedure.



Fig 5-9u Fully reconstructed: residual ridge, attached gingiva and missing teeth.



Fig 5-9v Patient following completion of the treatment.

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Fig 5-9w Follow-up panoramic radiograph after 13 years.



Fig 5-9x Overall view of the maxilla (cf. Fig 5-9t).

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Continued follow-up

It is interesting to see how stable the treatment result remained after several years of functional use. The patient presented for a check-up after 13 years, and the clinical situation was documented at this point in time. The osseous situation appeared to be stable on the follow-up panoramic radiograph (Fig 5-9w). Implant 22, loaded with a ceramic individual crown, appears very natural in the overall view (Fig 5-9x).

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Fig 5-9y Visible metal on the distal implant superstructures. Healthy gingival situation after 13 years.



Fig 5-9z The patient's long upper lip conceals the metal edges of the distal implants.

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The implant positioned furthest toward the labial vestibule also shows the highest degree of recession and the highest overall proportion of metal in its superstructure (Fig 5-9y). However, the patient's upper lip is long enough to allow her to smile broadly without revealing any metal parts (Fig 5-9z). The patient is not bothered by the visible metal edges and is more than satisfied with the final result.

Treatment course

- Implant placement, left-sided sinus floor elevation with vertical and horizontal augmentation (1999)
- 8 months to exposure and horizontal widening of the gingiva
- 6 weeks to the definitive prosthetic loading

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Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Gregor Cwajgart
Dental technology:	Gerhard Makowski

Problems and complications

Implant treatment after sinus floor elevation in two sessions

Baseline situation

This male patient's maxilla exhibited a multi-tooth gap in the molar/premolar region on both sides (Fig 5-10a). A single-tooth gap was also present due to the loss of tooth 14 (still visible on the panoramic radiograph). Tooth 15, with grade II mobility, showed a loss of attachment of approx 70% (Fig 5-10b). The plan was to preserve the tooth for as long as possible despite its poor state and to extract it only once the superstructure was ready to be incorporated (Fig 5-10c). Both maxillary sinuses were so pronounced that they did not offer any secure anchoring potential for a simple implant placement. For this reason, bilateral sinus floor elevation was needed before any implants were placed (see page 383).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation
2. Implant placement
3. Exposure
4. Definitive prosthetic loading

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Fig 5-10a Baseline situation.



Fig 5-10b Panoramic radiograph.

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Fig 5-10c Gaps between the teeth in the first quadrant.

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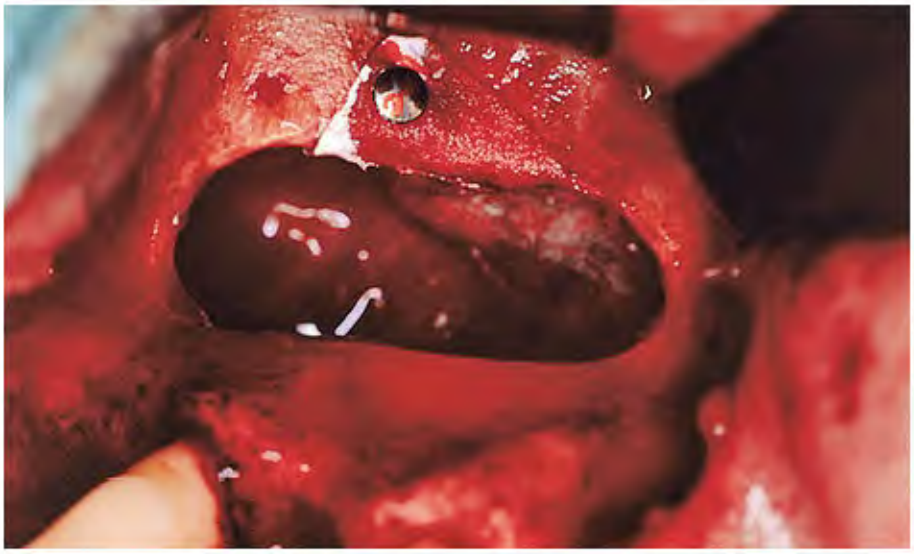


Fig 5-10d Sealing off the maxillary sinus mucosa with a membrane.

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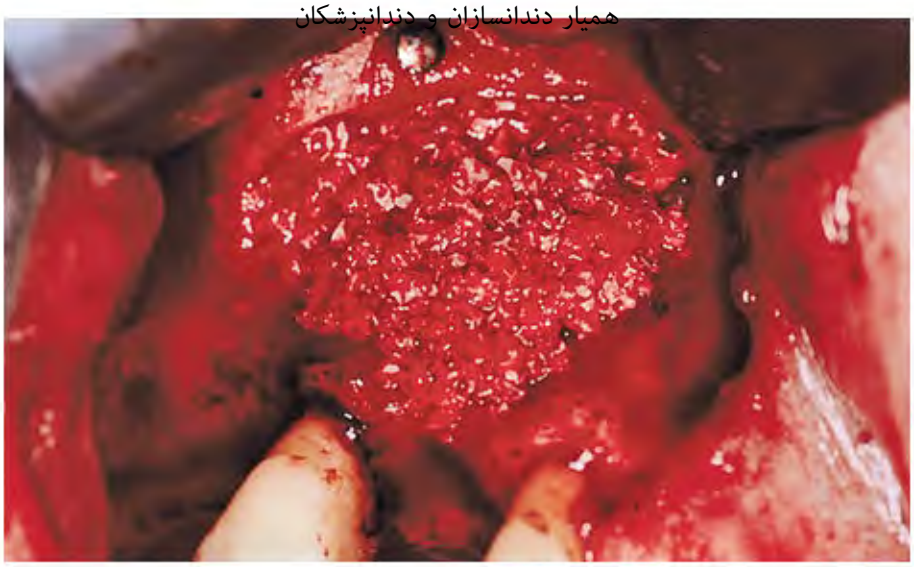


Fig 5-10e Lateral augmentation of the residual ridge.

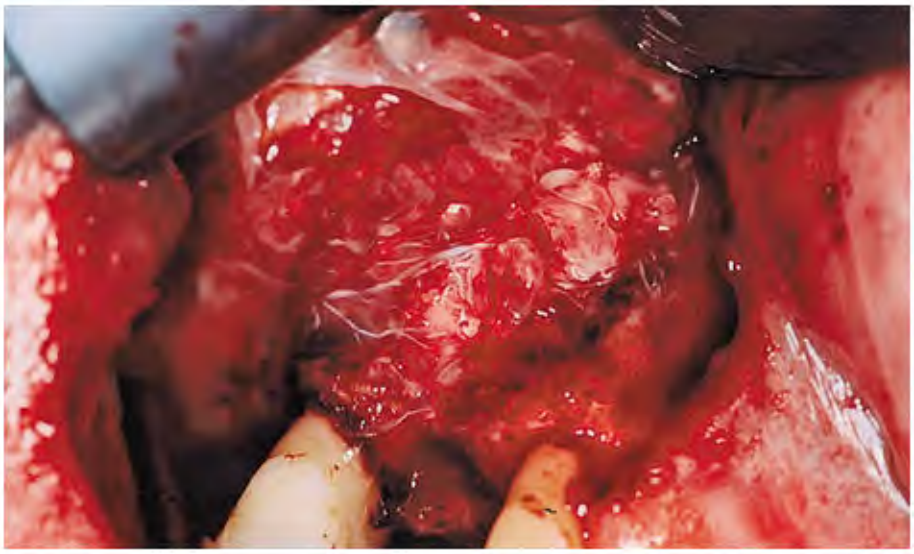


Fig 5-10f Atrisorb membrane.



Fig 5-10g Bone septa in the left maxillary sinus.

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Fig 5-10h View of the septa in the mirror.

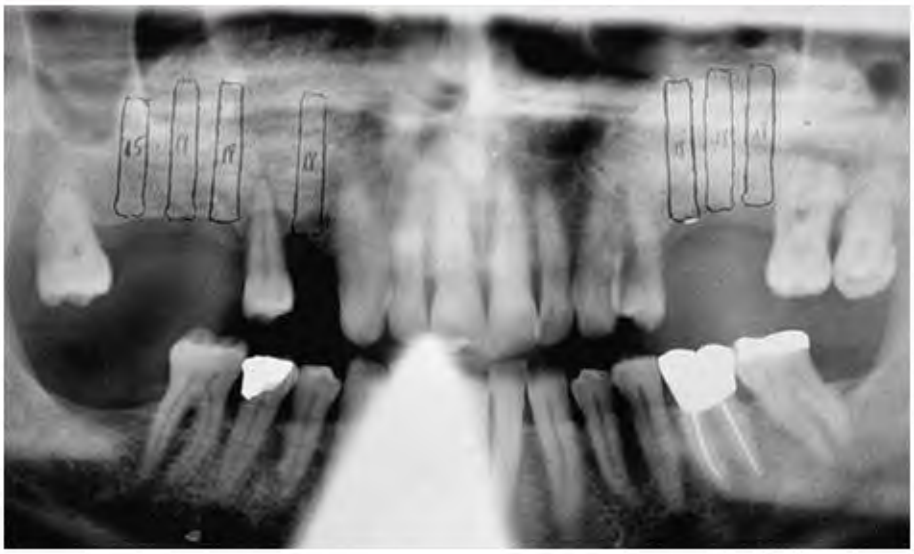


Fig 5-10i Postoperative panoramic radiograph.

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Sinus floor elevation

Fenestration of the lateral maxillary sinus wall from tooth 13 to the interdental space between teeth 15 and 16 was carried out on the right side.

Since the maxillary sinus mucosa was perforated during dissection in this instance, the perforation needed to be sealed off with a resorbable membrane. A Bio-Gide membrane was adapted onto the mucosa and attached with a titanium pin (Fig 5-10d). The resultant cavity was filled with a mixture of Bio-Oss, autologous bone and autologous blood. The lateral residual ridge augmentation was performed at the same time (Fig 5-10e). The liquid membrane Atrisorb (TOLMAR) was used to seal off the fenestration and the lateral augmentation (Fig 5-10f). The opposite side was prepared in the same way, the dissection of the maxillary sinus mucosa being complicated by the bone septa in the sinus (Figs 5-10g and 5-10h). The cavity was filled with the same augmentation material as that used on the other side. The window was closed

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with a resorbable Bio-Gide membrane, which was attached with titanium pins. The postoperative panoramic radiograph shows that both maxillary sinuses had been filled sufficiently to anchor long implants (Fig 5-10i).

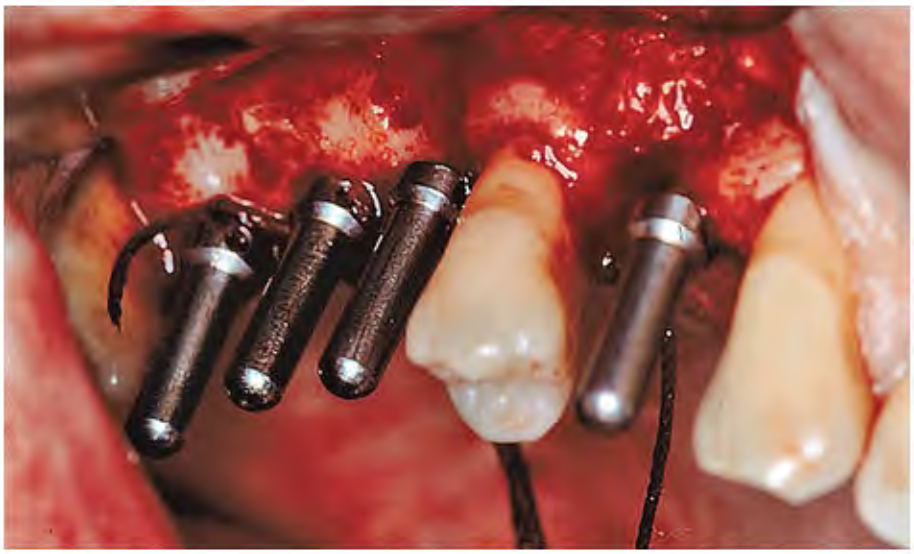


Fig 5-10j Preparation of the implant beds.

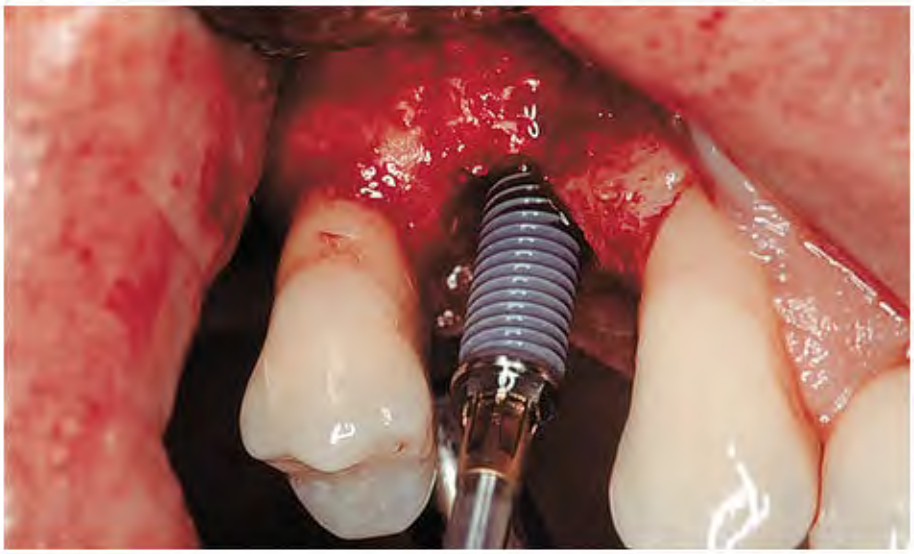


Fig 5-10k Brånemark System implant with TiUnite surface.

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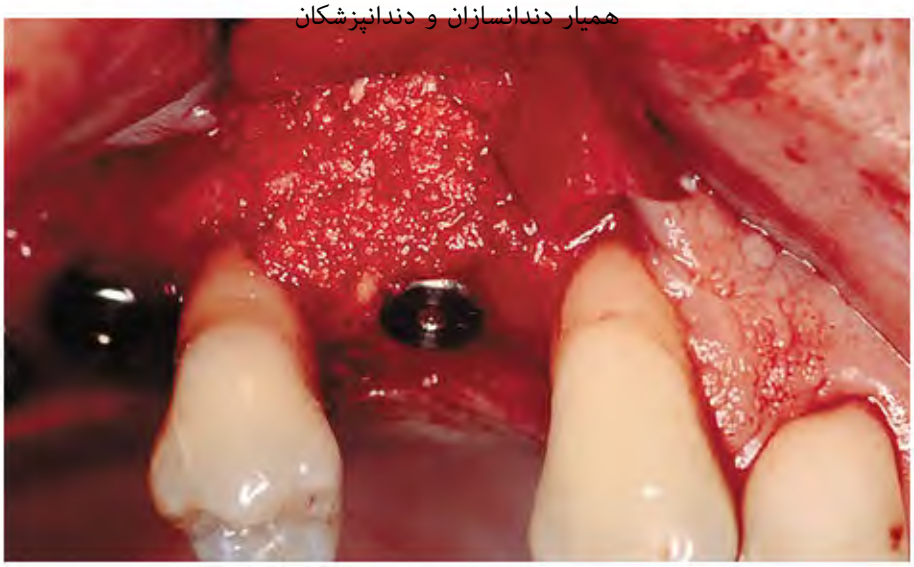


Fig 5-10l Bone augmentation around implant 14.



Fig 5-10m Attached membrane.

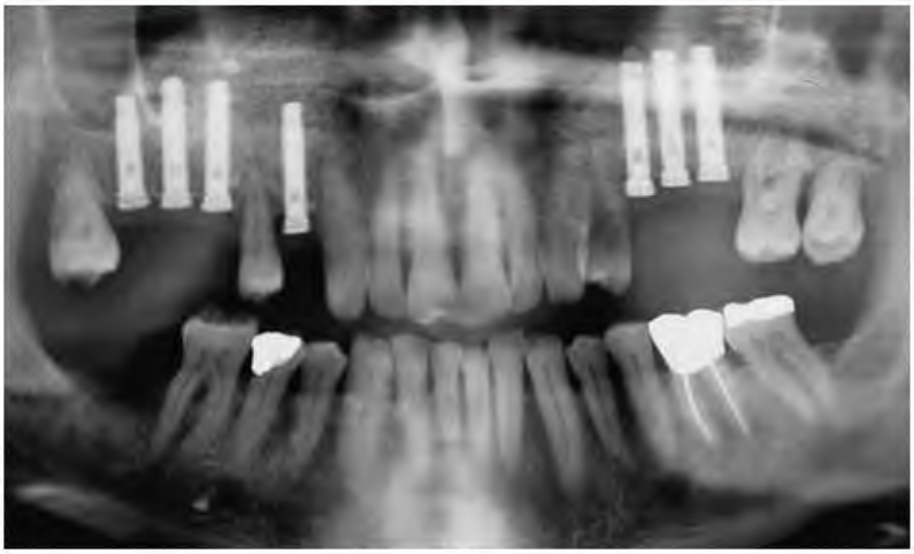


Fig 5-10n Postoperative panoramic radiograph.

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The beds for four implants were prepared after a healing period of 9 months (Fig 5-10j). A Brånemark System MK III implant with a TiUnite surface was inserted into position 14 (Fig 5-10k). Brånemark System MK IV implants, as recommended for augmented areas, were selected for the three remaining positions. Since the bone defect around implant 14 had not yet regenerated sufficiently, augmentation was repeated with bone harvested during preparation (Fig 5-10l). The augmentation was protected with a Bio-Gide membrane and attached with titanium pins (Fig 5-10m). Implant placement on the opposite side was performed in the same way. Three MK-IV implants were inserted here (Fig 5-10n).

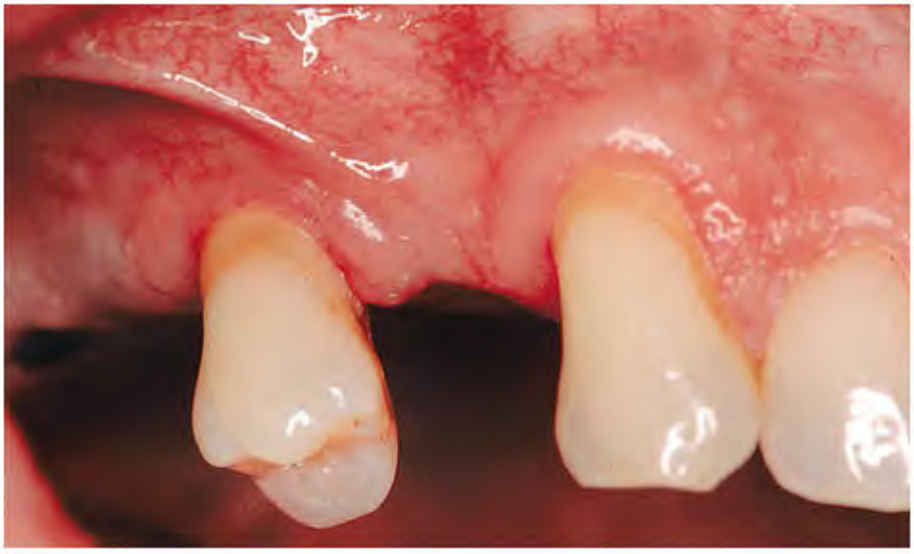


Fig 5-10o Residual ridge contours before the exposure.



Fig 5-10p Exposure incision.

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Fig 5-10q Bone regeneration around implant 14.

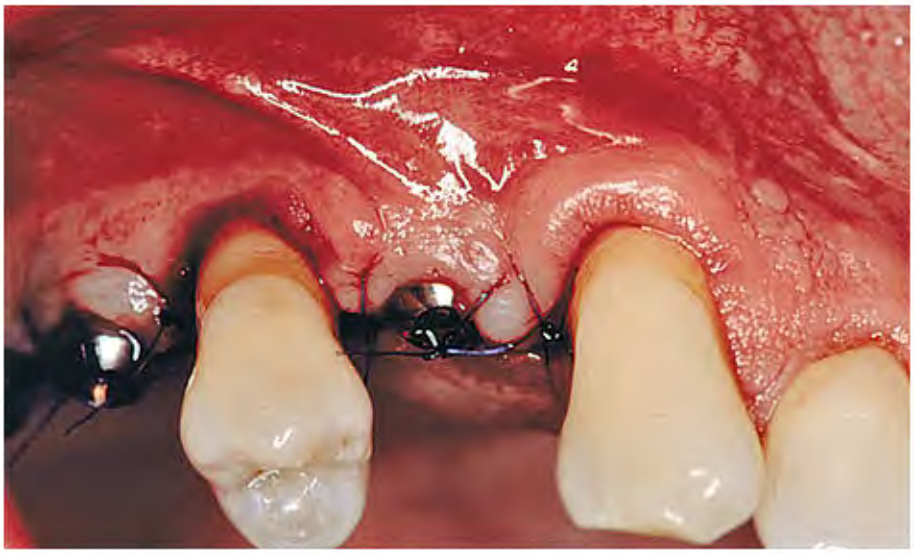


Fig 5-10r Improvement in the gingival situation.



Fig 5-10s Superstructure in the first quadrant.

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Exposure and prosthetic restoration

Exposure took place after an 8-month healing phase. As a result of the dual bone augmentation, an improvement in the residual ridge contour was apparent even before the exposure (Fig 5-10o). The incision was made according to the principles of the cosine curve technique for a single-tooth implant (Fig 5-10p). Flap reflection revealed a stable osseous situation around the TiUnite implant (Fig 5-10q). Following removal of the cover screws, healing abutments of reduced diameter were fitted onto all the implants. The gingiva was adapted around the abutments and stabilized with microsurgical sutures (Fig 5-10r). Customized abutments were fabricated on all the implants and a superstructure suitable for cement retention was prepared. Tooth 15 had already been removed from the cast. The extraction of this tooth took place at the time of incorporation of the superstructure (Fig 5-10s). The prosthetic restoration on the other side was also carried out using the cast coping technique (Fig 5-10t). One advantage of a cement-retained prosthetic restoration is that no screw access holes are visible on the occlusal side (Fig 5-10u). Despite the treatment duration of more than 2 years, the patient is very satisfied with the final result (Fig 5-10v).

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Fig 5-10t Superstructure in the second quadrant.

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Fig 5-10u Occlusal view.



Fig 5-10v Patient following completion of the treatment.



Fig 5-10w Right side after 12 years in functional use.

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Fig 5-10x Poor oral hygiene and mild gingivitis on the left side.

Continued follow-up

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The clinical situation has not worsened after a further 12 years, despite the patient's suboptimal oral hygiene. On the right side, the ceramic on the buccal side of crown 16 has cracked slightly (Fig 5-10w). However, this has caused the patient so little bother that he has not even noticed it. The left side shows mild inflammation of the gingiva between the implants, which should be treated with professional cleaning and photodynamic therapy (Fig 5-10x). The panoramic radiograph shows almost no change in bone level around the implants after 12 years of functional use (Fig 5-10y). There has also been little change in the patient's appearance and he continues to be happy about the long-term stability of his implant treatment outcome (Fig 5-10z).

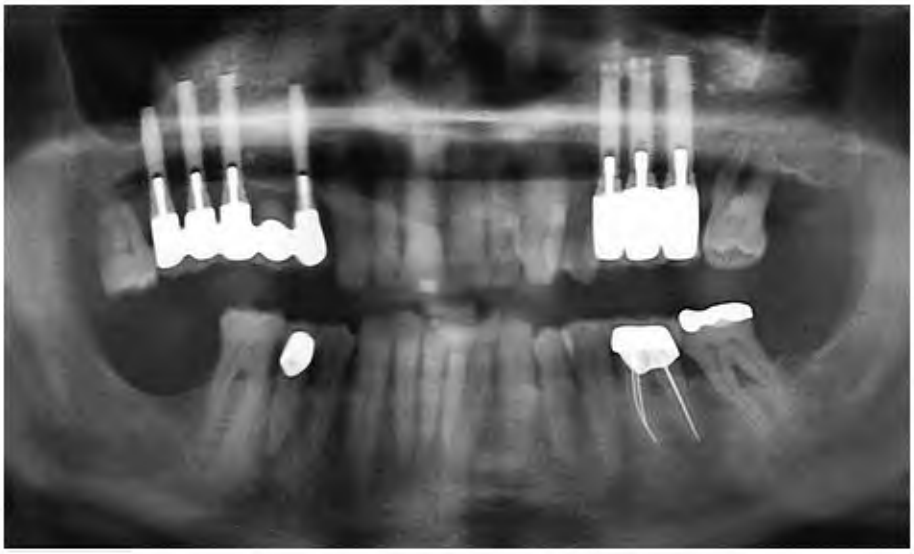


Fig 5-10y Stable bone situation on the panoramic radiograph after 12 years of functional use.

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Fig 5-10z Patient 12 years after completing the treatment.

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Treatment course

- Bilateral sinus floor elevation (1999)
- 9 months to implant placement
- 8 months to exposure
- 6 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Immediate loading

Immediate loading of a restoration on both provisional implants and natural teeth

Baseline situation

In this female patient, the mesial abutment tooth of fixed partial denture 14 to 17 had to be extracted. This was to be followed by a new prosthetic restoration of the right maxilla (Fig 5-11a). Since the patient was skeptical about having a new, extended fixed dental bridge, she decided to opt for an implant-supported superstructure as the definitive

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restoration. The good bone supply favored this decision (Fig 5-11b). However, the patient was not prepared to wear a removable prosthesis for the duration of the healing period. The only justifiable option for a fixed denture that was available at the time was an interim restoration on provisional implants. Preparing the healthy canine to support a provisional bridge was to be avoided.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Implant placement of permanent and provisional implants
2. Exposure
3. Definitive prosthetic restoration



Fig 5-11a Baseline situation.

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Fig 5-11b Good bone situation in the first quadrant.

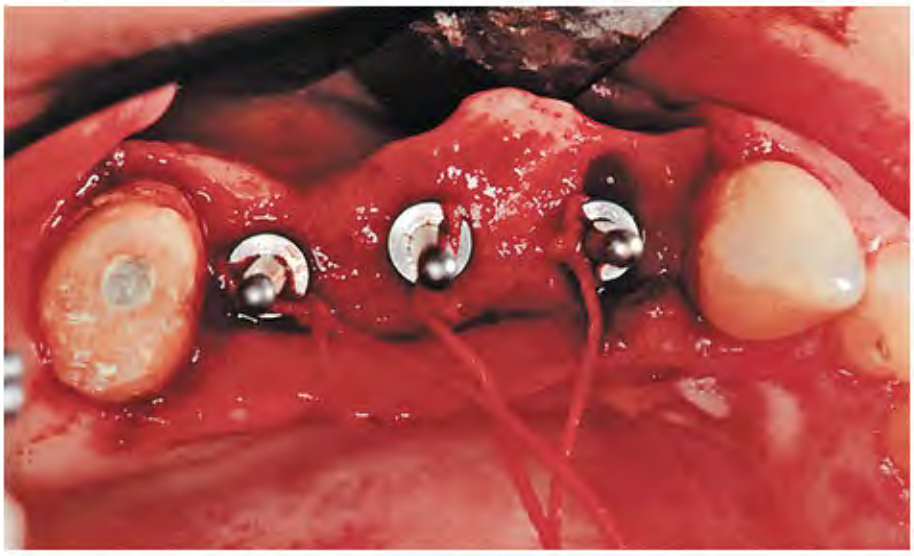


Fig 5-11c Preparation of the implant beds.

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Fig 5-11d Insertion of the definitive implants.

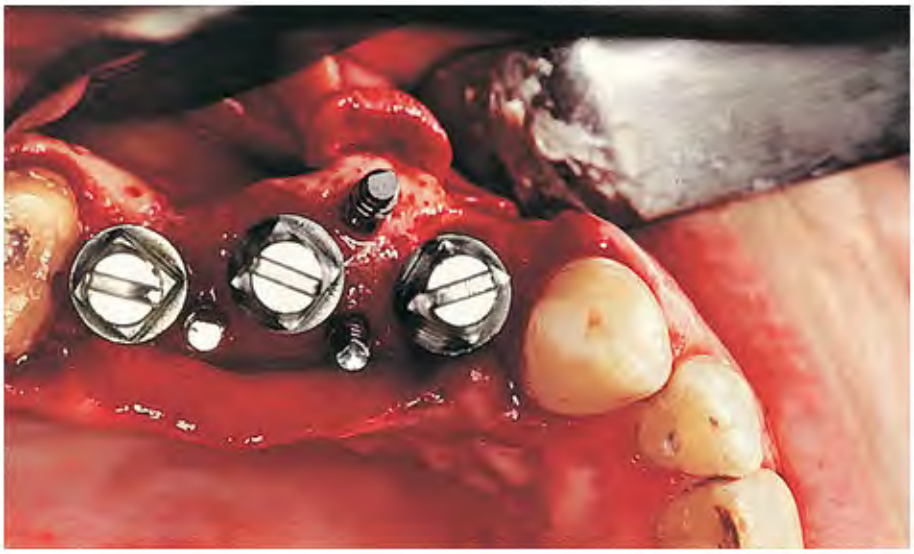


Fig 5-11e Insertion of the provisional implants.

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Implant placement

Three implant beds for implants 14, 15 and 16 were prepared in the conventional way at the prosthetically indicated positions (Fig 5-11c). Three Brånemark System MK IV implants, 18, 18 and 15 mm long, were used (Fig 5-11d). The insertion mounts were initially left on the definitive implants to provide directional guides for the placement of the provisional implants. Three Immediate Provisional Implants (IPIs; Nobel Biocare) were used for the immediate restoration at the positions where sufficient bone was still available (Fig 5-11e). These needed to be placed so as to ensure that they had no contact with the permanent implants (see Note on page 363).

Provisional restoration

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Two additional treatment steps had to be performed during the same session: the fabrication of the first provisional restoration and impression taking, including an interocclusal record for the long-term provisional. The preparation for both steps was identical. After the wound was sutured, caps were placed on the IPIs (Fig 5-11f). A double number of these were needed, for the impression taking and for the direct provisional. The caps were bound together with a ligature to stop them escaping from the mass.

Attention: ***It is sensible to fabricate the direct provisional first, before taking the impression. The following reasons support this sequence of steps:***

- ***The parallelity of the posts can be accurately controlled with the hard plastic mass.***
- ***The provisional can be shaped while the impression is being taken.***
- ***Even if time is short, there is no risk of the patient having to leave the practice without a fixed restoration.***

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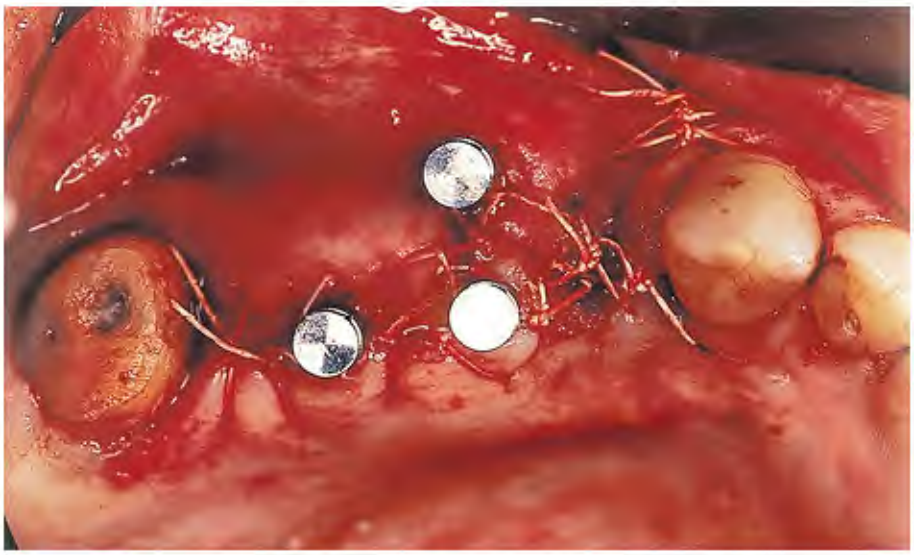


Fig 5-11f Impression caps on the provisional implants.

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Fig 5-11g Check panoramic radiograph.



Fig 5-11h Long-term provisional restoration.



Fig 5-11i Incorporated provisional.

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Fig 5-11j Definitive prosthetic restoration following removal of the provisional implants.

The first provisional was fabricated with the aid of a thermoplastic foil and a cold-cured polymer resin into which the caps were polymerized. The maxillomandibular relationship was recorded with silicone putty, while the impression for the long-term provisional was taken with Impregum (3M ESPE) in a custom tray. A check radiograph was taken once the provisional was put into place with TempBond (Fig 5-11g). After producing a definitive cast, the technician was able to fabricate a long-term, metal-reinforced provisional (Fig 5-11h).

The long-term provisional was incorporated at the time of removal of the sutures (Fig 5-11i). The permanent prosthetic restoration consisted of a separate metal-ceramic crown on tooth 17 and three compound crowns on telescopes on implants 16, 15 and 14. Figure 5-11j shows the clinical situation 18 months following removal of the IPIs and incorporation of the superstructure.

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Fig 5-11k Prosthetically loaded implants in the maxilla after 12 years in functional use.

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Fig 5-11l CBCT scan images after 12 years.



Fig 5-11m Three implants each in the maxilla and mandible.

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Continued follow-up

The clinical situation after 12 years remains stable (Fig 5-11k). A mild inflammatory reaction at the gingival margin, which required treatment, was apparent around implant 14. In the interim, endodontic treatment had been performed on tooth 17 and a pocket appeared to have formed between teeth 16 and 17. The CBCT scan images after 12 years show a stable osseous situation around all the implants (Fig 5-11l). None of the implants in either the maxilla or the mandible show any clinical pathology (Fig 5-11m).

Treatment course

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- Placement of definitive and provisional implants (1999)
- 7 months to exposure
- 5 weeks to the definitive prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Note

Aligning IPIs



Fig 5-12a Bending with parallel guide pins can produce the correct alignment necessary for the dental prosthesis.

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Fig 5-12b For an implant/tooth-supported structure, the alignment should be guided by the existing natural abutment tooth.

Because of their small diameter, IPIs are particularly suitable for partial restorations, particularly where space is limited. Since IPIs have a flexible neck segment, they can be bent with the aid of parallel guide pins to achieve the parallelity required for the dental prosthesis (Fig 5-12a). If an implant/tooth-supported structure is planned, the alignment should be guided by the existing natural abutment tooth (Fig 5-12b). The implants should not be aligned until after the insertion posts have been removed from the permanent implants and the cover screws placed on them. Small adjustments can still be made after the wound is sutured. During suturing, the penetration sites of the IPIs – particularly if placed far in the buccal/labial direction – need to be prepared with releasing incisions.

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Immediate loading

Sinus floor elevation with horizontal augmentation, implant placement and immediate restoration loaded onto IPIs

Baseline situation

This 55-year-old man lost abutment tooth 13, and with it the entire prosthetic restoration in his right maxilla (Fig 5-13a). The only remaining abutment on this side is tooth 17 (Fig 5-13b). Before implant placement, 3D planning using the SimPlant program was performed based on the CBCT scan (Fig 5-13c). The patient had been temporarily fitted with a clasp denture, but wanted to exchange this for an immediate fixed restoration as soon as possible.

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- CBCT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Right-sided sinus floor elevation with vertical and horizontal augmentation, implant placement, provisional implants, immediate provisional restoration
2. Exposure and horizontal widening of the gingiva
3. Definitive prosthetic loading



Fig 5-13a Large multi-tooth gap in the first quadrant.



Fig 5-13b Panoramic radiograph before the treatment.

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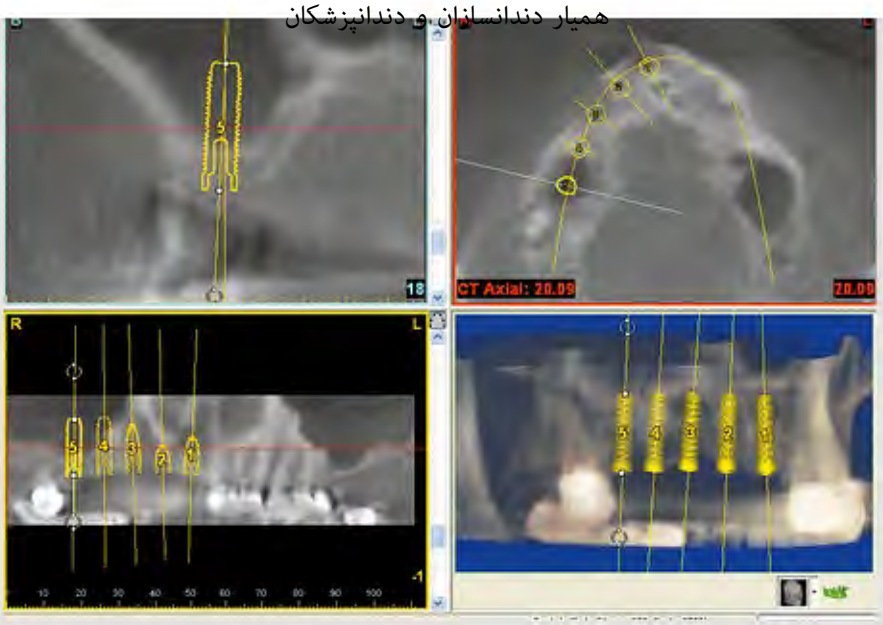


Fig 5-13c 3D SimPlant planning.

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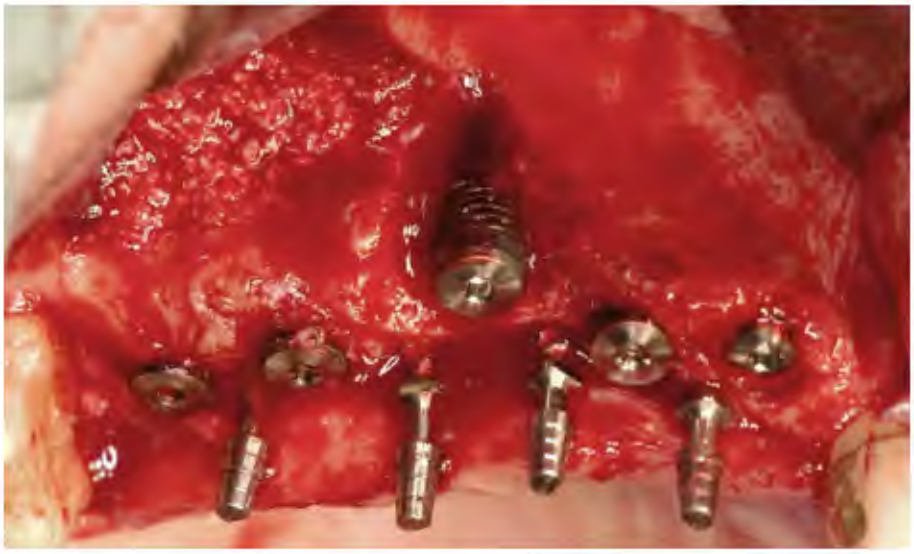


Fig 5-13d The definitive and provisional implants have been inserted. Note the bone defect around implant 13.

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Fig 5-13e Augmentation with Bio-Oss and autologous bone.



Fig 5-13f Large Tutodent membrane attached with titanium pins.

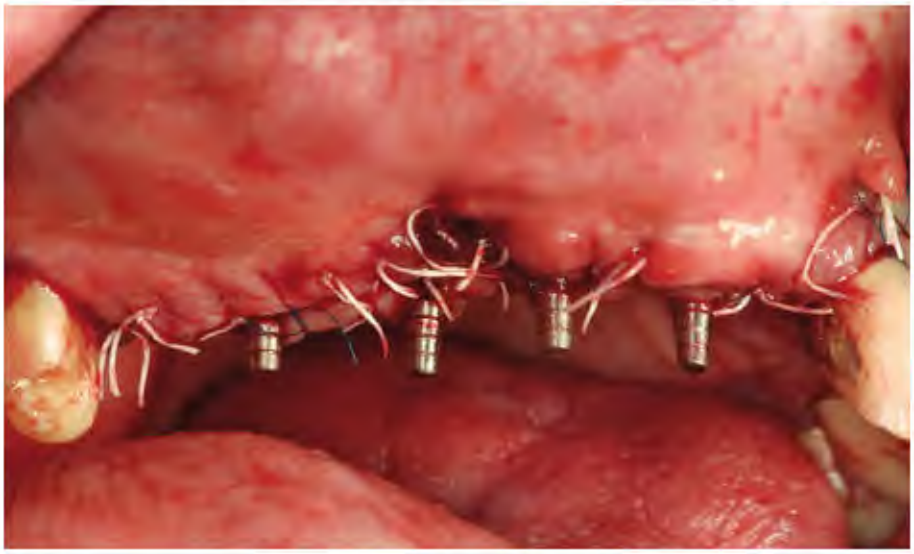


Fig 5-13g Suturing of the wound.

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First, sinus floor elevation on the right side needed to be performed under full general anesthesia. The cavity in the maxillary sinus was partially filled, after which the implant beds were prepared. Five 17-mm long Neoss implants were inserted, four with a diameter of 4 mm and one 4.5 mm in diameter. The implant in region 13 was slightly out of line and almost completely exposed on the labial side due to the extensive bone loss (Fig 5-13d). Four provisional IPIs were inserted between the definitive implants on the palatal side, to support the immediate restoration. In the next step, the maxillary sinus cavity was filled completely and the entire labial/buccal wall over the implants was coated with a thick layer of harvested bone chips and Bio-Oss (Fig 5-13e). The whole area was covered with a Tutodent membrane (Zimmer Dental) (30 × 40 mm), which was securely attached with titanium pins (Fig 5-13f). Generous periosteal slitting was required to allow tension-free repositioning of the flap over the overcontoured augmentation. The wound was closed with mattress and simple interrupted sutures, using Gore-Tex and Mopylen 6-0 sutures (Fig 5-13g). Using a thermoplastic foil, a short-term provisional restoration was fabricated out of Protemp over tooth 17 and the four provisional implants (Fig 5-13h). A panoramic radiograph was taken after the operation (Fig 5-13i). The sutures were removed after 2 and 3 weeks, followed by the incorporation of the long-term, metal-reinforced provisional (Fig 5-13j).

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Fig 5-13h Short-term provisional restoration.

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Fig 5-13i Postoperative panoramic radiograph.



Fig 5-13j Long-term provisional.



Fig 5-13k All the provisional implants have remained stable up to the time of exposure.

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Fig 5-13l Result of the augmentation.

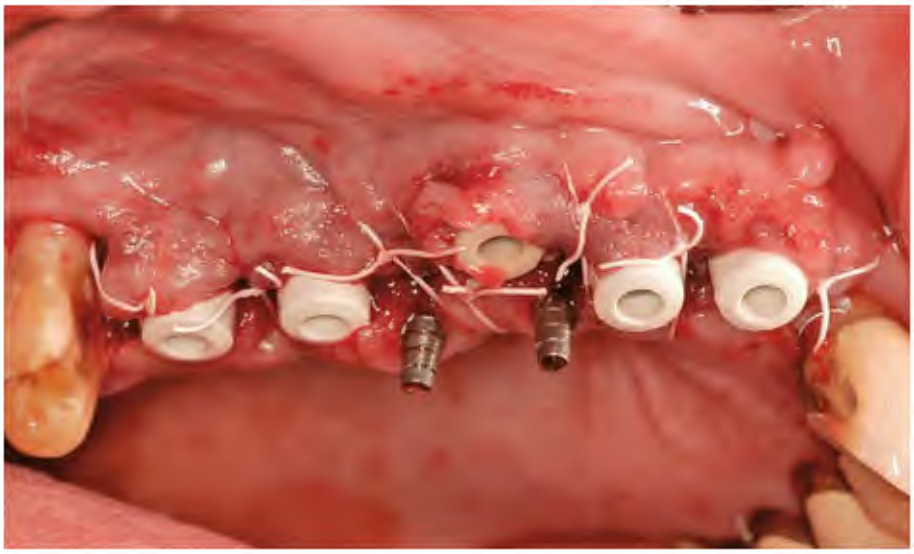


Fig 5-13m Exposed definitive implants.



Fig 5-13n New short-term provisional.

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Exposure

The healing period needed to be at least 9 months, especially for a horizontal augmentation of this size. After this time had elapsed, the long-term provisional was removed and the stability of the provisional implants checked (Fig 5-13k). The exposure incision was made along the residual ridge between the provisional and definitive implants. Slight mobilization of the flap revealed that the augmentation around the implants had consolidated well (Fig 5-13l). The cover screws were removed and 5-mm high PEEK healing abutments were screwed into their place. The attached gingiva that had been gained was adapted to the abutments and secured with Gore-Tex sutures (Fig 5-13m). In time, the greatest potential problems are likely to stem from implant 13, which protrudes too far toward the labial direction. Since the long-term, metal-reinforced provisional could not be adapted to the new situation, a new one had to be fabricated out of Protemp (Fig 5-13n).

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Treatment course

- Sinus floor elevation, implant placement and horizontal augmentation (2006)
- 9 months to exposure

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Hubertus Klaus
Dental technology:	Dental Technician Ludger Jansen

Immediate loading

Immediate restoration supported on definitive implants and one natural tooth

Baseline situation

This female patient, with an otherwise intact dentition, had lost the distal abutment of her fixed dental bridge 24 to 26. For esthetic reasons, pontic 25 had been left in situ (Fig 5-14a). The radiograph showed that sufficient bone was available in region 25 to 26 to allow three long implants to be inserted without sinus floor elevation (Fig 5-14b).

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Currently, according to the immediate loading protocol, a provisional restoration can be loaded directly and non-functionally onto the implants, if bone quality and quantity are good. The provisional should be incorporated within 48 h, and all the implants should be primarily interlocked.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Implant placement and augmentation, immediate loading
2. Definitive prosthetic loading

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Fig 5-14a Tooth 26, acting as distal abutment for the bridge, has been lost.

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Fig 5-14b Panoramic radiograph taken before implant placement.

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Implant placement

Working under procedural sedation and analgesia with intravenous Dormicum (midazolam), along with conduction and infiltration anesthesia, the cantilever bridge was first removed (Fig 5-14c). The incision was made along the residual ridge on the palatal side, with an additional releasing incision distally of tooth 24. Two 17-mm long and 3.5-mm wide Neoss implants, plus one 15-mm long and 4.0-mm wide Neoss implant, were inserted with primary stability. PEEK healing abutments were screwed directly onto the implants for the immediate loading of the prosthesis (Fig 5-14d). The residual ridge had a relatively favorable anatomic configuration for implant placement: it was wide at the coronal end and narrow at the apical end. As a consequence, apical fenestrations – which carried little risk – had developed at two of the implant sites (Fig 5-14e). The fenestrations were covered with harvested bone chips and Bio-Oss, followed by a Bio-Gide membrane. The augmentation also extended to the coronal segments of the buccal maxillary bone at the implant sites. Periosteal slitting was followed by wound closure with Gore-Tex and Mopylen 6-0 sutures, leaving the abutments clearly visible (Fig 5-14f). An immediate provisional was fabricated out of Protemp with the aid of a thermoplastic foil (Fig 5-14g) and cemented into place with TempBond. The whole wound was treated with Solcoseryl dental adhesive paste (Fig 5-14h). Despite the augmentation and widening of the zone of attached gingiva, the augmented area always shrinks with time (Fig 5-14i), as was clearly apparent from the long-term provisional restoration fabricated shortly after implant placement (Fig 5-14j). Both provisionals had to remain completely out of occlusion, to avoid premature functional loading of the implants. A panoramic radiograph was taken during the healing phase as a progress check (Fig 5-14k).

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Fig 5-14c Situation following removal of the bridge.



Fig 5-14d Inserted implants with healing abutments.

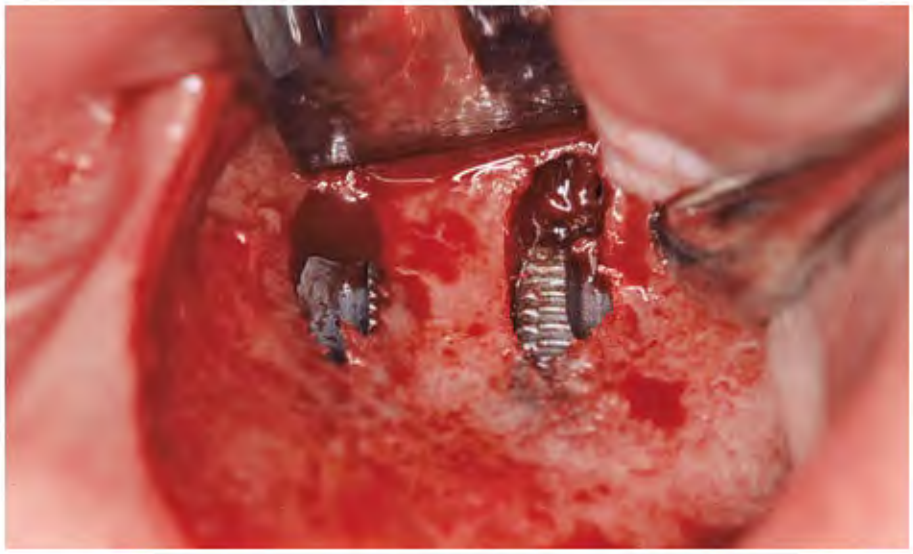


Fig 5-14e Apical fenestrations.

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Fig 5-14f Sutured wound with protruding healing abutments.



Fig 5-14g Short-term provisional restoration.



Fig 5-14h Provisional restoration directly after implant placement.

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Fig 5-14i Shrinkage of the augmentation during the course of healing.



Fig 5-14j The long-term provisional must also be placed out of occlusion.



Fig 5-14k Check panoramic radiograph.

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Treatment course

- Implant placement and immediate loading (2004)
- 9 months to the definitive prosthetic loading

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski
Dental technology: Ute Olbers

Free-end situation

If there is a free-end situation in the maxilla, full rehabilitation is not always possible without additional bone augmentation (sinus floor elevation). If the patient has a terminal canine tooth, he or she can sometimes be offered a restoration in the form of an abbreviated dental arch, by inserting two to three implants mesially of the maxillary sinus. This solution, however, can be considered only where there is an adequate bone supply, as well as sufficient support on the other side of the dental arch.

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Simple treatment course (without sinus floor elevation)

Restoration in the form of an abbreviated dental arch without sinus floor elevation

Baseline situation

This male patient had already had his canine 23 crowned, while tooth 22 needed crowning (Fig 5-15a). There was just enough space between the canine and the anterior wall of the maxillary sinus for two implants to be inserted (Fig 5-15b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- Dental cast analysis

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Treatment plan

1. Implant placement
2. Exposure
3. Definitive prosthetic loading



Fig 5-15a Baseline situation.

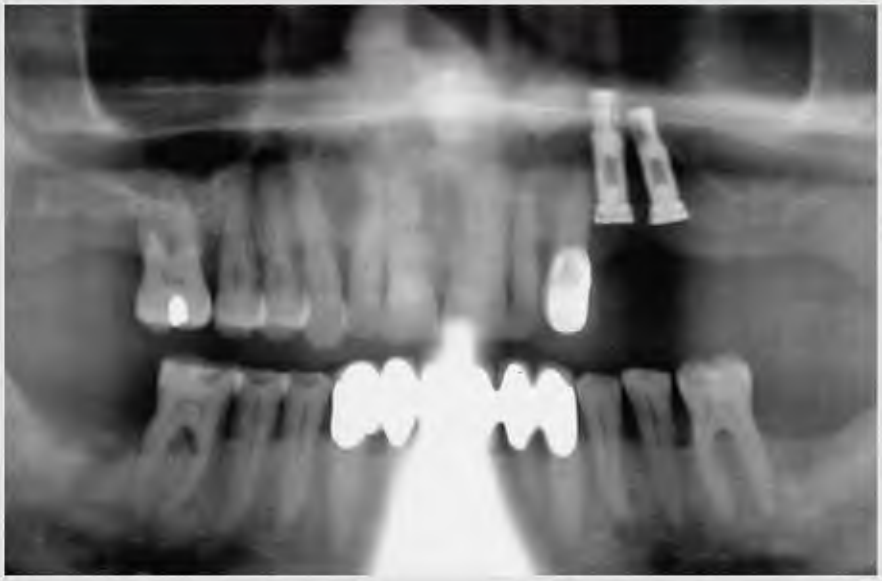


Fig 5-15b Inserted implants 24 and 25.

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Fig 5-15c Custom abutments.



Fig 5-15d Cement-retained compound crowns 22 and 23.



Fig 5-15e Definitive prosthetic restoration.

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Fig 5-15f Follow-up panoramic radiograph after 6 years.

Implant placement and prosthetic restoration

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The implant in region 25 had to be tilted slightly mesially, to stop it penetrating into the maxillary sinus. A near-axial position was achieved for implant 24. Once the implants had healed, crown 23 was removed and tooth 22 prepared (Fig 5-15c). The implants were fitted with custom-cast abutments for telescopic crowns. Metal-ceramic compound crowns with a distal attachment were cemented onto teeth 22 and 23 (Fig 5-15d). The telescopic fixed partial denture on customized abutments 24 and 25 was interlocked with the dental crowns via this attachment. For esthetic reasons, the superstructure was fitted with a distal cantilever replacing tooth 26, placed out of occlusion (Fig 5-15e). Biological or mechanical complications were likely if the distal cantilever was placed under any stress. The panoramic radiograph was taken 6 years after the superstructure was incorporated (Fig 5-15f).

Treatment course

- Implant placement (1998)
- 6 months to exposure and prosthetic loading.

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Implant placement without sinus floor elevation with a 3D template

Baseline situation

A male patient presented with a free-end situation in the second quadrant, a moderately atrophied residual ridge (Fig 5-16a) and a moderately pronounced left maxillary sinus (Fig 5-16b). At the same time as implant placement, the patient wanted an immediate prosthetic restoration and esthetic correction in the visible region.

Diagnostic tools

- Clinical examination
- Panoramic radiograph and CBCT
- SimPlant planning and fabrication of the SurgiGuide template
- Dental cast analysis

Treatment plan

1. Fabrication of the template based on the SimPlant planning, preoperative fabrication of the provisional prosthesis, implant placement with the aid of the template in regions 24, 25 and 26 with augmentation and gingival correction, direct incorporation of the provisional.
2. Definitive prosthetic loading



Fig 5-16a Moderately atrophied residual ridge in the second quadrant.

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Fig 5-16b Baseline situation on the panoramic radiograph.

3D planning plus fabrication of the template and provisional

After the CBCT scan, the implant positions were determined in the SimPlant program and a template with an additional stabilization pin was planned (Fig 5-16c). The completed plan was sent by email to the Materialise Head Office in Belgium (now Dentsply), where it formed the basis for fabrication of a corresponding series of templates (Fig 5-16c). Three templates with drill guides 2.0, 3.0 and 3.2 mm in diameter arrived in the mail 10 days later (Fig 5-16d). Apart from the three drill guides for the implants, a horizontal guide for the stabilization pin was integrated into each template (Fig 5-16e). A definitive cast was produced with the aid of the template and the provisional abutments were fitted to the cast (Fig 5-16f). An eggshell provisional restoration was fabricated on the provisional abutments (Fig 5-16g). The spaces left around the abutments in the provisional were to be filled in situ after implant placement (Fig 5-16h).

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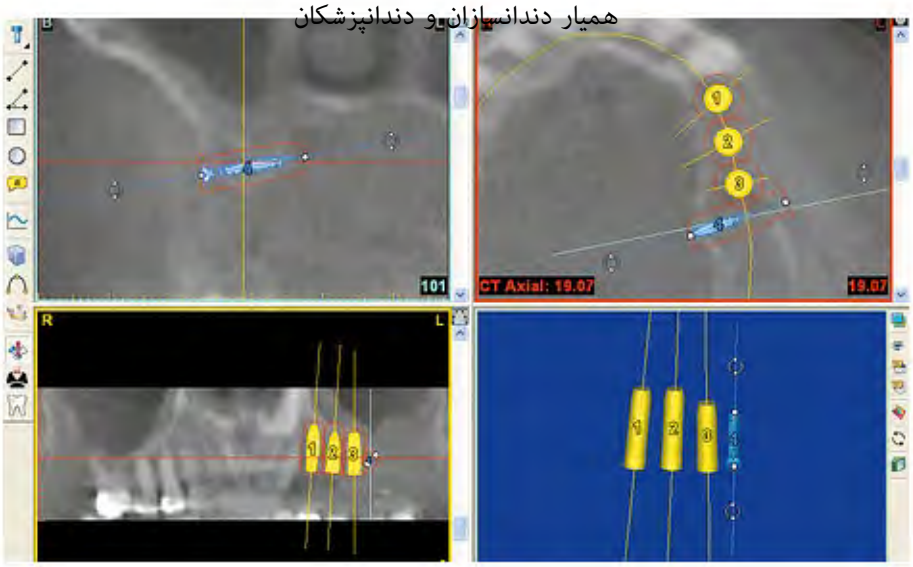


Fig 5-16c SimPlant planning for the SurgiGuide template.



Fig 5-16d SurgiGuide surgical template.



Fig 5-16e Horizontal guide for the stabilization pin.

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Fig 5-16f Provisional abutments on the cast.



Fig 5-16g Prepared provisional restoration.

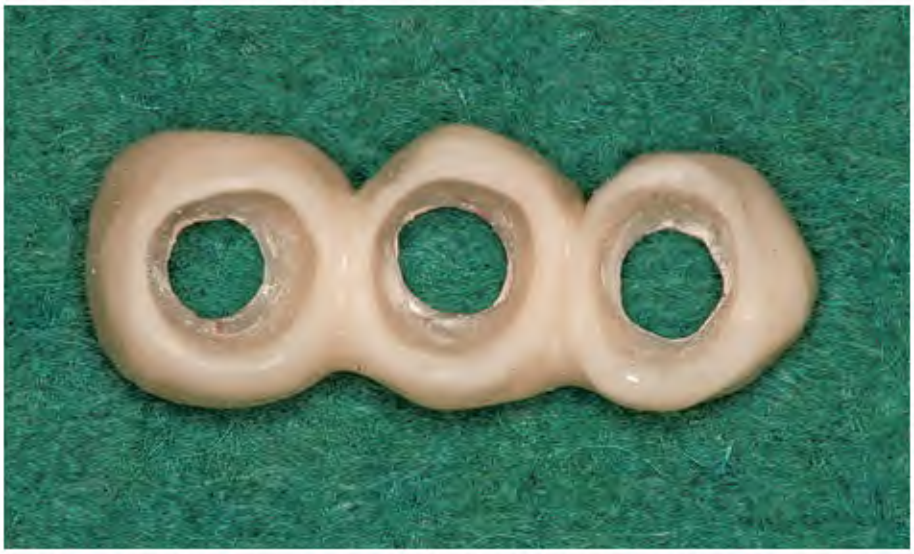


Fig 5-16h Spaces left for the abutments to be polymerized in.

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Fig 5-16i SurgiGuide put into place.



Fig 5-16j Stabilization of the template with horizontal pin.

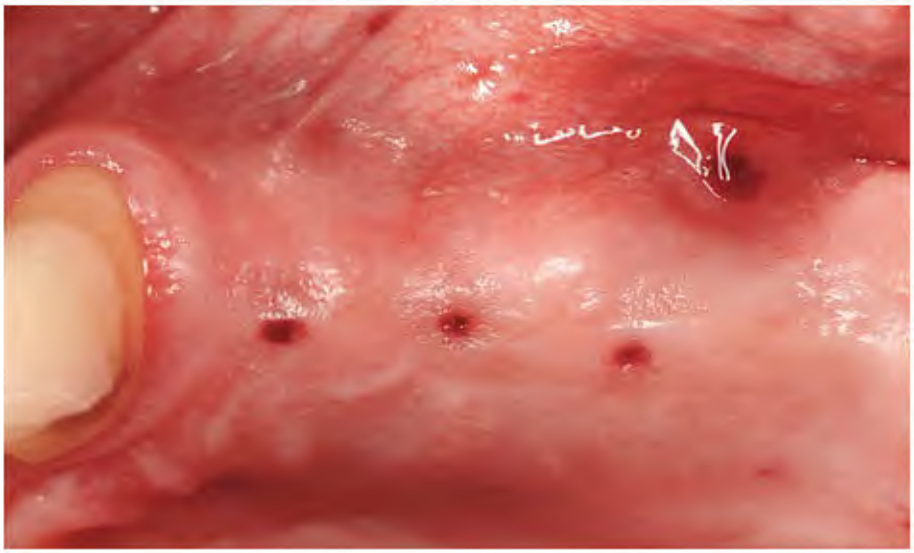


Fig 5-16k Marking the implant positions through the template.

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Fig 5-16l The template has been reinserted following flap reflection.

Implant placement

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After local anesthesia was administered, the template was put into place on the existing teeth and checked for fit and stability (Fig 5-16i). The horizontal drill hole for the stabilization pin was prepared first and the pin inserted (Fig 5-16j). An awl, pushed through the drill guides in the template, was used to mark the midpoints of the implant beds on the gum (Fig 5-16k). After the template was removed, a crestal incision was made on the palatal side of the implants, extending to bone level. Before the implant bed preparation, the mucoperiosteal flap was mobilized in the buccal direction, after which the template was reinserted with the flap reflected and stabilized with the pin (Fig 5-16l). Preparation with drills of increasing size followed, up to a diameter of 3.2 mm. When the template was removed, three Neoss implants 4 mm in diameter were inserted into the prepared channels (Fig 5-16m). The following implant lengths were used: region 24 to 17 mm; region 25 to 15 mm; region 26 to 13 mm. The implants were not fully inserted, but positioned slightly supracrestally, all at the same level, to leave space for the subsequent augmentation (Fig 5-16n). The prepared and marked provisional cylinders were screwed onto the implants (Fig 5-16o) and the provisional was tried in (Fig 5-16p). After some small adjustments, the gaps left in the provisional were filled with a fast-curing polymer. The provisional fixed restoration was unscrewed and shaped by the dental technician directly afterwards (Fig 5-16q). During this time, healing abutments were screwed onto the implants, the bone chips harvested for the augmentation were layered onto the buccal wall and the flap fixed with Gore-Tex sutures. Unlike the procedure adopted after flapless surgery, this means that there will be no loss of keratinized gingiva, as the flap is shifted approximately 5 mm toward the buccal vestibule (Fig 5-16r). Moreover, augmentation can be performed despite the template-guided surgery.

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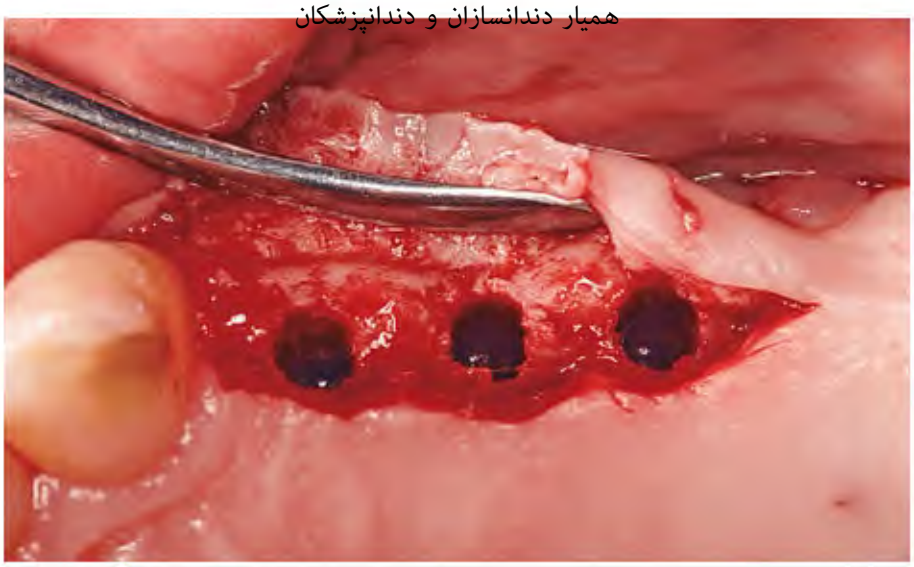


Fig 5-16m Prepared implant beds.

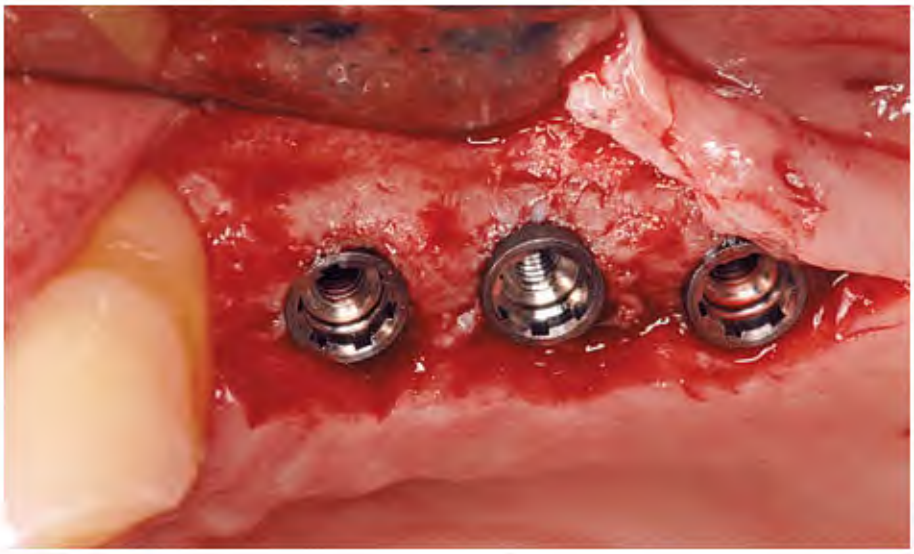


Fig 5-16n Supracrestally inserted implants.

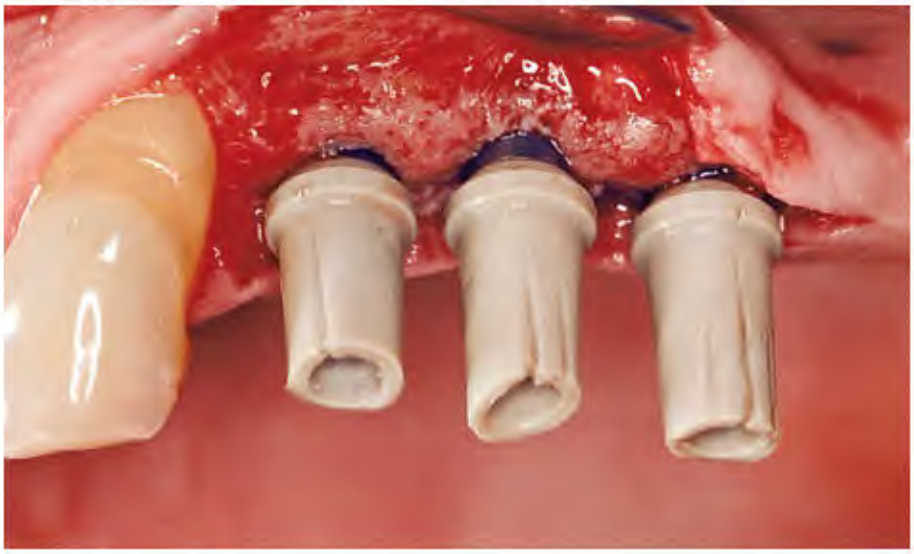


Fig 5-16o Provisional abutments fitted into place.

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Fig 5-16p Try-in of the provisional restoration.



Fig 5-16q Shaped provisional.

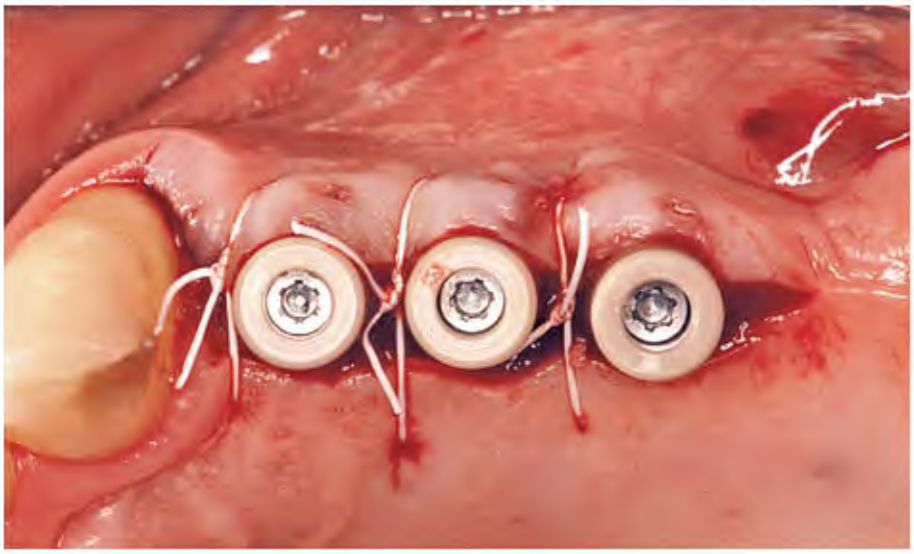


Fig 5-16r Widening the zone of attached gingiva.

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Fig 5-16s Fitted provisional directly after implant placement.



Fig 5-16t The provisional has been placed wholly out of occlusion.



Fig 5-16u Healing process after 2 weeks.

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Fig 5-16v Postoperative panoramic radiograph.

After the wound was sutured, the healing abutments were unscrewed and the provisional fitted in its place (Fig 5-16s). It was important for the fixed provisional to remain wholly out of occlusion, to avoid premature functional loading of the implants (Fig 5-16t). The sutures were removed after approximately 2 weeks (Fig 5-16u). The postoperative panoramic radiograph confirms that the implants have been inserted according to the plan (Fig 5-16v).

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Treatment course

- 3D planning, fabrication of the provisional, restoration directly followed by implant placement and insertion of the immediate provisional (2006)
- 6 months to definitive loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Typical treatment course

Sinus floor elevation with lateral augmentation and mucosal distraction

The case described here is a continuation of the 3D diagnosis on page 324.

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Baseline situation

A 56-year-old woman was having problems with the stability of her prosthetic restoration in the maxilla. The residual ridge on the left side had atrophied under her attachment-retained prosthesis and the denture was becoming increasingly wobbly (Fig 5-17a). The left maxillary sinus was very pronounced, so that sinus floor elevation was necessary before implant placement. The periodontal space around tooth 22 was also widening (Fig 5-17b). The exact 3D analysis and planning using SimPlant is described on page 324. The patient was a smoker (15 to 20 cigarettes a day) and wanted a fixed restoration supported on implants.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Sinus floor elevation with augmentation
2. Implant placement
3. Exposure and horizontal widening of the gingiva
4. Definitive prosthetic loading



Fig 5-17a Attachment on the loose terminal tooth 22.

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Fig 5-17b Pronounced left maxillary sinus and widening of the periodontal space around tooth 22.

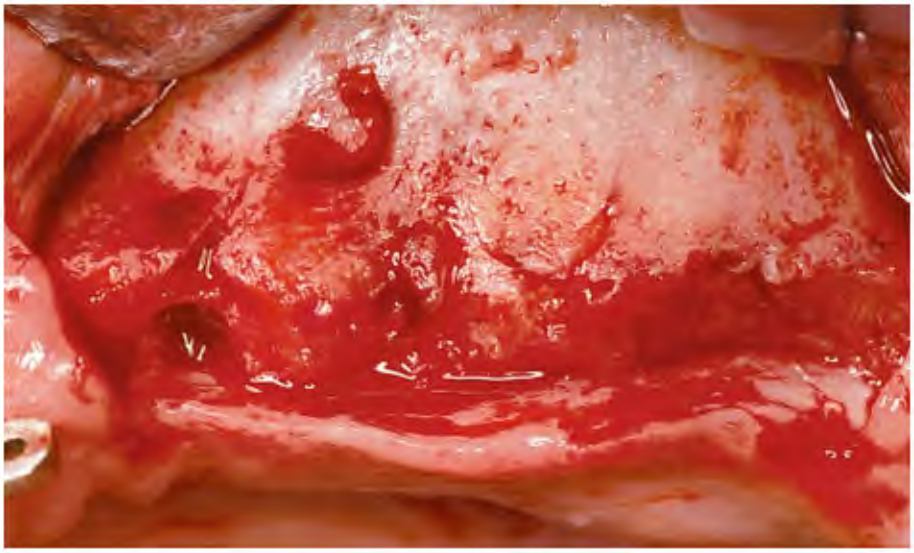


Fig 5-17c Several residual ridge defects.

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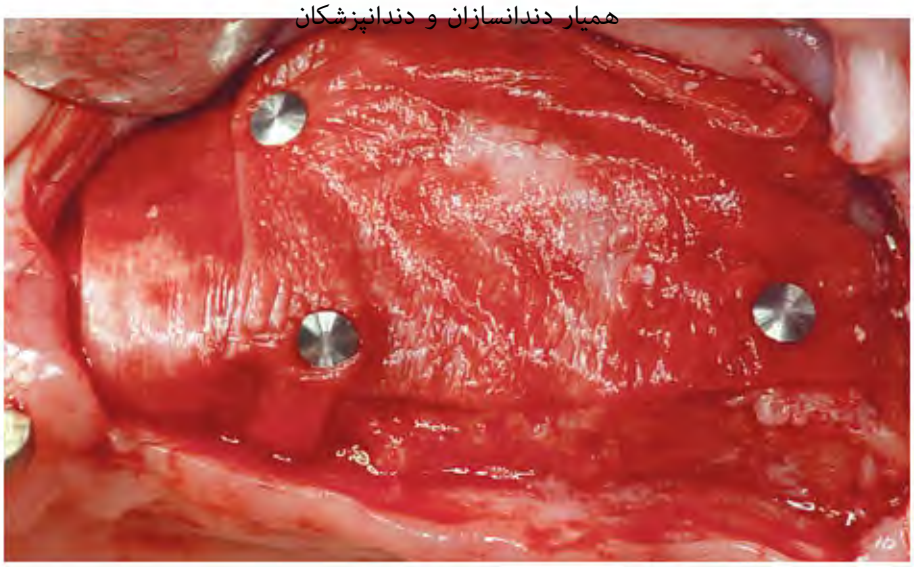


Fig 5-17d Augmentation material stabilized with a Bio-Gide membrane.



Fig 5-17e One year after the augmentation.

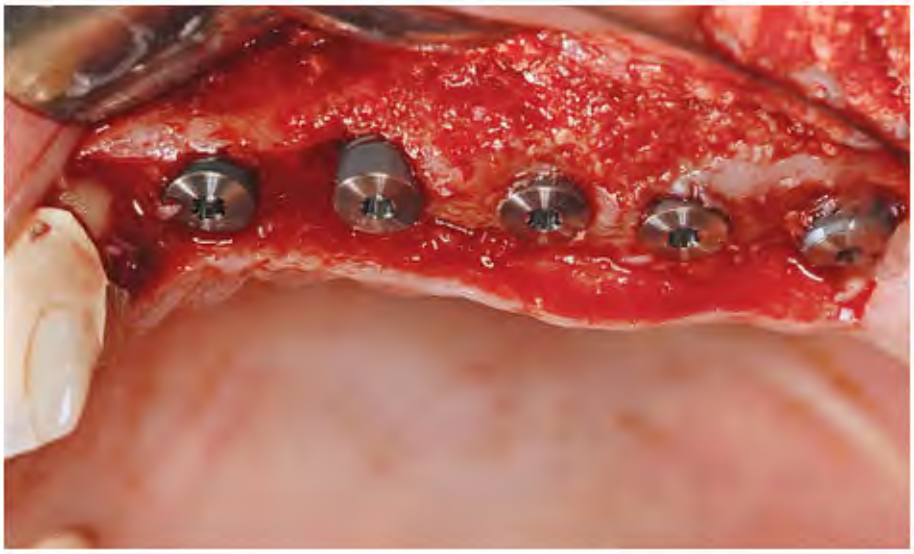


Fig 5-17f Five inserted implants.

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Sinus floor elevation

Dissection of the mucoperiosteal flap revealed several defects in the jaw, which were to be augmented concomitantly with the sinus floor elevation (Fig 5-17c). The lateral window was cut out and the maxillary sinus mucosa dissected away. The bone substitute Bio-Oss was used for the sinus elevation and lateral augmentation. The augmentation material was covered with a Bio-Gide membrane attached to the jaw with titanium pins (Fig 5-17d).

Implant placement and augmentation

Implant placement was performed a day short of 1 year later. If the implants were to be placed at the desired sites, the attachment on tooth 22 had to be cut off first (Fig 5-17e). This meant that the prosthesis also had to be reshaped after implant placement. The five implants were inserted at the original positions of teeth 23 to 27. Implants 23 and 24 were inserted to the same level for optimal esthetic results, necessitating vertical augmentation (Fig 5-17f). Since the maxilla in this region was too narrow, it also needed to be augmented horizontally (Fig 5-17g). The augmentation was carried out with the harvested bone chips and another Bio-Gide membrane (Fig 5-17h). The postoperative panoramic radiograph shows the extent of sinus elevation and the position of the implants in the maxilla (Fig 5-17i).

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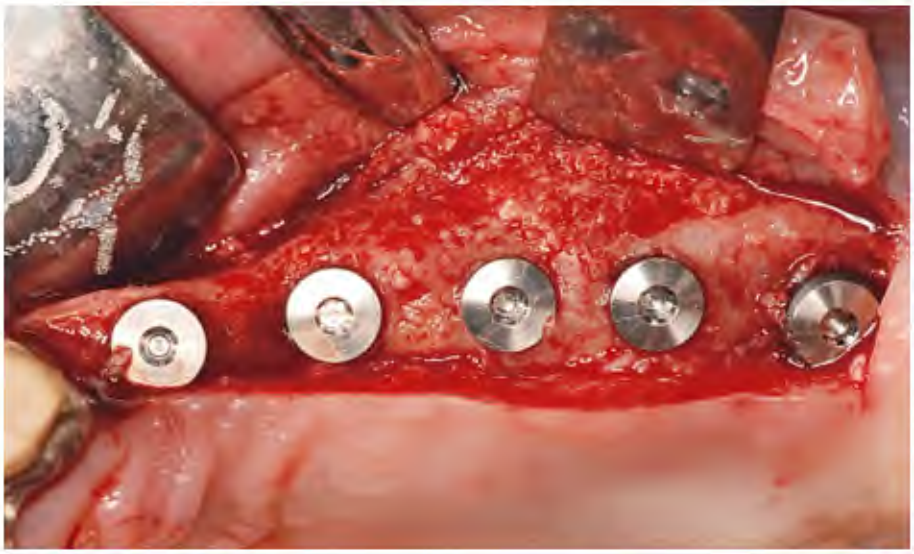


Fig 5-17g A narrow residual ridge necessitated another augmentation procedure.

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Fig 5-17h Augmentation material covered with a Bio-Gide membrane.



Fig 5-17i Positions of the implants following insertion.

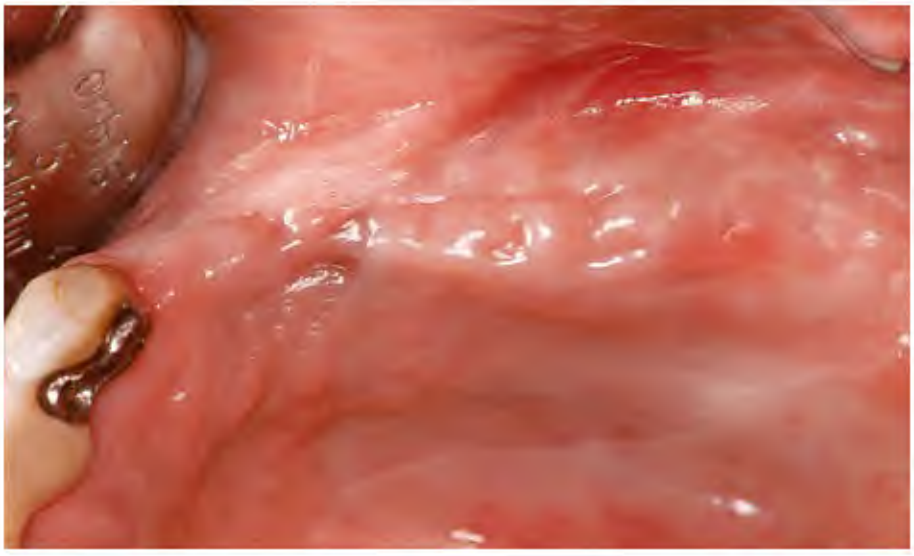


Fig 5-17j Thin mucosa over the implants.

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Fig 5-17k Mediocre augmentation result.

Exposure and mucosal distraction

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The implants were exposed after 7 months. The augmented area over implants 23 and 24 had receded, so that the implants shimmered through the mucosa; the possibility of a perforation could not be ruled out (Fig 5-17j). When the area was opened, it was found that neither the first nor the second augmentation had yielded the expected result (Fig 5-17k). The patient's smoking habit could have played an important role in this respect. An attempt was made to compensate for the osseous deficit by mucosal distraction. PEEK healing abutments were screwed onto all the implants. While this was being done, it emerged that the mesial margin of the flap was too short and did not reach up to tooth 22 (Fig 5-17l). An oblique releasing incision was made behind the last implant to make it possible to move the entire flap directed mesially (Fig 5-17m). Small perforations were prepared in the two anterior healing abutments (Fig 5-17n). The sutures that actively moved the flap in the coronal and mesial direction were threaded through these perforations. In addition to the sutures on the abutments, the flap was also attached to the palatal mucosa with additional sutures (Fig 5-17o). Of course, the mesial mobilization of the flap now resulted in a gingival deficit around the last implant (Fig 5-17p). However, this deficit presented less of a problem than would be the case around the more anterior implants. The whole flap was fixed into place as securely as possible, as it needed to heal in this position for at least 3 weeks (Fig 5-17q). The success of any augmentative treatment, including mucosal distraction, is also dependent on nicotine use; it is thus questionable in this patient. Once the region had healed completely, the superstructure in the form of metal-ceramic compound crowns was fabricated and incorporated (Fig 5-17r). The tissue deficits in regions 23 and 24 have remained unchanged despite a lot of effort and the use of various materials and techniques. However, the end result is totally acceptable to the patient herself.

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Fig 5-17l PEEK abutments screwed into place.

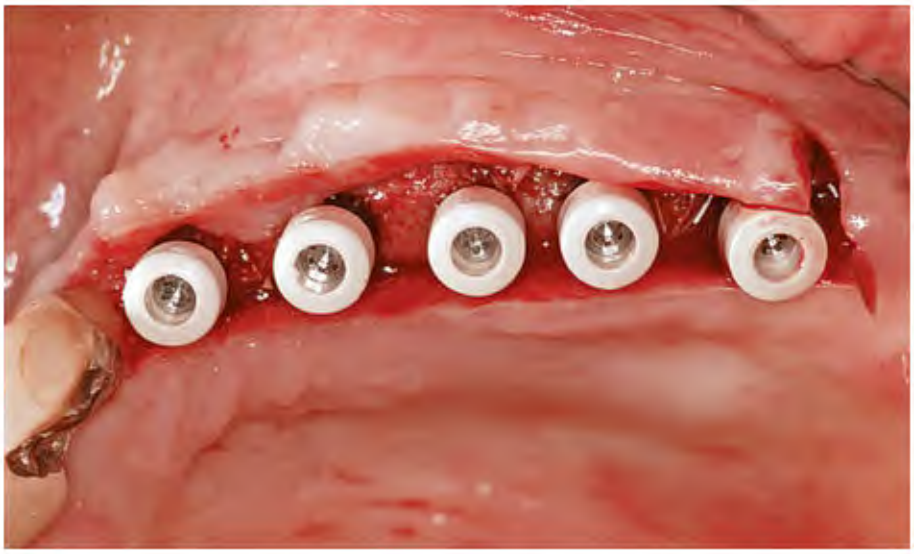


Fig 5-17m Shifting the attached gingiva toward the buccal vestibule and toward the middle by means of the distal releasing incision.

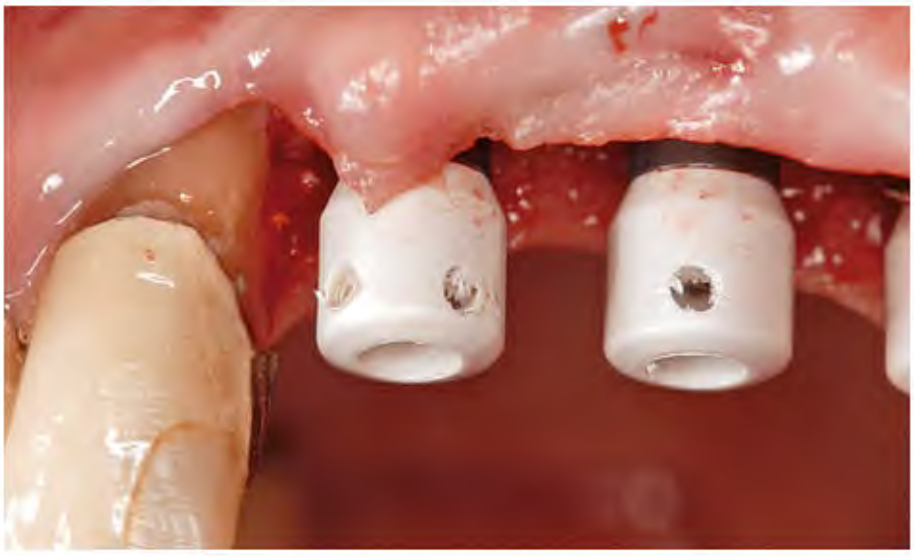


Fig 5-17n Small perforations in the PEEK abutments for the mucosal distraction.

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Fig 5-17o The flap has been stretched on the abutments in the mesial and coronal direction and secured into place.

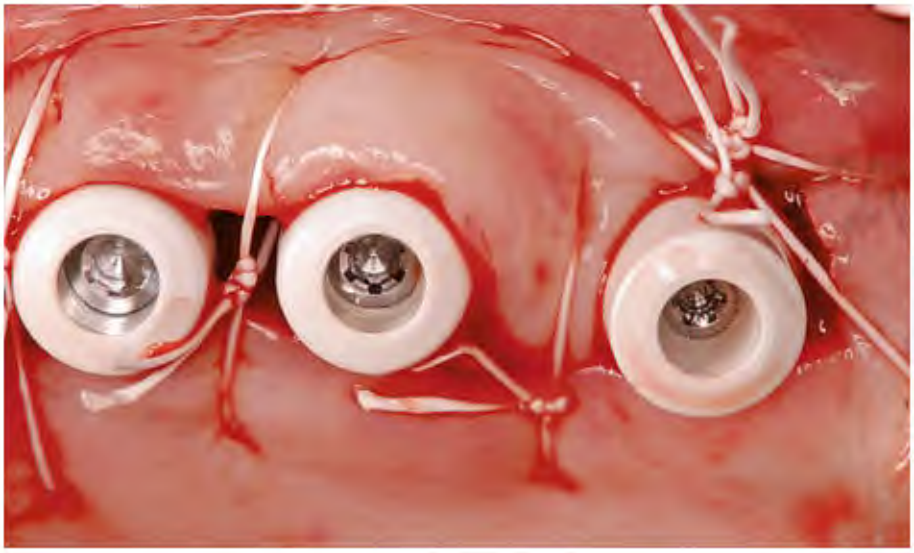


Fig 5-17p Gingival deficit resulting from the releasing incision beside the last implant.

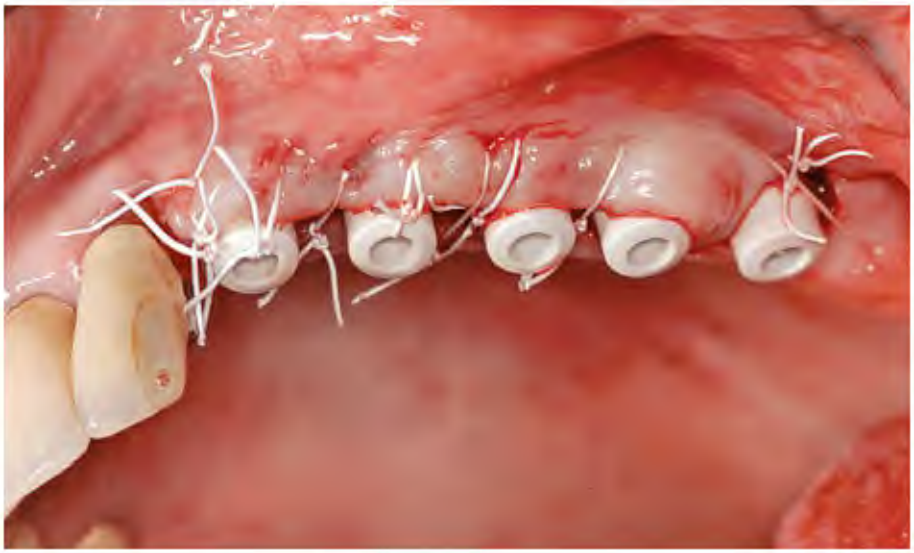


Fig 5-17q The whole flap has been fixed toward the middle.

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Fig 5-17r Persistent gingival deficit around implants 23 and 24.

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Treatment course

- Sinus floor elevation (2006)
- 1 year to implant placement and lateral augmentation
- 7 months to exposure
- 5 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Hubertus Klaus
Dental technology:	Horst Mosch

Note

Sinus elevation (sinus floor elevation, sinus lift)

Sinus floor elevation can be performed by transplanting a single bone block or numerous small bone particles into the maxillary sinus. The bone block needs to be securely fixed in the maxillary sinus (eg, with osteosynthesis screws). The aim is always to keep the maxillary sinus mucosa intact. When using bone particles, these can be mixed with a regenerative bone substitute. In contrast to using a bone block, the use of bone particles

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always requires them to be screened from the maxillary sinus, above all by keeping the Schneiderian membrane intact. The introduced bone particles are normally incorporated into the local bone within 1 to 2 years. The speed of incorporation and the quality of the augmentation depend on a number of factors, such as the material, the mixing ratio and nicotine use by the patient. Implant placement is normally performed approximately 6 to 9 months after sinus elevation (two-session approach).

If a sufficient local bone supply is already in place to anchor the implants securely, implant placement can take place concomitantly with sinus elevation (single-session approach). But, if the main concern is the reliability of the two methods, the two-session approach increases it in any case and reduces the risk of failure (a difference of approximately 10%, according to the literature).

The decision as to which method is to be given preference can only be made following a meticulous diagnostic procedure. Above all, it will be necessary to take into account the available bone height and the local bone quality. Ideally, the diagnostic investigations should include a computed tomography (CT) or cone beam CT (CBCT) scan, analyzed with one of the programs specially developed for the purpose, eg, SimPlant.

Procedure in the two-session approach



Fig 5-18a Dissection of the maxillary sinus mucosa.

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Fig 5-18b Filling the resultant cavity.



Fig 5-18c Insertion of the implants after 6 to 9 months.

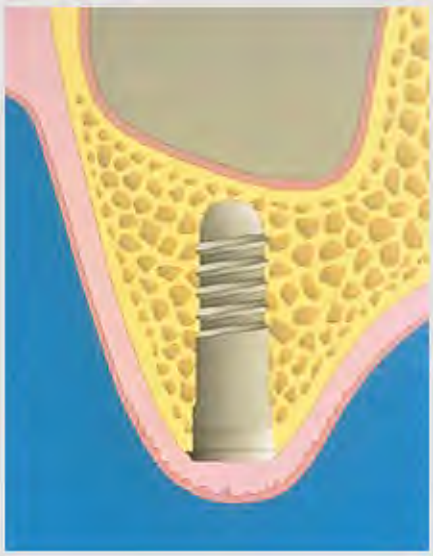


Fig 5-18d After another 6 to 9 months, the implants are ready to be loaded with a prosthesis.

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In the first step of the two-session approach, a bone window is cut in the lateral wall of the maxillary sinus and the mucosa is dissected away in the cranial direction (Fig 5-18a). The caudal part of the maxillary sinus is filled with bone or a bone substitute and tightly closed (Fig 5-18b). After approx 6 to 9 months, the implants are inserted into the regenerated bone (Fig 5-18c). The implants should be left to heal for another 6 to 9 months (Fig 5-18d) before the prosthetic loading can start.

Procedure in the single-session approach



Fig 5-18e Dissection of the maxillary sinus mucosa.



Fig 5-18f Single-session sinus elevation and implant placement.*

** Figs 5-18a to 5-18f used with the kind permission of Dr Ady Palti, Kreichtal, Germany.*

A residual bone height of at least 6 to 8 mm should be available for a single-session

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procedure. If sufficient primary implant stability cannot be achieved during the operation, the two-session approach must always be adopted. The preparation of the maxillary sinus is identical in both techniques (Fig 5-18e). In the single-session approach, however, the implants are stably anchored in the floor of the maxillary sinus once the available cavity has been partially filled. This is followed by the final filling of the maxillary sinus and tight closure by suturing (Fig 5-18f). The healing period is determined by the residual height of the local bone; its average length is 9 to 12 months.

Typical treatment course

Implant placement with sinus floor elevation using the two-session approach

Baseline situation

This male patient had a bilateral free-end situation in the maxilla. On the right side, the height of the residual ridge distally of terminal tooth 13 was so minimal (approximately 1 to 2 mm), that it offered no prospect of primary implant stability. The situation on the left side was slightly more favorable. However, this side also failed to offer the prerequisites for primary stability of the anchored implants, so that restoration of the bone bed by sinus floor elevation would be necessary first (Fig 5-19a).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- Dental cast analysis

Treatment plan

1. Sinus floor elevation
2. Implant placement
3. Exposure
4. Definitive prosthetic loading

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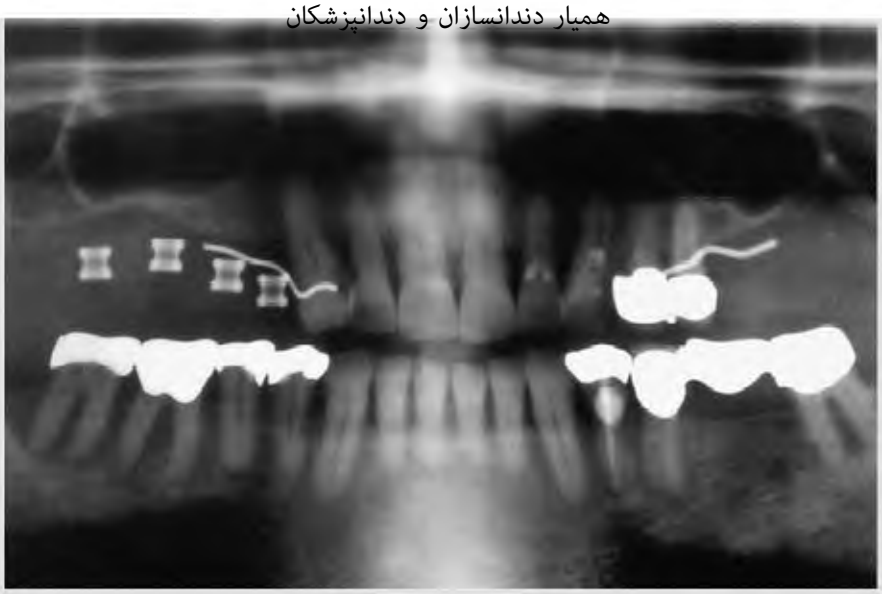


Fig 5-19a Measurement panoramic radiograph.

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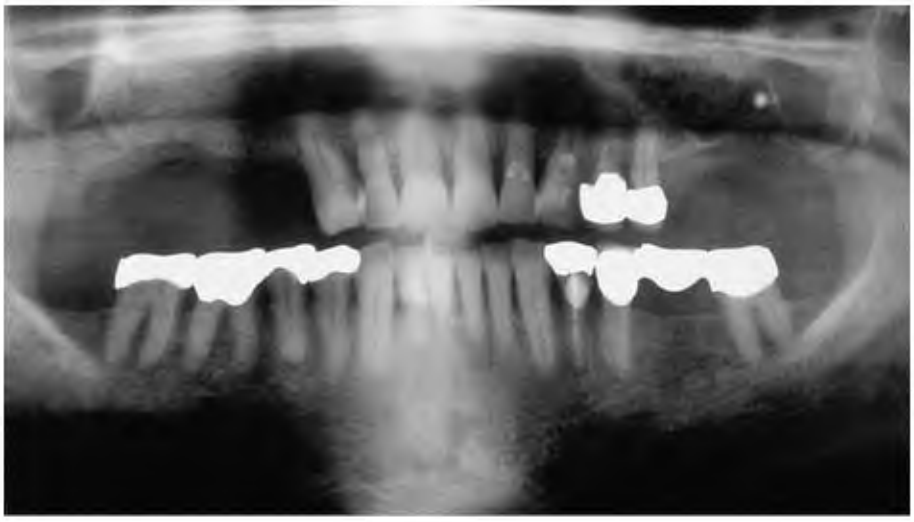


Fig 5-19b Postoperative panoramic radiograph following bilateral sinus elevation.

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Fig 5-19c Preparation of the implant beds.

Sinus floor elevation

The sinus floor elevation on both sides was performed using the same method (two-session approach) and the same materials (Bio-Oss and Bio-Gide). The postoperative panoramic radiograph shows bone augmentation in both maxillary sinuses (Fig 5-19b).

Implant placement

After a healing phase of 9 months, four 18-mm long Brånemark System MK II implants were placed on the right side parallel to the canine (Fig 5-19c). The residual ridge width was adequate for implant anchorage (Fig 5-19d). Only two MK-II fixtures, 15 mm (region 26) and 13 mm (region 27) long, were inserted on the left side. After a healing period of 8 months, all the implants were exposed and fitted with EsthetiCone abutments (Nobel Biocare) (Fig 5-19e). The provisional restoration in the form of plastic compound crowns with a reduced occlusal relief was incorporated and worn for 1 year in accordance with the rules of “Progressive Bone Loading” (Fig 5-19f).

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Fig 5-19d Inserted implants.



Fig 5-19e EsthetiCone abutments following exposure.



Fig 5-19f Provisional restoration.

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Fig 5-19g Definitive ceramic fixed implant bridge.



Fig 5-19h Access holes closed off with composite resin.

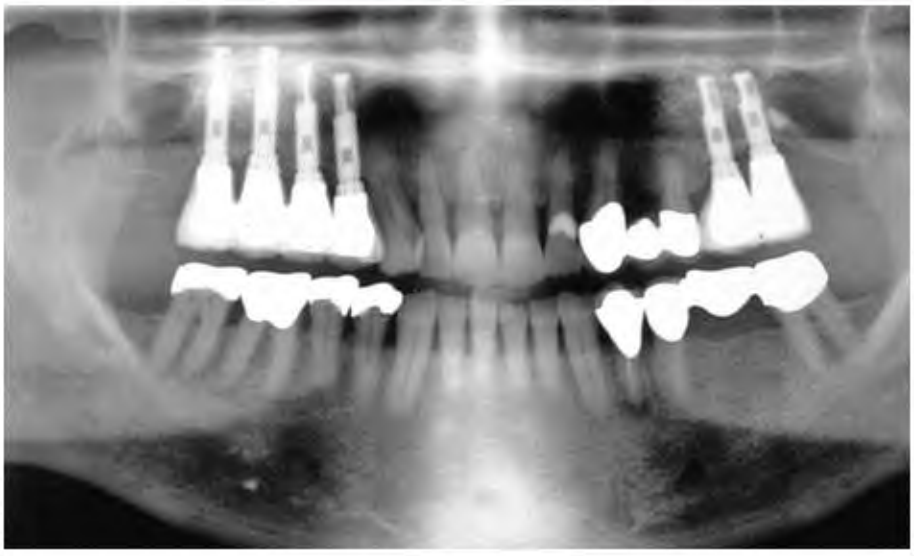


Fig 5-19i Follow-up panoramic radiograph after 6 years.

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Fig 5-19j Clinical situation after 6 years – peri-implantitis.

Attention: ***The "Progressive Bone Loading" theory was proposed by Misch in the early 1990s and gained wide acceptance in implantology circles. According to this, functional loading of the implants should be slow and gradual. This applies particularly to implants placed in poor-quality bone (including augmented bone following sinus floor elevation). The first provisional restoration made of plastic should be fitted in slight infraocclusion. It must not have any prominent cusps and should be slender in design. There should be absolutely no functional load on it in laterotrusion. The infraocclusion needs to be gradually reduced, the cusps built up and the occlusal relief extended, until full articulation function is eventually achieved. After 1 year in functional use, the provisional restoration can be exchanged for a metal-ceramic one.***

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Prosthetic loading

After 1 year, the implants were loaded with ceramic-faced crowns (Fig 5-19g). The screw access holes were sealed off with composite resin fillings (Fig 5-19h). Figure 5-19i shows a follow-up radiograph 6 years after the sinus elevation and Figure 5-19j the restoration at the same time, with signs of peri-implantitis.

Continued follow-up

This patient's example provides the opportunity to make an interesting comparison of the different treatment outcomes up to 16 years after treatment of the posterior maxilla. Figures 5-19a and 5-19b show the baseline situation at the start of the treatment: the dentition is intact from tooth 13 to 23, while teeth 24 and 25 have been crowned. Bilateral sinus elevation had been performed at the time (Fig 5-19b).

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Fig 5-19k Stable clinical situation on the right side after 16 years.

On the right side, four implants were inserted and loaded with compound crowns as the restoration. The clinical course on the right side is shown at 1 year (Fig 5-19g), 6 years (Fig 5-19j) and 16 years (Fig 5-19k) after the treatment.

On the left side, after 6 years, tooth 24 had been lost and the canine prepared to form an abutment for a fixed dental bridge 23 to 25. After another 6 years, none of the premolars were left and the canine had been transformed from a healthy tooth to a root with a post and core (Fig 5-19l). The two implants were in good condition after 12 years despite the lack of keratinized gingiva. Two TiUnite implants from the Brånemark System were inserted into regions 24 and 25 (Fig 5-19m). After a small augmentation around all four implants, the flap was repositioned and sutured into place (Fig 5-19n). A plastic provisional restoration was fabricated for the 6-month healing phase (Fig 5-19o). The implants were exposed after 6 months (Fig 5-19p). The final photo (Fig 5-19q) shows the clinical situation 16 years after the first implant placement and 4 years after the second implant placement. Despite the poor oral hygiene the clinical situation on the left side, while not as good as that on the right, is still stable.

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Fig 5-19l Teeth 24 and 25 are no longer present. The previously healthy tooth 23 was built up with the root pin.

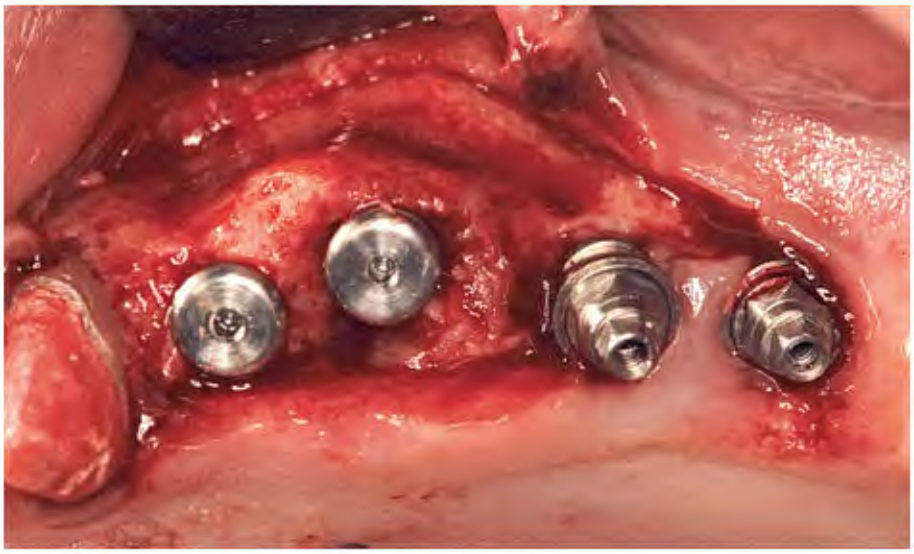


Fig 5-19m Insertion of implants 24 and 25.

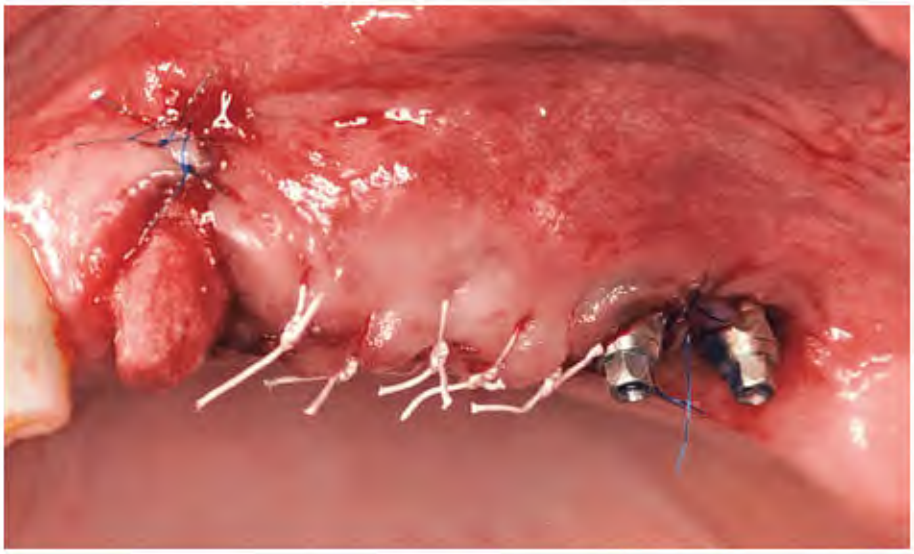


Fig 5-19n Suturing following implant placement and augmentation.

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Fig 5-19o Adjusted provisional restoration.



Fig 5-19p Exposure of implants 24 and 25.



Fig 5-19q The left side 16 years after the first implant placement and 4 years after the second implant placement.

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Treatment course

- Sinus floor elevation on both sides (1995)
- 9 months to implant placement
- 8 months to exposure
- 12 months with a long-term provisional restoration until the definitive prosthesis was fitted
- 12 years to implant placement 24 and 25
- 6 months to exposure and definitive restoration on the left side

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Uwe Hildebrandt
Dental technology:	Horst Mosch

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Atypical treatment course – problematic baseline situation

If a single-session approach appears a reasonable option due to the bone volume in the panoramic radiograph, it must be borne in mind that the panoramic radiograph can only deliver two-dimensional images (the vertical dimension, or bone height). The third dimension, ie, the width of the residual ridge, remains uncertain. For this reason, CT or CBCT imaging is necessary to obtain complete information about all three dimensions of the maxilla.

Implant placement with sinus floor elevation accompanied by concomitant apicoectomy and lateral bone augmentation

Baseline situation

In this female patient, an adequate bone supply for a single-session procedure (sinus floor elevation and concomitant implant placement) may be assumed to be present on the right side based on the panoramic radiograph (Fig 5-20a). However, the CT scan shows that the residual ridge was too narrow to guarantee primary implant stability. In the horizontal (axial) section of the maxilla, the width of the right residual ridge can be compared with that of the left (region 26; Fig 5-20b). The problematic situation becomes even more apparent in the cross section of the residual ridge in region 14 (Fig 5-20c). The two white

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upright bars at the bottom of Figure 5-20c represent the walls of the first titanium sleeve (internal diameter 2 mm) behind the terminal tooth in Figure 5-20a. On the screen, the implant (13-mm long and 3.75-mm in diameter) placed virtually into position 14 with the SimPlant program already appeared wider than the available residual ridge (Fig 5-20d). The program adjusts the implant axis to the course of the bone and not to the planned prosthetic restoration.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Sinus floor elevation with apicoectomy and lateral augmentation
2. Implant placement
3. Exposure and horizontal spreading of the gingiva
4. Definitive prosthetic loading

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Fig 5-20a The height of the residual ridge appears adequate for a single-session procedure.



Fig 5-20b Difference in residual ridge width on the left and right side.

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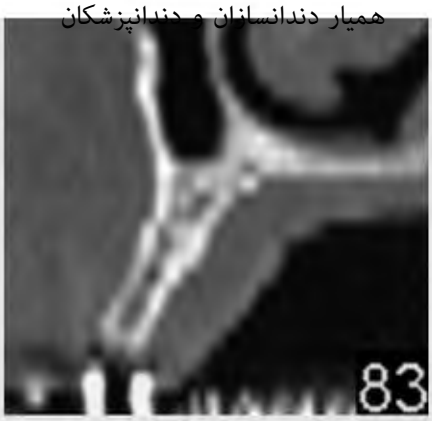


Fig 5-20c Cross section of region 14.



Fig 5-20d The diameter of the implants is greater than the width of the residual ridge.

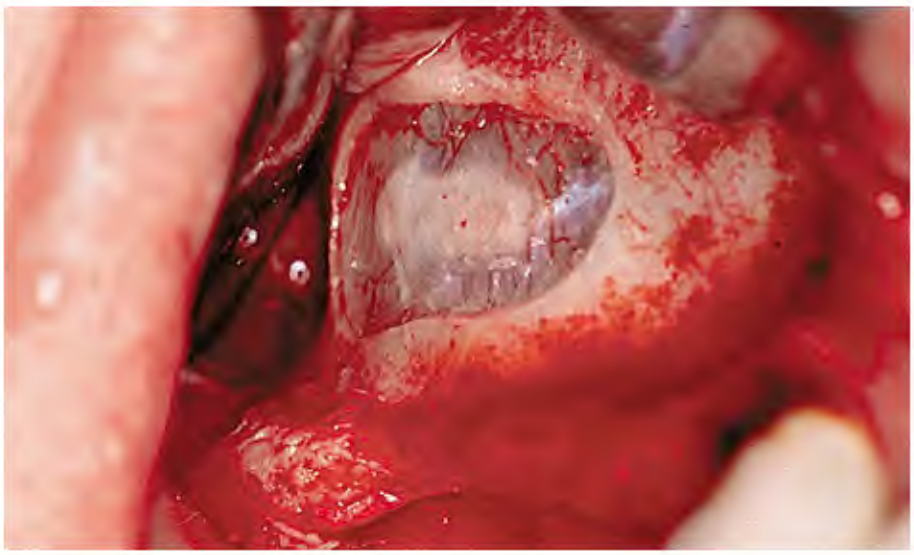


Fig 5-20e Fenestration of the maxillary sinus wall.

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Fig 5-20f Dissection of the maxillary sinus mucosa; note the narrow residual ridge.

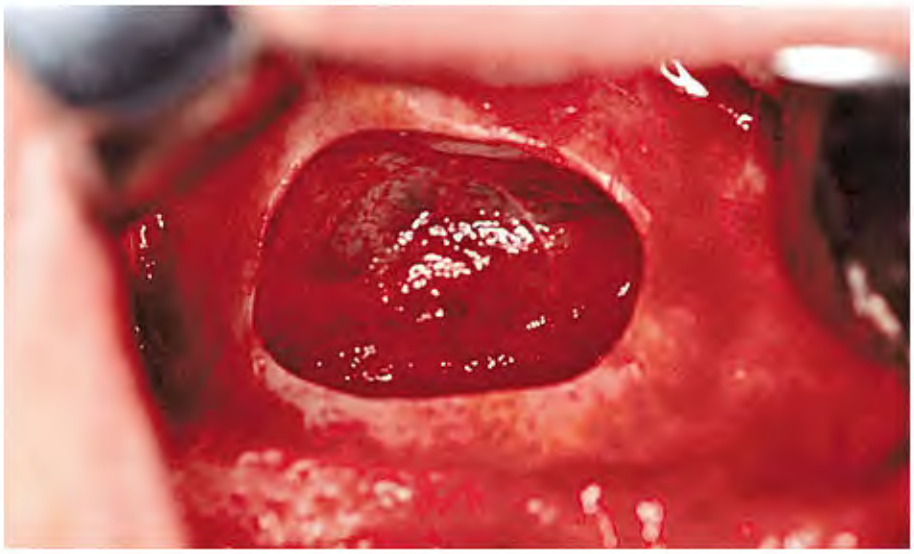


Fig 5-20g Maxillary sinus mucosa on inspiration.



Fig 5-20h Apicoectomy in region 13.

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Fig 5-20i Filling the cavities with Bio-Oss.

Sinus floor elevation and apicoectomy

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Following fenestration of the maxillary sinus wall (Fig 5-20e), one could clearly see the movements of the maxillary sinus mucosa with its bone lid on inspiration and expiration (Figs 5-20f and 5-20g). During the dissection, care must be taken not to perforate the very thin mucosa of the maxillary sinus (Fig 5-20g). The apicitis affecting tooth 13, which was visible on the radiograph (in the form of a radiolucency; see Fig 5-20a) was treated by apicoectomy at the time of the sinus floor elevation (Fig 5-20h).

The endodontic treatment of the tooth was performed under visual control (Fig 5-20h). The cavity in the maxillary sinus and the defect resulting from the apicoectomy were filled with Bio-Oss (Fig 5-20i).



Fig 5-20j Lateral augmentation.

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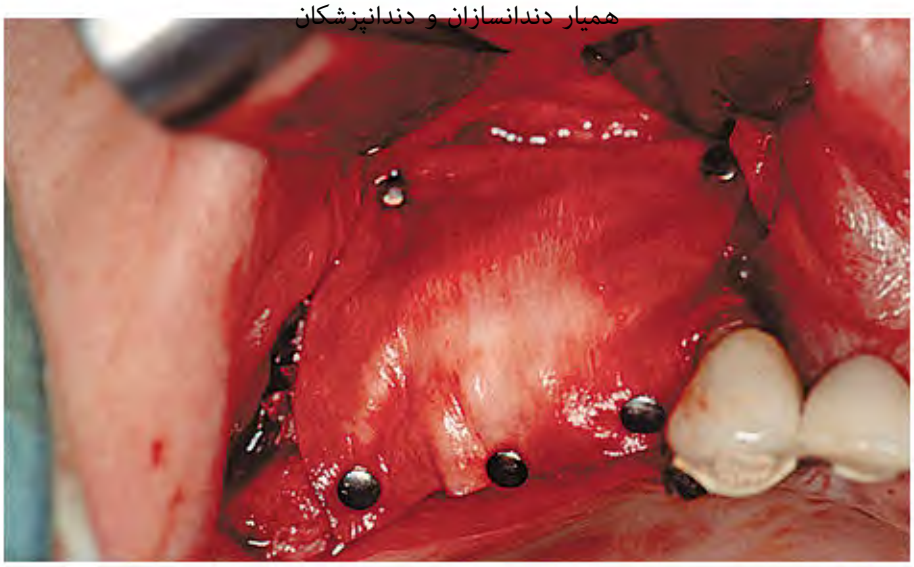


Fig 5-20k Attached resorbable membrane.

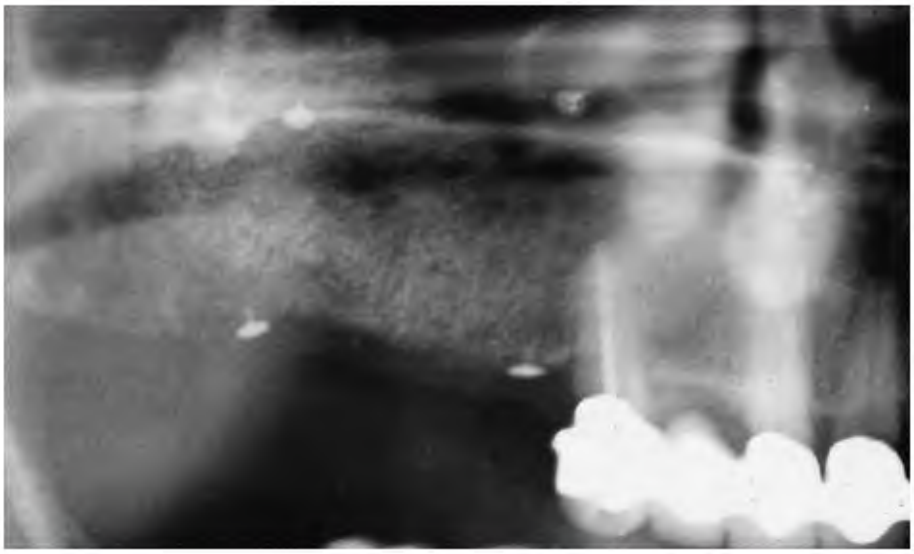


Fig 5-20l Postoperative radiograph.



Fig 5-20m Clinical situation before implant placement.

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Fig 5-20n Preparation of the implant beds.

Lateral bone augmentation

A lateral augmentation with Bio-Oss was also performed to widen the residual ridge (Fig 5-20j). The lateral bone augmentation was covered with a Bio-Gide membrane. To avoid displacement of the augmentation material, the membrane was securely attached with small titanium pins (Fig 5-20k). The postoperative radiograph shows the extent of the vertical augmentation and the result of the endodontic treatment of tooth 13 (Fig 5-20l).

Implant placement

The 10-month healing phase was uncomplicated (Fig 5-20m). Inspection at the time of implant placement showed good regeneration of the lateral augmentation, although the Bio-Oss particles were still clearly identifiable (Fig 5-20n). The three implant beds could now be prepared in regenerated tissue that was equivalent to natural bone (Fig 5-20o).

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Fig 5-20o Width of the residual ridge after augmentation.

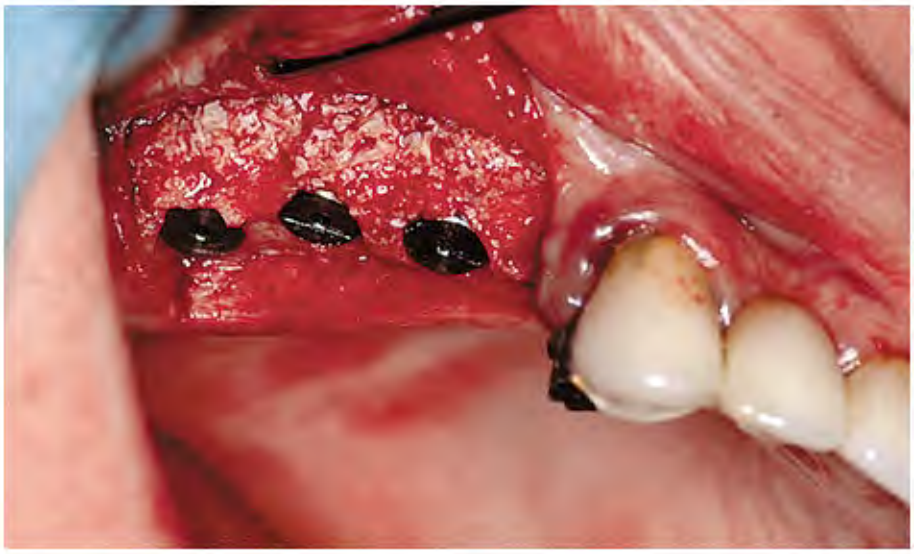


Fig 5-20p Fully inserted implants.

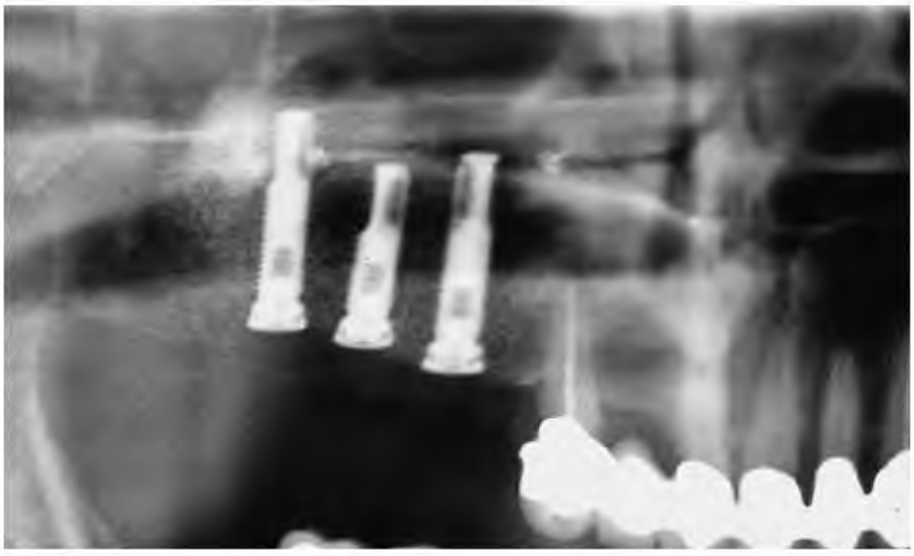


Fig 5-20q Postoperative radiograph.

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Fig 5-20r Residual ridge prior to exposure.

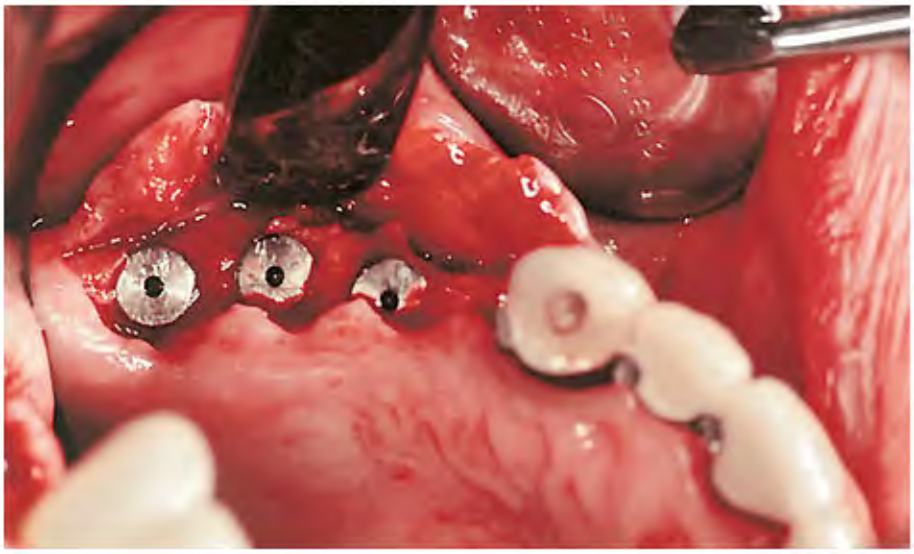


Fig 5-20s Incision made using the cosine curve technique.

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The three MK-II fixtures were fully inserted in the regenerated residual ridge (Fig 5-20p). The positions and lengths of the implants, as well as the adequate height of the augmentation, can be seen on the radiograph (Fig 5-20q).

Exposure with the cosine curve technique

Another 8 months were scheduled for implant healing (Fig 5-20r). The advanced reorganization of the lateral augmentation could be seen following exposure. The latter was performed with an incision using the cosine curve technique, which allows the zone of attached gingiva to be widened (Fig 5-20s). The flap that was slightly mobilized by this method was readily adapted around the healing abutments, allowing tight suturing of the soft tissue (Fig 5-20t) (see page 330). This exposure technique ensures that there is no loss of soft tissue.

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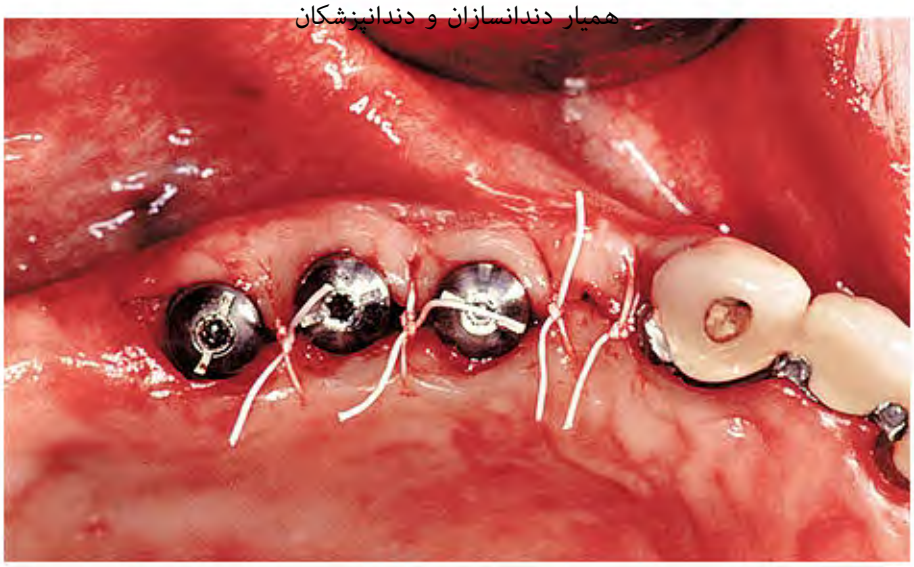


Fig 5-20t Adapting the soft tissue around the abutments.



Fig 5-20u Fillings show the axes of the implants.



Fig 5-20v Clinical situation after 2 years.

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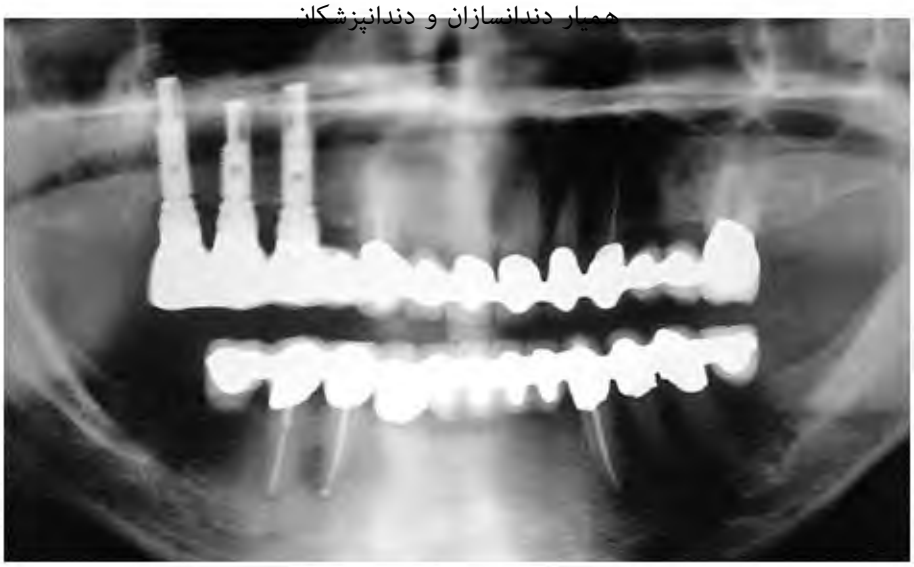


Fig 5-20w Osseous situation after 2 years.

Prosthetic restoration

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The implants were loaded with prostheses in the form of screw-retained compound crowns 17, 16 and 15 and a number 14 cantilever on EsthetiCone abutments. Designing the implant superstructure as a separate entity meant that fixed dental bridge 13 to 27 could be retained almost unchanged. The only adjustment was to reduce the distal attachment in region 13. The access holes to retaining screws 17, 16 and 15 were sealed off with fillings (Fig 5-20u). Filling 13 is a reminder of the previously performed root canal treatment. The final photograph (Fig 5-20v) shows the clinical situation 2 years following incorporation of the superstructure. Figure 5-20w shows the panoramic radiograph taken at the same time.

Treatment course

- Implant placement with lateral augmentation (1998)
- 10 months to implant placement
- 8 months to implant placement
- 5 weeks to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Eberhard Helbig

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Extensive augmentation in several directions

Baseline situation

A 68-year-old man with a prosthetic restoration of the first two quadrants presented due to loosening of his dental bridge 23 to 27. The large zones of bone loss around the abutment teeth and the severely pneumatized maxillary sinus on the left side can be seen on the panoramic radiograph (Fig 5-21a). Because of the patient's symptoms, the bridge was removed directly, together with abutment teeth 24 and 27. Tooth 23, though it had been destroyed, was still stable and could be reconstructed with a composite resin build-up.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Dental treatment including extractions in the second quadrant
2. Sinus floor elevation on the left side with vertical and horizontal augmentation
3. Implant placement
4. Exposure and horizontal mucosal distraction
5. Definitive prosthetic loading

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Fig 5-21a Zones of bone loss around abutment teeth 24 and 27.

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Sinus elevation and augmentation

Two months after the extraction, the bone defects were still clearly apparent on clinical inspection (Fig 5-21b). The plan was to perform sinus elevation with vertical and horizontal ridge augmentation under general anesthesia. The incision was made on the residual ridge on the palatal side of the expected defects. Mobilization of the mucoperiosteal flap clearly revealed the extent of the bone defects (Fig 5-21c). A window for sinus elevation was cut between the defects and the resultant cavity filled with the regenerative bone substitute Bio-Oss. The regeneration of the bone defects and the vertical and horizontal augmentation were performed with a mixture of autologous bone and Bio-Oss. Stabilization of the augmentation material was ensured with a non-resorbable membrane (Gore-Tex), attached to the residual ridge with titanium pins. The mucoperiosteal flap was sufficiently mobilized to ensure tension-free suturing. The sutures were removed after 2 weeks. A check panoramic radiograph was taken after the procedure (Fig 5-21d).

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Fig 5-21b Irregular residual ridge contours.

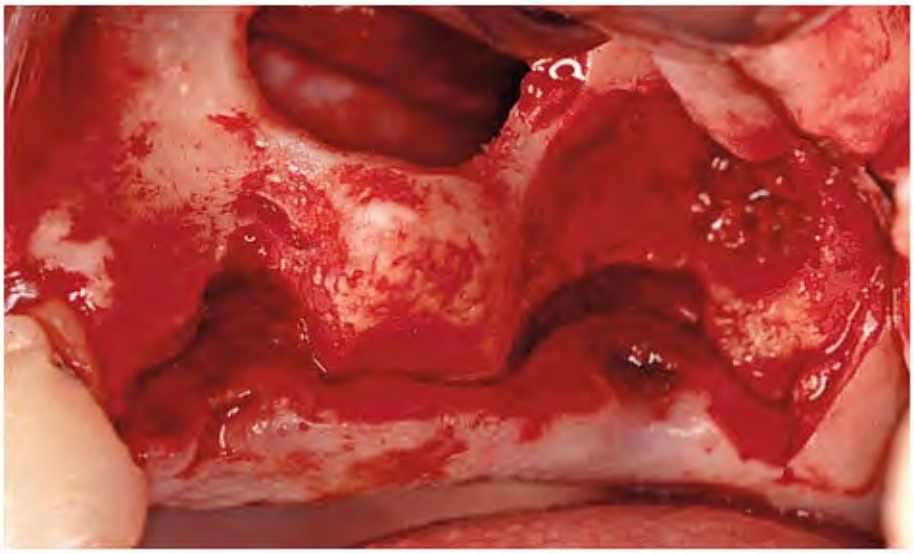


Fig 5-21c Large residual ridge defects in regions 24 and 27.



Fig 5-21d Postoperative panoramic radiograph.

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Fig 5-21e Visible demarcation of the augmented areas.

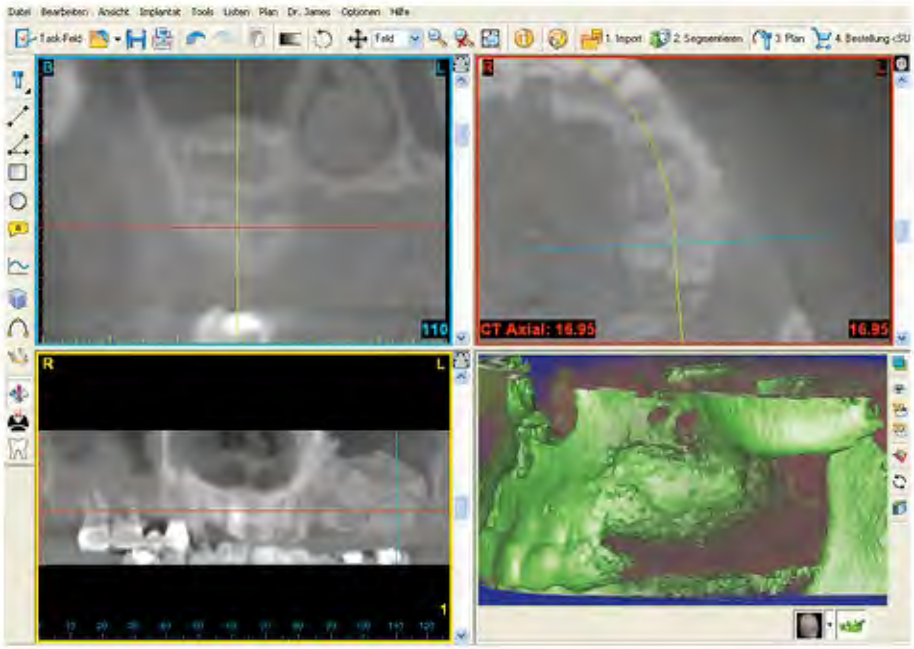


Fig 5-21f 3D CBCT scan images.

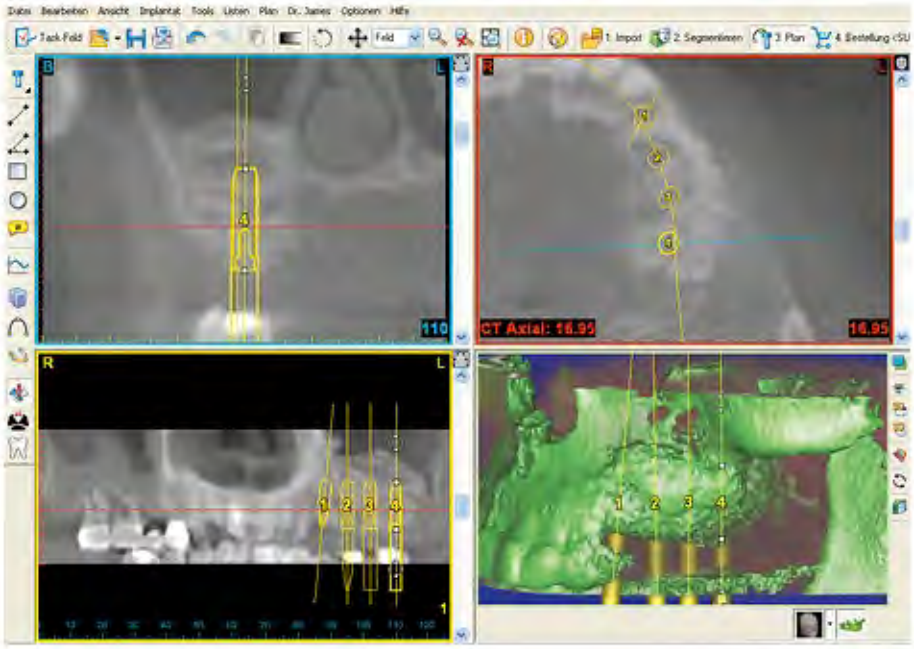


Fig 5-21g SimPlant planning.

Implant placement

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Nine months later, a CBCT scan was performed before implant placement. The demarcation of the augmented areas is clearly apparent on the panoramic section (Fig 5-21e). The more contrasted dark areas indicate a concentration of the Bio-Oss material, while the lighter ones indicate autologous bone. A lighter zone is apparent in the apical region of the sinus floor elevation. This could be an accumulation of bone chips. The data from the CBCT imaging were processed in the SimPlant program for planning purposes (Fig 5-21f). Four implants were virtually planned on screen in all three dimensions (Fig 5-21g).



Fig 5-21h Residual ridge before implant placement.

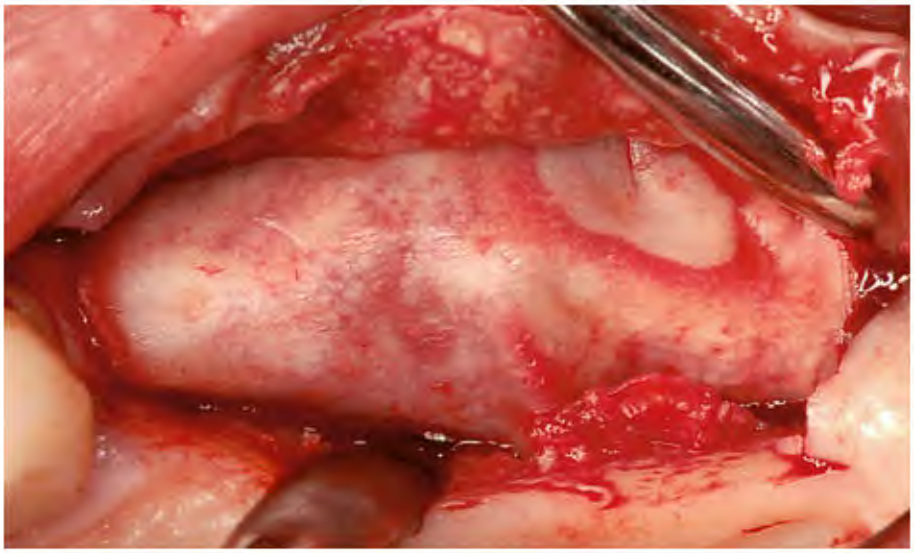


Fig 5-21i Gore-Tex membrane before removal.

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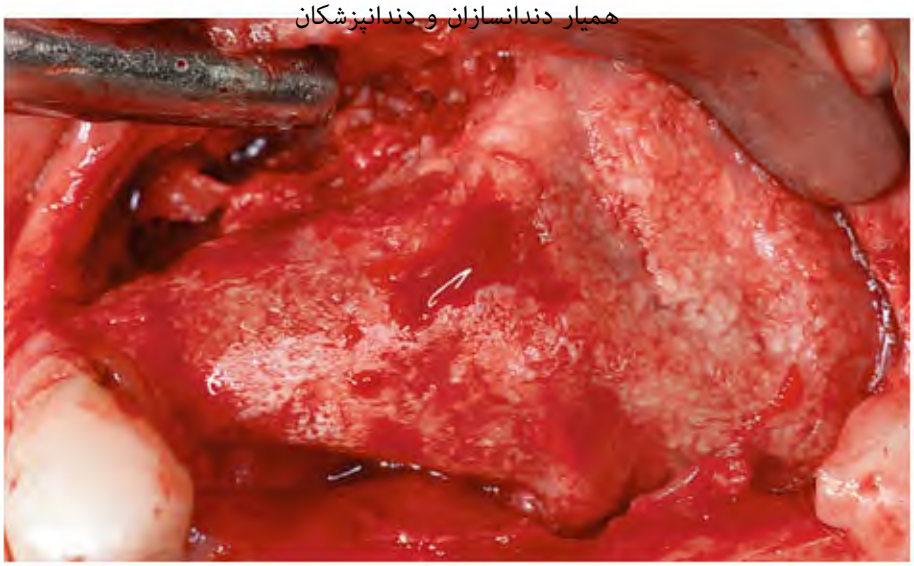


Fig 5-21j The non-resorbable membrane needed to be removed without leaving any residues.



Fig 5-21k Four implants were inserted into the residual ridge.



Fig 5-21l Panoramic radiograph taken after implant placement.

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Nine months after the augmentation, the contours of the residual ridge were regular, but the zone of attached gingiva was relatively narrow (Fig 5-21h). Implant placement was performed under local anesthesia (conduction anesthesia at the infraorbital foramen and greater palatine foramen, plus several doses of infiltration anesthesia at the tuberosity). The incision was made along the residual ridge, on the palatal side of the planned implants. After the releasing incision in region 28, the flap was mobilized to reveal the Gore-Tex membrane, which had to be removed in full (Fig 5-21i). First, the palatal pins were removed and the membrane dissected off in the buccal and cranial direction. Next, the pins around the sinus lift window were removed, after which the membrane could be removed in one piece. Removal of the membrane revealed a well-perfused augmentation, in which the Bio-Oss particles were still identifiable (Fig 5-21j). Four 17-mm long and 4 mm in diameter Neoss implants were inserted (Fig 5-21k).

The bone chips harvested during preparation were packed around the implants, followed by saliva-proof closure of the access to the operation site. The stable position of the implants can be seen on the postoperative panoramic radiograph (Fig 5-21l).

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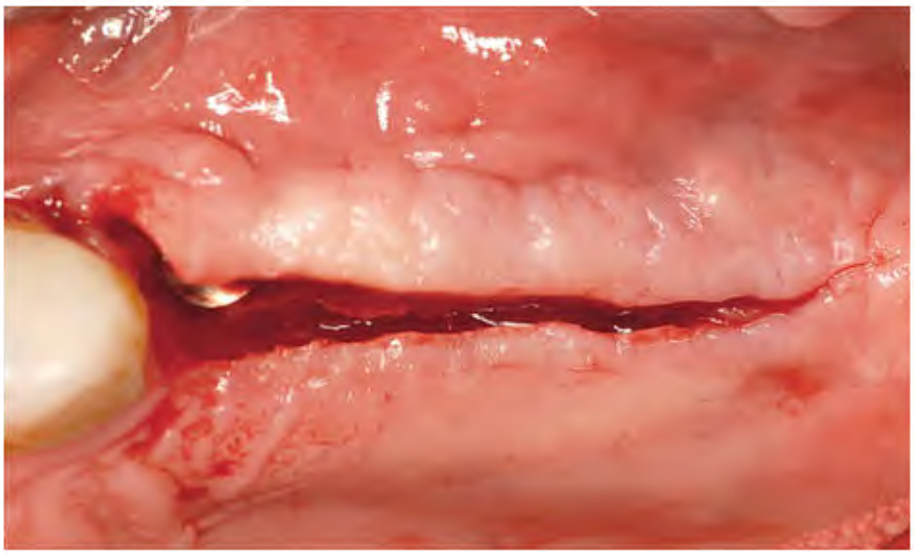


Fig 5-21m Palatal incision to expose the implants.

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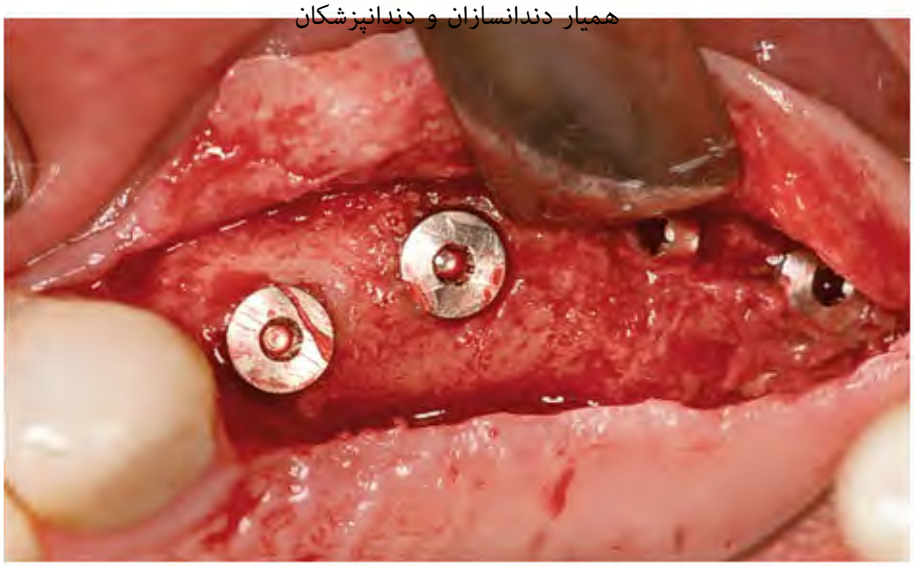


Fig 5-21n Flap mobilization.

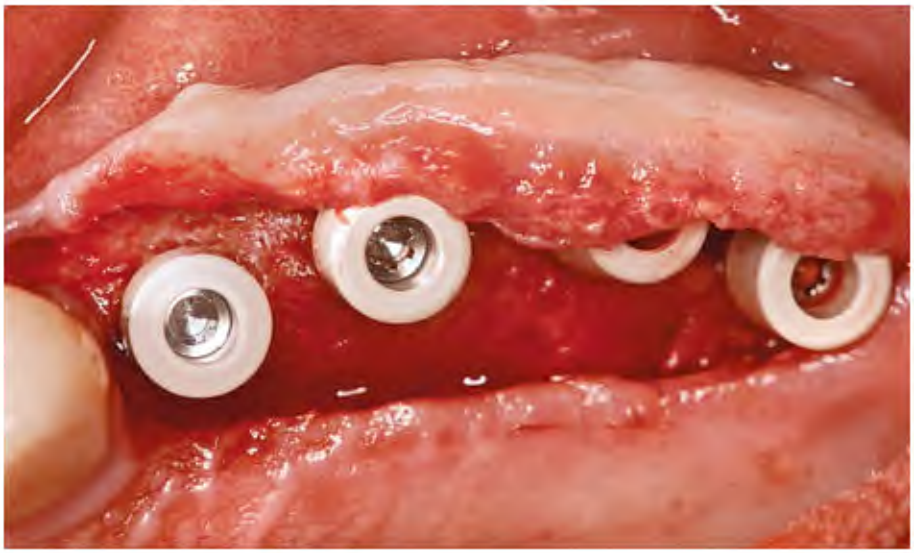


Fig 5-21o The palatal connective tissue is being transplanted in the buccal direction.

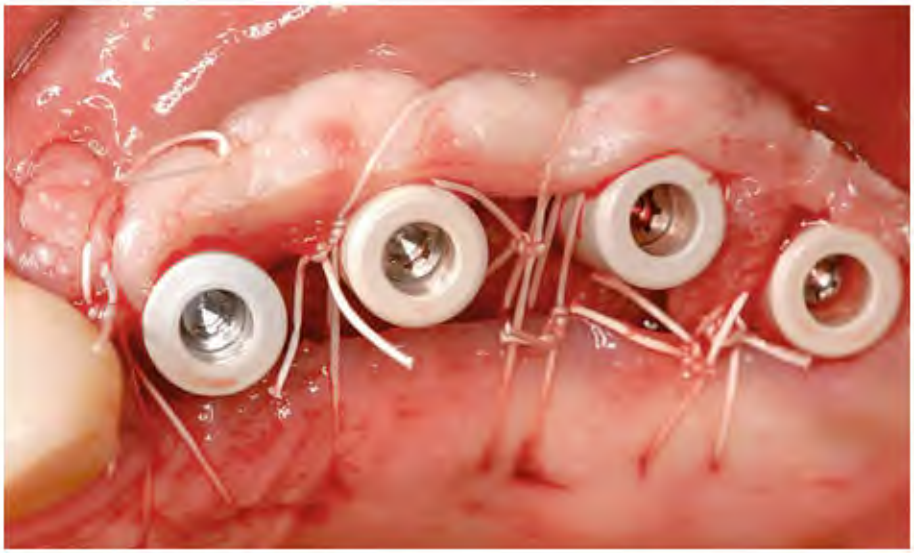


Fig 5-21p The entire flap has been mobilized toward the middle and secured into place with sutures.

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Exposure and horizontal mucosal distraction

Eight months after implant placement, the implants were exposed, at which time the zone of attached gingiva was also reconstructed. The incision was made along the residual ridge on the palatal side of the implants (Fig 5-21m). During the incision, the scalpel blade was tilted slightly palatally to allow the palatal connective tissue to be transplanted in the buccal direction. Mobilization of the flap clearly revealed the distance between the implants and the palatal edge of the incision (Fig 5-21n). The cover screws were removed and replaced with PEEK healing abutments, which also acted as a vertical barrier. The connective tissue volume around implants 25, 26 and 27 was more than adequate; in contrast, a deficit remained apparent around implant 24 (Fig 5-21o). Horizontal mucosal distraction was needed to compensate for this deficit: the entire flap had to be pulled mesially. This was realized by slitting the periosteum distally of last implant 28, actively pulling the flap in the mesial direction with diagonal Gore-Tex sutures and stabilizing it in this position (Fig 5-21p). The sutures remained in situ for 10 days.

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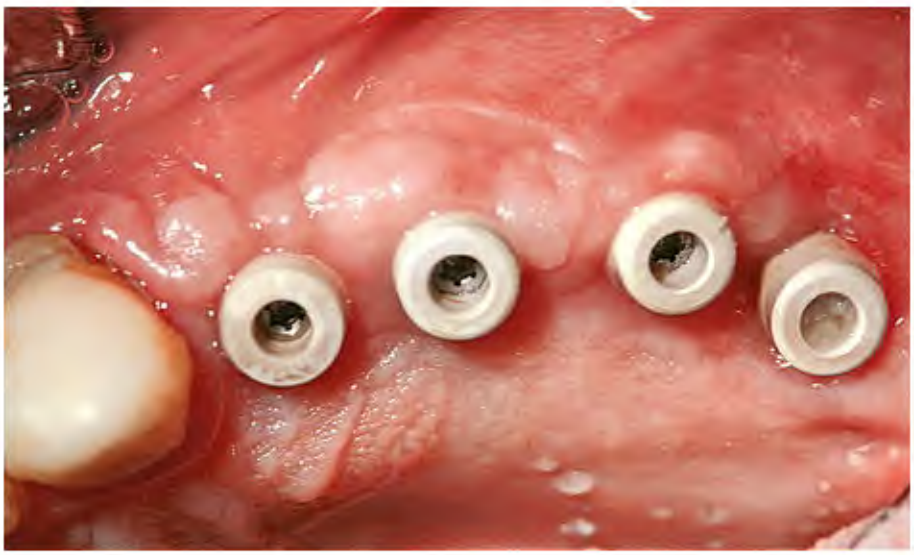


Fig 5-21q Stable gingival situation after 4 weeks.

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Fig 5-21r Clinical baseline situation.



Fig 5-21s Definitive implant bridge screwed into place. There has been a marked gain in both hard and soft tissue compared to baseline (Fig 5-21r).

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Fig 5-21t Check panoramic radiograph following incorporation of the superstructure.

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Prosthetic restoration

After approximately 4 weeks, the soft tissue situation was sufficiently stable to allow an impression for the prosthesis to be taken (Fig 5-21q). The plan for the definitive restoration included an individual crown on tooth 23 and compound crowns on the implants. The incorporated, occlusal, screw-retained implant bridge would not be esthetically acceptable to all patients, but it can be removed at any time without any problems (Fig 5-21s). Direct comparison between the baseline situation (Fig 5-21r) and the situation following treatment completion (Fig 5-21t) might even raise doubts as to whether only one patient is being depicted. However, both photographs do indeed show the same man. Following treatment completion, a half-panoramic radiograph was taken of the left side, confirming that the structure had a solid foundation (Fig 5-21t).

Treatment course

- Dental treatment (2005)
- 2 months to sinus floor elevation and augmentation
- 9 months to implant placement
- 8 months to exposure
- 4 weeks to impression taking and prosthetic loading

Treatment

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Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Michael Weber
Dental technology: Horst Mosch

Problems and complications

Sinus floor elevation involving avoidance of a blood vessel and perforation of the maxillary sinus mucosa

Baseline situation

This female patient presented to our center with a residual dentition in the anterior maxilla (Fig 5-22a). Due to denture phobia, she expressly asked for a fixed restoration. To realize this, an implant-supported restoration of the posterior dentition with sinus floor elevation was planned, based on the panoramic radiograph and CT scan images (Fig 5-22b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation
2. Implant placement
3. Exposure
4. Definitive prosthetic restoration

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Fig 5-22a Baseline situation.



Fig 5-22b Panoramic radiograph.

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Sinus floor elevation avoiding a blood vessel

Fenestration of the right maxillary sinus unexpectedly revealed a blood vessel in the bone wall (Fig 5-22c). There was a high risk of damaging the vessel and thus causing heavy bleeding. Mucosal dissection under visual control would no longer have been possible in this case. For this reason, the window was moved in the caudal direction and cut to a narrower shape, like a mailbox slot (Fig 5-22d). The prepared cavity (Fig 5-22e) was filled with Cerasorb (Curasan) (Fig 5-22f).

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Fig 5-22c Blood vessel in the maxillary sinus wall.



Fig 5-22d Fenestration below the vessel.



Fig 5-22e Mailbox slot window.

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Fig 5-22f Filling the cavity.

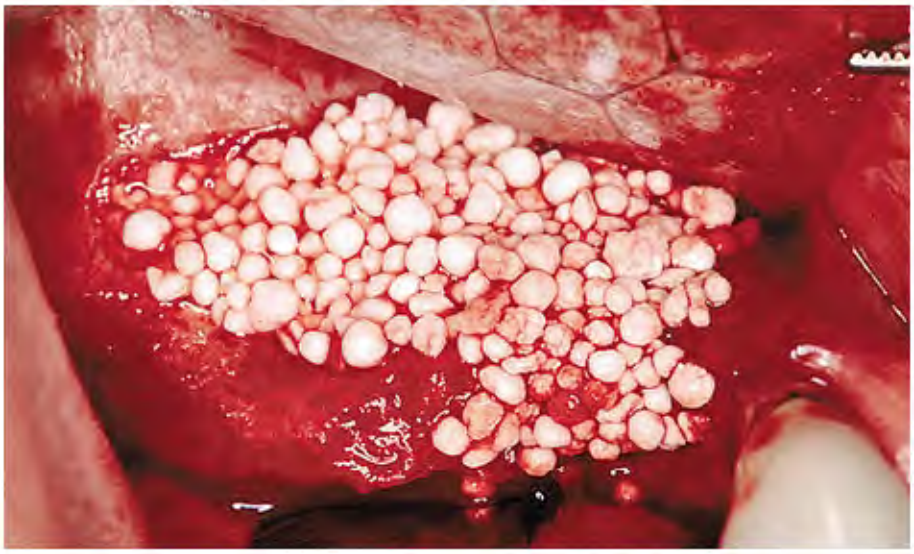


Fig 5-22g Vertical and horizontal augmentation of the residual ridge.

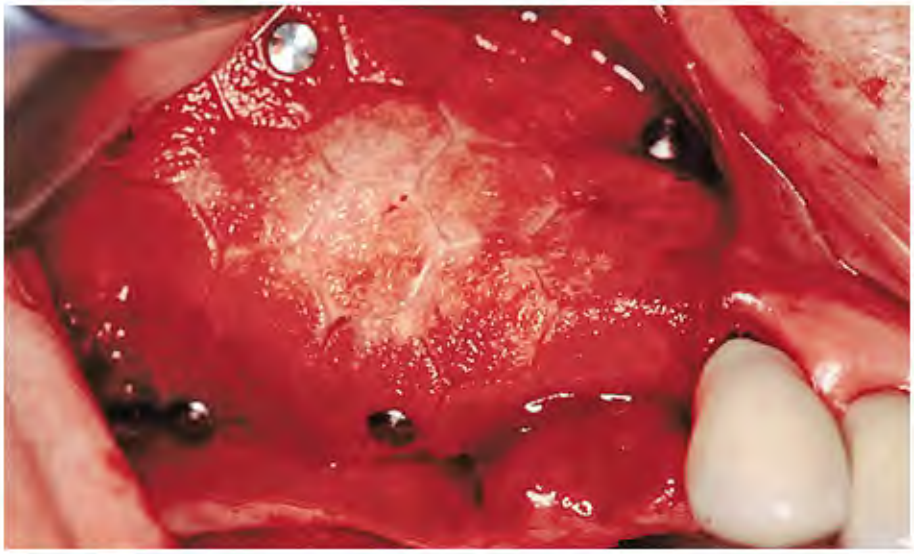


Fig 5-22h Resorbable membrane attached with pins.

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For the lateral augmentation, a resorbable membrane (Osseoquest; Gore Medical) was then attached at the apical side with titanium pins. The bone defect in region 14 and the lateral concavity were both filled with the same material (Fig 5-22g). After being adapted, the membrane was finally securely attached (Fig 5-22h).

Perforation of the mucosa

The left maxillary sinus was divided into two chambers. A perforation occurred during the dissection of the maxillary sinus mucosa (Fig 5-22i). Augmentation of the maxillary sinus in the presence of a perforation of the Schneiderian membrane would have caused the entire maxillary sinus to be infiltrated with bone granulate. This generally leads to chronic sinusitis. Therefore, it was essential to seal the membrane before the bone augmentation. To do this, a resorbable membrane (Vicryl-Mesh; Ethicon) was placed on the maxillary sinus mucosa and attached with titanium pins (Fig 5-22j). Placement of the membrane was further complicated by the bone septum.

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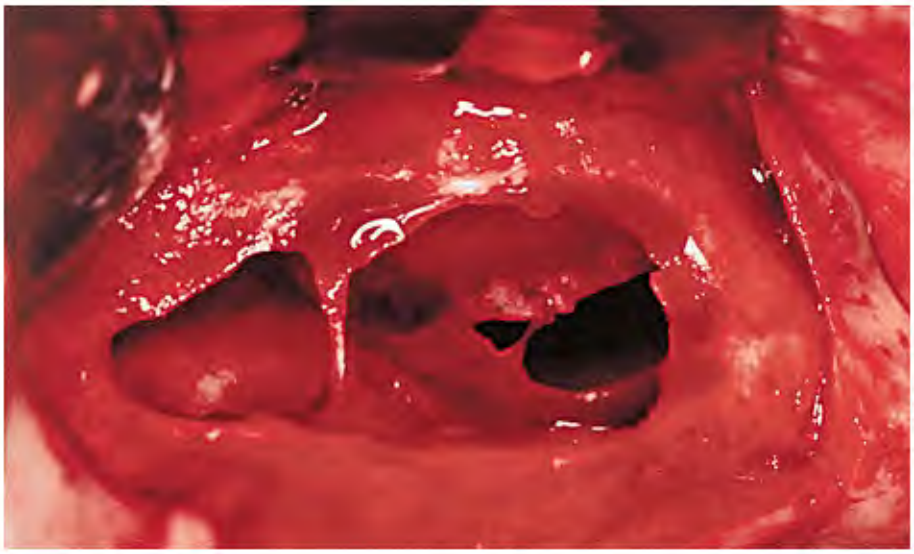


Fig 5-22i Bone septum and perforation of the maxillary sinus mucosa on the left side.

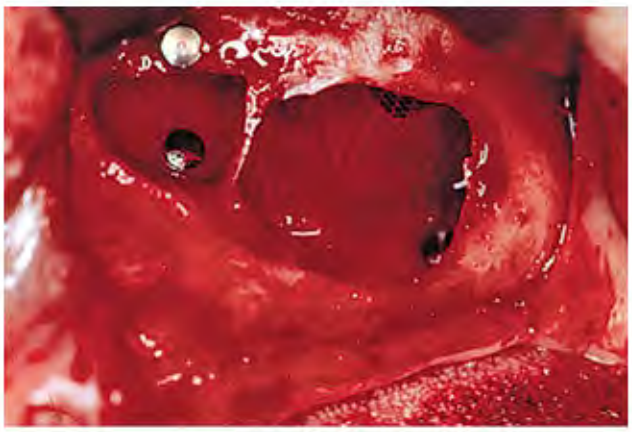


Fig 5-22j Sealing the perforation with a resorbable membrane.

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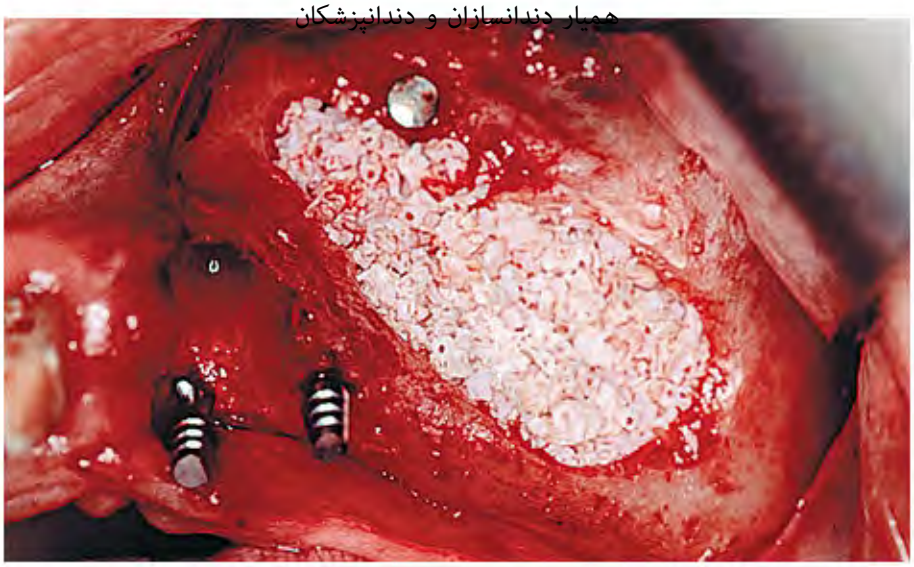


Fig 5-22k Filling the cavity and insertion of two provisional implants.



Fig 5-22l Attaching the resorbable membrane with pins.



Fig 5-22m Long-term provisional restoration supported on tooth 22 and the two provisional implants.

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Two provisional implants (IPIs) were inserted in the second quadrant to provide support for a fixed long-term provisional restoration. After the membrane of the maxillary sinus was sealed, it was possible to introduce the regenerative bone substitute (Bio-Oss; Fig 5-22k). The same material was used to fill the bone defect in region 23 and for the lateral augmentation of the residual ridge. The augmented areas were covered with a resorbable Bio-Gide membrane which was attached with pins (Fig 5-22l).

A provisional restoration, extended by tooth 24, was incorporated on the two IPIs and on the preserved tooth 22 (Fig 5-22m). The augmentation with two different materials (Cerasorb on the patient's right side, Bio-Oss on the left) and the positions of the provisional implants are visible on the postoperative radiograph (Fig 5-22n).

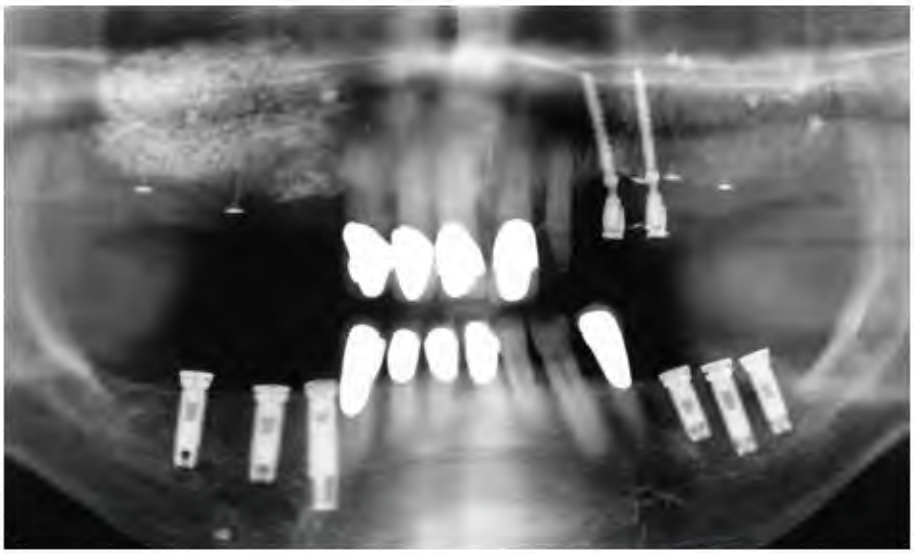


Fig 5-22n Postoperative panoramic radiograph.



Fig 5-22o Implants on the right side.

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Fig 5-22p Biopsy specimen with Cerasorb.

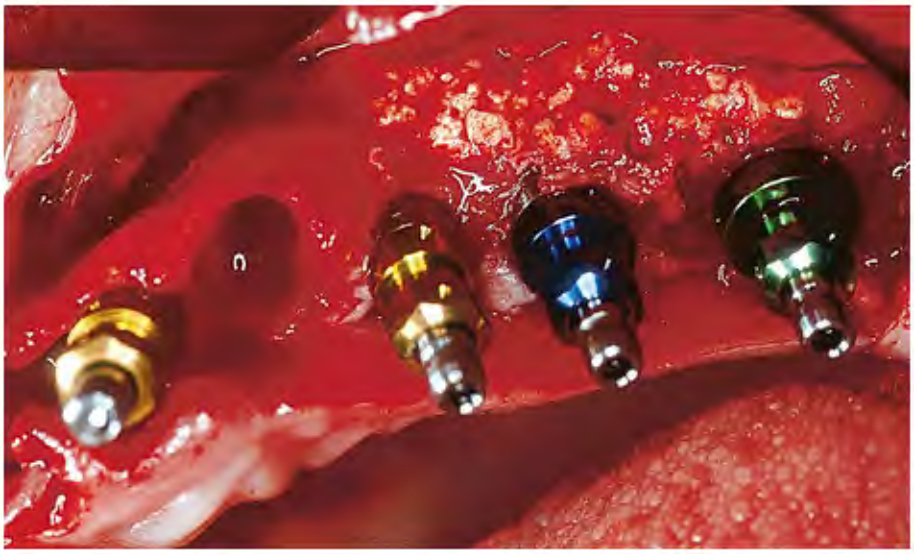


Fig 5-22q Implant placement on the left side.



Fig 5-22r Biopsy specimen with Bio-Oss.

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Fig 5-22s Distribution of the implants in the maxilla.

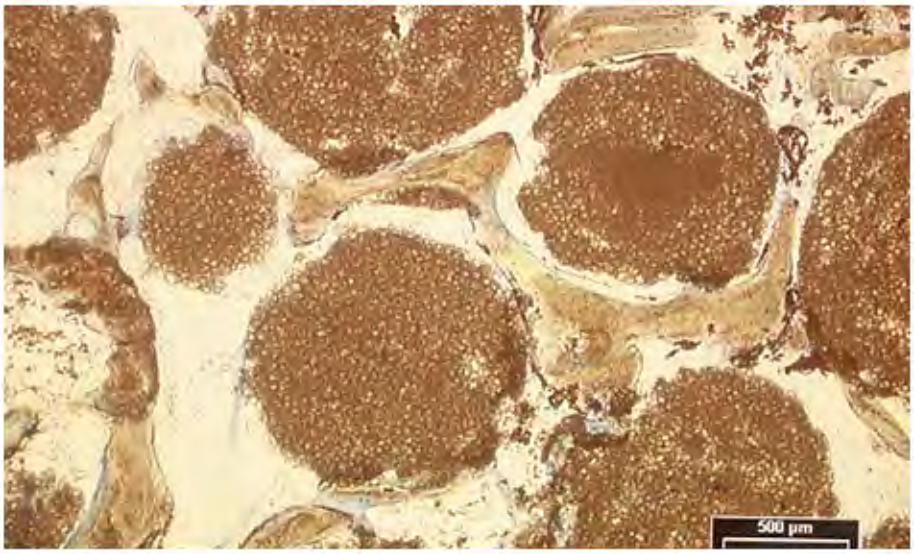


Fig 5-22t Section through the Cerasorb.



Fig 5-22u Section through the Bio-Oss.

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Implant placement

Implant placement was performed 1 year later to the day. During this time, both of the provisional implants had become loose and tooth 22 could no longer be preserved. A decision was made, jointly with the patient, to extract all the anterior teeth during implant placement and to fabricate an immediate total prosthesis as the provisional denture. Four Replace Select implants (Nobel Biocare) of different diameters were inserted following flap reflection on the right side (augmentation with Cerasorb; Fig 5-22o). A biopsy specimen for histomorphometric analysis was taken with a trephine during preparation of the implant bed in region 16 (Fig 5-22p). A wide implant (6 mm in diameter) was planned for this site. Implant placement on the left side (augmented with Bio-Oss) was performed as a virtual mirror image of the right (Fig 5-22q). A biopsy specimen was also taken from the position of tooth 26 (Fig 5-22r). Regions 2, 4, 5 and 6 were selected as the implant positions on each side (Fig 5-22s). Two sections of each biopsy specimen were produced at the University of Freiburg, Germany and subjected to histomorphometric analysis, which involved determining the percentages of bone tissue and bone substitutes within a set frame. The means of these results were calculated. On the right side (Cerasorb section, Fig 5-22t) the calculated mean values were 9.555% bone and 42.245% substitute. On the left side (Bio-Oss section, Fig 5-22u) there was a mean of 27.115% bone and 23.655% substitute.

The implants were to be exposed after another 8 months; however, as a result of the economic crisis at the time and its consequences, the implants have remained non-functional and covered with mucosa to date, ie, after 11 years. The patient is still wearing a maxillary complete denture.

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Treatment course

- Sinus floor elevation on both sides (1999)
- 1 year to implant placement
- 11 more years without exposure

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Uwe Hildebrand
Dental technology:	Horst Mosch

Problems and complications

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Apical granuloma on a smooth machined implant

Baseline situation

This patient presented to our center with a free-end situation in the first quadrant and a severely pneumatized right maxillary sinus (Fig 5-23a). Two years previously, three implants had been placed on each side of her mandible. The exposure and subsequent prosthetic loading took place following a 5-month healing period. As a comparative study, Osseotite implants (Biomet 3i) were used on the left side and TiUnite MK III implants from the Brånemark System on the right. The patient also wanted to have an implant-supported, fixed restoration for her maxilla. She presented with an incidental finding of a periapical lesion at tooth 15, which was to be exposed and resected during the procedure.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Intraoral radiograph
- CBCT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Sinus elevation on the right side
2. Implant placement
3. Exposure
4. Definitive prosthetic loading

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Fig 5-23a Cantilever bridge in the first quadrant.

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Sinus floor elevation

Once the cantilever bridge 13 to 15 with cantilever 16 was removed, the abutment teeth were cleaned before the operation (Fig 5-23b). The incision was made on the residual ridge from the canine to the tuberosity. The flap was shifted in the buccal direction to allow the fenestration for the sinus floor elevation to be performed (Fig 5-23c). Elevation of the Schneiderian membrane was followed first by the apicoectomy on tooth 15 (Fig 5-23d). The resultant cavity was filled with a mixture of autologous bone and Bio-Oss and the window sealed with a resorbable membrane (Resolut; W. L. Gore and Associates). The membrane was attached with four titanium pins (Fig 5-23e). This was followed by tight suturing of the wound and reincorporation of the fixed dental bridge, taking care to avoid any tension or pressure on the flap (Fig 5-23f). The postoperative panoramic radiograph shows the augmentation material in situ, resected tooth 15 and the prosthetically loaded implants in the mandible following 2 years of functional use (Fig 5-23g).

Implant placement

One year after the augmentation, the clinical situation continued to be stable (Fig 5-23h). Before implant placement, the provisionally attached fixed bridge was removed and a mucoperiosteal flap created toward the buccal vestibule. Four Brånemark System implants, each 18 mm long and 3.75 mm in diameter, were inserted into regions 14, 16, 17 and 18 (Fig 5-23i). The slightly supracrestal placement of the implants would support the additional augmentation (Fig 5-23j). The titanium pins were removed and the harvested bone chips packed vertically and horizontally onto the residual ridge around the implants. No membrane

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was used to cover the augmentation. The postoperative panoramic radiograph shows the position of the implants following insertion (Fig 5-23k).



Fig 5-23b Abutment teeth 15 and 13.



Fig 5-23c Fenestration for the sinus floor elevation.

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Fig 5-23d Apicoectomy on tooth 15.

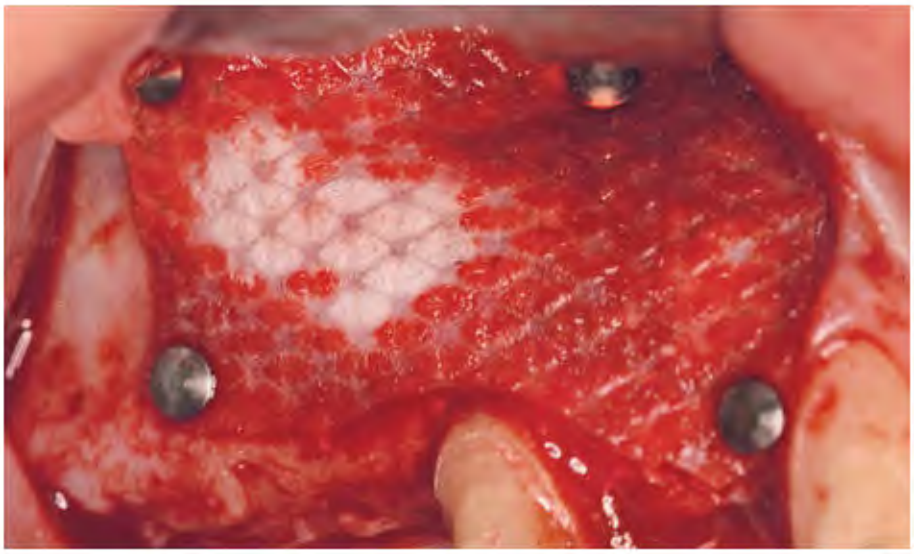


Fig 5-23e Attached Resolut membrane.



Fig 5-23f Reincorporation of the modified cantilever bridge.

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Fig 5-23g Postoperative panoramic radiograph.



Fig 5-23h Clinical situation after 1 year.

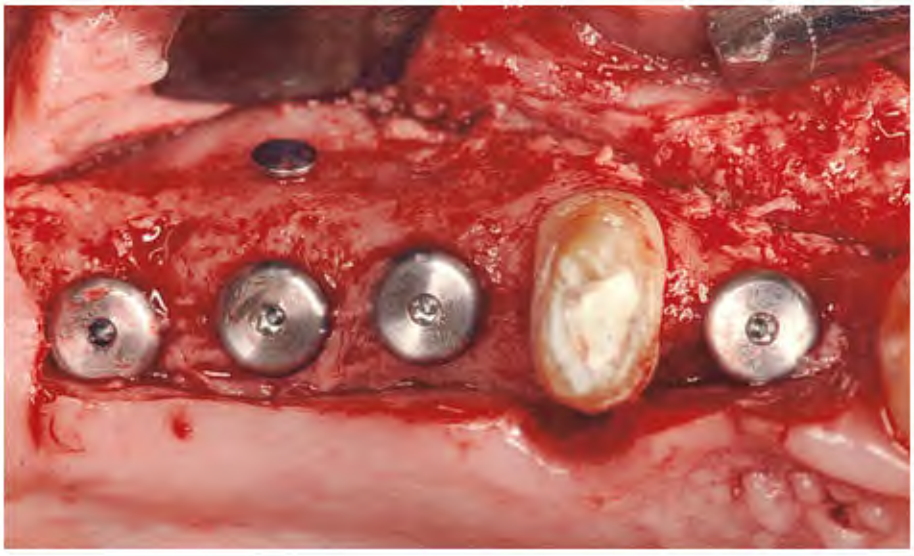


Fig 5-23i Four Brånemark System implants have been inserted.

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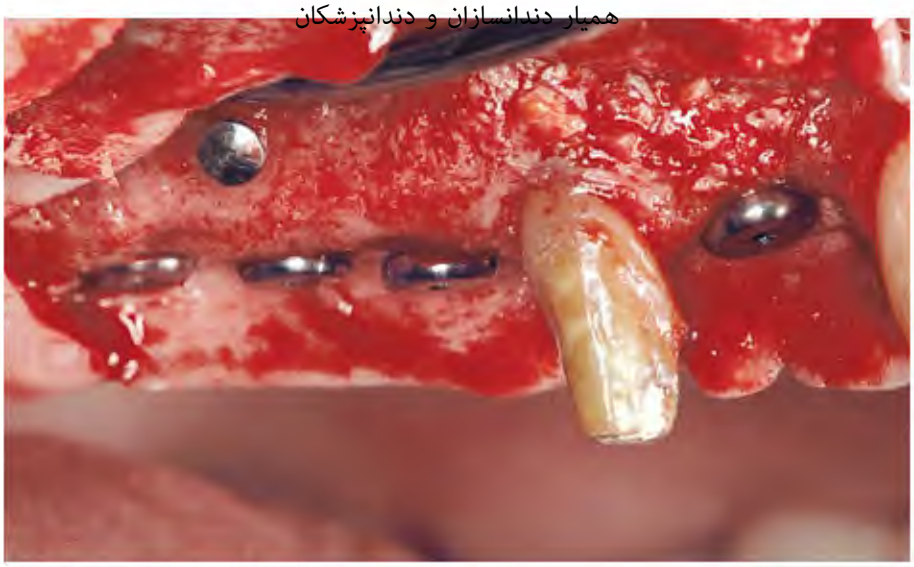


Fig 5-23j Supracrestal placement of the implants to provide support for the augmentation.



Fig 5-23k Positioning of the implants.

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Complication and exposure

The patient repeatedly complained of pain and tenderness to touch in regions 14 and 15. At the patient's request, the resected tooth 15 was extracted after 4 months and a new provisional with two cantilevers, extended to include the anterior teeth, was incorporated (Fig 5-23l). In the postoperative radiograph, both resected tooth 15 and implant 14 show a medium-sized "apical" radiolucency. The surgical revision with concomitant exposure of implants 14, 16, 17 and 18 took place 7 months after implant placement. The incision was made palatally along the residual ridge, in accordance with the implant exposure guidelines. Following creation of the mucoperiosteal flap, a granuloma-like defect was found around the smooth surface of the upper segment of implant 14 (Fig 5-23m). Approximately 5 mm of the tip of the implant was cut off, while ensuring adequate cooling (Fig 5-23n). The cut tip of the implants (Fig 5-23o) was removed and the defect plus the bone surface carefully cleaned and generously irrigated (Fig

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5-23p). Since the prognosis of the abbreviated implant in position 14 was questionable, an additional implant (TiUnite MK III, 15 mm long) was inserted at the position of extracted tooth 15 (Fig 5-23q). To save the patient from having to undergo another exposure operation, healing abutments were screwed onto all the implants (including region 15; Fig 5-23r).

The cavity left after the removal of the granuloma was filled with Bio-Oss and autologous bone and the lateral part of the residual ridge was slightly augmented (Fig 5-23s). The augmentation material was stabilized laterally with a resorbable membrane (Tutodent; Fig 5-23t). The mucoperiosteal flap was repositioned and fixed into place around the abutments with Gore-Tex 4-0 and Mopylen 6-0 sutures (Fig 5-23u). The final panoramic radiograph shows all the implants in good condition and loaded with a fixed implant bridge (Fig 5-23v).



Fig 5-23l New provisional restoration with cantilevers 14 and 15.

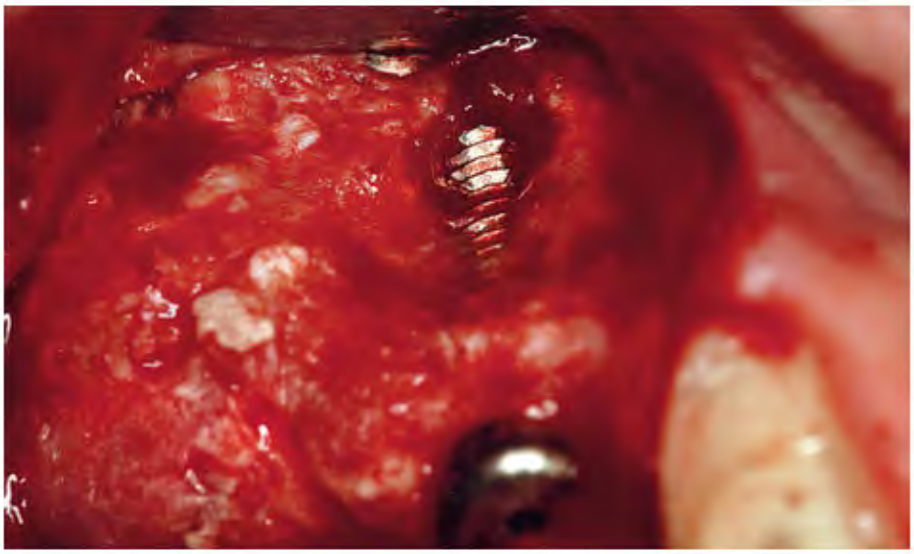


Fig 5-23m Granuloma around implant 14.

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Fig 5-23n Cutting off the implant tip.



Fig 5-23o Removed implant tip.

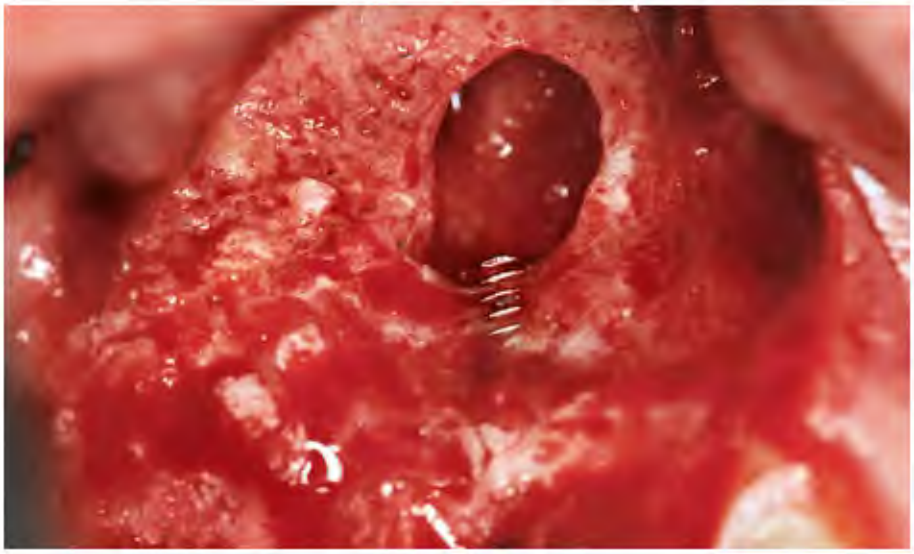


Fig 5-23p The defect has been cleaned and irrigated.

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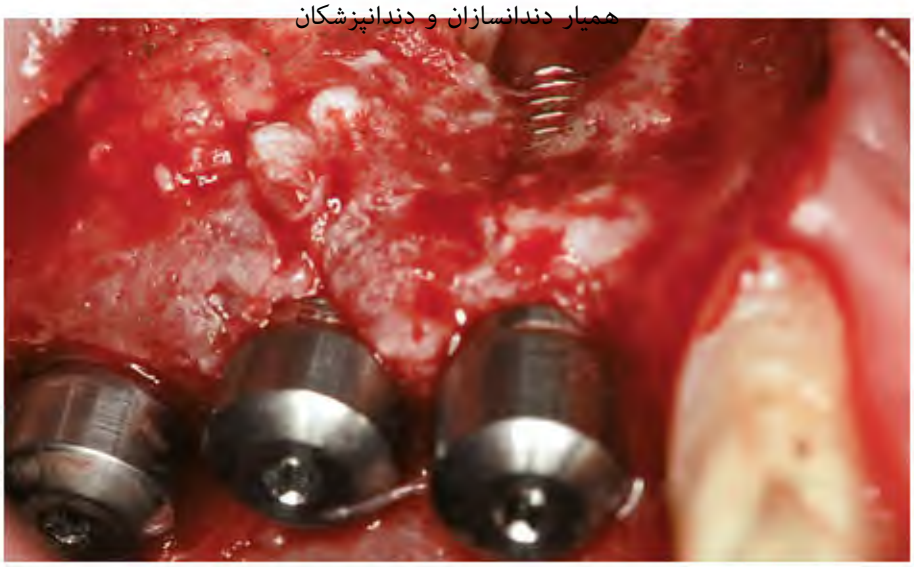


Fig 5-23q Extra implant 15 inserted as a safety measure.

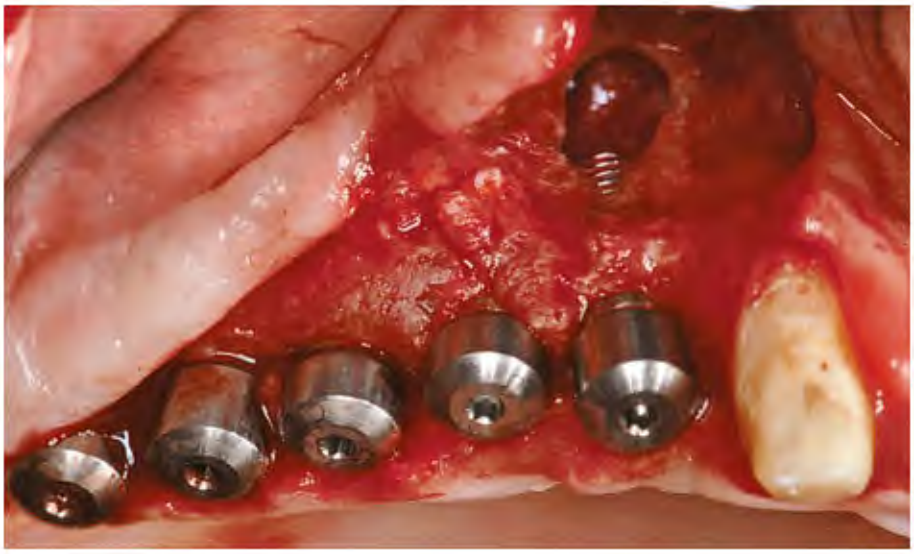


Fig 5-23r All the implants have been exposed.

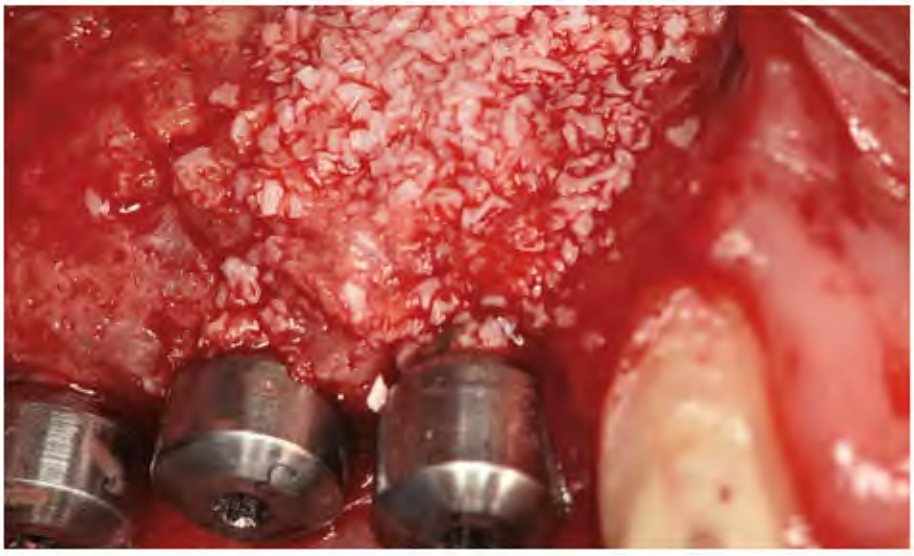


Fig 5-23s Augmentation of the defect.

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Fig 5-23t Membrane applied without fixation.

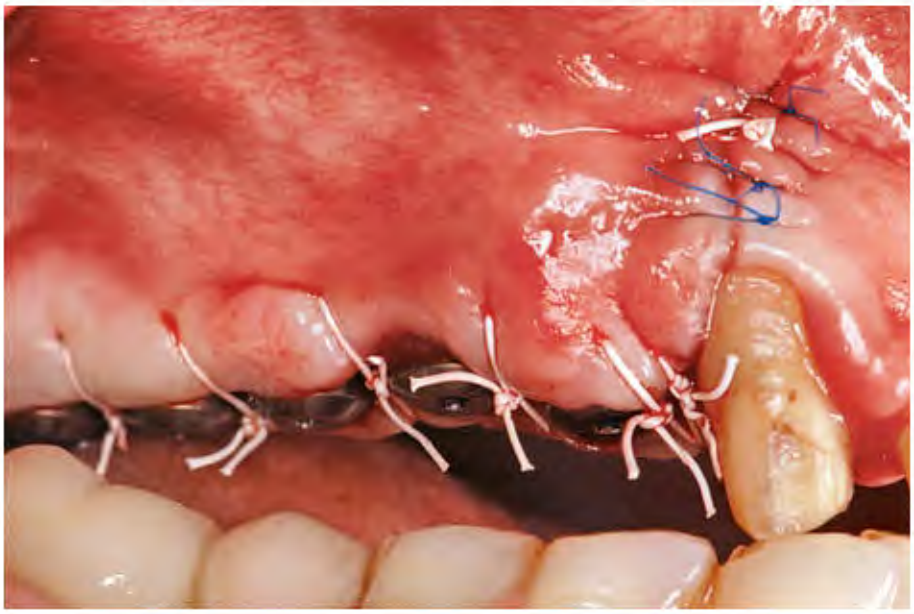


Fig 5-23u Suturing following exposure.

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Fig 5-23v Check panoramic radiograph following the prosthetic restoration.

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Treatment course

- Implant placement in the mandible (2002)
- 2 years to right-sided sinus floor elevation
- 1 year to implant placement
- 7 months to revision and exposure
- 2 months to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Immediate loading

Immediate restoration with concomitant sinus floor elevation

Baseline situation

This male patient lost both abutment teeth supporting his fixed partial denture 14 to 17, necessitating prosthetic restoration of a free-end situation in the right maxilla (Fig 5-24a).

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The patient wanted a fixed, implant-supported restoration. Since the posterior maxilla exhibited too little bone tissue to provide anchorage for implants, he would need sinus floor elevation. For esthetic reasons, it was important for the patient to be provided with a fixed restoration at least in the premolar region during the healing period. Thus, the plan was to insert two provisional IPIs in region 15 concomitantly with the sinus floor elevation and to fabricate a long-term provisional restoration supported on abutments 11-13-15.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Right-sided sinus floor elevation with insertion of the provisional implants; immediate provisional restoration
2. Implant placement
3. Exposure
4. Definitive prosthetic loading



Fig 5-24a Free-end situation in the first quadrant.

Sinus floor elevation and insertion of IPIs

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The lateral wall of the maxillary sinus was opened and bone defect in region 14 revealed, followed by fenestration of the sinus (Fig 5-24b). Elevation of the maxillary sinus mucosa made space for the augmentation material (Fig 5-24c). This consisted of Bio-Oss and platelet-rich plasma (PRP), the latter having been previously harvested from the patient's own blood (Fig 5-24d). For blood coagulation purposes, the mixture was first enriched with blood, before the prepared space was finally filled (Fig 5-24e). The window was covered with a liquid membrane (Fig 5-24f).

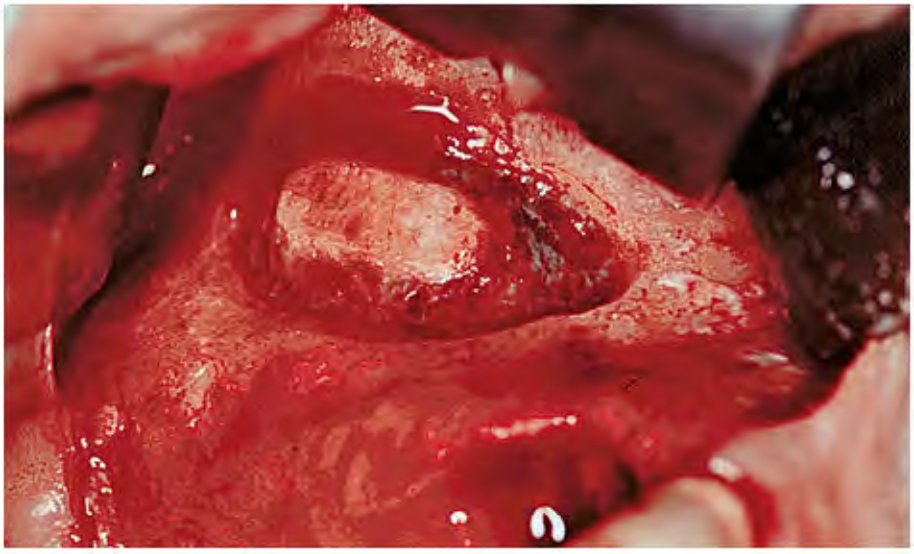


Fig 5-24b Fenestration of the maxillary sinus wall.

In the next step, two IPIs were inserted under the anterior maxillary sinus wall, tilted slightly mesially. The positioning of the provisional implants was guided by static principles (Fig 5-24g). After this, bone defect in region 14 was filled with the same material and also covered with an Atrisorb membrane (Fig 5-24h). For the long-term provisional restoration, a five-unit fixed partial denture was fitted onto natural teeth 11 and 13 plus the two temporary implants in region 15 (Fig 5-24i). The panoramic radiograph shows the situation after the procedure (Fig 5-24j).

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Fig 5-24c Elevation of the maxillary sinus mucosa.



Fig 5-24d Bio-Oss with platelet-rich plasma.



Fig 5-24e Filled cavity.

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Fig 5-24f Sealing the window with a liquid membrane.



Fig 5-24g Insertion of two provisional implants.



Fig 5-24h Augmentation of the bone defect left by the extraction of tooth 14.

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Fig 5-24i Long-term provisional restoration on teeth 11 and 13 and on the IPIs in region 15.



Fig 5-24j Postoperative panoramic radiograph.

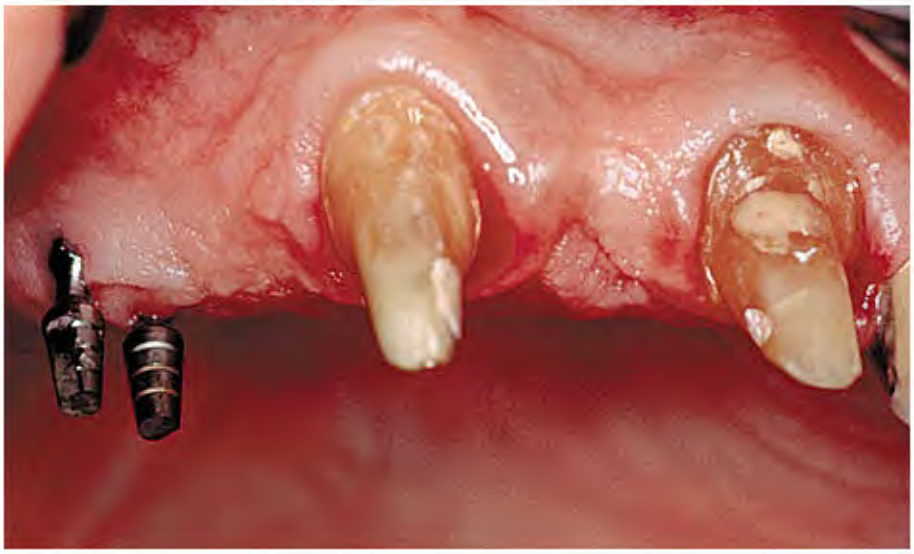


Fig 5-24k Clinical situation before implant placement.

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Fig 5-24l Removal of the palatal IPI.

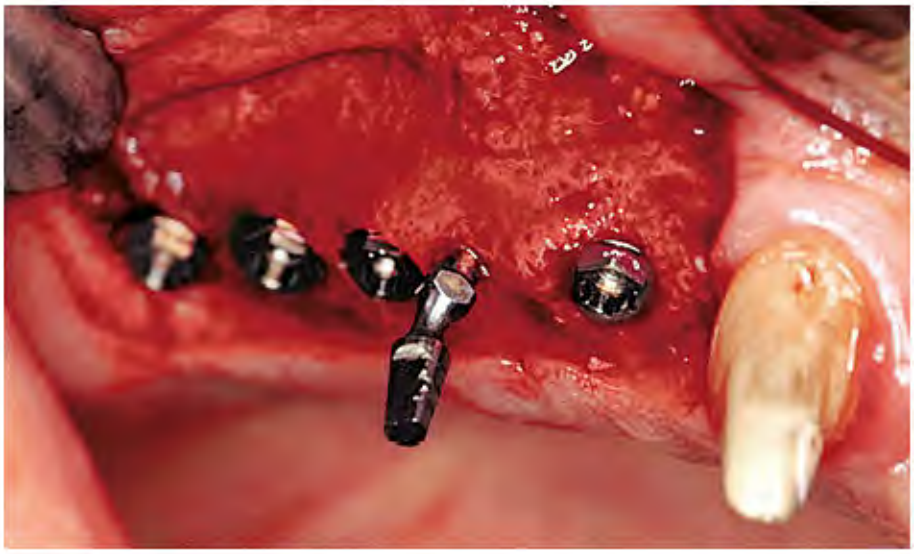


Fig 5-24m Insertion of four definitive implants.

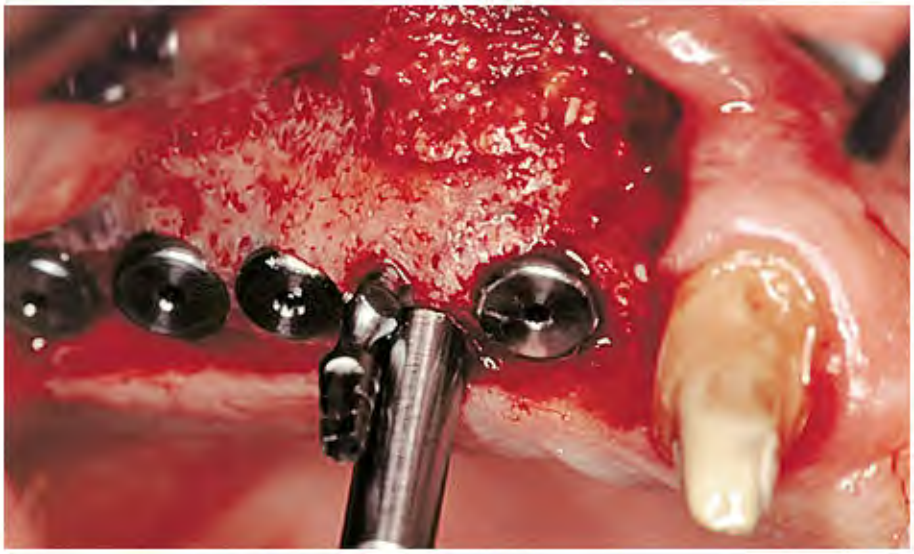


Fig 5-24n Preparation of a new bone bed for the palatal provisional implant.

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Implant placement in the augmented bone could proceed after a 9-month healing period. Four implants were planned for the restoration of the free-end situation (regions 14, 16, 17 mesial and 17 distal). While planning implant placement, it was found that there was insufficient space for the implant in region 14 in relation to the palatal IPI in region 15. Therefore, the provisional implant in the palatal position had to be removed.

When the fixed partial denture was taken out, it was found that both of the IPIs were completely stable (Fig 5-24k). The palatal IPI was unscrewed and removed as planned, and the drill holes for the permanent implants prepared (Fig 5-24l). All four implants were inserted into the planned positions (Fig 5-24m). Once the cover screws were put into place, a new bed was prepared for the palatal IPI. The hole was drilled in the same place, to run as parallel as possible to the head of the remaining IPI (Fig 5-24n). The aim of this procedure was to place the head of the palatal IPI back into the same place and at the same angle of tilt as before (Fig 5-24o). Tight suturing of the wound followed (Fig 5-24p). It proved possible to reinsert the existing provisional without adjustment (Fig 5-24q). This avoided the need to fabricate a new long-term provisional. The postoperative panoramic radiograph shows the positions of the permanent implants and that of the transposed palatal IPI in region 15 (Fig 5-24r).

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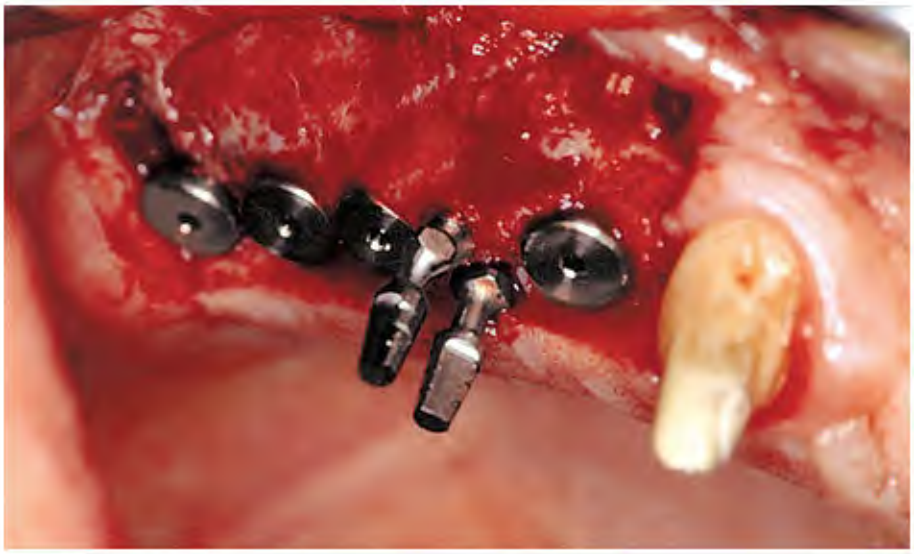


Fig 5-24o Palatal provisional implant inserted into the same site.

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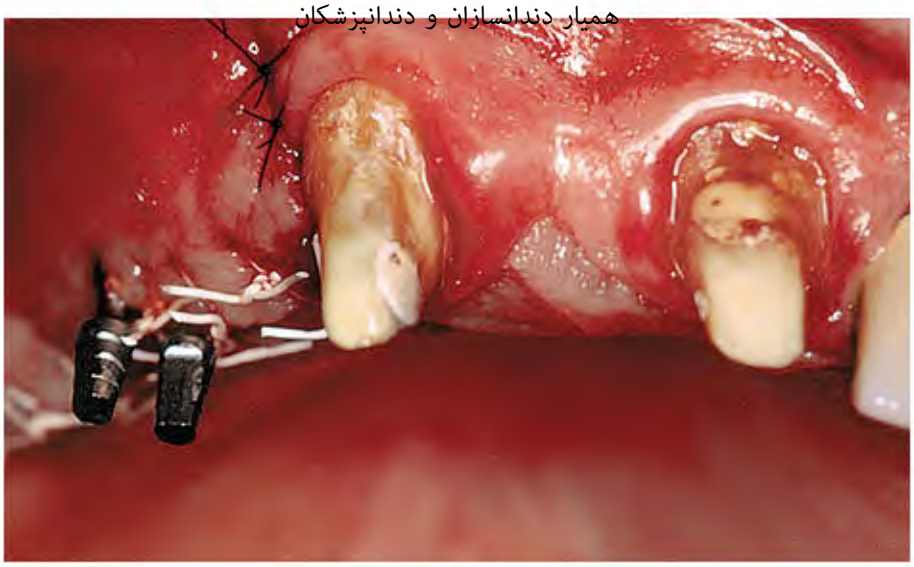


Fig 5-24p Closure of the wound by suturing.

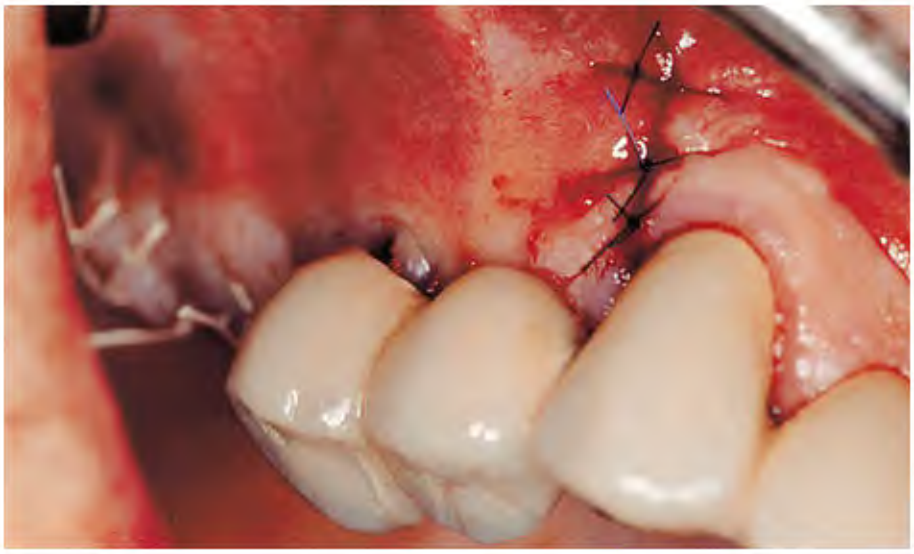


Fig 5-24q Incorporation of the existing long-term provisional.

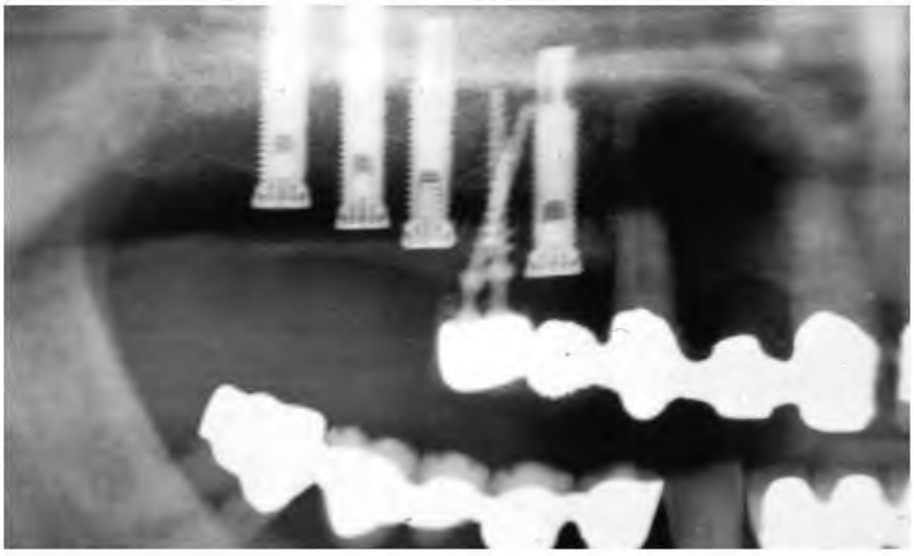


Fig 5-24r Check panoramic radiograph after the procedure.

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Exposure and prosthetic restoration

The implants were ready to be exposed after an 8-month healing phase. When the long-term provisional 11-13-15 was removed, it was found that the two IPIs were still completely stable. The exposure was performed using the cosine curve incision technique (Fig 5-24s). Healing abutments that were as short as possible were selected, to enable the patient to keep the provisional prosthesis (Fig 5-24t). The IPIs remained in situ until the permanent prosthetic restoration could be incorporated. This was cemented onto customized abutments with TempBond, independently of fixed dental bridge 11-13 (Fig 5-24u). A pontic was incorporated instead of the provisional implants in region 15. The patient got used to his prosthetic restoration very quickly and with a great deal of satisfaction (Fig 5-24v).

Continued follow-up

The clinical situation on the right side was still stable after 11 years (Fig 5-24w). At this point, implant placement in the fourth quadrant was being planned for the patient, and the opportunity was also taken to check the osseous situation in the maxilla with a CBCT scan (Fig 5-24x). This showed that tooth 13 needed root canal treatment.

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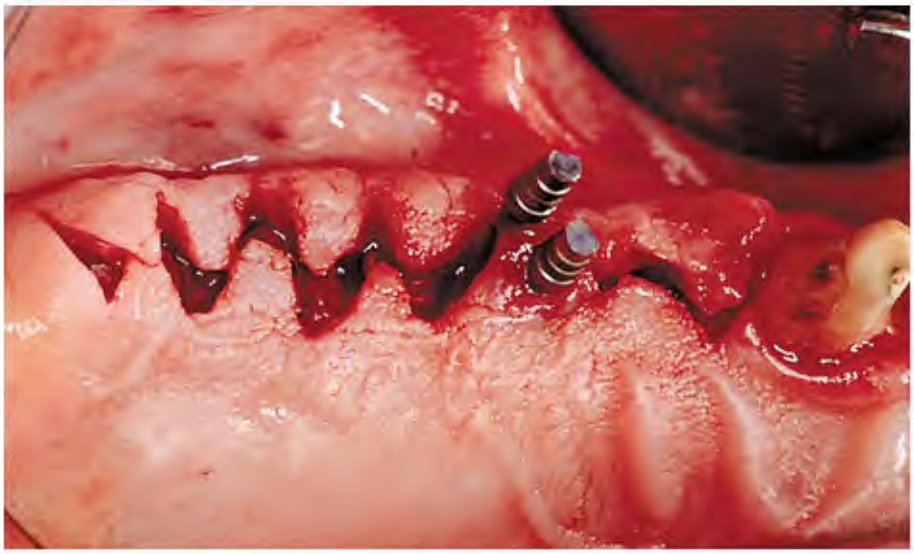


Fig 5-24s Cosine curve technique taking the provisional implants into account.

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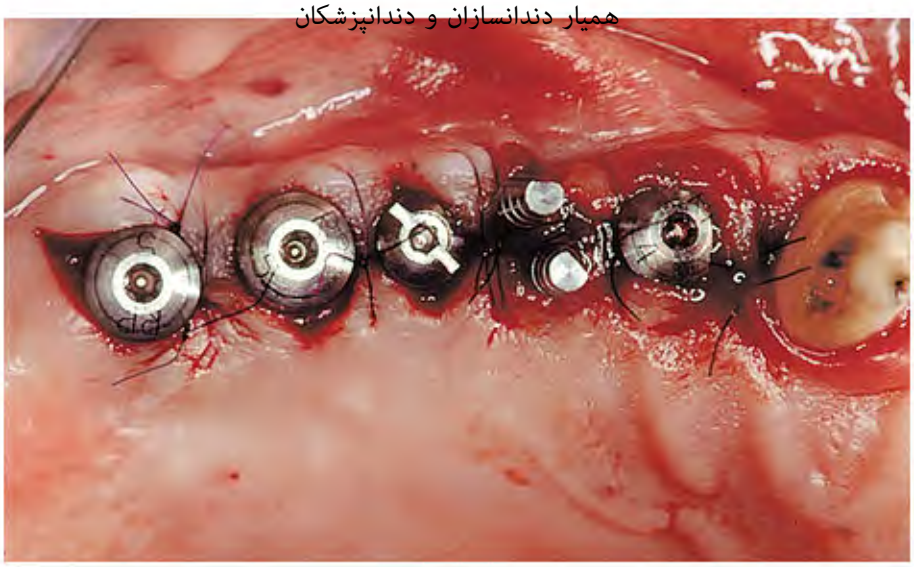


Fig 5-24t Adaptation of the flap and microsurgical suturing.



Fig 5-24u Ceramic compound crowns cemented onto the customized abutments.



Fig 5-24v Patient following treatment completion.

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Fig 5-24w Clinical situation after 11 years.

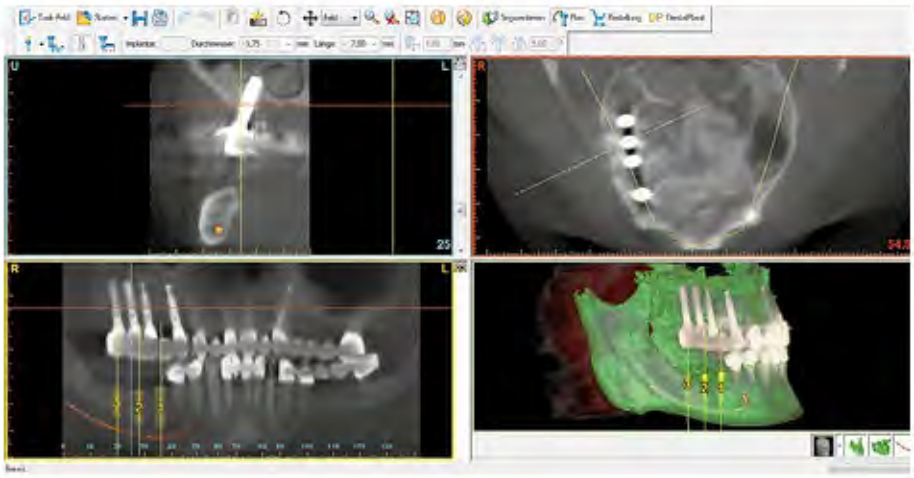


Fig 5-24x CBCT 11 years after implant placement.

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Treatment course

- Right-sided sinus floor elevation with insertion of provisional implants (2000)
- 9 months to implant placement
- 8 months to exposure
- 6 weeks to the definitive prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Sinus floor elevation, implant placement and immediate restoration loaded onto IPIs

Baseline situation

This male patient is the medical superintendent of a large clinic, was not prepared to go without a securely anchored dental restoration at any point. Following the necessary dental treatment, combined prostheses with locking bolt attachments for the maxilla and mandible were fabricated as his long-term provisional restoration (Fig 5-25a). Teeth 14 to 21 have remained in the maxilla, all of them with apical lesions, successfully remedied by endodontic treatment under the microscope (Fig 5-25b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT, SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation
2. Implant placement, provisional implants, immediate provisional restoration
3. Exposure and definitive prosthetic loading



Fig 5-25a Combined prostheses with locking bolt attachments as the long-term provisional restoration.

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Fig 5-25b Panoramic radiograph before the treatment.

Sinus floor elevation

Working under general anesthesia, definitive and provisional implants were first inserted into the left mandible, which was also extensively augmented. This was followed by bilateral sinus elevation.

Attention: ***This patient shows an unusual form of maxillary sinus anatomy. In most cases, the septa in the maxillary sinus have a virtually transverse course and subdivide it into an anterior, central and posterior compartment. Here, there is only one septum with an oblique sagittal/horizontal course, dividing the sinus into an upper and a lower compartment. Double fenestration was necessary: the upper compartment was opened first, and the mucosa dissected away in the cranial direction. Only then was it possible to cut the second window caudally of the first, while meticulously avoiding any damage to the mucosa (Fig 5-25c). After this, it was also possible to elevate the Schneiderian membrane in the lower compartment. Both compartments needed to be uniformly packed with the augmentation material.***

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Fig 5-25c Double fenestration for both chambers of the maxillary sinus.

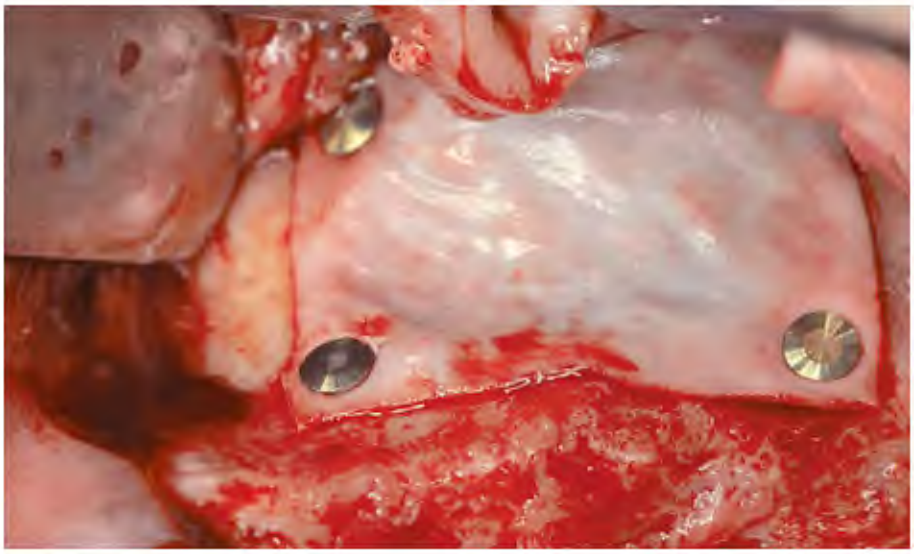


Fig 5-25d Window closed with a membrane.

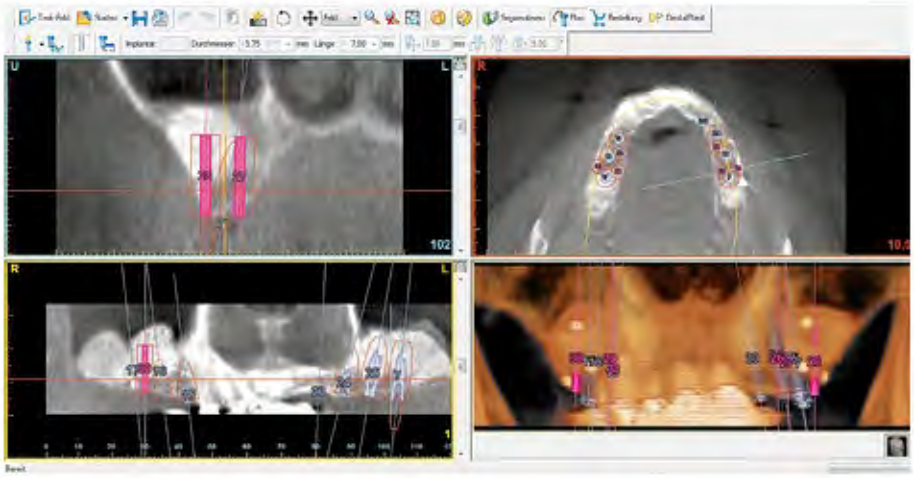


Fig 5-25e SimPlant planning before implant placement.

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Fig 5-25f Maxilla following removal of the long-term provisional.



Fig 5-25g Provisional restoration on IPIs in the mandible.

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After filling, the window of the maxillary sinus was sealed with a Bio-Gide membrane attached with titanium pins (Fig 5-25d). Nine months were scheduled for the healing period, which was uncomplicated.

Implant placement

After 9 months, the bone foundations were firm enough to anchor the definitive and provisional implants in the jaw with primary stability. Both the definitive and the provisional implants (IPIs) were planned in the SimPlant program (Fig 5-25e). A new fixed provisional restoration was planned on the interim implants, making it possible to replace the structure that had been functioning in the maxilla (Fig 5-25f). In the mandible, a fixed provisional had already been incorporated on provisional implants after the first operation (Figs 5-25g and 5-25h). The incision was made along the residual ridge from tooth 21 to tooth 27, slightly palatally, with

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two releasing incisions. Five implant beds were prepared in positions 23, 24, 25, 26 and 27 and checked with direction indicators (Fig 5-25i). Five Neoss implants were inserted at these sites, in a slightly supracrestal position (Fig 5-25j).



Fig 5-25h Panoramic radiograph after the sinus lift and implant placement in the left mandible.

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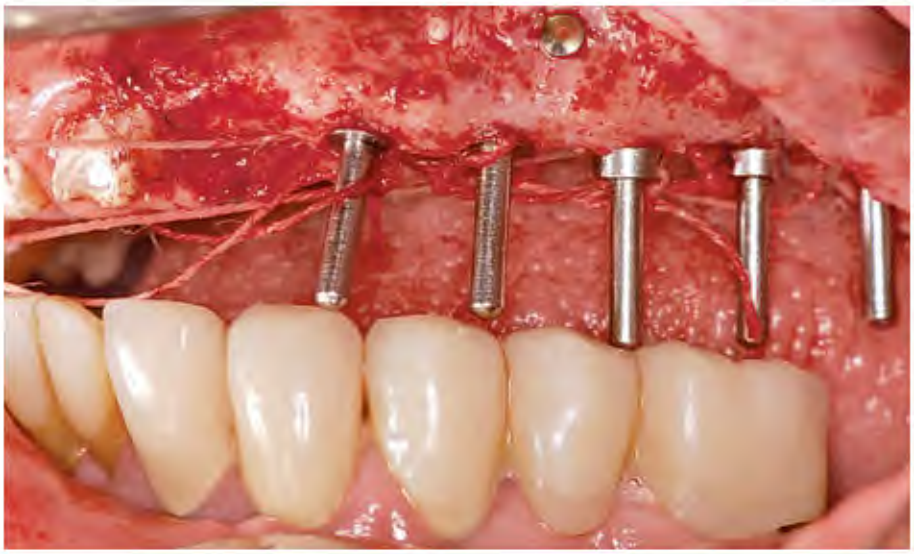


Fig 5-25i Five prepared implant beds in the maxilla.

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Fig 5-25j Supracrestally inserted implants.



Fig 5-25k Direction indicators screwed into place.

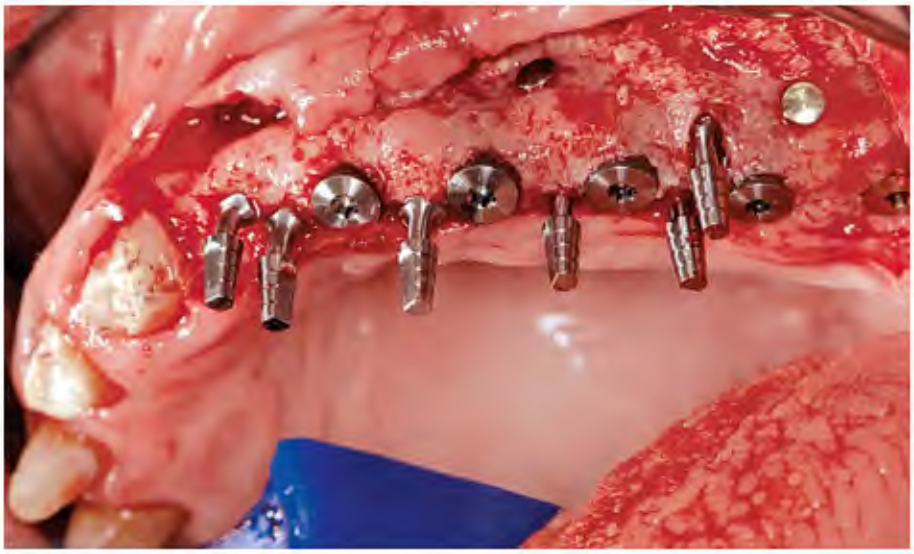


Fig 5-25l Collision-free insertion of six IPIs.

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Fig 5-25m The provisional implants have been aligned to be parallel to the anterior teeth and to one another.



Fig 5-25n Augmentation with the harvested bone chips.

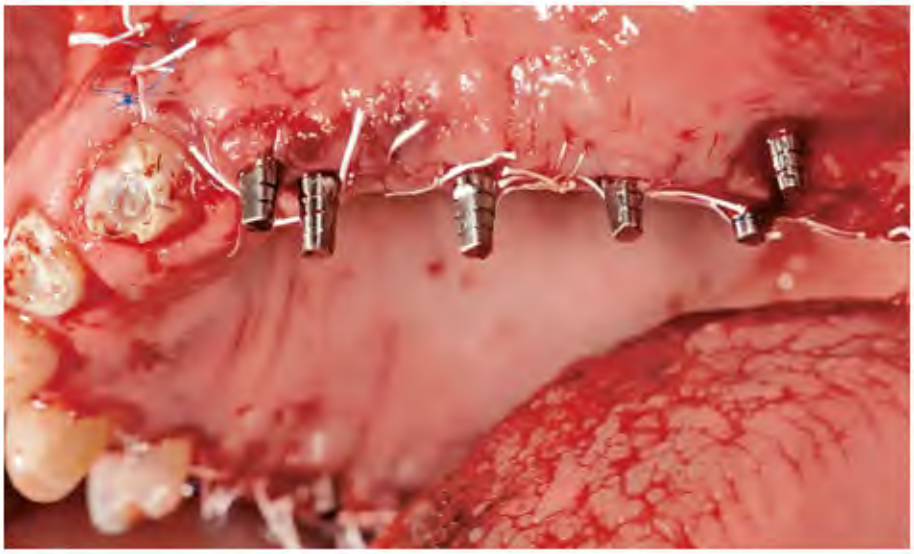


Fig 5-25o Tightly sutured wound.

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Fig 5-25p Parallel abutments for the cross-arch provisional.

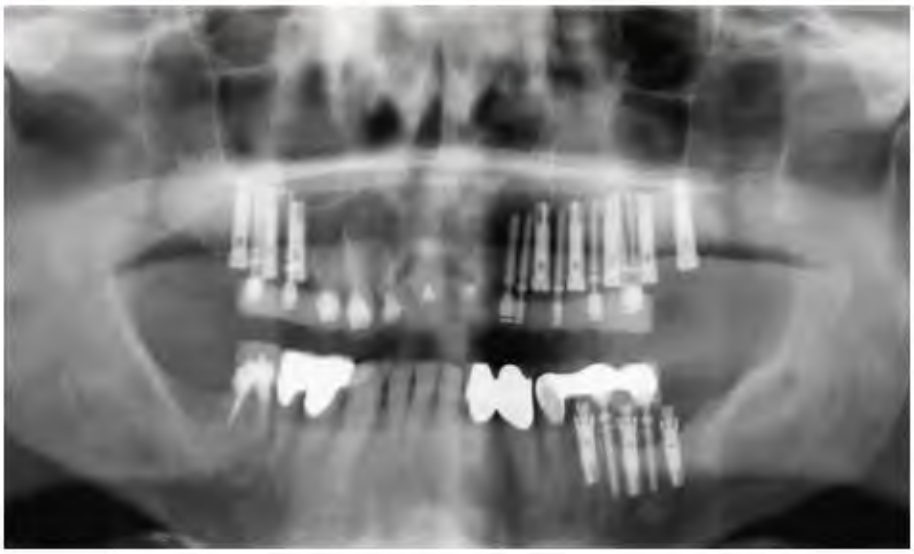


Fig 5-25q Postoperative panoramic radiograph.

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Attention: ***When trying to orientate between the 3D planning on the radiograph and the operation site, the titanium pins provide good reference points to ensure that the implants are placed according to plan.***

In the next step, the provisional implants were inserted between the definitive ones. When doing so, it is essential to ensure that the former do not come into contact with the latter. Direction indicators screwed onto the definitive implants are very helpful when aligning the provisional implants: collisions can be avoided by parallel alignment of the implant axes (Fig 5-25k). Since the patient wanted his prosthetic restoration to fit as securely as possible, six IPIs were inserted into the augmented bone in the left side of the maxilla (Fig 5-25l). The IPIs needed to be bent accordingly so that they were parallel to each other and to the existing teeth, to ensure a uniform direction of insertion (Fig 5-25m). Before suturing, a minimal augmentation was performed around the implants with the harvested bone chips (Fig 5-25n). The wound was closed with Gore-Tex and Mopylen 6-0 sutures (Fig 5-25o). Three definitive and three

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provisional implants were then inserted into the right maxilla. A cross-arch provisional was fabricated to fit over the stumps of the anterior teeth and all the provisional implants (Fig 5-25p). The postoperative panoramic radiograph shows the positioning of all the implants in both mandible and maxilla (Fig 5-25q).

All the anterior teeth in the maxilla had been treated endodontically while the sinus floor elevation healed. In the left mandible, there is an extensive bone defect around the implants even after such a short time, suggesting an inflammatory reaction.

Treatment course

- Dental and root canal treatment (2007)
- 5 months to sinus floor elevation
- 9 months to implant placement
- 8 months to exposure and prosthetic loading

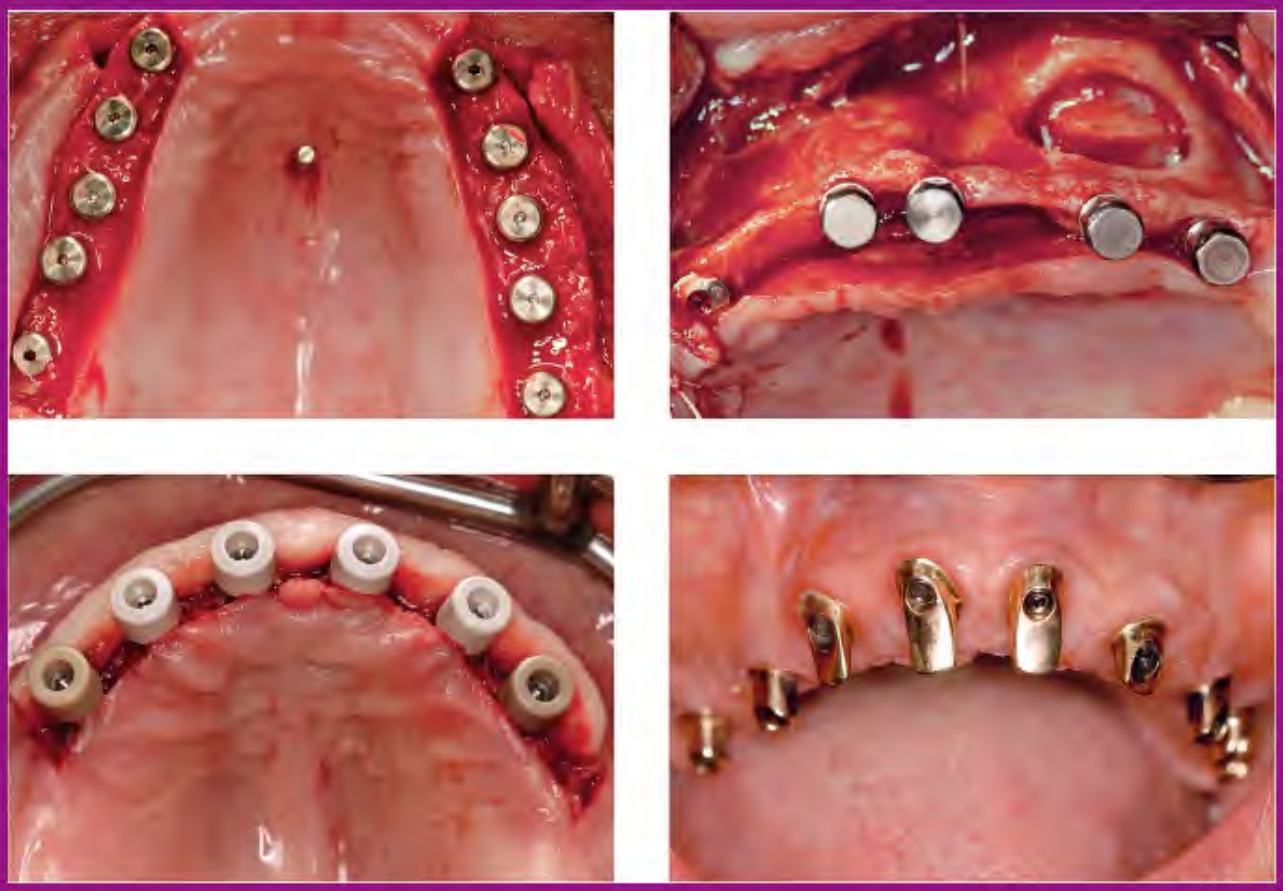
Treatment

Surgery:	Dr Christoph T. Sliwowski
Endodontics and prosthetics:	Dr Roland Althoff

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6
The Edentulous Maxilla



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Planning and carrying out implant treatment in the edentulous maxilla is a more difficult and more extensive process than that involved in any other indication. It requires highly meticulous diagnostic investigations, which should routinely include conventional computed tomography (CT) or cone beam computed tomography (CBCT) with a custom template. This is a time-consuming but also very effective method, and should form part of standard diagnosis.

3D diagnosis with a custom template

Usually, the patient for edentulous implant treatment has already been fitted with a complete prosthesis. Provided the tooth set-up is correct, this prosthesis can be used as a basis for

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fabricating the implant template. To do this, it is duplicated in full and converted into a template made of a transparent but radiopaque plastic (Fig 6-1a). However, if the old restoration does not meet the expectations of either the patient or the dentist, the teeth will need to be set up again according to the principles of full mouth rehabilitation and also duplicated, to allow the optimal implant positions to be determined.

If the duplicated prosthesis is available as a basis for the template, concrete planning for implant placement can now begin. To begin with, it is advantageous to plan more implants than will actually be needed. If analysis of the CT scan images or the situation at the time of implant placement shows that the anatomical structure of the maxillary bone is not suitable for implants at all the planned locations, the described procedure leaves the option of selecting the most favorable sites.

In the first step, one hole is drilled in the template at each of the planned implant positions; these need to reproduce the longitudinal axes of the implants (Fig 6-1b). The drilled holes provide good reference points in both CT and CBCT imaging without producing artifacts.

To ensure that the template remains uncluttered, the author prefers to place the drill holes in positions 1, 3, 5, 6 and 7 (Fig 6-1c). The lateral incisors and the first premolars can then be positioned between the existing holes as required.

Before taking the radiograph, the template is stabilized in the patient's mouth on the mandibular dentition, with an additional occlusion rim if necessary. A CT or CBCT scan is then performed on the patient while he or she bites down. The resultant data are fed into a planning program, eg, SimPlant (Dentsply) in Digital Imaging and Communications in Medicine (DICOM) format. In the SimPlant program, the maxilla can be visualized in three planes: axial, panoramic or cross-sectional, and also as a 3D reconstruction (Fig 6-1d). The panoramic and axial sections provide the best spatial orientation. However, the actual positioning of an implant usually takes place in the cross-sectional image. This section allows the position of the drill hole and the anatomy of the residual ridge to be brought into line (Fig 6-1e). In region 13, for example, a slight inclination palatally is sufficient to ensure that the implant is anchored in the bone (Fig 6-1f). In region 26, the drill hole corresponds almost exactly to the contours of the residual ridge (Fig 6-1g). However, shifting the implant slightly in the buccal direction allows it to be anchored more evenly in the bone that has been augmented following sinus elevation (Fig 6-1h).

The uniform distribution of thicker bone around the implant ensures a better supply of nutrients to the tissue. Due to anatomical reasons, however, no implants can be placed at some of the initially planned positions, such as region 21, so a substitute site needs to be found (Fig 6-1i). In addition to the template, the titanium pins used to attach the membrane (in this case, regions 13 and 16, buccal side in the axial section) during sinus elevation also provide good spatial reference points (Fig 6-1j).

Thanks to the accurate 3D diagnosis, it proved possible to place the 10 implants in the bone with good stability in the preoperatively planned positions (Fig 6-1k). At the patient's request, the dental treatment required in the mandible was to take place at a later date.

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For the treatment course, see pages 473–479.



Fig 6-1a Radiographic template – prosthesis duplicated in clear plastic.



Fig 6-1b Drill holes at the planned implant positions.

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Fig 6-1c Template in the axial section of the CBCT scan.

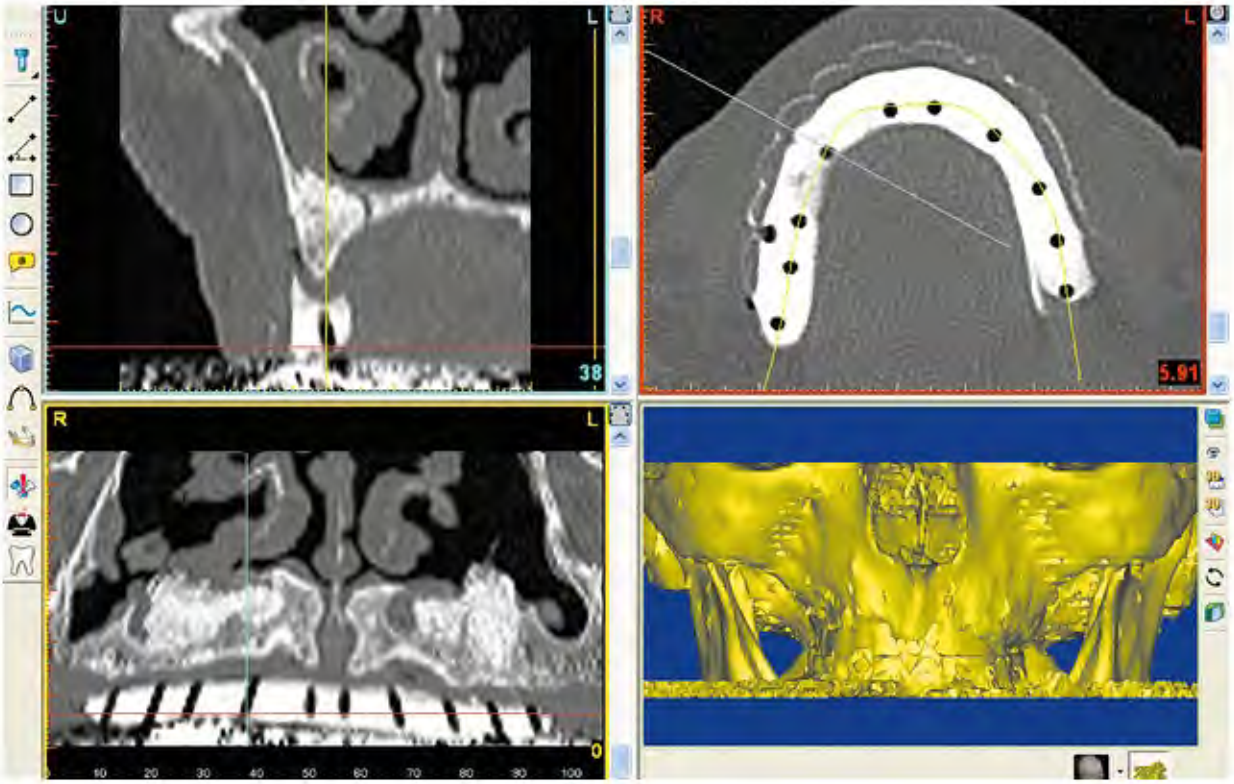


Fig 6-1d SimPlant planning with the template.

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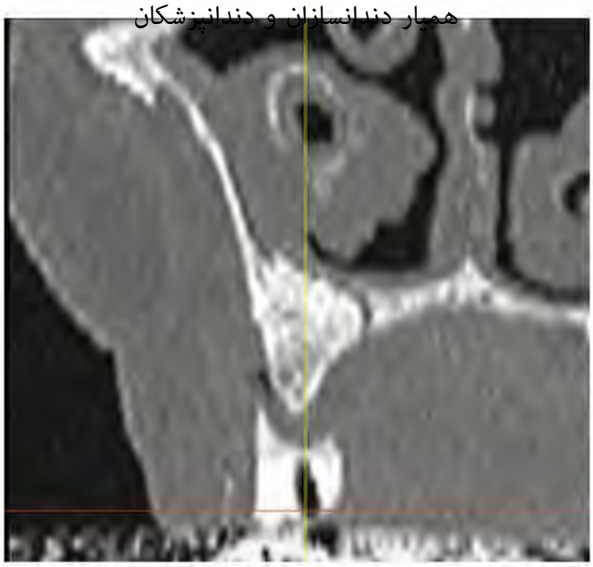


Fig 6-1e Cross section through the jaw in region 13.

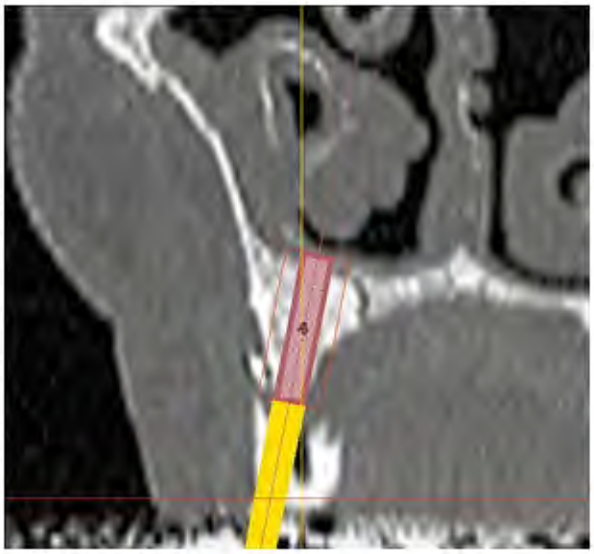


Fig 6-1f Change in inclination of implant 13.

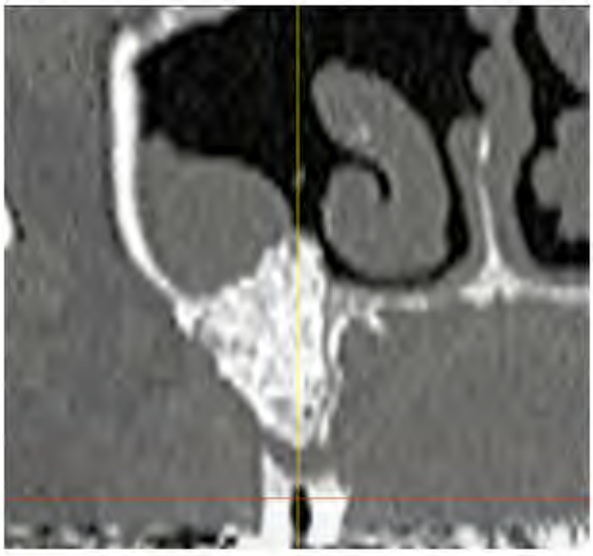


Fig 6-1g Drill hole for implant 26.

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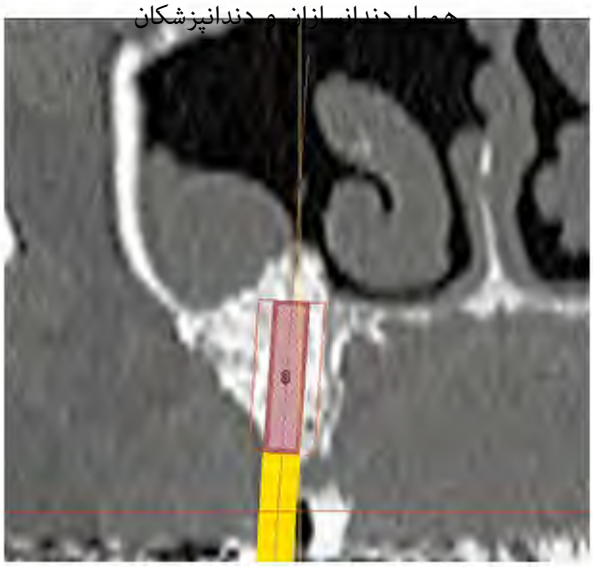


Fig 6-1h Implant 26 has been shifted slightly in the buccal direction.

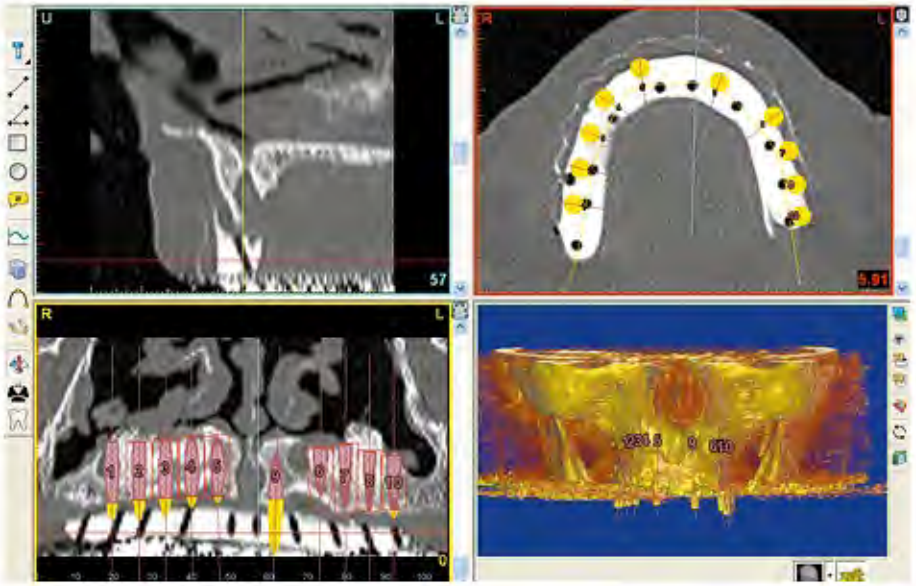


Fig 6-1i Unsuitable implant bed in region 21.

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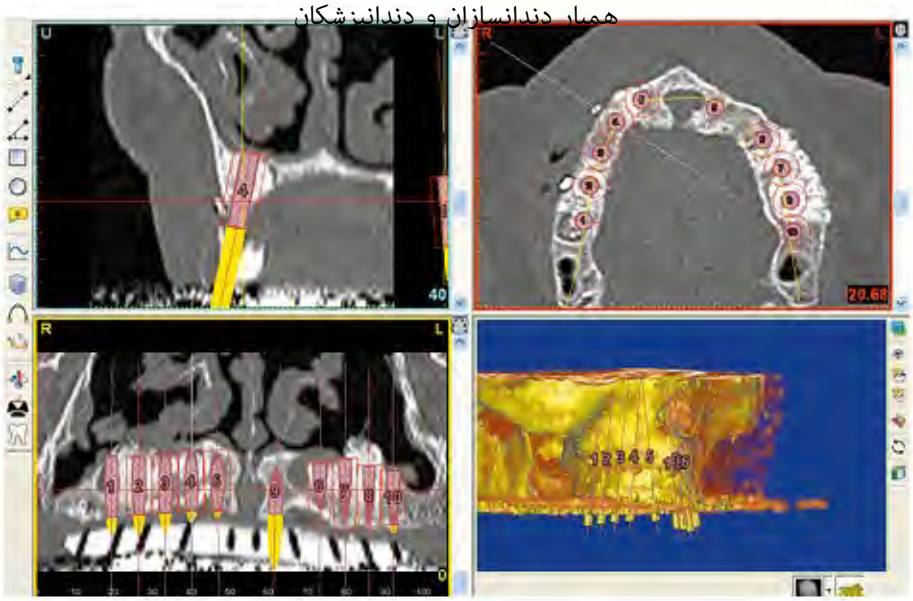


Fig 6-1j Planned positions for 10 implants. Titanium pins as spatial reference points.



Fig 6-1k Panoramic radiograph after implant placement.

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Note on the stabilization of the template

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Fig 6-2a Surgical drill template.



Fig 6-2b The template is stabilized by the mandibular dentition.

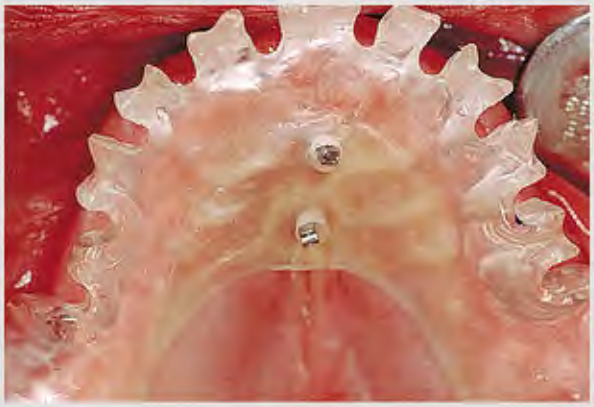


Fig 6-2c Stabilization screws driven into the palate.



Fig 6-2d Additional stabilization with the direction indicators.

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Fig 6-2e Checking the prepared implant beds.



Fig 6-2f Implants inserted following removal of the template.

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If an incision on the palatal side of the residual ridge is planned, the surgical template can be supported not only on the tuberosities, but also on the palate (Fig 6-2a). One or two additional perforations can be made in the plastic along the palatine suture, assuring stable placement of the template on screws driven into the palate (Fig 6-2a). As with the single-tooth template, the drill holes can be opened out on the labial/buccal side while preserving the tooth facets as much as possible (Fig 6-2b). If the incisal edges and occlusal surfaces of the teeth are reasonably intact, the template can be supported on the dentition of the opposing jaw, like a prosthesis (Fig 6-2b). The preserved facets also provide better spatial reference points for the surgeon.

If the position of the template has been defined with the mouth closed, its position should remain stable when the mouth is opened. The stabilization screws are driven into the palate through the perforations. The screws should be headless and with a smaller diameter than the perforations. They should be aligned parallel to each other and to the direction of insertion of the template (Fig 6-2c). These screws act as guidance pins, clearly defining the position of the template relative to the maxilla when it is inserted.

First, the template is used to drill holes for the canines and the first or second premolars. After this, the template can be stabilized further with the direction indicators, which prevent it from rotating (Fig 6-2d). With the template stable, the remaining bone beds are prepared and checked with more direction indicators (Fig 6-2e). Once the template is removed, the implants are inserted freehand into the prepared beds (Fig 6-2f). The stabilization screw is

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unscrewed from the palate.

Rehabilitation without reconstruction of the posterior maxilla

In an implant-supported restoration of the edentulous maxilla, the esthetic aspects involved in treating the anterior teeth combine with the functional aspects of restoring the posterior teeth. Above all, this means resolving the question of how the masticatory forces in the molar region (the center of occlusal force) are to be absorbed. One problem in the posterior maxilla is that very little bone tissue is often left after teeth are lost, and that this tissue also offers little retention for implants due to its cancellous structure. Without augmentation of the posterior maxilla (sinus floor elevation), implant placement is usually possible only in the anterior maxilla, where the bone supply tends to be sufficient. Even if full rehabilitation of the masticatory organ cannot be achieved, this form of restoration has also proved itself scientifically reliable. A hybrid prosthesis or a cantilever fixed implant bridge with a shortened dental arch (up to the first molar) can be incorporated.

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Typical treatment course

Bar connector restoration on six implants

Baseline situation

This female patient with an edentulous maxilla was having problems with her complete denture, particularly with the fact that it covered the palate (Fig 6-3a). She wanted to have a securely fixed and palateless prosthesis.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Implant placement

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2. Exposure and definitive prosthetic loading



Fig 6-3a Edentulous maxilla.

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Implant placement

Six implants were inserted into the anterior maxilla (Fig 6-3b). The two distal implants in regions 14 and 24 were inserted with a slight tilt in the mesial direction, to prevent contact with the maxillary sinus. This was followed by augmentation with the harvested bone chips and Bio-Oss (Geistlich). The augmentation material was covered with a membrane 30 × 40 mm in size, divided into two halves. The two halves of the membrane were attached at both the apical and coronal ends with titanium pins (Fig 6-3c).



Fig 6-3b Inserted implants with zones of labial/buccal dehiscence.

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Fig 6-3c Augmentation.

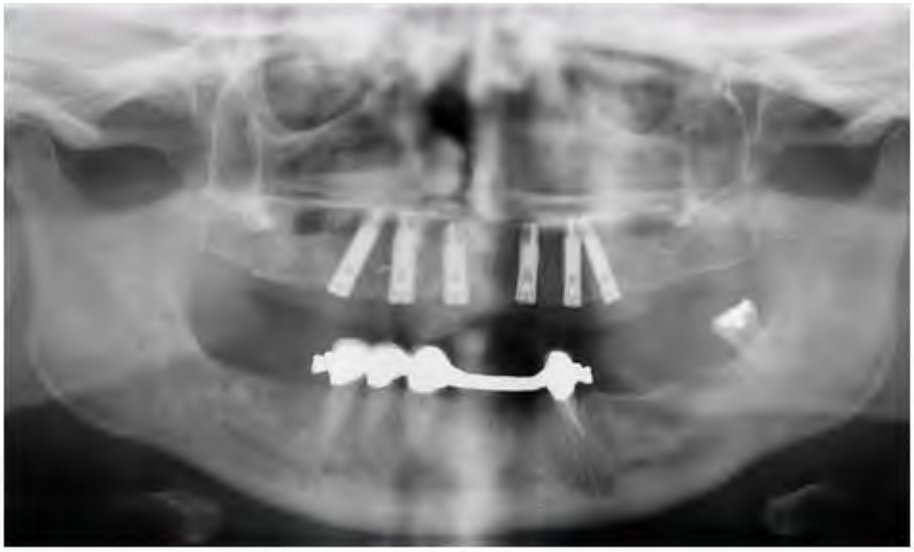


Fig 6-3d Postoperative panoramic radiograph.

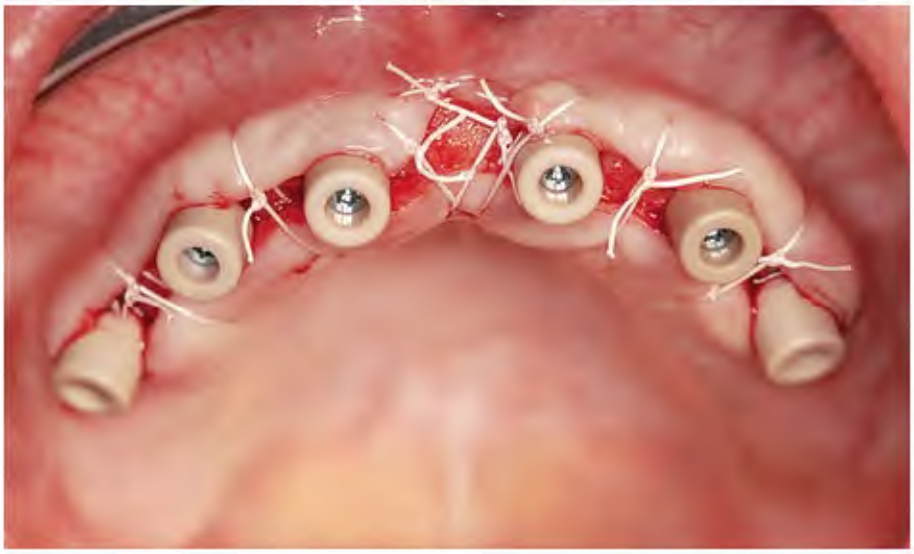


Fig 6-3e Exposure. Gingival deficit between the anterior implants.

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Fig 6-3f Milled non-noble alloy bar connector.



Fig 6-3g Metal framework of the prosthesis with incorporated MK1 attachments.

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Exposure and prosthetic restoration

The implants were ready for exposure after 6 months (Fig 6-3d). The incision was made on the palatal side, to allow keratinized gingiva to be transposed toward the labial/buccal vestibule. Once the healing abutments were screwed on, the radius of the flap was increased to such an extent as to necessitate a deficit of approximately 5 mm at the midline (Fig 6-3e; see Note on page 427). At the time of incorporation of the prosthesis 2 months later, nothing identifiable remained of the soft tissue deficit created after the exposure (Fig 6-3f). The palateless prosthesis was stabilized on the bar connector that had been milled at the same time, and additionally "locked on" with two MK1 attachments (Figs 6-3g and 6-3h). When closed, the attachments were flush with the palate plate, so that they were virtually undetectable by the tongue (Fig 6-3i). From the labial/buccal side, the prosthesis can be designed like a complete denture and the access holes to the attachments are barely visible (Fig 6-3j). The follow-up

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radiograph after 4 years of functional use shows a stable bone situation around the implants (Fig 6-3k). The patient is happy not only about her securely fitting prosthesis and the absence of a plate covering her palate, but also that the cost involved was reasonable (Fig 6-3l).



Fig 6-3h Parallel direction of insertion for the prosthesis.



Fig 6-3i Palateless prosthesis after being locked into place.

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Fig 6-3j Barely visible access holes to the locking attachments.

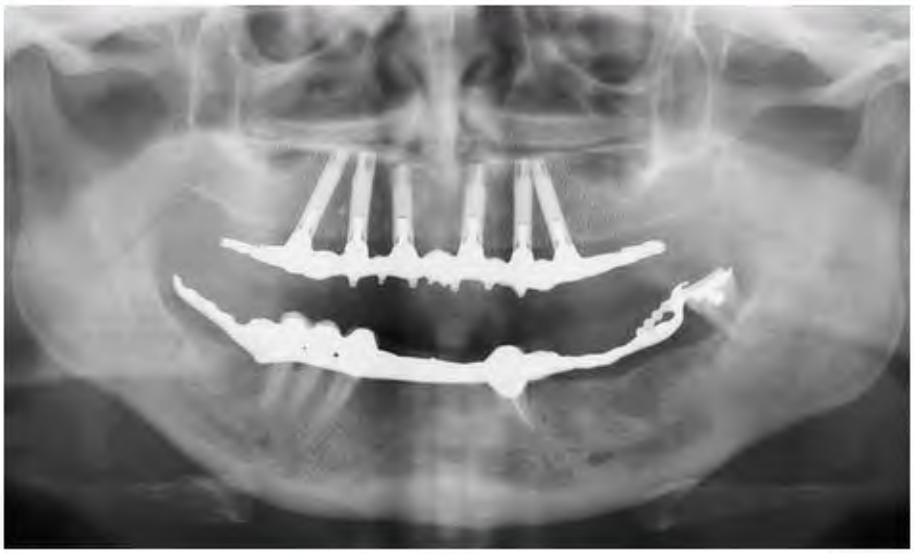


Fig 6-3k Panoramic radiograph taken after 4 years in functional use.



Fig 6-3l Patient following treatment completion.

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Treatment course

- Implant placement and augmentation (2004)
- 6 months to exposure
- 2 months to final fabrication

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Gregor Cwajgart
Dental technology:	Gerhard Makowski

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Note

Exposure technique

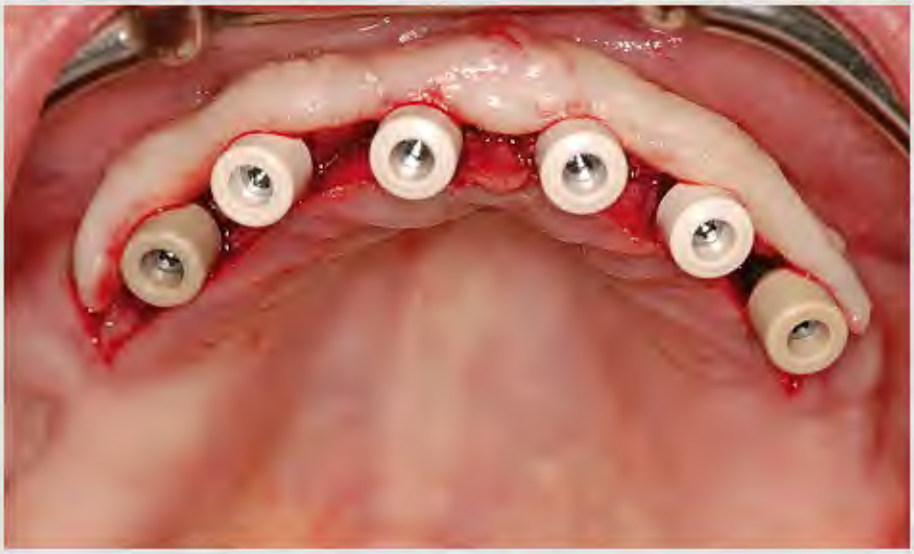


Fig 6-4a Distally extended palatal incision.

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Fig 6-4b Gingival deficits distally of the implants.



Fig 6-4c Suturing.



Fig 6-4d The distal gingival deficits have filled with granulation tissue.

When performing an implant exposure operation in the anterior region of the edentulous maxilla, the surgeon can use a technique that allows the keratinized gingiva to be transplanted in the labial/buccal direction. The incision is made continuously on the palatal

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side of the implants, but is extended by approximately 5 to 10 mm at the distal ends (Fig 6-4a). This increases the length of the flap in both directions and covers the distal implants on the buccal side (Fig 6-4b). The flap is secured with sutures in the interdental spaces and distally of the implants (Fig 6-4c). Within the next 2 weeks, the deficient regions distal from the implants normally fill completely with granulation tissue (Fig 6-4d)

Typical treatment course

Cantilever implant bridge on nine implants

Baseline situation

This female patient had an edentulous maxilla and wished to be fitted with a fixed restoration right from the start. Following the CT and panoramic radiograph analysis, the implant positions were established according to prosthetic aspects and taken into account in a custom-made template (Fig 6-5a).

Diagnostic tools

- Clinical examination
- Panoramic radiograph with template
- CT with template
- Dental cast analysis

Treatment plan

1. Implant placement
2. Exposure and long-term provisional restoration
3. Definitive prosthetic loading

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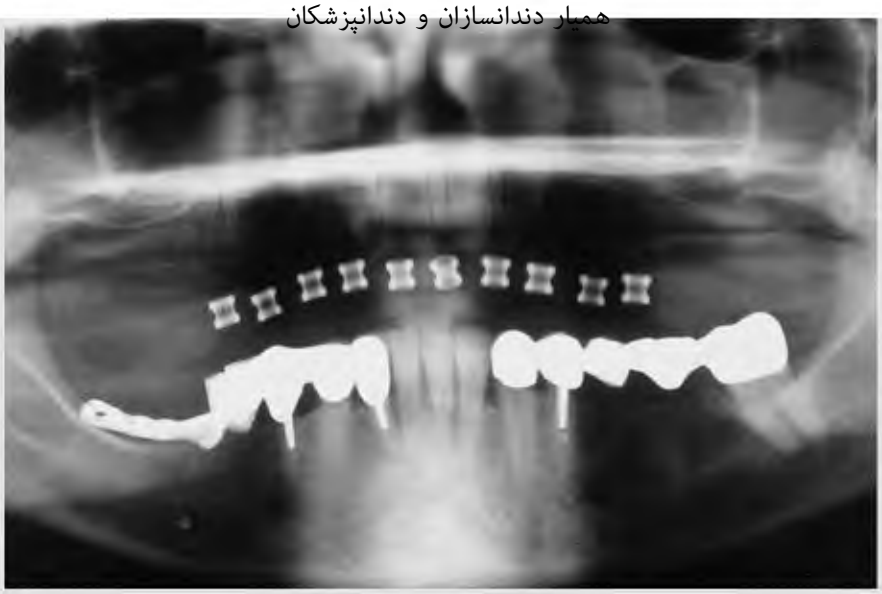


Fig 6-5a Panoramic radiograph with the template.

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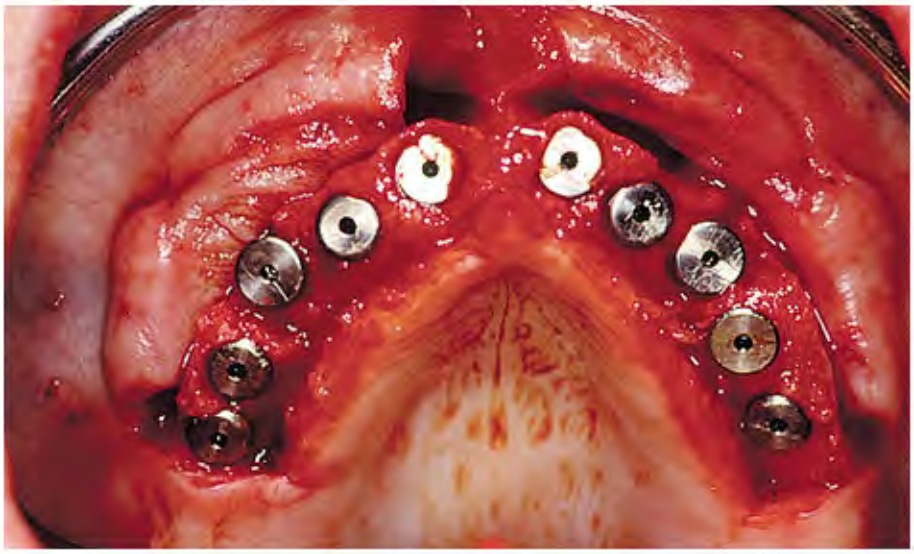


Fig 6-5b Implants in situ.

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Fig 6-5c Long-term provisional restoration.

Implant placement and prosthetic restoration

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It proved possible to insert all 10 implants at the planned positions (Fig 6-5b). At the time of exposure, however, it emerged that the 8.5-mm long implant at position 25 had not been osseointegrated. This meant that it had to be removed. A long-term provisional to be supported on the nine osseointegrated implants was fabricated according to the “Progressive Bone Loading” concept (see page 387; Fig 6-5c). This provisional was made of plastic with a metal framework and screwed onto EsthetiCone abutments (Nobel Biocare) (Fig 6-5d). The provisional could not be extended with cantilevers at the distal ends to avoid the risk of excess loading of the implants.

The definitive fixed restoration was fabricated after the patient had worn the fixed provisional for 1 year (Fig 6-5e). A cantilever could now be added to the definitive prosthesis (Fig 6-5f). After 5 years in situ, the front view of the denture is satisfactory, apart from the visible metal parts (Fig 6-5g). The panoramic radiograph shows a currently stable bone situation, along with the extent of the cantilevers (Fig 6-5h).

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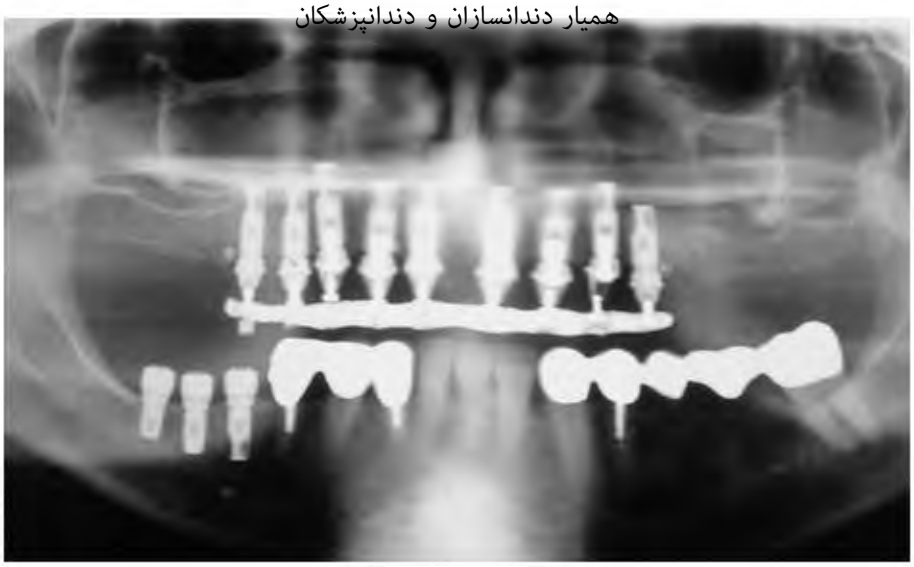


Fig 6-5d Postoperative panoramic radiograph.



Fig 6-5e Definitive superstructure.



Fig 6-5f Superstructure with distal cantilever, incorporated after 1 year.

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Fig 6-5g Clinical situation after 5 years.

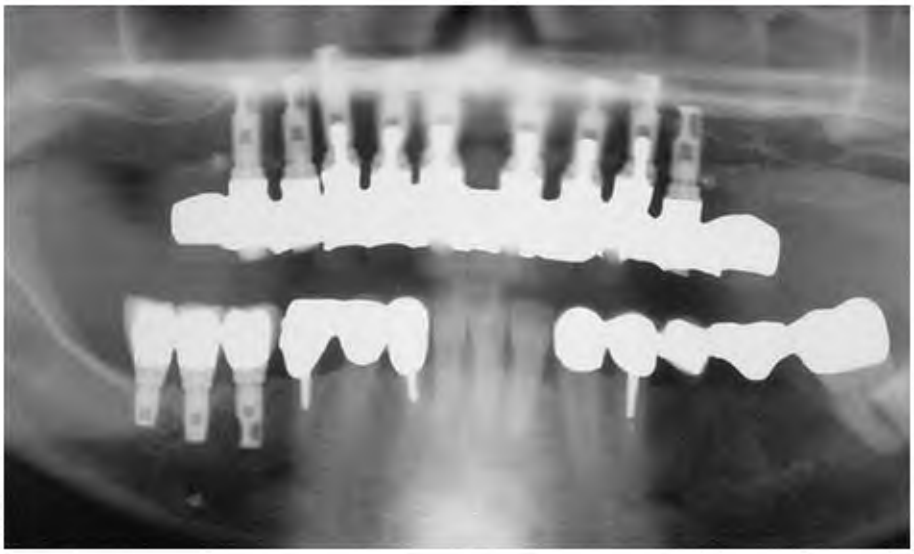


Fig 6-5h Stable bone situation.

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Treatment course

- Implant placement (1997)
- 7 months to exposure and the long-term provisional
- 1 year to the definitive loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Removable restoration – incidental finding by CT imaging

Baseline situation

For a number of years, this female patient had worn an overdenture as her maxillary restoration. However, the two canines that had supported the denture now needed to be extracted (Fig 6-6a). Therefore, the plan was to fit her with a removable bar connector prosthesis on six implants.

Diagnostic tools

- Clinical examination
- Panoramic radiograph with template
- CT with template
- Dental cast analysis

Treatment plan

1. Extraction of the impacted tooth and implant placement
2. Exposure, extraction and definitive prosthetic loading



Fig 6-6a The non-preservable canines, which have held the overdenture in place.

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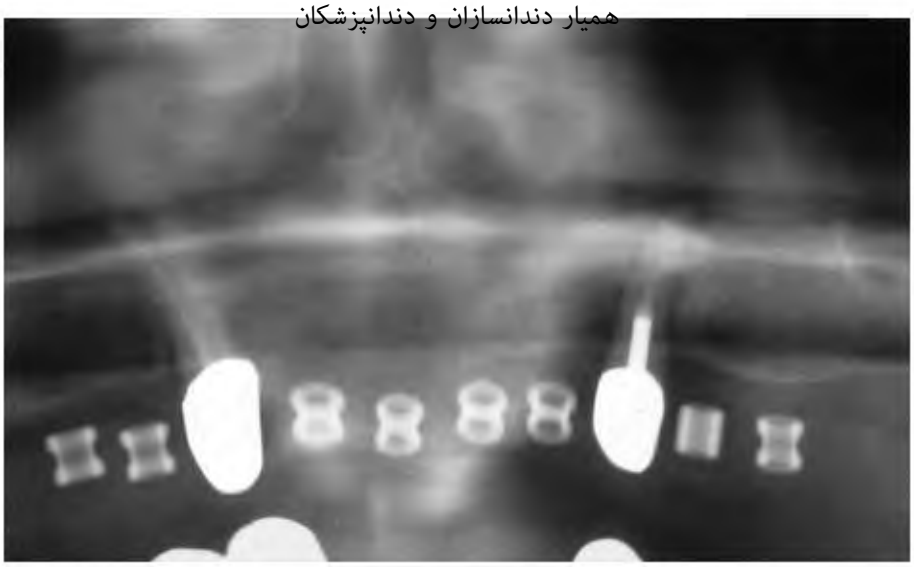


Fig 6-6b Panoramic radiograph with template. One retained tooth, barely visible.

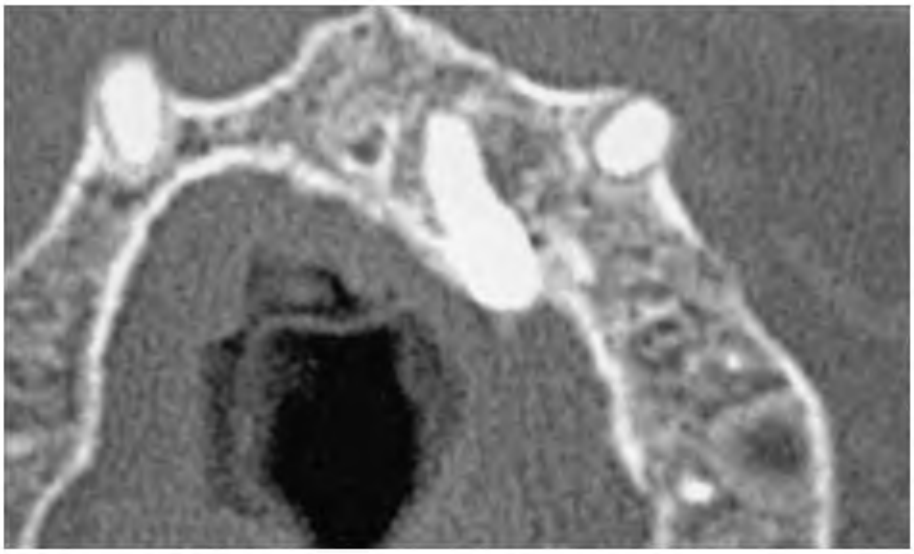


Fig 6-6c The retained tooth on the CT scan image.

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Implant placement and extraction

However, the diagnostic investigations for the patient's restoration revealed an incidental finding. On the panoramic radiograph (Fig 6-6b) one can barely distinguish an ectopic, impacted tooth in the maxillary bone in regions 21 to 23. The root apex of this tooth was close to the planned implant position (Fig 6-6c). The three-dimensional (3D) visualization in the CT scan allowed the position of this tooth to be accurately determined. The vertical sections show that the body of the tooth runs from the palate and into the nasal cavity (Fig 6-6d). During implant placement, the palatal mucosa was dissected away, the tooth divided and removed. The extracted tooth can be seen in Fig 6-6e. Following the extraction, the implants were successfully inserted into region 21 and five further positions, as planned.

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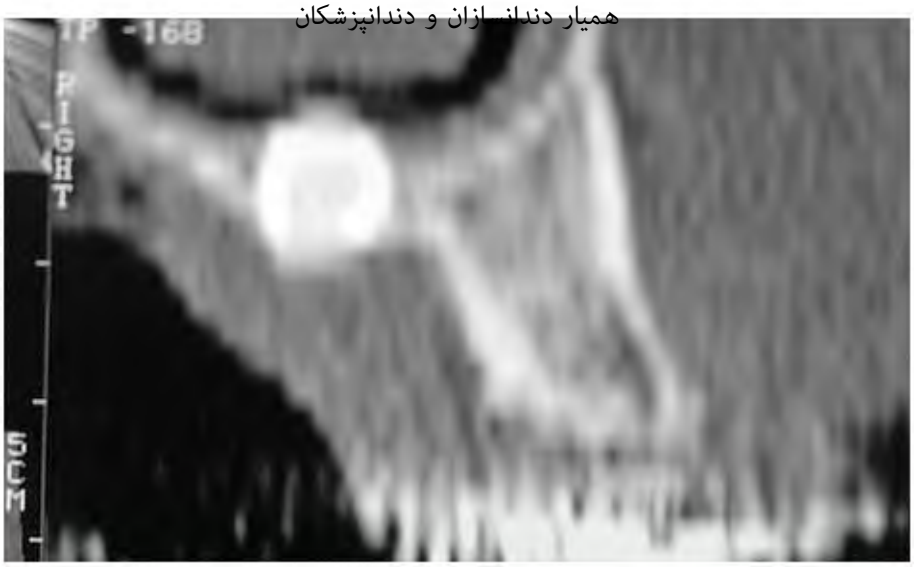


Fig 6-6d Side view of the tooth in cross section.



Fig 6-6e The retained tooth following extraction.



Fig 6-6f Implants following exposure, with the teeth still in situ.

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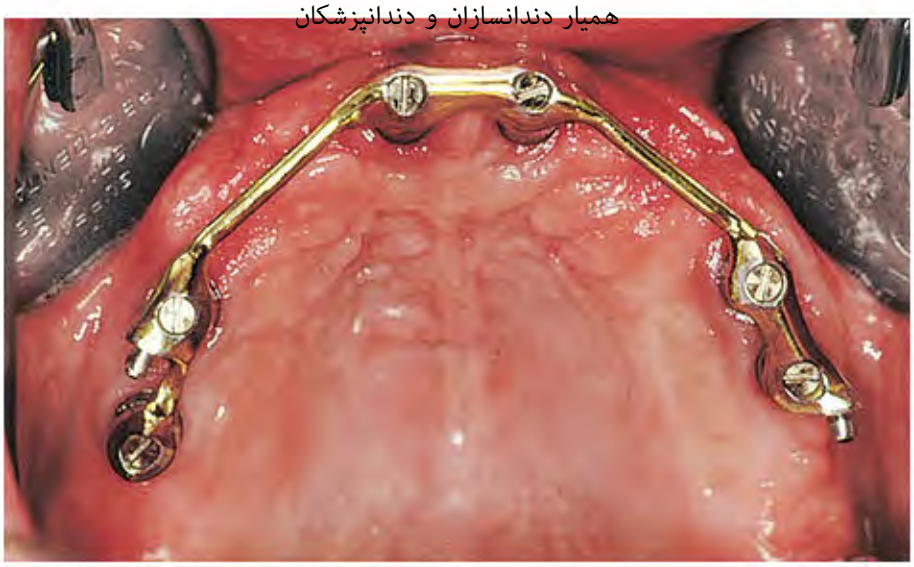


Fig 6-6g Denture with bar connector.



Fig 6-6h Retaining elements in the prosthesis.



Fig 6-6i Bar connector after 5 years of functional use.

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Prosthetic restoration

The canines were left in situ until the new prosthetic restoration was fabricated, so that they could continue to secure the overdenture (Fig 6-6f). Five weeks after exposure, a fabricated continuous bar connector was screwed on to the six implants (Fig 6-6g). The distal locking attachments hold the palateless denture securely in place (Fig 6-6h). The bar connector and the mucosal situation remain stable 5 years after the implants were loaded with the prosthesis (Fig 6-6i). The condition of the prosthesis is also satisfactory (Fig 6-6j). Moreover, a stable bone situation is apparent from the follow-up panoramic radiograph taken after 5 years (Fig 6-6k).



Fig 6-6j Overdenture after 5 years.

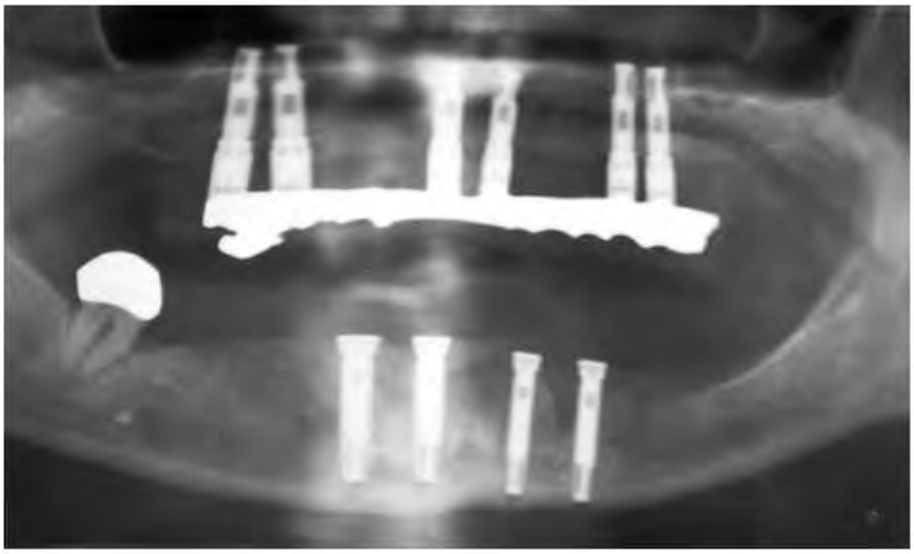


Fig 6-6k Stable bone situation at the same point in time.

Treatment course

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- Extraction of the retained tooth, implant placement (1996)
- 6 months to exposure
- 5 weeks to extraction of the canines and the definitive prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Problems and complications

Fixed restoration with a change in implant inclination – a mechanical complication

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Baseline situation

This male patient, who had already been edentulous for 15 years (Fig 6-7a), had a removable complete denture as his maxillary restoration. In contrast, the overdenture in the mandible had been stabilized with the aid of two implants and a bar. The patient wanted a fixed restoration for the maxilla. However, both maxillary sinuses showed pronounced pneumatization, so the bone supply in the anterior maxilla was very limited (Fig 6-7b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph with template
- CT with template
- Dental cast analysis

Treatment plan

1. Implant placement in the maxilla and mandible
2. Exposure and definitive prosthetic loading

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Fig 6-7a The patient's edentulous maxilla.



Fig 6-7b Panoramic radiograph.

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Implant placement and exposure

The custom-made surgical template with the desired implant positions was fabricated in the laboratory and placed into the operation site following flap reflection (Fig 6-7c). Since the template did not stay in place securely due to the high proportion of unattached mucosa, it was stabilized further with direction indicators once the first two beds were drilled. Only then were the beds for the remaining implants drilled (Fig 6-7d).

The residual ridge had atrophied greatly during the 15 years' use of the complete denture and was narrower than the diameter of the implants. Consequently, the implant threads were exposed on both the labial/buccal and palatal sides. Moreover, the implants had to be placed further palatally than originally planned (Fig 6-7e). Bone augmentation was performed with a

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mixture of Bio-Oss and bone chips, not only on the labial/buccal but also the palatal side (Fig 6-7f). Bio-Gide (Geistlich) membranes were used to cover the augmentation.

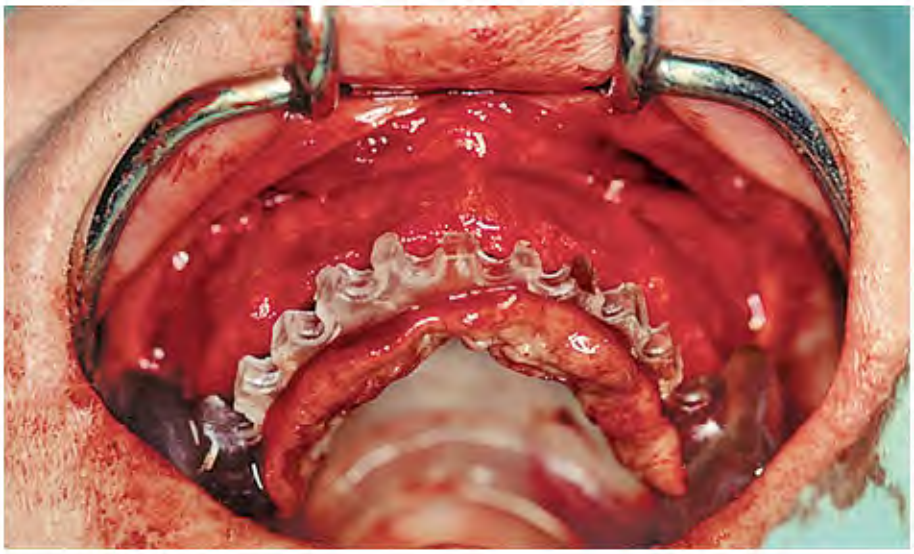


Fig 6-7c Surgical template following flap reflection.



Fig 6-7d Stabilization of the template with the direction indicators.

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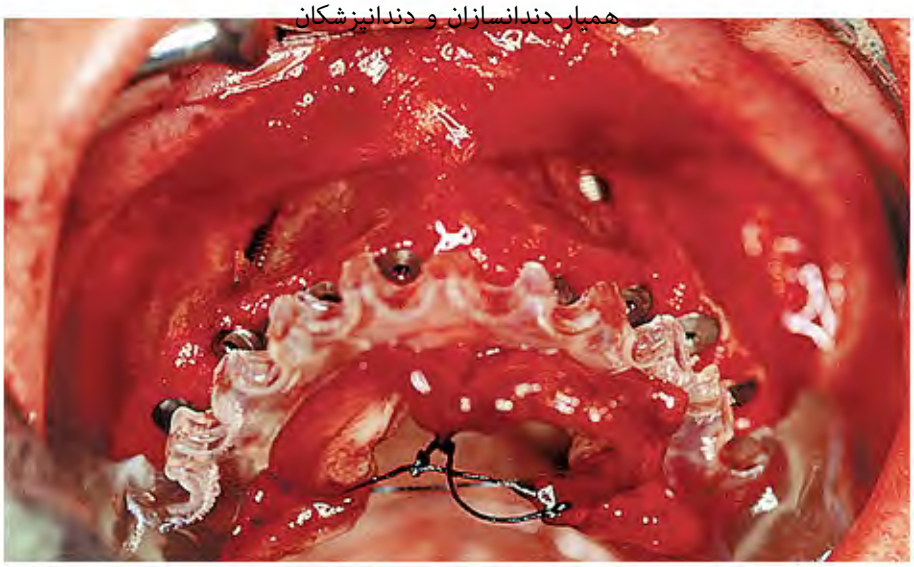


Fig 6-7e Implants inserted further palatally than planned.

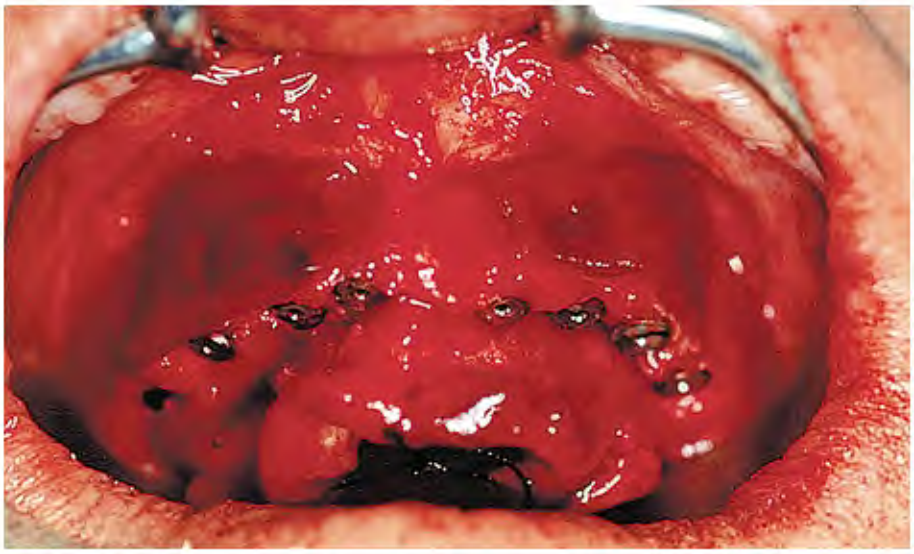


Fig 6-7f Bone augmentation.



Fig 6-7g EsthetiCone abutments.

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Fig 6-7h Angled abutments to correct the inclination of the implants.

Following healing and exposure, the implants were fitted with EsthetiCone and angled abutments (Fig 6-7g). The deliberate inclination of implants 13 and 25 to avoid the maxillary sinus was compensated for by using abutments angled at 17 degrees (Fig 6-7h).

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Fig 6-7i Cantilever fixed restoration screwed into place.

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Fig 6-7j Gold crown 24 fitted at the patient's request.



Fig 6-7k The patient 5 years after completion of the treatment.

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Fig 6-7l Stable bone situation at the same point in time.

Prosthetic restoration

The cantilever implant bridge replacing teeth 16 to 26 was screwed onto the implants with occlusal screws (Fig 6-7i). At the patient's request, crown 24, like the one in his previous complete denture, was fabricated out of gold (Fig 6-7j). The patient is very satisfied with the fixed restoration of both mandible and maxilla (Fig 6-7k). The follow-up radiograph after 5 years of wear confirms a stable bone situation even in the presence of the inclined implants in regions 13 and 25 and the short 8.5-mm implant in region 15 (Fig 6-7l).

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Treatment course

- Implant placement and augmentation (1996)
- 6 months to exposure
- 2 months to fabrication

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski
Dental technology: Horst Mosch

Note

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Mechanical complications





Patients with fixed implant-supported prostheses in both mandible and maxilla often generate enormous masticatory forces, as the restorations are very stable and can take high loads. At the same time, however, the masticatory apparatus loses most of its sensitivity (as there is no periodontal feedback), so that mechanical complications, such as fractures or the prosthesis teeth snapping off, are not uncommon (Figs 6-8a and 6-8b). This risk can be minimized if the teeth are set up in balanced articulation and all early contacts are eliminated.

Immediate loading

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Immediate loading of definitive implants with NobelGuide

Baseline situation

This female patient, who had had an edentulous maxilla for many years, was having a lot of trouble with her uncomfortable complete denture. On clinical inspection, the dimensions of the residual ridge still seemed adequate (Fig 6-9a), but the tomographic imaging performed for planning purposes showed that it was narrow and that implant placement could only be considered on a conditional basis (Fig 6-9b). The patient had heard about the NobelGuide technique from an advertising campaign (Nobel Biocare) and was now insisting that this method be used for her treatment.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- Double CBCT
- NobelGuide planning
- Dental cast analysis

Treatment plan

1. Implant placement, immediate definitive prosthetic loading or long-term provisional restoration



Fig 6-9a The edentulous maxilla before treatment.

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Fig 6-9b 3D planning of the implants.

Preoperative preparation

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Using two CBCT scans (patient with prosthesis and the prosthesis alone) as the basis, the 3D planning was carried out with the NobelGuide software. Based on the data set, a 3D template was fabricated in Sweden and sent to the clinic (Fig 6-9c). With the aid of the template, implant analogs were inserted into the definitive cast at the exact positions where implants were to be placed in the maxilla later on (Fig 6-9d). The dental prosthesis was then fabricated on the resultant cast even before the operation (Fig 6-9e). The prosthesis needed to be able to compensate for any irregularities, particularly those caused by mucosal resilience during the operation. It was to be used as a long-term provisional restoration and, in the best-case scenario, even as the definitive one. An occlusion rim was also made out of putty to ensure exact positioning of the template (Fig 6-9f).



Fig 6-9c NobelGuide template.

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Fig 6-9d Implants placed into the definitive cast.



Fig 6-9e Dental prosthesis fabricated in advance.



Fig 6-9f Occlusion rim used to position the template.

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Implant placement and immediate restoration

Following extensive block and infiltration anesthesia (it is extremely difficult to top up the anesthesia with the template in situ), the template was placed into the mouth with the occlusion rim. To enable the relative positions of the occlusion rim to the template to be verified, vertical lines were drawn on both with a marker pen (Fig 6-9g). After the template was

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inserted, the patient was asked to bite down hard for a few minutes, to reduce the mucosal swelling caused by the infiltration anesthesia. With the patient still biting down lightly, three holes were drilled through the horizontal sleeves and the template secured to the jaw with three pins. After this, beds were drilled for implants 13 and 24 using sleeves that had been adjusted relative to one another, and these implants were placed. The insertion mounts were then replaced with stabilization abutments and two further implants inserted into regions 14 and 23 (Fig 6-9h). After all the implants were placed, the template was removed, showing how atraumatic this method is (Fig 6-9i). The abutments prepared in advance in the laboratory were screwed on in pairs and incorporated into the dental prosthesis with Pattern Resin (GC America) (Fig 6-9j). The completed dental prosthesis was finished and polished by the laboratory technician (Fig 6-9k) and attached to the implants in the mouth with screws. The screw access holes were provisionally sealed (Fig 6-9l). After only one operation, the patient was able to leave the clinic immediately with a fixed restoration. She was fully fit, with no pain or swelling (Fig 6-9m). The final photo shows the dental prosthesis after 4 years of functional use (Fig 6-9n).

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Treatment course

- Planning and advance fabrication of the template and the dental prosthesis
- Implant placement and immediate prosthetic restoration (2005)

Treatment

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Dental technology: Horst Mosch

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Fig 6-9g Occlusion rim with template in situ.

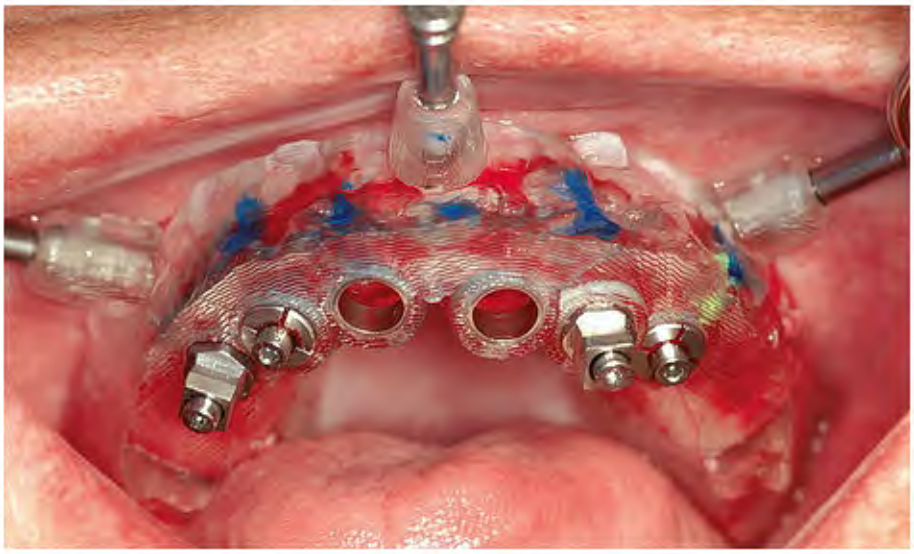


Fig 6-9h Insertion of the implants through the template.

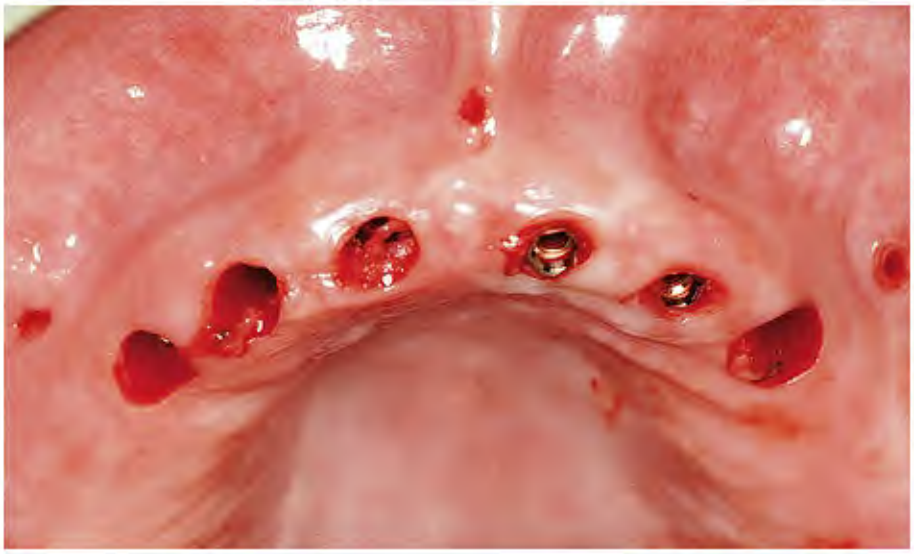


Fig 6-9i Inserted implants following removal of the template.

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Fig 6-9j Inserting the abutments.



Fig 6-9k Finished prosthetic restoration prior to fitting.

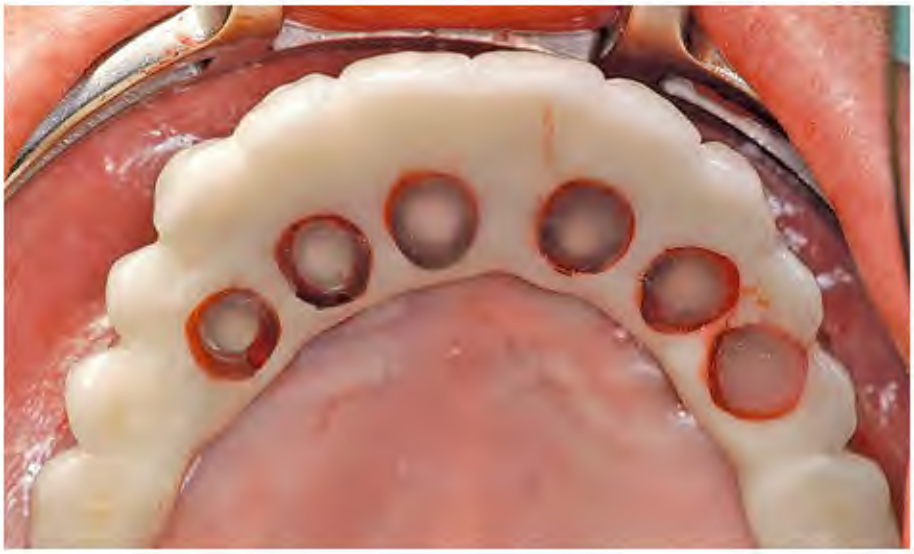


Fig 6-9l Treatment completion; the screw access holes have been sealed off.

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Fig 6-9m Fixed implant bridge in situ.



Fig 6-9n The same restoration after 4 years of functional use.

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Note

Immediate restoration on healing abutments

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Fig 6-10a Maxilla before the extraction.

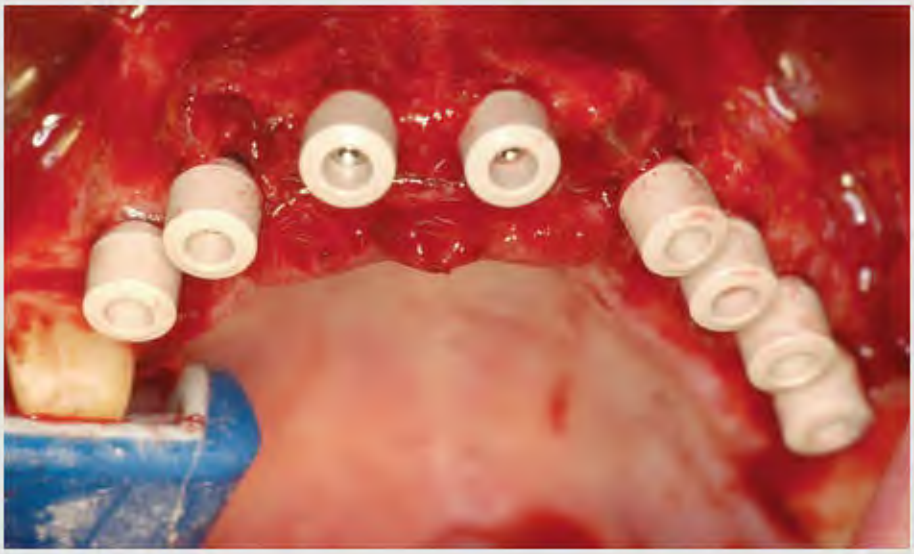


Fig 6-10b Healing abutments screwed onto the implants.

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If the bone situation is good, it is sometimes possible to insert implants following extraction and load them immediately with a provisional restoration. In this sort of situation, it is an advantage if a few posterior teeth can continue to carry most of the load during the healing period, at least, and if a sufficient number of long implants can be inserted with primary stability. In the case reported here, the four anterior teeth were extracted, while the posterior teeth were left in situ (Fig 6-10a). Both extraction and implant placement took place under general anesthesia. Before the operation, the existing crowns had to be removed from the posterior teeth and the latter prepared accordingly. Here, three implants were inserted on the right side and five on the left, all with primary stability, and fitted with healing abutments directly afterwards (Fig 6-10b). Filling of the bone defect was followed by tight suturing of the wound (Fig 6-10c). The thermoplastic foil, which had been prepared in advance, was tried in. It needed to lie over the implant abutments and the patient's own teeth without tension and be supported by the opposing dentition when the patient was biting

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down (Fig 6-10d). The foil was filled with a material for provisional restoration (eg, Protemp; 3M ESPE) and held in place by biting down until the material hardens. The provisional is then taken out of the foil, shaped and reincorporated (Fig 6-10e). It was attached to the teeth with provisional cement (eg, TempBond; Kerr), to avoid any hypersensitivity reactions. On the other hand, provisional cementing is usually unnecessary on healing abutments, as the retention is generally sufficient and no hypersensitivity reactions are likely. After 2 weeks, the provisional was taken out for removal of the sutures and a wound check, and was then set back into place (Figs 6-10f and 6-10g). Over the subsequent weeks, it could be replaced with a long-term provisional.

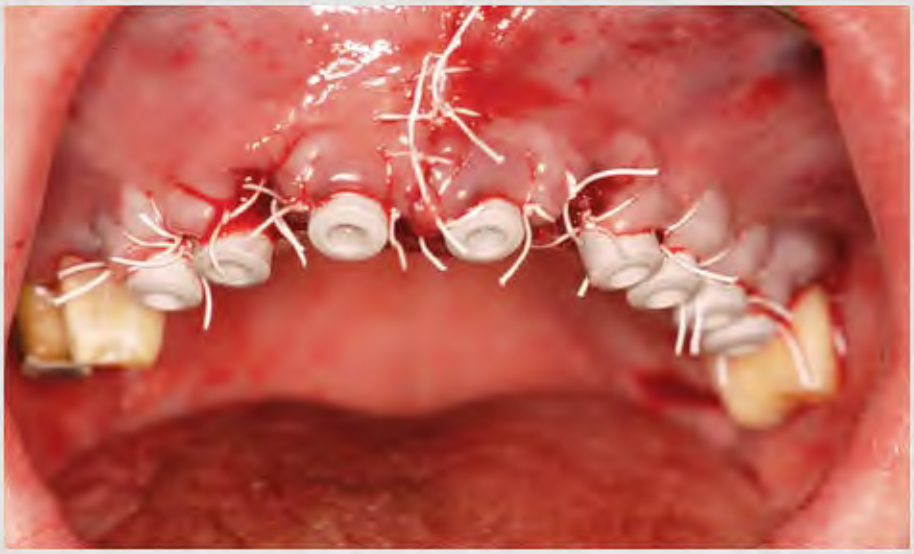


Fig 6-10c Suturing after implant placement and augmentation.



Fig 6-10d Try-in of the thermoplastic foil.

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Fig 6-10e Completed immediate provisional restoration.



Fig 6-10f Removal of the sutures.



Fig 6-10g Clinical situation after 2 weeks.

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Rehabilitation with reconstruction of the posterior maxilla

Considerable bone loss is often seen in the maxillary sinus due to the loss of teeth in the molar region. This bone loss progresses in the caudal and mesial directions. The technique known as sinus floor elevation, or simply sinus floor elevation, has become an established way of creating a firm “foundation” in this region (see page 383). It is a highly effective surgical procedure, enabling full prosthetic rehabilitation of the posterior maxilla to be achieved.

After bone augmentation in the posterior maxilla, where the masticatory forces are at their most powerful, implants can be placed there in accordance with static principles. In exchange, the anterior maxilla can be restored with pontics fabricated with esthetics in mind, without the use of implants. Moreover, the whole maxilla offers sufficient space for the abutments needed for a provisional restoration, whether it is supported on the patient’s own teeth or on provisional implants.

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Typical treatment course

Sinus floor elevation and implant placement in a single session

Baseline situation

This female patient with an edentulous maxilla had a complete removable denture that was causing her a lot of trouble. She wanted to have a fixed or securely anchored prosthetic restoration loaded onto implants (Fig 6-11a). The residual ridge has already atrophied extensively, especially on the left side (Fig 6-11b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation, implant placement and lateral augmentation

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2. Exposure and widening of the zone of attached gingiva
3. Definitive prosthetic loading



Fig 6-11a The patient's edentulous maxilla.

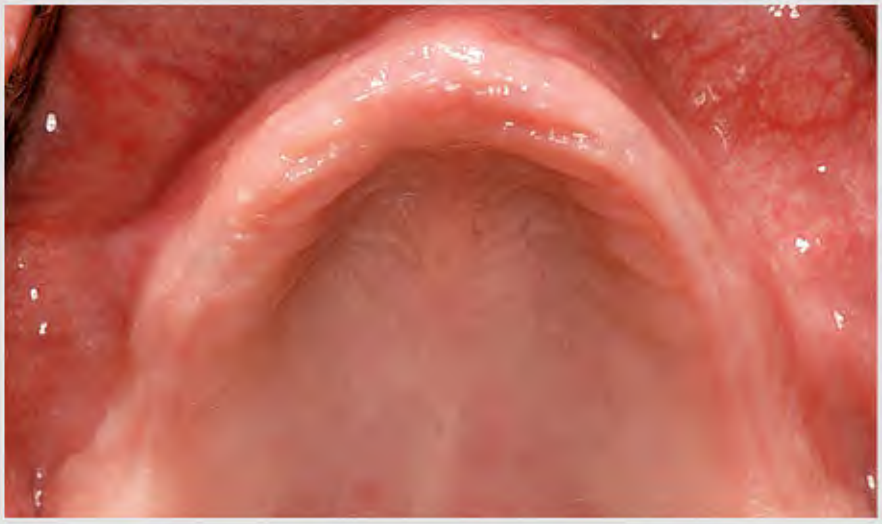


Fig 6-11b More severe atrophy on the left side.

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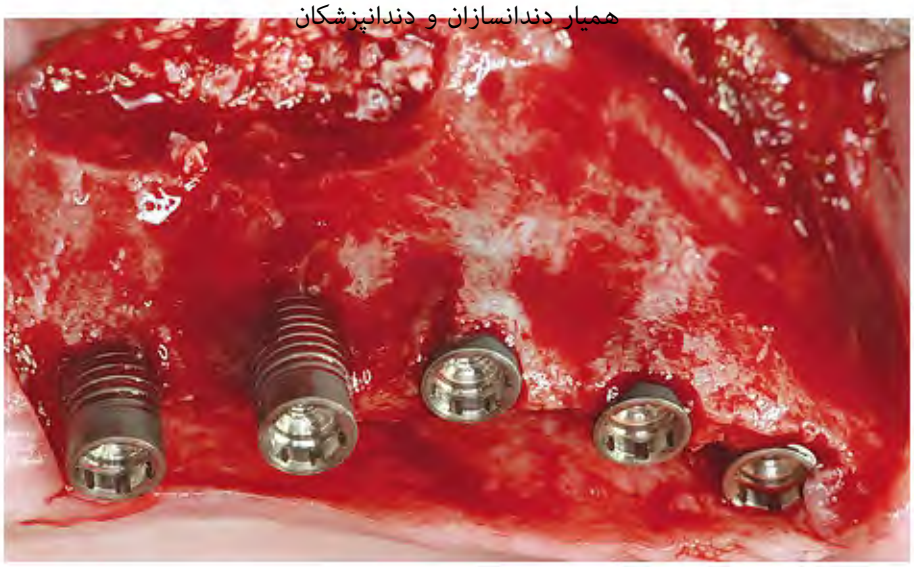


Fig 6-11c Implantation performed concomitantly with sinus elevation.

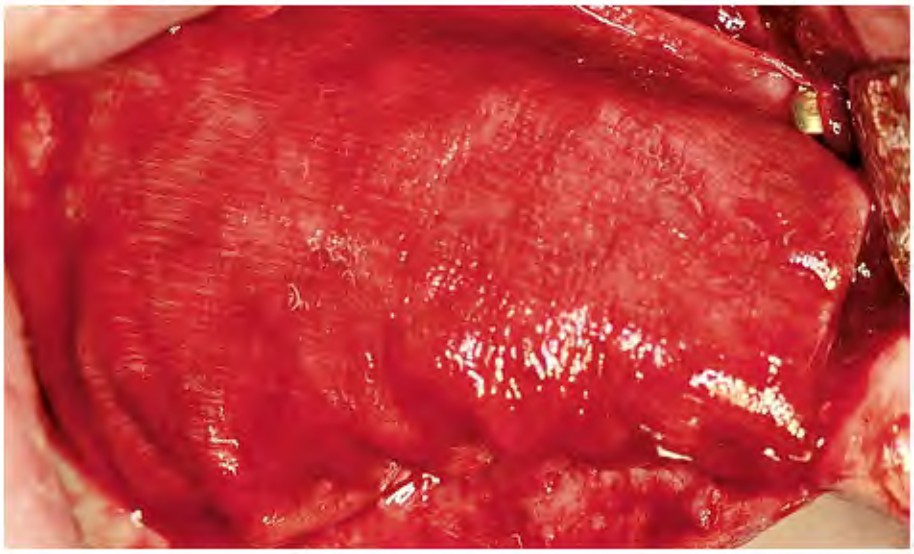


Fig 6-11d Augmentation on the right side.

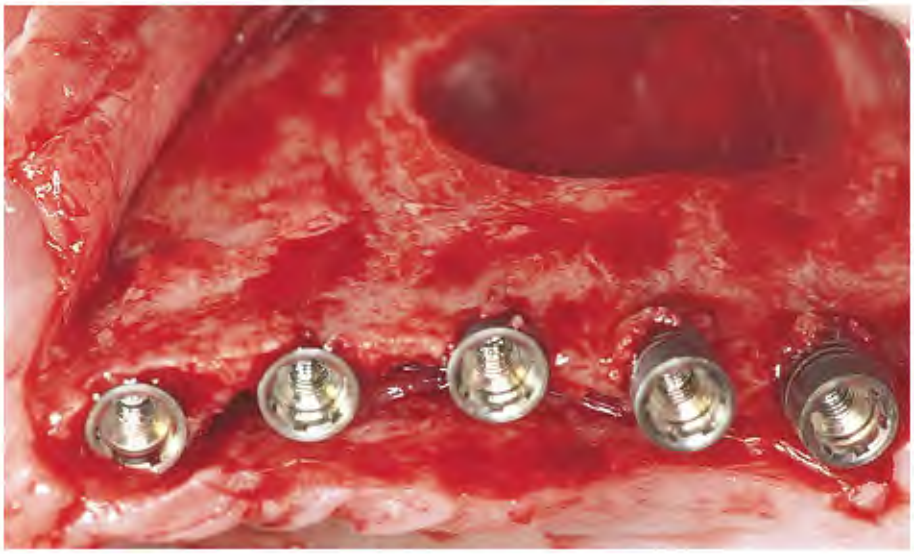


Fig 6-11e Stable insertion of the implants on the left side despite the narrow jaw.

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Since the dimensions of the bone in the posterior maxilla were still sufficient to anchor implants with primary stability, implant placement was performed in the same session as sinus elevation (Fig 6-11c). The maxillary sinus was prepared first, after which the implant beds were drilled and the three mesial implants fully inserted.

Initially, the two distal implants were not inserted fully. The maxillary sinus was then augmented, allowing these implants to also be inserted fully. After the cover screws were fitted, lateral augmentation was performed with harvested bone chips and Bio-Oss. The membrane was attached to the maxilla with titanium pins (Fig 6-11d). This procedure was repeated on the left side (Fig 6-11e). The residual ridge was quite narrow in the anterior maxilla, and the implants were inserted further toward the palatal direction (Fig 6-11f). The bone was also augmented over the screw threads exposed on the palatal side (Fig 6-11g). A membrane was attached with pins at the apical end and pushed under the palatal periosteum (Fig 6-11h). This was followed by saliva-proof closure of the operation site. The postoperative panoramic radiograph shows the positions of the implants and the extent of sinus elevation (Fig 6-11i).

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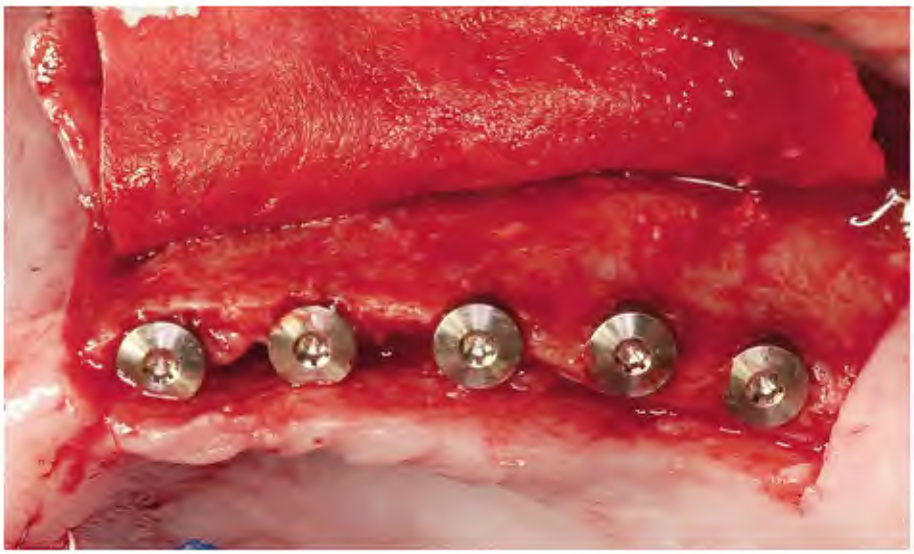


Fig 6-11f Membrane attached at the apical end.

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Fig 6-11g Palatal augmentation was also necessary.

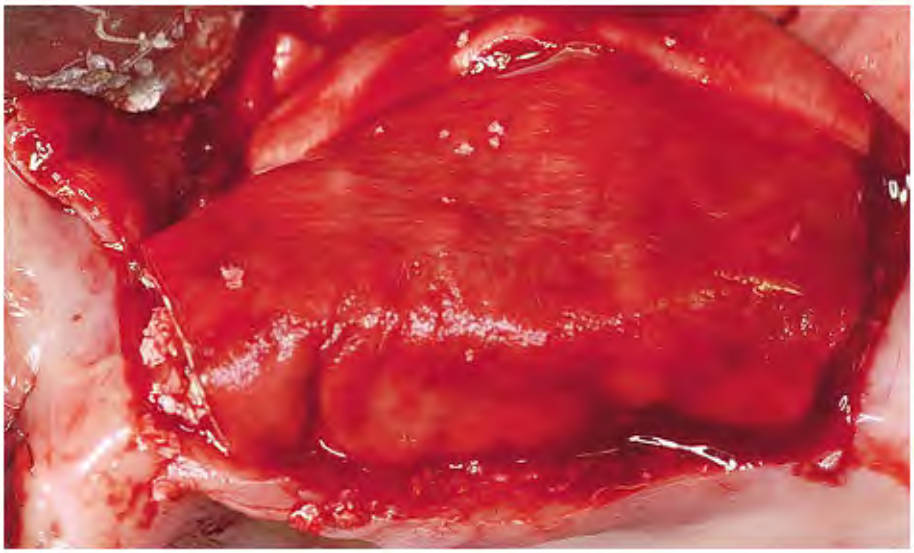


Fig 6-11h Augmentation material stabilized with the membrane.



Fig 6-11i Postoperative panoramic radiograph.

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Exposure

The healing period was uncomplicated and the implants were exposed 10 months after the first operation (Fig 6-11j). The residual ridge looked much wider compared to baseline, which suggests a successful augmentation (compare Figs 6-11b and 6-11k). On close inspection, however, we found that the solid substructure was covered only with unattached mucosa on the labial side (Fig 6-11l). In fact, the time of implant exposure offers the best opportunity of correcting this, by transplanting keratinized gingiva from the palate to the vestibule in the form of a pedunculated graft (Fig 6-11m). Sutures were used to bring the soft tissue of the palate much closer to the tissue surrounding the implants (Fig 6-11n). On the left side, the implants were already faintly visible through the unattached mucosa (Fig 6-11o). The incision was also made on the palate, alongside the implants (Fig 6-11p). Distal extension of the incision enabled better adaptation of the flap and made suturing easier (Fig 6-11q). Three weeks after exposure, the soft tissue situation on both sides was stable (Figs 6-11r and 6-11s). The zone of attached gingiva around the implants had a positive effect on their long-term prognosis. Direct comparison of the residual ridge at the start of the treatment and after the surgical and regenerative phase shows a marked improvement (Figs 6-11b and 6-11t), which is even more remarkable, given that the result was achieved by relatively simple means (ie, with no bone block grafts, mucosal distraction or free mucosal grafts) in only two sessions. The impression for the prosthetic restoration was taken once the correct positioning of the impression copings was checked on the radiograph (Fig 6-11u).

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Fig 6-11j Clinical situation after 10 months.

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Fig 6-11k Residual ridge made wider by augmentation.

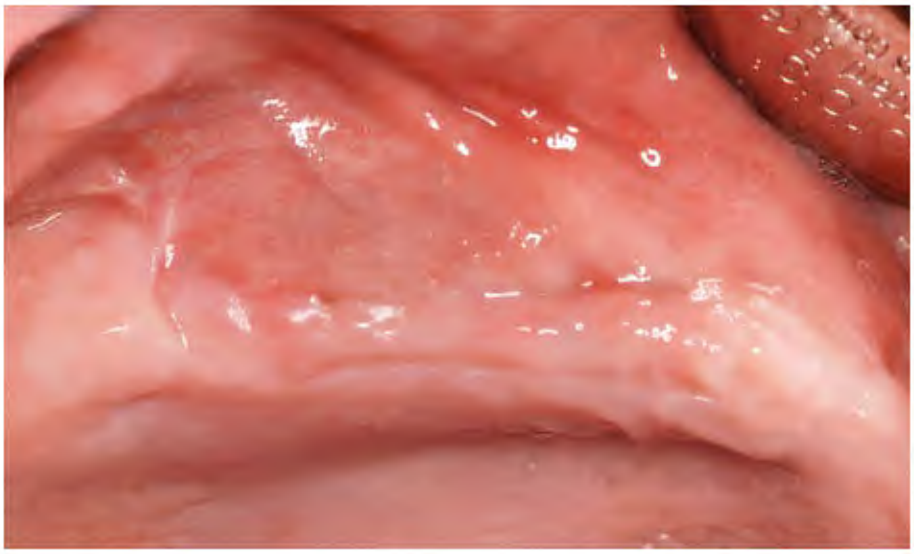


Fig 6-11l Unattached mucosa on the residual ridge.

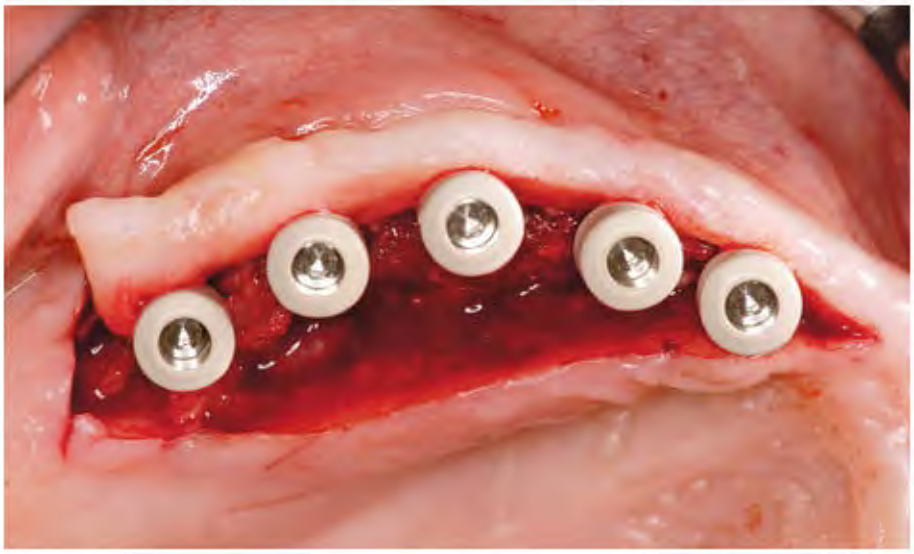


Fig 6-11m Attached gingiva gained from the palate at the time of implant exposure.

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Fig 6-11n Fixing the gingiva into place with sutures.



Fig 6-11o The implants shimmering through the mucosa.



Fig 6-11p Palatal incision on the left side.

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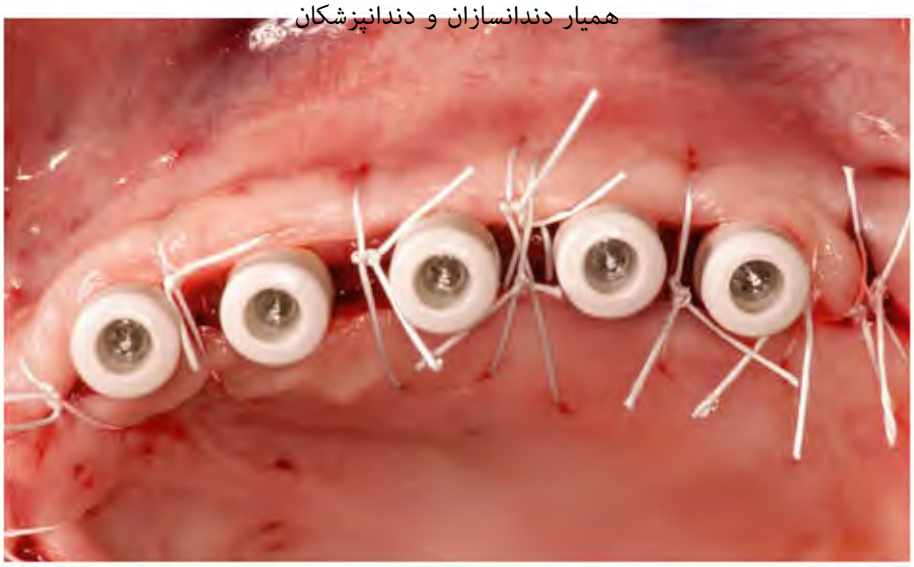


Fig 6-11q Widening the zone of attached gingiva on the left side.

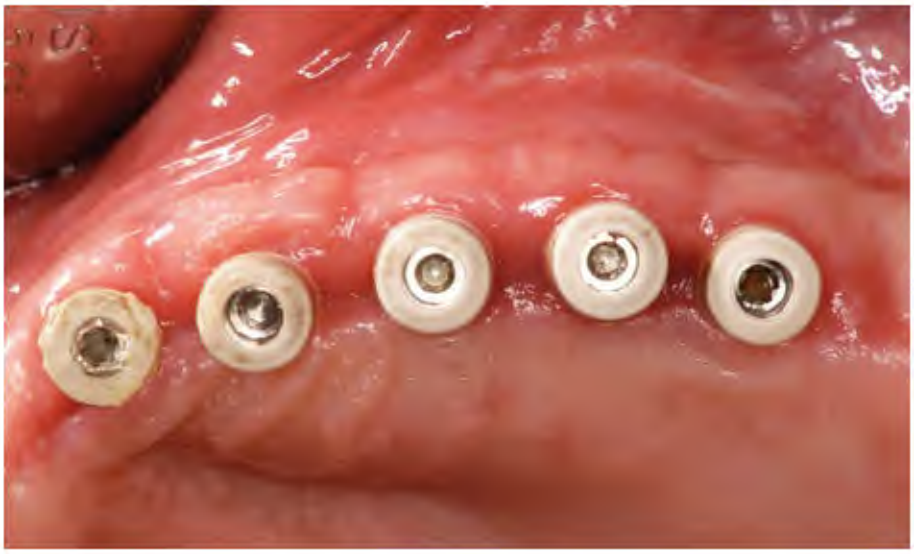


Fig 6-11r Stable gingival situation after 3 weeks.



Fig 6-11s Wider gingiva on the right side.

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Fig 6-11t Wide residual ridge compared to baseline (Fig 6-11b).



Fig 6-11u Check panoramic radiograph with the impression posts.

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Treatment course

- Sinus floor elevation with implant placement and augmentation (2007)
- 10 months to exposure

Treatment

Surgery: Dr Christoph T. Sliwowski

Typical treatment course

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Severe residual ridge atrophy: sinus floor elevation and vertical augmentation prior to implant placement

Baseline situation

Originally, this female patient with an extremely atrophied maxilla had experienced a lot more problems with a loose denture in the similarly atrophied mandible; the right side was particularly badly affected. The mandibular problem had been largely resolved 5 years before the treatment of the maxilla, by means of a cantilever fixed bridge on six implants placed in the interforaminal region (Fig 6-12a). However, the continuing progression of the atrophy of the mandibular residual ridge had since caused the implants to become exposed, and the mobile mucosa around the implants may require surgical intervention.

The patient only became aware of the poor retention and fit of her maxillary denture after being fitted with her fixed mandibular restoration. A bony residual ridge is now present only in the molar region, whereas only a mobile flabby ridge remains in the anterior and premolar region (Fig 6-12b). The CBCT scan clearly shows a severely atrophied maxilla (Fig 6-12c). Only a trace of bone is visible in the anterior residual ridge on the cross-sectional image (Fig 6-12d). Pronounced malocclusion in the anterior maxilla, apparent both vertically and horizontally, was diagnosed on clinical inspection (Fig 6-12e). The vertical atrophy is particularly marked in the premolar region on the left side (Fig 6-12f). In this region, vertical augmentation was to be performed as well as sinus floor elevation (Fig 6-12g).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation with vertical augmentation
2. Implant placement with repeat augmentation
3. Exposure and mucosal distraction
4. Prosthetic loading

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Fig 6-12a Cantilever fixed bridge in the mandible after 5 years of functional use.

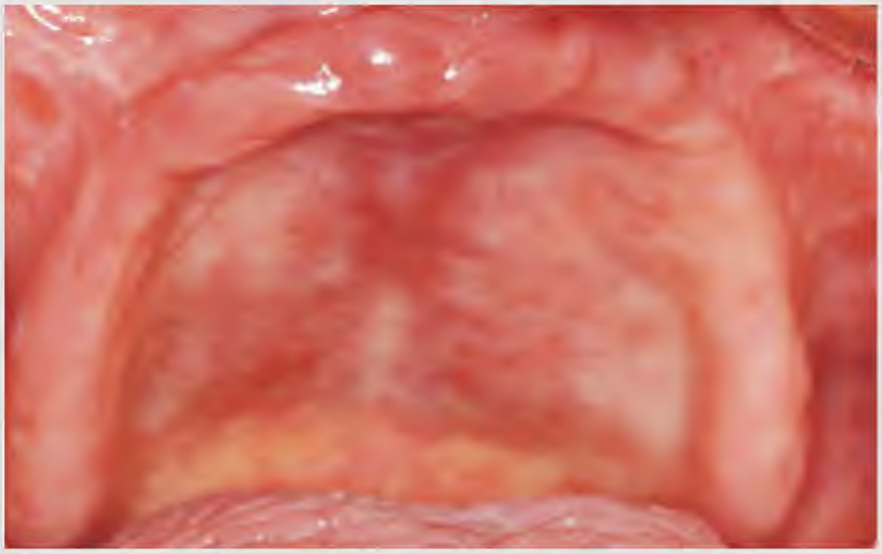


Fig 6-12b Severely atrophied maxilla with anterior flabby ridge.

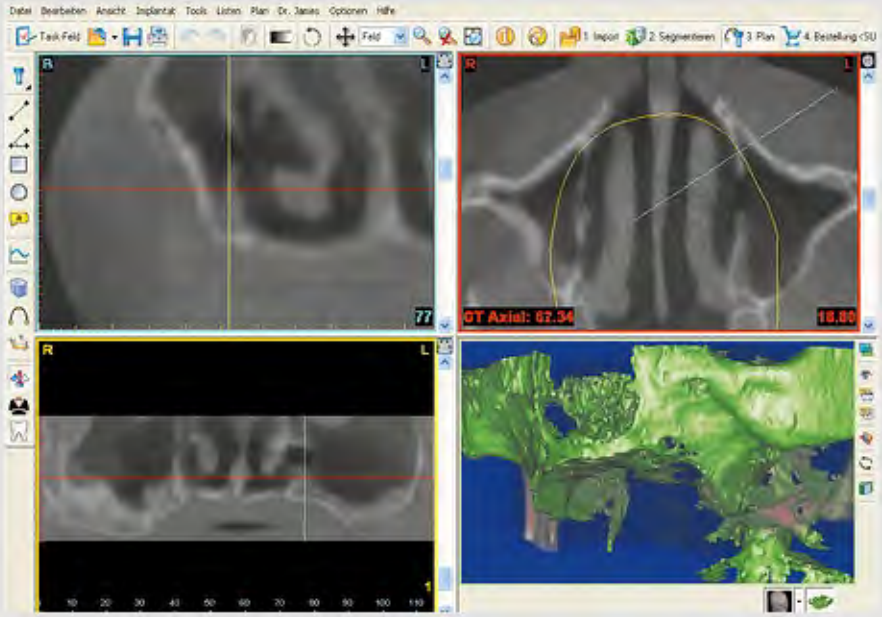


Fig 6-12c 3D analysis of the maxilla.

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Fig 6-12d Cross section through the anterior maxilla.



Fig 6-12e Pronounced malocclusion in the right anterior maxilla.

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Fig 6-12f Pronounced malocclusion in the left anterior maxilla.



Fig 6-12g Vertical augmentation is required.

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Sinus floor elevation

The first step was to perform sinus elevation on both sides of the maxilla. Titanium pins (5-mm long) (Figs 6-12h and 6-12j) were used as supports for the augmentation material and the membrane used in the vertical reconstruction of the residual ridge on the left side (at the time, it was level with the palate or even slightly below it; see Fig 6-12i). The augmentation of the cavity in the maxillary sinus and the vertical augmentation were performed with Bio-Oss and a Bio-Gide membrane. Following periosteal slitting and marked mobilization of the mucoperiosteal flap, the operation site was closed with Gore-Tex 4-0 and Mopylen 6-0 sutures (W. L. Gore and Associates and Resorba, respectively). The sutures were removed around 2 and 3 weeks after sinus elevation (Fig 6-12k).

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Fig 6-12h Titanium pins (5-mm long), used as vertical stops, support the membrane.

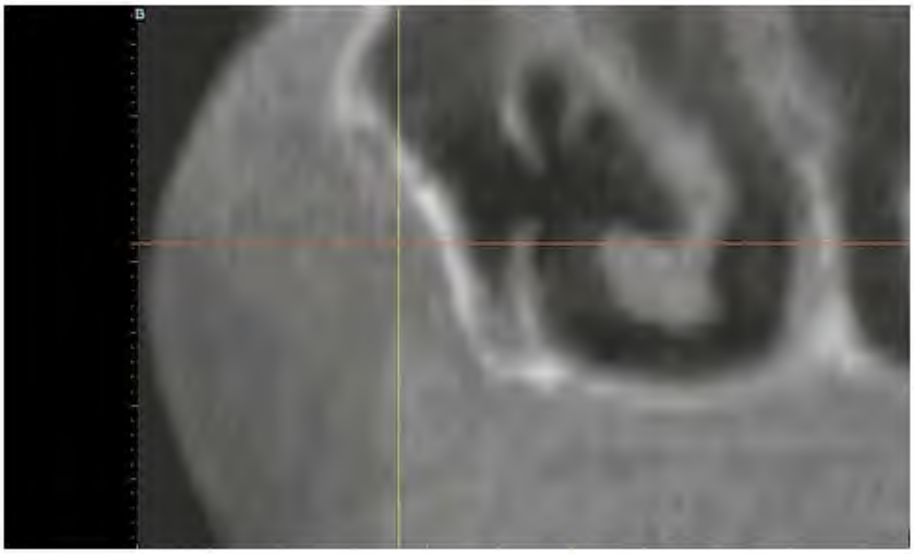


Fig 6-12i The residual ridge lies slightly below the level of the palate.

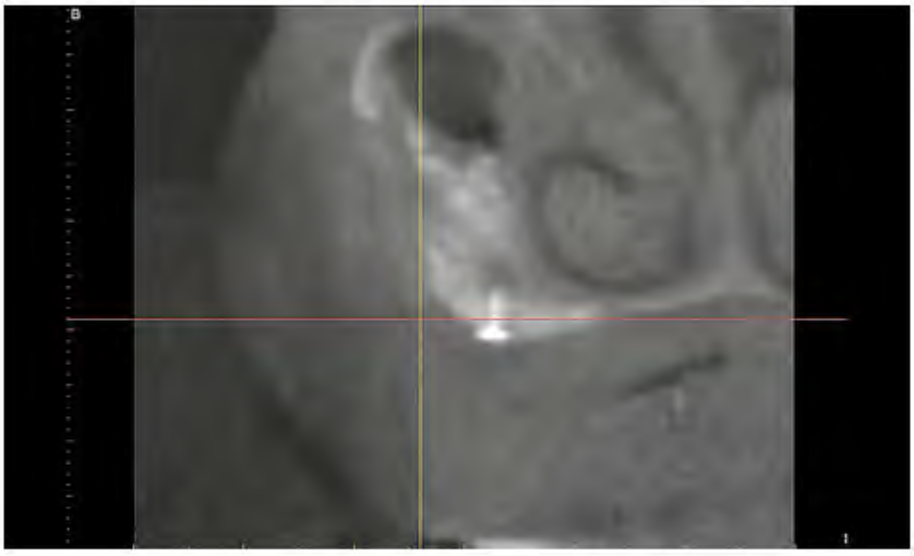


Fig 6-12j The residual ridge has been augmented by approx 4 mm in the vertical direction.

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Fig 6-12k Clinical situation at the time of suture removal.

Implant placement

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Because of the extreme atrophy (Fig 6-12l), a 1-year healing period was scheduled after sinus elevation and ridge augmentation, before implant placement could take place (Fig 6-12m). The gain in bone mass is clearly apparent in the 3D reconstructions (compare Figs 6-12l and 6-12m). A panoramic radiograph was taken as a check after augmentation (Fig 6-12o). Implant placement was planned using SimPlant, based on the up-do-date CBCT scan (Fig 6-12p).

The overall contours of the residual ridge (Fig 6-12n), but particularly the zones of vertical augmentation in the left premolar region (Fig 6-12q), appeared to have improved markedly relative to baseline (see Fig 6-12f). In accordance with the SimPlant planning, five implants were inserted into the augmented bone on the left side (Fig 6-12r). The right side turned out to be more problematic, as much less bone had formed there. It was only possible to insert four implants here, placing them not in line but alternately on the palatal and buccal side of the crest, to leave sufficient space between them (Fig 6-12s). This staggered placement also ensured better distribution of the masticatory forces over the prosthetic superstructure. The region was re-augmented with the harvested bone chips and Bio-Oss, followed by tight suturing. A postoperative panoramic radiograph was taken after implant placement (Fig 6-12t).

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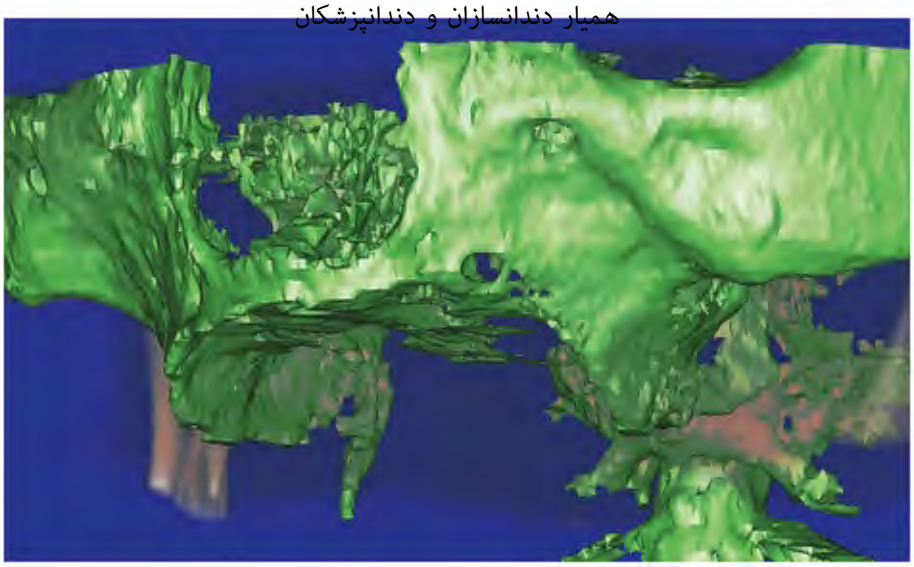


Fig 6-12l 3D reconstruction before augmentation.

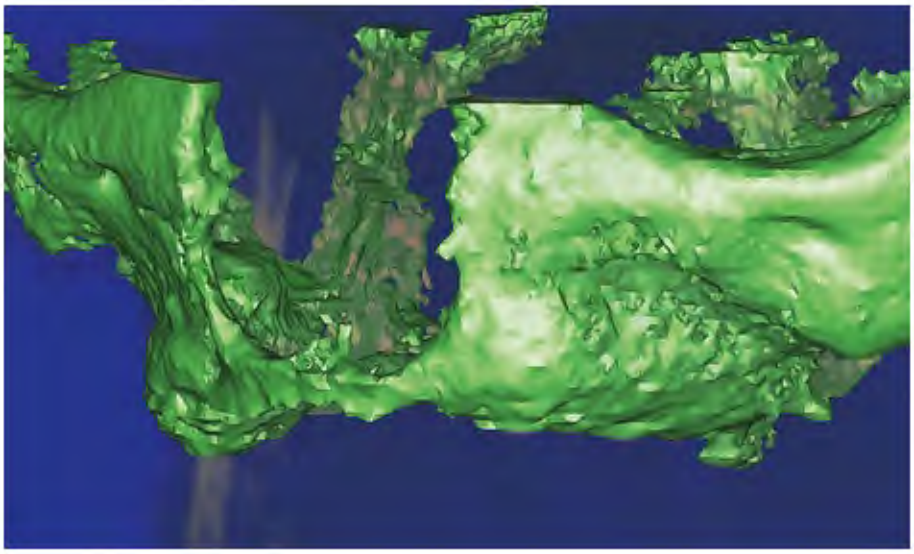


Fig 6-12m 3D reconstruction after augmentation.



Fig 6-12n Residual ridge 1 year after augmentation.

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Fig 6-12o Panoramic image after augmentation.

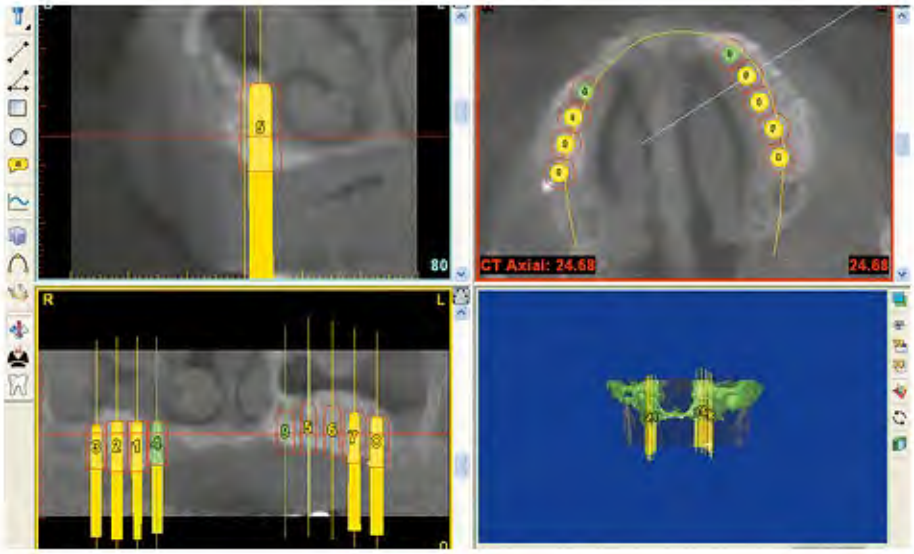


Fig 6-12p Virtual implant placement in the SimPlant program.



Fig 6-12q Considerably reduced malocclusion in the left premolar region (see Fig 6-12f).

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Fig 6-12r Implants in the left maxilla following insertion.

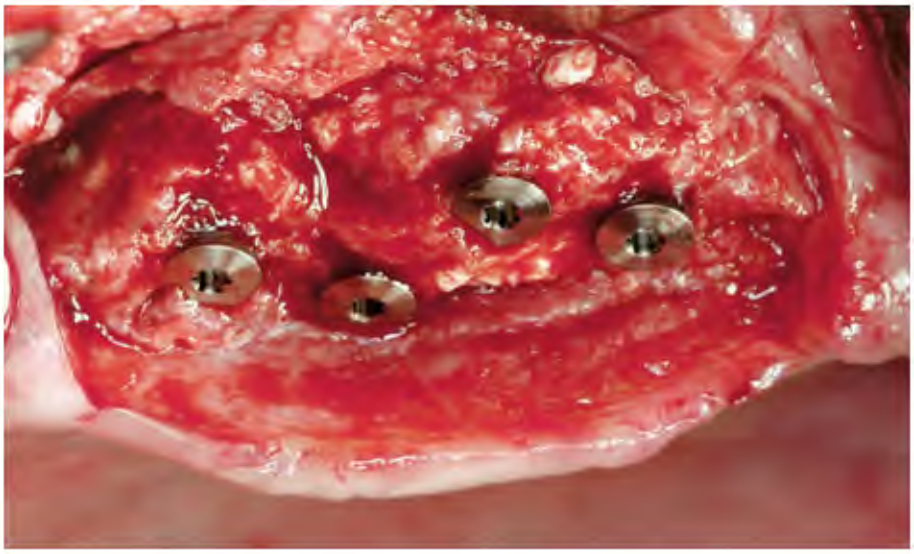


Fig 6-12s Implants placed on the palatal and buccal sides of the crest.

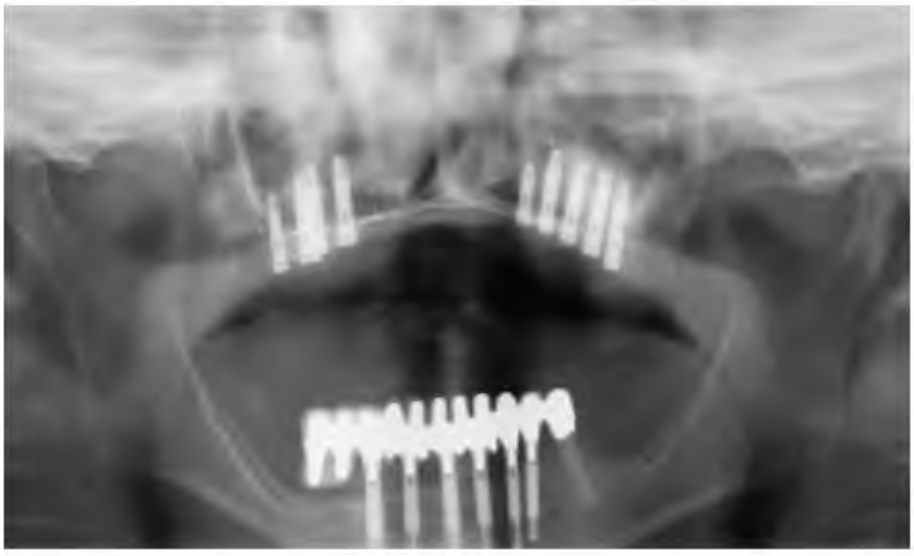


Fig 6-12t Postoperative panoramic radiograph after implant placement.

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Fig 6-12u Residual ridge before exposure.



Fig 6-12v Palatal incision made for implant exposure.

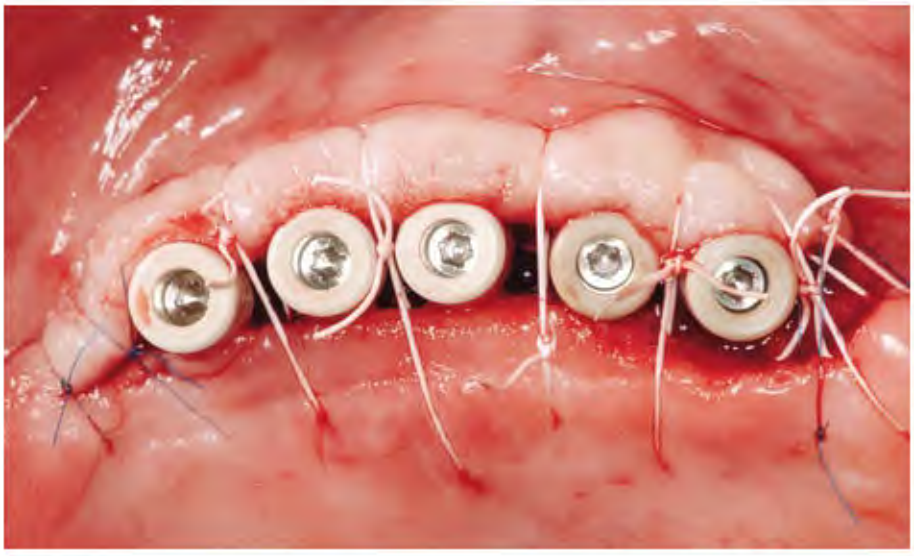


Fig 6-12w Spreading the zone of attached gingiva.

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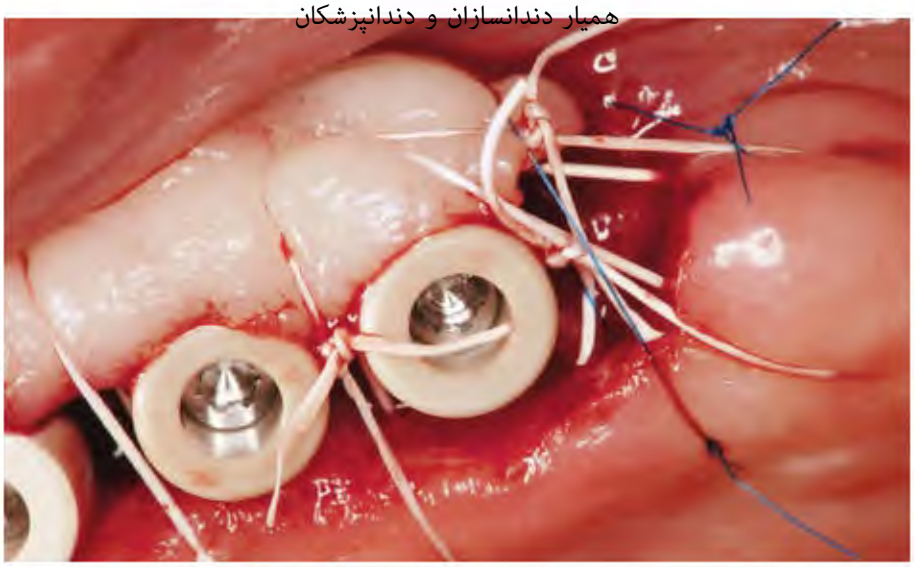


Fig 6-12x Gingival deficit distally of the implants.

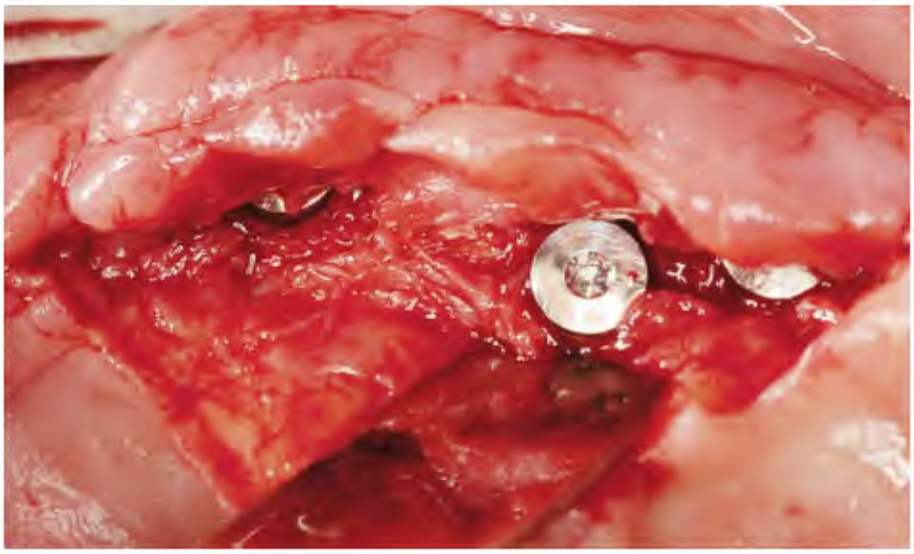


Fig 6-12y Exposure on the right side.

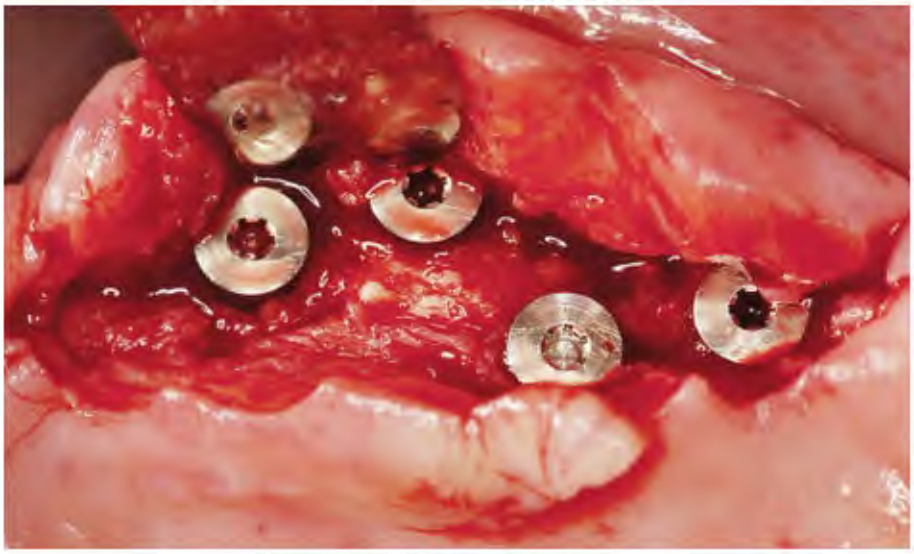


Fig 6-12z The cosine curve technique.

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Exposure

Due to the soft bone structure, a further 9 months elapsed before exposing the implants (Fig 6-12u). On the left side, the exposure incision was made on the palatal side of the implants (Fig 6-12v) and the flap packed in the buccal direction (Fig 6-12w). However, the increased radius resulted in a soft tissue deficit, ie, the flap was too short to cover the wound fully. This flap deficit distally of the last implants was minimized with the aid of various suturing techniques (Fig 6-12x). On the right side, the incision was guided by the palatal cover screws, due to the staggered placement of the implants (Fig 6-12y). The cosine curve technique was used here (Fig 6-12z). To compensate for the staggering of the implants, rotated flaps according to the technique reported by Palacci were created (Fig 6-12aa) and secured into place between the implants with Mopylen 6-0 sutures (Fig 6-12bb). Only then was the flap adapted to the healing abutments and tightly sutured with Gore-Tex (Fig 6-12cc). The sutures were removed after about 2.5 weeks.

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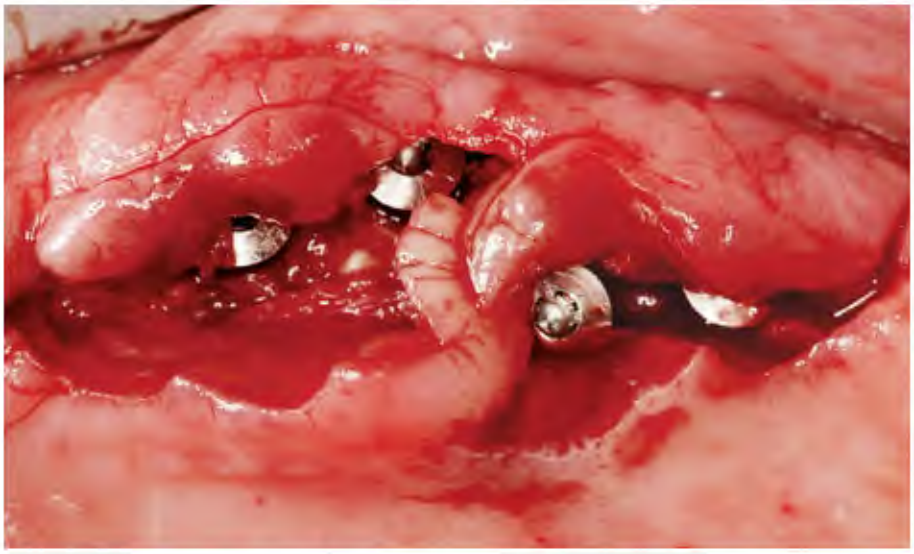


Fig 6-12aa Creating the rotated Palacci flaps.

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Fig 6-12bb Fixing the rotated flaps into place.

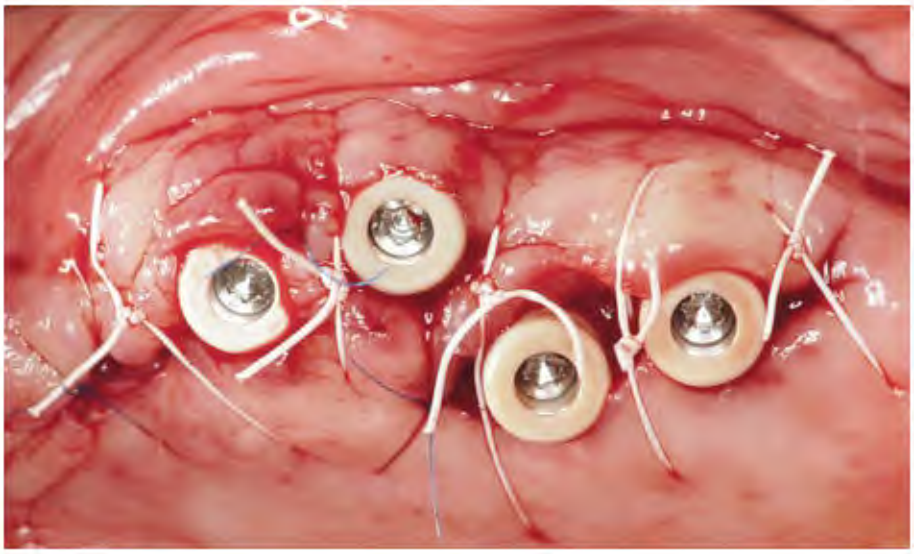


Fig 6-12cc Gore-Tex suturing.



Fig 6-12dd Occlusal view of the bar connector.

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Fig 6-12ee Stabilization of the attached gingiva on the left side.

Prosthetic restoration

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A continuous connecting bar was fabricated over all the implants to act as the supporting mesostructure and then incorporated (Fig 6-12dd). On the left side, the bar connector has a uniform, slightly arcuate course. As intended at the time of exposure, a wide, buccal zone of keratinized gingiva had formed and stabilized to a satisfactory extent, even at the distal end and up to the last implant (Fig 6-12ee). There is also keratinized gingiva on all the implants on the right side. Here, the bar connector has an irregular course. Special cleaning channels were fashioned to facilitate good hygiene (Fig 6-12ff). At the anterior region of the bar connector, mesially of the implants, there are two anchoring elements, which ensure that the prosthesis with its built-in MK1 locking attachments can be securely locked to the bar (Figs 6-12gg and 6-12hh). The prosthesis covers the bar completely, but is still palateless (Fig 6-12ii). The openings for the locking mechanism are barely visible.



Fig 6-12ff Irregular course of the bar connector on the right side.

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Fig 6-12gg MK1 attachments at the anterior region of the bar connector.

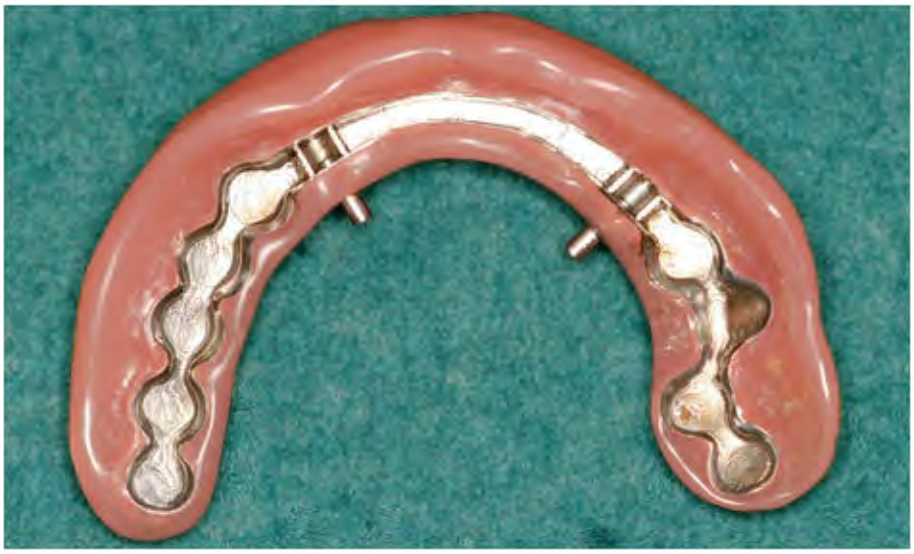


Fig 6-12hh Metal framework of the denture with integrated attachments.



Fig 6-12ii Palateless denture.

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Fig 6-12jj Stable mucosal situation in the maxilla despite poor hygiene.



Fig 6-12kk The patient's smile after the treatment.

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After another 2 years, the clinical situation in the maxilla was stable and required no further intervention at the time, apart from improved oral hygiene and regular professional cleaning of the implants (Fig 6-12jj). The patient was very satisfied following completion of her treatment and, despite the extremely problematic baseline situation, was able to enjoy a good quality of life again with her secure, firmly anchored prosthetic restorations in both mandible and maxilla (Fig 6-12kk).

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Fig 6-12ll Clinical situation after 7 years.



Fig 6-12mm Good gingival situation on the left side.



Fig 6-12nn Loss of attached gingiva around implant 15.

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Fig 6-12oo Follow-up panoramic radiograph after 7 and 12 years, respectively.

Continued follow-up

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The clinical situation continues to be stable after 7 years (Fig 6-12ll). The left side, with the implants placed in a uniform line, has retained a zone of keratinized gingiva of sufficient width (Fig 6-12mm). The right side, with the palatal/buccal staggering of the implants, has fared less well after 7 years. Implant 15, in particular, with its outlying position, has no attached gingiva around it and is thus more susceptible to potential infections (Fig 6-12nn). The bone surrounding the implants in both mandible and maxilla appears to be stable in the follow-up panoramic radiograph taken 7 and 12 years, respectively, following implant placement (Fig 6-12oo).

Treatment course

- Implant placement and prosthetic loading in the mandible
- 5 years later, bilateral sinus elevation (2005)
- 12 months to implant placement
- 9 months to exposure
- 6 weeks to fabrication of the maxillary dental prosthesis

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Gregor Cwajgart
Dental technology:	Gerhard Makowski

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Note

Several augmentative procedures in one operation



Fig 6-13a Clinical baseline situation.



Fig 6-13b Panoramic radiograph before the treatment.

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Fig 6-13c View of the operation site and fenestration.

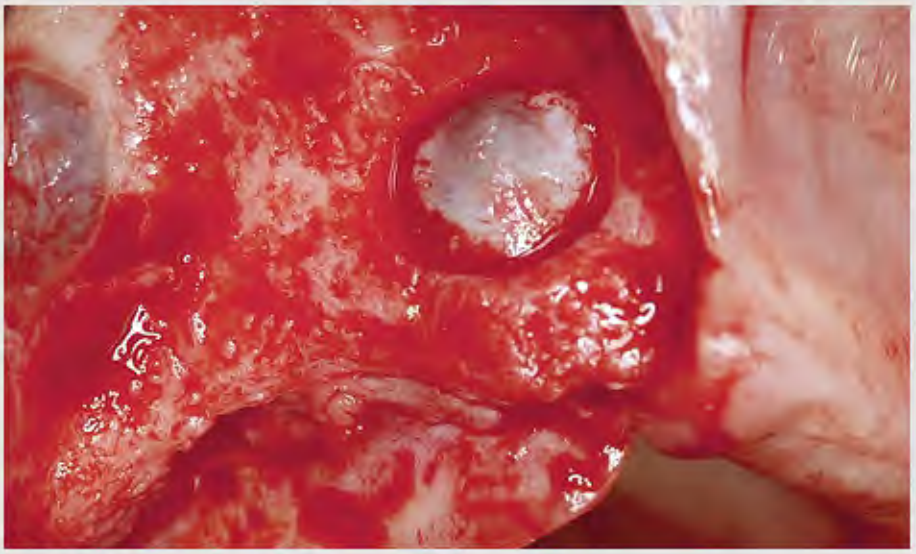


Fig 6-13d Cyst in region 13.

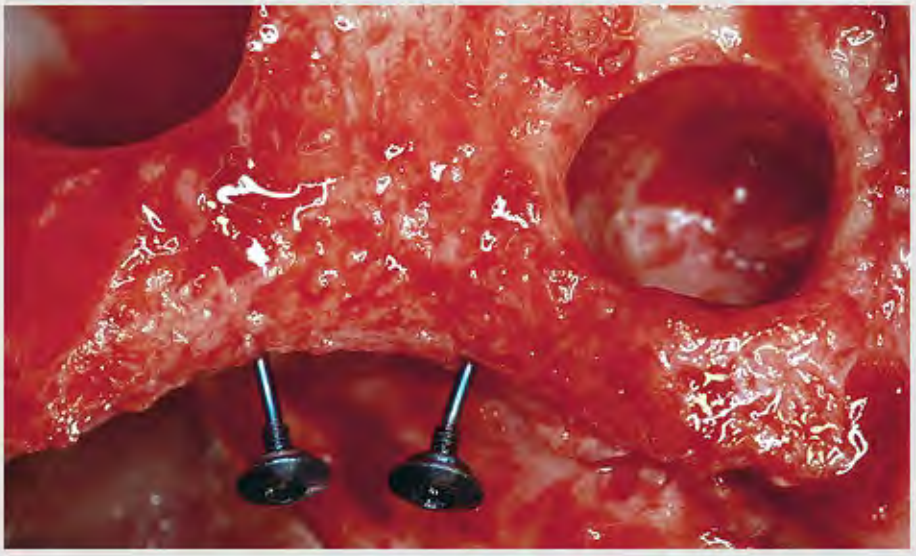


Fig 6-13e The bone has been refreshed following removal of the cyst.

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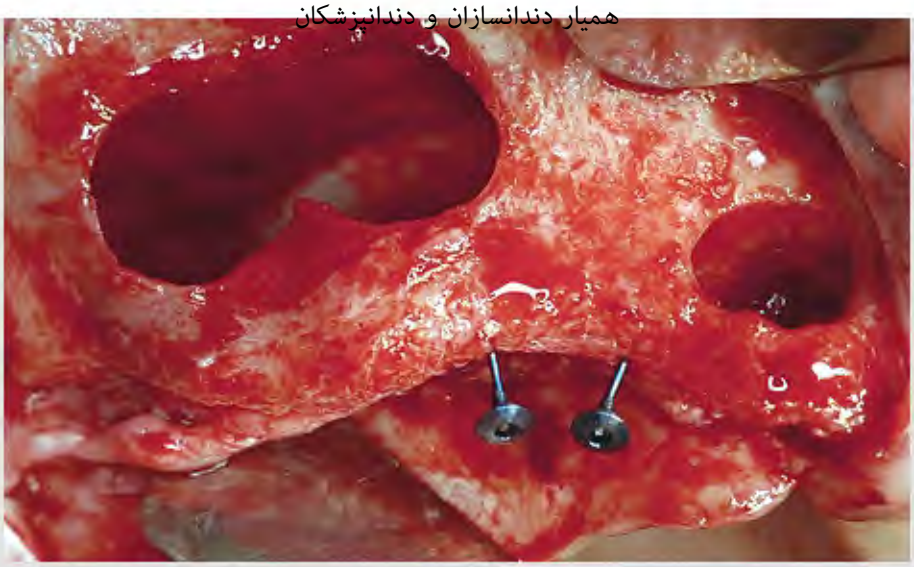


Fig 6-13f Preparations for the bone bed augmentation. Titanium pins used as vertical stops.



Fig 6-13g Augmentation.

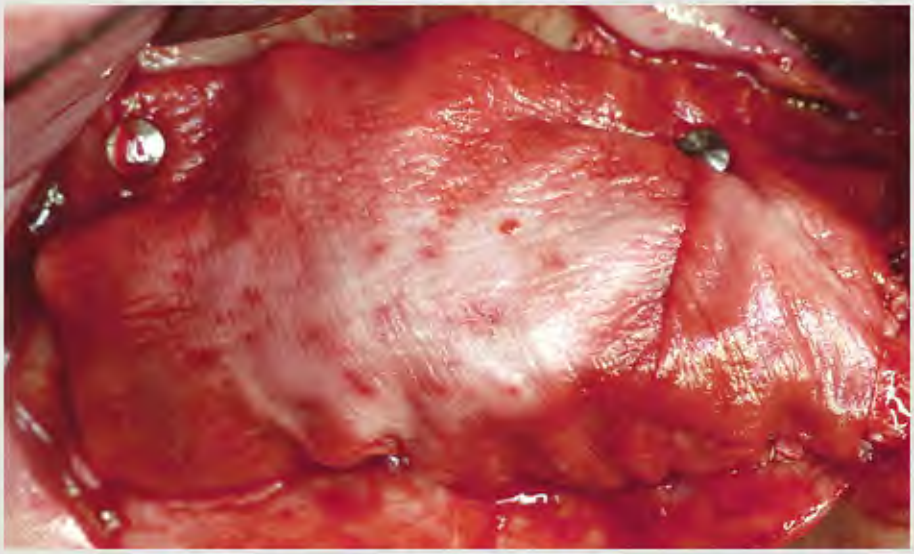


Fig 6-13h Attaching the membranes.

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Fig 6-13i Removal of the sutures after 3 weeks.



Fig 6-13j Vertically augmented residual ridge.



Fig 6-13k Improved residual ridge contours.

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In addition to sinus elevation, some patients also require vertical augmentation of the residual ridges (Fig 6-13a). In addition to her severely pneumatized maxillary sinus and vertical bone defect, this patient was found to have a cyst in region 13, which also needed treatment (Fig 6-13b). The incision was made on the right side, just by the midline at the height of tooth 11 (Fig 6-13c). A window for sinus elevation was cut first, after which the cyst was cleanly exposed (Fig 6-13d). When the cyst was removed, the bone around it was refreshed (Fig 6-13e). The maxillary sinus mucosa was lifted and prepared for sinus elevation. Two 5-mm long titanium pins were inserted as stops for vertical bone augmentation and to support the membrane (Fig 6-13f). After this, a Bio-Gide membrane 30 × 40 mm in size was attached cranially of the bone window and of the defect left by the cyst, using two short titanium pins. The cavity prepared in the maxillary sinus for the augmentation and the bone defect was filled with Bio-Oss, and the whole residual ridge augmented both horizontally and vertically (Fig 6-13g). The membrane was placed over the augmentation material and pushed under the palatal periosteum (Fig 6-13h). Extensive periosteal slitting was followed by tension-free suturing of the flap. The simple interrupted sutures were removed after 2 weeks, the mattress sutures after 3 weeks (Fig 6-13i). The 9-month healing period was uncomplicated (Fig 6-13j). The contours of the entire maxilla improved markedly relative to baseline as a result of the augmentation, appearing more uniform and more pleasing (compare Figs 6-13a and 6-13k).

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Atypical treatment course – problematic baseline situation

Extremely problematic baseline situation following the loss of sinus augmentation material and implants

Baseline situation

This female patient presented to our clinic with an extremely atrophied maxilla following several operations at various clinics in the past 12 years (Fig 6-14a). Implants had already been placed into her maxilla 12 years previously, but were lost a short time afterwards. In the years that followed, she had undergone three iliac crest bone graft procedures to augment the maxilla, without success. Sinus elevation with Cerasorb (curasan) had also been undertaken on both sides, but nothing remained of the results achieved with these procedures either. The extent of maxillary bone loss is apparent from her current prosthesis (Fig 6-14b). The patient presented to our clinic for the first time in considerable despair. She had virtually no residual ridge left, but would not give up her wish for a fixed dental prosthesis.

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- CT
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Periosteal harvesting for bone engineering
2. Bilateral sinus floor elevation
3. Implant placement and extensive augmentation
4. Exposure and definitive prosthetic loading

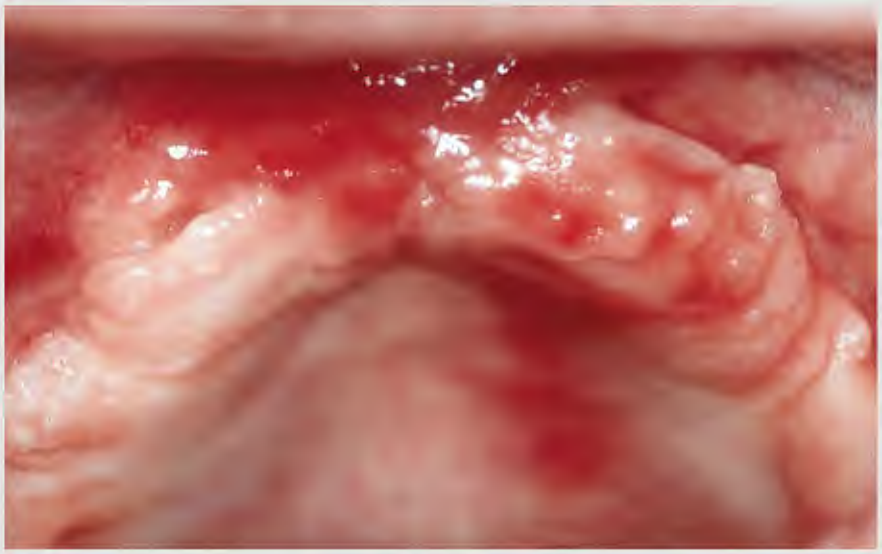


Fig 6-14a Extremely atrophied maxilla.



Fig 6-14b The extent of the atrophy is clearly apparent from the prosthesis.

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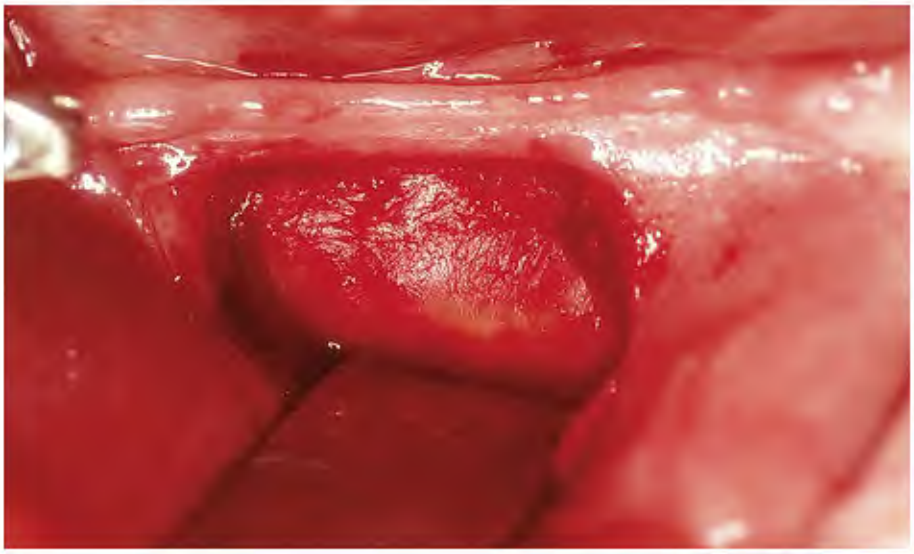


Fig 6-14c Dissection of a periosteal patch in the mandible.

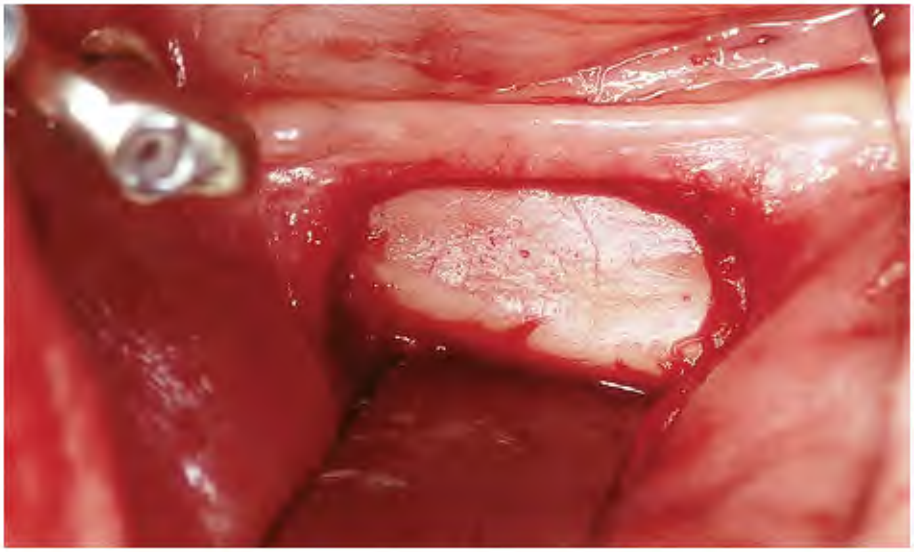


Fig 6-14d Harvesting the periosteum.

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Fig 6-14e The mandible has been sutured.



Fig 6-14f Cultured bone pellets.

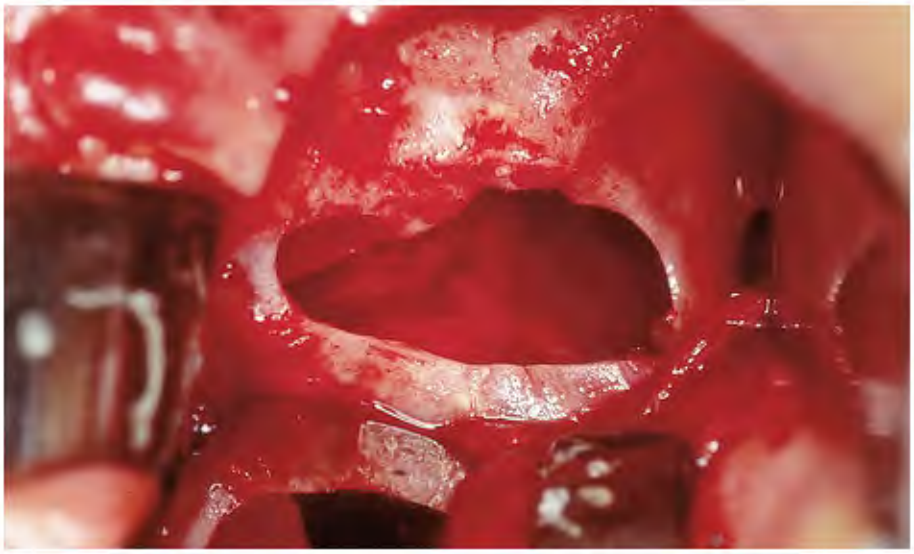


Fig 6-14g Maxillary sinus fenestration.

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Periosteal harvesting

To increase the chances of a successful bone augmentation with Bio-Oss (Geistlich), a periosteal patch approximately 10 × 10 mm in size was cut from the posterior mandible and sent, along with autologous blood, to BioTissue in Freiburg to be cultured for bone engineering (Figs 6-14c and 6-14d). The area was tightly sutured following the harvesting of the periosteal patch (Fig 6-14e).

Sinus floor augmentation

Seven weeks later, 32 cultured BioSeed (BioTissue) bone pellets were sent back and the operation under general anesthesia could begin (Fig 6-14f). The maxillary sinus was opened by fenestration (Fig 6-14g), and the delivered bone pellets and Bio-Oss were gradually introduced into the lumen of the sinus (Figs 6-14h and 6-14i). The fenestration was closed with an Atrisorb membrane (TOLMAR), a product commonly used at the time (Fig 6-14j).

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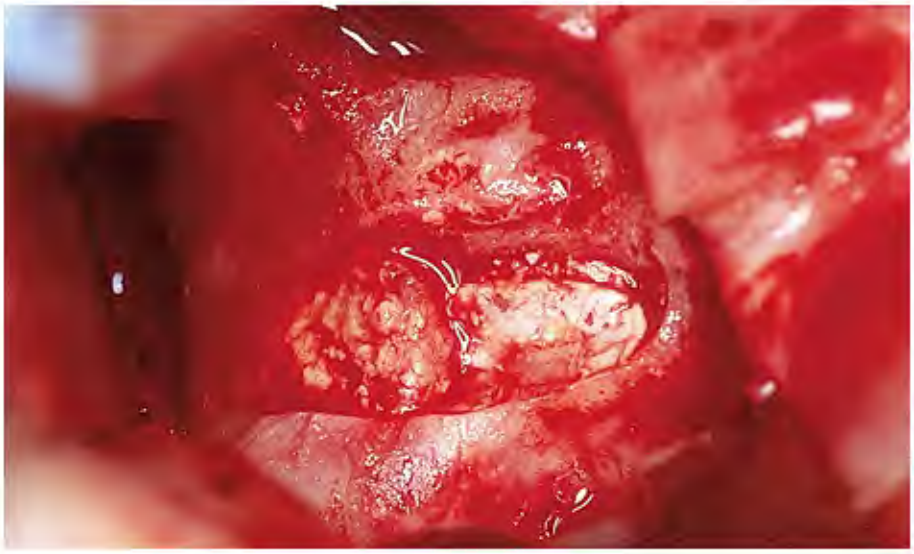


Fig 6-14h Bone pellets being introduced into the maxillary sinus.

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Fig 6-14i Layering of the bone pellets and Bio-Oss.

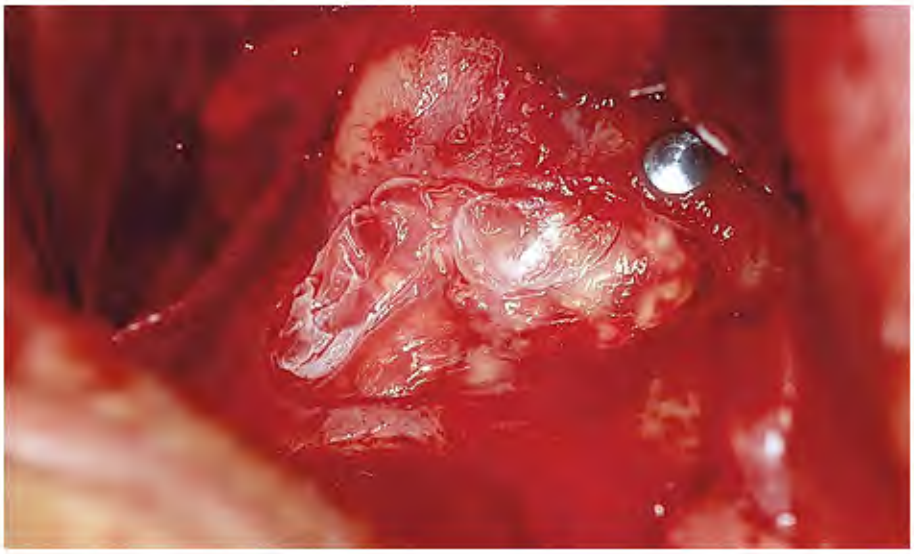


Fig 6-14j The fenestration has been sealed with an Atrisorb membrane.

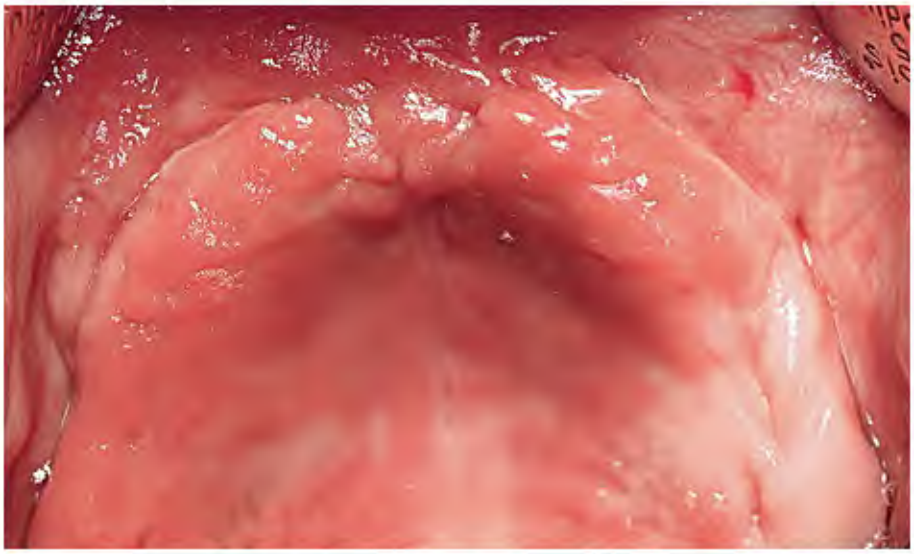


Fig 6-14k Residual ridge 1 year after augmentation.

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Fig 6-14l Inserted implants on the right side. Two of them are on the anterior side of the residual ridge, although their apices are anchored in the maxillary sinus elevation.

Implant placement and augmentation

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The implants were inserted after a 1-year healing phase, again under general anesthesia. The bilateral sinus elevation had resulted in extraordinary augmentation of the maxilla toward the cranial direction, to ensure that sufficient bone tissue would be preserved to anchor stable implants despite the loss of residual ridge height. Even on clinical inspection alone, the situation already looked a little better than at the start of the treatment, even though there was little left of the bony residual ridge (Fig 6-14k). Despite the precise 3D planning, it was very difficult to locate the anatomical structures at the operation site. The incision and mobilization of the flap had to be performed very slowly and carefully. The anterior edge of the residual ridge ran almost centrally below the maxillary sinus, necessitating the placement of two implants each anteriorly and posteriorly to ensure a firm hold in the augmented bone (Fig 6-14l). It was possible to insert only half of the 18 mm length of the implants in the bone. The bone around the other half had to be augmented. Implant 17 was positioned in the palate, and the augmentation here needed to be undertaken from the palatal side. In contrast, augmentation on the buccal side was needed for implant 14, placed far into the buccal vestibule (Fig 6-14m). The augmentation was performed with harvested bone chips and Bio-Oss. The augmentation material was stabilized with a Bio-Gide membrane, attached to the palate and at the buccal end with titanium pins (Fig 6-14n). On the left side, implants 24 and 25 stood particularly far toward the buccal vestibule. Augmentation on the buccal side was needed here (Fig 6-14o). This augmentation was performed analogously with Bio-Oss and a Bio-Gide membrane, also secured into place with pins (Fig 6-14p). One year was scheduled for the implant-healing phase.

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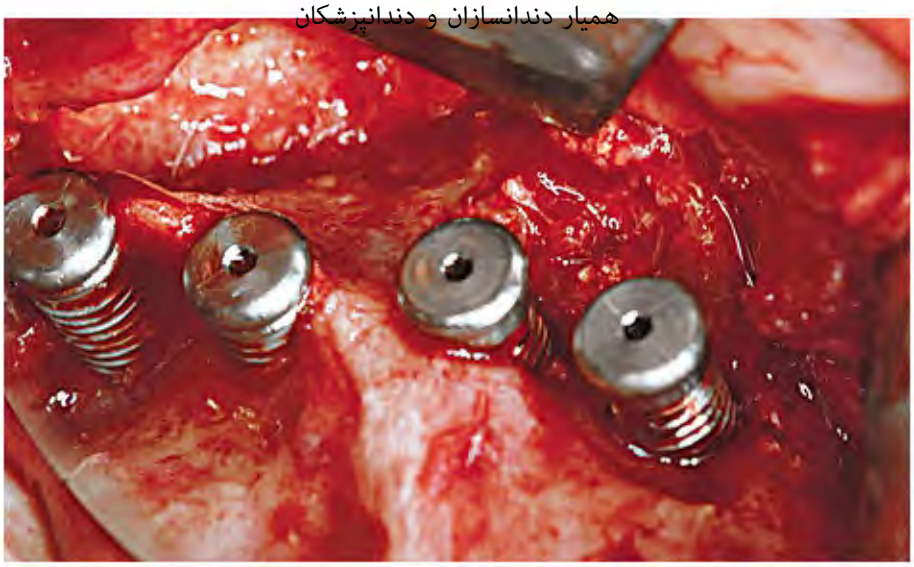


Fig 6-14m Augmentation was needed on the palatal side of implant 17 and the buccal side of implant 14.

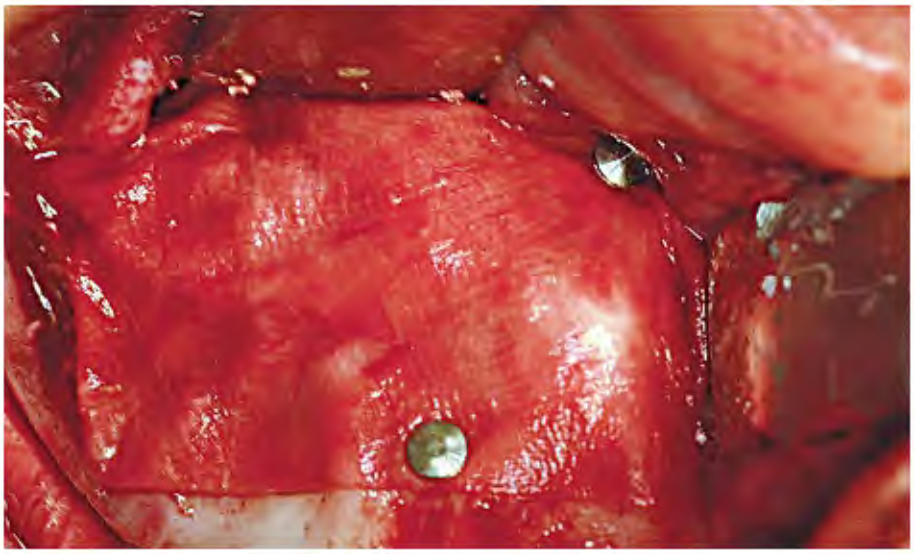


Fig 6-14n The Bio-Gide membrane has been attached to the palate and at the buccal end with titanium pins.

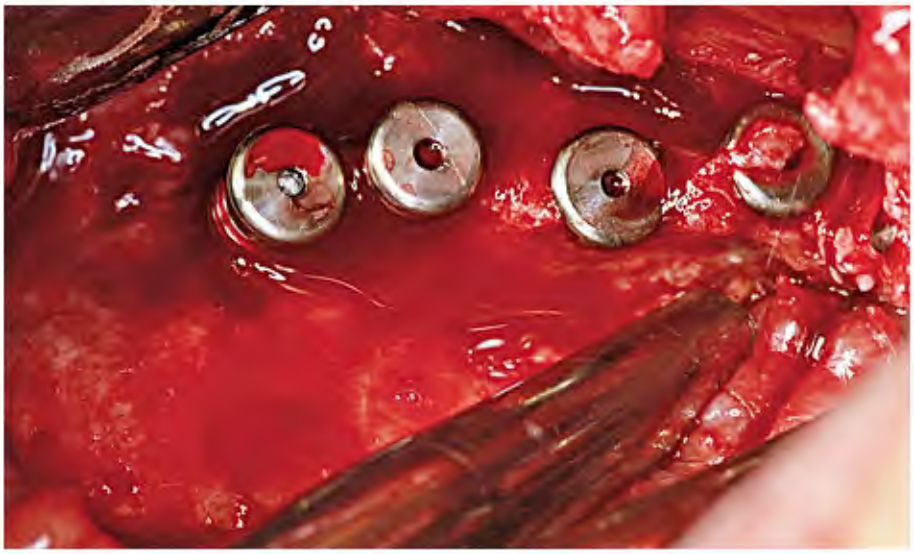


Fig 6-14o Implants on the left side.

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Fig 6-14p Augmentation on the left side.

Exposure

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After a year's uncomplicated healing, the implants were ready to be exposed (Fig 6-14q). The CBCT scan made at the time shows a good augmentation and implant placement result (Fig 6-14r). Implant 17, located far out of line toward the palate, appeared to be surrounded by bone (Fig 6-14s). The large buccal defect around implant 24 had also regenerated (Fig 6-14t). To ensure at least partial reconstruction of the zone of attached gingiva, the incision on the right side was made palatally of the implants and the gingiva packed around the healing abutments on the buccal side (Fig 6-14u). Then the gum was adapted with Gore-Tex sutures (Fig 6-14v). On the left side, it was necessary to create a rotational flap and drape it around the anterior implants (Fig 6-14w).

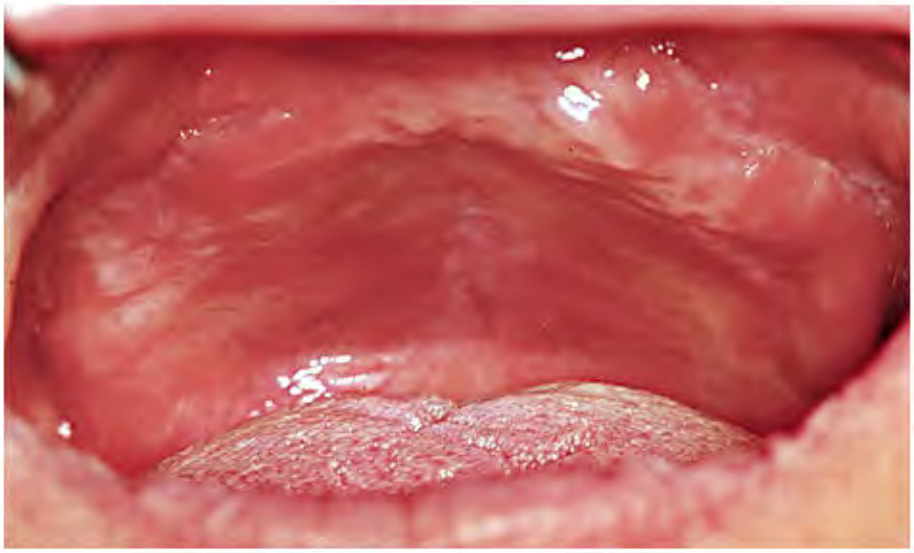


Fig 6-14q Residual ridge 1 year after implant placement.

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Fig 6-14r CBCT scan before exposure. Note the negative residual ridge in the anterior region (cross section – top left).

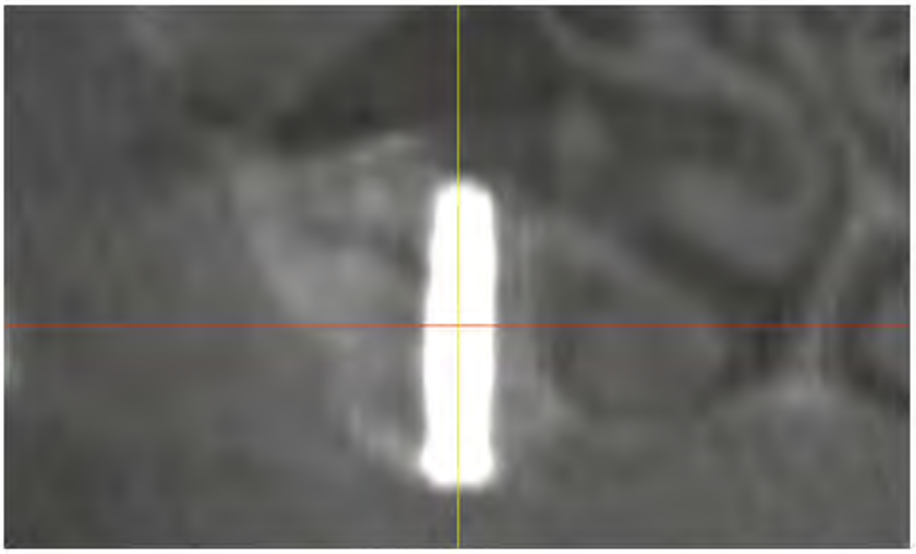


Fig 6-14s Successful palatal augmentation around implant 17.

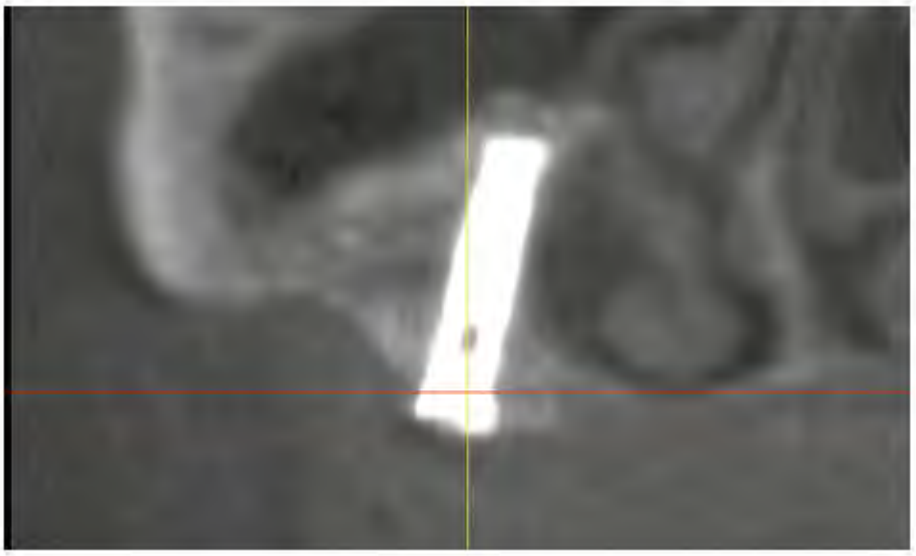


Fig 6-14t Buccal augmentation around implant 24.

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Fig 6-14u The attached gingiva has been shifted towards the buccal vestibule.

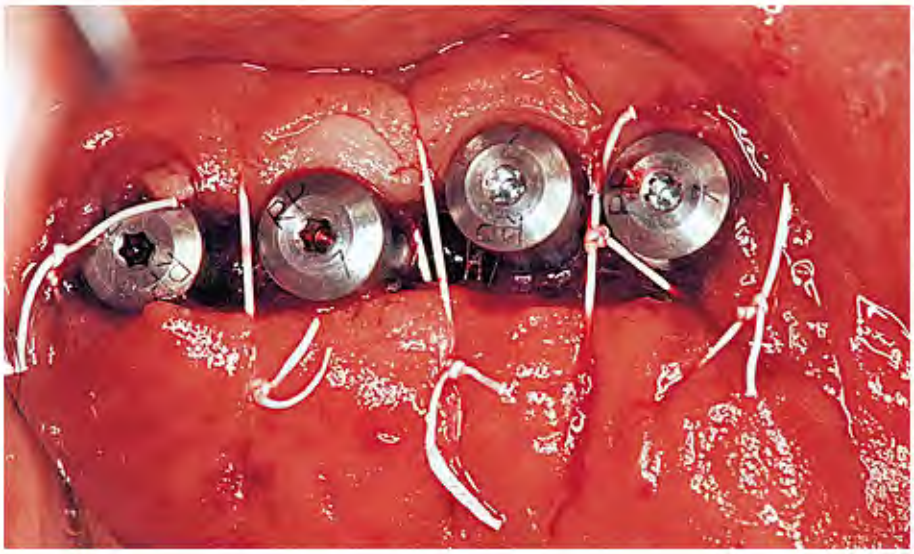


Fig 6-14v Stabilization of the graft with sutures.

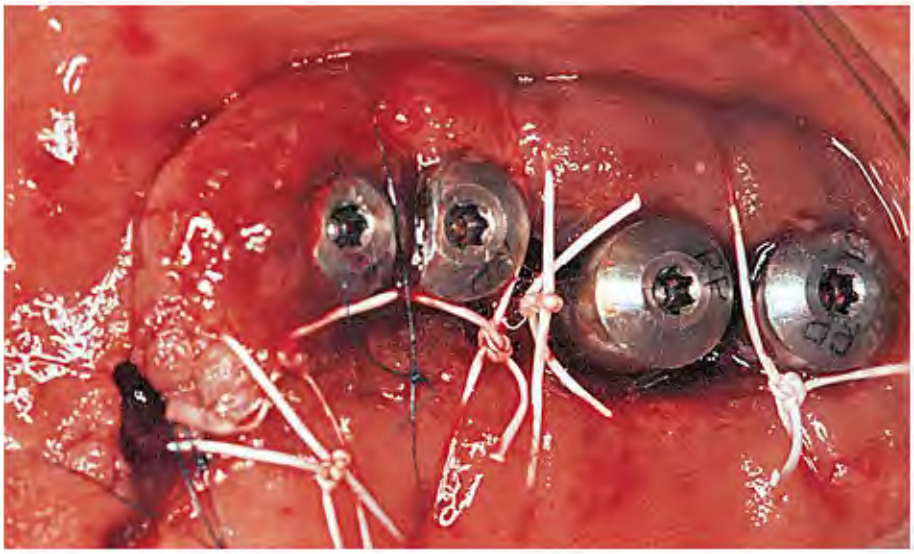


Fig 6-14w Analogous graft with an additional rotational flap on the left side.

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Fig 6-14x The mucosal situation stabilized slowly after 4 weeks.



Fig 6-14y Healed rotational flap on the left side.



Fig 6-14z Large span to be bridged between 14 and 24.

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Fig 6-14aa Custom-milled connector bar on all the implants.



Fig 6-14bb The prosthesis has been reinforced with a gold framework.



Fig 6-14cc Two MK-1 attachments have been built in to anchor the denture.

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Four weeks after exposure, the mucosal situation around the implants had stabilized to such an extent as to allow an impression to be taken for the bar connector (Fig 6-14x). The rotational flap around implants 24 and 25 had also healed well (Fig 6-14y). The distance between the lines of implants on both sides of the maxilla was considerable, as the bone supply in the anterior region was completely insufficient for the placement of implants. Consequently, this region had to be bridged with the mesostructure (Fig 6-14z). This was done with a solid, milled bar connector made of gold, which linked the two lines of implants (Fig 6-14aa). The prosthesis was fabricated over a gold framework made to fit the connector bar (Fig 6-14bb). A collar of pink denture acrylic was applied to provide a visual replacement for the missing residual ridge. The largely palateless prosthesis was held onto the bar with two MK1 attachments (Fig 6-14cc). The bar was screwed to the implants with gold screws. Its shape follows the course of the residual ridge (Fig 6-14dd). In contrast to the mandible, where the implants are in the anterior region, the ones in the maxilla are concentrated in the molar area (Fig 6-14ee). The prosthesis was securely anchored in the mouth and the patient was able to bite her teeth together again (Fig 6-14ff). After a treatment lasting almost 15 years (the first 12 of these having been unsuccessful), the patient was finally satisfied; even after another 5 years, her dental prosthesis has continued to function faultlessly (Fig 6-14gg).

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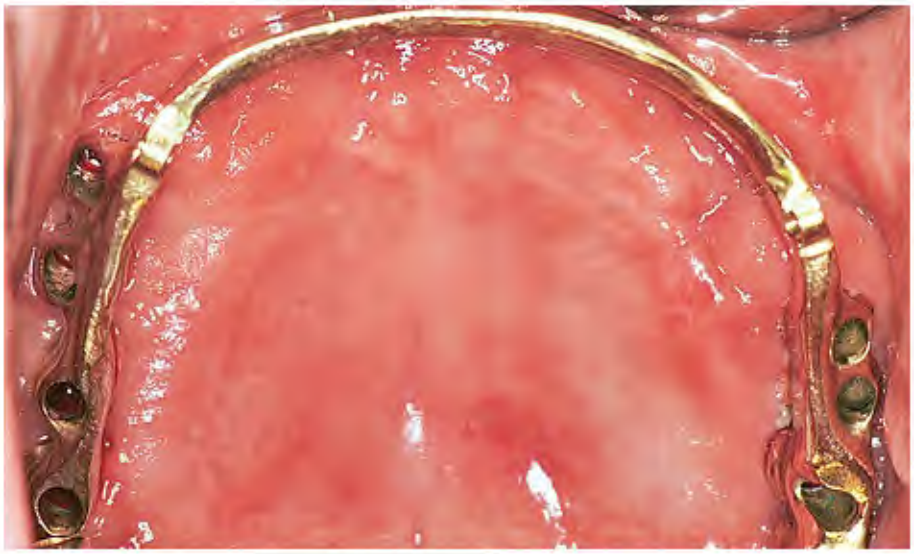


Fig 6-14dd Wide span between the implants.

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Fig 6-14ee Check panoramic radiograph taken following treatment completion.



Fig 6-14ff Dental prosthesis after 5 years of functional use.



Fig 6-14gg The patient is satisfied despite her many years of treatment.

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Treatment course

- Periosteal patch harvesting for BioSeed-OralBone
- 2 months to sinus floor elevation (2003)
- 1 year to implant placement
- 1 year to exposure
- 2 months to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Atypical treatment course – problematic baseline situation

Extreme residual ridge atrophy, sinus floor elevation with no bony sinus floor

Baseline situation

This male patient who presented to our center with severe residual ridge atrophy in the maxilla, wanted a fixed restoration (Fig 6-15a). Bilateral sinus elevation was necessary before implant placement. The right side appeared to be particularly problematic, although hardly any bone was available on either side. The CBCT scan images appeared to show no bony border between the maxillary sinus and the mouth (Fig 6-15b).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation

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2. Implant placement
3. Exposure and definitive prosthetic loading



Fig 6-15a Maxilla before the treatment.

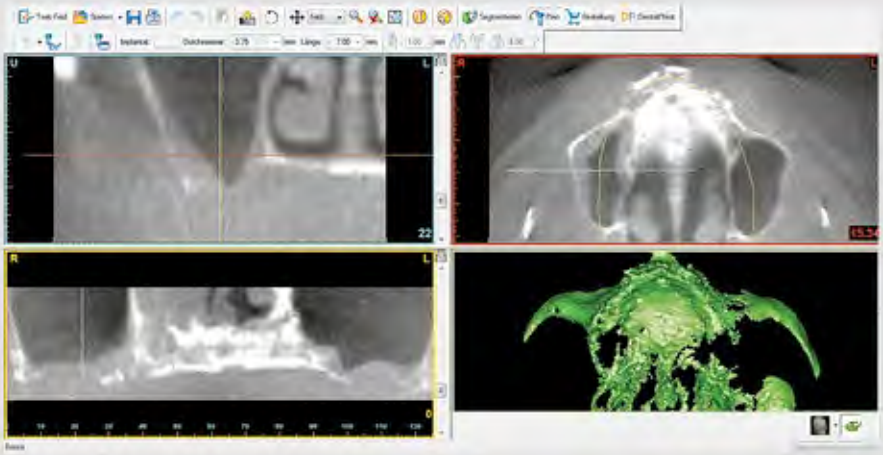


Fig 6-15b CBCT scan before treatment. The sinus has no bony floor.

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Sinus floor augmentation

The radiological diagnosis was confirmed during the operation: after the right maxillary sinus had been opened and its mucosa elevated, we found that the bony floor was partially missing (Fig 6-15c). In the molar region, there was a gaping basal hole approximately the size of the lateral bone window. Elevation of the maxillary sinus mucosa is extremely difficult under these circumstances. The entire maxillary sinus needs to be sealed off both cranially and caudally. This can be accomplished with, eg, a 5 × 6 cm piece of Vicryl mesh (Ethicon); in this case, the mesh was stabilized with several titanium pins (Fig 6-15d). The membrane was of sufficient size to leave some material over to cover the lateral window and also for the other side (Fig 6-

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15e). The postoperative CBCT scan shows adequate filling of both maxillary sinuses, with a clearly defined demarcation both cranially and caudally (Fig 6-15f).



Fig 6-15c No bony floor in the maxillary sinus.

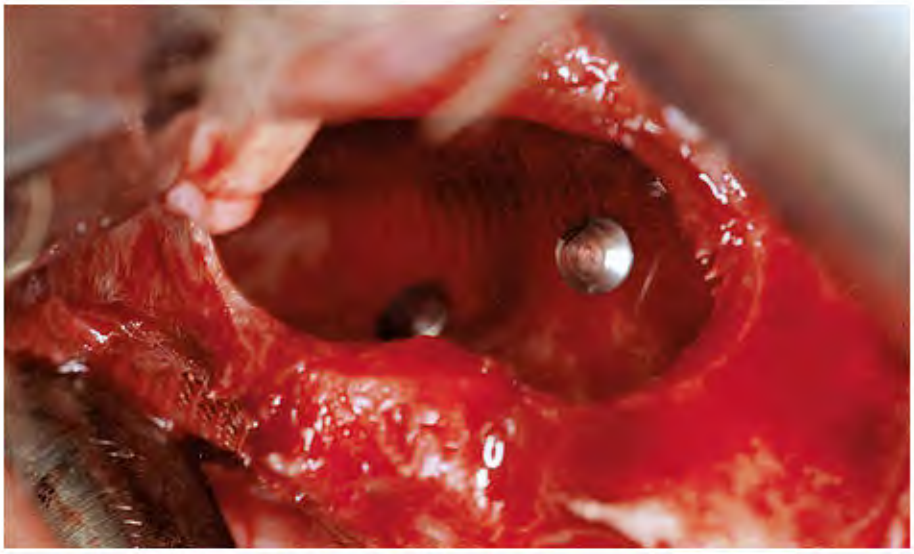


Fig 6-15d Sealing the floor with a piece of Vicryl mesh.

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Fig 6-15e Closing the lateral window.



Fig 6-15f Postoperative CBCT after sinus elevation.



Fig 6-15g Residual ridge before implant placement.

Implant placement

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In cases like this one, the healing period should be approximately 1 year. The entire healing period was uncomplicated and implant placement could begin (Fig 6-15g). On the right side, where the large defect had been located, the new bone was still soft and had not consolidated sufficiently. However, stable insertion of the Replace Select implants (Nobel Biocare) (with diameters of 3.5, 4.3, 5.0 and 6.0 mm) was still possible due to their conical shape (Fig 6-15h). Further augmentation was needed around the distal implants in particular. The harvested bone chips were used for a vertical bone augmentation in the molar region and a horizontal one in the anterior maxilla. Overall, the bone on the left side was harder, and good primary stability was achieved here as well, by using implants of different diameters (Fig 6-15i). The implants were ready to be exposed after another 10 months. The small perforations over implants 13 and 27 were probably attributable to pressure exerted by the complete denture (Fig 6-15j). The highest-risk site around implants 16 and 17 remained completely intact despite the concerns. All 10 implants had osseointegrated successfully (Fig 6-15k).

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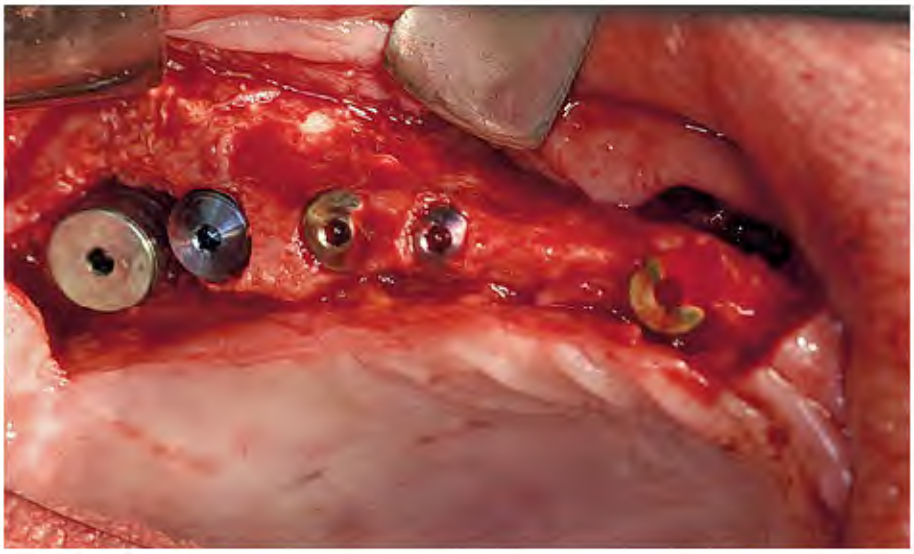


Fig 6-15h Implant placement on the right side. Residual defect in region 17.

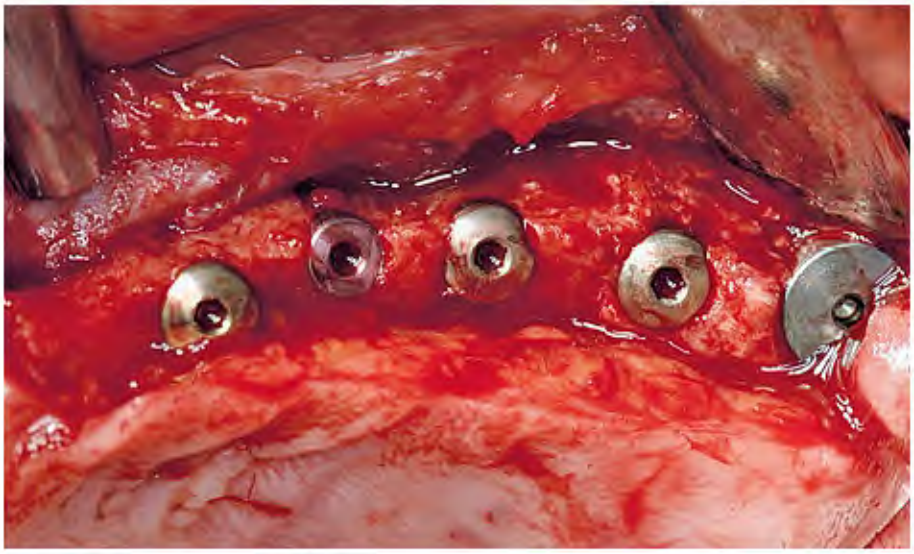


Fig 6-15i Implant placement on the left side.

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Fig 6-15j Clinical situation before exposure.



Fig 6-15k Check panoramic radiograph following treatment completion.

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Treatment course

- Sinus floor elevation on both sides (2003)
- 1 year to implant placement
- 10 months to exposure

Treatment

Surgery: Dr Christoph T. Sliwowski

Problems and complications

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Severe horizontal residual ridge atrophy and loss of an implant

Baseline situation

Five years before the treatment of her maxilla, this patient had already been fitted with an implant-supported mandibular restoration, consisting of a cantilever fixed bridge on six implants in the interforaminal region. Following the restoration of her mandible with a fixed denture, the patient became aware of the looseness and poor fit of her maxillary prosthesis. Severe residual ridge atrophy, both vertically and horizontally, was diagnosed at the clinical examination (Fig 6-16a). The horizontal atrophy affected particularly the premolar and anterior region on both sides (Figs 6-16b and 6-16c). The 3D analysis confirmed a severely atrophied, knife-edge residual ridge and a pronounced maxillary sinus on the left side (Fig 6-16d). Eleven positions were prepared for the 10 implants in the SimPlant planning program (Fig 6-16e). Implant placement was to take place concomitantly with sinus elevation and residual ridge augmentation.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus elevation, immediate implantation, horizontal and vertical augmentation
2. Exposure and mucosal distraction
3. Prosthetic restoration

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Fig 6-16a Severely atrophied residual ridge.

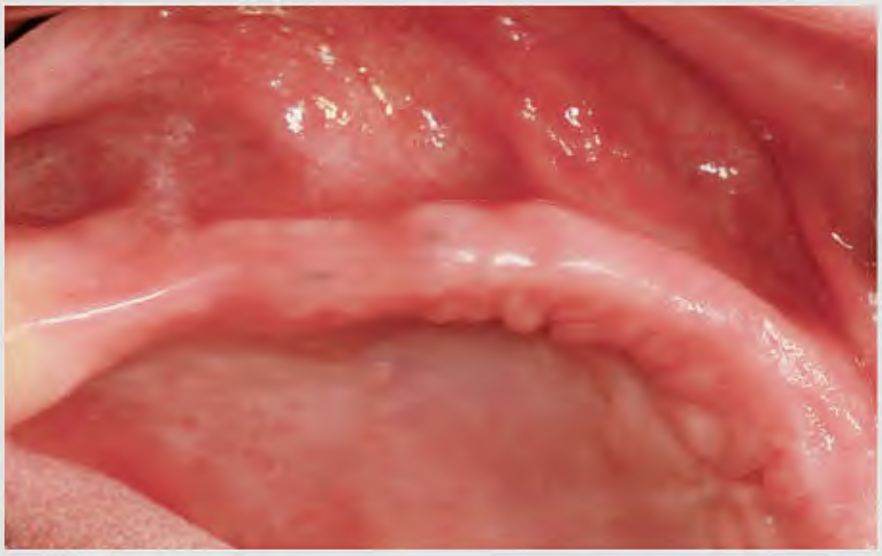


Fig 6-16b Particularly pronounced atrophy in the premolar region on the right side.



Fig 6-16c Left side.

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Fig 6-16d CBCT scan before treatment.

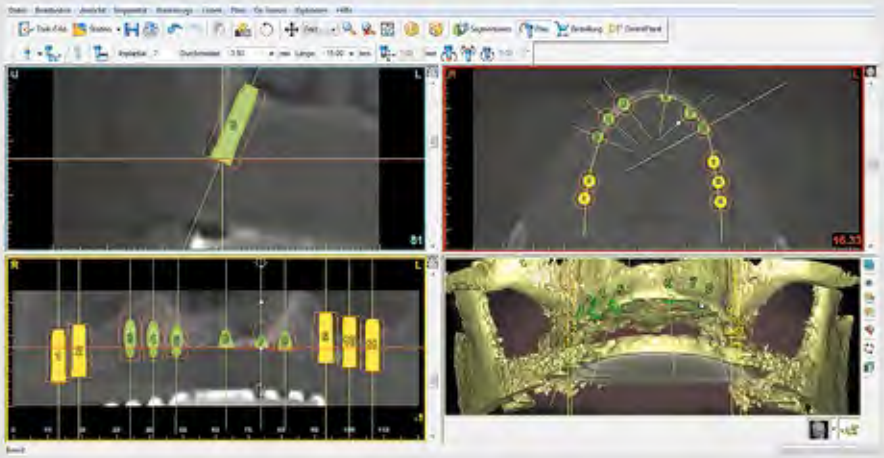


Fig 6-16e SimPlant planning.

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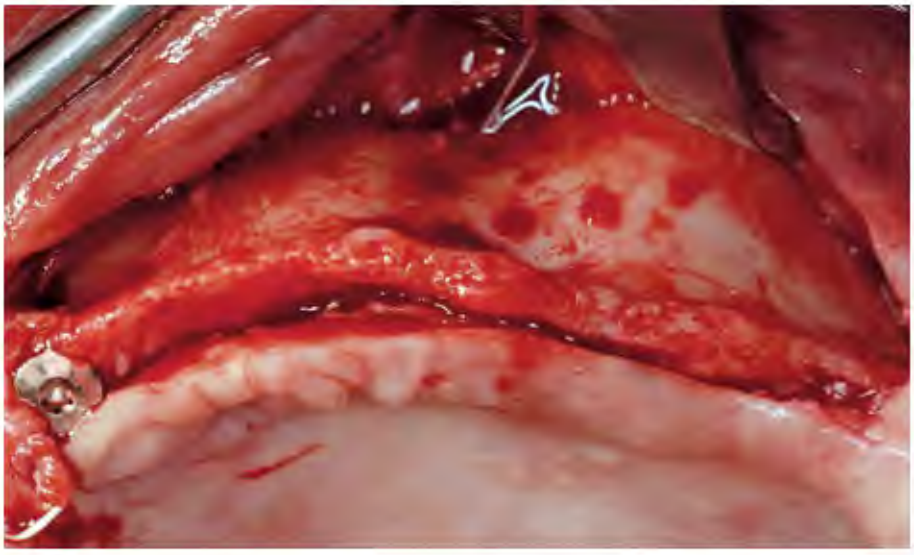


Fig 6-16f Narrow residual ridge following flap reflection.

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Fig 6-16g Fenestration for the sinus elevation.

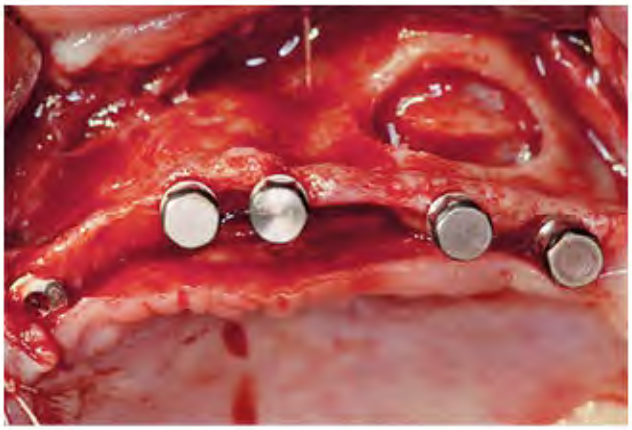


Fig 6-16h Spreading the residual ridge.

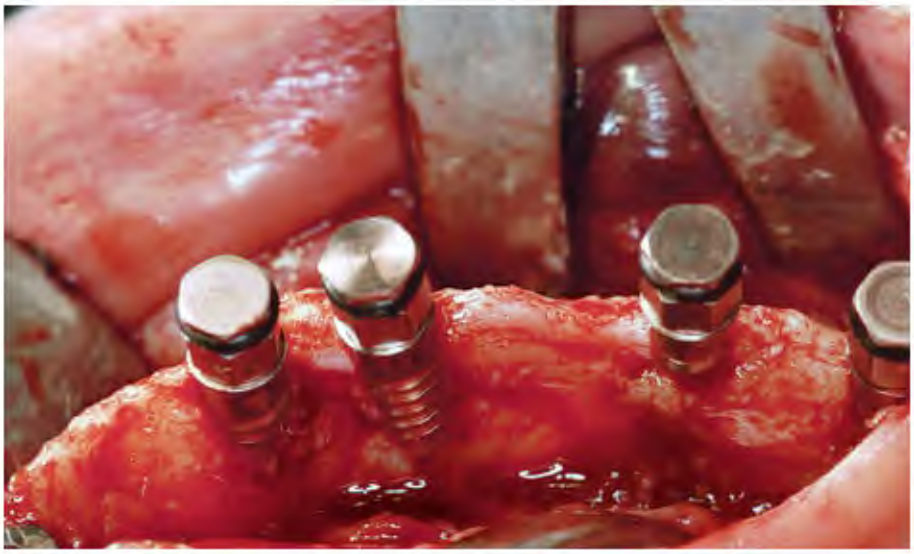


Fig 6-16i The instruments are being inserted more from the palatal side.

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Sinus floor elevation, residual ridge spreading, implant placement, and ridge augmentation

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As expected, the crestal incision revealed a very narrow residual ridge on the left side (Fig 6-16f). Only the region directly at the incisal canal provided sufficient bone for the insertion of an implant in position 21. Fenestration for the sinus elevation was performed prior to implant placement in the posterior region (Fig 6-16g). Since the width of the residual ridge was not sufficient for implant placement, spreaders were used to spread the ridge in the palatal-vestibular direction (Fig 6-16h). The instruments were inserted more from the palatal side, to direct the spread more towards the vestibule (Fig 6-16i). Spreading was followed by sinus elevation with a mixture of autologous bone and Bio-Oss. Four implants were then inserted into the prepared sites (Fig 6-16j). Since the residual ridge was narrower than the implant diameter of 3.5 mm despite the spreading, the implants were inserted slightly toward a palatal direction. The expected resorption of the augmentation material from this direction would be reduced by the vestibular bone wall and the displaced bone fragments (Fig 6-16k). The residual ridge around the implants was generously augmented with Bio-Oss, and the augmentation material stabilized with a Tutodent membrane (Tutogen Medical). The double-layer technique was used, the lower membrane being attached with titanium pins (Fig 6-16l).

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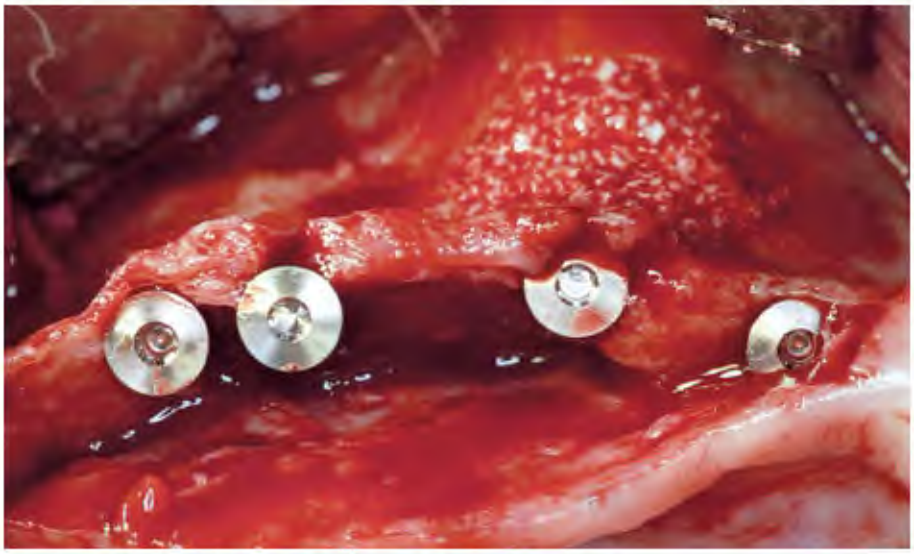


Fig 6-16j Four implants following insertion.

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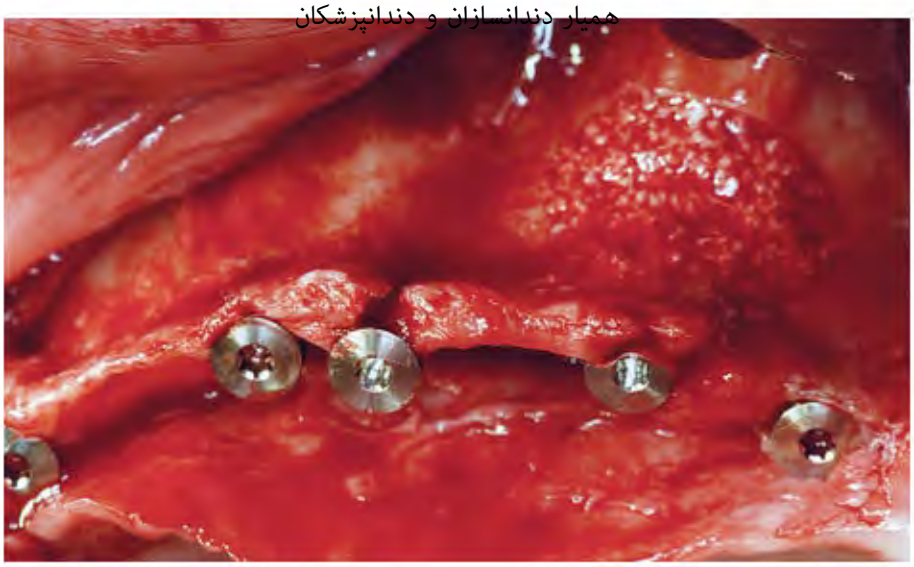


Fig 6-16k Remaining bone on the buccal side.



Fig 6-16l Augmentation with the double-layer technique.

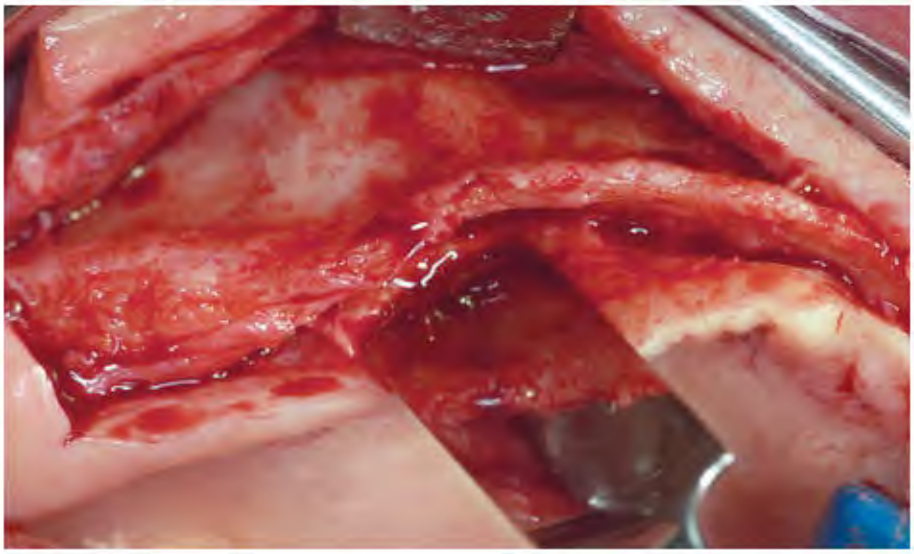


Fig 6-16m The residual ridge on the right side is also narrow.

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When the residual ridge was exposed on the right side, a similar problem was revealed here (Fig 6-16m). To establish better conditions for the spreading, the residual ridge bone was split along its course using a thin osteotome blade. After sequential drilling with the 1.5- and 2-mm drill bits, spreading screws were used for the continued preparation of the implant beds (Fig 6-16n).

The thin vestibular lamella ruptured despite the very careful spreading. However, it remained securely attached to the residual ridge (Fig 6-16o). Even without a sinus elevation, regions 16 and 17 were suitable for the insertion of one wider implant each, 4.0 mm in diameter and 17 mm long (Fig 6-16p). Implants 3.5 mm wide were used in the anterior region. Great care was needed, both during implant placement and augmentation, to ensure that the thin, loosened bone lamellae were not broken off and lost (Fig 6-16q). The whole area, from region 11 to 15, was augmented with bone substitute (Bio-Oss) and covered with a Tutodent membrane 30 × 40 mm in size, fastened on the vestibular and palatal side with titanium pins (Fig 6-16r). Following extensive periosteal slitting, the mucoperiosteal flap was mobilized and then sutured with Gore-Tex sutures for saliva-proof closure. The sutures were removed in two stages, after 2 and 4 weeks (Fig 6-16s). The postoperative panoramic radiograph shows the position of the implants in the maxilla and the stable situation of the mandibular implants after 5 years of functional use (Fig 6-16t).

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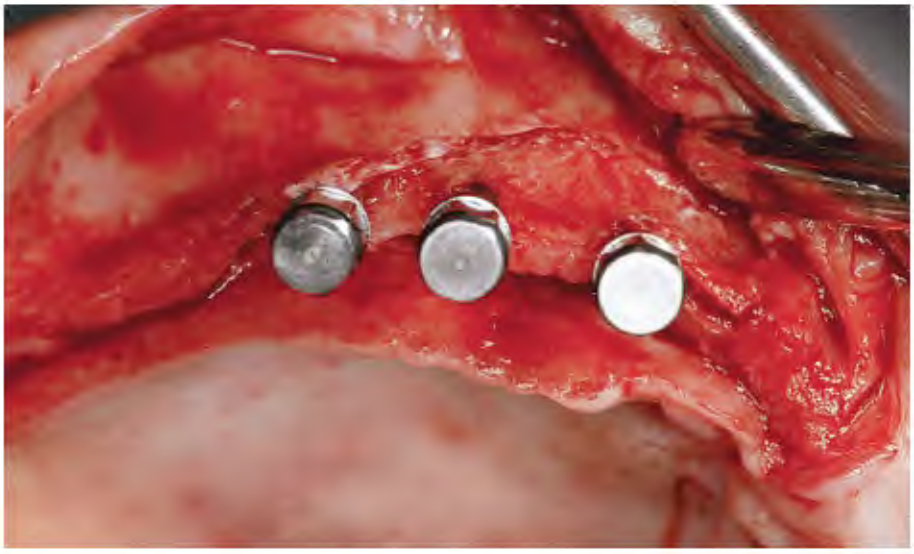


Fig 6-16n Spreading the residual ridge.

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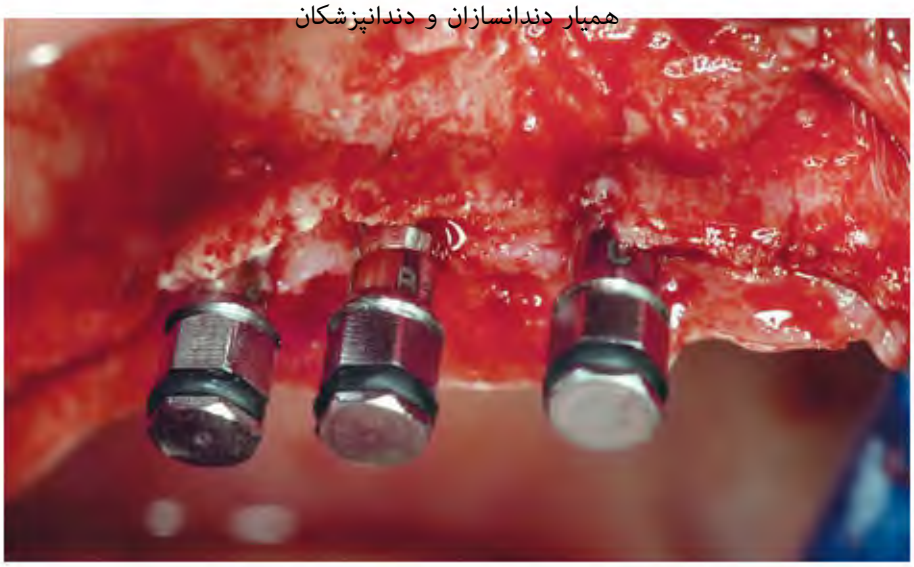


Fig 6-16o Rupture of the thin vestibular lamella.

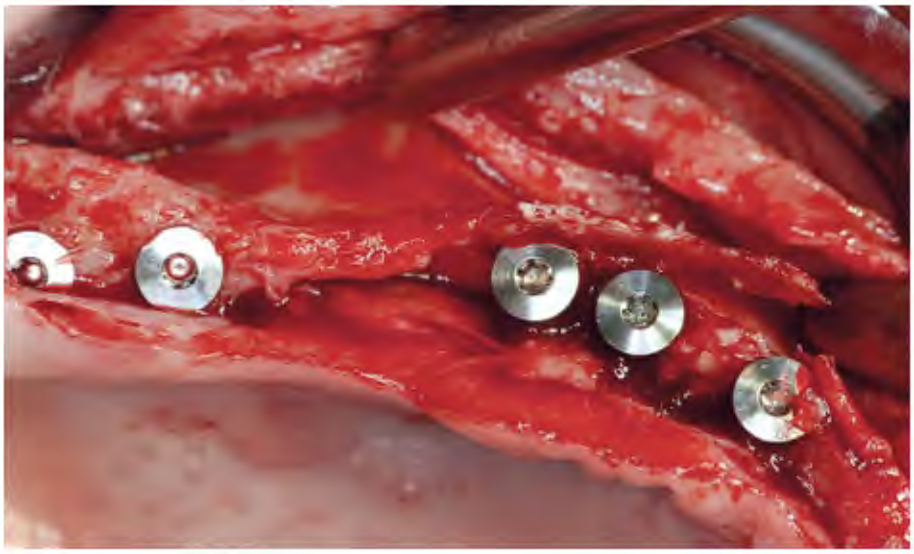


Fig 6-16p Inserted implants.

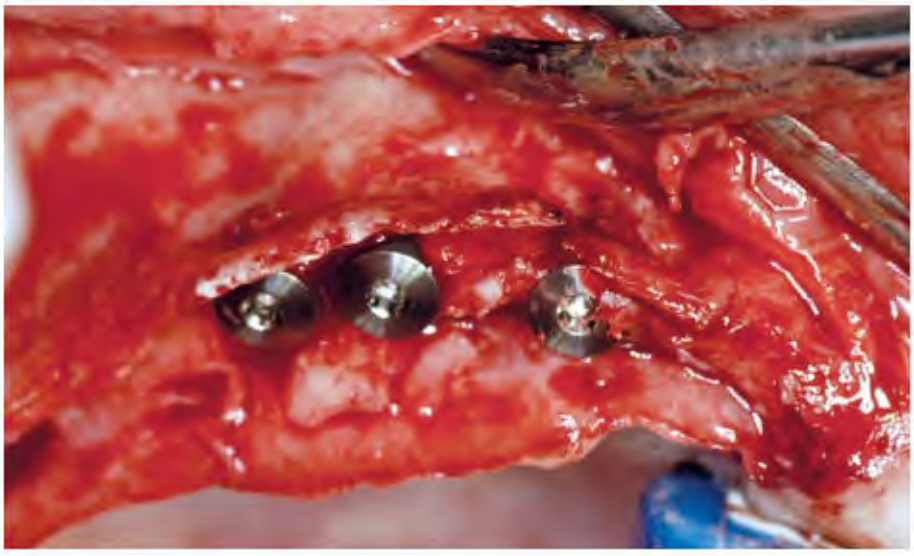


Fig 6-16q Careful handling of the vestibular lamella.

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Fig 6-16r Augmentation with a large membrane, attached on both the vestibular and palatal sides.

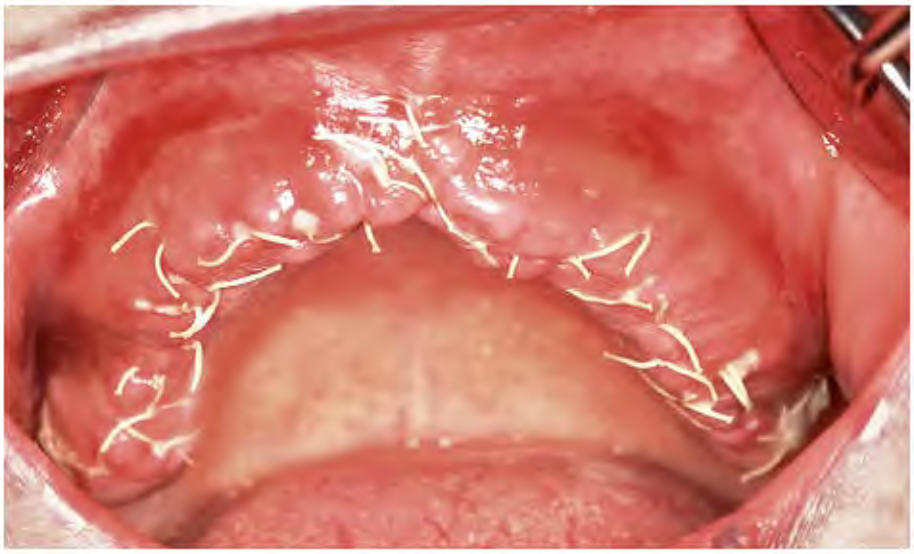


Fig 6-16s Augmentation results prior to removal of sutures.



Fig 6-16t Postoperative panoramic radiograph after implant placement.

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Fig 6-16u Residual ridge before exposure.

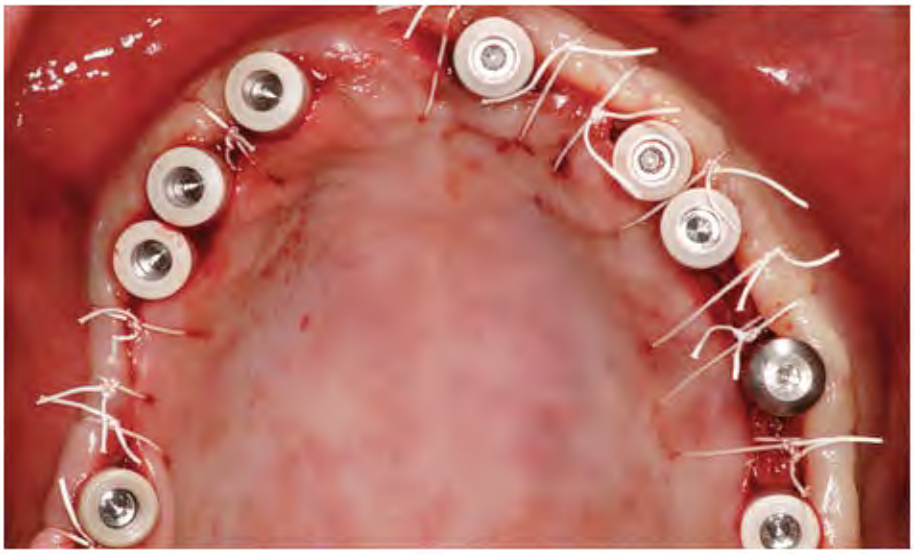


Fig 6-16v Healing abutments screwed into place.



Fig 6-16w Titanium abutment on implant 26.

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Fig 6-16x Provisional fixed restoration fabricated with a fast-curing polymer.

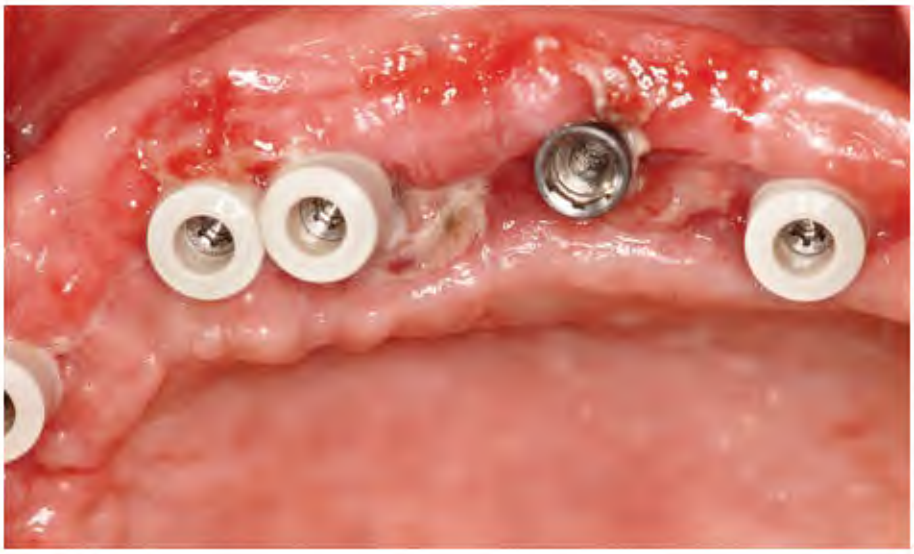


Fig 6-16y Loosening of implant 26.

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Exposure and prosthetic restoration

The 10-month healing phase was uncomplicated and the implants were ready to be exposed (Fig 6-16u). The incision was made on the palatal side of the implants, to spread the zone of attached gingiva. Polyetheretherketone (PEEK) healing abutments (5 mm high) were screwed onto all the implants, with the exception of implant 26 (Fig 6-16v): in this position, the 5-mm abutment was a bit too short, and a 7-mm titanium abutment was used as a makeshift solution (Fig 6-16w).

The tension of the sutured mucoperiosteal flap was considerably greater over the titanium abutment than over all the other abutments. Since the existing prosthesis could only have been adapted with difficulty, a provisional was fabricated with the aid of a thermoplastic foil and inserted (Fig 6-16x). Although all the implants were stable at the time of exposure, tenderness to touch and slight mobility of implant 26 were detected 3 weeks later (Fig 6-16y). In view of

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this finding, implant 26 was removed directly under infiltration anesthesia, to minimize any subsequent complications (Fig 6-16z). A fixed cross-arch bridge 17 to 27 was fabricated on the remaining nine implants and incorporated (Fig 6-16aa).

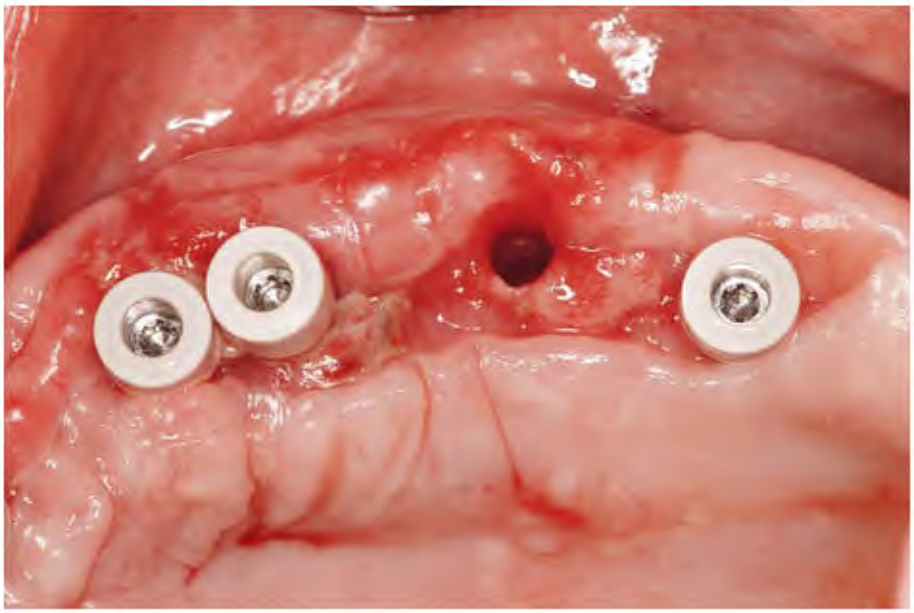


Fig 6-16z Removal of implant 26.



Fig 6-16aa Fixed cross-arch bridge 17 to 27 on 9 implants.

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Fig 6-16bb Completion of treatment.



Fig 6-16cc The patient is proud of her new teeth.

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Following treatment completion, the patient's dentition was prosthetically restored with fixed bridges on six implants in the mandible and nine implants in the maxilla (Fig 6-16bb). Six years after the first implant placement, the patient is still very satisfied with the results of her treatment (Fig 6-16cc).

Treatment course

- Implant placement and prosthetic loading in the mandible
- 5 years later, left-sided sinus floor elevation and implant placement with augmentation in the maxilla (2006)

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- 10 months to exposure
- 3 weeks later, loss of implant 26
- After 6 weeks, fabrication of the definitive maxillary restoration

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Gregor Cwajgart
Dental technology:	Gerhard Makowski

Problems and complications

Sinus floor elevation and implant placement following loss of the old implants

The case presented here is a continuation of the case report in the 3D diagnosis section on page 420.

Baseline situation

This 68-year-old man had several implants inserted into the maxilla at another clinic 2 years previously. Clinical examination at first presentation revealed only a single implant in region 15 (Fig 6-17a). Two implants in regions 15 and 23 are still visible in the radiograph brought in by the patient, along with a fractured implant in region 13 (Fig 6-17b). The only implant on the left side in region 23 has since been lost. Implant 15 was loaded with a Locator abutment (Dentsply) and was acting as the sole retaining element for the palateless prosthesis (Fig 6-17c).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation
2. Implant placement

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3. Exposure and definitive prosthetic restoration

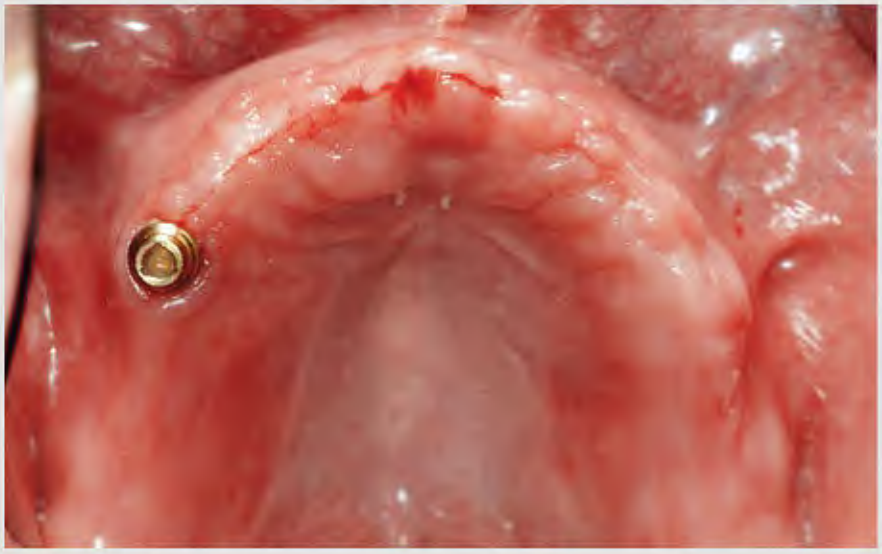


Fig 6-17a Edentulous maxilla with an implant in region 15.



Fig 6-17b Panoramic radiograph brought in by the patient before the start of his treatment.

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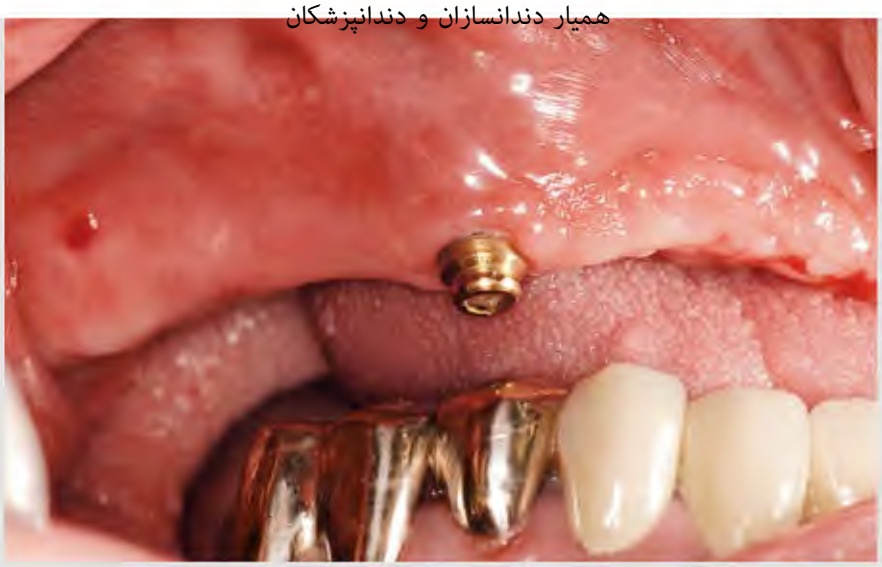


Fig 6-17c Locator abutment on the implant.

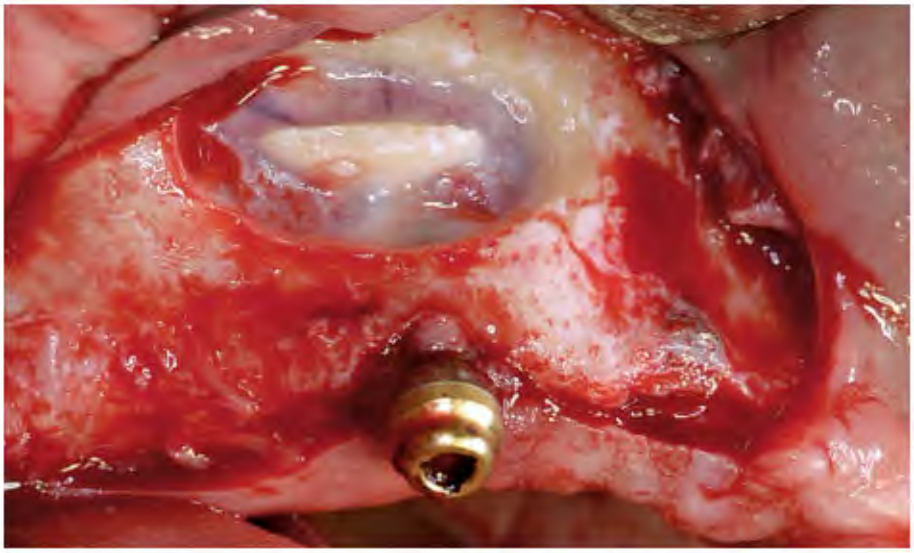


Fig 6-17d Creating the window.

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Fig 6-17e Implant apex in the maxillary sinus.

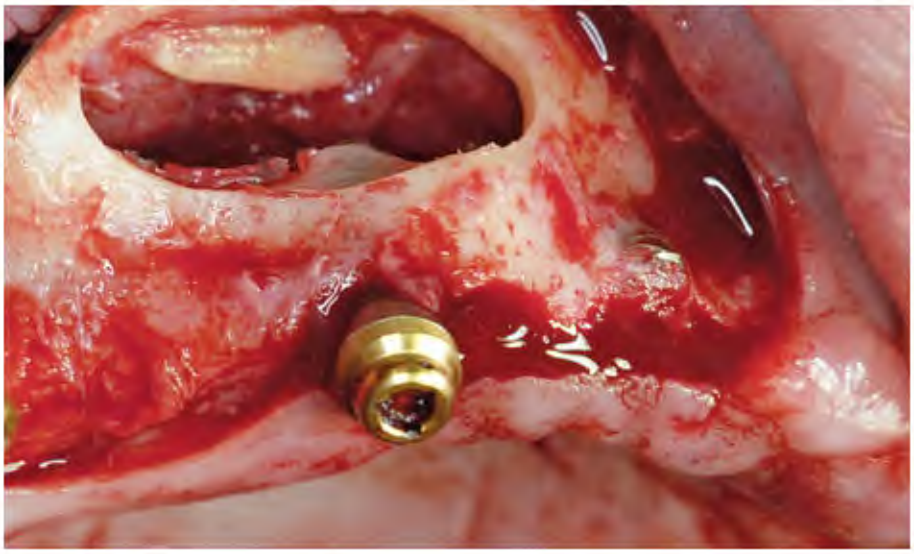


Fig 6-17f Fractured implant in region 13.

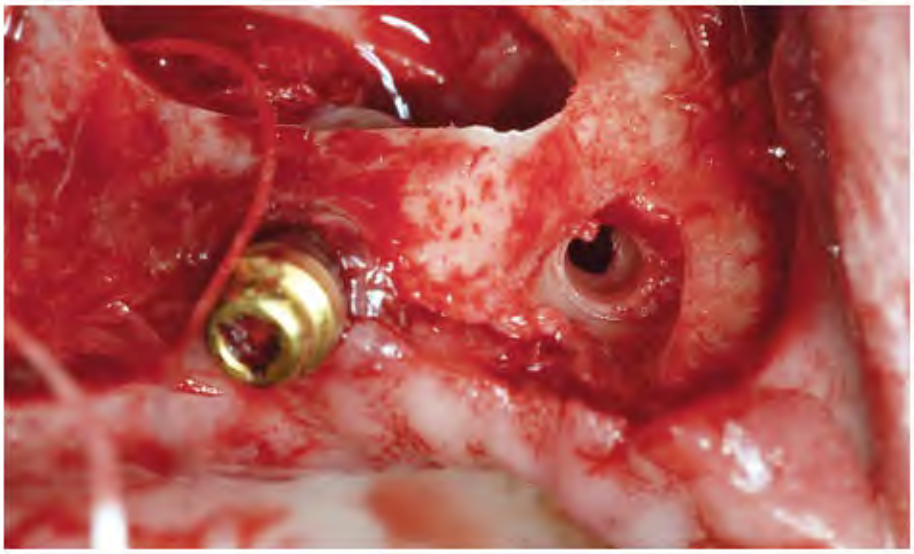


Fig 6-17g Perforation of the maxillary sinus following removal of the broken implant.

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Sinus floor elevation and removal of a fractured implant

The operation took place under general anesthesia. On the right side, an incision was made on the residual ridge and on the buccal side around implant 15. An access window for the maxillary sinus elevation was cut above the implant (Fig 6-17d). The fenestration clearly revealed that the implant protruded slightly into the maxillary sinus (Fig 6-17e). The maxillary sinus mucosa was carefully mobilized from the implant apex and lifted together with the bony lid (Fig 6-17f). The fractured implant was located approximately 10–15 mm directed mesially. It was carefully removed with a trephine (Fig 6-17g), revealing a communicating link to the maxillary sinus. After sinus elevation and the filling of the bone defects, the augmented areas were covered with Bio-Gide membranes attached with titanium pins (Fig 6-17h). This was followed by tight suturing on the right side. The left side was prepared for sinus elevation in a similar way to the right side (Fig 6-17i). A bony septum was found during fenestration, and needed to be taken into account in the dissection (Fig 6-17j). The maxillary sinus mucosa on both sides of the septum was carefully lifted away without damaging it (Fig 6-17k). The resultant cavity was filled with a mixture of autologous bone and Bio-Oss and covered with a membrane (Fig 6-17l). The postoperative panoramic radiograph shows the extent of sinus elevation and the only remaining implant 15 (Fig 6-17m).

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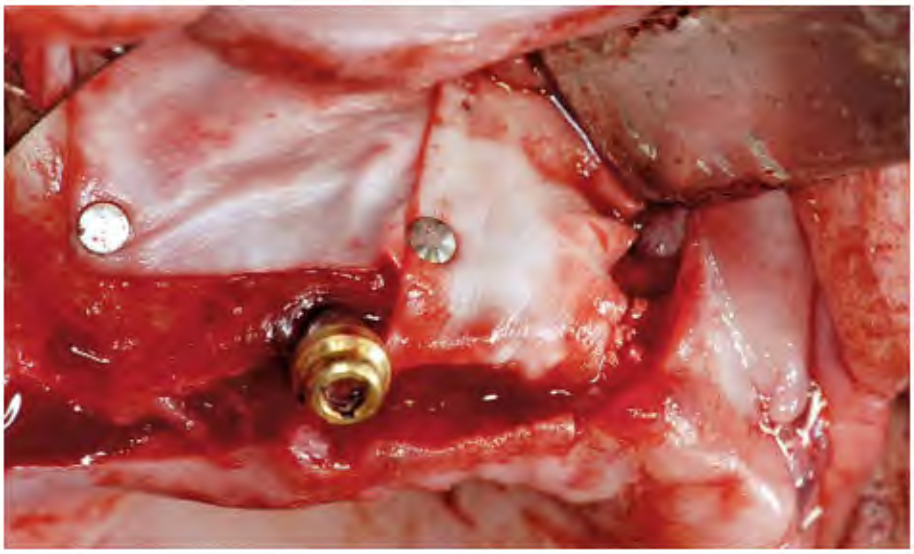


Fig 6-17h Membranes attached with titanium pins.

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Fig 6-17i Opening the left side.

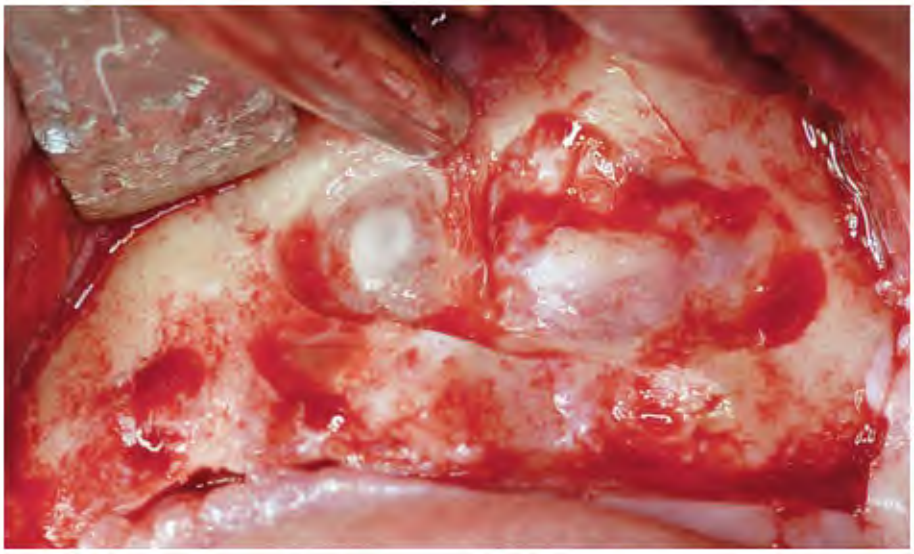


Fig 6-17j Fenestration with a septum.

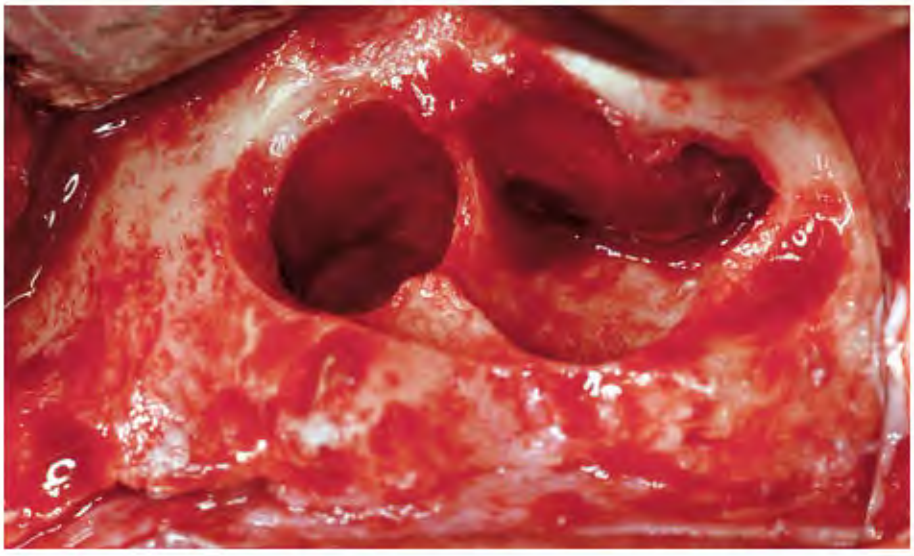


Fig 6-17k Maxillary sinus divided by the septum.

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Fig 6-17l Attached membrane.



Fig 6-17m Postoperative panoramic radiograph.

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Implant placement

Approximately 4 months after sinus elevation, the last implant in region 15 also ceased to function, so that the patient presented with a completely edentulous maxilla at the time of implant placement 1 year later (Fig 6-17n). The exact preoperative 3D diagnostic procedure can be found on page 420 onwards. The panoramic radiograph (Fig 6-17o) provides an overview of the baseline situation. Implant placement was performed quadrant by quadrant. On the right side, the result of the augmentation and the titanium pins used to attach the now resorbed membrane were revealed when the flap was opened (Fig 6-17p). Surprisingly, there was no identifiable residual ridge defect following the loss of implant 15. As planned, five implants were inserted centrally into the residual ridge in positions 13, 14, 15, 16 and 17 (Fig 6-17q). One anterior implant was inserted into region 21 on the left side. The remaining four implants were inserted into regions 24, 25, 26 and 27 (Fig 6-17r). The positions of the

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implants can be seen on the postoperative panoramic radiograph (Fig 6-17s).



Fig 6-17n Clinical situation before implant placement.



Fig 6-17o Radiological situation before implant placement.

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Fig 6-17p Augmentation result on the right side.



Fig 6-17q Implant placement on the right side.

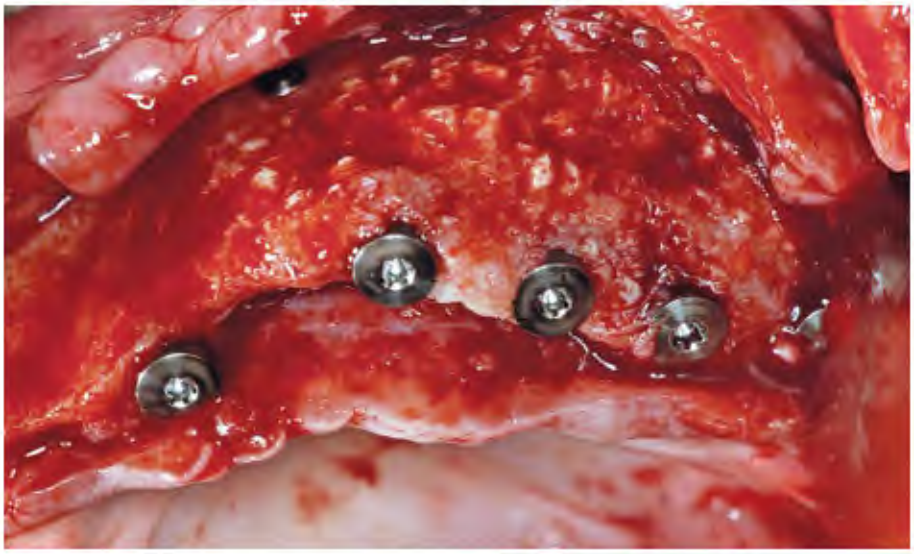


Fig 6-17r Implant placement on the left side.

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Fig 6-17s Postoperative panoramic radiograph.

Exposure and prosthetic restoration

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All the implants were exposed after an 8-month healing period. On the left side, all seemed in order at first glance. On closer inspection, however, one could see a slight buccal dehiscence around implant 26 and a palatal swelling at implant 22 (Fig 6-17t).

The dehiscence was corrected at the time of exposure, in conjunction with the procedure to widen the zone of attached gingiva (Fig 6-17u). No zones of dehiscence were visible on the right side and all the implants were covered by mucosa (Fig 6-17v). The exposure was performed according to the same principle (Fig 6-17w). The impression taking with Impregum (3M ESPE) on a custom tray took place 3 weeks after exposure. At this point, the patient favored a screw-retained fixed implant bridge as his dental restoration. It was only after the try-in of the wax-up on a plastic base that he decided to opt for a removable solution instead. Since the maxilla had atrophied considerably more in the horizontal than in the vertical direction, horizontal malocclusion (underbite) of more than 10 mm had developed between the upper and lower dental arch, which could only be “hidden” with a removable restoration fitted with a vestibular shield. The connector bar was first modeled according to the prosthetic aspects, then scanned and milled out of a single piece of titanium (Fig 6-17x). The milling technique resulted in a high-precision fit on the implants.

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Fig 6-17t Barely visible dehiscence at implant 26.



Fig 6-17u Widening the zone of attached gingiva.

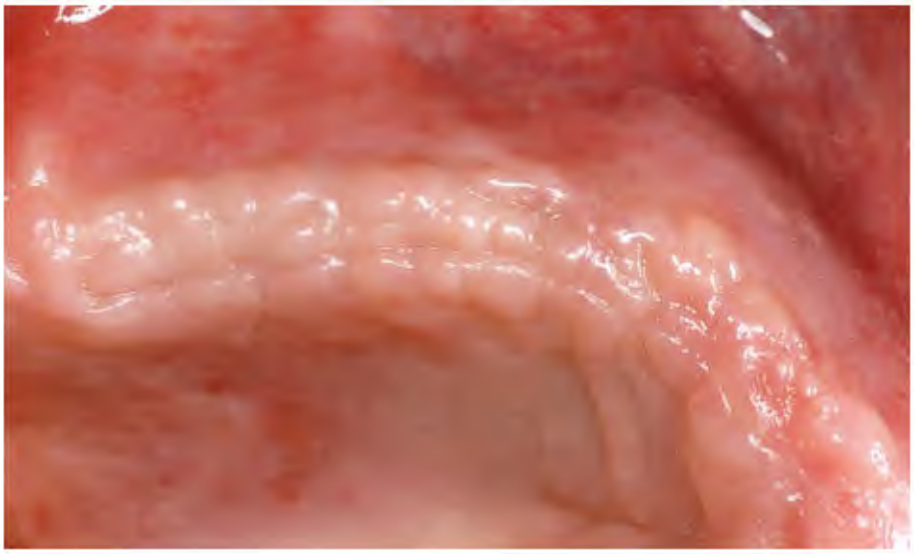


Fig 6-17v Right side before exposure.

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Fig 6-17w Right side after exposure.



Fig 6-17x Milled titanium bar connector.

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Because of the atrophy and to compensate for the vertical malocclusion, the bar ran further on the labial side of the implants in the anterior region (Fig 6-17y). To keep the prosthesis as thin as possible and to achieve a precise fit, its framework was fabricated out of gold using electroplating (Fig 6-17z). In addition to the precise fit, two MK-1 attachments were built in on both sides of the bar to secure the denture (Fig 6-17aa). The combination of deflected bar and removable denture allowed the dental arch to be shifted forwards (Fig 6-17bb). The dental arch of the palateless prosthesis runs over the bar, thus compensating for the horizontal atrophy of the residual ridges (Figs 6-17cc and 6-17dd). A check-up 4 months after the denture was fitted showed a stable gingival situation around all the implants (Fig 6-17ee). Following cleaning and hygiene instructions to the patient, the bar was refitted and blended in harmoniously with the overall appearance (Fig 6-17ff). The follow-up panoramic radiograph shows the precise fit of the titanium bar and a favorable bone situation around the implants, and also in the mandible, now restored with the aid of telescopic crowns (Fig 6-17gg). The missing areas of the residual ridge have been visually restored with pink acrylic. The

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prosthesis also provides support for the upper lip (Fig 6-17hh). After a long treatment, the patient is very satisfied with the final result (Fig 6-17ii).



Fig 6-17y Spatial relationship of the bar connector to the implants.

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Fig 6-17z Prosthesis base made out of gold.

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Fig 6-17aa MK1 attachment on the bar connector.



Fig 6-17bb Spatial relationship of the dental arch to the implants.



Fig 6-17cc In the anterior region, the bar connector runs far on the labial side of the implants.

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Fig 6-17dd The prosthesis in situ with locked attachments.



Fig 6-17ee Wide zone of attached gingiva around the implants.



Fig 6-17ff Occlusal view of the bar connector.

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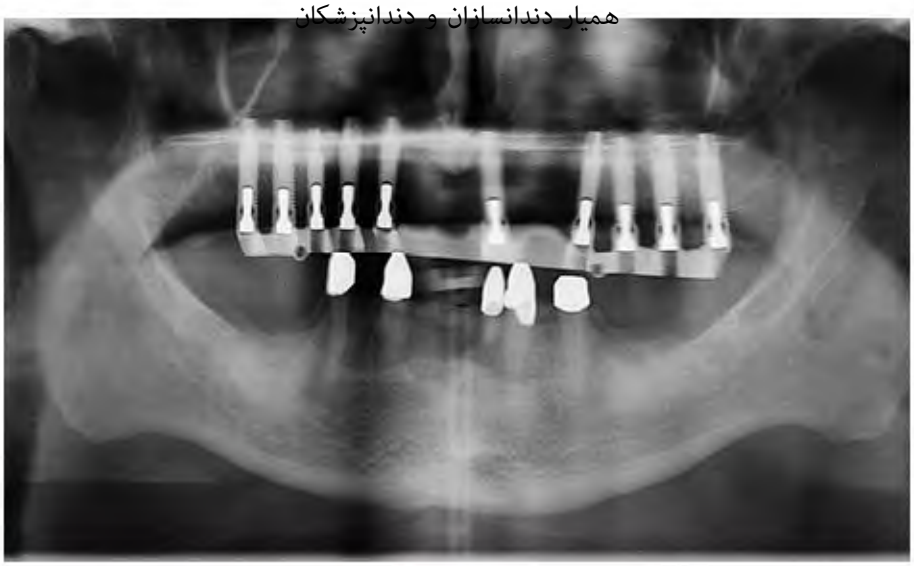


Fig 6-17gg Panoramic radiograph following treatment completion in the maxilla and mandible.



Fig 6-17hh Firmly anchored restoration in situ.



Fig 6-17ii The satisfied patient following completion of his treatment.

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Treatment course

- Bilateral sinus floor elevation (2008)
- 1 year to implant placement
- 8 months to exposure and fabrication of the dental prosthesis

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental technician Ludger Jansen

Immediate loading

Typical treatment course

Immediate restoration of provisional implants following extraction

Baseline situation

This female patient presented to our center with non-preservable residual teeth in the maxillary anterior region (Fig 6-18a). The maxillary sinuses were severely pneumatized, so that the posterior region offered no anchoring sites for implants (Fig 6-18b). Part of the radiologic diagnosis was confirmed following removal of the old restoration: the distal abutment toot of the left bridge had been almost completely destroyed (Fig 6-18c). The loss of this abutment tooth meant that an uninterrupted period with a fixed left provisional would not be possible without provisional implants.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- SimPlant planning
- Dental cast analysis

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Treatment plan

1. Extraction, implant placement in the anterior region and provisional implants with immediate provisional restoration
2. Bilateral sinus floor elevation
3. Implant placement
4. Exposure and definitive prosthetic loading



Fig 6-18a Baseline situation.

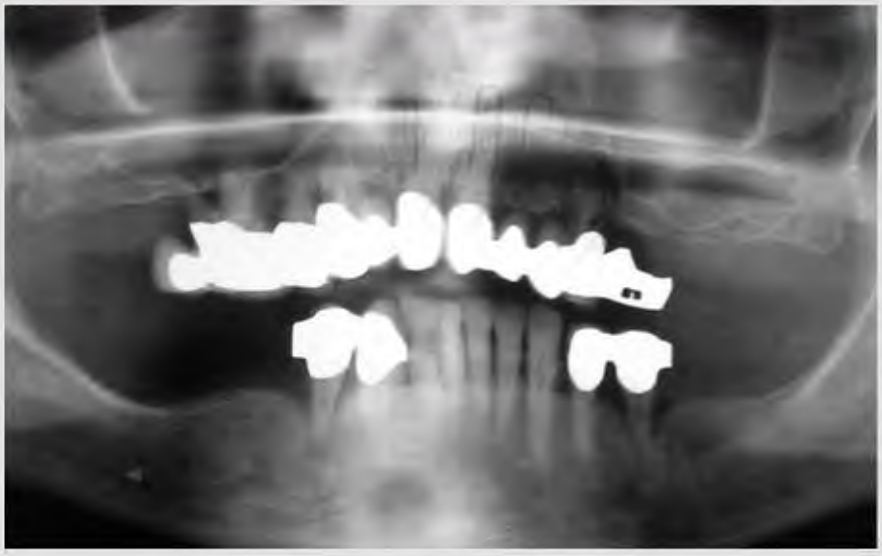


Fig 6-18b Panoramic radiograph.

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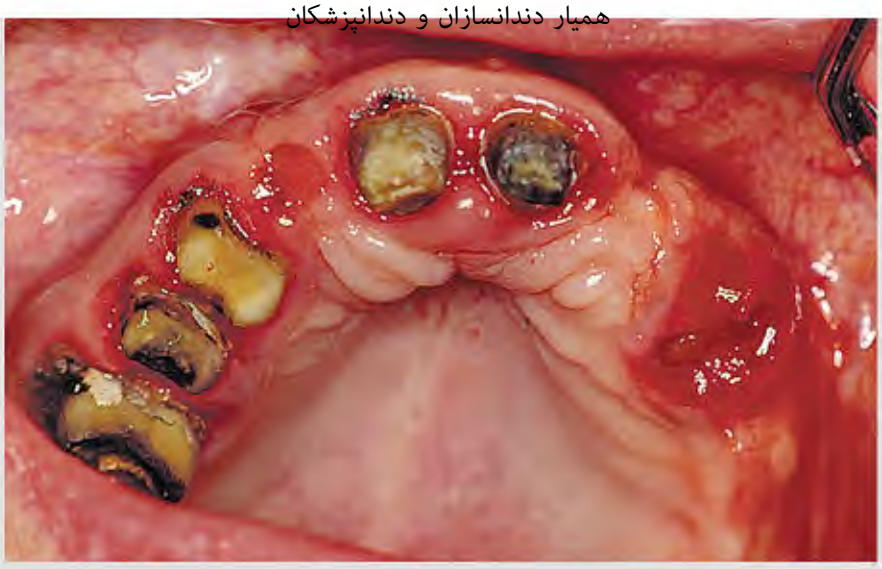


Fig 6-18c Clinical situation following removal of the old restoration.

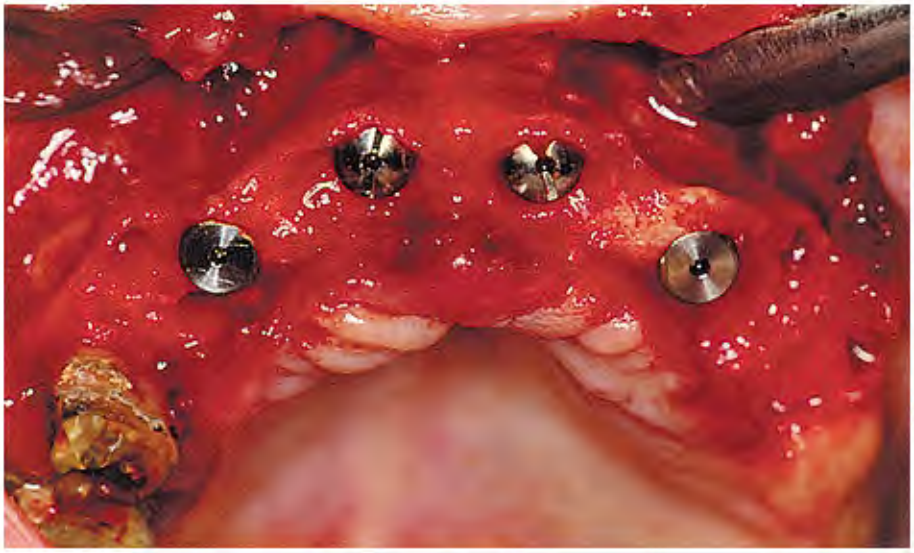


Fig 6-18d Insertion of four definitive implants into the anterior region.

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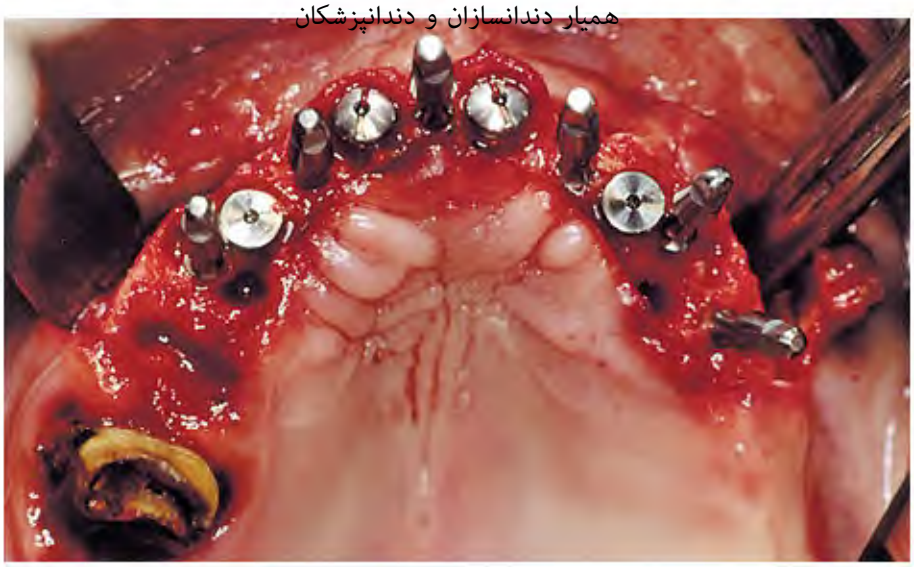


Fig 6-18e Insertion of six provisional implants.

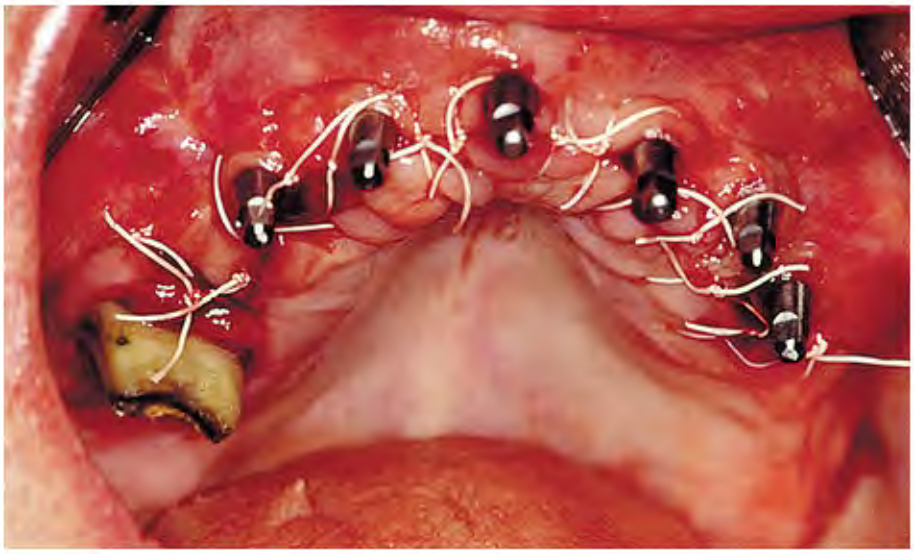


Fig 6-18f Parallelization of the provisional implants.



Fig 6-18g Long-term provisional restoration.

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Fig 6-18h Postoperative panoramic radiograph.

Dental extractions and implant placement in the anterior region

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After opening of the operation area, teeth 11, 14, 15 and 21 plus root 24 were extracted carefully and without bone loss. Four implants were inserted in the anterior maxilla (Fig 6-18d). Tooth 16, though also needing extraction, was left in situ for the time being as an added abutment for the provisional restoration. Six provisional implants were inserted into the intra-alveolar septa and between the permanent implants (Fig 6-18e). Following bone augmentation and suturing, the implants were aligned so that the direction of insertion of the provisional would be parallel to tooth 16 (Fig 6-18f). A metal-reinforced provisional restoration, which the patient could wear throughout the duration of treatment, was fabricated on the provisional implants and on tooth 16 (Fig 6-18g). The postoperative panoramic radiograph shows the positions of the implants (Fig 6-18h).

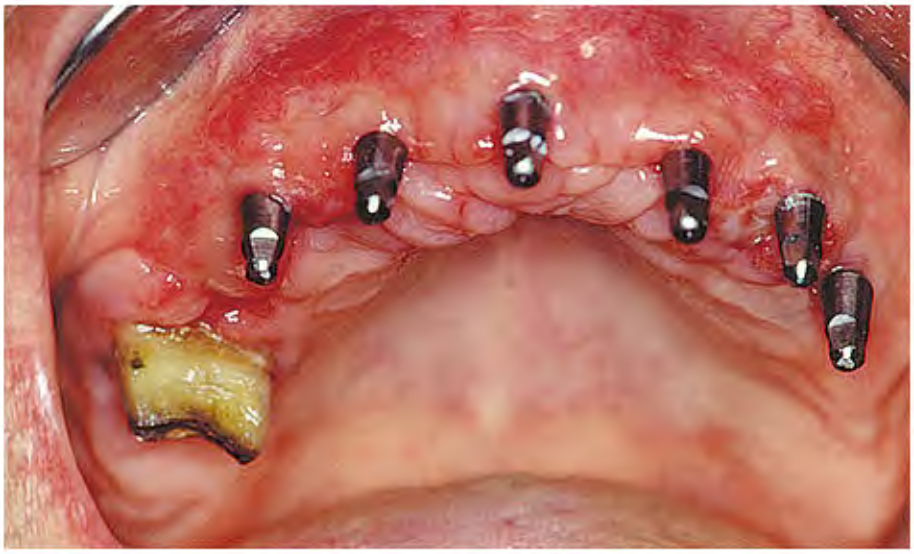


Fig 6-18i Clinical situation after 3 months.

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Fig 6-18j Filling the left maxillary sinus.

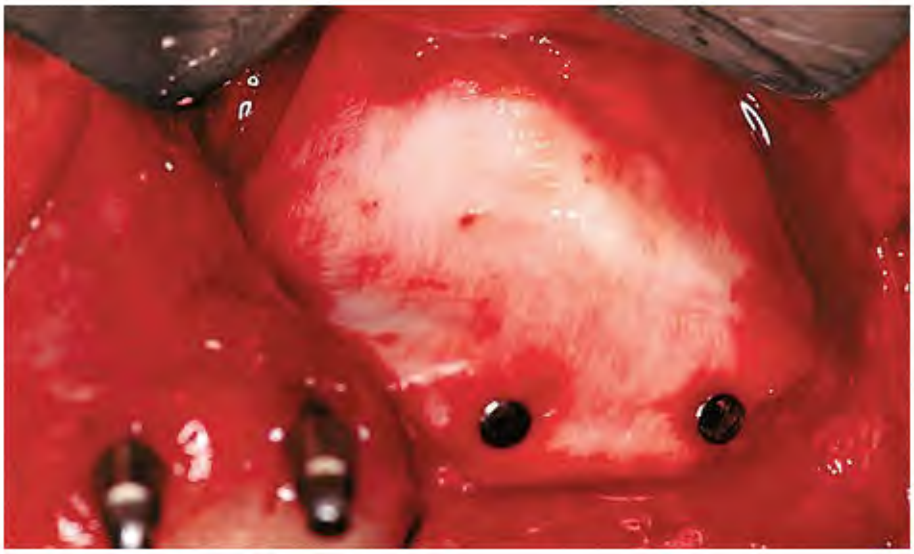


Fig 6-18k Resorbable membrane.



Fig 6-18l Fenestration of the right maxillary sinus.

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Fig 6-18m Elevating the maxillary sinus mucosa.

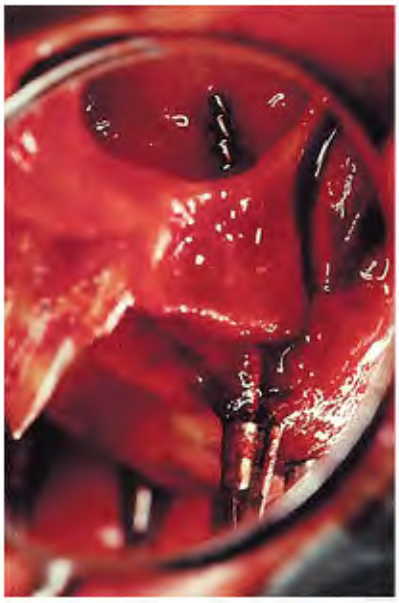


Fig 6-18n Penetration of a provisional implant into the maxillary sinus.

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Sinus floor elevation

After a 3-month healing period, the osseous and mucosal situation was stable, allowing sinus floor elevation to be performed (Fig 6-18i). On the left side, the maxillary sinus was filled with a mixture of Bio-Oss and autologous bone (Fig 6-18j) and the access window covered with a resorbable Bio-Gide membrane (Fig 6-18k). On the right side, the fenestration had to be created apically from the roots of tooth 16 without damaging them (Fig 6-18l).

The bone structures around the roots also had to be taken into account when elevating the maxillary sinus mucosa (Fig 6-18m). Preparation of the anterior segment of the maxillary sinus was more problematic, as one of the provisional implants had accidentally penetrated into the maxillary sinus, unavoidably causing a mucosal perforation (Fig 6-18n). This perforation was sealed with a resorbable Bio-Gide membrane, attached with titanium pins (Fig 6-18o). The

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cavity was filled with Cerasorb (Fig 6-18p) and sealed with the liquid membrane Atrisorb (Fig 6-18q). This was followed by tight suturing of the wound (Fig 6-18r). Precise adaptation and suturing of the distal releasing incision was particularly important, as suture dehiscences are particularly common in these areas (Fig 6-18s). In the radiograph, the augmentation materials differ in the degree of contrast: Bio-Oss, on the patient's left side, is less radiopaque than the Cerasorb on the right side (Fig 6-18t).



Fig 6-18o Sealing the perforation of the maxillary sinus mucosa with a membrane.



Fig 6-18p Filling the right maxillary sinus.

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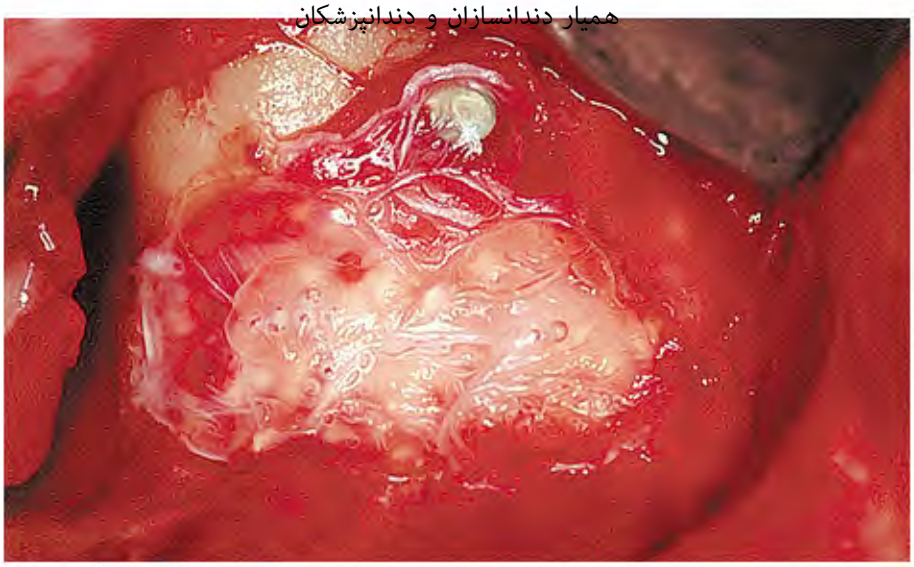


Fig 6-18q Closing the window with a liquid membrane.

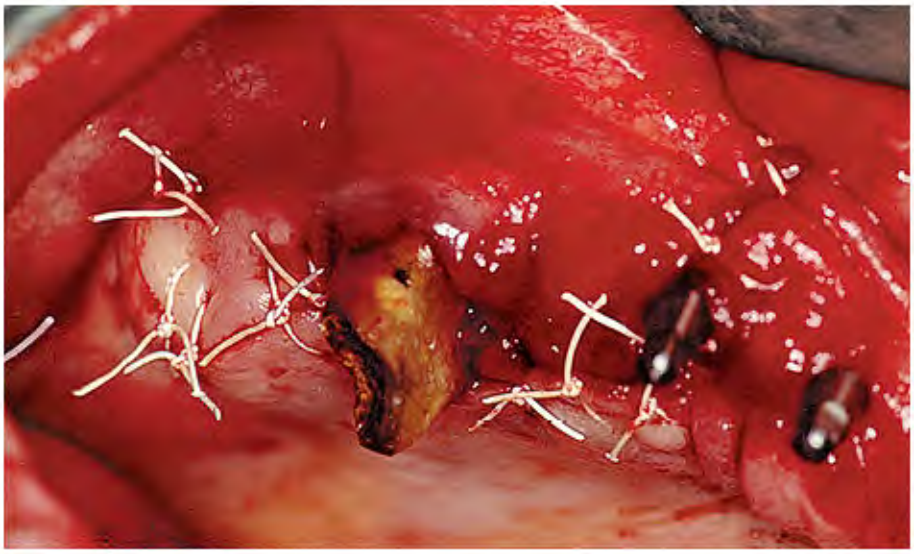


Fig 6-18r Tightly sutured wound.

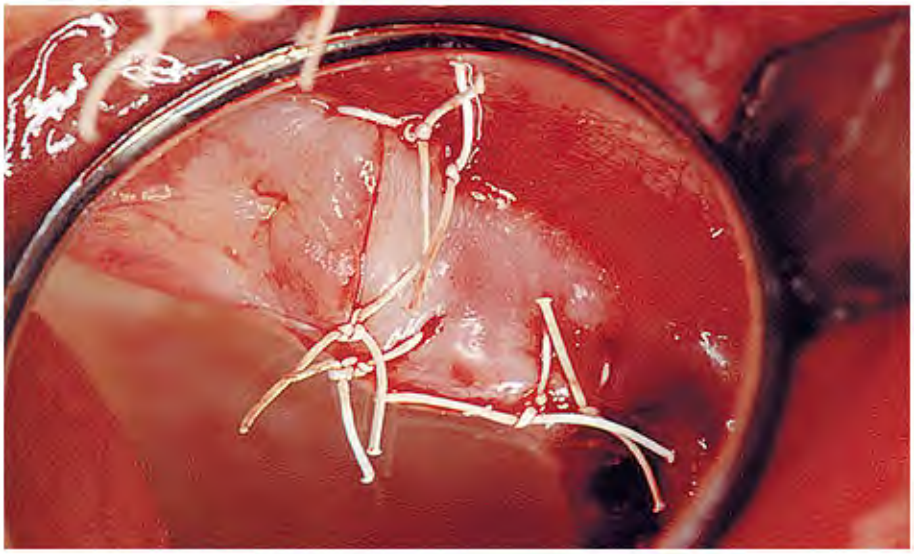


Fig 6-18s Particularly high dehiscence risk at the distal releasing incision.

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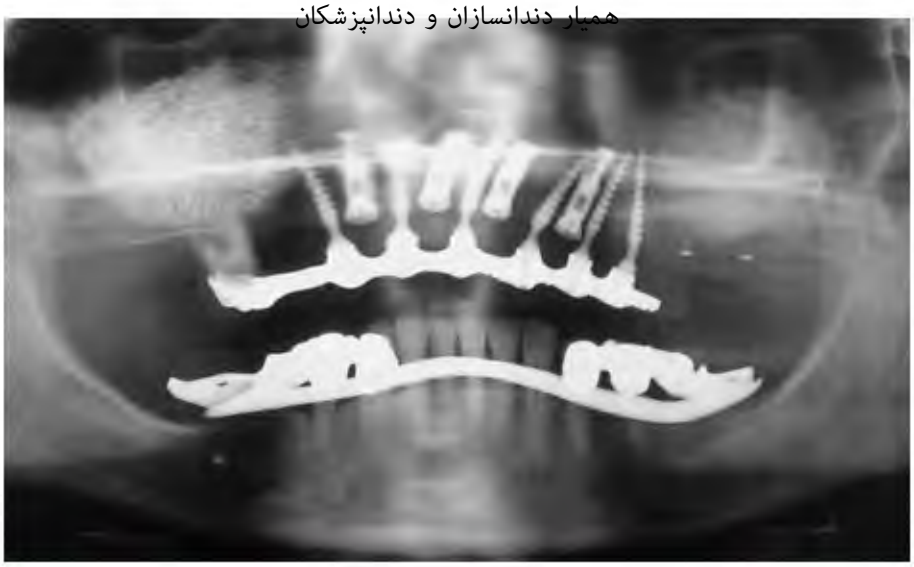


Fig 6-18t Postoperative panoramic radiograph (Bio-Oss vs Cerasorb).

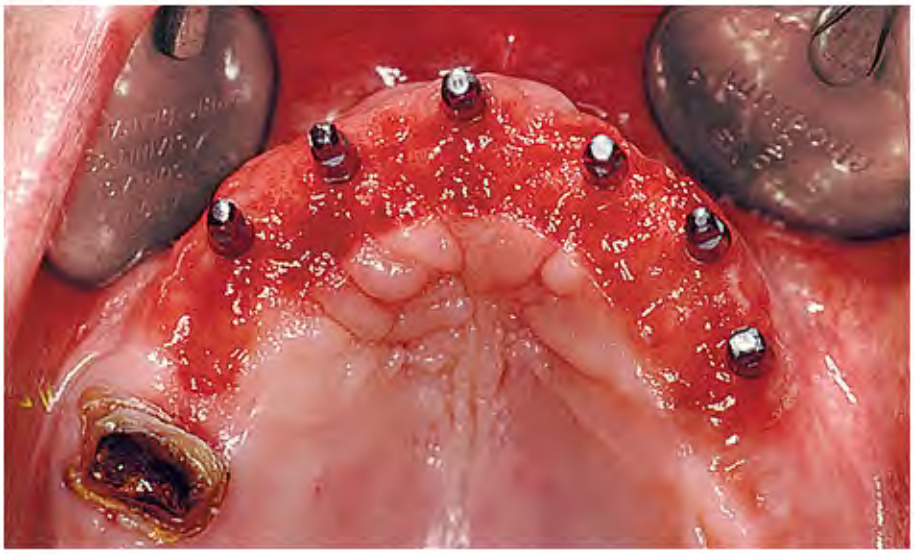


Fig 6-18u The mucosa shows a mild inflammatory reaction under the fixed provisional restoration.

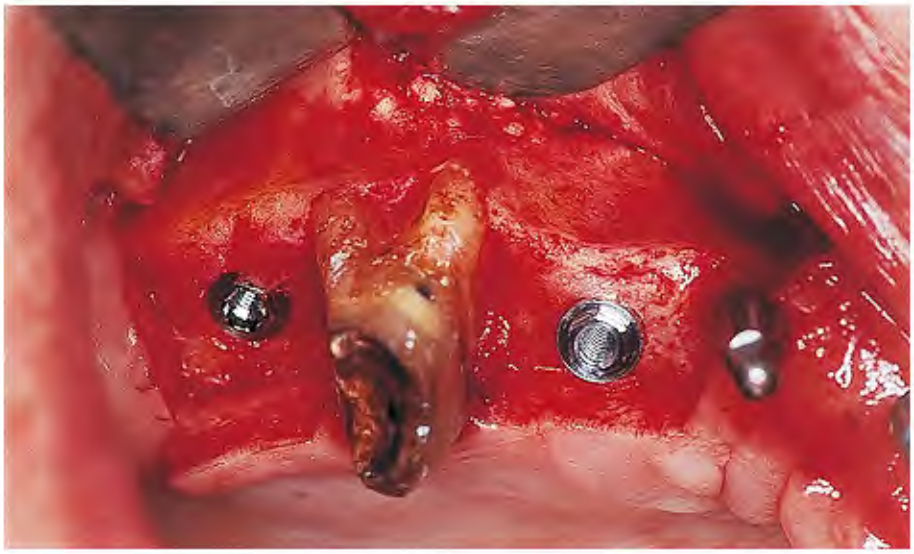


Fig 6-18v Two implants inserted on the right side. The Cerasorb is visible.

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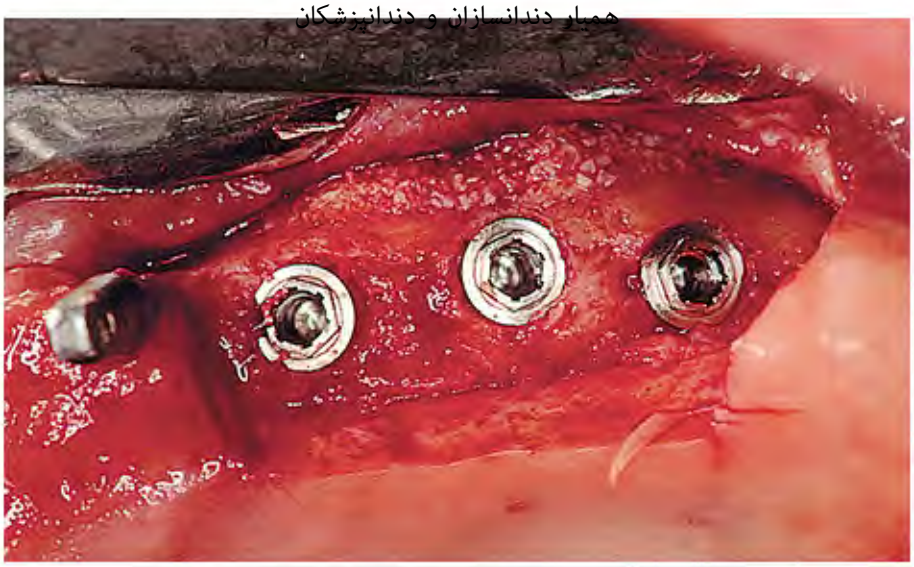


Fig 6-18w Three implants on the left side. The Bio-Oss is visible.

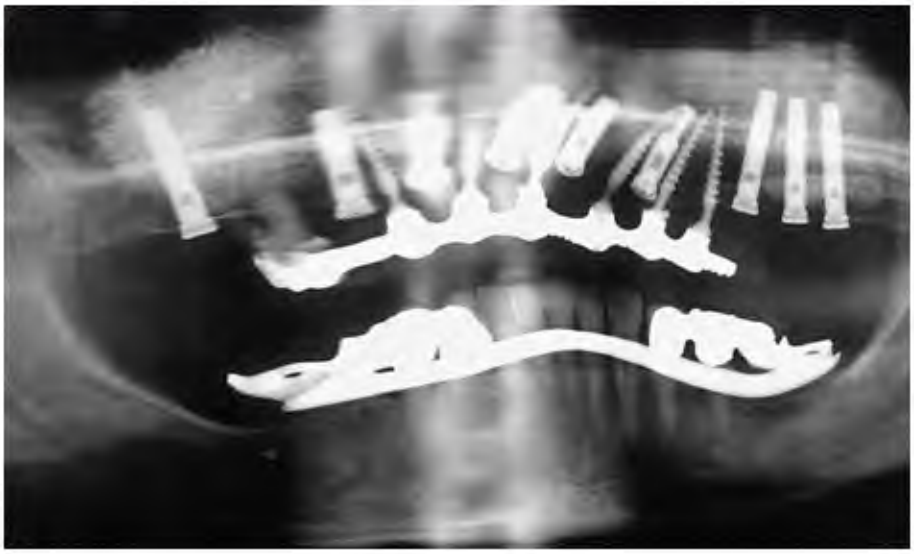


Fig 6-18x Panoramic radiograph after the implantation.

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Implant placement

The 9-month healing period was uncomplicated, except that mucosal irritation developed under the rather oversized fixed provisional restoration, which made access for cleaning difficult (Fig 6-18u). On the right side, two implant beds were prepared adjoining tooth 16 and two Brånemark System MK IV implants inserted (Fig 6-18v). Three Brånemark System MK IV implants were inserted accordingly on the left side (Fig 6-18w). At the time of implant placement, it was clearly apparent how the consistency of the augmentation material had changed during the 9-month healing phase: the augmentation with Cerasorb showed rather loose particles (Fig 6-18v), whereas the Bio-Oss had consolidated well with regenerative bone growth (Fig 6-18w). Mineralization of the augmented areas, particularly on the left side, was also clearly detectable on the check radiograph in comparison with the previous postoperative panoramic radiograph (compare Figs 6-18t and 6-18x).

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Exposure and prosthetic restoration

It was possible for the patient to continue wearing the same provisional restoration (Fig 6-18y). The exposure was performed in previously described fashion (the cosine curve technique) 8 months after implant placement (Fig 6-18z). Customized abutments were fabricated on the implants using the cast coping method and transferred to the mouth with the aid of a transfer key (Fig 6-18aa). An overimpression was taken. This was followed by a try-in of the diagnostic tooth set-up and verification of the esthetic and functional parameters (Fig 6-18bb). In the laboratory, the telescopic crowns were fabricated on the abutments using electroplating, with a separate metal framework fashioned over them.

Completion of the preliminary dental technician work was followed by removal of the provisional implants and the extraction of tooth 16 (Fig 6-18cc). Only now could the metal framework be attached to the electroplated caps with adhesive in situ. The patient was able to leave the clinic the same day with the finished superstructure (Fig 6-18dd). The prosthesis shows a slender design as well as a perfect fit (Fig 6-18ee). It is very lightweight compared to conventionally cast superstructures. This type of structure makes it possible to design very patient-friendly access sites for cleaning, so that good healing and an improvement of the gingival situation were apparent even after a short time (Fig 6-18ff and panoramic radiograph Fig 6-18gg).

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Fig 6-18y Long-term provisional.

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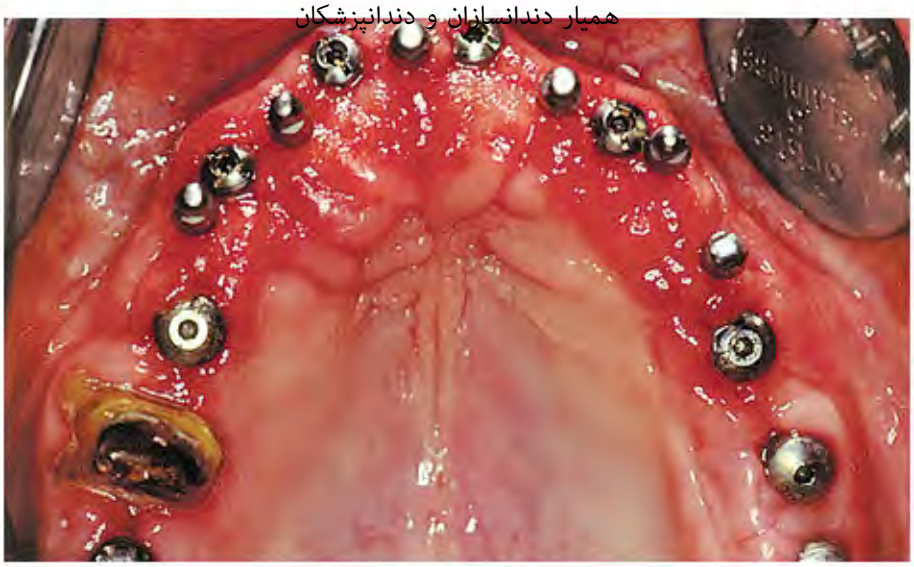


Fig 6-18z Exposure of the implants.

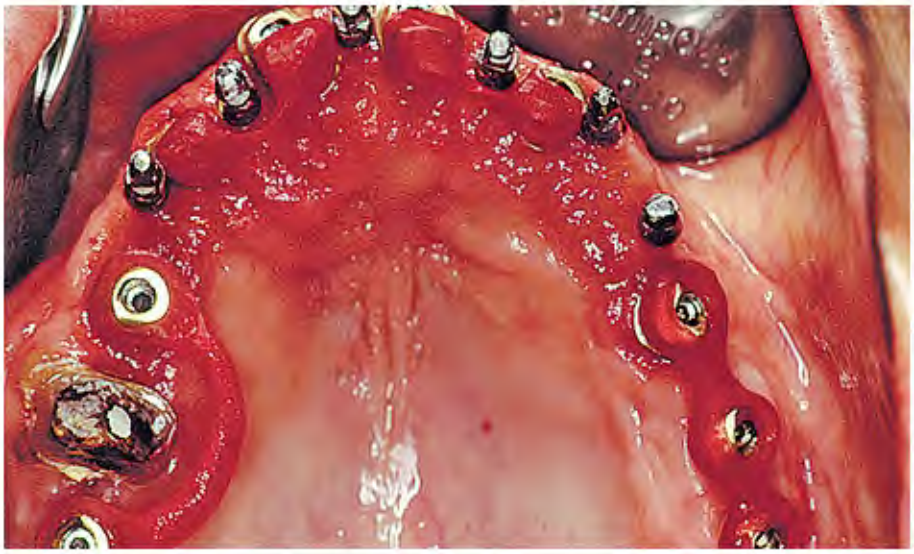


Fig 6-18aa Customized abutments held in place with a transfer.

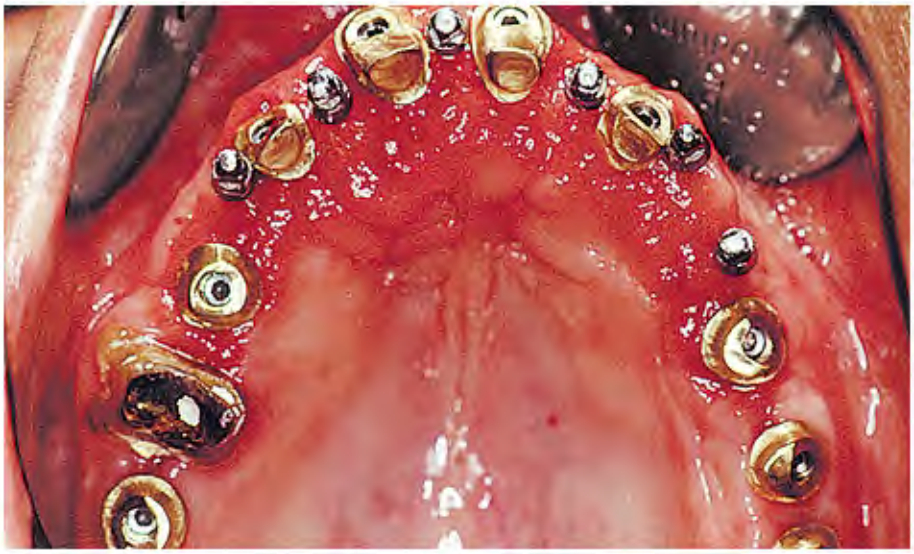


Fig 6-18bb Customized abutments screwed into place.

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Fig 6-18cc Removal of the provisional implants and extraction of tooth 16.



Fig 6-18dd Superstructure in the form of an overdenture.



Fig 6-18ee The slender superstructure.

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Fig 6-18ff Clinical situation after 6 months.



Fig 6-18gg Follow-up panoramic radiograph after 6 months.



Fig 6-18hh Patient before the treatment.

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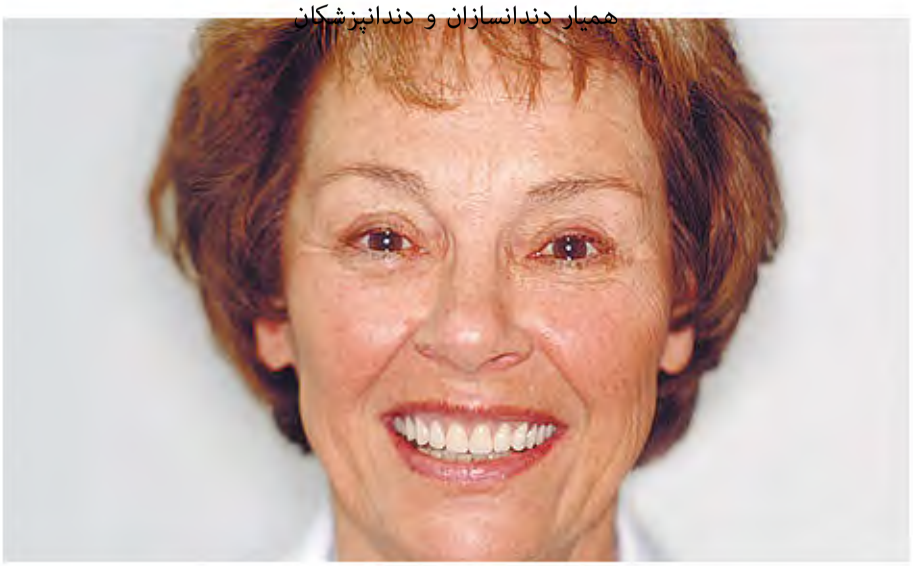


Fig 6-18ii Patient following completion of the treatment.

The last images show the patient at the beginning and end of the treatment, with more than 2 years having elapsed between the two (Figs 6-18hh and 6-18ii).

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Fig 6-18jj Prosthetic restoration after 11 years of functional use.

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Fig 6-18kk Occlusal view with prosthesis.



Fig 6-18ll Mild inflammatory reaction around implants 13 and 25.



Fig 6-18mm The peri-implant tissue of the other implants shows nothing of note.

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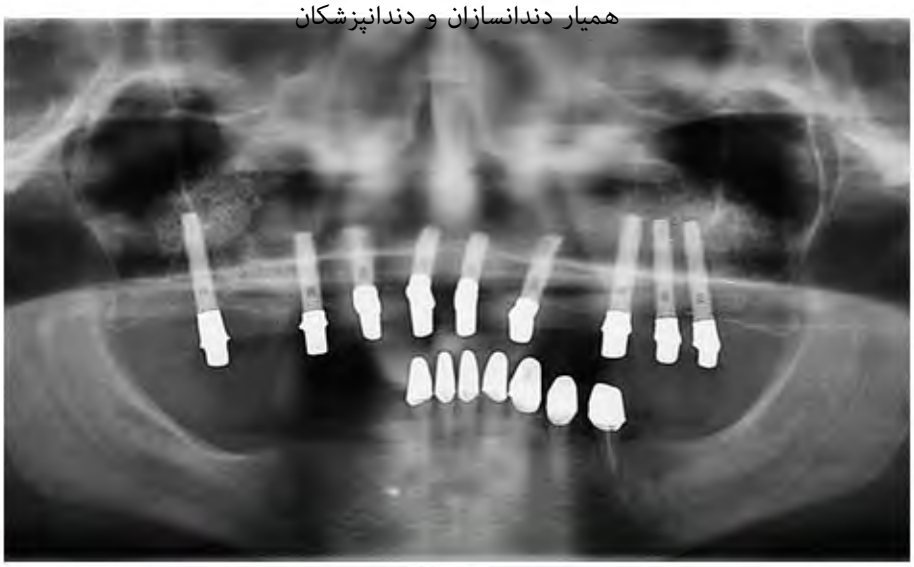


Fig 6-18nn Panoramic radiograph after 11 years. Different augmentation materials in the maxillary sinuses.



Fig 6-18oo Electroplated outer telescope crowns after 11 years.

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Continued follow-up

Eleven years after the treatment, the patient continues to be very satisfied with the final result. During this time, the acrylic of the denture had become a bit worn on the labial/buccal side, but was still intact (Fig 6-18jj). The occlusal view of the prosthesis has also changed: traces of wear and possible bite corrections are apparent (Fig 6-18kk). The gingival situation is largely stable; mild inflammation is apparent only around implants 13 and 25 (Fig 6-18ll). The contours of the residual ridge and the palate also show nothing of note (Fig 6-18mm). The clinical findings are confirmed by the panoramic radiograph, which also reveals how the two bone augmentation materials have fared 11 years after sinus elevation (Fig 6-18nn) The outer telescope crowns in the prosthesis show signs of use, but are completely intact (Fig 6-18oo). The patient is shown before treatment (Fig 6-18hh), after 2 years at the time of completion of the treatment (Fig 6-18ii) and 13 years after her treatment began (Fig 6-18pp). The biggest

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difference can be seen in the first 2 years; there has been hardly any change in the patient over the next 11 years.



Fig 6-18pp The patient 13 years after the start of the treatment (see Fig 6-18hh).

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Treatment course

- Extraction, immediate provisional restoration on provisional implants (1999)
- 3 months to sinus floor elevation
- 9 months to implant placement
- 8 months to exposure
- 2 months to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Typical treatment course

Immediate restoration with sinus floor elevation and implant placement

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Baseline situation

This female patient, with non-preservable residual teeth in the anterior region, wanted a fixed restoration as soon as possible. The plan was for sinus floor elevation and implant placement (provisional and permanent implants) to take place in a single treatment session. The posterior regions of the maxilla still showed a residual bone height of approx 7 to 8 mm, which offered the prospect of sufficient primary stability for the planned Brånemark System MK IV implants (Fig 6-19a). Enough bone was still available in the anterior region for the provisional implants, so that a single-session procedure could be planned here. At the patient's request, the treatment of the apicitis of tooth 34 is to take place only after the necessary dental treatment in the maxilla.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Dental Treatment
2. Bilateral sinus floor elevation, implant placement and immediate loading of a prosthesis on the provisional implants
3. Exposure and definitive prosthetic restoration

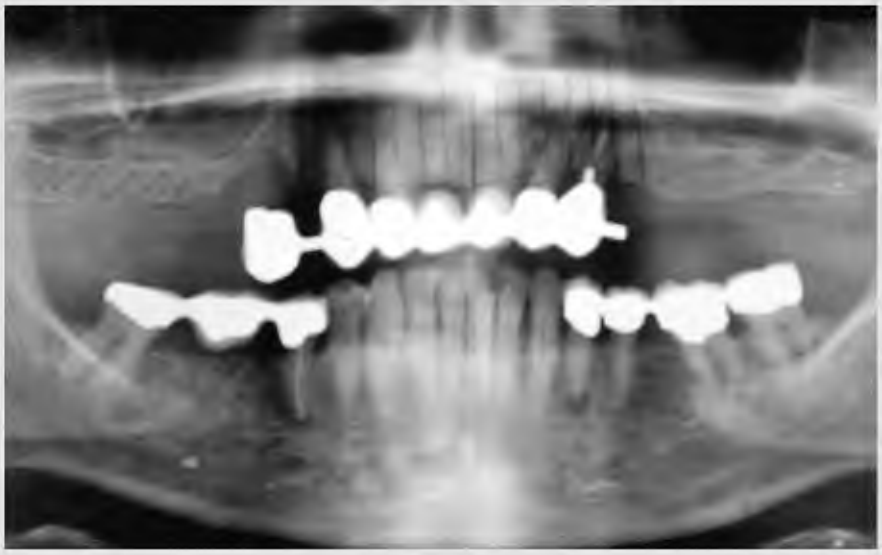


Fig 6-19a Panoramic radiograph before the dental treatment.

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The first step consisted of extracting the residual dentition in the maxilla, to allow the apical inflammation in the bone to subside. Six weeks after the extractions, the residual ridge had healed sufficiently to allow the implant treatment to begin (Fig 6-19b). On the right side, a window was cut into the lateral maxillary sinus wall in conventional fashion (Fig 6-19c). Dissection and elevation of the maxillary sinus mucosa was followed by the preparation of bone beds for five implants (Fig 6-19d). Simultaneously with implant placement, the prepared cavity was gradually filled distally to mesially (Fig 6-19e). The window was sealed with the liquid Atrisorb membrane (Fig 6-19f).

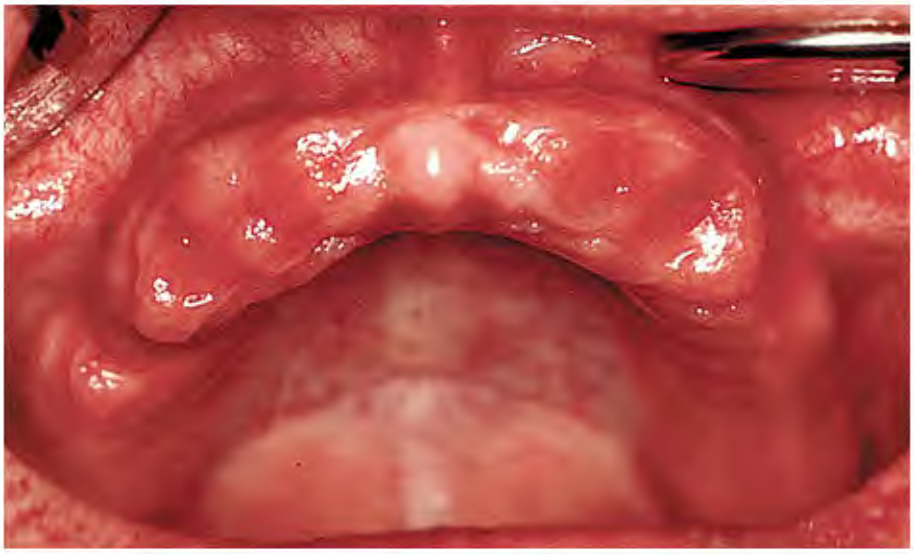


Fig 6-19b Clinical situation before the treatment.



Fig 6-19c Fenestration of the right maxillary sinus.

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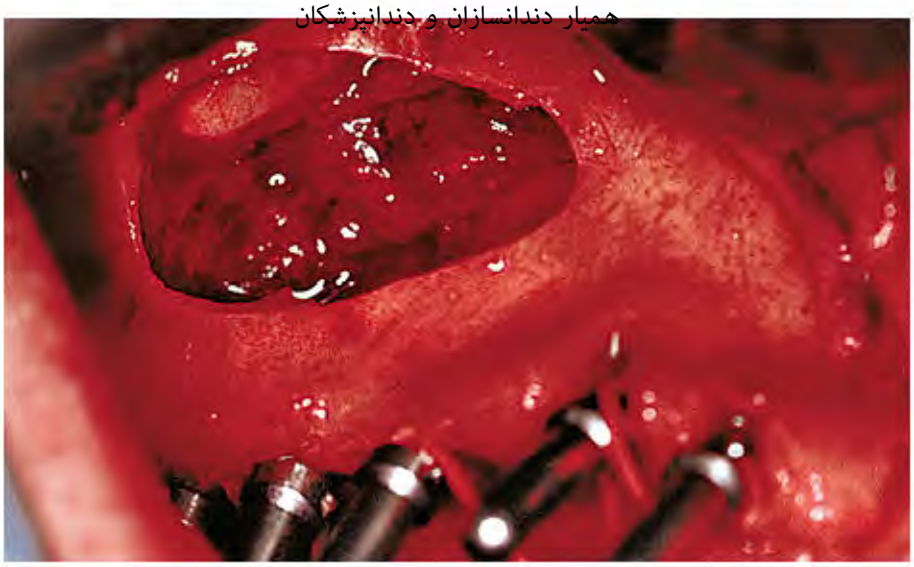


Fig 6-19d Elevation of the maxillary sinus mucosa followed by preparation of the implant beds.



Fig 6-19e Simultaneous filling of the maxillary sinus and insertion of the implants.

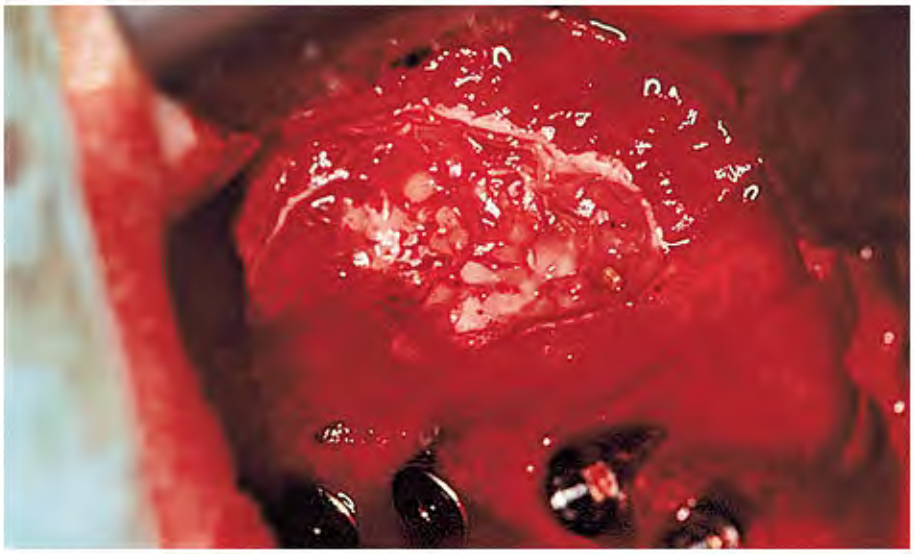


Fig 6-19f Closing the fenestration.

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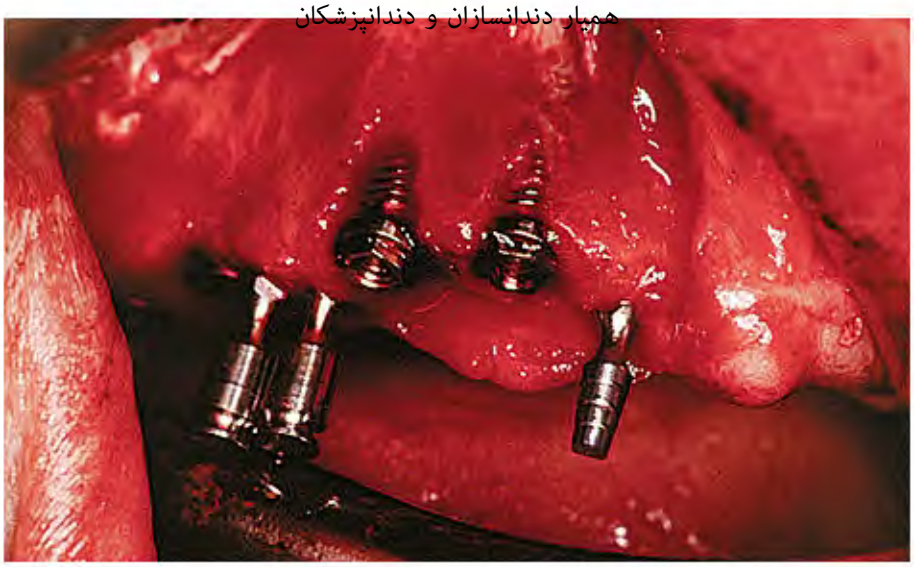


Fig 6-19g Insertion of the provisional implants. Bone dehiscences.

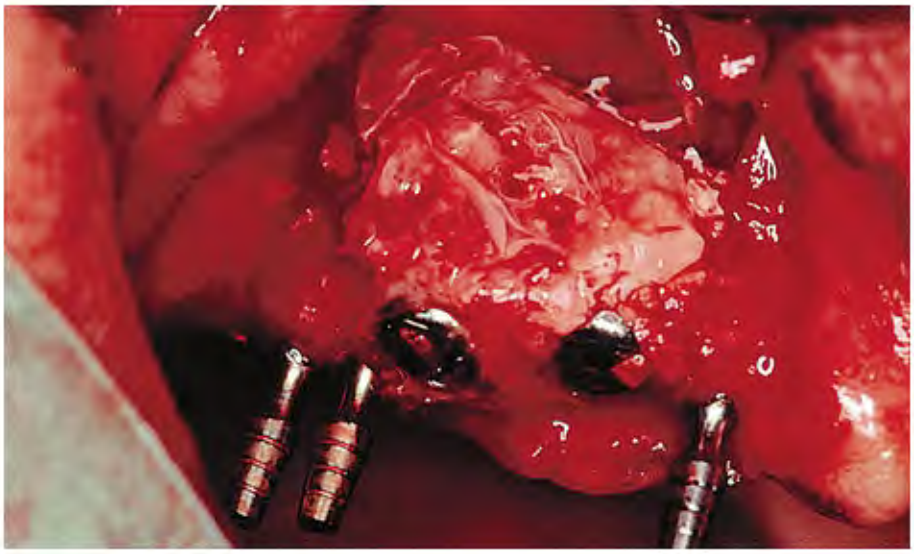


Fig 6-19h Lateral augmentation of the residual ridge.



Fig 6-19i The same procedure in the second quadrant.

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Fig 6-19j Impression caps bound together with a ligature.



Fig 6-19k Try-in of the thermoplastic foil.



Fig 6-19l Immediate restoration.

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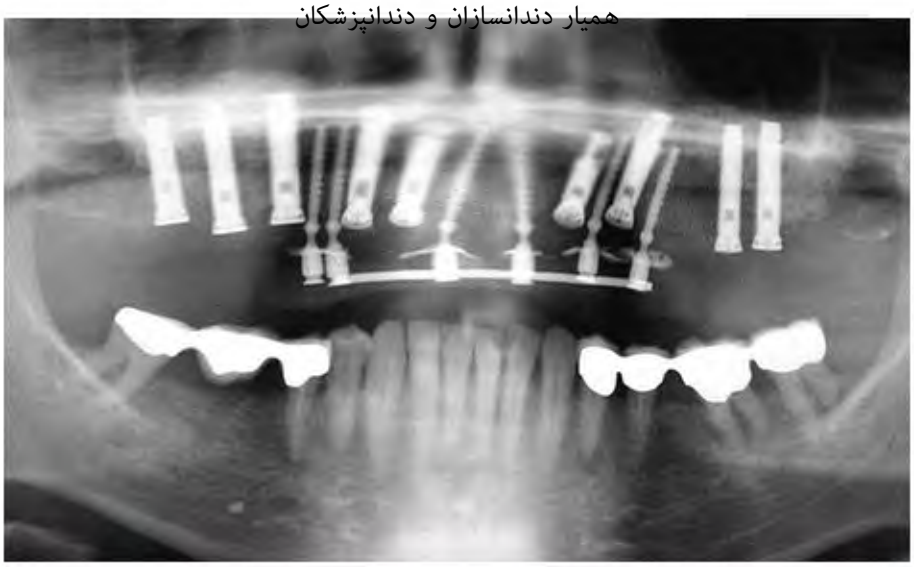


Fig 6-19m Postoperative panoramic radiograph.



Fig 6-19n Long-term provisional restoration.

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Three permanent implants were inserted into the posterior and two into the anterior maxilla. The remaining bone supply in the anterior residual ridge was used to anchor three provisional implants (Fig 6-19g). A lateral augmentation was performed, since the residual ridge was generally narrow and the screw threads of the implants were exposed (Fig 6-19h). The same procedure was repeated on the opposite side (Fig 6-19i). After tight suturing of the wound, the temporary implants were parallelized by bending the flexible implant heads. Caps were placed onto the Immediate Provisional Implants (IPIs; Nobel Biocare) and bound together with a wire ligature (Fig 6-19j). The thermoplastic foil with a set-up dental arch, prepared in advance, was tried in to ensure sufficient space for the implant caps and also in occlusion (Fig 6-19k). The gaps left in the foil around the caps were filled in with fast-curing polymer resin, resulting in the immediate provisional restoration (Fig 6-19l). The patient was to wear this direct provisional for approx 1 week. The postoperative panoramic radiograph shows the positioning of the implants and the extent of the sinus floor elevation (Fig 6-19m). When the patient came in for removal of her sutures, the direct provisional was exchanged for a long-term provisional

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fabricated in the laboratory (Fig 6-19n).

Treatment course

- Extraction (2000)
- 6 weeks to the sinus floor elevation, implant placement and immediate provisional restoration on provisional implants
- 8 months to exposure
- 2 months to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

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Atypical treatment course – problematic baseline situation

Sinus floor elevation and subsequent implant placement with immediate restoration loaded onto mixed implants

Baseline situation

This female patient with an edentulous maxilla wanted a fixed restoration without any compromises. The plan for the restoration was to perform the sinus floor elevation and implant placement in two sessions (Fig 6-20a).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- SimPlant planning
- Dental cast analysis

Treatment plan

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1. Bilateral sinus floor elevation
2. Placement of definitive and provisional implants.
3. Exposure and definitive prosthetic loading

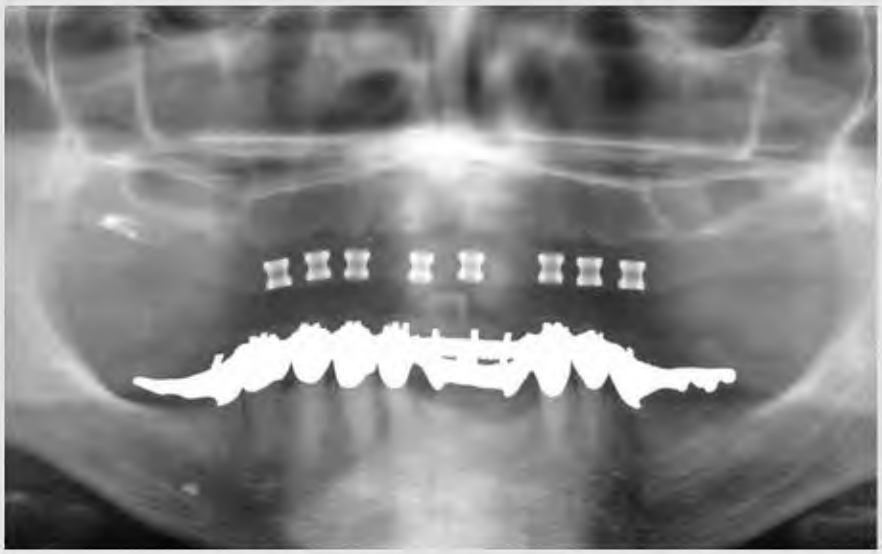


Fig 6-20a Panoramic radiograph before treatment.

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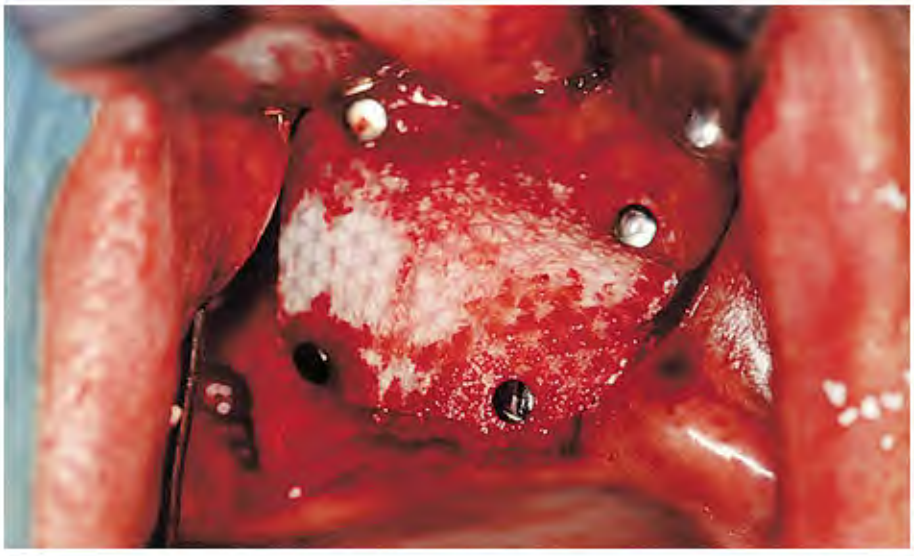


Fig 6-20b Sinus elevation and lateral augmentation of the residual ridge.

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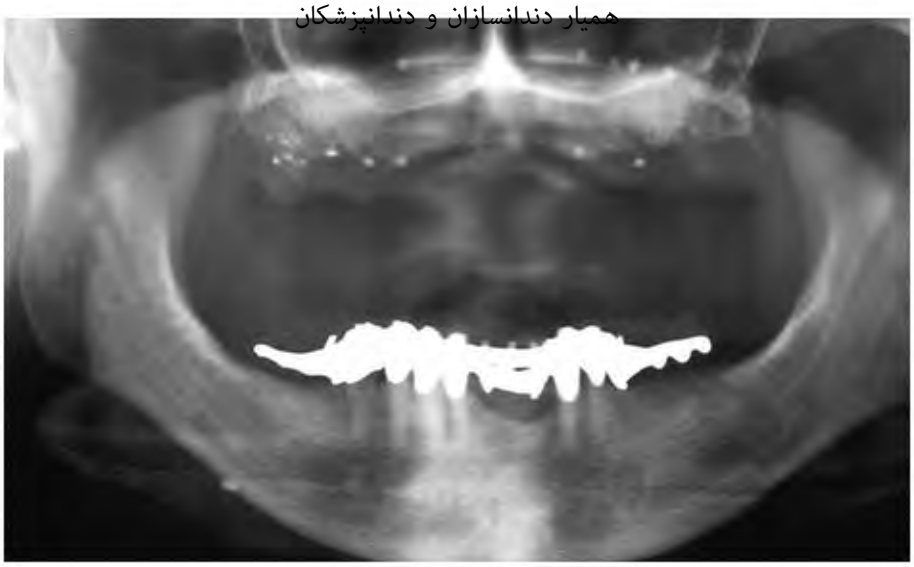


Fig 6-20c Postoperative panoramic radiograph.

Sinus floor elevation and implant placement

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Sinus floor elevation was performed using the conventional technique and without any complications. In addition, lateral bone augmentation of the residual ridge was carried out with Bio-Oss and the slowly resorbing Resolut membrane (Gore Medical) (Fig 6-20b). After a 9-month regeneration phase, the augmentation material was sufficiently stable for implant placement (Fig 6-20c). The augmented residual ridge was of sufficient width and quality for four permanent and two provisional implants to be placed on each side (Fig 6-20d). Two more provisional implants were inserted transmucosally in the anterior region (positions 11 and 21; Fig 6-20e).

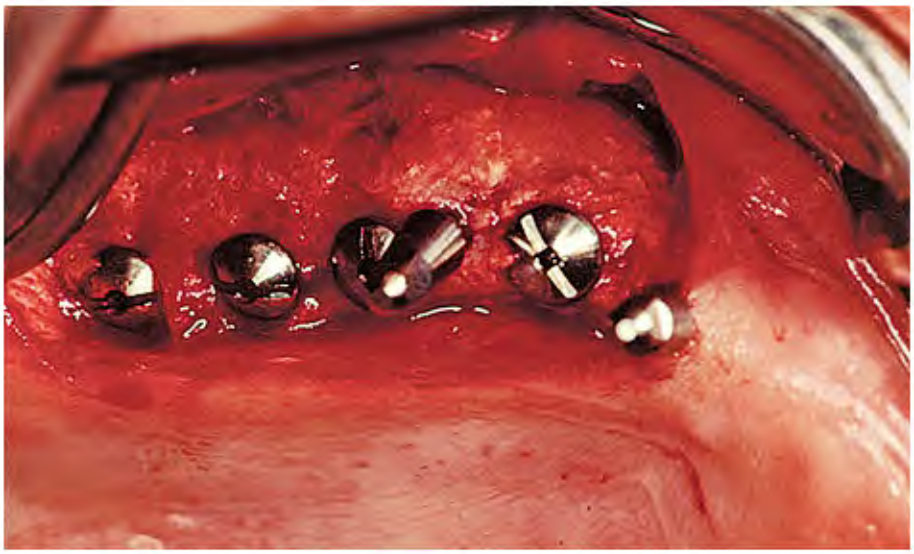


Fig 6-20d The residual ridge has been widened. Four definitive and two provisional implants after insertion.

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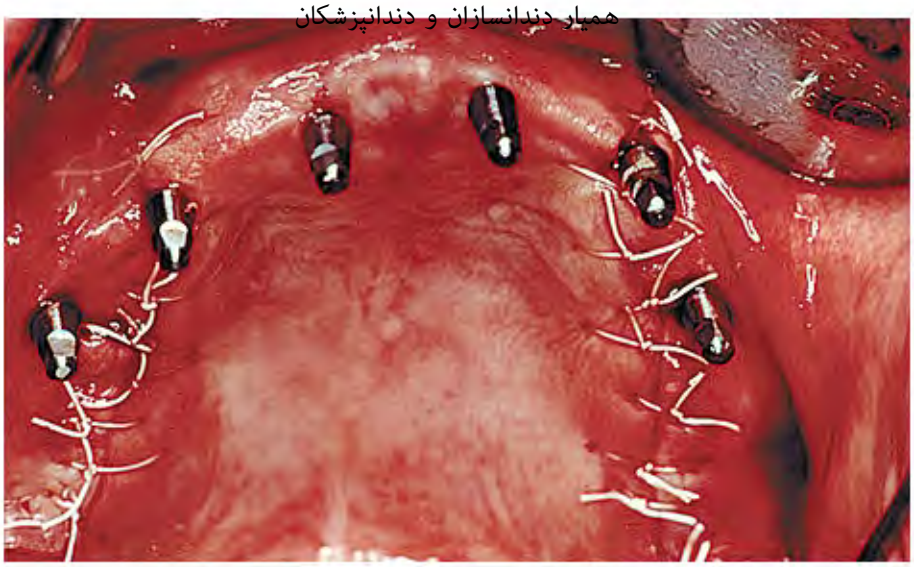


Fig 6-20e Two transmucosally inserted provisional implants.



Fig 6-20f Immediate provisional restoration



Fig 6-20g Long-term provisional.

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Fig 6-20h Check panoramic radiograph.

Using a thermoplastic foil, a simple plastic provisional restoration was fabricated on the six provisional implants during the operation (Fig 6-20f). A long-term provisional fabricated in the laboratory was ready to be incorporated 1 week later, at the time of suture removal (Fig 6-20g). The check panoramic radiograph shows the locations of the implants: the temporary implants had been inserted predominantly in the anterior region, the permanent implants in the posterior region (Fig 6-20h).

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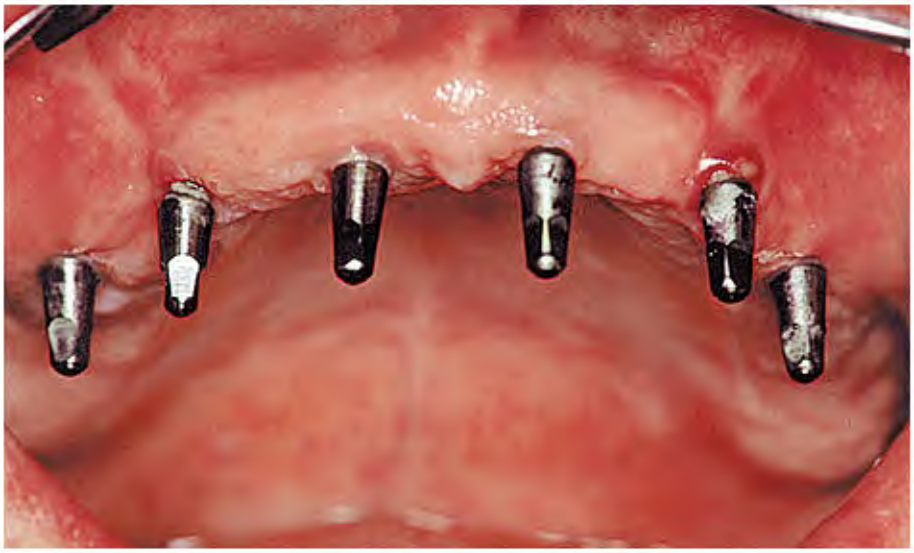


Fig 6-20i Inflammatory reaction around provisional implant 23.

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Fig 6-20j Exposure of the implants and concomitant impression taking.

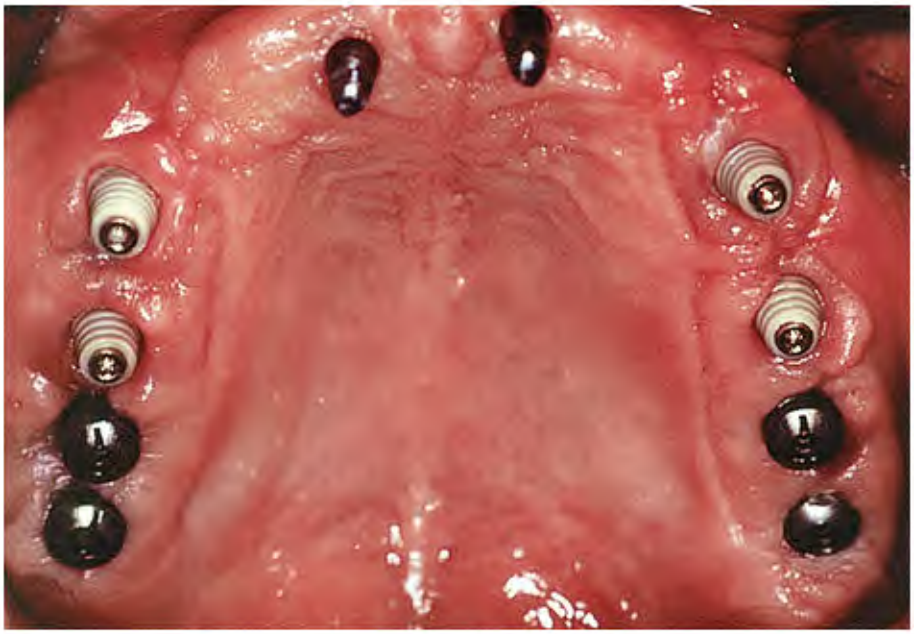


Fig 6-20k Provisional plastic cylinders as abutments for a new long-term provisional.

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Fig 6-20l The new long-term provisional, still with a shortened dental arch.

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Exposure and prosthetic loading

The exposure operation took place after another 8 months. When the long-term provisional was removed, an inflammatory reaction was revealed around temporary implant 23. Both implant 23 and implant 15 were found to be loose (Fig 6-20i). Implants 13 and 25 showed minimal mobility. It was decided to remove provisional implants 15, 13, 23 and 25, and instead include the four permanent mesial implants into the provisional structure. Implants 14, 15, 24 and 25 were fitted with EsthetiCone abutments, while implants 16, 17, 26 and 27 were fitted with healing abutments. This was followed by impression taking in region 15 to 25 (Fig 6-20j). Plastic cylinders prepared in advance were screwed onto the EsthetiCone abutments of implants 14, 15, 24 and 25 (Fig 6-20k). A second long-term provisional was fabricated on these plastic cylinders and on temporary implants 11 and 21, and cemented on with TempBond (Fig 6-20l).

After the gingival situation had stabilized, EsthetiCone abutments were fitted onto the remaining four distal implants and a new overall impression was taken (Fig 6-20m). The eight permanent implants and the two provisional anterior ones acted as abutments for the reshaped long-term provisional. The provisional was worn for 1 year according to the Progressive Bone Loading principle (see pages 387 and 506; Fig 6-20n). After 1 year, the long-term provisional was replaced with a definitive fixed restoration (Fig 6-20o).

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Fig 6-20m All the implants have been fitted with EsthetiCone abutments.



Fig 6-20n Extended and modified long-term provisional.

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Fig 6-20o Patient following treatment completion.

Treatment course

- Bilateral sinus floor elevation (1999)
- 9 months to implant placement
- 8 months to exposure
- 1 year to prosthetic loading

Treatment

Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Barbara Wonschik

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Atypical treatment course – problematic baseline situation

Sinus floor elevation with immediate restoration of provisional implants and no definitive implants

Baseline situation

This male patient with a moderately atrophied maxilla was having a lot of trouble with his very loose complete denture. He reported that the four implants had been inserted at another center 2 years previously (Fig 6-21a), but that all of them had been lost. Bone defects remained as a result of implant placement, especially in the molar region on the left side (Fig 6-21b). The panoramic radiograph and the CT scan confirmed that bone augmentation (bilateral sinus elevation) was necessary to achieve a permanent solution (Fig 6-21c).

Since sufficient bone tissue was available in the anterior maxillary region for the insertion of provisional implants, the plan was to load the provisional implants with an immediate restoration directly after the operation.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation and immediate provisional restoration on IPIs
2. Implant placement
3. Exposure and definitive prosthetic loading

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Fig 6-21a Panoramic radiograph taken 2 years previously.



Fig 6-21b Baseline situation.

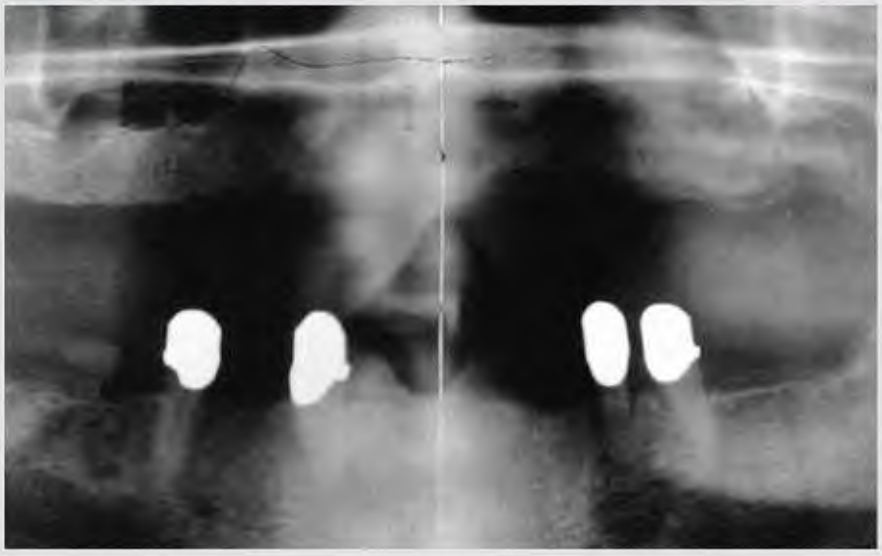


Fig 6-21c Panoramic radiograph before treatment.

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Fig 6-21d Insertion of the provisional implants into thickenings in the residual ridge.

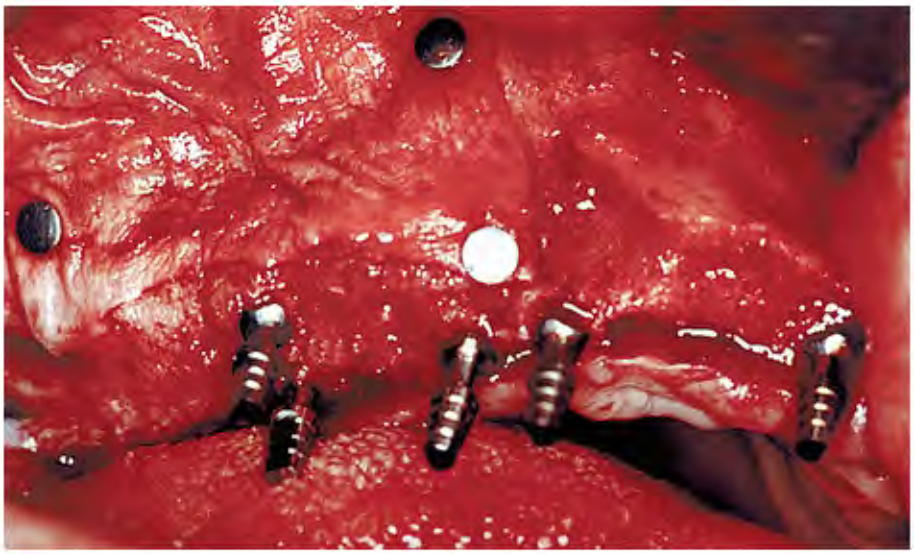


Fig 6-21e Filling of the maxillary sinus and closure of the window.

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Fig 6-21f The second quadrant was treated after suturing the first.

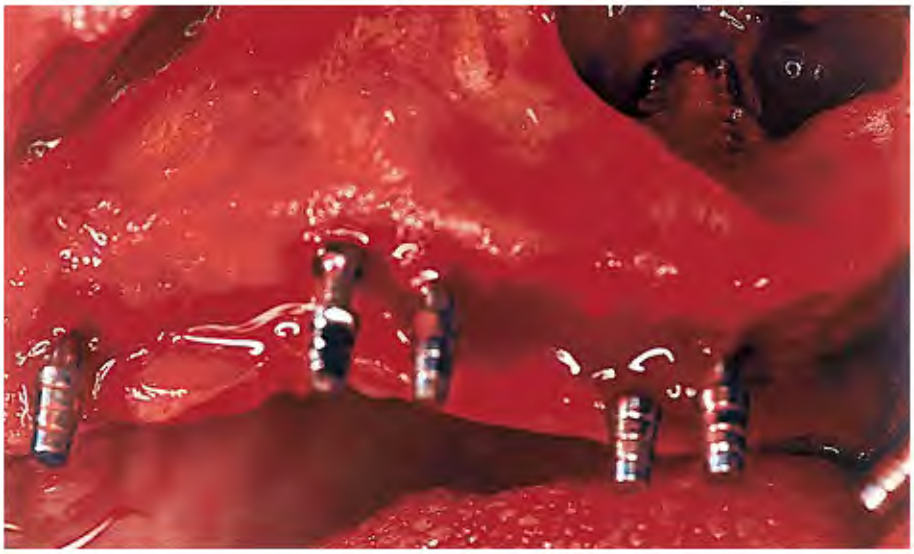


Fig 6-21g Provisional implants anchored in the septum of the maxillary sinus.

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Sinus floor elevation and insertion of provisional implants

The exact positioning of the provisional implants was determined with the SimPlant program following bone density analysis. Since the bone was poorer in quality and quantity in the posterior maxilla, small thickening in the residual ridge and the maxillary sinus septa were used to give greater stability to the provisional implants. First, a window was cut in the sinus wall on the right side and the mucosa elevated. Working under visual control, the thickened broader segments of the residual ridge were located and two IPIs inserted side by side in that exact location (Fig 6-21d). Three more IPIs were then inserted into the anterior maxilla. Once stable anchoring of the implants was achieved, the cavity was filled with Bio-Oss, bone chips and platelet-rich plasma and the window sealed with a Bio-Gide membrane and titanium pins (Fig 6-21e). The vertical bone defect was treated with the same substitute and the same

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membrane. Once the right side was sutured, the same procedure was repeated on the left side (Fig 6-21f). As planned, the septum of the maxillary sinus was used to give greater stability to the two distal IPIs (Fig 6-21g). After opening the maxillary sinus and elevated the mucosa, it is highly advantageous for the surgeon to be able to insert the implants precisely under visual control.

Further treatment proceeded similarly to the right side, including the augmentation of the vertical bone defect (Fig 6-21h). The left side was sutured and all 10 provisional implants aligned (Fig 6-21i). Caps were placed on the implants and bound together with a ligature (Fig 6-21j). A thermoplastic foil, prepared in advance, was used to fabricate an immediate provisional restoration out of a fast-curing resin (Trim; Bosworth Dental), after which the provisional was incorporated (Fig 6-21k). The postoperative panoramic radiograph shows the extent of the sinus floor elevation, and the distribution and anchoring of the provisional implants (Fig 6-21l). An impression was taken at the same time to allow a long-term provisional to be fabricated in the laboratory and inserted when removing the sutures (Figs 6-21m and 6-21n).

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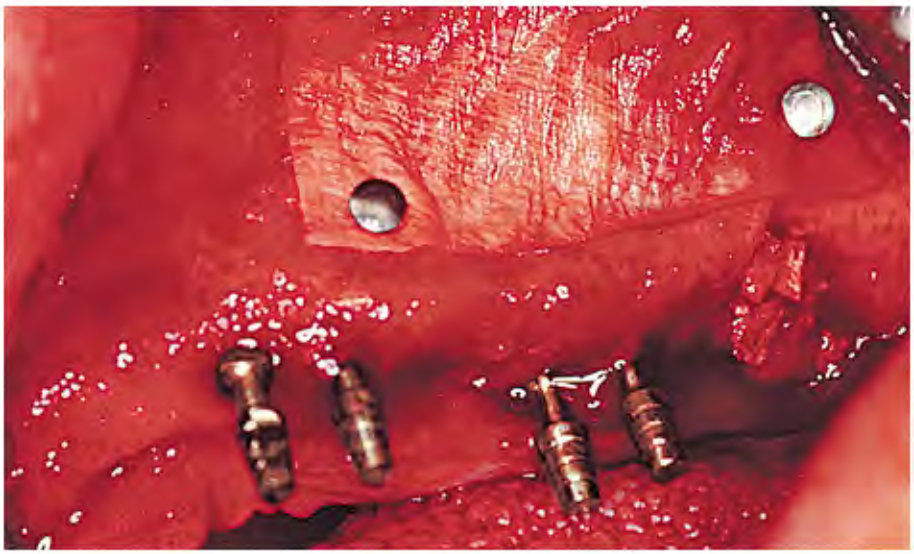


Fig 6-21h Membrane attached with pins.

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Fig 6-21i Parallelization of the provisional implants.



Fig 6-21j Impression caps bound together with a ligature.

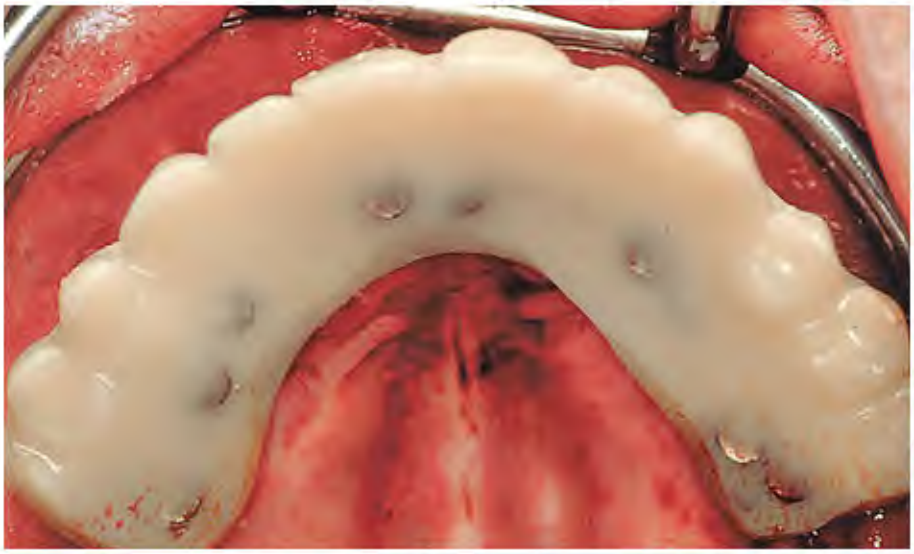


Fig 6-21k Immediate restoration.

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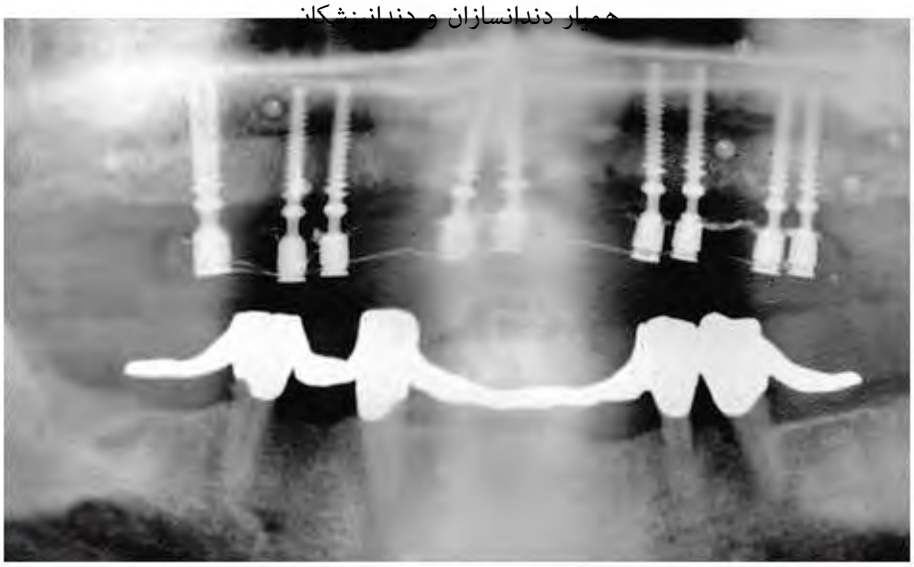


Fig 6-21l Postoperative panoramic radiograph.

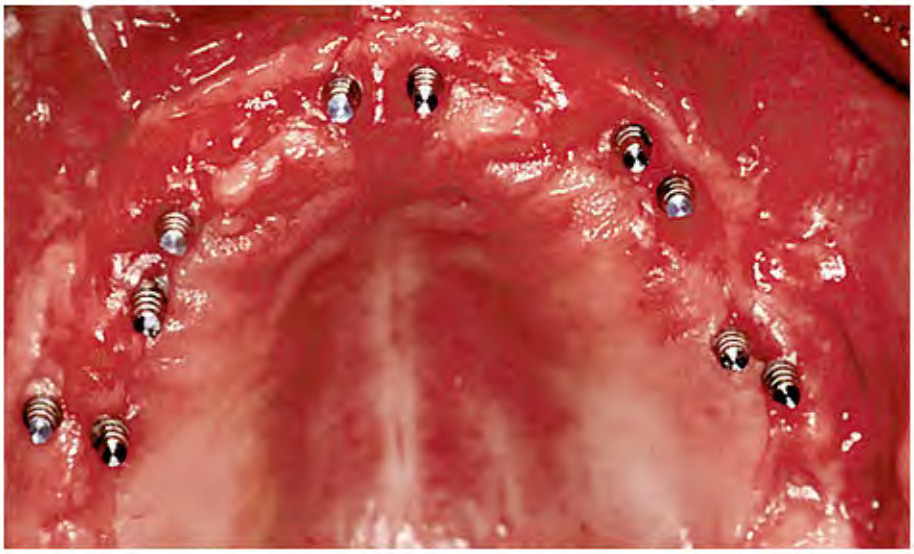


Fig 6-21m Clinical situation following removal of the sutures.



Fig 6-21n Long-term provisional.

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Fig 6-21o Clinical situation after 9 years.

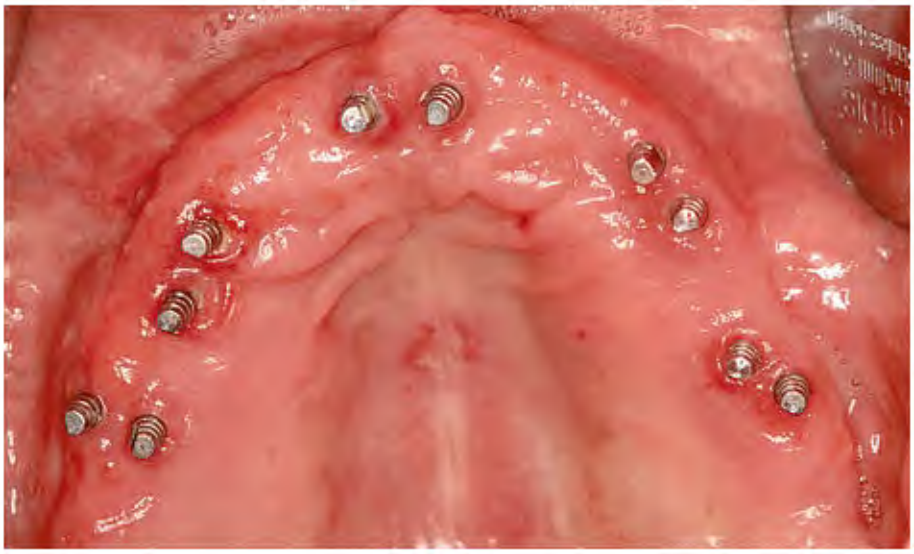


Fig 6-21p Mild peri-implantitis around a few of the provisional implants.



Fig 6-21q Removable long-term provisional after 9 years.

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Fig 6-21r Small fractures and cracks after 9 years of functional use.



Fig 6-21s The provisional is palateless and meets the patient's needs in every aspect.

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Continued follow-up

The patient received no further treatment due to general medical contraindications and his lack of motivation. After 9 years, all the provisional IPIs are still integrated in the bone with full stability (Fig 6-21o). Minor inflammation can be seen around implants 15, 14, 11, 26, and 27, but is not causing any functional impairment (Fig 6-21p). The patient is able to remove the dental prosthesis, but his oral hygiene is inadequate, despite the optimal conditions (Fig 6-21q). The surface of the long-term provisional already shows traces of wear, and small fractures and cracks are visible after 9 years of functional use (Fig 6-21r). However, the long-term provisional fulfills the patient's needs: it is palateless, fits securely and has been functioning faultlessly far beyond his expectation (Fig 6-21s). The patient was informed about the risk of losing his restoration, but is so happy with it that he strictly refuses any further change or treatment (Fig 6-21t).

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Fig 6-21t The patient is very satisfied not only with the function, but also with the esthetics of his provisional restoration.

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Treatment course

- Sinus floor elevation and immediate provisional restoration on provisional implants (2000)

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Problems and complications

Premature loss of provisional implants

Baseline situation

This male patient with an edentulous maxilla is a heavy smoker and suffers from severe osteoporosis. The residual ridge was so atrophied that it provided virtually no hold for his complete denture. He wanted a fixed restoration. In view of the severely pneumatized maxillary sinuses and the reduced residual ridge, the plan was to perform bilateral sinus floor elevation to provide sufficient bone to anchor implants (Fig 6-22a).

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- CT
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation
2. Implant placement and immediate restoration loaded onto the provisional implants
3. Exposure and definitive prosthetic restoration



Fig 6-22a Panoramic radiograph before treatment.

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Sinus floor elevation

The fenestration of the maxillary sinuses was performed in conventional fashion, with the maxillary sinus mucosa elevated and the cavity filled with Bio-Oss. A Bio-Gide membrane was used for coverage and was attached with titanium pins. This was followed by tight suturing. The postoperative panoramic radiograph shows the extent of sinus floor elevation (Fig 6-22b).

Implant placement and provisional restoration

The healing period was extended to 12 months due to the patient's heavy smoking habit. At least 10 permanent implants were planned for the same reason. Implants were placed into the

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right side first (Fig 6-22c), including five permanent and three temporary ones (Fig 6-22d). The left side was then treated in the same way (Fig 6-22e). The postoperative panoramic radiograph shows the locations of the implants (Fig 6-22f). For the prosthetic loading, the heads of the temporary implants had to be parallel to one another, which was achieved by bending the flexible neck segments (Fig 6-22g). A thermoplastic foil, prepared in advance (Fig 6-22h), allowed a provisional restoration to be incorporated directly after implant placement (Fig 6-22i). An impression of the maxilla was taken at the same time (Fig 6-22j). A long-term provisional was fabricated in the laboratory using this impression and an interocclusal record (Fig 6-22k). This provisional was inserted in place of the first when the sutures were removed about 1 week later (Fig 6-22l).

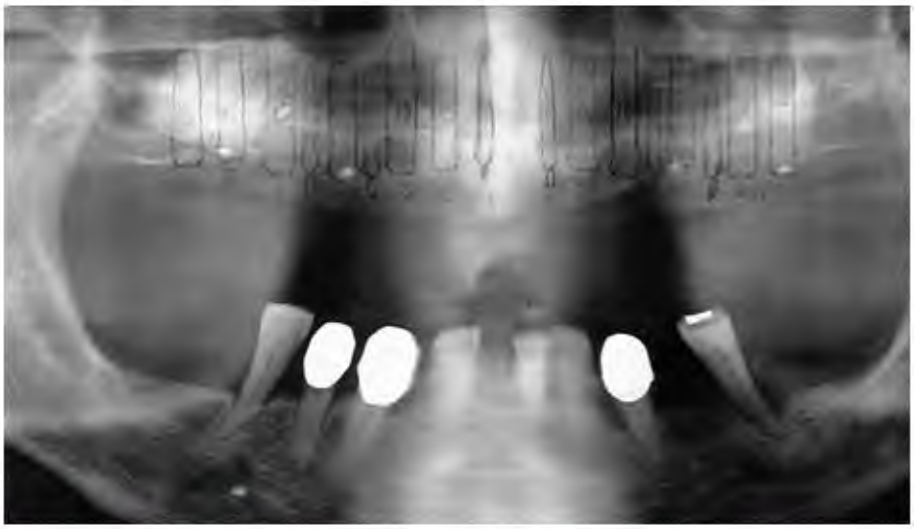


Fig 6-22b Postoperative panoramic radiograph after the bilateral sinus elevation.

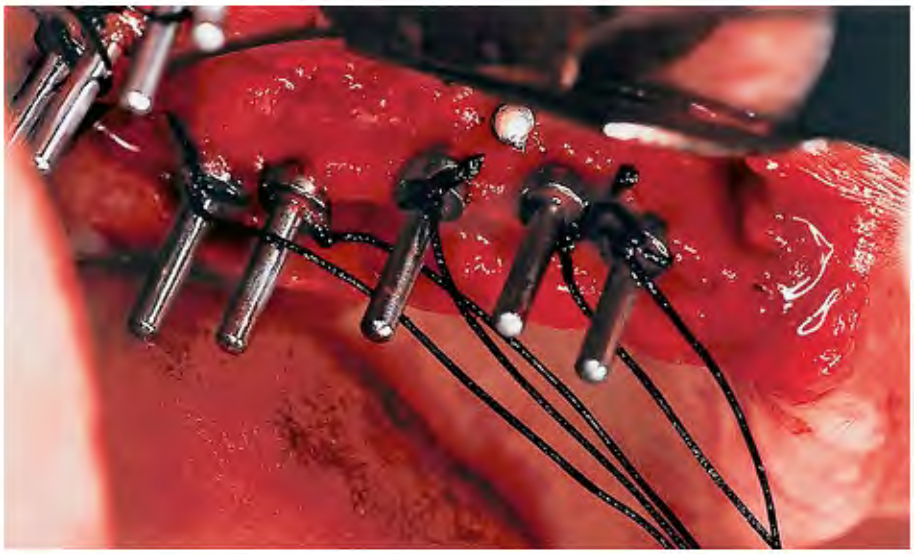


Fig 6-22c First quadrant – insertion of five definitive implants.

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Fig 6-22d Insertion of three provisional implants.



Fig 6-22e Insertion of five definitive and three provisional implants in the second quadrant.

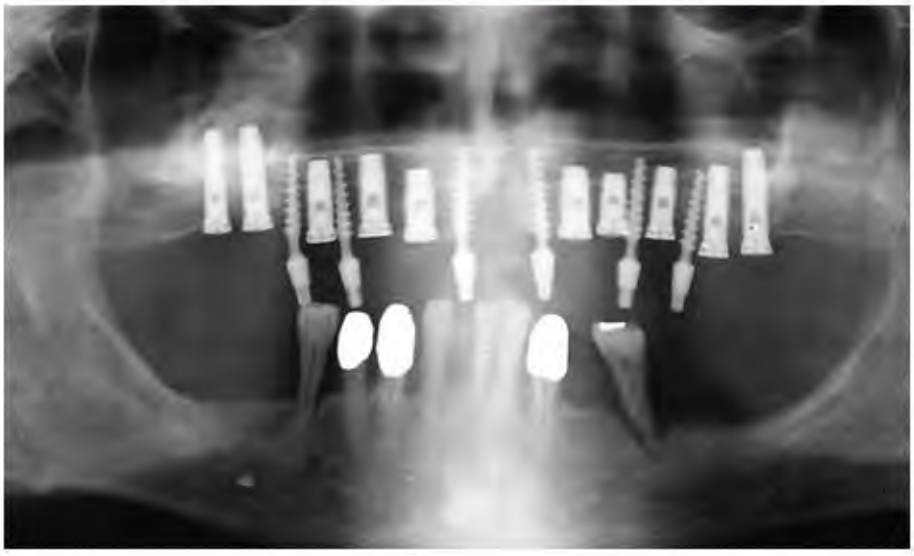


Fig 6-22f Postoperative panoramic radiograph after implant placement.

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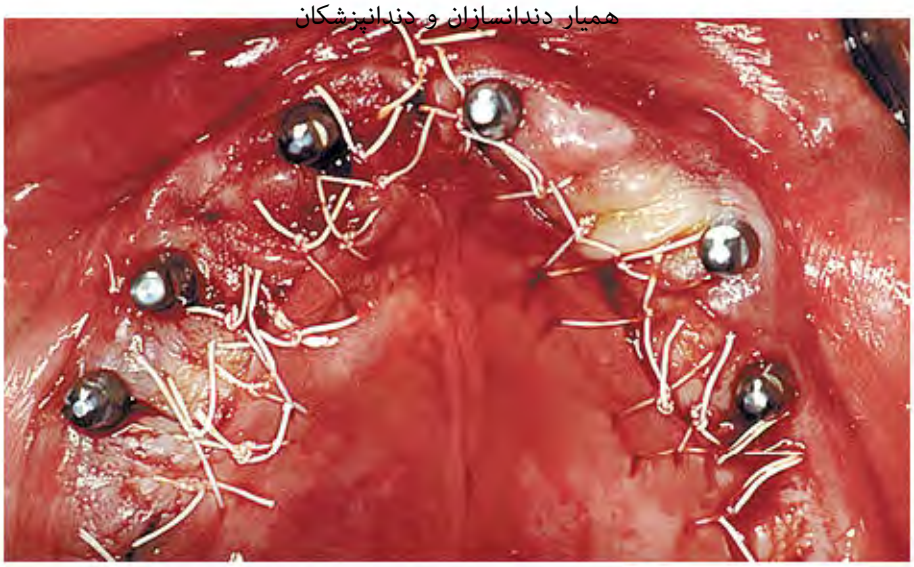


Fig 6-22g Parallelization of the provisional implants by bending the flexible segment.



Fig 6-22h Thermoplastic foil prepared in advance.



Fig 6-22i Immediate restoration.

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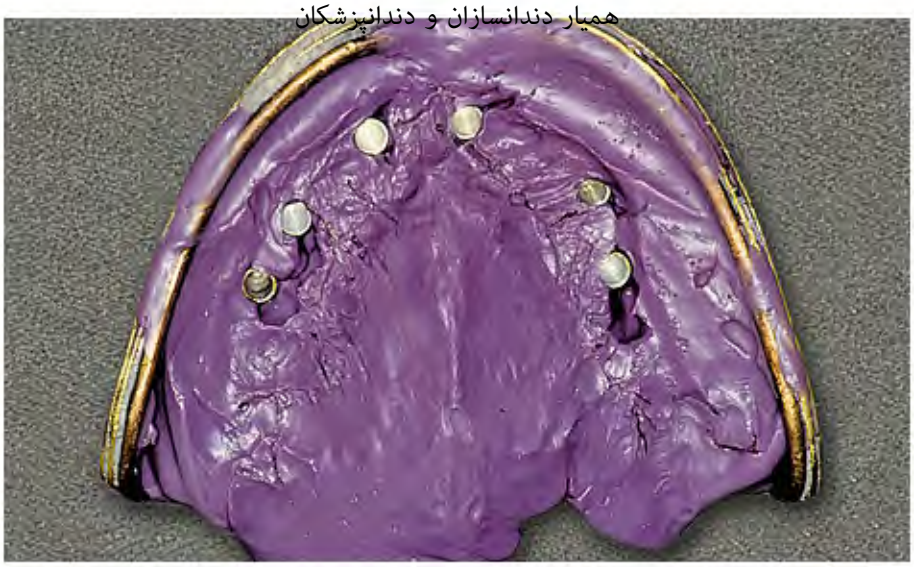


Fig 6-22j Impression taking.



Fig 6-22k Recording the maxillomandibular relationship.



Fig 6-22l Long-term provisional restoration.

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Fig 6-22m Fistulation in regions 12 and 23.

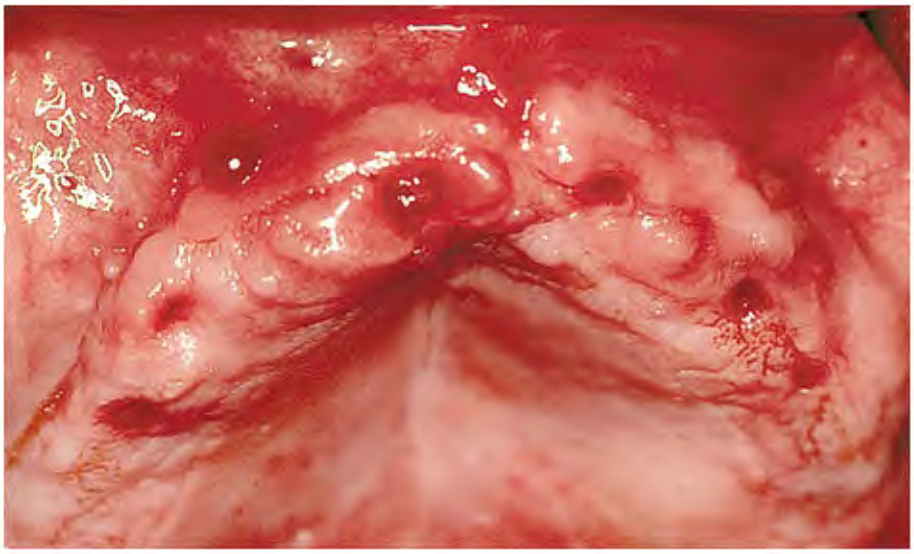


Fig 6-22n Explantation of all the provisional implants.



Fig 6-22o Long-term provisional fixed restoration reworked into a complete denture.

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Complication

The patient attended our clinic unexpectedly after approximately 3 months, as his fixed provisional had become loose. Examination confirmed this. Removal of the provisional revealed a fistulation in regions 12 and 23, as well as mobility of temporary implants 13, 11 and 23 (Fig 6-22m). All the temporary implants were removed due to the risk of the inflammation spreading to the permanent implants (Fig 6-22n).

Since the provisional was now unusable and the old complete denture was no longer in existence, the existing fixed provisional restoration had to be reworked into a complete denture (Fig 6-22o). The impression for this needed to be taken before removal of the provisional implants, to retain the relationship to the residual ridge. The full postoperative healing period was 10 months. The patient wore the complete denture for 7 of these months. A perforation of the mucosa developed in the second quadrant, probably due to the pressure from the prosthesis (Fig 6-22p).

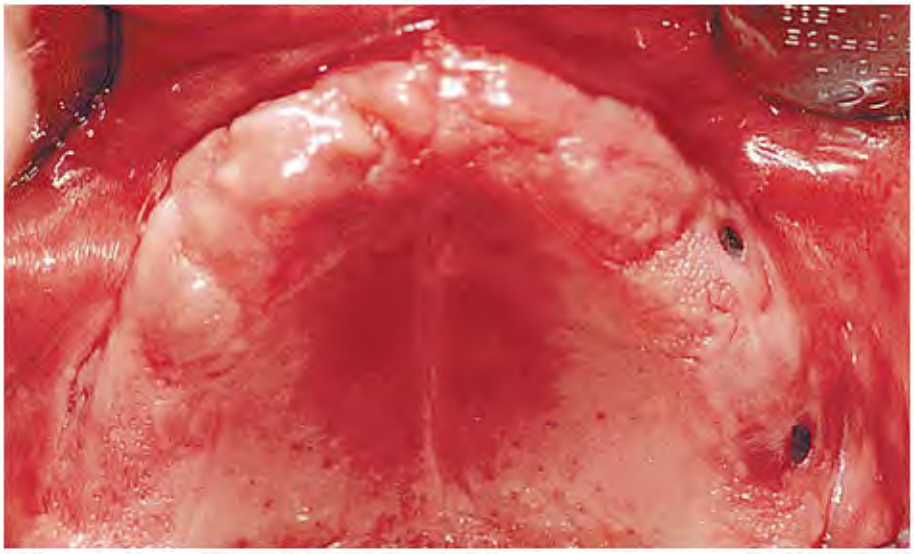


Fig 6-22p Mucosal perforation over the implants.

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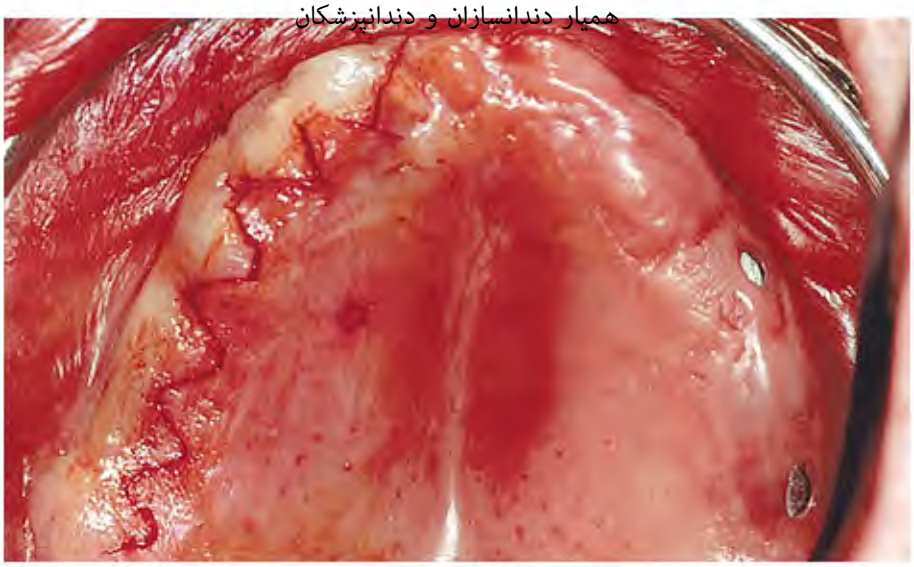


Fig 6-22q Exposure using the cosine curve technique.

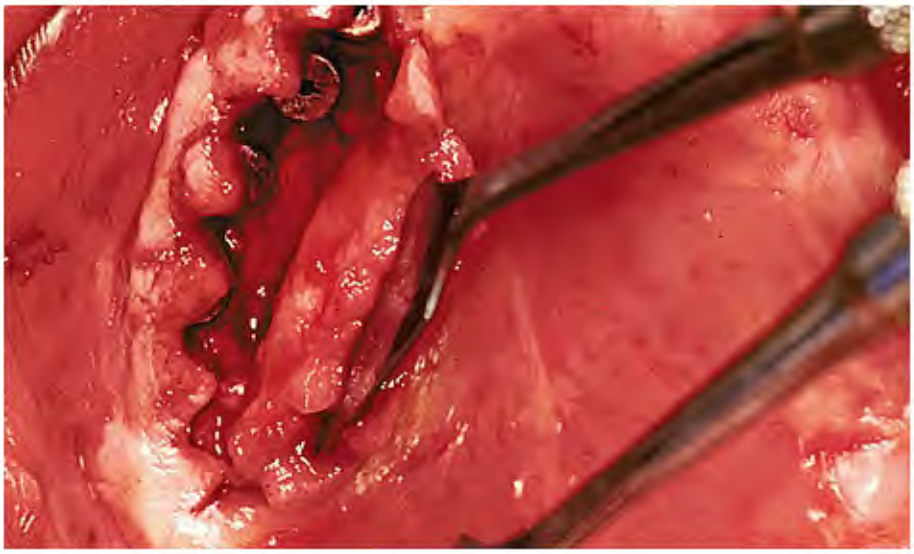


Fig 6-22r Taking a connective tissue graft from the palate.

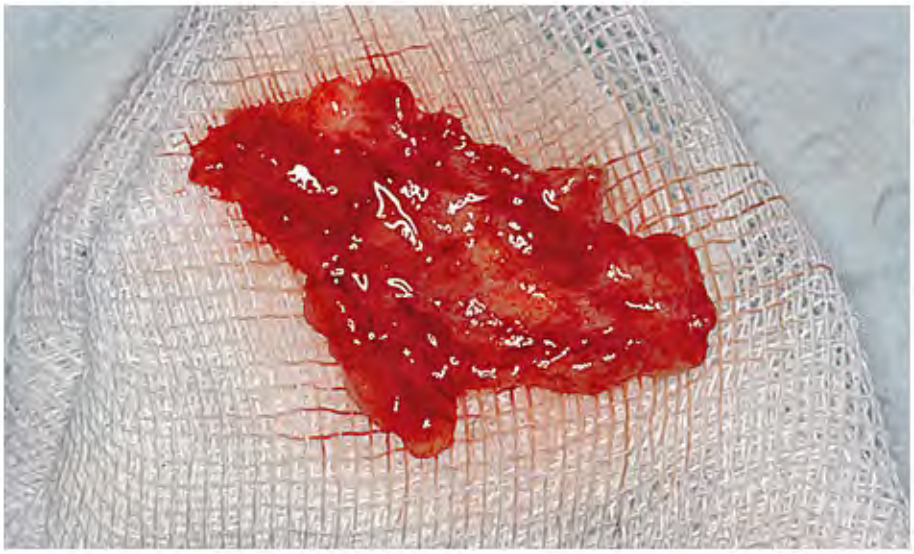


Fig 6-22s Connective tissue graft.

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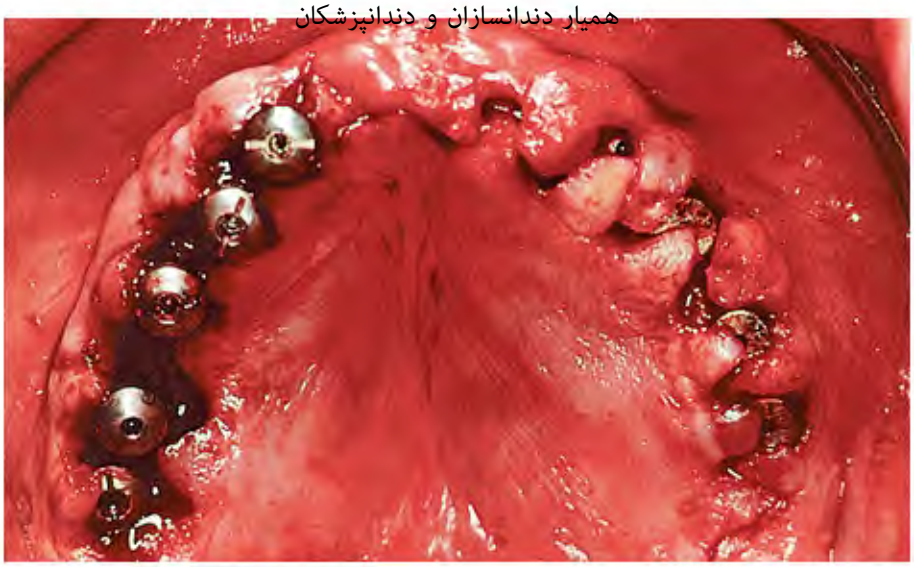


Fig 6-22t Exposure in the second quadrant.

Exposure and prosthetic restoration

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The incision (Fig 6-22q) was made using the cosine curve technique (see page 330). A connective tissue graft was taken from the palate concomitantly with the exposure (Fig 6-22r). The function of this graft (Fig 6-22s) was to support the additional widening of the residual ridge on the vestibular side, for esthetic reasons. Once the healing abutments were fitted on the right side, the left side was exposed in the same way (Fig 6-22t).

At the time of exposure, it was found that implant 26 had not been osseointegrated and had to be removed (Fig 6-22u). However, this implant was not correlated with the inflammation around the temporary implants, and no pressure from the denture was observed at this site either.

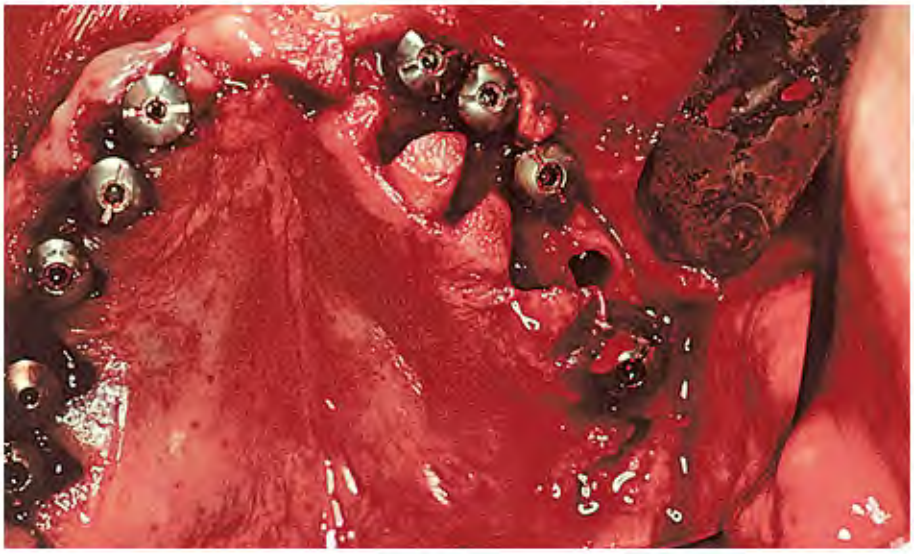


Fig 6-22u Removal of the implant in region 26.

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Fig 6-22v Immediate insertion of a wide platform (WP) implant.

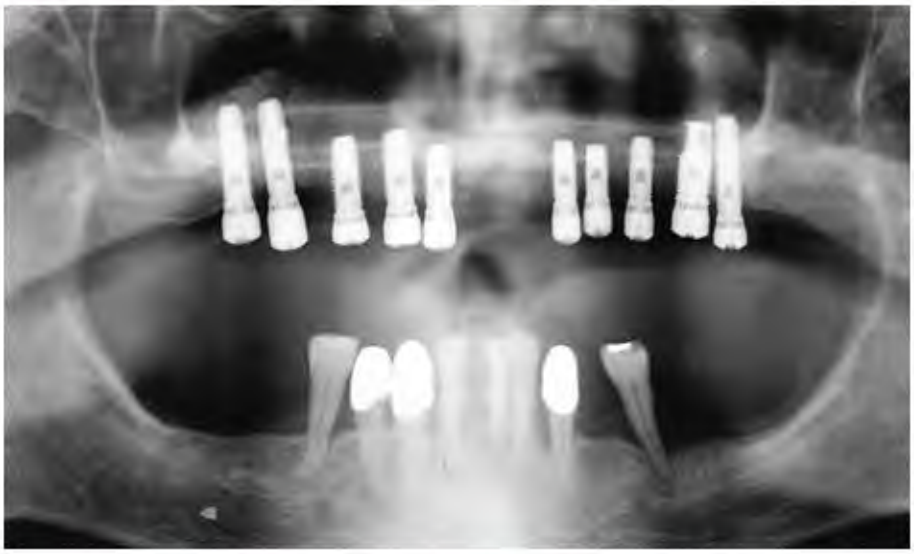


Fig 6-22w Post-exposure panoramic radiograph.



Fig 6-22x Long-term provisional.

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Fig 6-22y The definitive fixed cross-arch bridge was incorporated after 1 year.



Fig 6-22z The patient 3 years after treatment completion.

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Directly after the removal of implant 26, a Brånemark System MK IV wide platform (WP) implant 5 mm in diameter was inserted at this position and fitted with a healing abutment (Fig 6-22v). The panoramic radiograph shows the bone situation after exposure (Fig 6-22w). The patient was fitted with a plastic provisional fixed restoration for about 1 year (see “Attention” on page 506) (Fig 6-22x).

After 1 year, the long-term provisional was replaced with the definitive fixed cross-arch bridge (Fig 6-22y). This denture was retained on the 10 implants with occlusal screws. The gaps over the screws were filled with cotton wool pellets and composite fillings. The patient is very satisfied with his restoration, despite the prolonged treatment (Fig 6-22z).

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Fig 6-22aa Fixed implant bridge after 13 years.



Fig 6-22bb Severe peri-implantitis on the left side.

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Attention: ***According to the "Progressive Bone Loading" treatment concept (see page 387), the function of the provisional is to test the implants for load-bearing capacity. Occlusion and articulation need to be very accurately adjusted. Moreover, according to "Progressive Bone Loading," no prominent cusps should be constructed, to reduce the extra-axial loads.***

Continued follow-up

After a break of several years, ie, 13 years after implant placement, the patient presented for a check-up and for professional dental cleaning (Fig 6-22aa). Severe inflammatory reactions were apparent around the implants on both sides (Figs 6-22bb and 6-22cc). Because of acute peri-implantitis, the cleaning had to be accompanied by urgent treatment. While the etiology of peri-implantitis was not clear, heavy smoking could have played a role, in addition to poor

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oral hygiene. The fixed implant bridge was removed and thorough peri-implantitis treatment carried out around all the implants. Implant 23 showed loosening and was removed. Following stabilization of the gingival situation, impression copings were fitted onto the remaining implants and an impression taken for the new superstructure (Fig 6-22dd). To make access easier for hygiene purposes, the plan was to fabricate a removable denture on nine individual telescopic crowns.



Fig 6-22cc Slightly less aggressive peri-implantitis on the right side.



Fig 6-22dd Check panoramic radiograph taken during the impression taking for the new overdenture.

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Treatment course

- Bilateral sinus floor elevation (1997)
- 12 months to implant placement and the loading of the immediate provisional restoration onto provisional implants

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- 3 months to the complication and removal of the provisional implants
- 7 months to exposure
- 2 months to prosthetic loading
- 13 years to the peri-implantitis treatment and a new overdenture

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Problems and complications

Sinus floor elevation and immediate restoration loaded onto provisional implants, implant loss during the healing phase

Baseline situation

This male patient had an atrophied maxilla with pronounced vertical bone defects in the molar region (Fig 6-23a). These defects probably developed following extraction of the teeth and the insertion of the deep-contoured prosthesis (Fig 6-23b). The panoramic radiograph showed extreme vertical bone atrophy in both the posterior and anterior maxilla (Fig 6-23c). These findings were confirmed by the CT scan. At the patient's request, the desperate state of the mandibular teeth was left unattended, despite the severe periodontal defects.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus floor elevation with vertical augmentation

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2. Implant placement and provisional implants with immediate provisional restoration
3. Exposure and definitive prosthetic loading

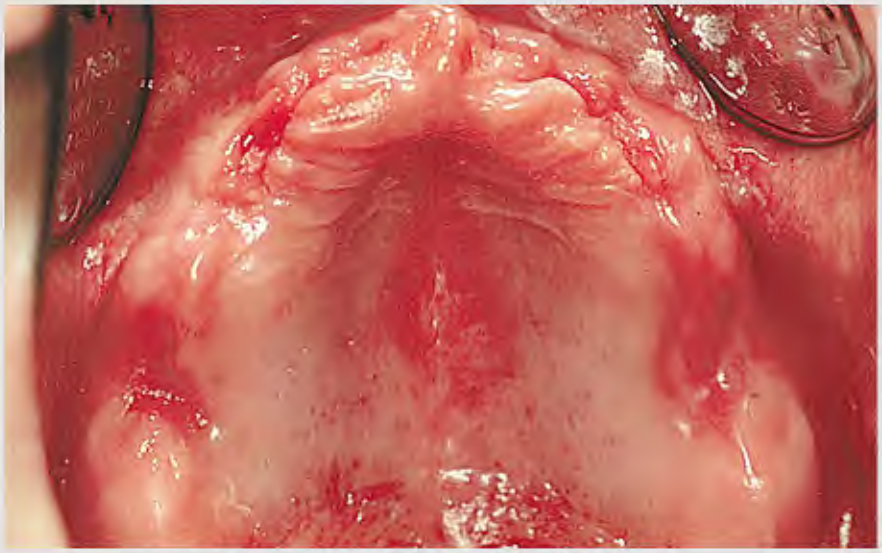


Fig 6-23a Baseline situation.



Fig 6-23b Complete maxillary prosthesis. Overcontouring in the molar region.

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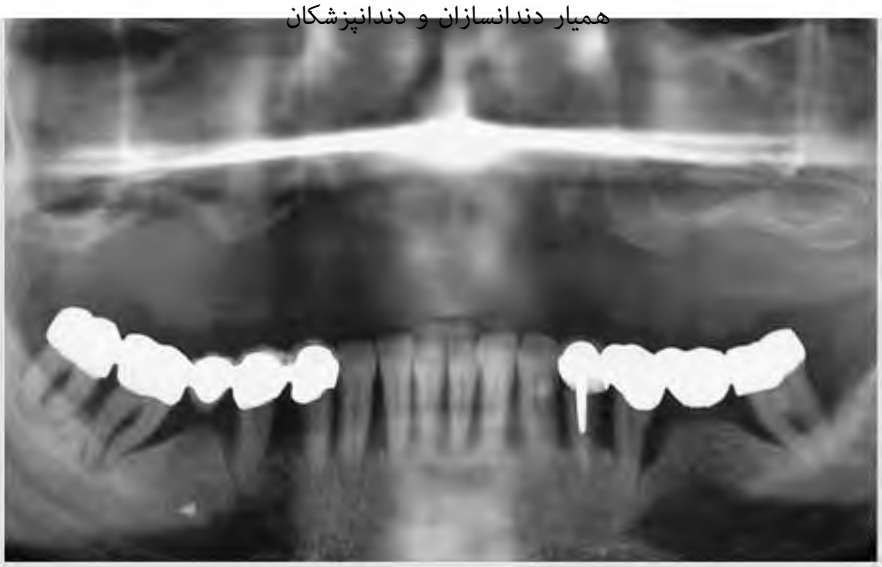


Fig 6-23c Panoramic radiograph.

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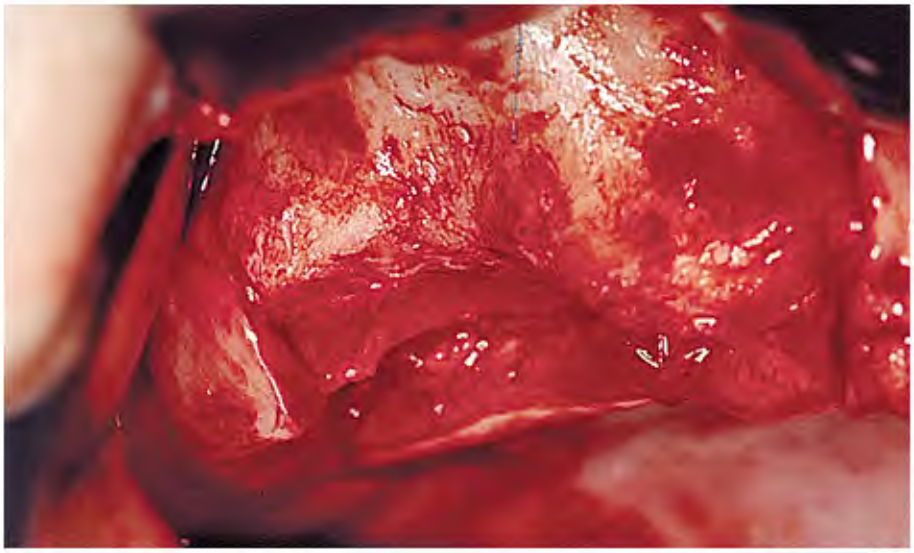


Fig 6-23d Vertical bone defect.

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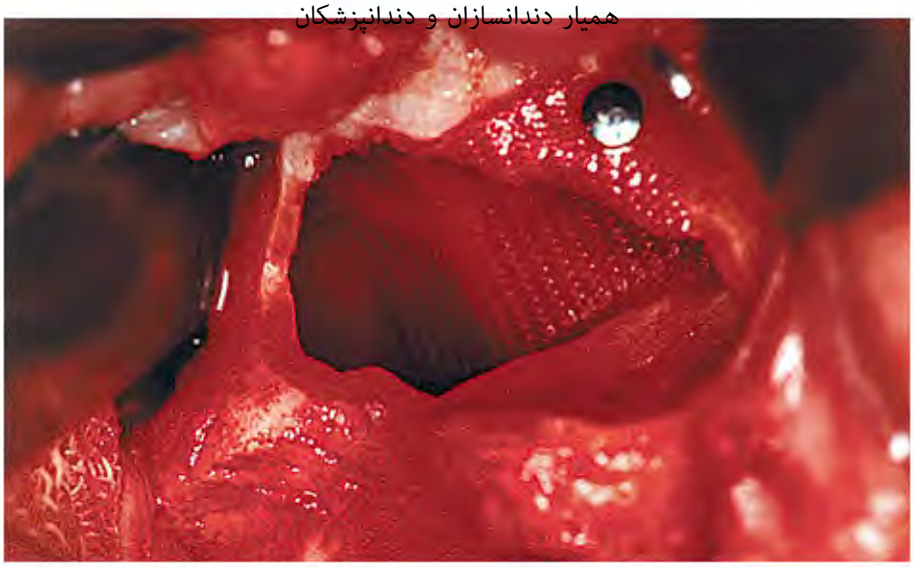


Fig 6-23e Sealing off the maxillary sinus mucosa.

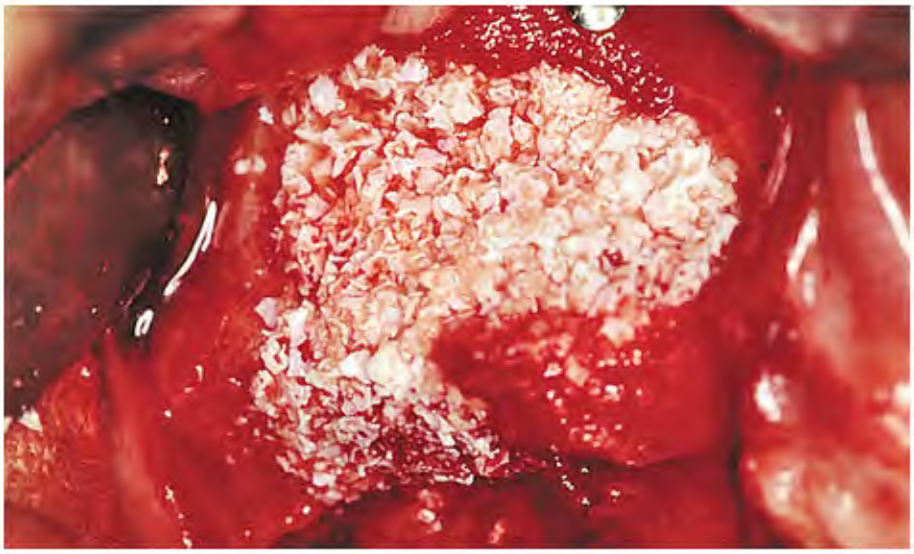


Fig 6-23f Vertical bone augmentation.

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Bilateral sinus floor elevation

The extent of the vertical bone defect of approximately 7 to 8 mm was revealed following flap reflection (Fig 6-23d). Fenestration of the lateral wall of the maxillary sinus was performed over the residual ridge defect and the mucosa elevated. During this procedure, a perforation was made in the Schneiderian membrane, which was sealed off with a Vicryl mesh (Fig 6-23e). The cavity created was filled with a mixture of Bio-Oss and autologous bone. The vertical bone defect was augmented with the same material (Fig 6-23f). A Bio-Gide membrane was applied over the augmented areas and tightly sutured into place. The same procedure was repeated on the other side.

Implant placement and insertion of provisional implants

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The positions of the definitive and provisional implants were planned on the basis of the panoramic radiograph (Fig 6-23g). The course of the residual ridge had largely improved following the augmentation in the molar region (Fig 6-23h, see Fig 6-23a).

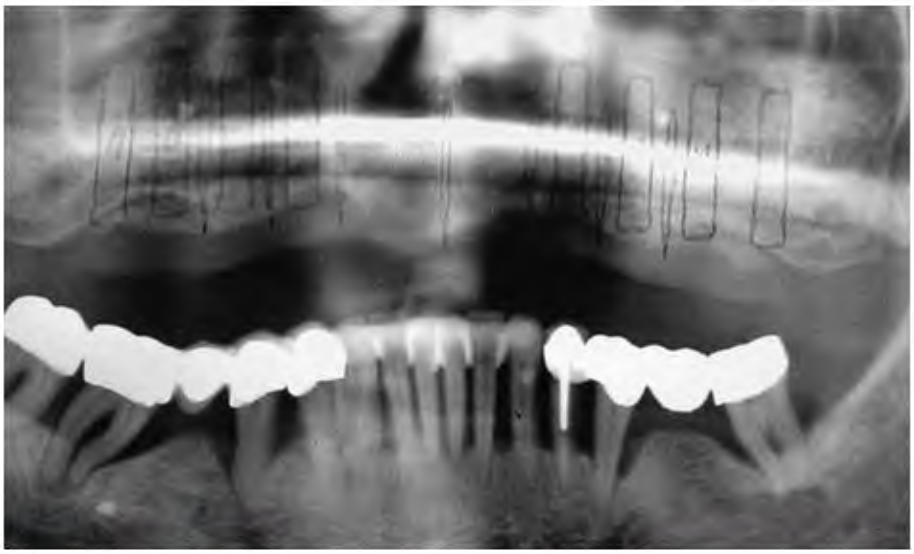


Fig 6-23g Planning implant placement on the panoramic radiograph.



Fig 6-23h Contours of the residual ridge following augmentation.

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Fig 6-23i Orientation of the surgical template.

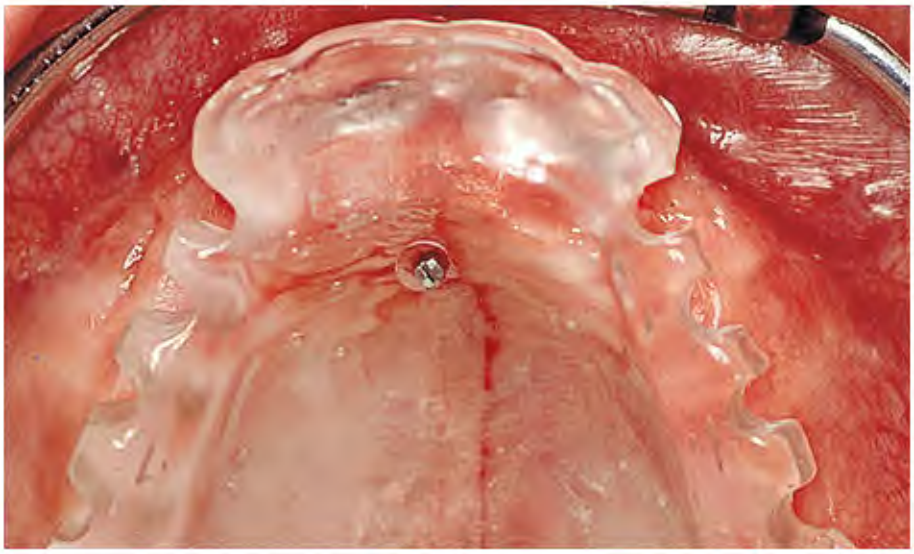


Fig 6-23j Stabilization screw for the template, driven into the hard palate.



Fig 6-23k Additional stabilization with direction indicators.

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Fig 6-23l Insertion of eight definitive and eight provisional implants.

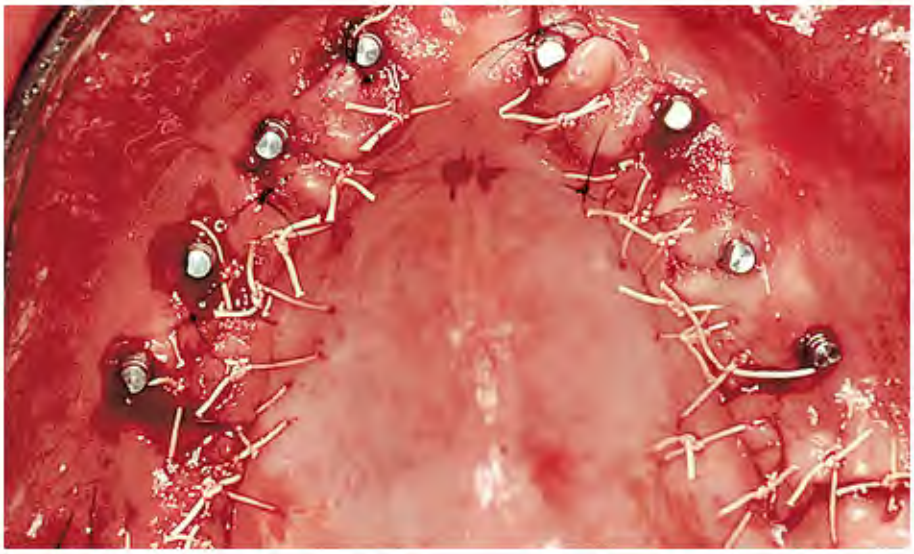


Fig 6-23m Parallelization of the provisional implants.

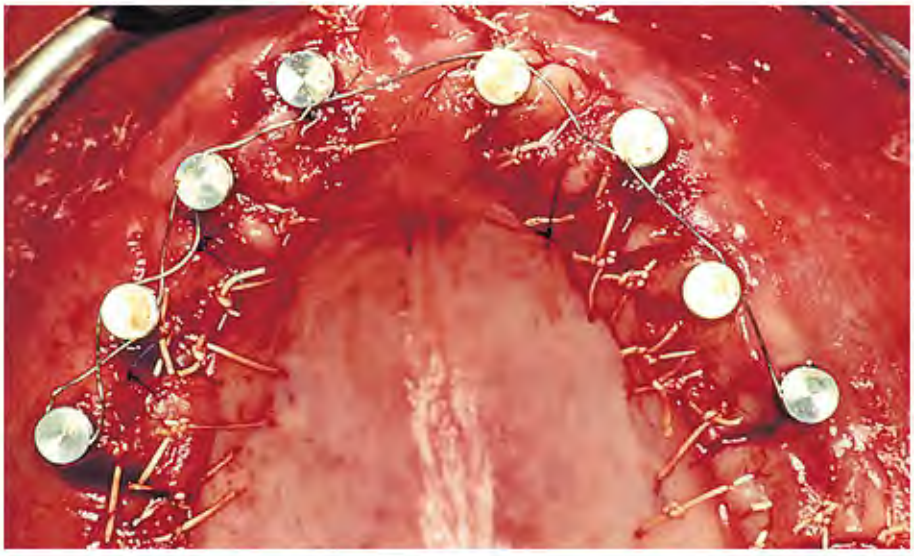


Fig 6-23n Impression caps bound together with a ligature.

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Fig 6-23o Immediate restoration.

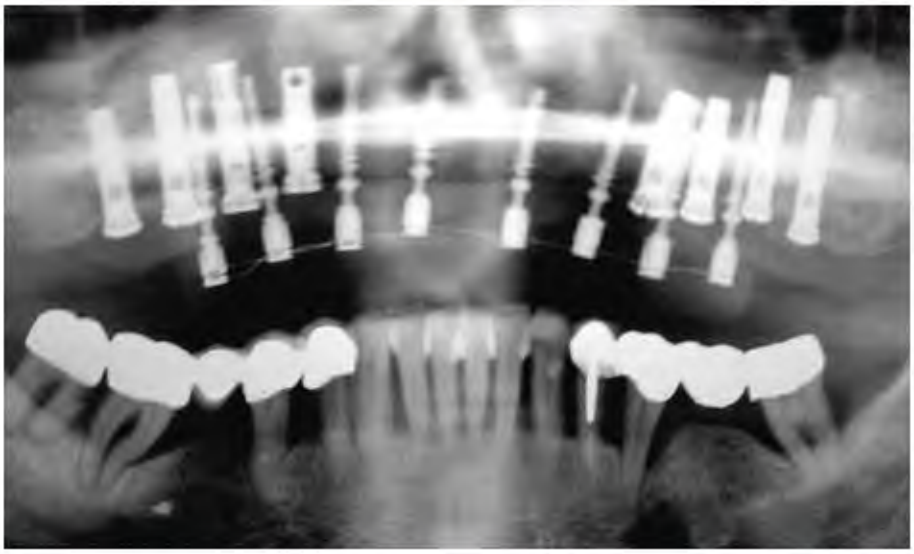


Fig 6-23p Postoperative panoramic radiograph.

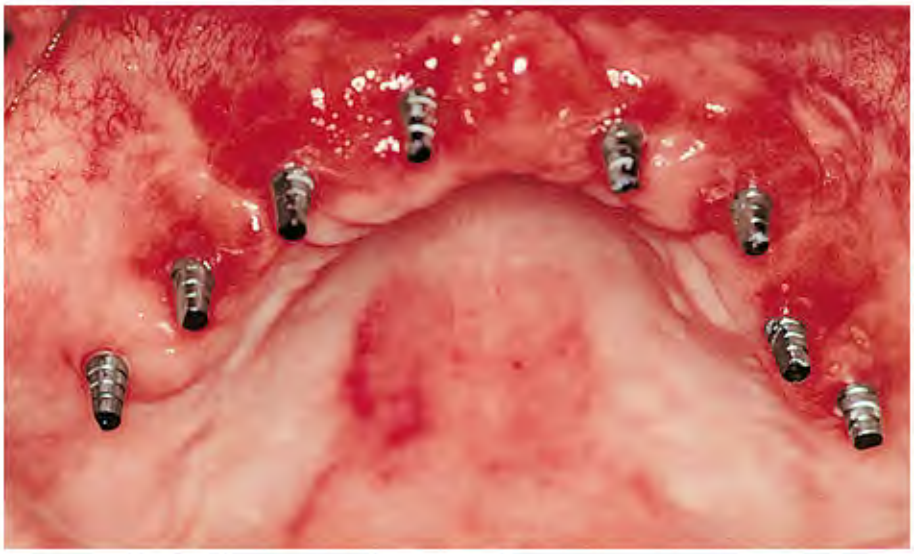


Fig 6-23q Clinical situation.

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Fig 6-23r Long-term provisional.

A surgical template, with the incisors left inside it, was fabricated for implant placement (Fig 6-23i). This allowed the correct position of the template to be established more quickly with the patient biting down. It was fixed into position more securely by driving a screw into the hard palate through a perforation in the template (Fig 6-23j; see page 423). This reference point allows the template to be removed and always put back into the same place. The incision to open the soft tissue was made on the palatal side, with the flap reflected toward the vestibular side. Two holes were drilled on each side and direction indicators inserted for better stabilization of the template (Fig 6-23k).

Four more implant beds were then prepared and then all eight definitive implants inserted into the planned positions. The remaining stable segments of the residual ridge were used for the placement of the provisional implants (Fig 6-23l). The provisional implants were aligned, followed by suturing of the wound (Fig 6-23m). Caps were placed onto the temporary implants and bound together with a ligature (Fig 6-23n). An immediate provisional restoration was fabricated with the aid of a thermoplastic foil and incorporated (Fig 6-23o). The postoperative radiograph shows the placement of the definitive and provisional implants (Fig 6-23p). Once the sutures were removed (Fig 6-23q), the patient was fitted with a long-term provisional (Fig 6-23r).

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Fig 6-23s Exposure of the implants using the cosine curve technique.

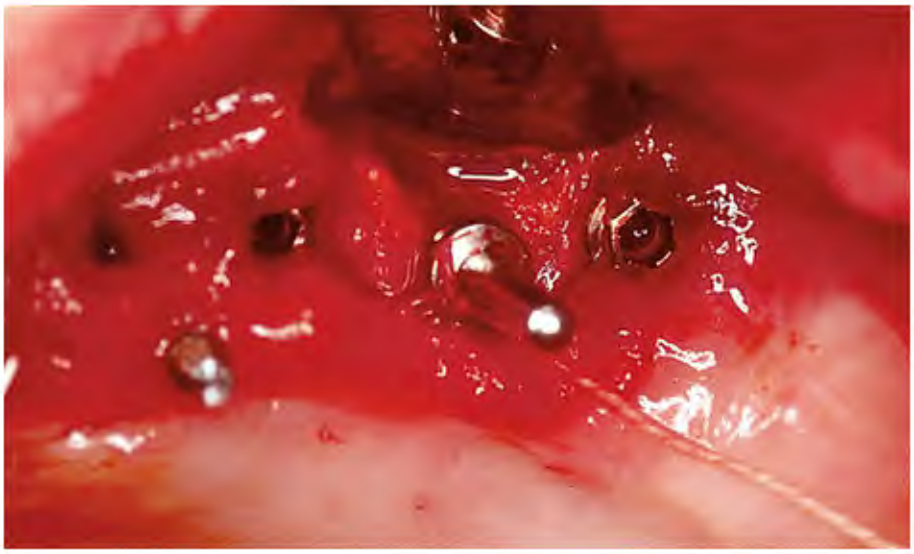


Fig 6-23t Removal of implant 26.

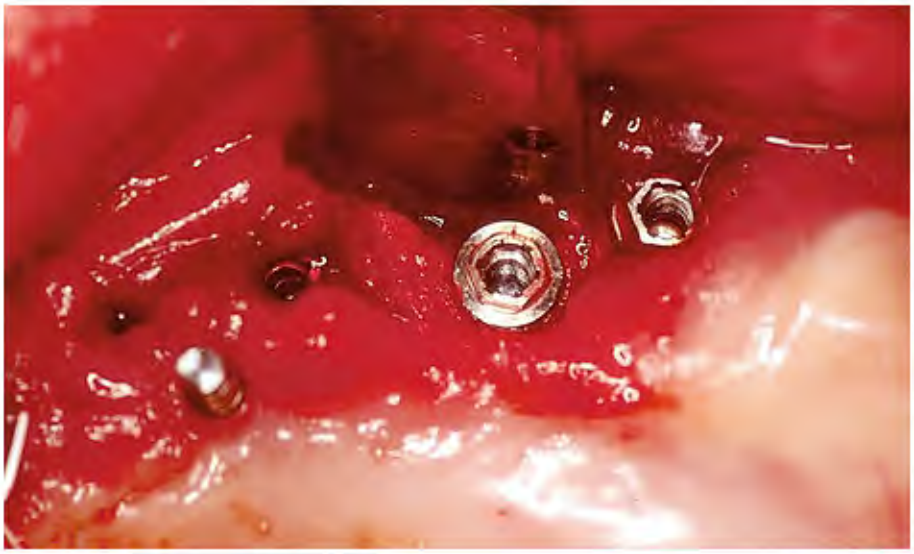


Fig 6-23u Inserted WP implant.

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Fig 6-23v Augmentation in region 26.

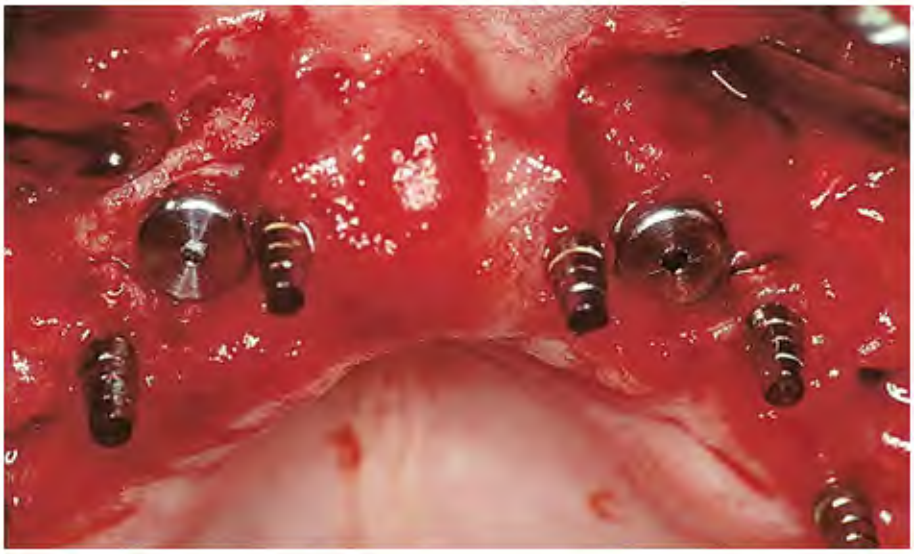


Fig 6-23w Implant placement in regions 12 and 22.

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Exposure and complication

After 8 months, the implants were exposed with the aid of the cosine curve technique (Fig 6-23s). In doing so, it was found that implant 26 had not become osseointegrated, and was removed directly (Fig 6-23t). A Brånemark System MK IV TiUnite implant (Nobel Biocare) 18 mm long and 5 mm in diameter was reinserted into this position during the same session (Fig 6-23u). The bone defect was filled with bone chips (Fig 6-23v). Unfortunately, after another 3 weeks, the patient complained of pain and swelling in region 26, so the reinserted implant was removed immediately. To increase the stability of the structure, two implants were inserted 3 months later into regions 12 and 22 (Fig 6-23w).

Prosthetic restoration

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After another 6 months, the anterior implants were exposed and all the implants were loaded with a fixed restoration. The final images show the prosthetic restoration after 11 years of functional use (Fig 6-23x). The superstructure consisted of three parts, also held together with occlusal screws (Fig 6-23y). The follow-up panoramic radiograph after 11 years shows a stable situation around the implants in the maxilla and a dismal residual dentition in the mandible requiring urgent treatment (Fig 6-23z). During this time, teeth 47 and 48 had decayed almost completely.



Fig 6-23x Definitive prosthetic restoration after 11 years of functional use.

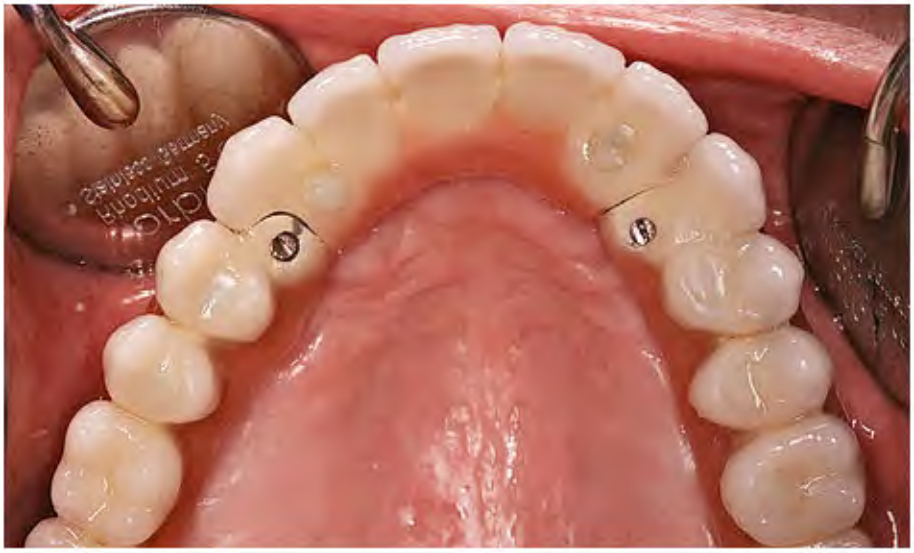


Fig 6-23y Occlusal view of the three-part structure.

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Fig 6-23z Check panoramic radiograph after 11 years of functional use.

Treatment course

- Sinus floor elevation with vertical augmentation (2000)
- 9 months to implant placement and immediate provisional restoration on provisional implants
- 8 months to exposure and removal of implant 26
- 3 months to placement of implants 12 and 22
- 6 months to exposure
- 2 months to prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Gregor Cwajgart
Dental technology:	Gerhard Makowski

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7
The Edentulous Maxilla and Mandible



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Full rehabilitation of the maxilla and mandible

Apart from patients with an edentulous maxilla or mandible, there are also a number of who are totally edentulous and require treatment in both jaws. But how does one go about planning such treatment? If treating both jaws simultaneously does not appear or sound possible, this presents the question of which jaw should be given preference. If the main concerns are an effective use of time or the need to complete the treatment as soon as possible, the maxilla should be treated first. Treatment of the maxilla is often more complex and lasts much longer, so that its healing times can be used to treat the mandible without delay. Since the maxilla requires more implants and longer healing times for a comparable restoration, one could safely

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say that treating the maxilla lasts twice as long and costs twice as much as the mandible.

If the patient is not yet totally convinced of the advantage of implant treatment, and the main priority is for him or her to have the positive experience of a speedy and reliable outcome, then it is better to start with the mandible.

3D diagnosis

The diagnosis and planning for the two jaws separately have already been discussed in the relevant chapters. Where an overall concept is involved, the planning for both jaws should also be coordinated logistically and with regard to timing. An advantage in this type of planning is that a single cone beam computed tomography (CBCT) scan is usually sufficient to plan treatment in both jaws.

3D planning for implant placement in the maxilla and a Sliwowski Overdenture System (SOS) in the mandible

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An edentulous woman wanted a fixed restoration in both jaws. A CBCT scan was taken. Both jaws, especially the mandible, still appear well-preserved. The maxilla seems to be of sufficient height, but the anterior segment appears very narrow (Fig 7-1a). A total of eight implants were planned in the maxilla; only narrow platform (NP) implants were an option in the anterior maxilla (Fig 7-1b). In the posterior maxilla, the residual ridge was wide enough, but its quality was insufficient for the insertion of regular platform (RP) implants (Fig 7-1c). Bone density around the planned implant in position 16 was approximately 0 Hounsfield units (which corresponds to the density of water). In region 26, the bone was softer still, its density being even less than 0 (Fig 7-1d). In the anterior maxilla, the residual ridge was harder and its density around implant 23 was much more favorable. However, it was so narrow that augmentation was required (Fig 7-1e).

Planning in the maxilla was followed by implant placement planning for the mandible using the same CBCT scan images. In the mandible, the initial plan was to insert five implants in the interforaminal region to support a fixed cantilever bridge (Fig 7-1f). However, once the planning was complete, it emerged that the patient could not afford the full treatment at that time. Following a detailed consultation with her, it was decided that implant placement in the maxilla would be performed first. The mandible was to be treated in the next stage, but the financial investment associated with it needed to be considerably reduced. As part of the overall plan, the intention was to start with the more affordable Sliwowski Overdenture System (SOS) treatment in the mandible. A new CBCT scan with a template with integrated markers and a housing replica for the planning software coDiagnostiX (Dental Wings) was performed to plan implant placement in the mandible (Fig 7-1g). Two parallel implants at a distance of exactly 18 mm, positioned at the center of the interforaminal region, were planned.

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This scan provided the opportunity to evaluate implant placement in the maxilla, which had taken place in the interim. As planned, the apex of implant 16 was anchored in the cortical septum between the maxillary sinus and the nasal cavity (see Figs 7-1c and 7-1h).

For the treatment course, see page 520.

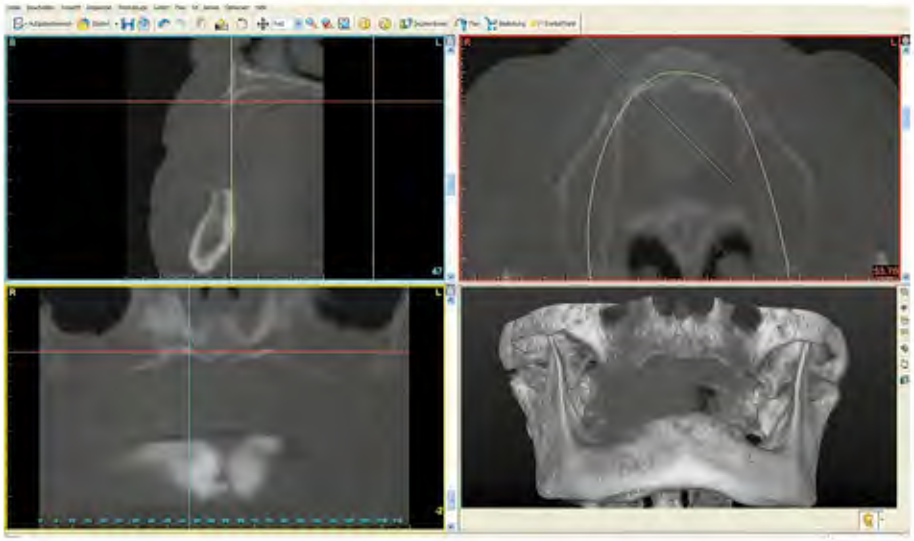


Fig 7-1a CBCT scan of both jaws.



Fig 7-1b Eight implants have been planned in the maxilla.

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Fig 7-1c Poor bone quality around implant 16.

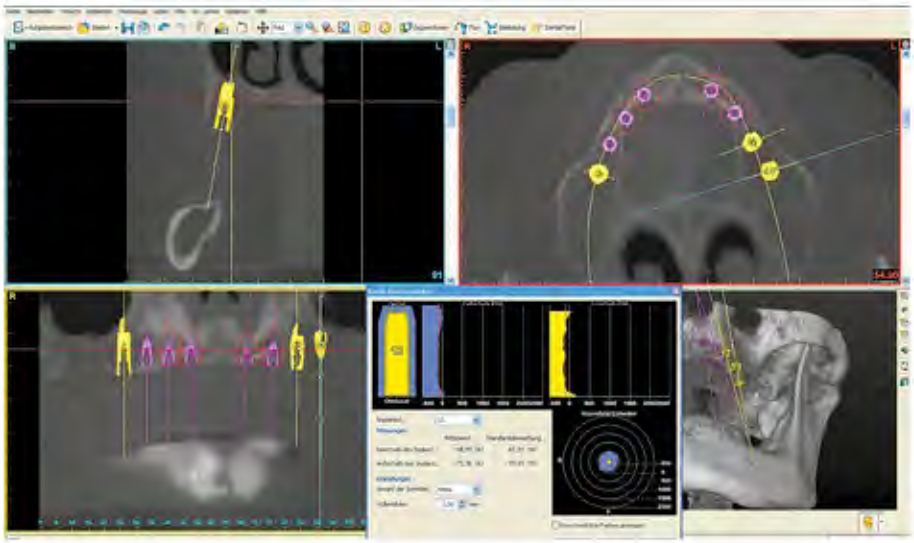


Fig 7-1d Even softer bone around implant 26.

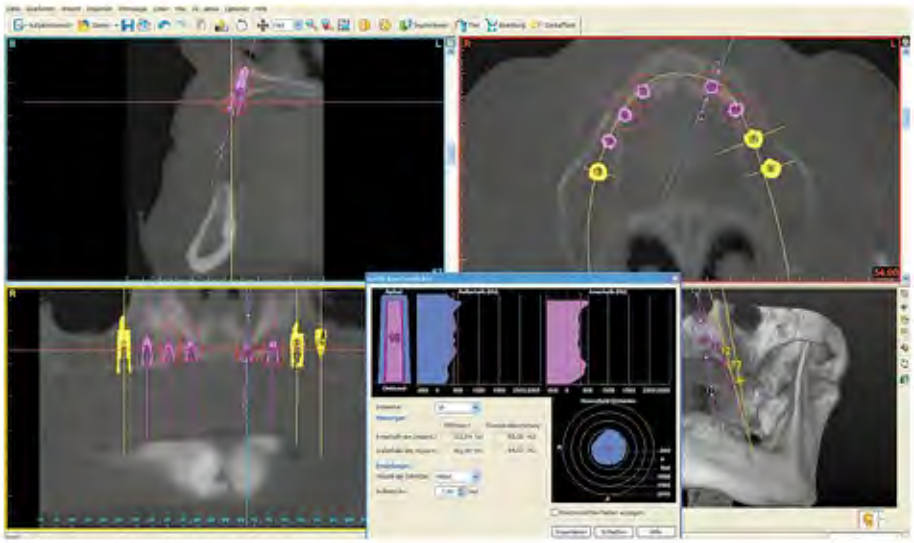


Fig 7-1e Narrower but harder residual ridge in region 23.

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Fig 7-1f Five interforaminal implants have been planned for a fixed cantilever bridge.

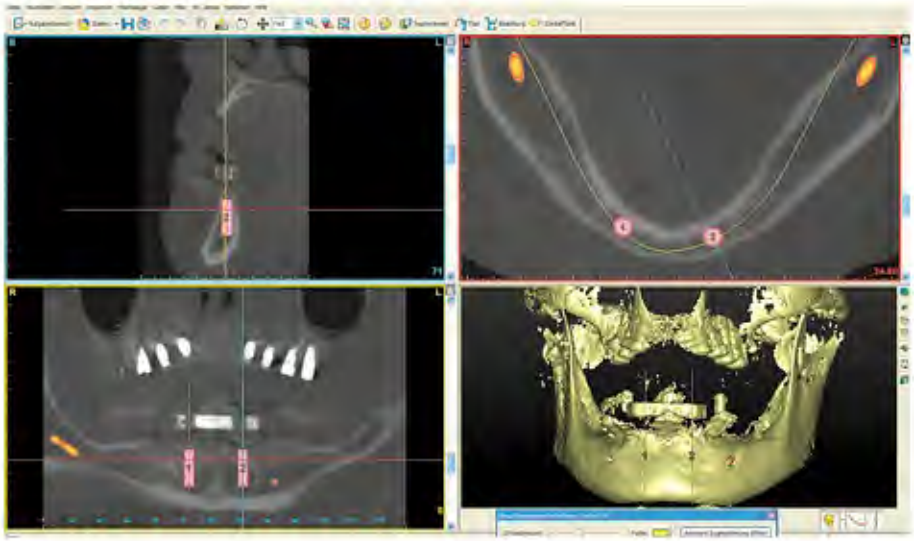


Fig 7-1g Change in plan for the Sliwowski Overdenture System (SOS) treatment.

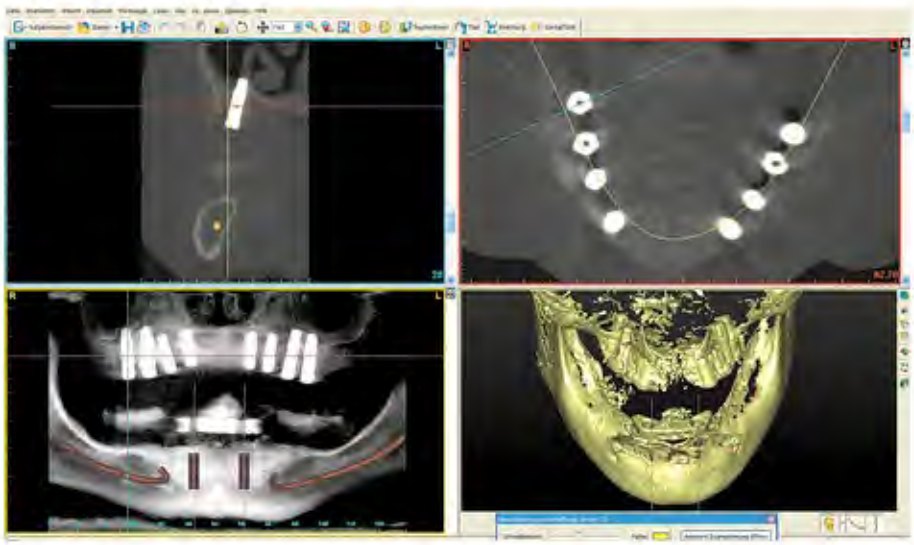


Fig 7-1h Checking implant placement in the maxilla. Bicortical anchoring of implant 16.

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3D planning for sinus elevation in the maxilla and implant placement in the mandible

This male patient wanted a fixed restoration in both jaws. There were still a few teeth left in both jaws; these were being used to anchor the overdentures. His existing prostheses were to remain in use until the definitive superstructures were incorporated onto the implants.

In the maxilla, the maxillary sinuses on both sides were so pronounced that sinus elevations would also need to be performed before implant placement (Fig 7-2a). Both maxillary sinuses contained a few septa, which could complicate dissection of the maxillary sinus mucosa. Since the operation was to be performed under general anesthesia, implant placement in the mandible was scheduled to take place along with the sinus elevation (Fig 7-2b). The plan was to place a total of eight implants for a fixed restoration in the mandible. Four long implants were to be inserted in the interforaminal segment, plus two per side in the posterior region (Fig 7-2c). The implants in the mandible were aligned to the dentition of the maxilla (Fig 7-2d). Clear visualization of the alveolar nerves facilitated implant planning in the posterior regions (Fig 7-2e). In the cross sections, the implants were planned to ensure that the distance between implant and nerve was not less than the 2-mm limit (Fig 7-2f). If the residual ridge was wide enough, the plan was to insert implants with a diameter of 4 mm (shown in yellow here). In the anterior segment, the residual ridge was much narrower, so that long implants, but with a reduced diameter of 3.5 mm (shown in green) were been planned here (Fig 7-2g).

For the treatment course, see page 539–543.

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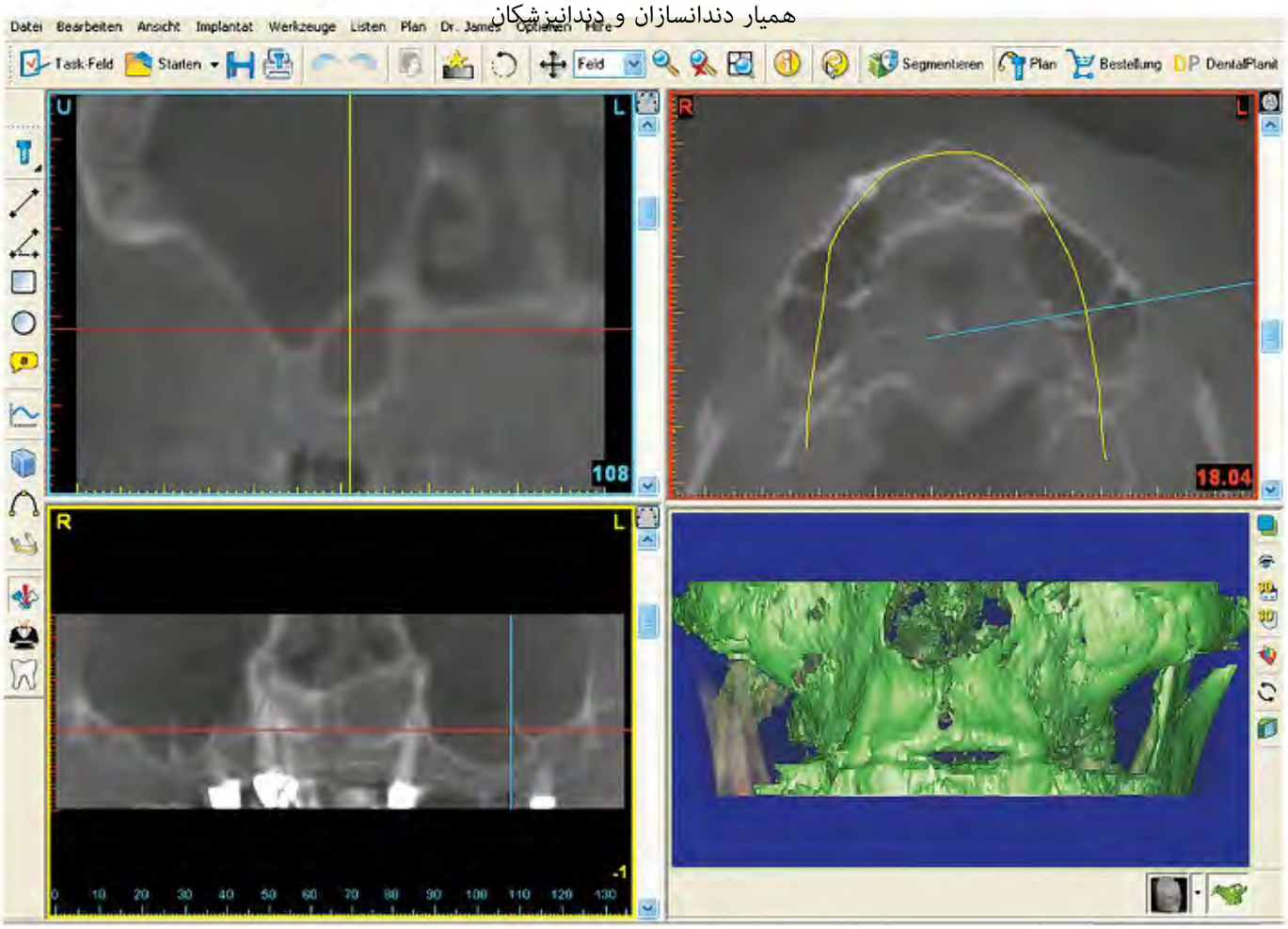


Fig 7-2a Very pronounced maxillary sinuses with several septa.

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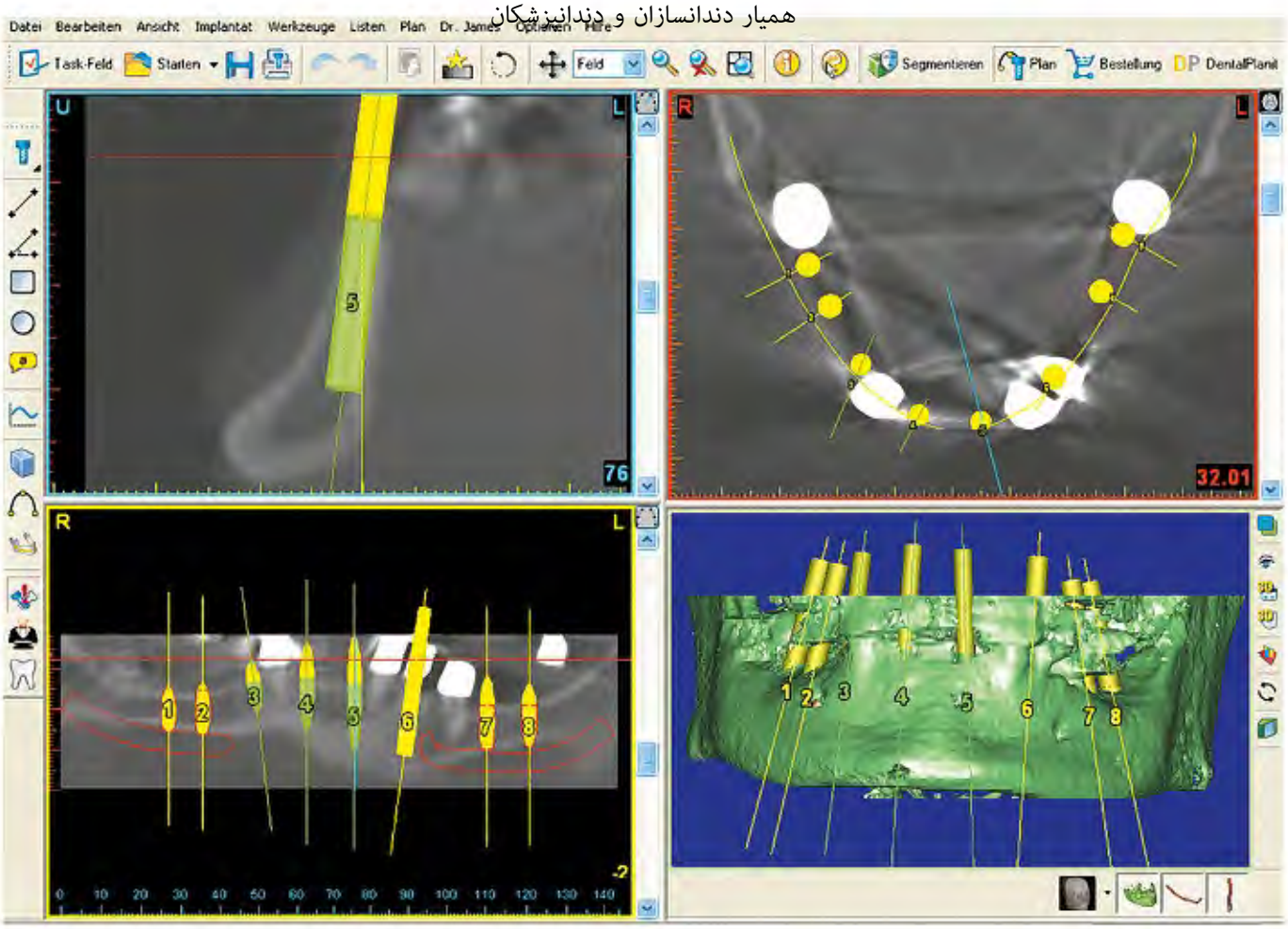


Fig 7-2b SimPlant implant planning for the mandible.

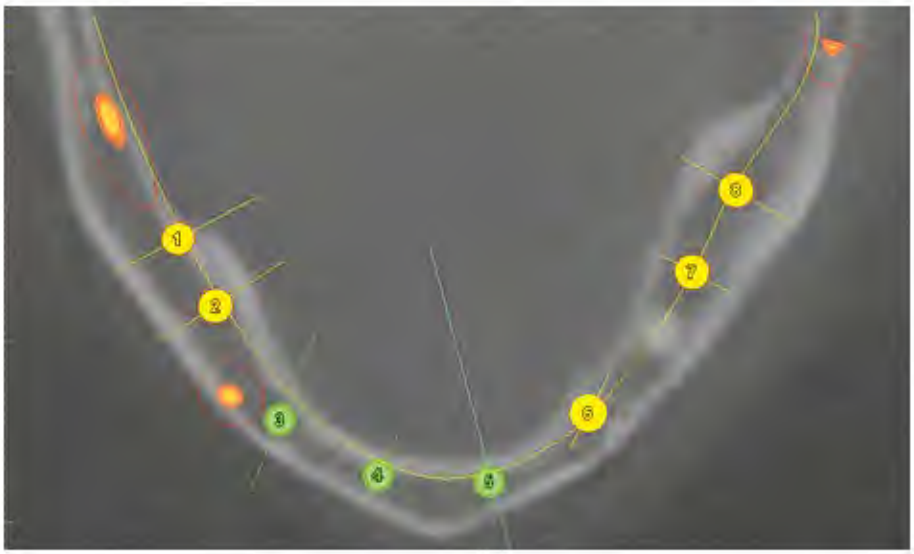


Fig 7-2c Uniform distribution of the implants in the mandible.

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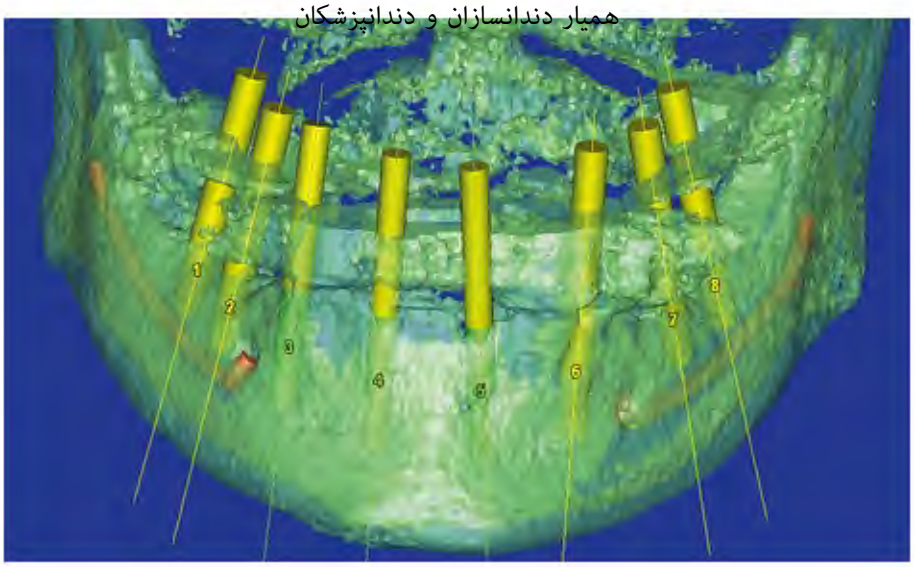


Fig 7-2d The implant axes have been aligned to the dentition in the maxilla.

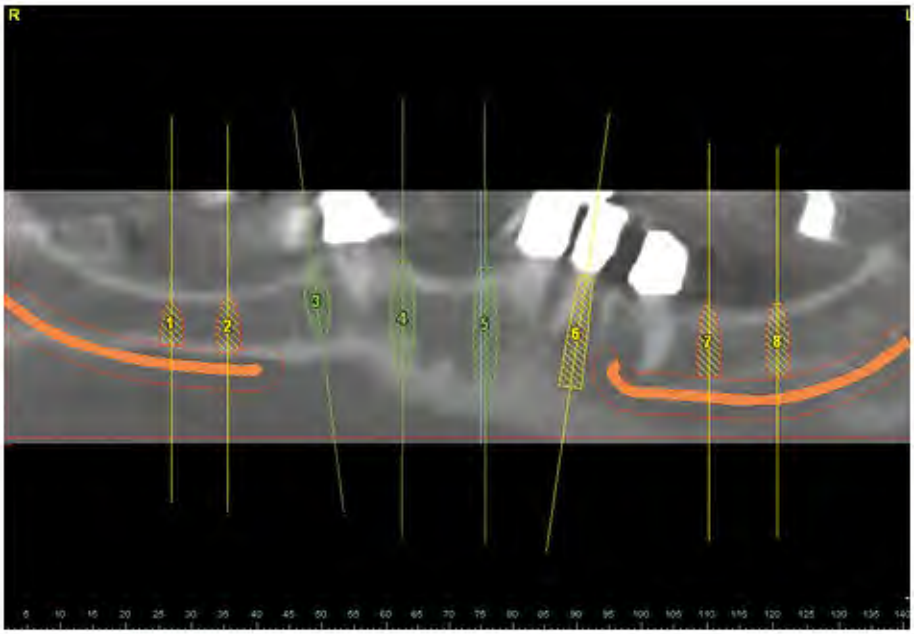


Fig 7-2e The alveolar nerves in the mandible have been marked in red.

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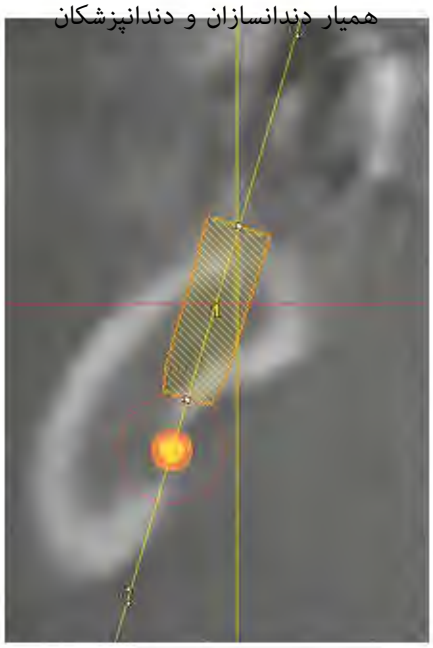


Fig 7-2f The minimum distance between implant and nerve is 2 mm.

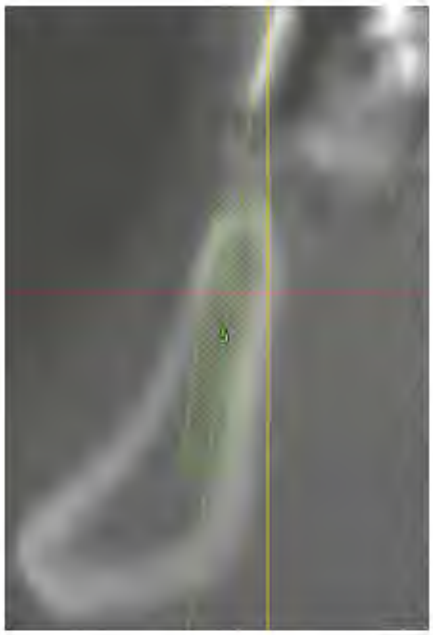


Fig 7-2g High, but narrow residual ridge with corresponding implant.

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Typical treatment course

Bar structures with locking attachments in both maxilla and mandible

This treatment course follows on from the 3D diagnosis on page 516.

Baseline situation

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A 60-year-old, edentulous woman, who is a heavy smoker, wanted a fixed restoration in both jaws. The placement of implants in both jaws was planned in accordance with her wishes using SimPlant (Dentsply) (see 3D diagnosis, page 516). However, the patient's financial means were limited at that time, so her wishes could not be realized in full. As a compromise, we agreed to provide her with a fixed restoration of the maxilla straightaway, while performing the SOS treatment in the mandible as an interim solution. The patient had the option to have additional implants placed in the mandible at a later date, and to have the restoration fabricated using the SOS method reworked into a fixed implant bridge.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT and planning with the SimPlant program
- Repeat CBCT: the patient with mandibular template and the template alone
- SimPlant planning and SOS SurgiGuide (Dentsply) drill guide for the mandible

Treatment plan

1. Implant placement in the maxilla
2. Implant placement and direct prosthetic loading in the mandible
3. Exposure and definitive prosthetic loading in the maxilla

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Implant placement in the maxilla

The patient's maxilla appeared to be very well preserved, both in the CBCT scan images (see 3D diagnosis, on page 516; Fig 7-1a, page 517) and on clinical inspection (Fig 7-3a). Implant placement took place under general anesthesia. As planned, the Replace Select NP implants (Nobel Biocare) were inserted into the positions of the canines and first premolars (Fig 7-3b). Implants 18 mm long and 4.3 mm in diameter were placed in the posterior region. As already expected at the planning stage, the bone was very soft, so that there would be virtually no primary stability for implant 26 following drilling with the 3-mm twist drill. The machine was stopped at 5 N/cm, as it would otherwise have driven the implant in further. Because of the very soft bone and the consequently doubtful prognosis, especially for implant 26, the patient was requested to stop smoking and the healing period was extended to 10 months. The residual ridge was then augmented with the harvested bone chips. The postoperative panoramic

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radiograph shows the implants, distributed according to the plan (Fig 7-3c).

Implant placement and SOS restoration in the mandible

Implant placement and direct prosthetic loading in the mandible with the SOS method was planned 2 months after implant placement in the maxilla (see Fig 7-1g, page 517). The mandible was both radiologically and clinically very well suited for this treatment (Fig 7-3d). Using the prepared drill guide and special instruments, two implant beds were prepared for the SOS implants (Fig 7-3e). The exact procedure is described in Chapter 3, “The Edentulous Mandible” (see page 119). The next day, the reworked prosthesis was incorporated on the prefabricated bar in the mandible (Fig 7-3f).

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Fig 7-3a Edentulous maxilla before treatment.

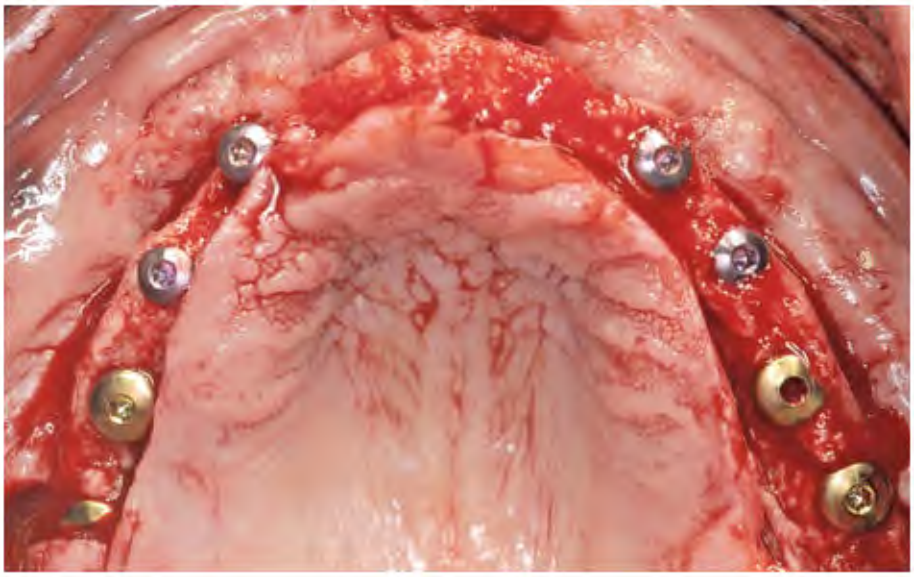


Fig 7-3b The eight inserted implants before augmentation.

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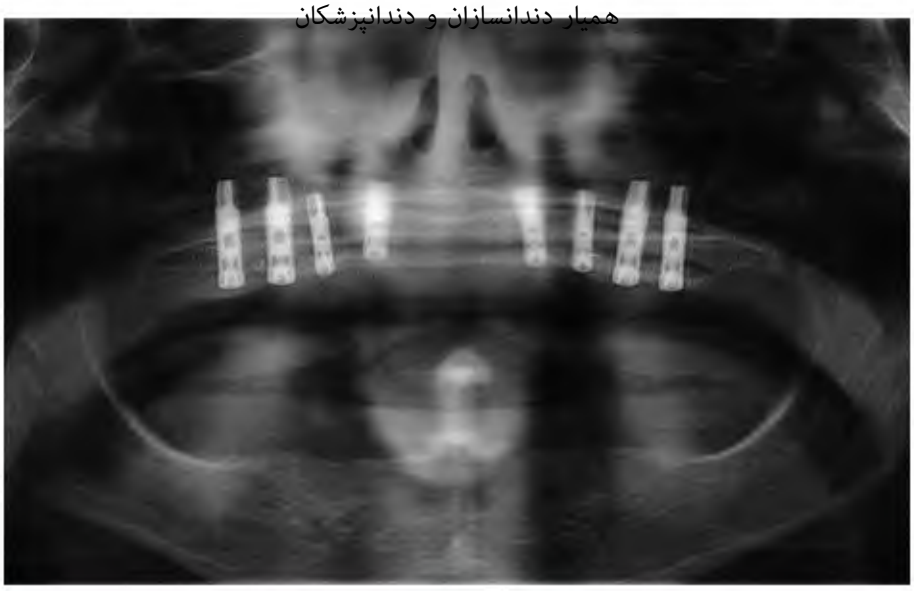


Fig 7-3c Postoperative panoramic radiograph.



Fig 7-3d Edentulous mandible.

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Fig 7-3e SOS treatment.



Fig 7-3f Prefabricated SOS bar 1 day after surgery.

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Exposure and prosthetic loading in the maxilla

Eight months later, the implants in the maxilla, already partly visible through the mucosa, were ready for exposure (Fig 7-3g). The patient had followed our advice and had not smoked any cigarettes throughout her treatment period and had managed to quit smoking completely. Corrective measures for the mucosa and the procedure to widen the zone of attached gingiva around the healing abutments were performed at the time of implant exposure (Fig 7-3h). Three weeks later, the gingival situation had stabilized, allowing an impression to be taken (Fig 7-3i). A panoramic radiograph was taken after the impression copings were fitted (Fig 7-3j). This also provided the opportunity for a radiologic check of the implants in the mandible. A custom-made bar on eight implants was fabricated in the laboratory using the computer-

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assisted design/manufacturing (CAD/CAM) technique and screwed onto the implants (Fig 7-3k). The prosthesis made to fit this was based on an electroplated gold framework and included two MK1 attachments, providing considerably greater stability than the central attachment in the mandible (Fig 7-3l). To remove the prostheses, both attachments would need to be pushed toward the palate for the maxillary denture, and just one lingual for the mandibular one; the prostheses were now unlocked (Fig 7-3m).



Fig 7-3g Implants showing through the mucosa.

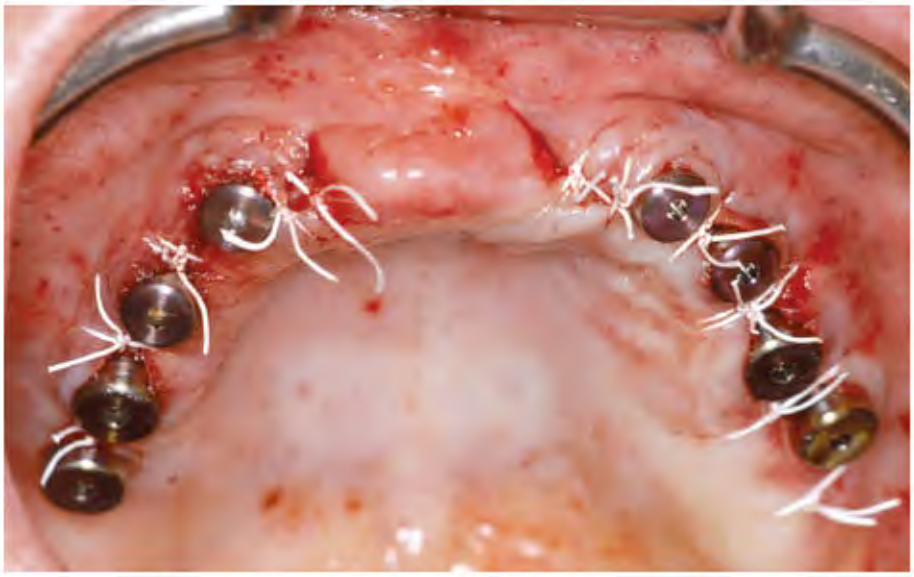


Fig 7-3h Exposing the implants.

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Fig 7-3i Situation prior to impression taking.



Fig 7-3j Panoramic radiograph to check the positions of the impression copings.

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Fig 7-3k Connector bar fitted to the maxilla.

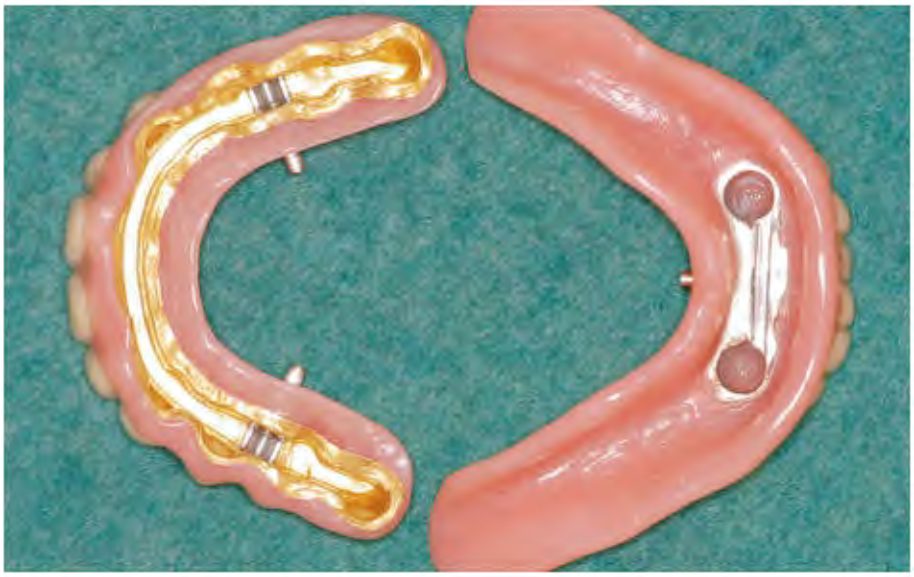


Fig 7-3l Maxillary prosthesis with two locking attachments and mandibular prosthesis with one attachment.



Fig 7-3m Occlusal view of both prostheses.

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Fig 7-3n Maxillary prosthesis locked into place.



Fig 7-3o SOS bar after 1 year of functional use.



Fig 7-3p Anterior view of both prostheses.

Once the prostheses were inserted, the attachments were locked, after which they were virtually undetectable with the tongue (Fig 7-3n). Of course, the prosthesis was designed to be

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palateless. The patient was very satisfied with her treatment and radiantly happy about her securely fitting fixed dentures. One year after treatment completion, the gingival situation in both jaws showed nothing of note (Fig 7-3o). Potential further treatment in the mandible was discussed. The patient's financial situation had improved significantly, but she was so happy with the restoration in her mandible that she wanted no change and described the SOS method as an ideal restoration (Fig 7-3p).

Treatment course

- Implant placement in the maxilla (2011)
- 2 months to the SOS treatment in the mandible
- 8 months to exposure in the maxilla
- 2 months to prosthetic loading

Treatment

Surgery:	Dominika Sliwowska, DDS Dr Christoph T. Sliwowski
Prosthetics:	Dominika Sliwowska, DDS
Dental technology:	Dental Technician Ludger Jansen, DentaLab

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Typical treatment course

Sinus elevation and subsequent implant placement, reconstruction of the gingival zone

Baseline situation

A 62-year-old man's dentition required urgent attention (Fig 7-4a). He wanted a fixed restoration in the maxilla and mandible, if possible one that he could wear throughout his treatment period. In view of the patient's denture phobia, three anterior teeth were left in each jaw to allow him to be fitted with a fixed provisional restoration during the healing period (Fig 7-4b). Long-term, metal-reinforced provisional restorations were fitted on these teeth (Fig 7-4c). The maxilla required bilateral sinus elevation to be performed first. The shadows in both maxillary sinuses, particularly the right, presented additional problems. In the mandible, a post-extraction healing time of 2 months was to be followed directly by SimPlant planning and preparation of implant placement (Fig 7-4d).

Diagnostic tools

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- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Dental treatment including extractions
2. Bilateral sinus lift and implant placement in the mandible
3. Implant placement in the maxilla
4. Exposure and definitive prosthetic loading



Fig 7-4a Panoramic radiograph before dental treatment.



Fig 7-4b Panoramic radiograph with the long-term provisional restorations.

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Fig 7-4c Fixed provisionals, each supported on three teeth in the maxilla and mandible.

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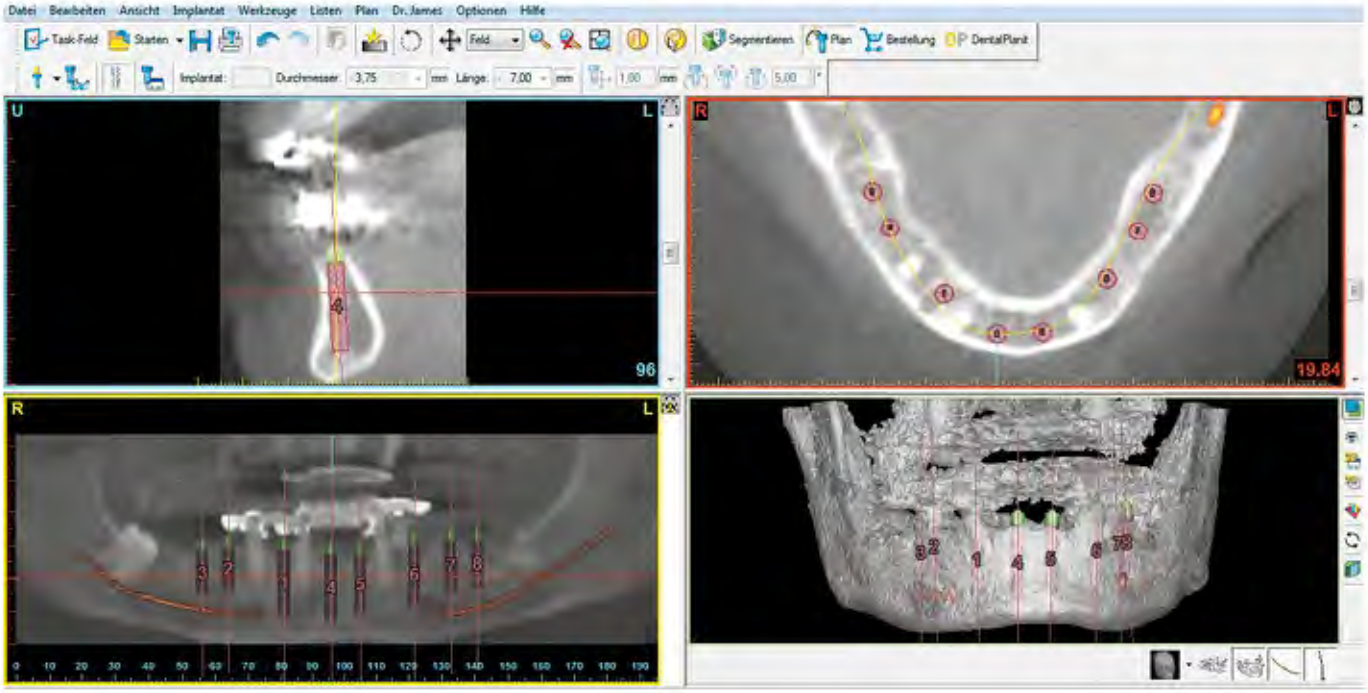


Fig 7-4d SimPlant planning for the mandible.

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Fig 7-4e Sinus elevation.

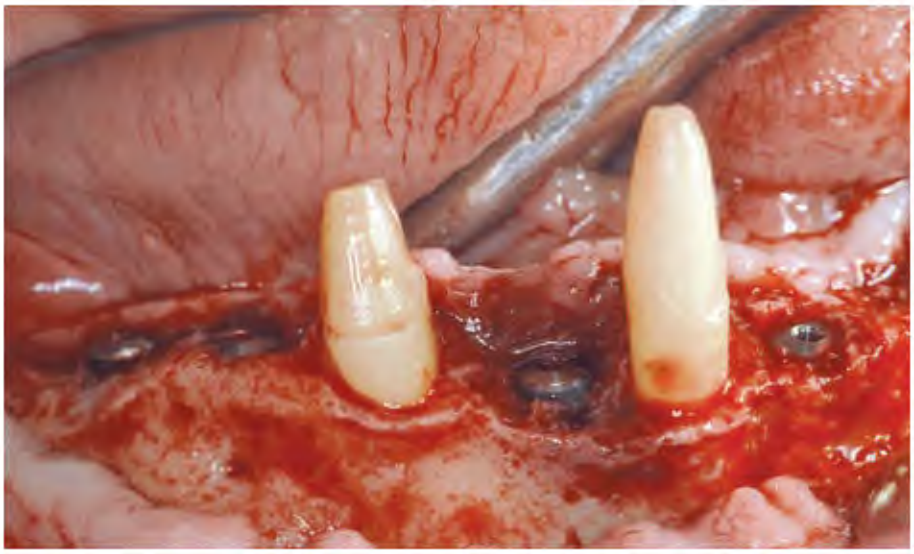


Fig 7-4f Implant placement in the right mandible.

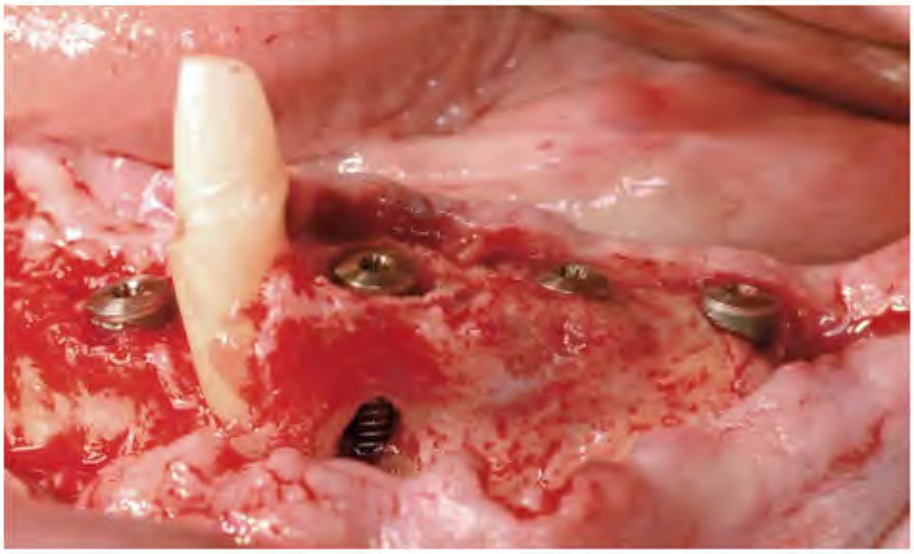


Fig 7-4g Implant placement on the left side of the mandible.

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Working under general anesthesia, the sinus floor augmentation was performed on each side of the maxilla, as planned (Fig 7-4e). Directly afterwards, implants 42, 44, 46 and 47 were inserted into the right side of the mandible (Fig 7-4f). The bone defects (especially around implant 44) were augmented with the harvested bone chips and a Bio-Gide (Geistlich) membrane. Only the canine remained in the left side of the mandible, so that one implant was placed in the anterior mandible and three in the posterior mandible (Fig 7-4g). In addition to the marginal defect, which remained after the extraction, implant 34 also showed an apical fenestration (Fig 7-4g). Augmentation was performed around all the implants.



Fig 7-4h The maxilla before implant placement.



Fig 7-4i Visible residual ridge defects following removal of the fixed provisional bridge.

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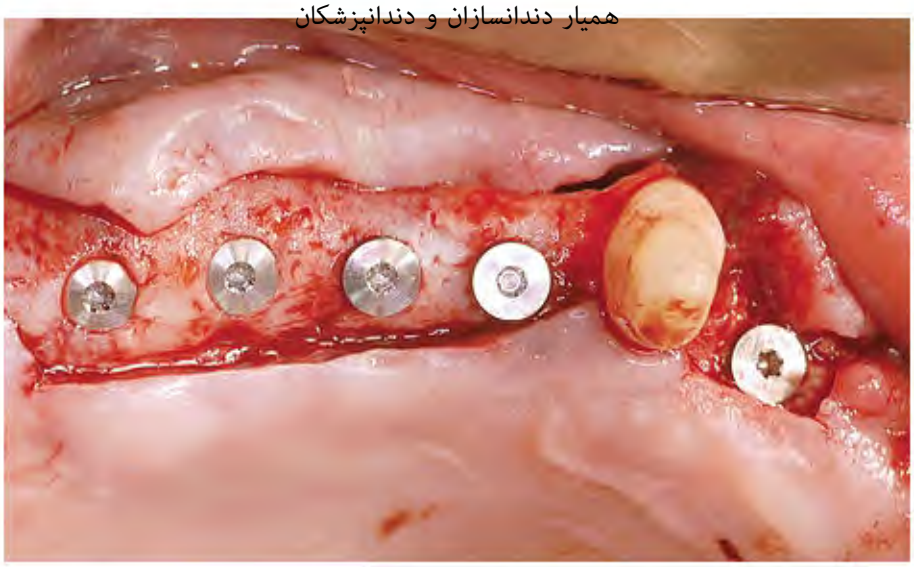


Fig 7-4j Implant placement on the right side.

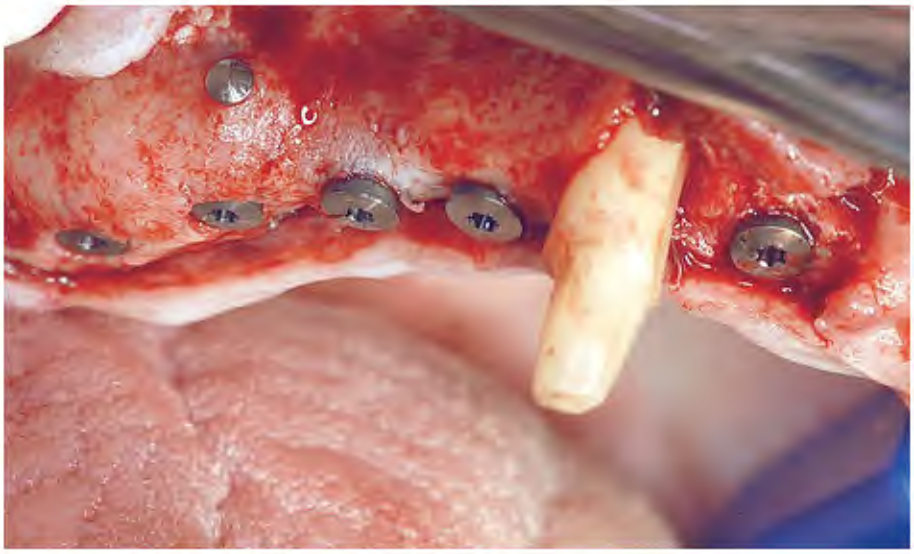


Fig 7-4k Implant positioning has been used to compensate for differences in residual ridge height.

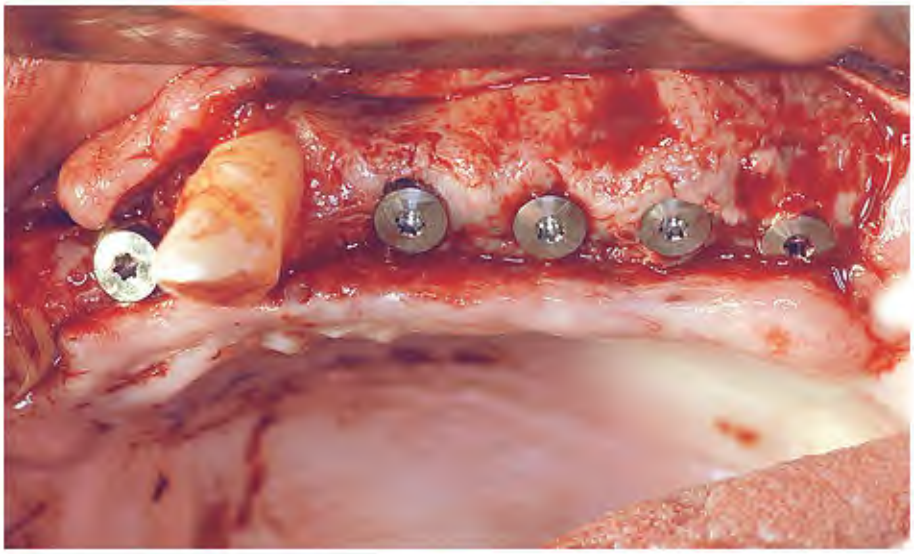


Fig 7-4l Implant placement on the left side.

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Fig 7-4m Panoramic radiograph after the implantation.

Implant placement in the maxilla

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Eight months after the sinus elevation, the maxilla was ready for implant placement (Fig 7-4h). Pronounced bone defects were apparent as a result of the prior dental treatment and extractions, especially in the anterior segment (regions 12, 11 and 22; Fig 7-4i). On the right side, the implants were distributed so that one was placed into the position of the lateral incisor and another four in the posterior region (Fig 7-4j). On the right side, the residual ridge presented a well-defined tuberosity and molar segments, but an already severely atrophied premolar region (Fig 7-4k). Whereas the shoulders of the anterior implant protruded a little above bone level, the posterior ones lay slightly below the crest. Augmentation was performed around the anterior implants. The implants on the left side were positioned as a near-mirror image of those on the right (Fig 7-4l); augmentation was also needed here. The postoperative panoramic radiograph shows the positioning of the implants (Fig 7-4m).

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Fig 7-4n Thin mucosa and slight perforations over the implants.

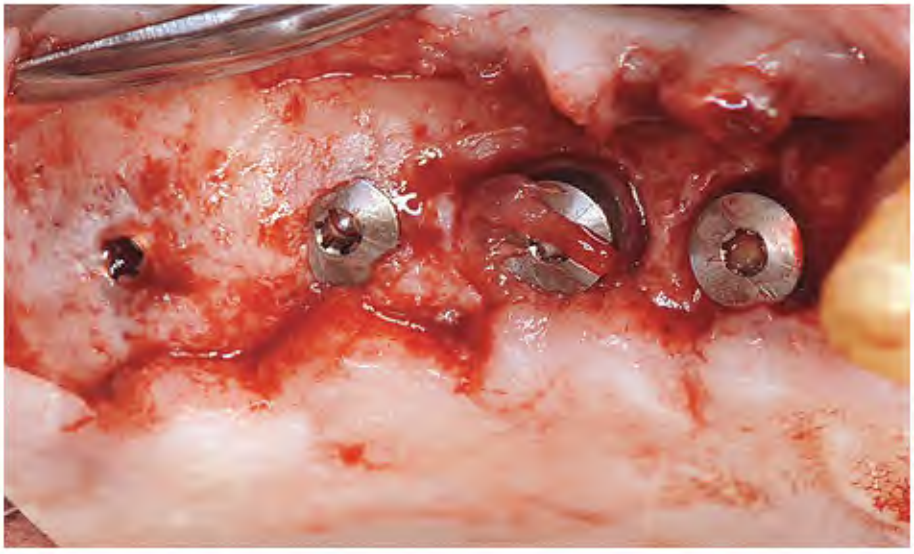


Fig 7-4o Distal implants overgrown with bone and peri-implantitis around the mesial implants.

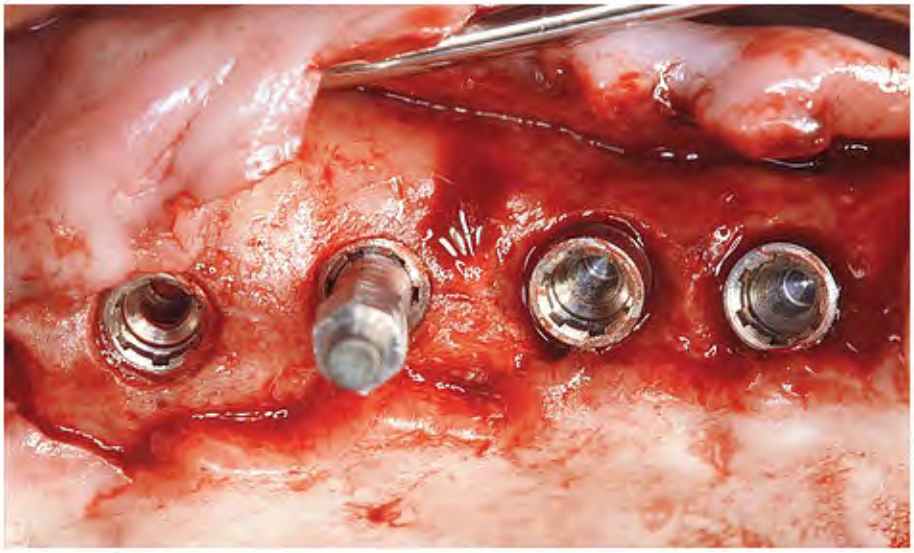


Fig 7-4p Measuring implant stability with resonance frequency analysis.

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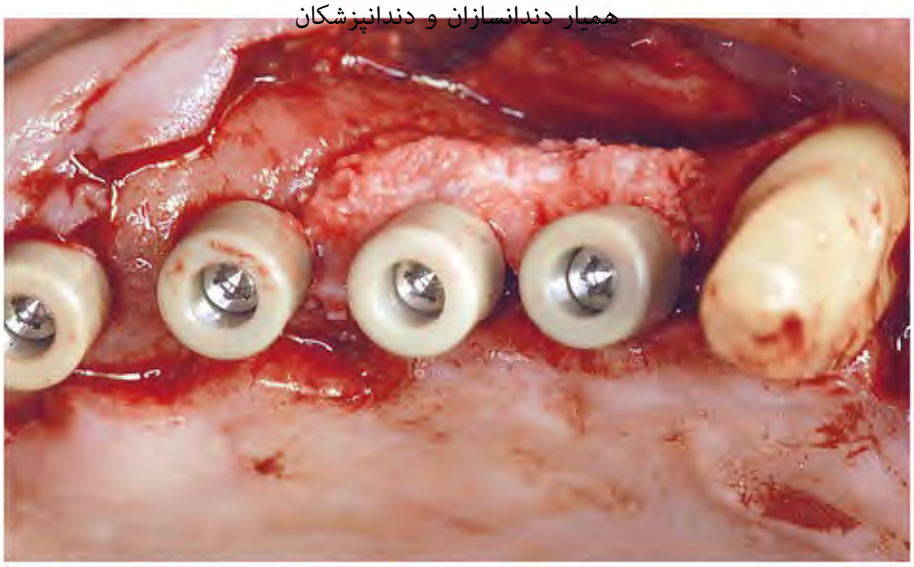


Fig 7-4q Augmentation of the defects at the time of exposure.

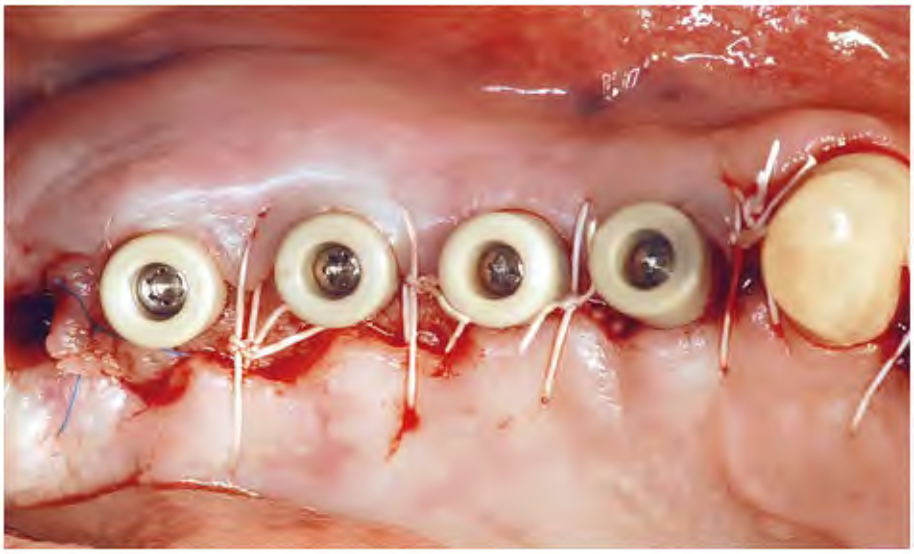


Fig 7-4r Widening the zone of attached gingiva.

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Exposure in the maxilla

All the implants were exposed 7 months after implant placement in the maxilla. Although the patient had not been wearing a removable denture at the time, the mucosa above the implants appeared to be perforated already (Fig 7-4n). The consequences of a perforation with an inflammatory component can be seen in Figure 7-4o. Whereas the posterior implants were partly covered with bone, funnel-shaped defects were visible around the anterior ones. These defects had filled with granulation tissue, which had to be carefully removed (Fig 7-4p). During the exposure operation, the stability of the implants was measured with resonance frequency analysis (Osstell Mentor; Osstell). The values were good, with no marked differences: going from region 17 to 14, they were 77, 80, 75 and 78, respectively. After cleaning, the defects were filled with hydroxylapatite (Ostim; Heraeus Kulzer) and the healing abutments screwed into place (Fig 7-4q). The labial/buccal flap was adapted to the abutments

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and fixed into place with sutures (Fig 7-4r).

Note on split-thickness flaps and roll flaps

On the left side, a pedunculated subepithelial graft was taken from the palate. A deep incision was made obliquely to the palate (Fig 7-4s) and a split-thickness flap approximately 10 mm in depth was created (Fig 7-4t). Heavier bleeding from the palatine artery region is to be expected with this kind of deep dissection. The lower part of the flap was separated from the bone, together with the periosteum at a depth of about 7 to 10 mm and dissected away in a coronally directed way (Fig 7-4u). The two parts of the flap were cleanly separated over the implants (Fig 7-4v). The long labial/buccal flap was prepared for rolling (Fig 7-4w). The healing abutments were fitted onto the implants and the labial/buccal flap adapted to their surfaces in the form of a roll flap (Fig 7-4x) and fixed into place with sutures (Fig 7-4y). This would later result in a wide zone of attached gingiva on the labial/buccal side (Fig 7-4z).

All the implants in the maxilla had undergone osseointegration and were exposed using the technique for widening the zone of keratinized gingiva (Fig 7-4aa).

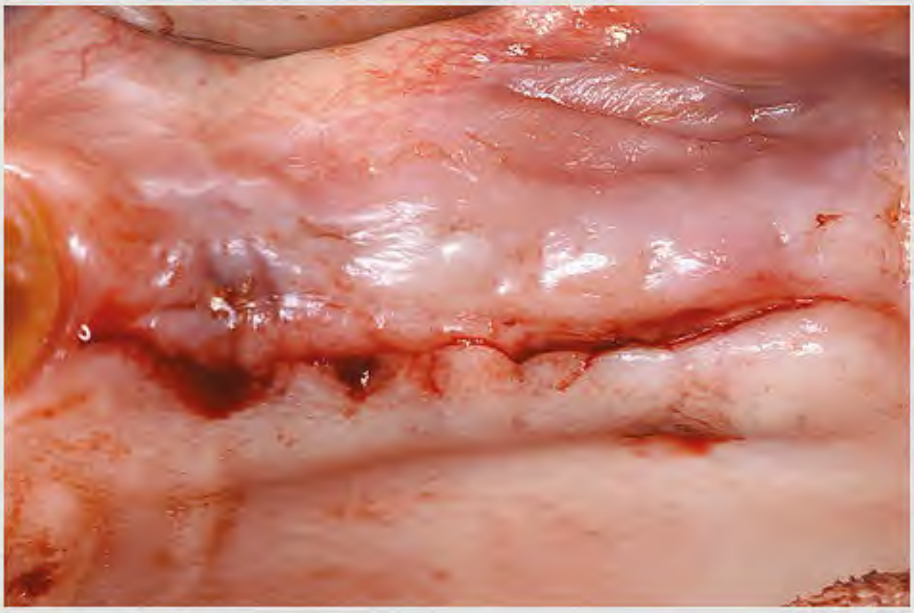


Fig 7-4s Incision for the pedunculated subepithelial graft.

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Fig 7-4t Creating the split-thickness flap.

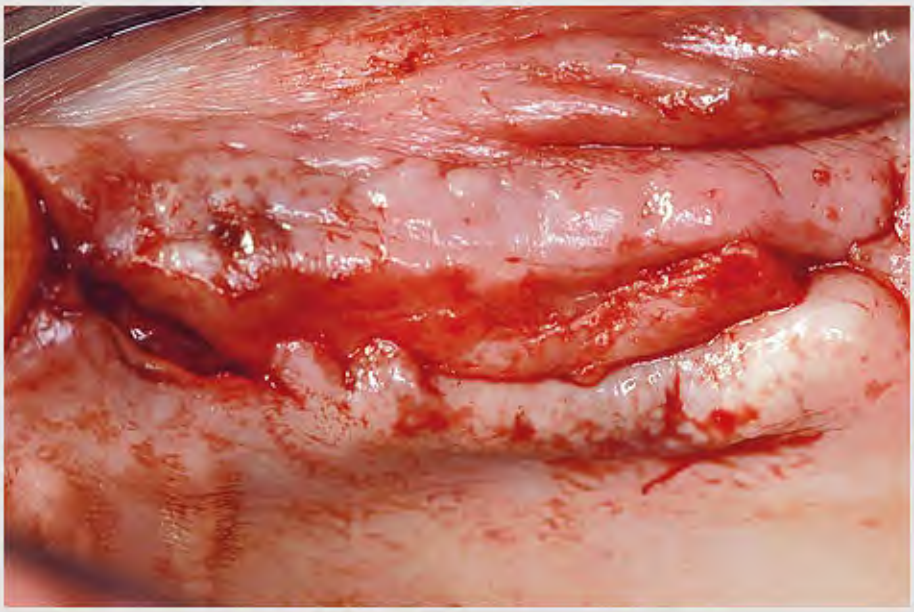


Fig 7-4u Separating the lower split-thickness flap with periosteum from the bone.

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Fig 7-4v Dividing the flaps.

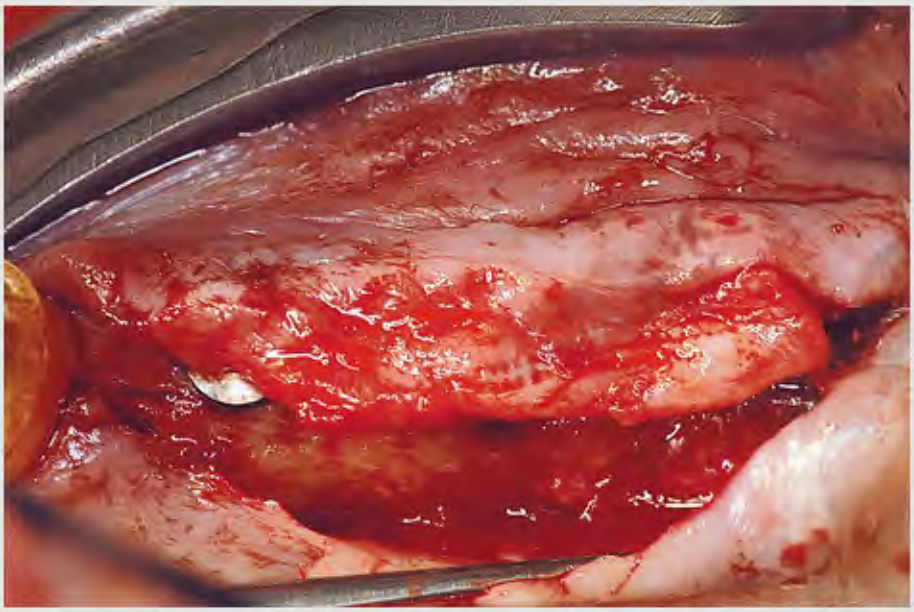


Fig 7-4w Preparing the labial/buccal roll flap.

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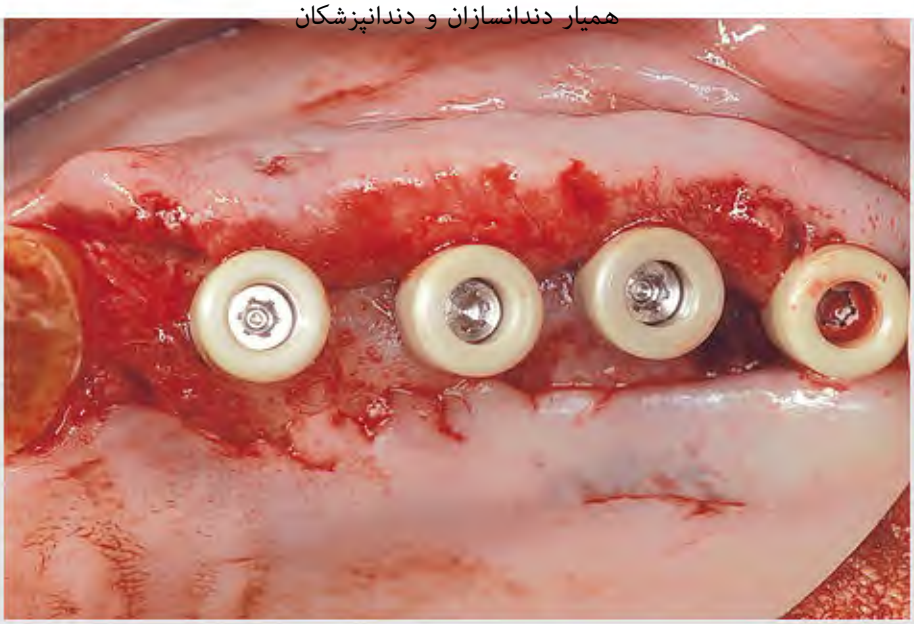


Fig 7-4x Healing abutments screwed into place to act as supports.

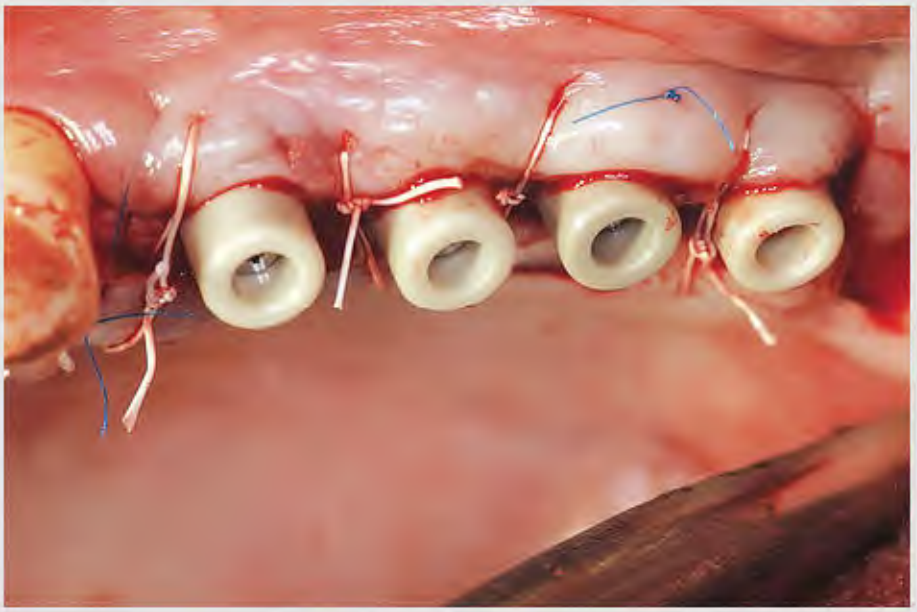


Fig 7-4y Fixing the flap into place with sutures.

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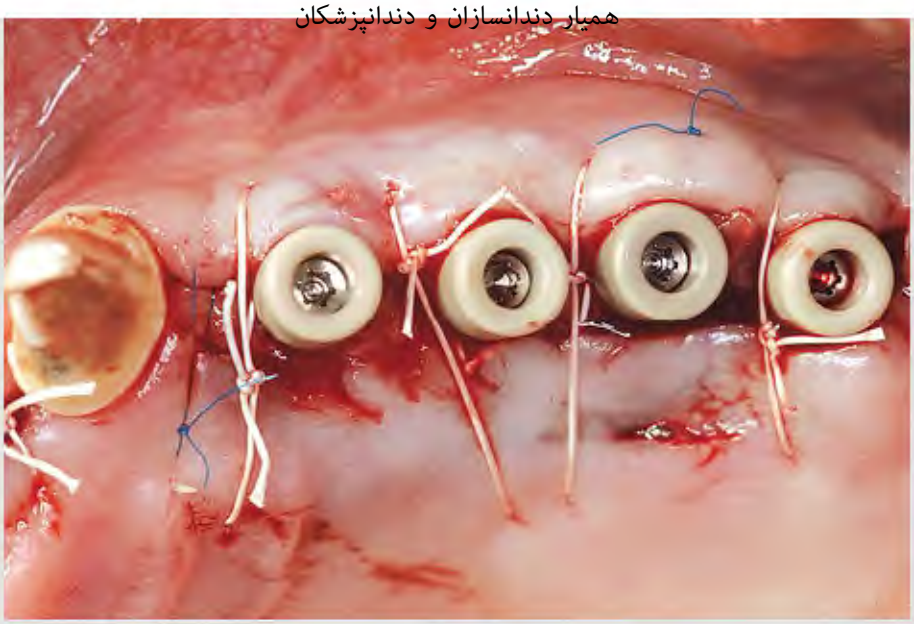


Fig 7-4z Widened the zone of attached gingiva.

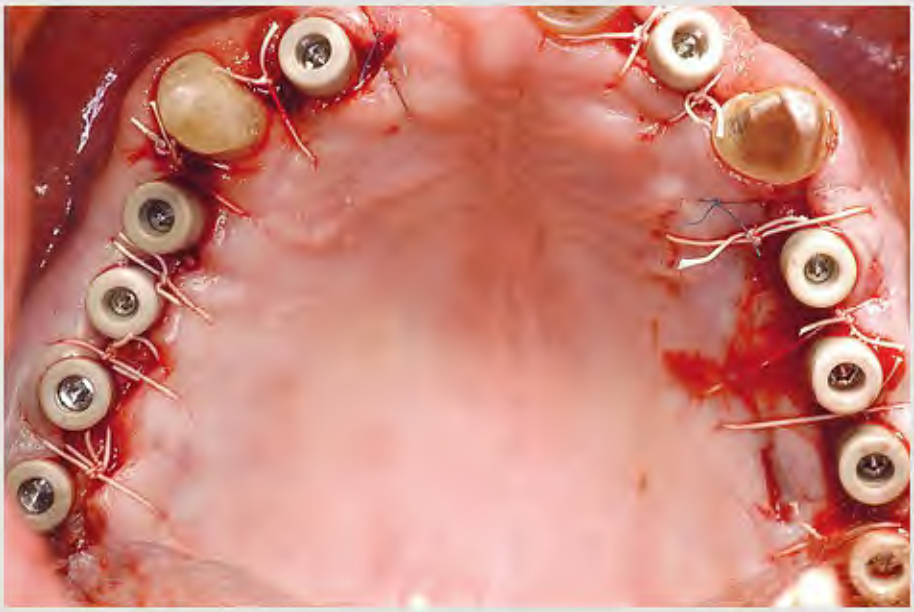


Fig 7-4aa Maxilla after the exposure.

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Fig 7-4bb More than successful augmentation in the anterior mandible.

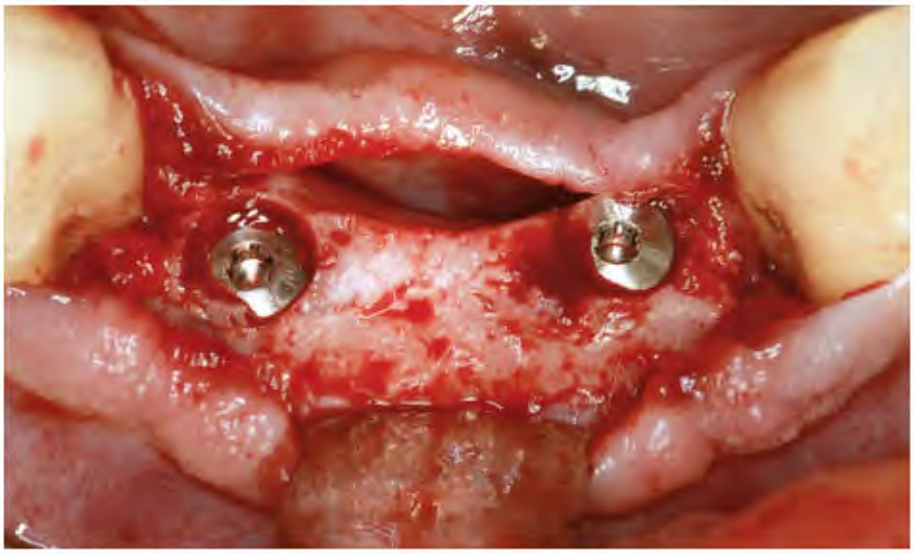


Fig 7-4cc Reaming the bone away from the implants.

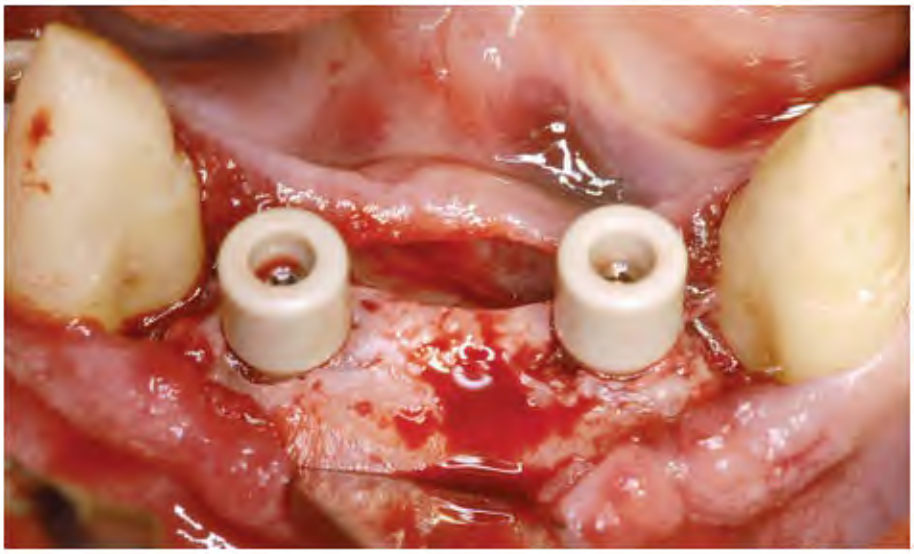


Fig 7-4dd Healing abutments screwed into place.

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Fig 7-4ee Check panoramic radiograph with the abutments in place.



Fig 7-4ff Screw-retained, metal-ceramic fixed bridges in both jaws.

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Exposure in the mandible

The eight implants in the mandible were also exposed during the same session, after a healing period of 15 months. The augmentation had been particularly successful in the anterior segment (see Fig 7-4d and 7-4bb). The implants were so overgrown with new bone that they had to be located first and the bone reamed away to expose them (Fig 7-4cc). When screwing on the healing abutments, care was needed to ensure that they were not collided with the bone margins at the sides (Fig 7-4dd).

Prosthetic restoration

Customized abutments were fabricated on all the implants and their fit checked with a

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panoramic radiograph (Fig 7-4ee). A horizontal, screw-retained attachment was incorporated into each quadrant to ensure secure fixation of the superstructure. All the implants in the maxilla and mandible were prosthetically loaded with metal-ceramic fixed restorations, divided at the midline (Fig 7-4ff). The four fixed bridges were screwed onto the implants, allowing the dentist to remove them easily at any time.

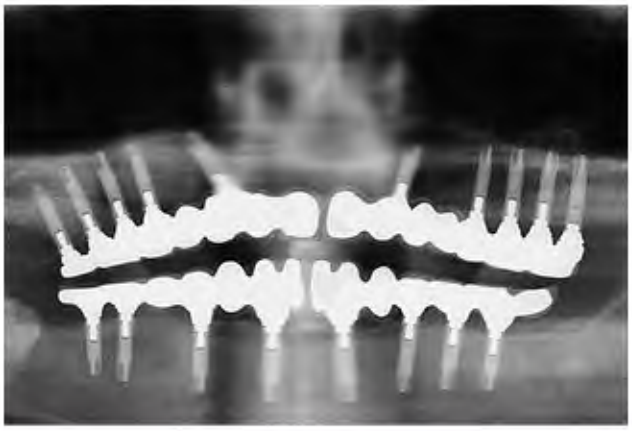


Fig 7-4gg Follow-up panoramic radiograph taken after 8 years.

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Fig 7-4hh Near-natural appearance of the restoration on the left side.

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Fig 7-4ii Short implant crowns on the right side.



Fig 7-4jj Secondary diastema between the two fixed bridges in the maxilla.

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Continued follow-up

The bone situation after 8 years appears to be stable on the panoramic radiograph (Fig 7-4gg). The volume gained with the sinus elevation appears to have changed little during this time. An incidental finding made on this occasion was that the screw of implant 27 was missing and that a gap had opened up there. The fixed restorations on the left side, in both jaws, look comparatively natural in the molar region (Fig 7-4hh). On the right side, the distance between the jaws is very small and the implant crowns appear correspondingly short (Fig 7-4ii). One facet has broken off on the mandibular side. The overall picture after 8 years is satisfactory, apart from an imminent (and necessary) professional cleaning session (Fig 7-4jj). It is interesting to note that a diastema has formed between the front teeth, which was not detectable at the time of fitting (see Fig 7-4ff).

Treatment course

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- Dental treatment including extractions (2003)
- 2 months to bilateral sinus elevation and implant placement in the mandible
- 8 months to implant placement in the maxilla
- 7 months to exposure of all the implants
- 3 months to the final prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Atypical treatment course – problematic baseline situation

Sinus elevation, subsequent implant placement without immediate prosthetic loading

Baseline situation

A 55-year-old man, who is a heavy smoker (20 to 30 cigarettes a day), was complaining of inadequate dental prostheses in his maxilla and mandible and wanted to know if a fixed restoration was an option (Fig 7-5a). Although his four mandibular incisors were still in relatively good condition, they stood in the way of a fixed restoration and needed to be extracted before implant placement (Fig 7-5b). The panoramic radiograph showed severely pneumatized maxillary sinuses on both sides, so that implant placement in the maxilla would not be possible without prior sinus elevation (Fig 7-5c). In this radiograph, the mandible appeared to be in very good condition; in particular, it was of sufficient height in the interforaminal region. The width of the residual ridge, however, was apparent only in the CBCT scan (Fig 7-5d). This showed it to be very narrow and that a reduction in the height of the residual ridge plus augmentation around the implants would be needed in addition to implant placement.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT

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- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus elevation and implant placement in the mandible
2. Implant placement in the maxilla
3. Exposure in the maxilla and mandible
4. Prosthetic loading



Fig 7-5a Inadequate dental prostheses before treatment.



Fig 7-5b Clinical baseline situation.

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Fig 7-5c Panoramic radiograph before treatment.

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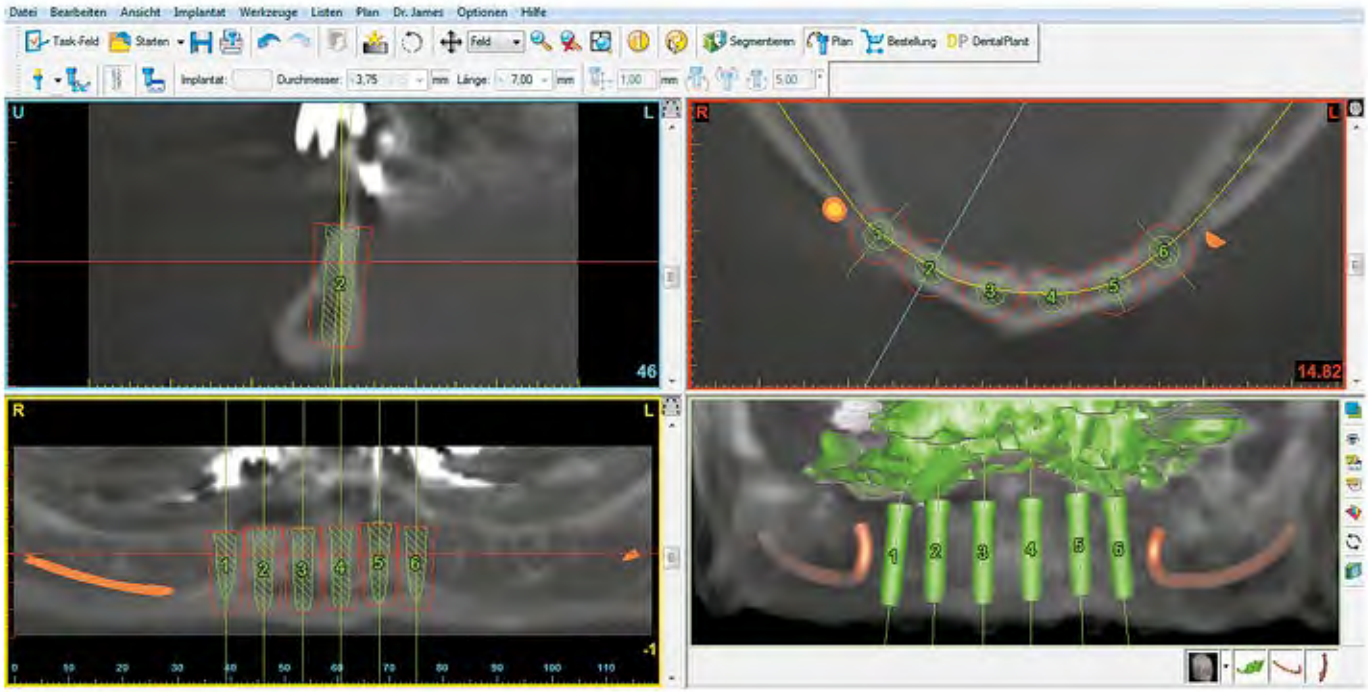


Fig 7-5d SimPlant planning for the mandible.

Implant placement in the mandible and sinus elevation

The operation took place under general anesthesia, starting with the mandible.

Attention: ***This sequence (mandible before maxilla) has been shown to be favorable for***

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the following reason: when preparing bone beds for the implants in the mandible, it is often possible to collect larger quantities of bone chips with a filter, allowing them to be used for lateral augmentation of the maxilla. When doing so, it must be kept in mind that these bone chips are frequently contaminated with saliva and are not suitable for adding to the bone substitute (eg, Bio-Oss; Geistlich) used for sinus elevation, as they can infect it.

The anterior teeth and the remaining root of tooth 33 were extracted, the residual ridge was exposed and the top smoothed with a large reamer. Six implant beds were prepared in the interforaminal segment, and just as many 17-mm long implants were inserted. While the residual ridge was high, it was also very narrow, so that the screw threads of most of the implants were uncovered on the labial/buccal side (Fig 7-5e). The ridge was particularly narrow on the right side; for this reason, almost the full lengths of the implants in this area were exposed on the lingual sides (Fig 7-5f). Accordingly, it was not possible to harvest as much bone as usual in this case, and most of this bone was used up for the augmentation in the mandible. Immediate loading of the implants with an implant-supported provisional restoration had to be avoided. The augmentation was performed with the harvested bone chips and Bio-Oss. A BioGide (Geistlich) membrane 30 × 40 mm in size was used to cover the augmentation. Following saliva-proof suturing of the operation site, work began on the maxilla.

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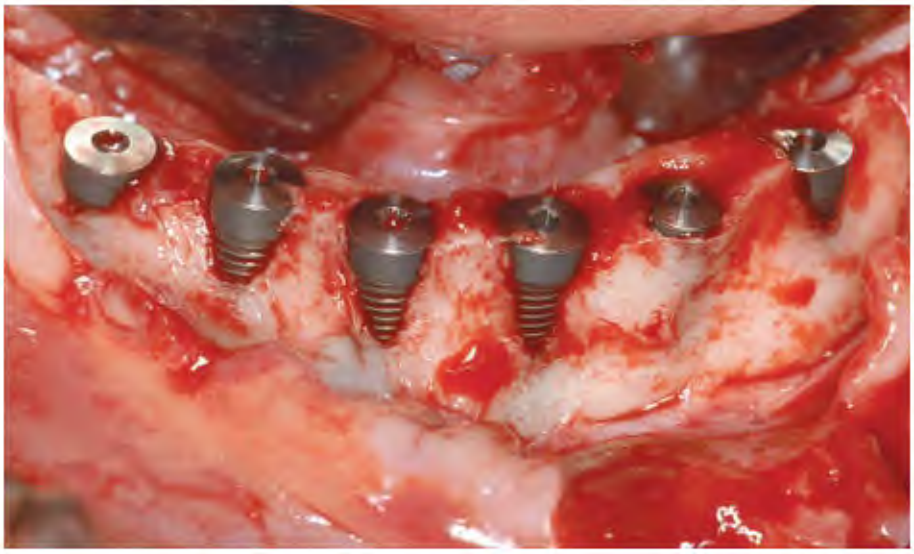


Fig 7-5e Visible screw threads on the labial/buccal side of almost all the implants.

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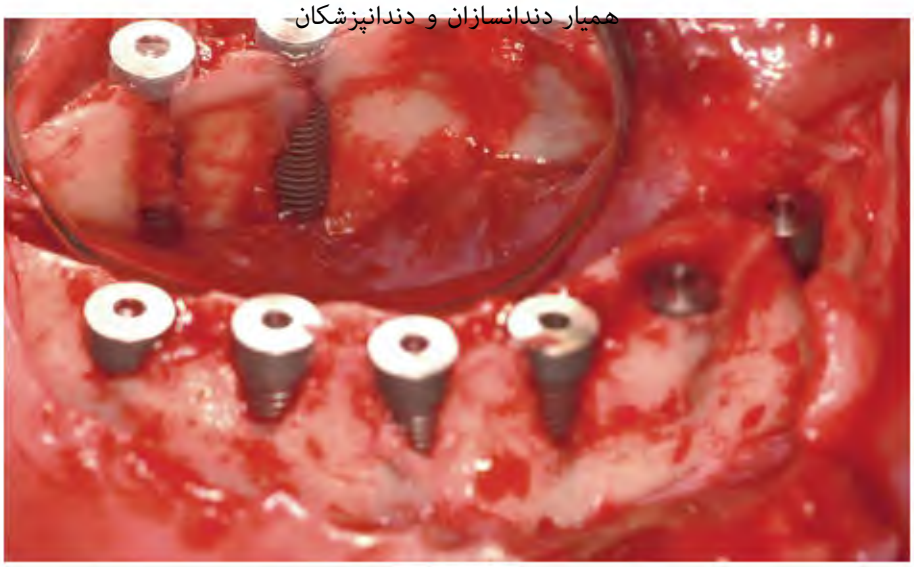


Fig 7-5f The screw threads on the lingual side are also exposed.

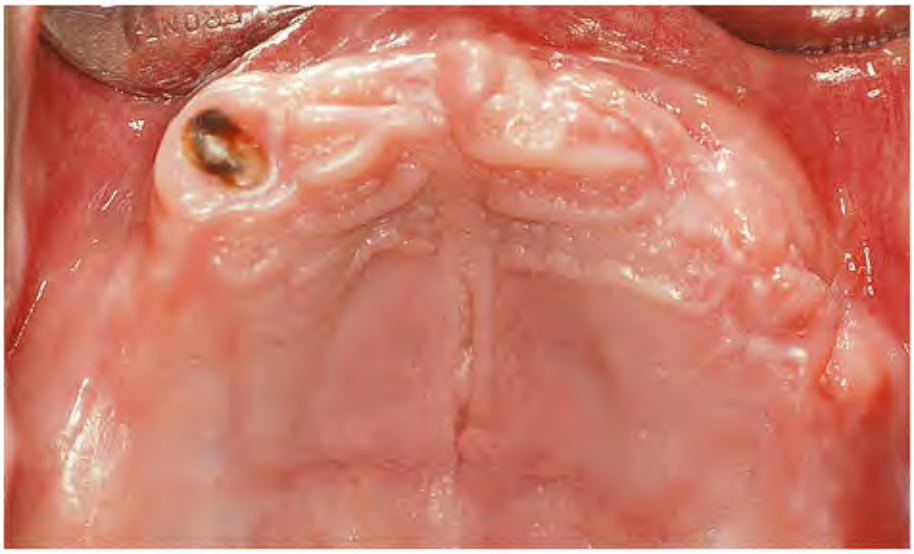


Fig 7-5g Maxilla before sinus elevation.

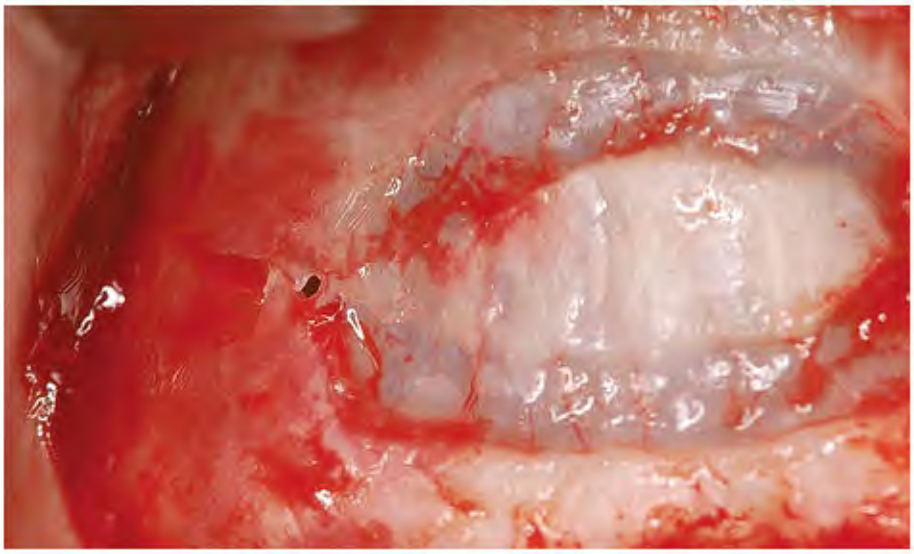


Fig 7-5h Perforation of the maxillary sinus mucosa during fenestration.

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Fig 7-5i The mucosa has been carefully elevated.

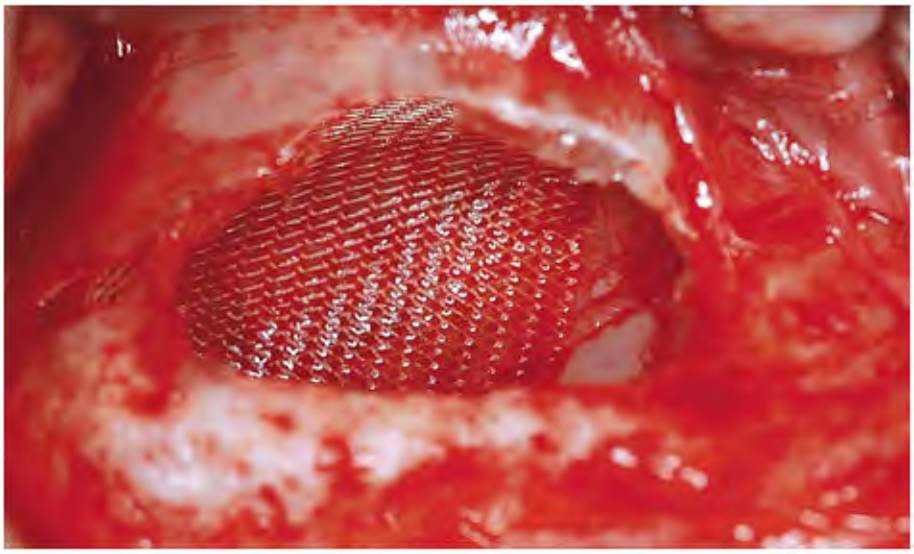


Fig 7-5j Sealing the perforation.

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After infiltration anesthesia was induced, root 13 was extracted and the fenestration prepared for the sinus elevation on the right side (Fig 7-5g). The patient is of very slender, almost asthenic build, and has a bone structure to match. The outer wall of the maxillary sinus was so thin that the periosteal elevator fell into the maxillary sinus during the dissection (Fig 7-5h), causing direct perforation of the sinus mucosa. Extremely careful dissection was needed to prevent the perforation from spreading any further (Fig 7-5i). The perforation was covered with Vicryl mesh (Ethicon), to stop the graft material from escaping into the maxillary sinus (Fig 7-5j). The prepared cavity was filled with Bio-Oss (Fig 7-5k) and the window closed with a membrane. The left maxillary sinus was divided by a septum, making dissection more difficult (Fig 7-5l). A perforation occurred despite the increased care exercised while detaching the membrane (Fig 7-5m). However, the perforation was kept within limits, allowing the mucous membrane to be elevated over the septum (Fig 7-5n). After the augmentation material was introduced, the window was sealed with a Bio-Gide membrane and the operation site sutured closed. A healing period of 9 months was scheduled. The postoperative panoramic

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radiograph clearly shows the distribution of the implants in the mandible, in contrast to the sinus elevation in the maxilla (Fig 7-5o). The patient wanted to keep tooth 38 at any cost.

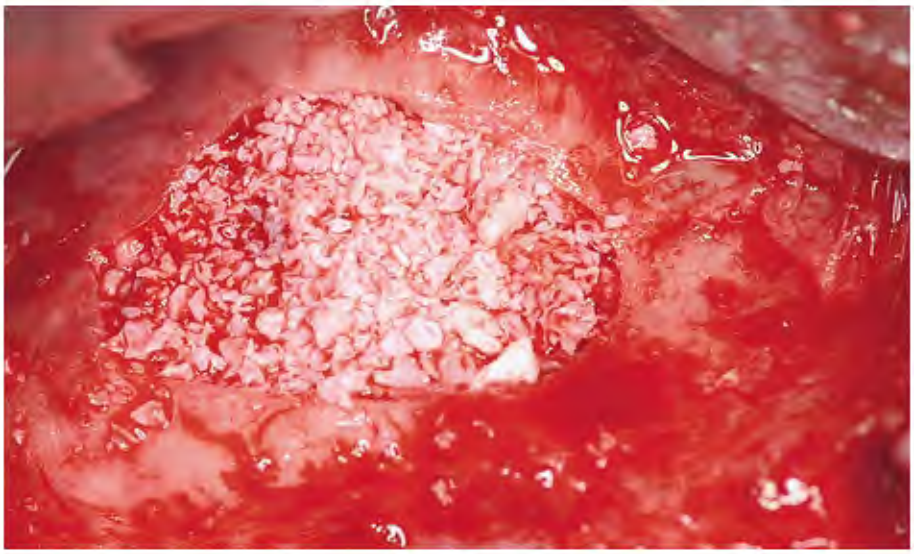


Fig 7-5k Filling the cavity.

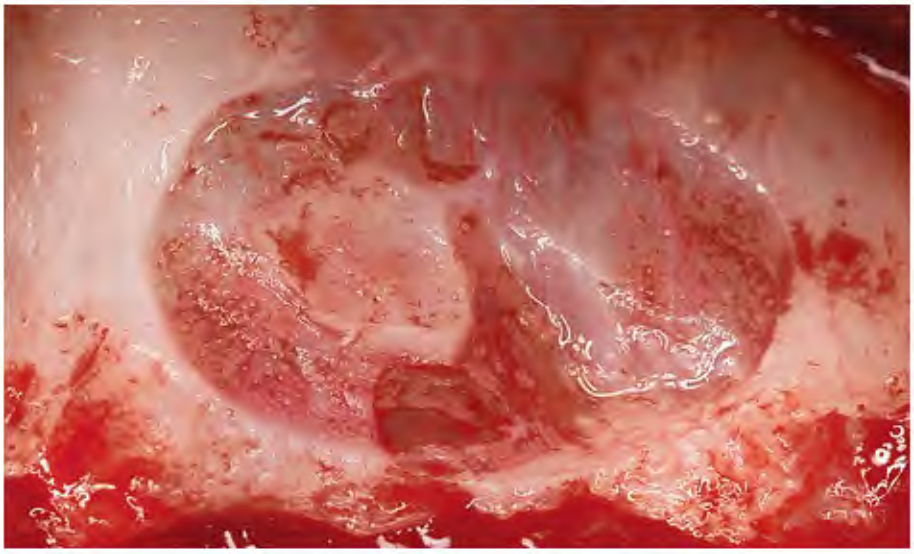


Fig 7-5l Fenestration of the left maxillary sinus.

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Fig 7-5m Perforation of the maxillary sinus mucosa at the septum.

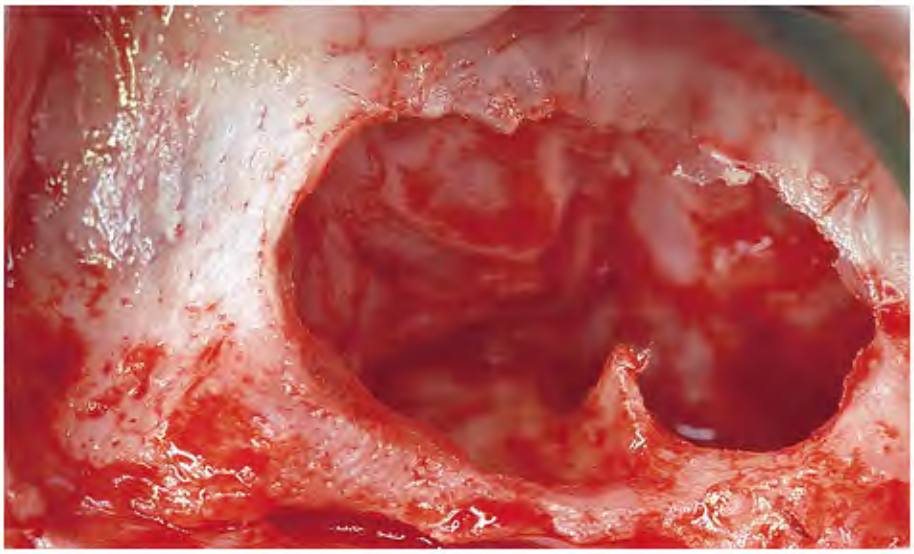


Fig 7-5n The mucosa has been lifted.



Fig 7-5o Panoramic radiograph after the operation.

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Fig 7-5p Exposed distal implants in the mandible.

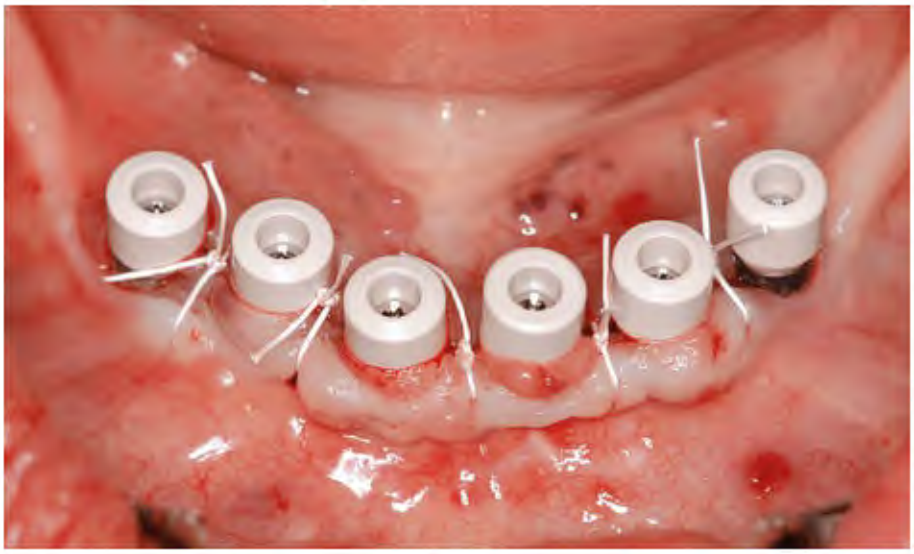


Fig 7-5q Healing abutments screwed into place.



Fig 7-5r Screw-retained cantilever bridge as the definitive restoration in the mandible.

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Fig 7-5s Maxilla before implant placement.

Exposure in the mandible

Since a 9-month healing phase was scheduled for the maxilla, versus only 6 months for the mandible, exposure of the implants in the mandible was given priority. The two distal implants were already exposed, and only the four anterior implants still remained to be uncovered (Fig 7-5p). After polyetheretherketone (PEEK) healing abutments were screwed onto the implants, the gingiva was stabilized with sutures (Fig 7-5q). The screw-retained fixed implant bridge 36 to 46 was incorporated after another 2 months (Fig 7-5r). At the patient's request, tooth 38 was still left in situ.

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Implant placement in the maxilla

Implant placement in the maxilla was ready to take place 9 months after the sinus floor augmentation (Fig 7-5s). Despite sinus elevation, the bone supply here was poor, making implant placement problematic. Five implants were inserted at anatomically favorable sites on the right side (Fig 7-5t). The bone chips harvested during the implant bed preparation were used for additional ridge augmentation, which was covered with a Tutodent (Tutogen) membrane (20 × 30 mm; Fig 7-5u). On the left side, the bone situation was even more problematic, allowing a maximum of three implants to be inserted in the molar region, which also had to be augmented (Fig 7-5v). A fourth implant (11 × 3.5 mm) was inserted at position 22.

Exposure

The implants in the maxilla were exposed after another 9 months. On the right side, the

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keratinized gingiva was forced from the palate to the labial/buccal vestibule (Fig 7-5w). The left side was exposed with two separate incisions in the molar region and at position 22 (Fig 7-5x). One month later, it was possible to complete the prolonged treatment with the prosthetic restoration (Fig 7-5y).

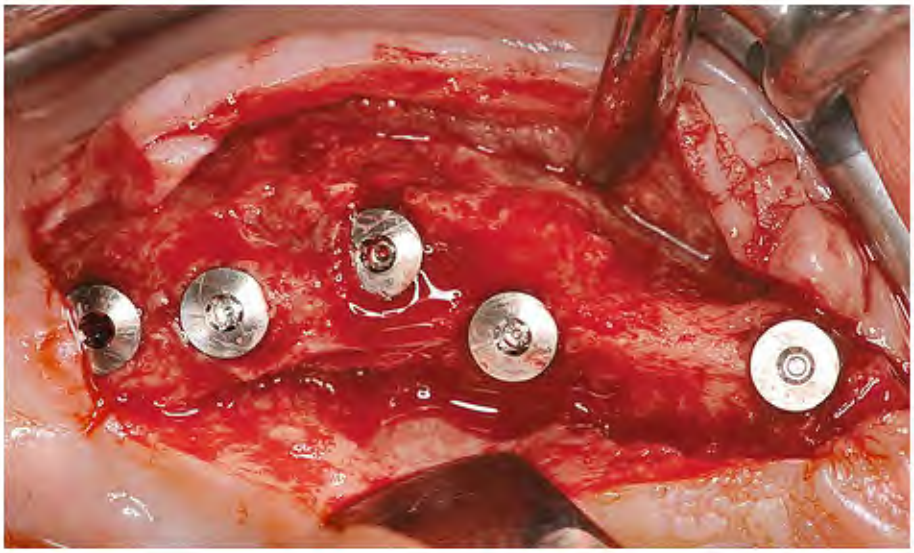


Fig 7-5t Implant placement on the right side.

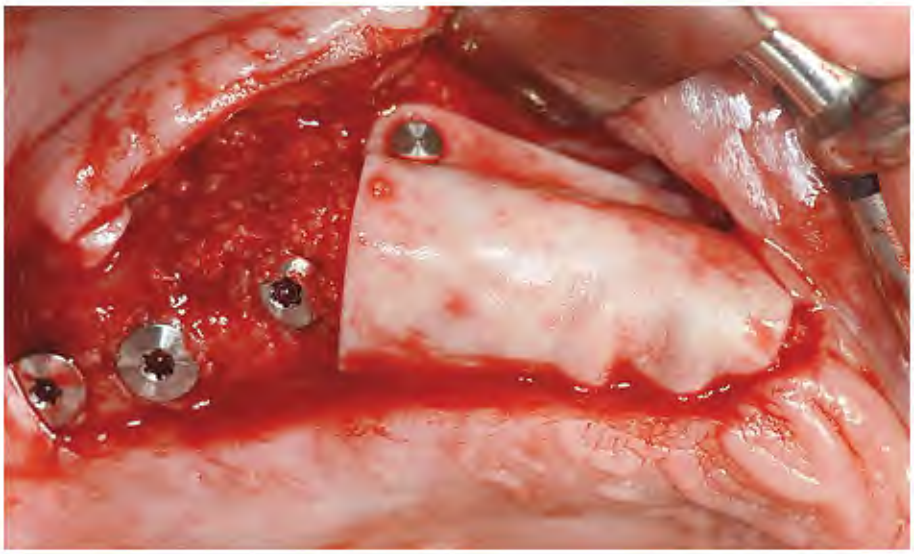


Fig 7-5u Subsequent augmentation.

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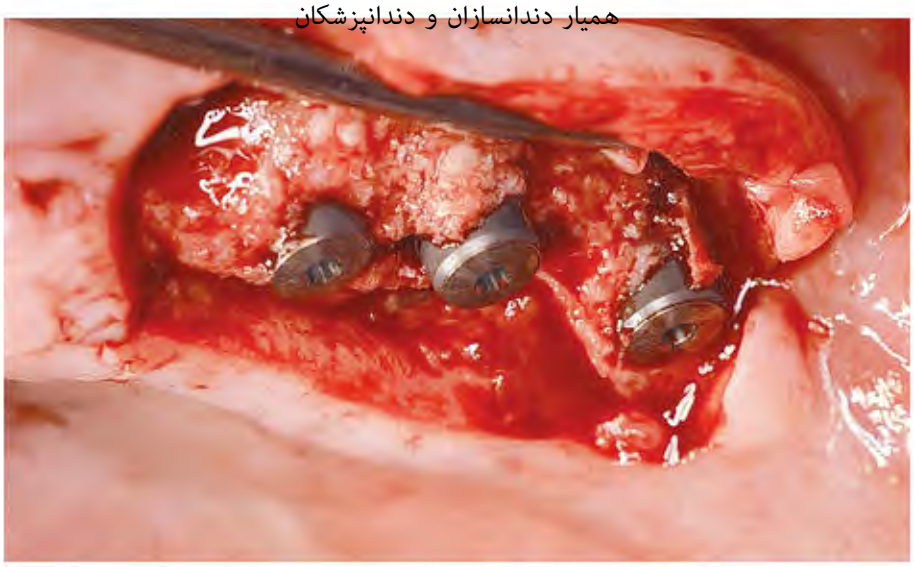


Fig 7-5v Problematic bone situation on the left side.

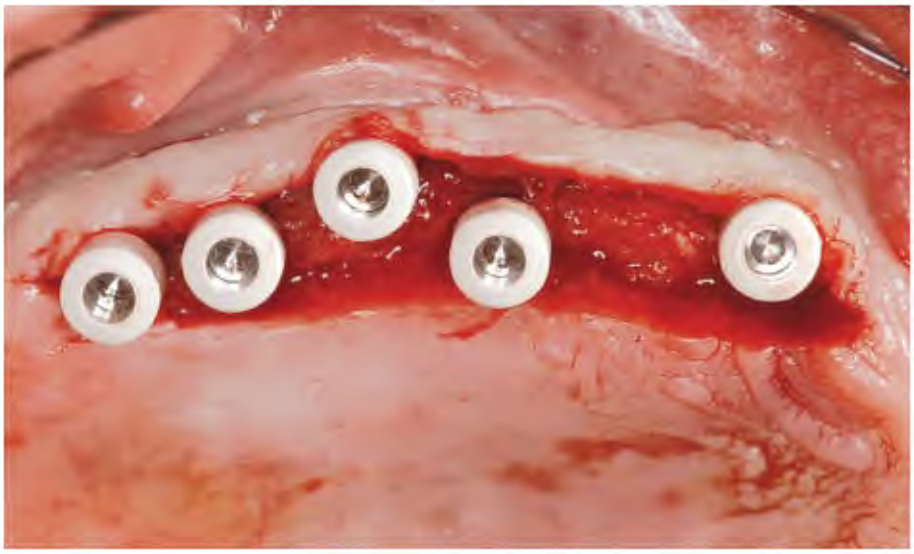


Fig 7-5w Widening the zone of attached gingiva.

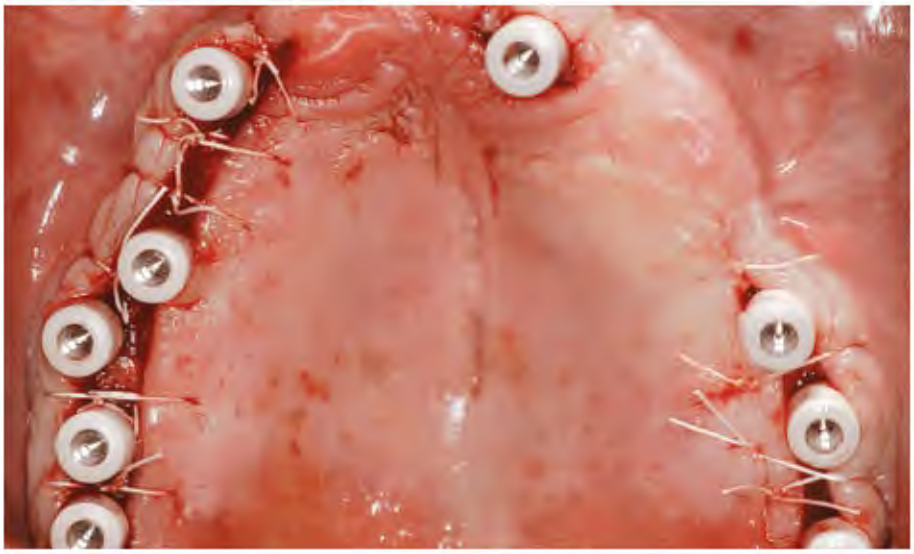


Fig 7-5x Maxilla after exposure.

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Fig 7-5y Clinical situation before taking an impression.

Prosthetic restoration and continued follow-up

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A titanium-based, occlusal screw-retained fixed implant bridge was fitted into the maxilla (Fig 7-5z). After 5 years, the bridge was unscrewed during a progress check. In doing so, it was found that the screw in implant 28 had fractured (Fig 7-5aa), and was replaced with a new one. Mild gingival inflammation requiring treatment was visible around implant 13 (Fig 7-5bb). A follow-up panoramic radiograph was taken after 5 years of functional use. In the maxilla, the bone situation was stable, but bone loss was apparent around implants 32 to 44 in the mandible (Fig 7-5cc). The patient continues to refuse extraction of his last tooth, number 38.

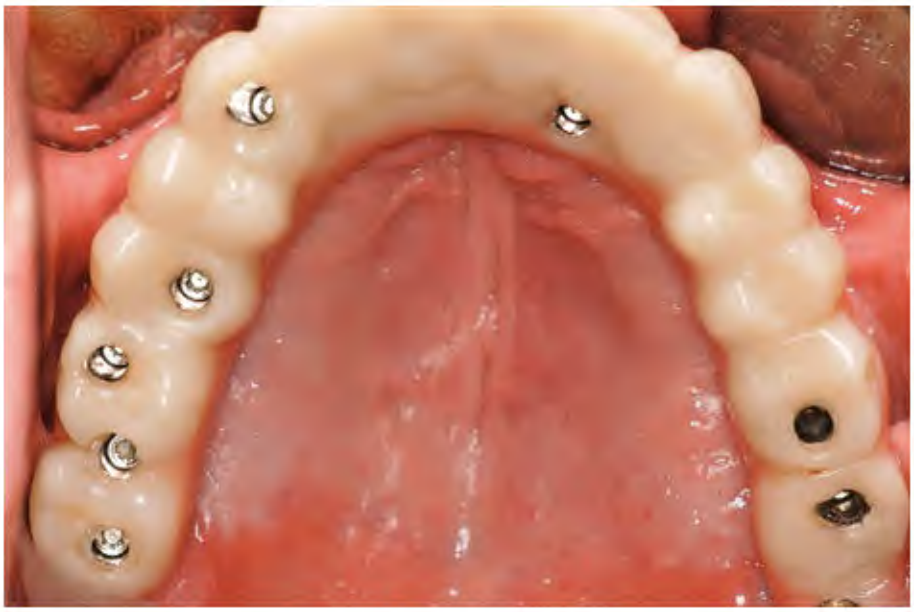


Fig 7-5z Occlusal, screw-retained cross-arch bridge in the maxilla.

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Fig 7-5aa Clinical situation after 5 years in functional use.



Fig 7-5bb Mild inflammation around implant 13 after 5 years.

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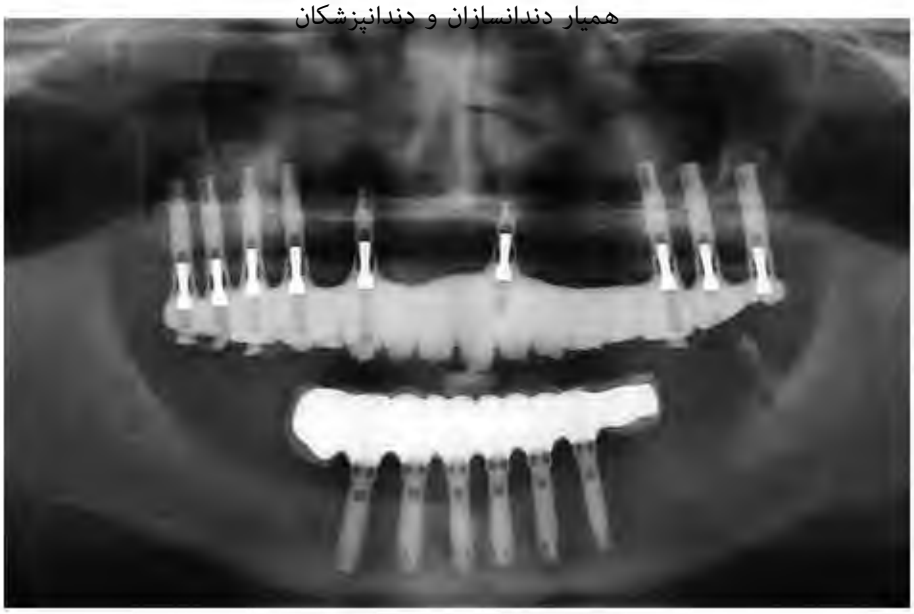


Fig 7-5cc Follow-up panoramic radiograph after 5 years.

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Treatment course

- Bilateral sinus elevation and implant placement in the mandible (2007)
- 6 months to exposure in the mandible
- 3 months to implant placement in the maxilla
- 9 months to exposure in the maxilla

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Atypical treatment course – problematic baseline situation

Switch from overdentures to implant-supported fixed restorations in both jaws

This atypical treatment course follows on from the 3D planning on page 518.

Baseline situation

This male patient still had five teeth per jaw, which were fitted with telescopic crowns

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(Figs 7-6a and 7-6b). Despite his high-quality overdentures, the patient wanted a fixed restoration in both maxilla and mandible. The teeth did not have a bad prognosis in the medium term, but ought to be extracted in due course (Fig 7-6c). The existing overdentures were to remain in use until the definitive superstructures were loaded onto the implants.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Bilateral sinus elevation and implant placement in the mandible
2. Implant placement in the maxilla
3. Exposure and definitive prosthetic restoration of both jaws



Fig 7-6a Anterior view of the maxilla.

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Fig 7-6b Occlusal view of the mandible.



Fig 7-6c Panoramic radiograph showing the baseline situation.

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Fig 7-6d Implant placement in the anterior, right mandible.

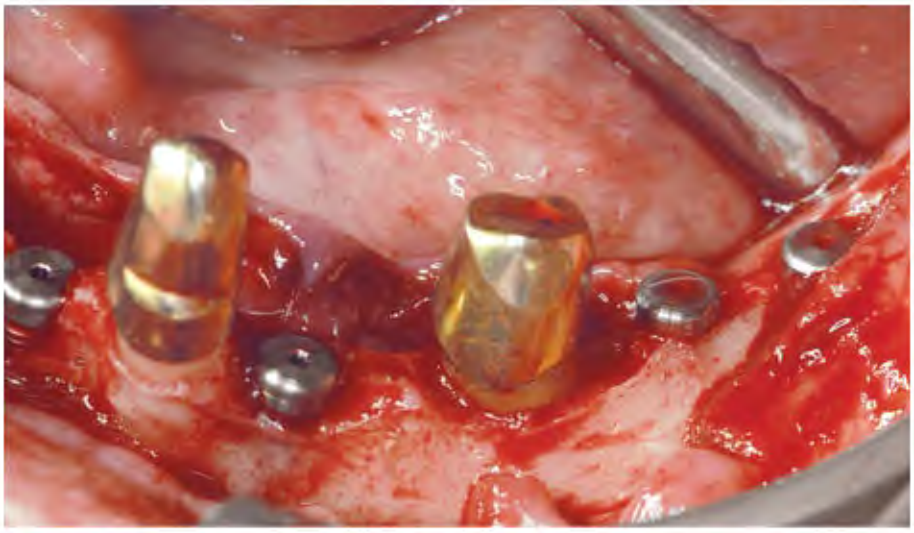


Fig 7-6e Implant placement in the left mandible.

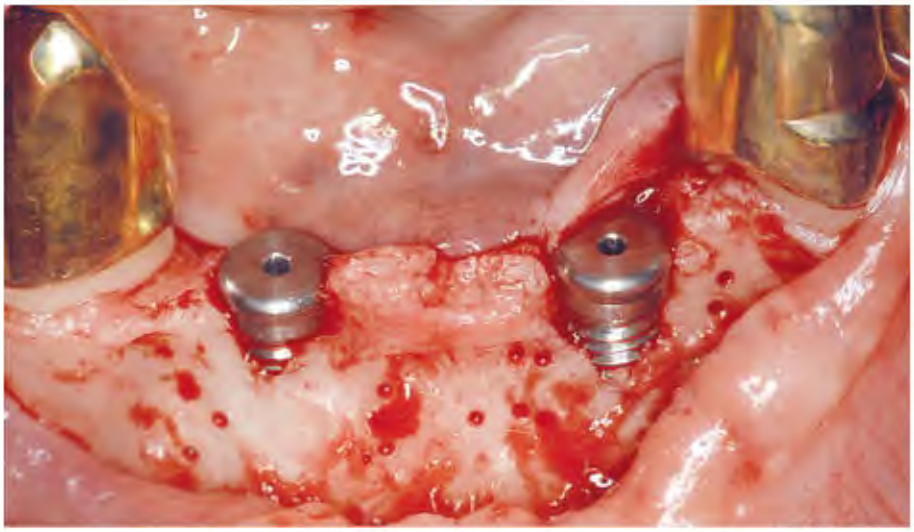


Fig 7-6f Visible implant threads before augmentation.

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Fig 7-6g The cortical bone has been perforated to improve the blood supply to the augmentation material.

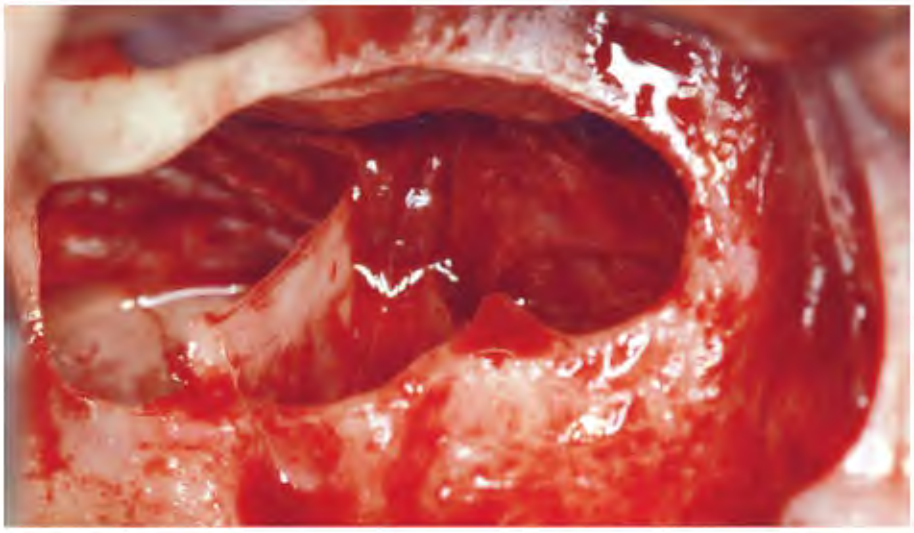


Fig 7-6h Bone septa in the right maxillary sinus.



Fig 7-6i Septa as seen in the mirror.

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Bilateral sinus elevation and implant placement in the mandible

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The mandibular implants were inserted first. Tooth 34 was in a strategically important location, and already needed to be extracted at this point, in accordance with the plan. Three implants were inserted at positions 44, 45 and 46 on the right side (Fig 7-6d). On the left side, tooth 34 was extracted and additional implants inserted in its place in regions 36 and 37 (Fig 7-6e). Two 18-mm long Brånemark System implants (Nobel Biocare) were inserted between the canines in regions 32 and 42 (Fig 7-6f). The residual ridge was very narrow in the anterior region and on the right side, and needed augmenting (Fig 7-6g).



Fig 7-6j Inserted implants on the “NanoBone” side.

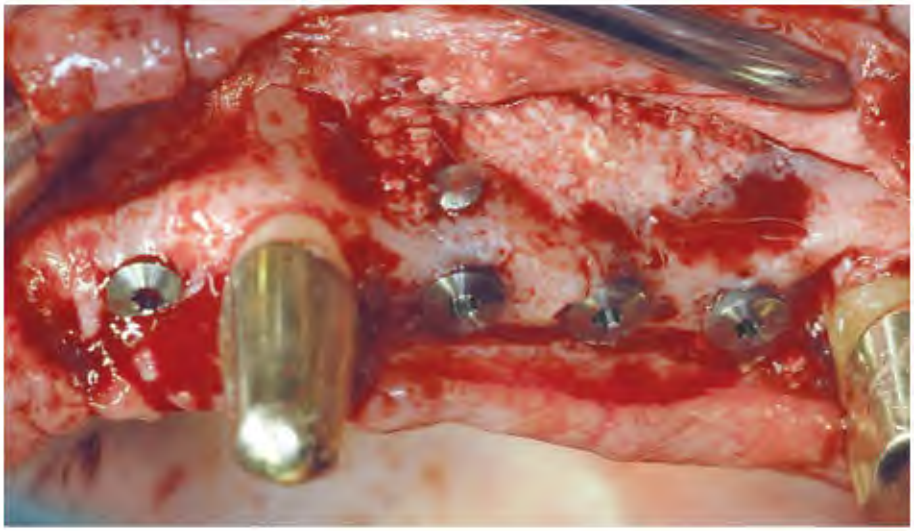


Fig 7-6k Inserted implants on the “Bio-Oss” side.

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Fig 7-6l Mandible before the exposure.



Fig 7-6m Small mucous perforations around the implants in the maxilla.

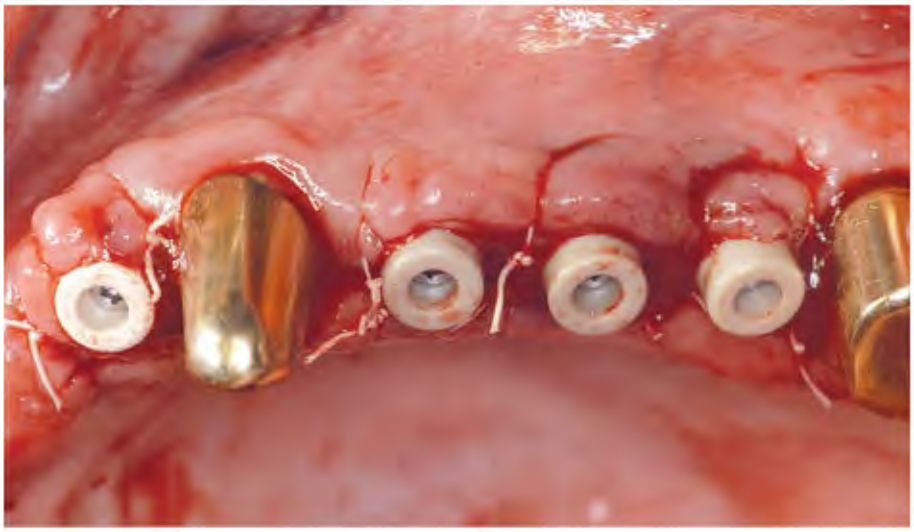


Fig 7-6n Correcting the gingival situation on the left side.

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Fig 7-6o Widening the zone of attached gingiva on the right side.

Implant placement in the mandible was followed by sinus elevation in the maxilla. After the fenestration on the right side, the maxillary sinus mucosa was very carefully dissected around the septa to avoid perforating it (Fig 7-6h). The septa were high and sharp, as apparent when seen in the mirror (Fig 7-6i). Different augmentation materials were used on the two sides for a comparative study. NanoBone (Artoss) was used on the right side and Bio-Oss on the left.

Implant placement in the maxilla

Implant placement in the maxilla was ready to be performed 9 months after sinus elevation. At this point, no further treatment was undertaken in the mandible, as the implants in both jaws were to be loaded with prosthetic restorations at the same time. Implant placement in the maxilla started on the right side (Fig 7-6j). The augmentation material NanoBone had not yet consolidated fully after 9 months, but it proved possible to anchor all the implants with good stability. On the left side, the Bio-Oss augmentation material seemed to show better ossification and offered outstanding stability for the implants (Fig 7-6k).

Exposure

All the implants in both jaws were ready to be exposed after another 6 months. In the mandible, the posterior implants were already uncovered, so that only the implants in the anterior segment still needed exposing (Fig 7-6l). In the maxilla, a few of the implants were partially visible on the labial/buccal side, necessitating reconstruction of the zone of attached gingiva (Fig 7-6m). The incision was made on the palatal side and the gingiva was stabilized on the healing abutments on the labial/buccal side (Fig 7-6n). This procedure was then repeated on the right side (Fig 7-6o).

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Fig 7-6p Check panoramic radiograph with the customized abutments in situ.



Fig 7-6q Clinical situation following incorporation of the superstructure.



Fig 7-6r Clinical situation following removal of the fixed implant bridges after 6 years.

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Fig 7-6s Signs of mild peri-implantitis in the right mandible.

Prosthetic restoration

An impression was taken 3 weeks after exposure. The panoramic radiograph taken to check the fit of the customized abutments on the implants also showed the stable bone situation even before the superstructure was incorporated (Fig 7-6p). All the remaining teeth were extracted and four fixed implant bridges, one per quadrant, were fitted (Fig 7-6q).

Continued follow-up

Six years after being fitted, the fixed restorations in the maxilla and mandible were removed for professional cleaning (Fig 7-6r). The gingival situation in the right maxilla appeared stable, but signs of mild inflammation with swelling and bleeding could be seen in the mandible (Fig 7-6s). The electroplated cap on implant 46 had worked loose from the supersctructure and remained stuck to the telescope. On the left side, the gingival situation in both jaws showed nothing of note (Fig 7-6t). The missing cap was visible on the underside of the bridge, top right in the picture (Fig 7-6u). The transverse screw-retaining mechanisms, intended to prevent accidental loosening of the superstructure, were clearly visible in the restorations for the maxilla (Fig 7-6v). The panoramic radiograph after 6 years shows a stable bone situation around the implants (Fig 7-6w). The fixed restorations, reinserted after cleaning, blend in with the overall picture (Fig 7-6x). To the patient, the structures feel as if they are his own teeth and he remains very satisfied with the final result (Fig 7-6y).

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Fig 7-6t Stable gingival situation on the left side.



Fig 7-6u Superstructure taken from the mandible.



Fig 7-6v Maxillary restoration with the transverse retaining screws.

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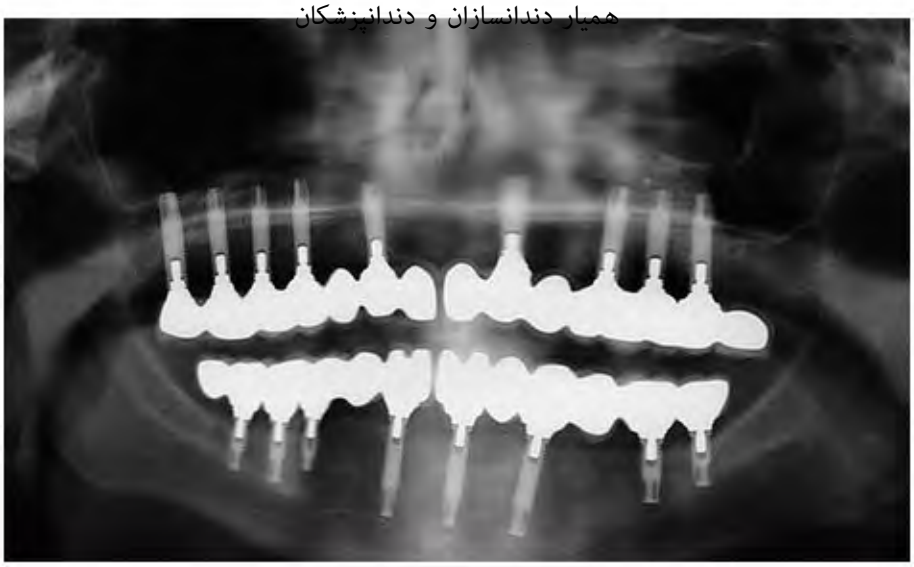


Fig 7-6w Follow-up panoramic radiograph after 6 years.



Fig 7-6x Full prosthetic restoration after 6 years.



Fig 7-6y Satisfied patient 6 years after treatment completion.

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Treatment course

- Bilateral sinus elevation and implant placement in the mandible (2005)
- 9 months to implant placement in the maxilla
- 6 months to exposure of all the implants
- 2 months to the completed prosthetic restoration

Treatment

Surgery: Dr Christoph T. Sliwowski
Prosthetics: Dr Michael Weber
Dental technology: Horst Mosch

Problems and complications

Complication following an earlier treatment with disk implants in a heavy smoker with poor oral hygiene

Baseline situation

A 59-year-old man, with loose implant-supported restorations in both jaws, was desperately seeking help (Fig 7-7a). Five years previously, at another clinic, six disk implants had been inserted into his maxilla and four into his mandible, and immediately loaded with prostheses (Fig 7-7b). The patient is a heavy smoker and admits to 40 to 60 cigarettes a day. His oral hygiene can also be described as deficient. A few months previously, the maxillary restoration had fractured between positions 11 and 12, and had been provisionally repaired with adhesive several times, without success. The restorations in the mandible and in the right maxilla showed grade II to III loosening (Fig 7-7c). The fractured part on the left side of the maxilla was now hanging only on the soft tissue, so that an alginate impression was contraindicated due to the risk of losing the restoration (Fig 7-7d). The implant fractures have probably been caused by uneven loading. The restoration in the right mandible has been shortened up to the first premolar (Fig 7-7c). For this reason, most of the masticatory force is being exerted on the left side, which probably contributed to the fracture of the thin titanium posts in one of the jaws (Fig 7-7d). The remaining posts have only worked loose on the implants.

This patient's oral hygiene left a lot to be desired. In view of the heavy smoking and such poor oral hygiene, the prognosis for reinserting the implants and a definitive prosthetic restoration loaded on the implants required critical appraisal.

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Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning

Treatment plan

1. Removal of the disk implants in the maxilla and mandible, augmentation and possibly implant placement in the mandible, provisional implants in the maxilla, fixed immediate restoration in both jaws
2. Implant placement in the maxilla, exposure in the mandible
3. Exposure in the maxilla
4. Definitive prosthetic loading in both jaws

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Fig 7-7a Baseline clinical situation.

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Fig 7-7b Panoramic radiograph before treatment.



Fig 7-7c Shortened right dental arch.

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Fig 7-7d Very poor oral hygiene.



Fig 7-7e Following removal of the superstructures.

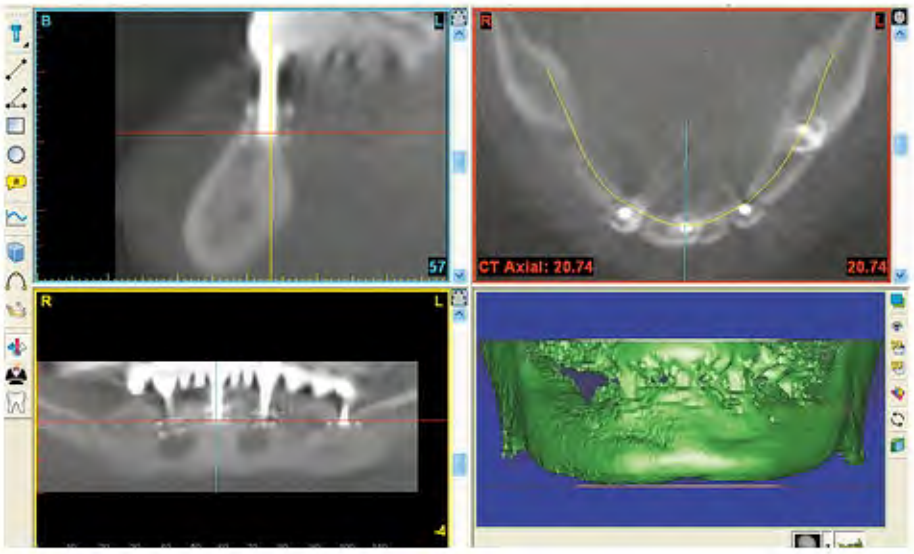


Fig 7-7f Marked zones of osteolysis around the implants in the mandible, as seen in the tomographic images.

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The fixed restorations in the mandible and maxilla were removed; in doing so, the left, broken-off segment in the maxilla came out together with the implant posts (Fig 7-7e). The mandible was operated on first. The preoperative tomography and the earlier panoramic radiograph showed zones of osteolysis around implants 33 and 44, which were also the cause of the implant loosening (Fig 7-7f). Implants 37 and 41 still appeared to be anchored in the bone, but the fixed restoration had worked loose from these abutments. When the operation site was opened up, inspection confirmed the radiological diagnosis around the implants (Fig 7-7g). While implants 33 and 44 were already loose and encapsulated in connective tissue, they could not be removed without laborious reaming, performed in as minimally invasive a fashion as possible. Implant 41 was barely anchored in the bone, but still stable (Fig 7-7h). The bone around the three implants in the anterior region was reamed out with extreme care, with the aid of powerful loupe glasses, to preserve as much of the local bone as possible (Fig 7-7i). Implant 37 was left in situ for the time being to act as a provisional abutment. Five 17-mm long and 4 mm in diameter Neoss implants were inserted in the interforaminal segment. Healing abutments were fitted onto implants 32 and 42, for partial support of the long-term provisional restoration (Fig 7-7j). The defects around the three remaining implants were augmented with bone chips, Bio-Oss and Bio-Gide membranes. Two additional implants were inserted on each side distally of the mental foramina. Implants 35 and 36 were fitted with cover screws for submerged healing with concomitant augmentation, while implants 46 and 47 were fitted with healing abutments to act as provisional abutments for the temporary restoration (Fig 7-7k). Following augmentation, the operation site was closed as tightly as possible with Gore-Tex sutures (W. L. Gore and Associates). The newly inserted Neoss implants in positions 32, 42, 46 and 47 were intended for immediate loading, to support the long-term provisional restoration, along with the still stable implant in region 37 (Fig 7-7l).

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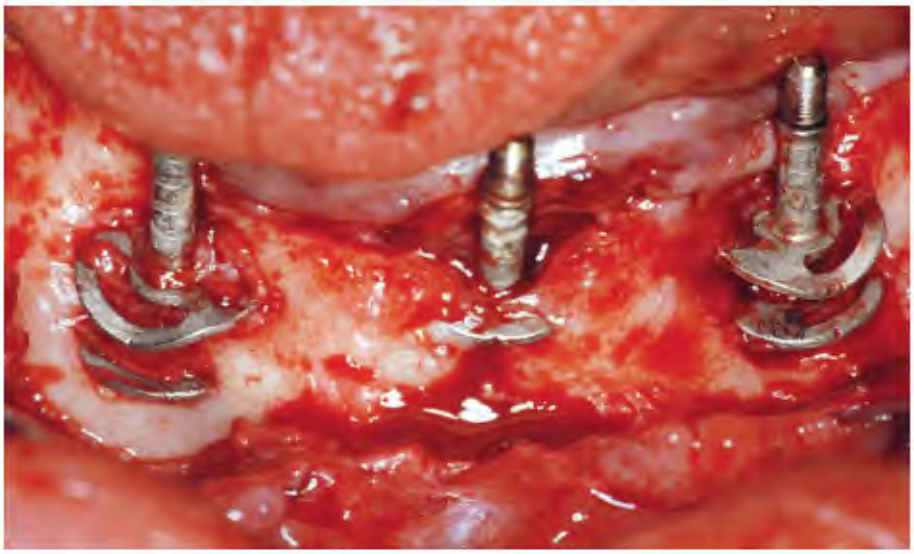


Fig 7-7g Loose disk implants 33 and 44.

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Fig 7-7h Perforation of the disks on the lingual side.



Fig 7-7i Bone defects following implant removal in the mandible.

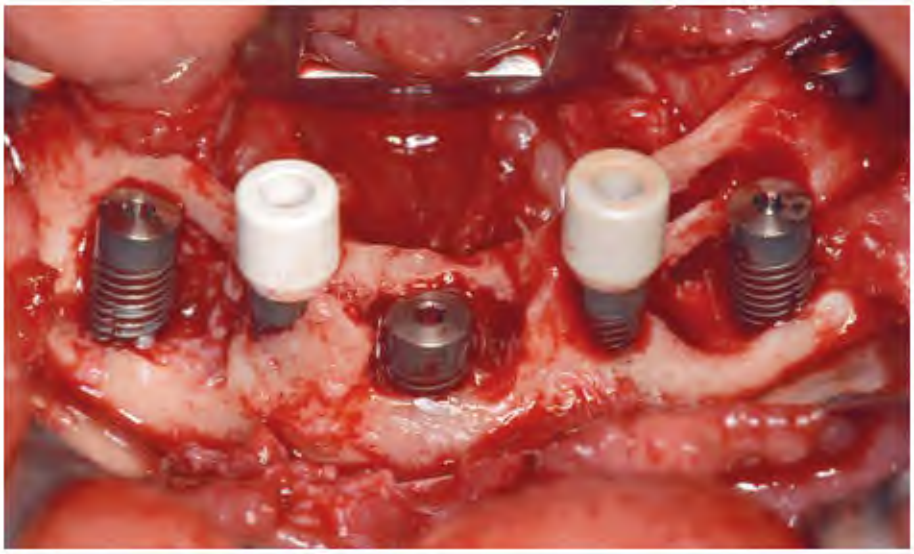


Fig 7-7j Insertion of five implants in the interforaminal region.

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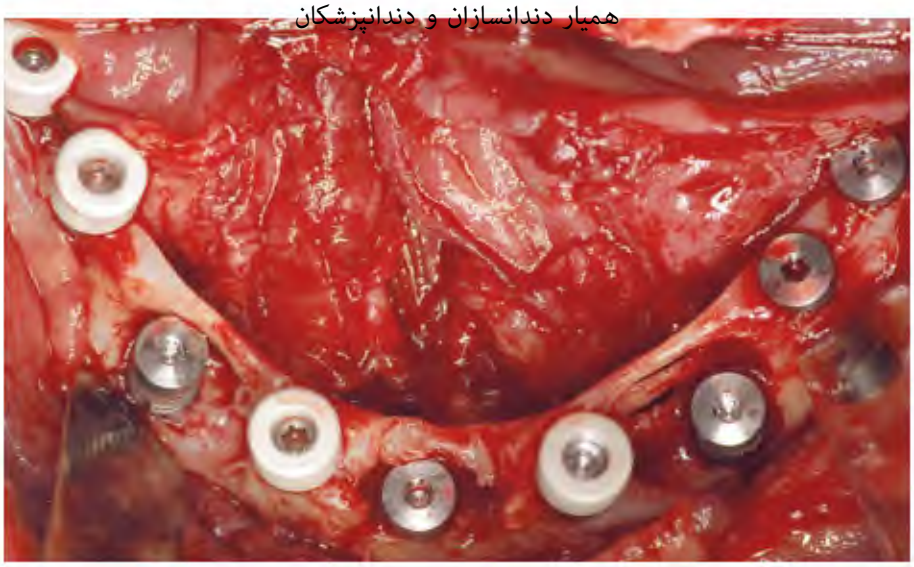


Fig 7-7k Implants with cover screws are intended for augmentation, those with healing abutments for provisional loading.

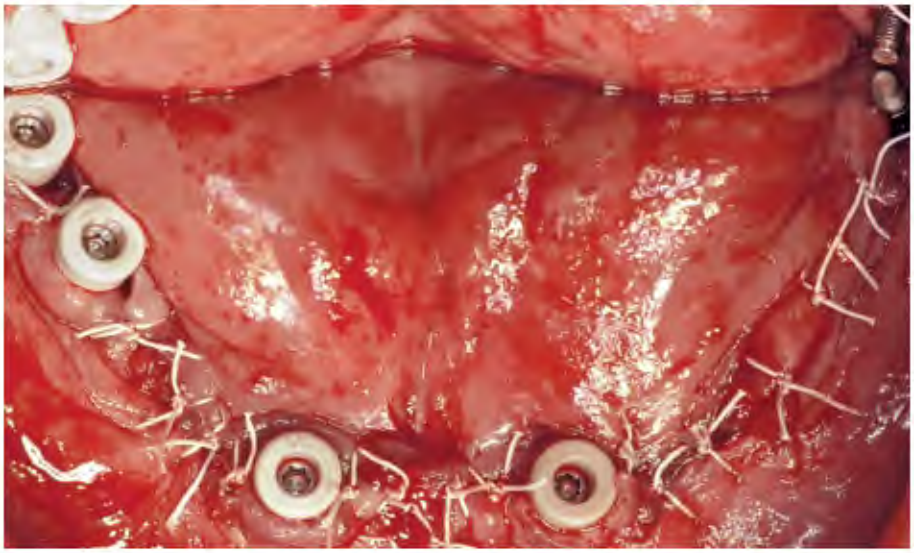


Fig 7-7l Abutments for the long-term provisional restoration.

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Fig 7-7m Maxilla before dental treatment.

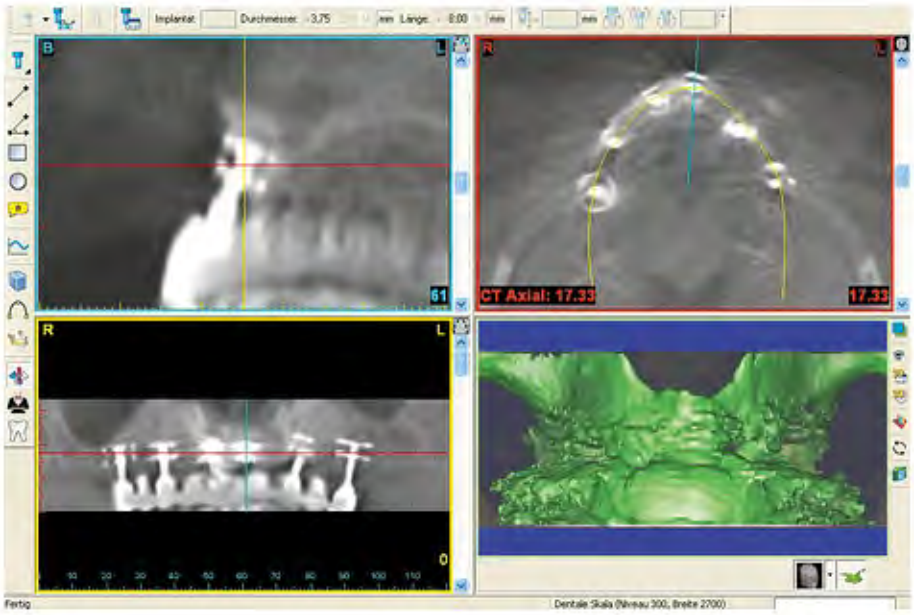


Fig 7-7n Tomography of the maxilla before treatment.

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Fig 7-7o Disk implants on the right side.

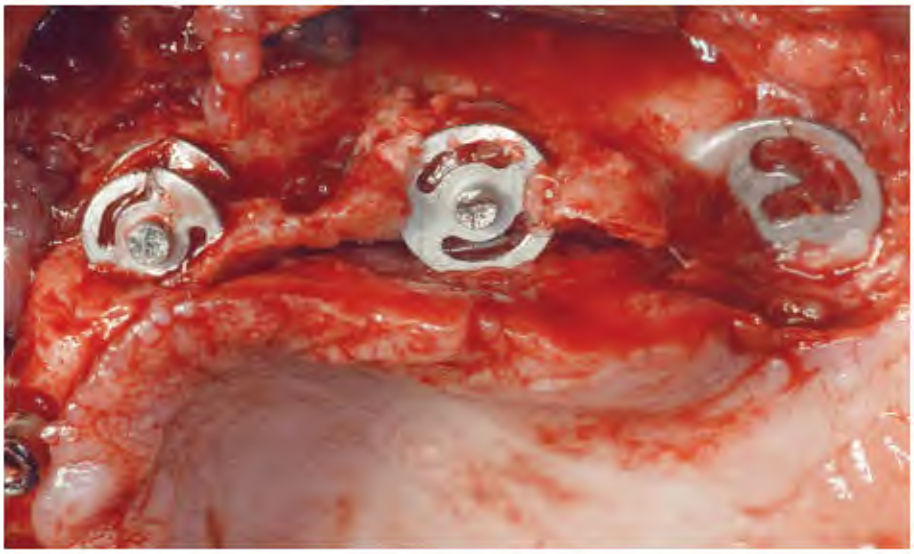


Fig 7-7p Fractured disks without posts in the maxilla.

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Implant removal and augmentation in the maxilla

Since the entire operation was performed under general anesthesia, the procedure in the maxilla followed on directly after suturing the mandible. Bridge 16 to 25, which had fractured between pontics 12 and 11, had already been briefly and provisionally repaired with adhesive several times. Fragment 11 to 25 had already come out before the procedure, together with the fractured posts. The prosthesis posts 12, 14 and 16 on the right side were still stable. They were unscrewed only after the superstructure was removed (Fig 7-7m). The preoperative CBCT analysis in the SimPlant program showed that all the implants in the maxilla had undergone at least partial osseointegration (Fig 7-7n). On the right side, clinical inspection showed that the implants were still adequately integrated into the jaw and that only the labial/buccal edges of the disks were exposed (Fig 7-7o). However, cardinal signs of manifest

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peri-implantitis were apparent around post 14 and, above all, around post 16 (Fig 7-7o). At this point, it was therefore necessary to resolve the highly problematic question of whether it would be better for the patient if the implants were left in situ or if they were reamed out. Since all three implants on the left side had fractured (Fig 7-7p), total implant removal and re-insertion appeared to be the more sensible option in the long term. The prosthetic posts of implants 21 and 23 had broken off and the entire post of implant 25 had worked loose together with the upper disk. The fragments remaining in the bone on both sides were carefully and very meticulously reamed out, working with the aid of loupe glasses.

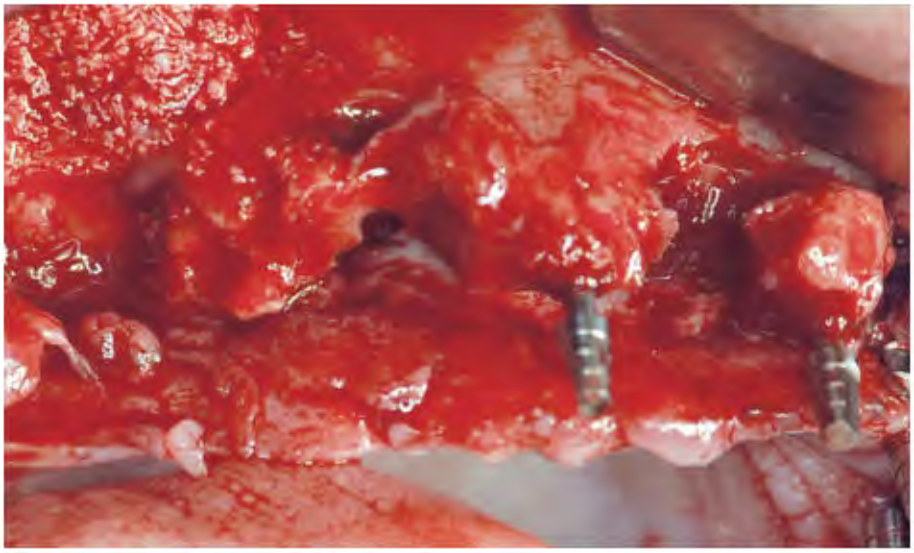


Fig 7-7q Sinus elevation and provisional implants on the right side.

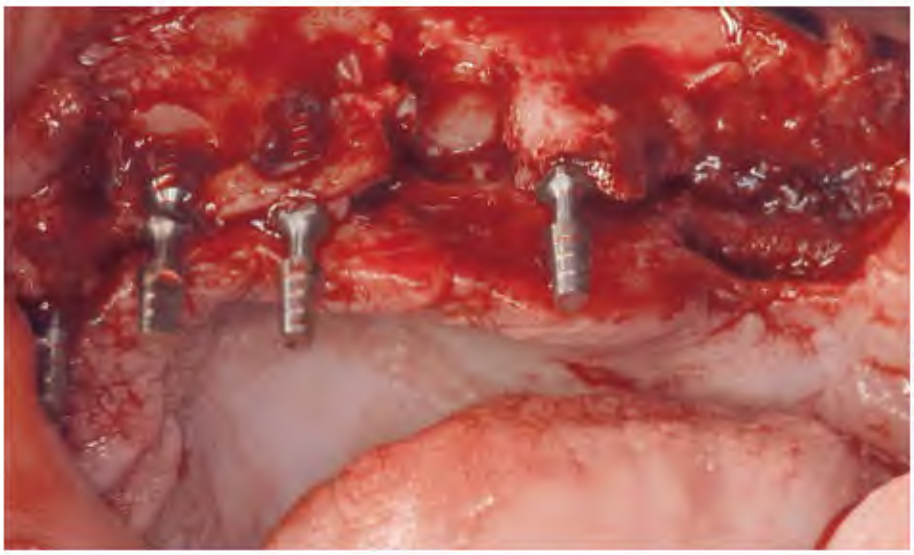


Fig 7-7r Provisional implants on the left side, only just anchored in the bone.

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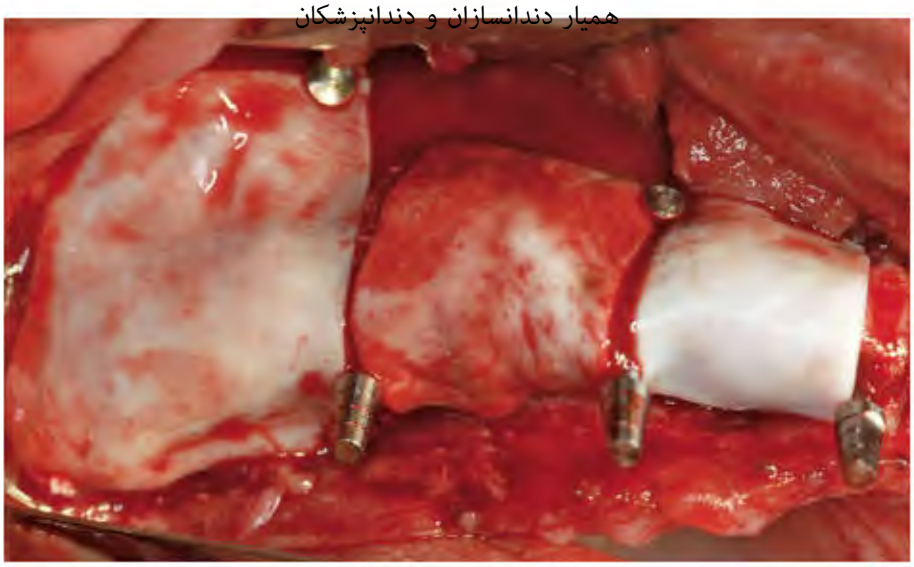


Fig 7-7s Augmentation on the right side.

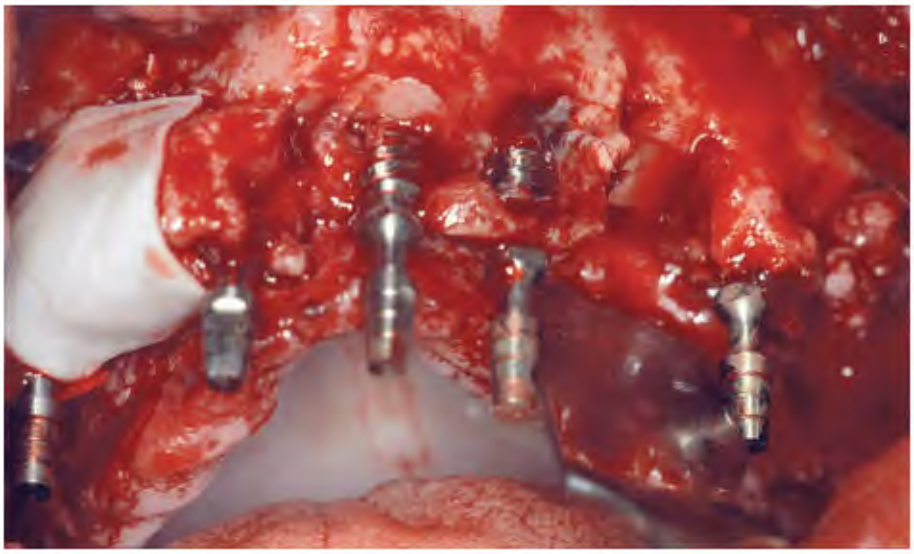


Fig 7-7t Moving across to the left side.

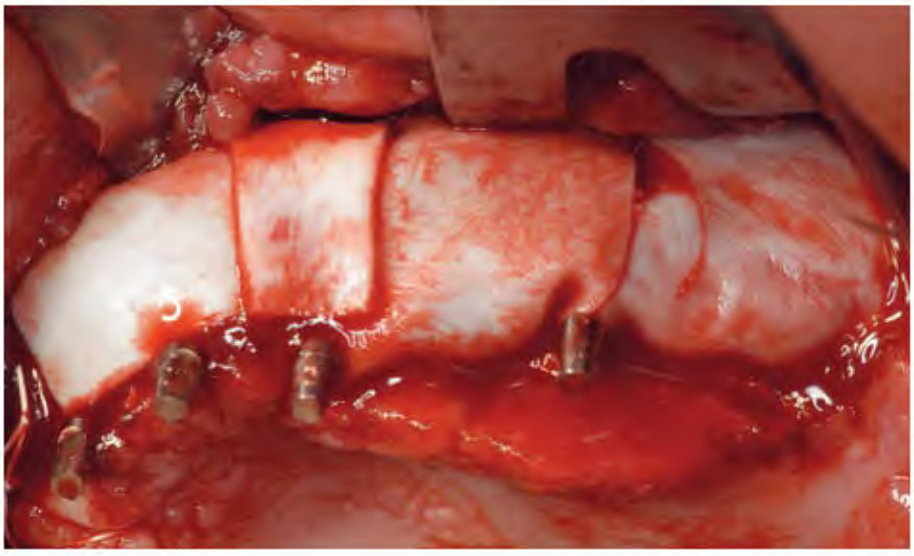


Fig 7-7u Augmentation on the left side.

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Fig 7-7v Removed implant fragments.



Fig 7-7w The patient’s oral hygiene continues to be poor.

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Fig 7-7x All the implants are stable following removal of the provisionals.

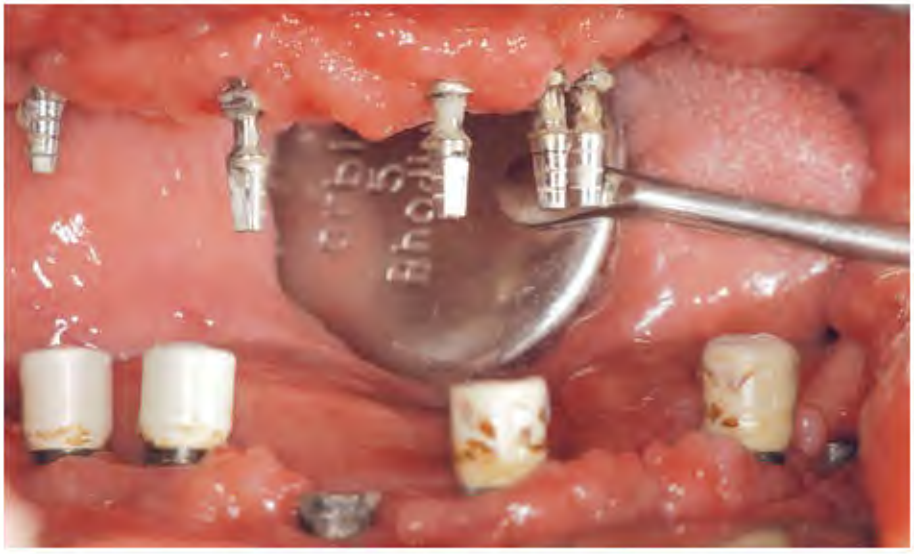


Fig 7-7y Sagittal plane malocclusion between maxilla and mandible.



Fig 7-7z Maxilla before implant placement.

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The planned sinus elevation was first performed on the right side. Provisional implants were then inserted into the still well-preserved local bone between the defects (Fig 7-7q). The osseous situation on the left side was considerably more problematic, offering very little option for the insertion of implants with primary stability (Fig 7-7r). Augmentative measures were performed on both sides following the insertion of Immediate Provisional Implants (IPIs; Nobel Biocare). On the right side, the bone window for sinus elevation and the augmentation material in the molar region were covered with a large membrane, and the other segments of the augmented residual ridge with two smaller membranes (Fig 7-7s). All the membranes were attached to the bone with titanium pins. The anterior region was augmented predominantly in the horizontal plane, with some vertical augmentation (Fig 7-7t). An overcontoured horizontal and vertical augmentation was also carried out on the left side and covered with membranes (Fig 7-7u). Extensive release of the periosteum, heavily scarred by the previous operations, was needed in order to achieve saliva-proof closure with sutures. Figure 7-7v shows the "collection" of items removed from the mandible and maxilla.

Implant placement in the maxilla

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Implant placement did not take place until 15 months after augmentation, again under general anesthesia. Unfortunately, the patient's oral hygiene had not improved significantly in this period, despite exhaustive instruction (Fig 7-7w), and his tobacco consumptions had not decreased either. A first cursory glance at the clinical situation revealed marked shrinkage of the augmented areas. At the time of insertion, the long-term provisional in the maxilla had been in contact with the gingiva; now, a gap of 2 to 3 mm could be seen between the two (Fig 7-7w). The augmented areas in the mandible had also shrunk, and a few implants, particularly the one in region 44, had become uncovered even before exposure (Fig 7-7x). Following removal of the long-term provisional, the lateral view clearly shows the relationship between the maxilla and mandible and the resultant sagittal malocclusion (Fig 7-7y). Despite the very unfavorable baseline situation, all the provisional implants remained functional and stable even after 15 months (Fig 7-7z).

To enable optimal positioning of the definitive implants, it was necessary to remove the IPIs in regions 13 and 23. In view of the patient's prior history and his poor compliance, including inadequate oral hygiene and the undiminished cigarette consumption, six definitive implants were placed prophylactically on each side, after providing the patient with the appropriate information and obtaining his consent (Fig 7-7aa). The remaining bone defects were filled with the harvested bone chips and covered with two Bio-Gide membranes (Fig 7-7bb). Since one provisional implant had to be removed from each side for strategic reasons, a new one had to be inserted on the palatal side in positions 16 and 26, to reinforce the structure. The bone situation on the left side had been far more problematic from the start of treatment, and despite attempts to balance the two sides out by augmentation, these problems persisted. The residual ridge was more severely atrophied in both the vertical and horizontal planes, and needed

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repeated augmentation to allow comparable placement of the implants (Fig 7-7cc). Once again, the augmentation was undertaken with the harvested bone chips and Bio-Gide membranes (Fig 7-7dd). After further, extensive periosteal slitting, the area was sutured as tightly as possible (Fig 7-7ee).



Fig 7-7aa Placement of six implants in the augmented maxilla.



Fig 7-7bb Further augmentation.

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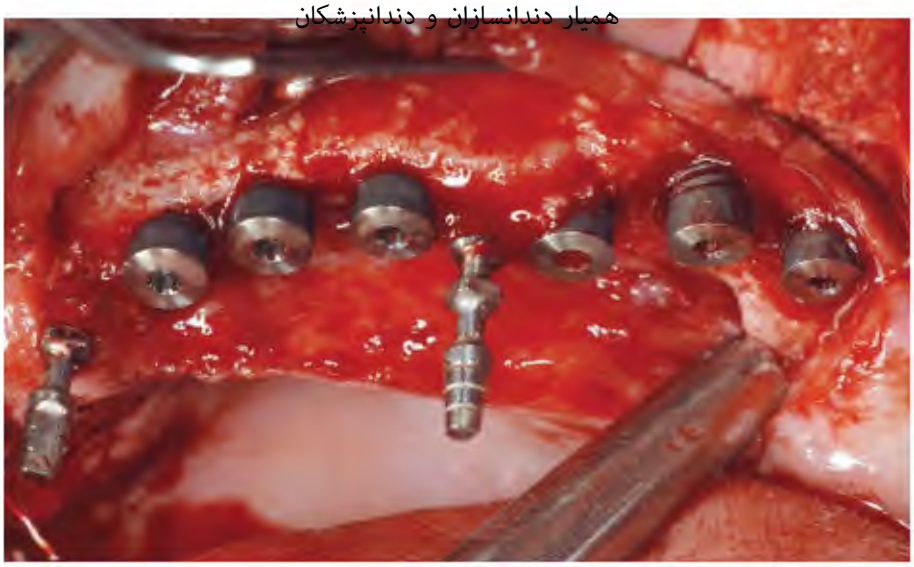


Fig 7-7cc Implant placement on the left side.

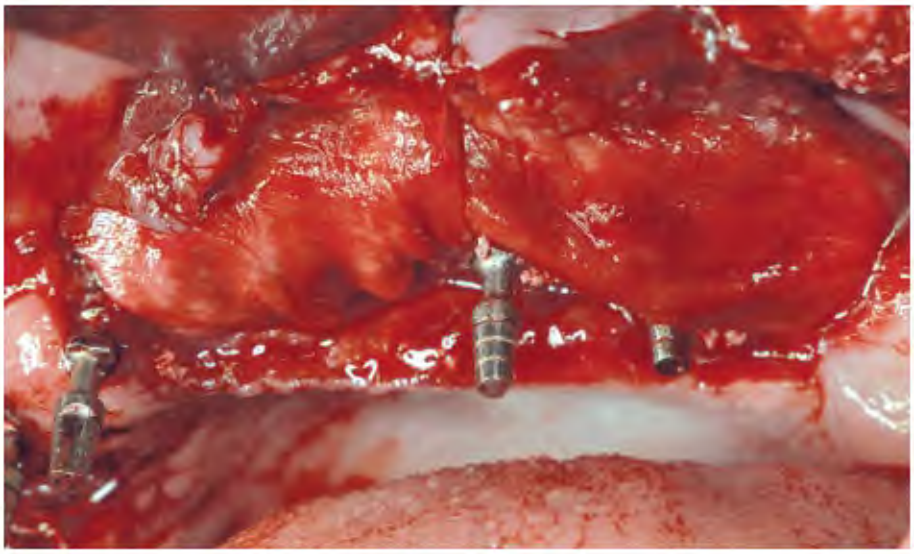


Fig 7-7dd Even more extensive augmentation is needed at the left side.

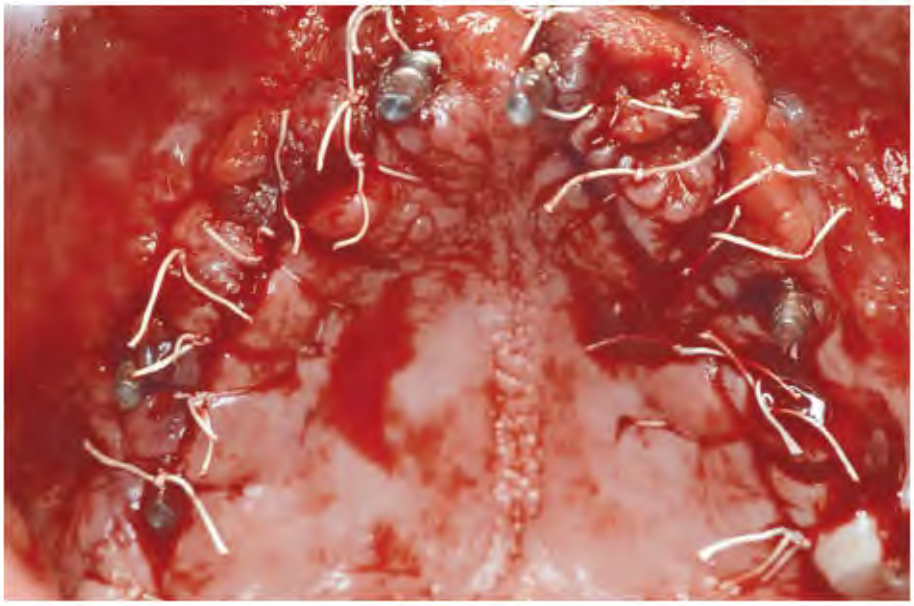


Fig 7-7ee Suturing following repeated flap mobilization.

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Fig 7-7ff Already partially exposed implants in the mandible.

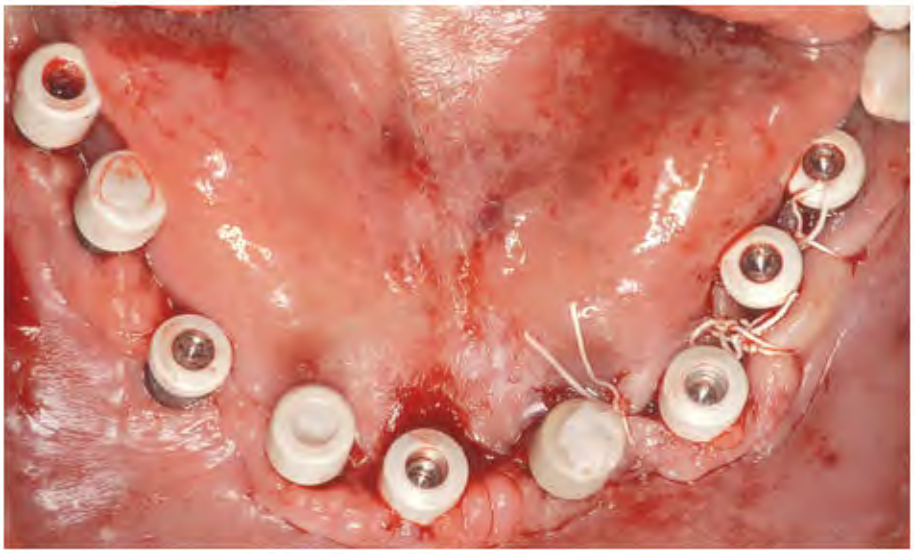


Fig 7-7gg All the implants have been exposed.



Fig 7-7hh Modified provisionals have been incorporated.

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Exposure in the mandible

Exposure of the implants in the mandible took place under the same general anesthesia. Implants 32, 42, 46 and 47 had been fitted with healing abutments directly after implant placement and supported the long-term provisional together with the remaining disk implant 37. Implants 33 and 36 were already partially visible and implant 44 was almost completely uncovered (Fig 7-7ff). Only implants 31 and 45 showed no dehiscence and still required exposure. The cover screws were replaced with healing abutments. However, suturing was necessary only in the third quadrant (Fig 7-7gg). The provisionals were then reincorporated, in the maxilla initially without any adjustment, whereas the base of the mandibular denture had to be relined (Fig 7-7hh). Both provisionals were reshaped in the laboratory, taking the new IPIs into consideration.

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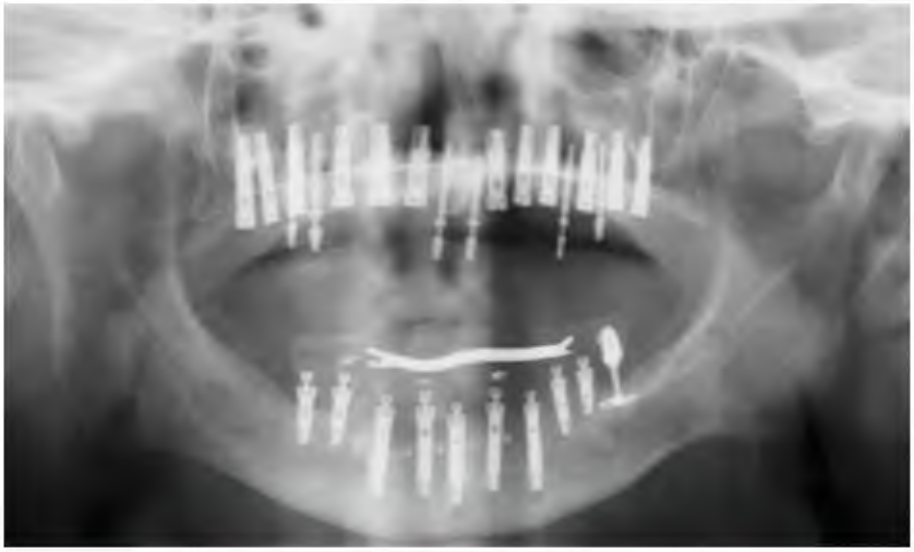


Fig 7-7ii Follow-up panoramic radiograph during the healing phase.

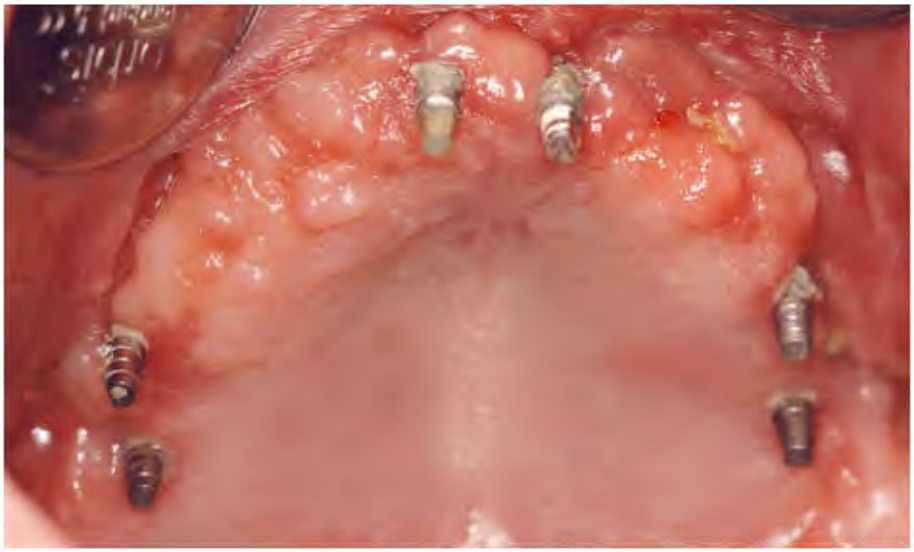


Fig 7-7jj The maxilla before exposure.

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Exposure in the maxilla

Seven months after implant placement, the bone situation in the panoramic radiograph appeared to be stable and the implants were ready for exposure (Fig 7-7ii). The long-term provisional was removed and the stability of the provisional implants tested (Fig 7-7jj). While the implants on the right side were fully submerged under the mucosa, the zone of attached gingiva in the molar region was narrow and now needed widening (Fig 7-7kk). The distal IPI was unscrewed from the bone and the incision was made palatally of the implants (Fig 7-7ll). The definitive implants were tested for stability and the cover screws exchanged for long healing abutments (Fig 7-7mm). This was followed by suturing with polytetrafluoroethylene (ePTFE; W. L. Gore and Associates) thread. The situation on the left side continued to be problematic. The buccal gingiva in the molar region had receded considerably so that the implants were already partially uncovered at the sides (Fig 7-7nn). An attempt was made to transplant a sizeable pedunculated connective tissue graft from the palate toward the buccal vestibule (Fig 7-7oo). Despite the suture adaptation, the distance between the graft and its base on the palatal side was rather large, so that a lack of blood supply and marked degeneration of the graft were to be expected (Fig 7-7pp). The clinical situation after 10 weeks confirmed this fear, showing extensive graft failure (Fig 7-7qq). All the implants had become osseointegrated despite the problematic baseline situation, the heavy smoking and the poor oral hygiene, and were about to be loaded with the definitive prosthetic restoration.

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Prosthetic restoration and continued follow-up

All the implants remain in situ even after another 6 years. The transocclusal, screw-retained fixed cross-arch bridge 17 to 27 in the maxilla shows clear signs of the patient's heavy smoking (Fig 7-7rr). A fixed restoration retained on the mesostructure with TempBond cement (Kerr) has been inserted into the mandible (Fig 7-7ss). It is astonishing that the entire structure is still functioning so well after 6 years (Figs 7-7tt and 7-7uu), despite the very heavy smoking (still at 40 to 60 cigarettes a day) and poor oral hygiene (despite repeated attempts to encourage the patient to improve it). The disk implant in region 37 is also still functioning.

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Fig 7-7kk Loss of attached gingiva around the provisional implants.

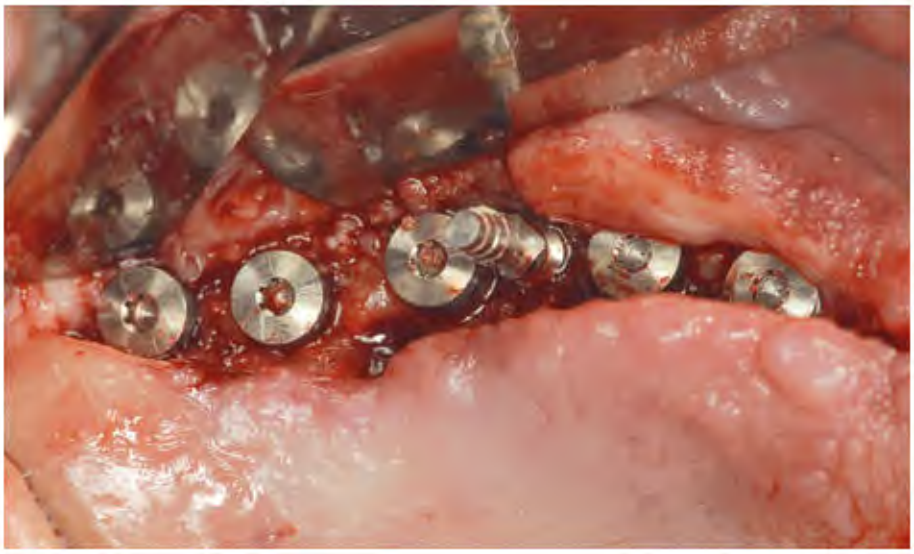


Fig 7-7ll Palatal incision following removal of a provisional implant.



Fig 7-7mm Exposed implants on the right side.

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Fig 7-7nn Unfavorable gingival situation on the left side.

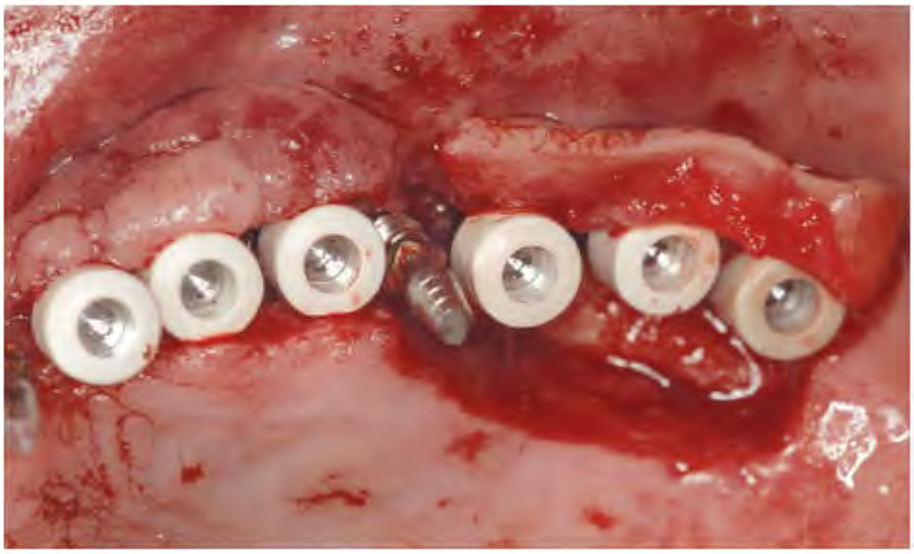


Fig 7-7oo Oversized graft in the distal region.

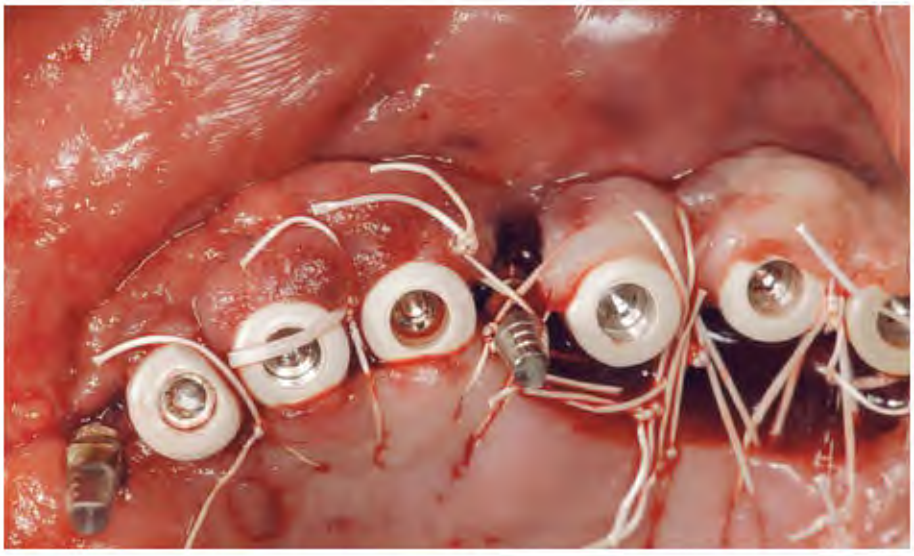


Fig 7-7pp Lack of blood supply to the graft.

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Fig 7-7qq All the implants have become osseointegrated.



Fig 7-7rr Occlusal view of the maxilla after 6 years.



Fig 7-7ss The mandible has also been fitted with a fixed superstructure.

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Fig 7-7tt Stable clinical situation after 6 years despite the deplorable oral hygiene.

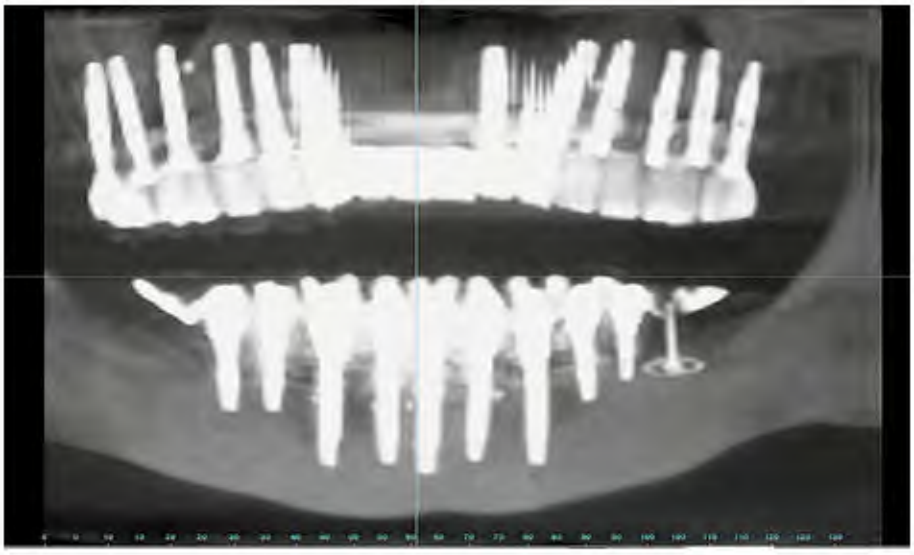


Fig 7-7uu Summated panoramic reconstruction of the CBCT scan performed after 6 years of functional use.

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Treatment course

- Dental treatment, implant placement in the mandible, augmentation in the maxilla and mandible (2005)
- 15 months to implant placement in the maxilla
- 7 months to exposure
- 3 months to prosthetic loading

Treatment

Surgery: Dr Christoph T. Sliwowski

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Prosthetics: Dr Michael Weber
Dental technology: Horst Mosch

Problems and complications

Implant-supported restoration in a heavy smoker with poor oral hygiene

Baseline situation

A 48-year-old man with extremely poor oral hygiene and just as extreme denture phobia wanted a fixed restoration for his maxilla and mandible (Figs 7-8a and 7-8b). He is also a heavy smoker, admitting to 20 cigarettes a day, but his yellowish-brown fingers would suggest double that consumption. At this point, many fellow practitioners might ask how one can even contemplate implant treatment in a heavy smoker with such poor oral hygiene – and quite rightly so. However, I want to defer my reply for some time. The only certainty is that many more problems and complications are to be expected in such a case.

Diagnostic tools

- Clinical examination
- Panoramic radiograph, CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Dental treatment and provisional implants in the maxilla and mandible, definitive implants in the mandible, fixed immediate restoration in both jaws
2. Bilateral sinus elevation
3. Implant placement in the maxilla
4. Exposure in the maxilla and mandible
5. Prosthetic loading

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Fig 7-8a Residual dentition in a patient with extremely poor oral hygiene.



Fig 7-8b Panoramic section of the CBCT scan.

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Fig 7-8c Maxilla following dental treatment. Transmucosally inserted provisional implants.

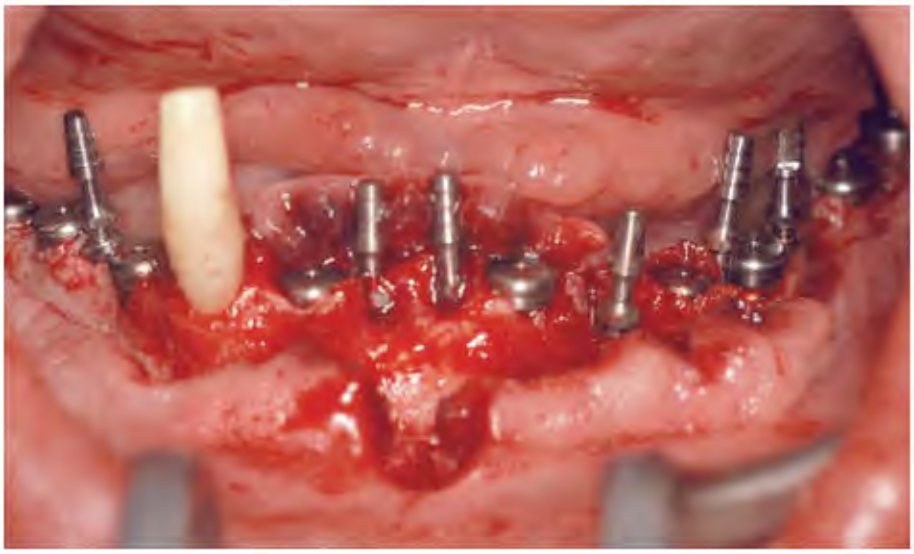


Fig 7-8d Definitive and provisional implants inserted into the mandible.

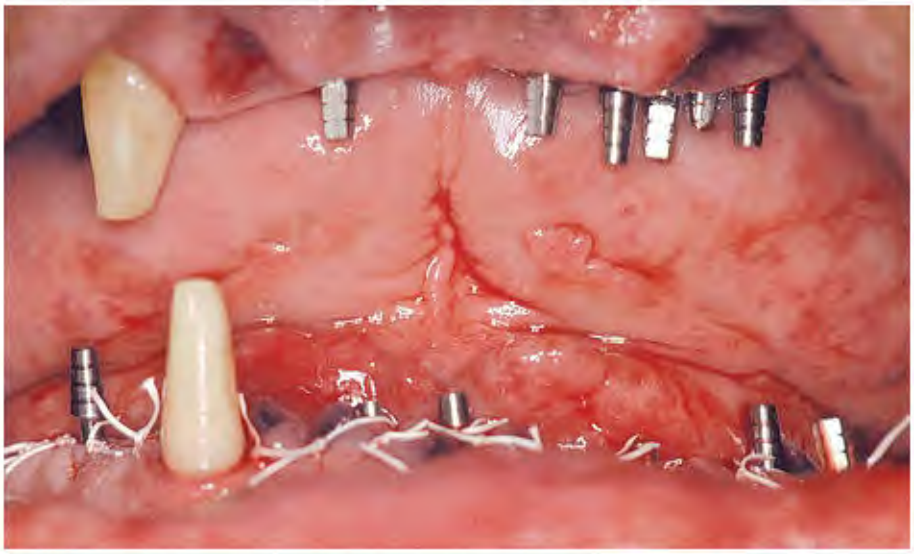


Fig 7-8e Aligned provisional implants in both jaws.

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Fig 7-8f Immediate provisional restoration in the mandible.



Fig 7-8g Immediate provisional in the maxilla.

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Dental treatment and immediate provisional restoration on IPIs

Working under general anesthesia (no dental treatment was possible in this patient without it), all the teeth in the maxilla and mandible were first extracted, apart from 13 and 43. After the extractions, the oral cavity was repeatedly and generously disinfected with H_2O_2. The two canines were prepared to provide additional support for the provisional restoration. In the maxilla, nine provisional IPIs were inserted through the mucosa or into the sockets at the positions determined in SimPlant (Fig 7-8c). The lingual and labial/buccal flaps were created in the mandible. Ten definitive implants were inserted at the planned sites, with seven provisional ones between them (Fig 7-8d). The harvested bone chips were used for the augmentation in the mandible, but without using a membrane. The operation site was sutured and the provisional implants aligned parallel to the canines (Fig 7-8e). Using thermoplastic

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foils prepared during the procedure (alginate impressions could only be taken under general anesthesia due to the severe loosening of the teeth), the immediate provisional restorations for the mandible and maxilla were fabricated and incorporated (Figs 7-8f and 7-8g).



Fig 7-8h Maxilla 3 months after the dental treatment.

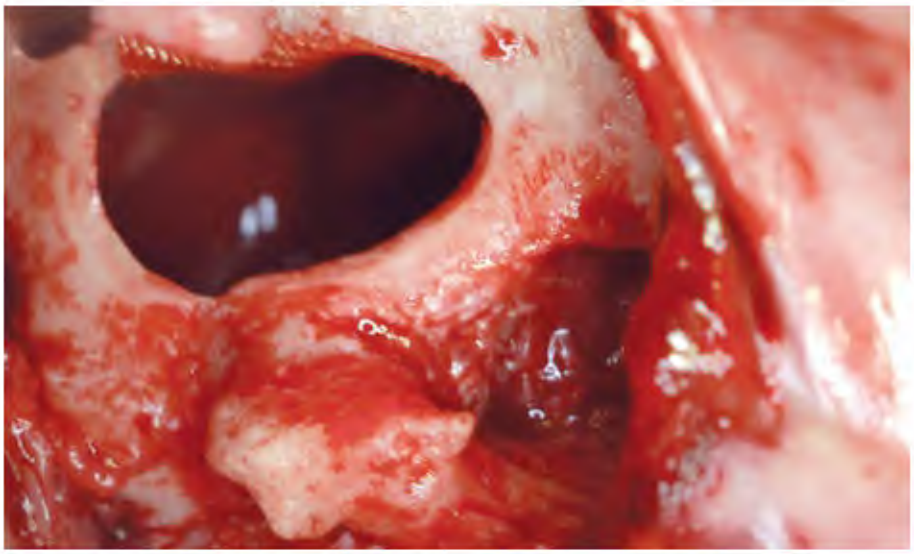


Fig 7-8i Fenestration for sinus elevation.

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Fig 7-8j One provisional implant is protruding into the maxillary defect.



Fig 7-8k Maxilla before implant placement.

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Sinus elevation

Bilateral sinus elevation was performed 3 months after the dental treatment, also under general anesthesia. The long-term provisional restoration, fabricated in the interim, was removed only from the maxilla (Fig 7-8h). Only one root in region 24 remained after the dental treatment and one IPI at the same site was loose and had to be removed. Although bone regeneration had been going on for 3 months, the residual ridge was still very irregular (Fig 7-8i). The defect in region 15, in particular, was still very large. It is interesting to note that one of the IPIs was visible from distally on the mesial wall of this defect (Fig 7-8j). All the defects and the two sinus elevation cavities were packed with Bio-Oss and covered with membranes. A Vicryl mesh was used to seal off the maxillary sinus mucosa above, while the lateral window was closed with a Bio-Gide membrane. Saliva-proof suturing of the operation sites followed.

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Implant placement in the maxilla

The definitive implants were inserted into the maxilla 10 months after sinus elevation (Fig 7-8k). On the right side, an IPI in region 14 was removed and a definitive implant inserted in its place (Fig 7-8l). Further implants were inserted at positions 12 and 16, and at position 17 mesially and distally. On the left side, the IPI in region 22 was removed and implants inserted at positions 22, 24, 25, 26 and 27 (Fig 7-8m). Apart from one 15-mm long implant with an active surface, it proved possible to insert 17-mm long implants into all the remaining planned sites in the maxilla. Since the bone was very brittle and of poor quality, 10 months were scheduled for the implant healing. The bone defects were filled with harvested bone chips and Cerasorb (curasan), then covered with Bio-Gide membranes.

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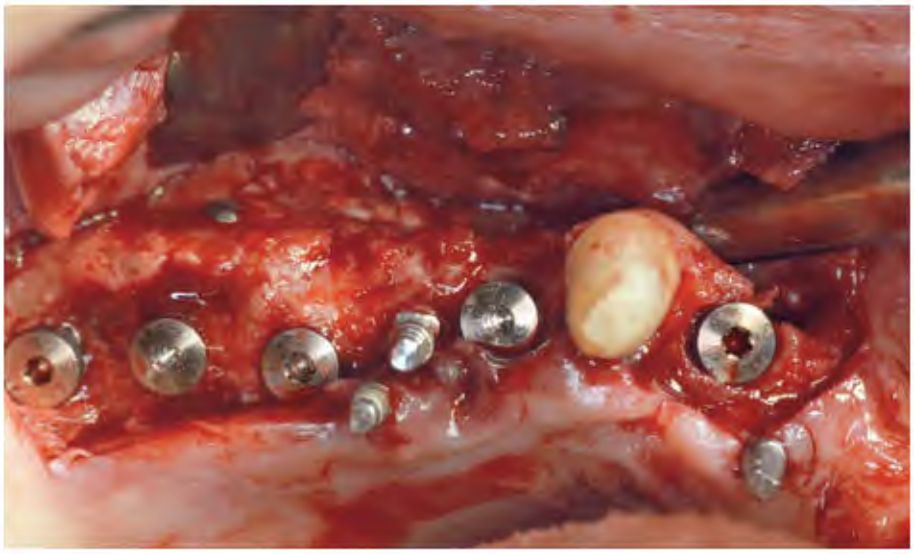


Fig 7-8l Implant placement on the right side.

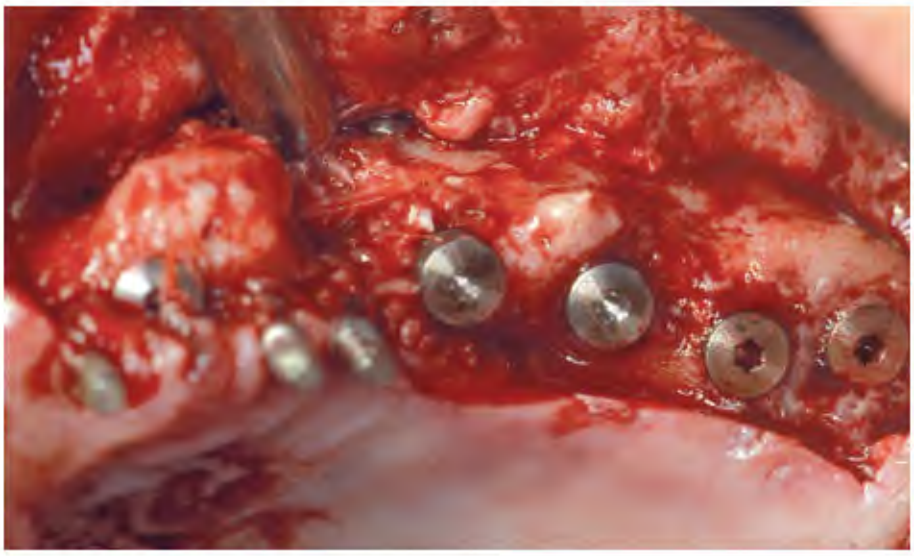


Fig 7-8m The IPI in region 22 has been exchanged for a permanent implant.

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Fig 7-8n Follow-up panoramic radiograph.



Fig 7-8o The oral hygiene continues to be poor.



Fig 7-8p Hygiene on the left side is extremely poor.

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Fig 7-8q The right side has already improved slightly compared to baseline.

Exposure and prosthetic restoration

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All 20 implants in both jaws were ready to be exposed after 10 months (Fig 7-8n). During this time, the patient's oral hygiene continued to be far from ideal (Fig 7-8o). The left side was almost completely covered with tartar (Fig 7-8p). Care on the right side was also not optimal, but still much better than the left, when compared to the baseline situation (Fig 7-8q). This makes it clear that the patient had problems cleaning on the left side, and that the right side was easier or more accessible for him.

The long-term provisionals in both jaws were removed for the exposure operation. A few of the implants in the maxilla were virtually uncovered, which others still needed to be exposed (Fig 7-8r). The implant in region 25, 17 mm long and 4.0 mm in diameter, had not become osseointegrated (it was already partially uncovered) and was removed directly. All the other implants were stable and were fitted with healing abutments. Impressions for the prosthetic restorations were taken a few weeks later. At this point, we found that the implant in region 26 was also loose and needed to be removed directly. All the implants in the mandible were stable, allowing a definitive restoration to be incorporated directly (Fig 7-8s). Re-insertion of the implants was needed in the maxilla, to enable a new long-term provisional to be incorporated on eight implants (Fig 7-8t).

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Fig 7-8r A few implants in the maxilla are already uncovered.



Fig 7-8s Definitive restoration in the mandible and new provisional in the maxilla.

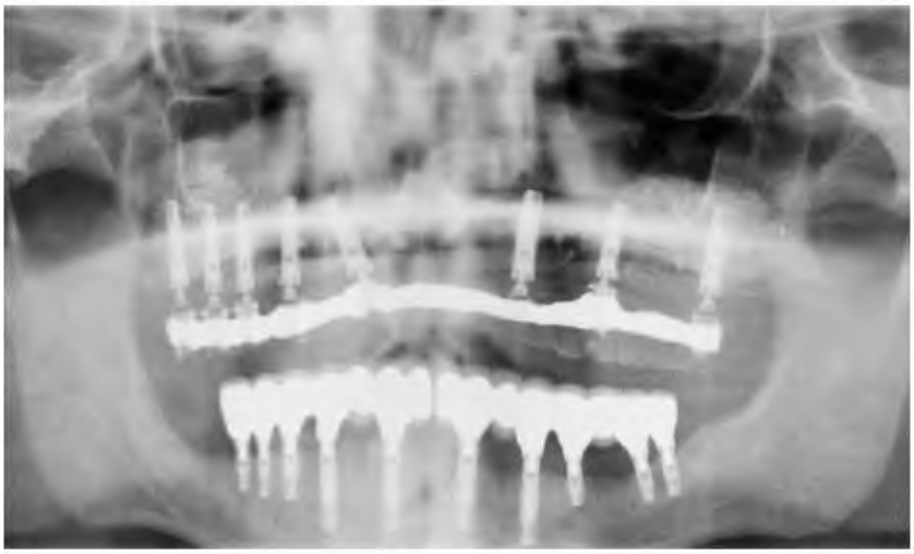


Fig 7-8t Panoramic radiograph following the loss of two implants on the left side.

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Fig 7-8u Stable situation on the right side.

Re-insertion of implants in the maxilla

Re-insertion of implants took place after another 8 months. The right side was completely stable and had healed well (Fig 7-8u). The left side continued to show a tissue deficit in the premolar region (Fig 7-8v). Following the incision, the flap was mobilized toward the labial/buccal vestibule and implants were inserted at positions 24, 26 and 27 (Fig 7-8w). The defect in regions 24 and 25 was filled with harvested bone chips and covered with a Bio-Gide membrane. The wound was closed with Gore-Tex sutures in such a way as to ensure that only the healed implants were accessible for the long-term provisional restoration (Fig 7-8x). The patient promised to stop smoking to increase his chances of a successful treatment.

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Repeat exposure

The implants remained submerged in situ for 1 year before they were ready to be exposed (Fig 7-8y). During this time, the patient was repeatedly encouraged to keep up his oral hygiene. After 1 year, his restorations already looked a little better than at the start of the treatment (Fig 7-8z). There was already a definitive restoration in the mandible, which was not removed. The long-term provisional in the maxilla was unscrewed for the exposure, revealing that the augmentation in regions 24 and 25 had not been particularly successful (Fig 7-8aa). An incision was made over the implants and the flap raised slightly. The tissue between implants 24 and 25, which looked necrotic, was refreshed. The cover screws were unscrewed, when implant 27 unexpectedly came out with the screw (Fig 7-8bb). Thus, implant 27 had not become osseointegrated and was removed directly (Fig 7-8cc). Healing abutments were fitted onto the two other implants and the wound was sutured (Fig 7-8dd).

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Fig 7-8v Left side with only three implants.

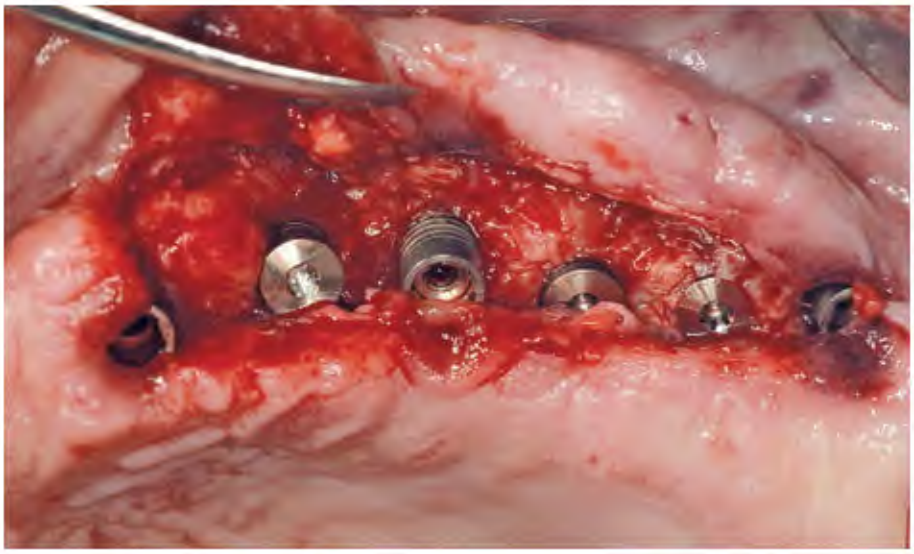


Fig 7-8w Re-insertion of three implants on the left side.

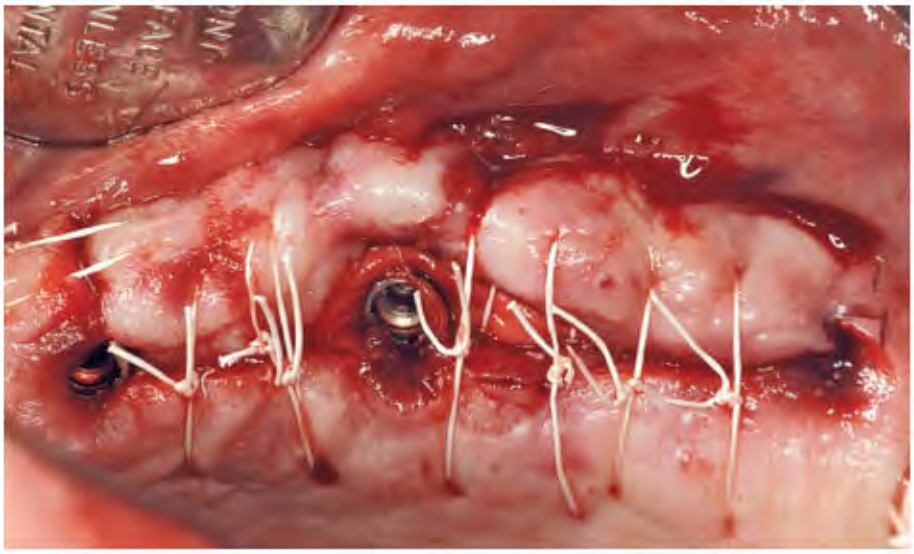


Fig 7-8x Suturing.

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Fig 7-8y Follow-up panoramic radiograph.



Fig 7-8z The oral hygiene has improved markedly.



Fig 7-8aa The left side before exposure.

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Fig 7-8bb Implant 27 has not become osseointegrated.

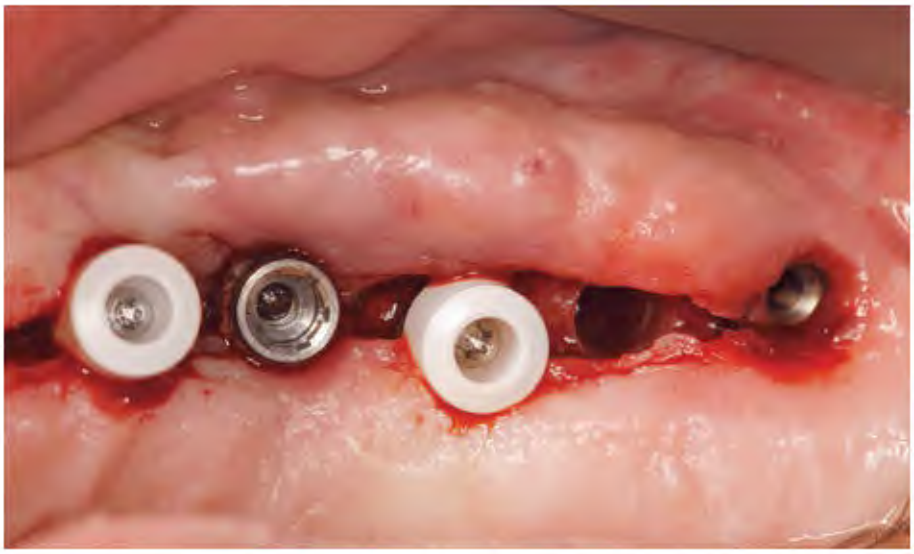


Fig 7-8cc Removal of implant 27.



Fig 7-8dd Suturing.

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Fig 7-8ee Marked maxillary defect in regions 24 and 25.



Fig 7-8ff Customized telescopes on the implants.



Fig 7-8gg Stable situation on the right side.

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The treatment was successfully completed after almost 4 years. As originally planned, there were ten osseointegrated implants in each jaw and the definitive restoration of the maxilla could now take place as well. On the left side, the defect between regions 24 and 25 was still present, and would probably remain (Fig 7-8ee). All the implants were fitted with customized telescopes (Figs 7-8ee and 7-8ff). On each side, the two penultimate implants were interlinked to ensure stable horizontal screw retention for the superstructure. Compared to the mandible, which had already been functioning for 2 years, the maxilla was now finally ready for incorporation of the superstructure. In the interim, the patient had learned and implemented the correct hygiene techniques, so that the situation had not become any worse (Fig 7-8gg). Moreover, he now seemed to be managing better with the more problematic left side (Fig 7-8hh). The tissue defect in regions 24 and 25 was hidden with pink ceramic in the superstructure. The patient has very long lips, so that this defect does not cause any esthetic problems in any case. He asserted that he had not smoked for a long time; this now sounded plausible, in view of the clinical situation at that point in time. He was very happy that he had finally been provided with securely fitting, fixed restoration despite the long and complicated treatment, and promised to look after them correctly at all times. The results at 3 and 5 years, respectively, after the implant bridges were fitted confirmed the patient's continuing motivation in this respect (Fig 7-8ii). The question, posed before the treatment, of whether implant treatment can be considered in a heavy smoker with such poor oral hygiene, depends on a variety of factors; unfortunately, it can only be answered several years after the treatment has been completed.

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Fig 7-8hh Markedly better hygiene on the left side.

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Fig 7-8ii Overall rehabilitation after 3 and 5 years of functional use, respectively. Denture care is much better compared to baseline.

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Treatment course

- Dental treatment and immediate restoration in both jaws, implant placement in the mandible (2004)
- 10 months to implant placement in the maxilla
- 10 months to exposure of all the implants
- 8 months to the re-insertion of implants
- 1 year to exposure
- 2 months to the full prosthetic loading

Treatment

Surgery:	Dr Christoph T. Sliwowski
Prosthetics:	Dr Michael Weber
Dental technology:	Horst Mosch

Immediate loading

Immediate restoration of provisional implants directly after dental treatment

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Baseline situation

A 58-year-old woman, a smoker with a non-preservable dentition supporting a removable dental prosthesis, wanted a fixed restoration in the maxilla and mandible. She was wearing cast overdentures in both jaws, the maxillary structure being clinically so mobile that she was afraid of taking it out (Fig 7-9a). The patient also wanted to have a fixed provisional restoration immediately, so that the plan was to insert provisional implants in both jaws, to guarantee support for this type of restoration during the healing period (Fig 7-9b). Due to the large residual ridge defects, implant placement in the mandible was planned only after the healing was completed (Fig 7-9c).

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Dental treatment, bilateral sinus elevation and provisional implants for an immediate restoration in both jaws
2. Implant placement in the maxilla and mandible
3. Exposure and definitive prosthetic loading



Fig 7-9a Clinical baseline situation.

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Fig 7-9b Maxilla before the dental treatment.



Fig 7-9c Baseline panoramic radiograph.

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Fig 7-9d Maxilla following removal of the overdenture.



Fig 7-9e Overdenture with its abutment teeth.



Fig 7-9f Inflammation under the palatal plate.

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Fig 7-9g Right-sided sinus elevation.

Dental treatment, sinus elevation and provisional implants

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Two days before the operation, the patient started antibiotic cover with the standard regimen: amoxicillin 750 mg, 3 times daily for 1 week. Due to the extent of the procedure and the patient's severe phobia, the operation took place under general anesthesia. First, the maxillary prosthesis was removed (Fig 7-9d). Teeth 14, 13 and 24 came out directly with the prosthesis when the latter was taken out. The patient's fears were thus wholly justified (Fig 7-9e). Because of the prolonged period without any cleaning, food residues had accumulated under the transpalatal arch. This had led to inflammation of the palate (Fig 7-9f). Before sinus elevation, the entire oral cavity was cleaned mechanically and generously irrigated with H_2O_2 and chlorhexidine. Sinus elevation on the right side was performed first (Fig 7-9g). The provisional implants needed for the immediate restoration were inserted around the maxillary defects caused by loose teeth 13 and 14 (Fig 7-9h). Before augmentation, the residual ridge was carefully cleaned of any granulation tissue and refreshed with a small rose head bur (Fig 7-9i). In addition to sinus elevation, the residual ridge defect at positions 13 and 14 was regenerated and the entire lateral residual ridge augmentation was performed (Fig 7-9j). The augmentation material Bio-Oss was covered with a large Tutodent membrane, which was also attached with titanium pins. Periosteal slitting was followed by saliva-proof suturing.

Sinus elevation on the left side was the next step. In addition to the large bone defect, this was complicated by a vertical septum (Fig 7-9k). Based on the implant planning, tooth 23 also had to be extracted and the residual ridge defects augmented, especially in regions 24 and 27. Sinus elevation was performed first, after which the provisional implants were inserted in the remaining bone fragments (Fig 7-9l). After thorough cleansing, the residual ridge defects were filled with a mixture of Bio-Oss and autologous bone, and the augmentation material was stabilized in situ with membranes and pins (Fig 7-9m). The entire operation site in the maxilla was closed with sutures and the provisional implants aligned to be as parallel to one another

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as possible (Fig 7-9n). In the mandible, after the necessary dental treatment, teeth 43 and 45 were left in situ and supplemented with four Alpha-Bio (Alpha-Bio Tec) implants as abutments for the long-term provisional (Fig 7-9o). In both jaws, the first immediate provisionals were produced with the aid of thermoplastic foil and incorporated (Fig 7-9p). The postoperative panoramic radiograph shows the bone situation after the dental treatment (Fig 7-9q). The long-term provisionals, fabricated in the laboratory, were incorporated 10 days after the operation and worn by the patient for 1 year while the sinus lifts and augmentation healed (Fig 7-9r)

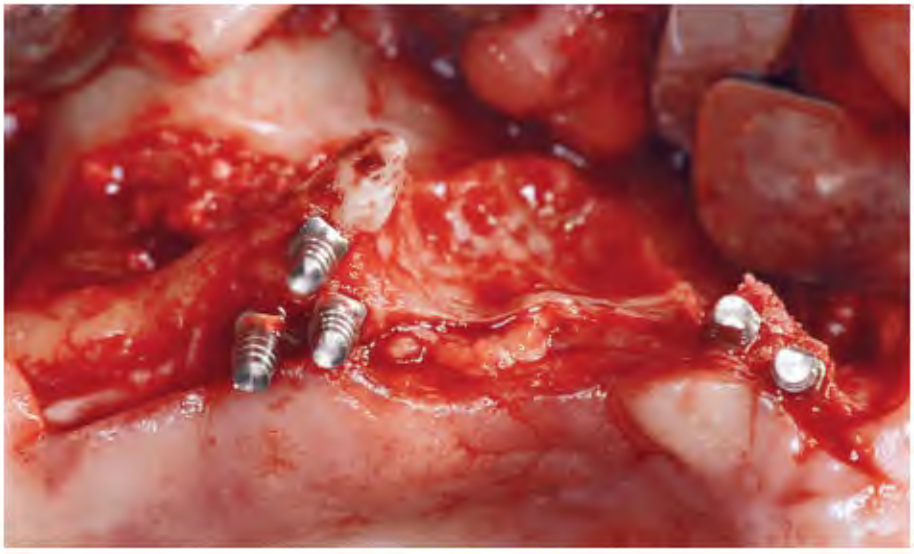


Fig 7-9h Inserting the provisional implants.

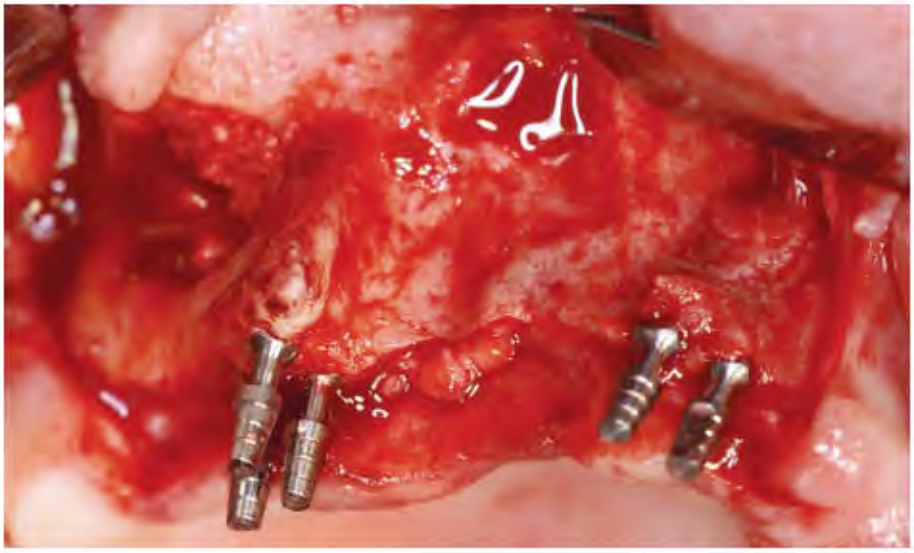


Fig 7-9i Large residual ridge defect in regions 13 and 14.

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Fig 7-9j Augmentation on the right side.

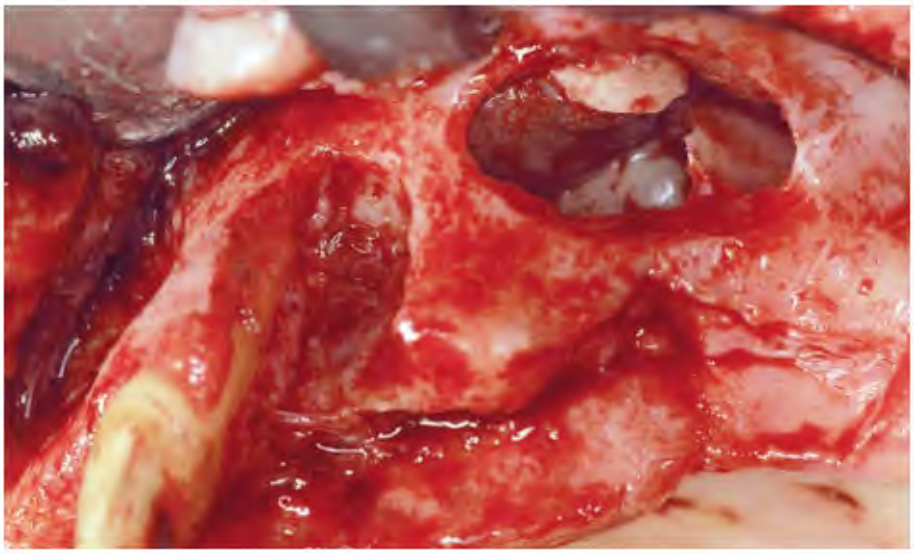


Fig 7-9k Large defects on the left side.

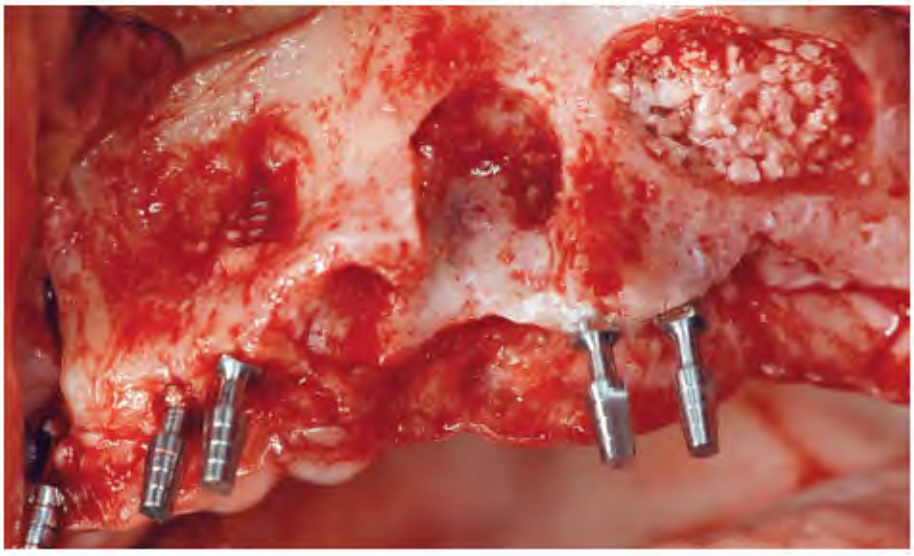


Fig 7-9l Left-sided sinus elevation.

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Fig 7-9m Augmentation on the left side.

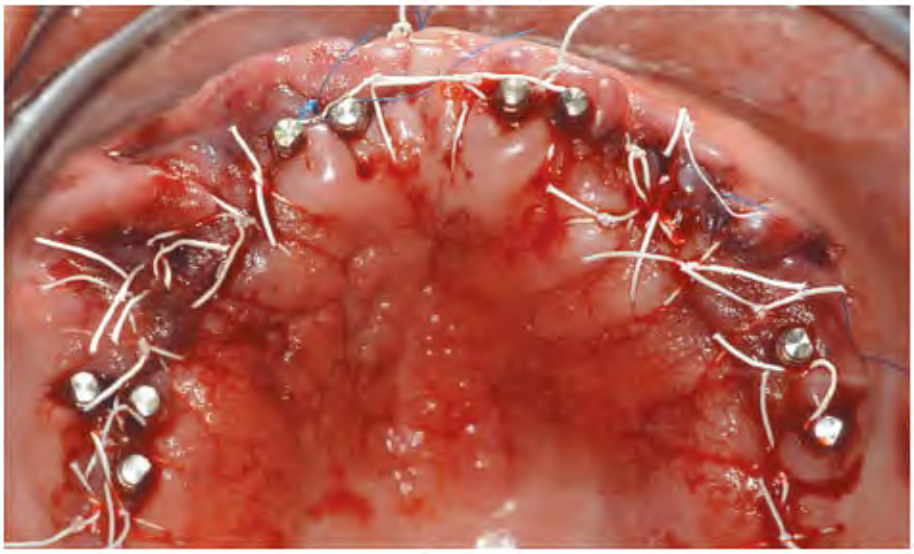


Fig 7-9n Occlusal view following suturing.



Fig 7-9o Provisional implants following dental treatment in the mandible.

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Fig 7-9p Fixed immediate provisionals in both jaws.

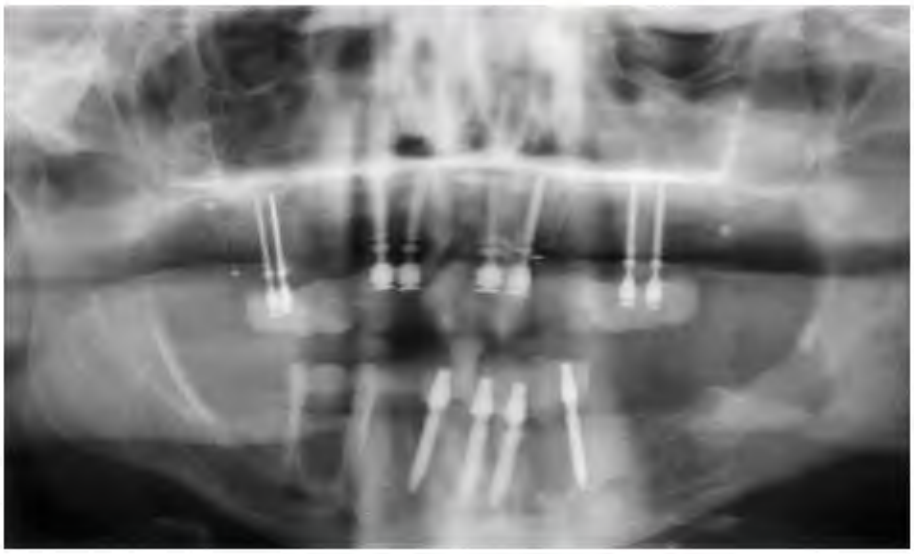


Fig 7-9q Follow-up panoramic radiograph after the dental treatment.



Fig 7-9r Incorporated long-term provisionals in situ.

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Fig 7-9s Provisional implants following removal of the fixed provisionals.



Fig 7-9t The IPIs in the maxilla had to be repositioned.



Fig 7-9u Insertion of five implants in the second quadrant.

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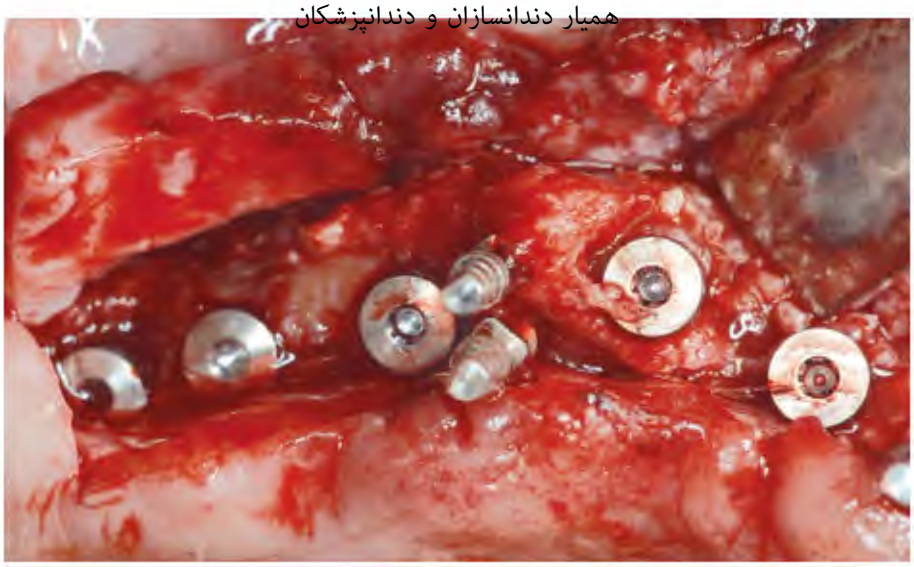


Fig 7-9v Implant placement on the right side.

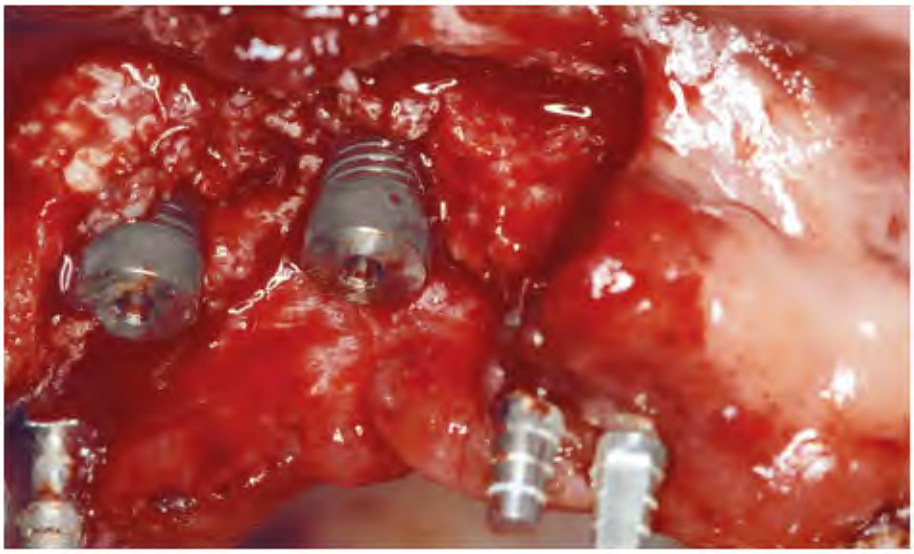


Fig 7-9w Large bone defect in the anterior region.

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Implant placement and augmentation

Because of the extent of the procedure and at the patient's request, implant placement was also performed under general anesthesia. The long-term provisionals in both jaws were removed and the abutments mechanically cleaned and disinfected with H_2O_2 (Fig 7-9s). While all the provisional implants were stable and showed nothing of note, their positions had to be changed (Fig 7-9t). The IPI in region 15 needed to make place for a permanent implant, and the regenerated bone on the left side provided a bed for the insertion of a new IPI to reinforce the structure. On the left side, five definitive implants and one IPI in region 24 were inserted with primary stability (Fig 17-9u). Five definitive implants were also inserted on the right side, one of them in place of the IPI in region 15 (Fig 7-9v). There was a bone shortage in the anterior maxilla, especially regions 12 and 13 (Fig 7-9w). The entire maxilla needed additional

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augmenting before the area was sutured (Fig 7-9x). Once the operation in the maxilla was completed, implant placement continued in the mandible. First, the definitive implants in regions 33, 35, 36 and 37 were inserted on the left side, without changing the positions of the IPIs or of the long-term provisional (Fig 7-9y). On the right side, the implants were inserted next to the abutment teeth in positions 42, 44, 46 and 47 (Fig 7-9z). Before the area was sutured, all the remaining bone defects in the mandible were also augmented (Fig 7-9aa). The postoperative panoramic radiograph shows the distribution of the implants in both jaws (Fig 7-9bb).

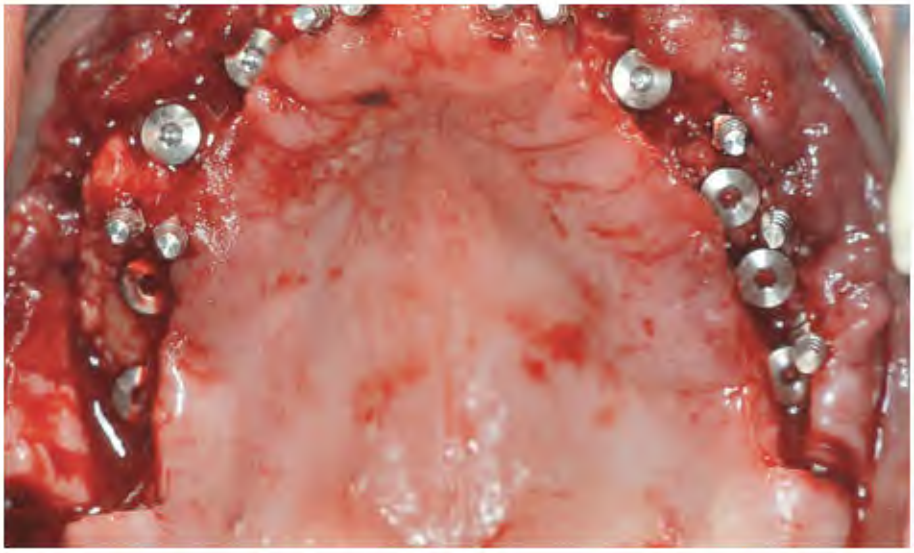


Fig 7-9x Maxilla before augmentation.

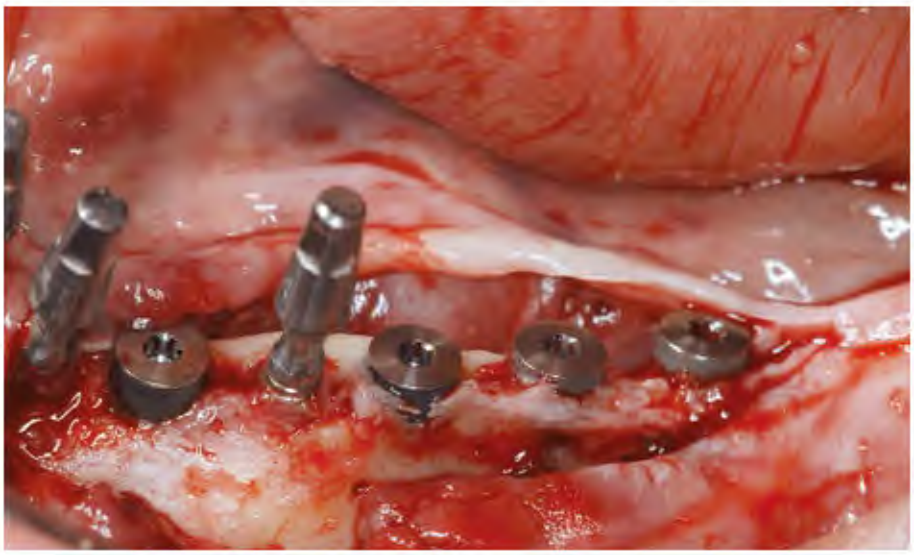


Fig 7-9y Implant placement in the third quadrant.

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Fig 7-9z Insertion of the implants in the right mandible.

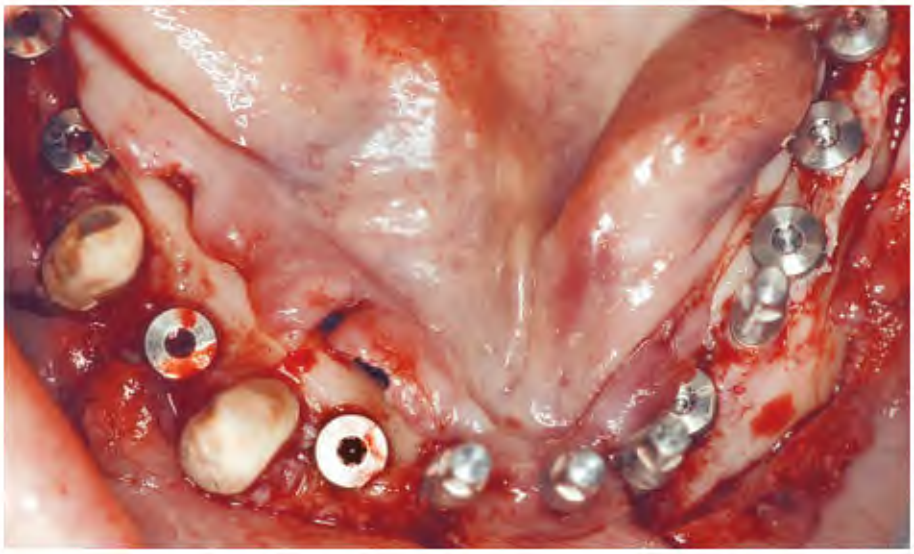


Fig 7-9aa Whole mandible before augmentation.

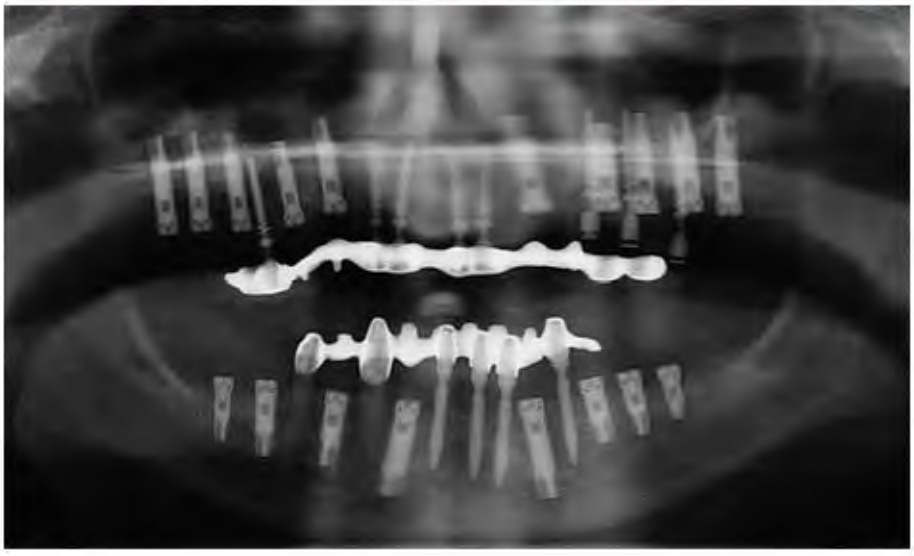


Fig 7-9bb Postoperative panoramic radiograph after implant placement.

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Fig 7-9cc Exposure in the mandible.



Fig 7-9dd Maxilla prior to exposure.

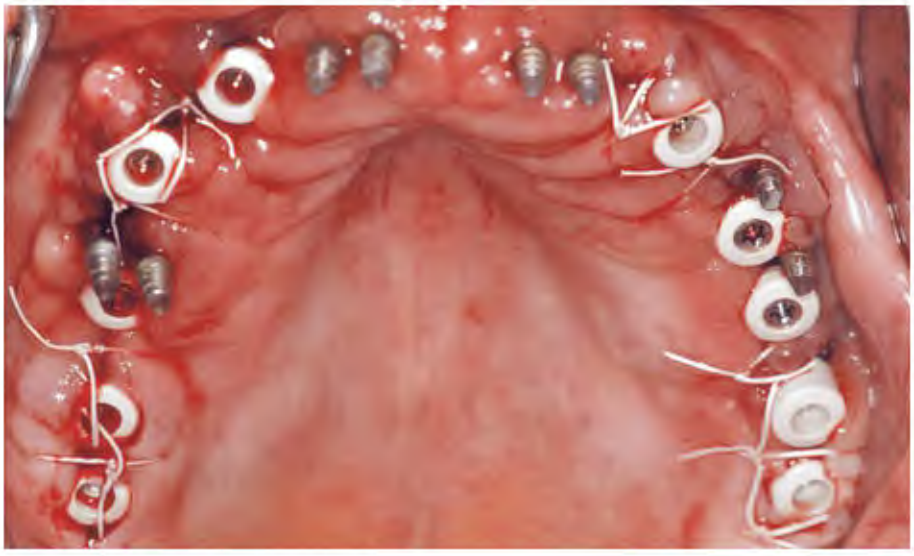


Fig 7-9ee Healing abutments screwed into place in the maxilla.

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Fig 7-9ff Maxilla before the impression was taken.



Fig 7-9gg Stable gingival situation in the mandible after 3 weeks.

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Exposure

All the implants were exposed after a healing period of 10 months. Exposure began in the mandible (Fig 7-9cc). In the maxilla, implant 26 had become uncovered spontaneously, while the others were exposed with a scalpel (Fig 7-9dd). During the exposure operation, every effort was made to reconstruct the zone of attached gingiva around all the implants (Fig 7-9ee).

Prosthetic restoration

Three weeks after exposure, the gingival situation in both jaws had stabilized, allowing impressions to be taken (Figs 7-9ff and 7-9gg). Both were taken on custom trays with Impregum (3M ESPE). Before this, the exact positioning of the impression copings was

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verified with a check radiograph. A screw-retained interocclusal record was fabricated in the laboratory, to facilitate the precise transfer of the maxillo-mandibular relationship.



Fig 7-9hh Index key for precision testing in the maxilla.

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Fig 7-9ii Index key with hollowed-out teeth in the mandible.

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Fig 7-9jj Screw-retained, metal-ceramic cross-arch bridge in the mandible.



Fig 7-9kk Finished and fitted superstructure in the maxilla.

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Attention: ***The next steps would have been the wax-up, the framework try-in and possibly the bisque bake try-in. However, it is a laborious process to perform both try-ins in the presence of the provisional implants, and these are needed to provide support for the long-term provisionals until the definitive restorations are fabricated. To simplify the procedure, the precision of the definitive casts can be checked instead. This is done with a resin or metal index key, which is tried-in inside the mouth and allows each implant to be checked individually for any tension. It is important to ensure that the key is not supported on the IPIs at any point (Figs 7-9hh and 7-9ii). The unbelievably high precision of CAD/CAM superstructures milled from a single piece of material normally allows the restoration to be fabricated directly. However, the dentist needs to be aware that it will no longer be possible to insert the old long-term provisionals once any remaining teeth have been extracted and the provisional implants have been removed.***

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The finished fixed restoration was incorporated into the mandible directly following the extraction of both teeth and removal of the Alpha-Bio implants (Fig 7-9jj). In the maxilla, all the IPIs were unscrewed from the bone and the finished metal-ceramic fixed cross-arch bridge screwed into place (Fig 7-9kk). Both of the freshly incorporated superstructures can be seen in Figure 7-9ll. After 1 year of functional use, both superstructures were unscrewed for a progress check. In the mandible, the gingival situation around all the implants, except at position 33, appeared healthy (Fig 7-9mm). In the maxilla, there is reddening of the gingiva under the fixed implant bridge in a few places, indicating the need for an improvement in cleaning technique in these areas (Fig 7-9nn). The bone situation in the panoramic radiograph looks satisfactory after 1 year (Fig 7-9oo).



Fig 7-9ll Overall rehabilitation following treatment completion (see Fig 7-9a).

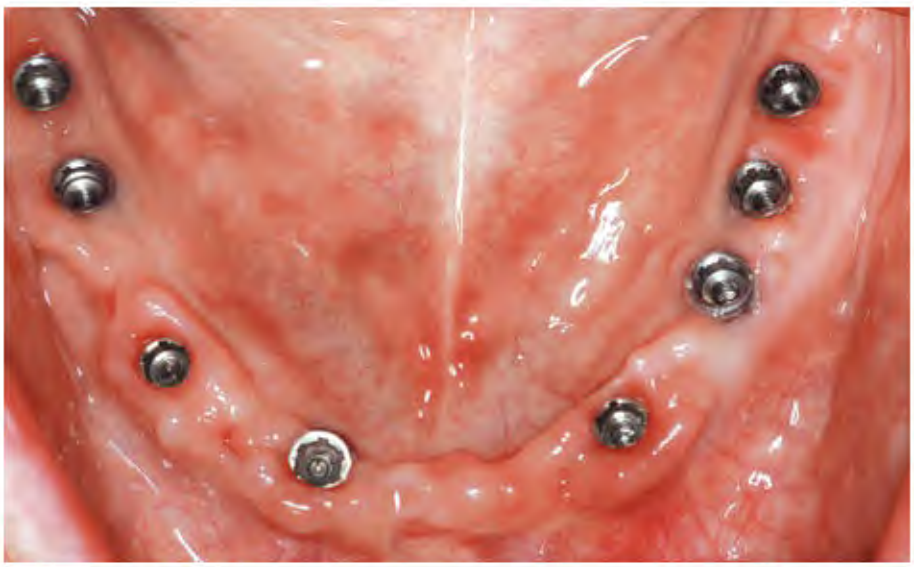


Fig 7-9mm Gingival situation in the mandible after 1 year.

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Fig 7-9nn Areas of mild inflammation under the superstructure in the maxilla after 1 year.

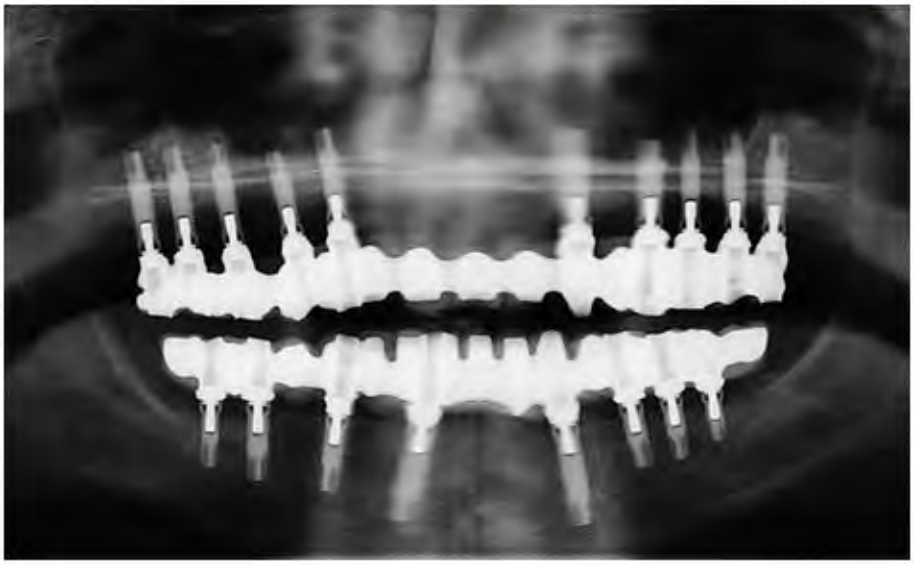


Fig 7-9oo Panoramic radiograph after 1 year of functional use.

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Treatment course

- Dental treatment, sinus elevation and provisional implants with immediate provisional restoration (2008)
- 1 year to implant placement in the maxilla and mandible
- 10 months to exposure and prosthetic loading

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski and Dominika Sliwowska, DDS
Dental technology: Dental Technician Ludger Jansen, DentaLab

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Immediate restoration of provisional implants in the maxilla and definitive implants in the mandible, with a life-threatening complication

Baseline situation

A young man (38 years of age), all of whose residual dentition was to be extracted, suffered from severe dental phobia, as evidenced by the state of his teeth (Fig 7-10a). He was in excellent health and very athletic, being particularly involved in marathon running, which will be of some significance to the course of his treatment. All of the patient's hematology and lab test results were outstanding. Eight definitive and eight provisional implants were to be inserted into the maxilla once all the teeth had been extracted (Fig 7-10b). In the mandible, six definitive implants were to be inserted following the necessary dental treatment and loaded with an immediate provisional restoration.

Diagnostic tools

- Clinical examination
- Panoramic radiograph
- CBCT
- SimPlant planning
- Dental cast analysis

Treatment plan

1. Dental treatment including extractions, implant placement in the maxilla and mandible with fixed immediate restoration
2. Exposure and definitive prosthetic loading

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Fig 7-10a Clinical situation before the treatment.



Fig 7-10b Occlusal view of the maxilla.

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Implant placement and life-threatening hemorrhage

Following the administration of infiltration anesthesia, all the teeth were first extracted from the maxilla and mandible and the oral cavity extensively disinfected with H_2O_2. Six 17-mm long and 4-mm diameter implants were inserted into the mandible, with an immediate provisional restoration to be loaded onto to them (Fig 7-10c). Despite repeated injections of articaine with norepinephrine at a ratio of 1:100000, heavy bleeding from the wound continued unabated. Implant placement was therefore performed swiftly. Once the mandible had been tightly sutured, implant placement continued in the maxilla. Despite the same interventions, the

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maxilla bled even more heavily than the mandible. Because of the severe and unstoppable hemorrhage, the eight definitive and nine provisional implants were inserted using an expedited procedure (Figs 7-10d and 7-10e). In the surgeon's view, the wound needed to be closed as quickly as possible to stop the bleeding. This was also the case in the maxilla, but it did prove possible to fabricate the immediate provisional out of Protemp (3M ESPE) with the aid of a thermoplastic foil (Fig 7-10f). While this was being done, we observed that the floor of the mouth was so swollen as to make it totally impossible to fabricate the provisional in the mandible. An analysis of the situation showed that a very large hematoma had developed at the floor of the mouth, that the patient would not have been able to breathe at all following extubation (Fig 7-10g). Therefore, the patient's life was critically at risk. Since the operations were taking place in a hospital under general anesthesia, the patient was transferred to the intensive care unit after discussion with the anesthetist. After 3 days of intensive cooling and the administration of corticosteroids, the hematoma subsided completely, allowing the patient to be extubated without risk. The long-term provisionals for the mandible and maxilla were fabricated and incorporated a few days later.

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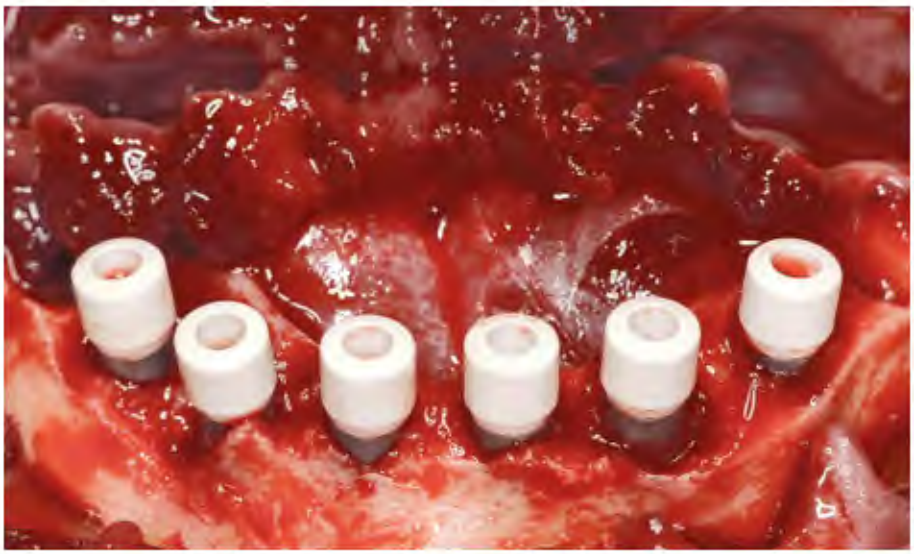


Fig 7-10c Implant placement in the mandible.

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Fig 7-10d Insertion of the definitive and provisional implants in the maxilla.

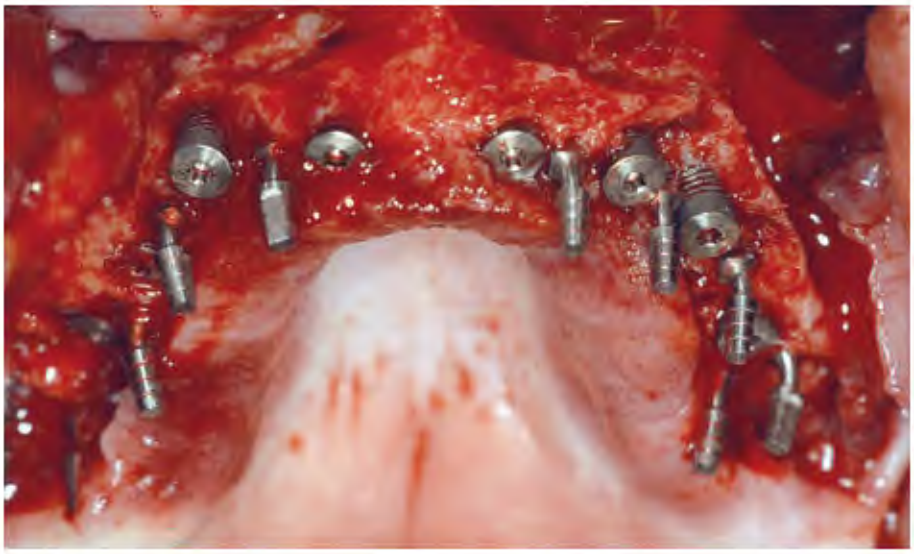


Fig 7-10e Aligning the provisional implants.



Fig 7-10f Immediate provisional restoration in the maxilla.

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Fig 7-10g Life-threatening hematoma at the floor of the mouth.



Fig 7-10h Long-term provisionals in the maxilla and mandible.

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Fig 7-10i Follow-up panoramic radiograph.



Fig 7-10j Removing the provisional from the maxilla.

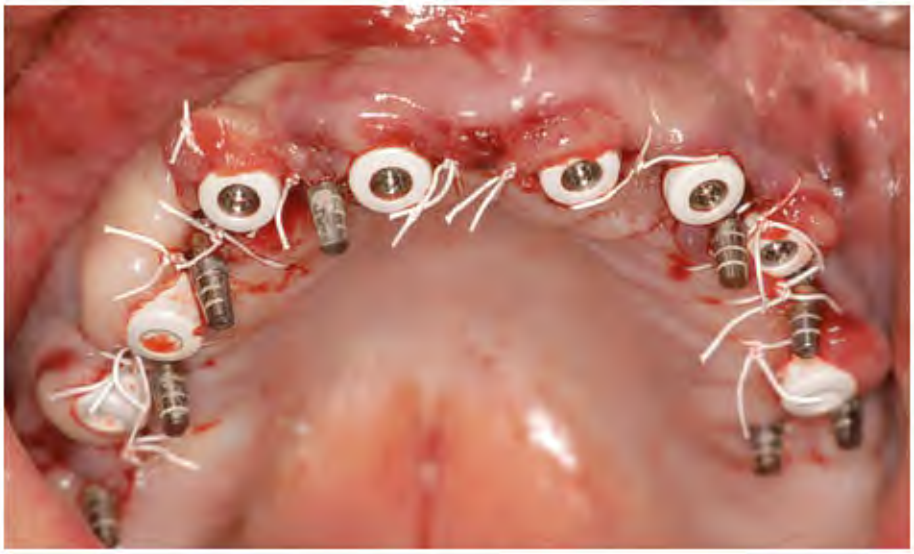


Fig 7-10k Exposure of the implants.

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Exposure and prosthetic restoration

The patient was able to see through the 10-month healing period with long-term fixed provisionals (Fig 7-10h). The bone situation appeared stable in the panoramic radiograph (Fig 7-10i). The long-term provisional in the maxilla was removed and the provisional implants cleaned (Fig 7-10j). All the definitive implants were exposed, with two provisional ones having to be removed (Fig 7-10k). The long-term provisional was reshaped and incorporated again directly after exposure (Fig 7-10l). After 4 weeks, the gingival situation was stable, allowing an impression to be taken (Fig 7-10m). Before this was done, the positions of the impression copings were checked with a panoramic radiograph (Fig 7-10n). The superstructure for both jaws were fabricated at the same time, and were ready for incorporation and retention with titanium screws without the need for any corrective adjustments. Three months after the incorporation, the fixed bridges were removed and the screws exchanged. The gingival situation in the maxilla was stable and clean (Fig 7-10o). The restorations was now reattached with gold screws, tightened at 20 N/cm. The screw access holes were sealed off with composite resin (Fig 7-10p). This was followed by removal of the fixed bridge in the mandible (Fig 7-10q). The insides of the implants were irrigated with H_2O_2 and then reattached with gold screws (Fig 7-10r). After the prosthetic loading of the implants, the patient's oral hygiene had improved to such an extent that there was little need for professional cleaning (Fig 7-10s).

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Fig 7-10l The long-term provisional has been reincorporated.

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Fig 7-10m Situation before the impression was taken.

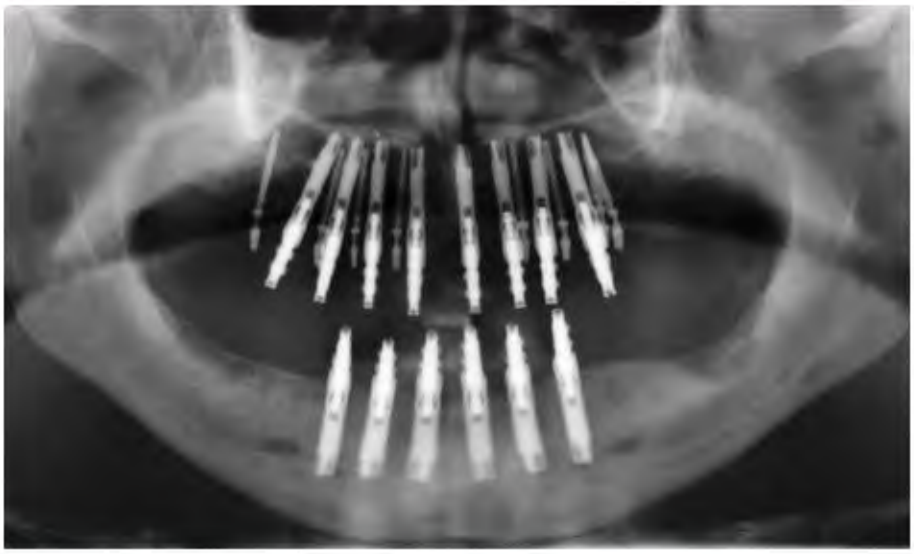


Fig 7-10n Radiologic check of the positions of the impression copings.



Fig 7-10o Stable gingival situation in the maxilla.

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Fig 7-10p Occlusal, screw-retained cross-arch bridge in the maxilla.



Fig 7-10q The superstructure has been removed from the mandible.



Fig 7-10r Screw-retained, cantilever fixed implant bridge 36 to 46 in the mandible.

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Fig 7-10s Overall picture following treatment completion.

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Treatment course

- Dental treatment, implant placement and immediate provisional dentures (2008)
- 10 months to exposure
- 4 weeks to impression taking and fabrication of the dental prostheses

Treatment

Surgery and prosthetics: Dr Christoph T. Sliwowski, Dominika Sliwowska, DDS
Dental technology: Dental Technician Ludger Jansen, DentaLab

Notes on life-threatening hemorrhage

1. When performing such an extensive implant placement in the mandible, the surgeon must always consider the possibility of a life-threatening hemorrhage or hematoma, which could block the airways.
2. Highly athletic individuals whose physical performance depends on a speedy oxygen supply are likely to suffer heavier bleeding during surgery.
3. In this case, it was an advantage that the mandible was treated first and that the patient was not extubated directly after the wound was sutured.
4. It is an advantage to perform major procedures under general anesthesia at a hospital and with a professional anesthesia team in attendance.

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List of materials

Surgery

Medicines
Amoxicillin, Ratiopharm, Ulm, Germany
Arnica D 12, Deutsche Homöopathie-Union, Karlsruhe, Germany
Bromelain, Ursapharm, Saarbrücken, Germany
Dormicum, Roche, Grenzach, Switzerland
Fortecortin Inject, Merck Serono, Darmstadt, Germany
Gentamicin, Ratiopharm, Ulm, Germany
Gelonida, Gödecke, Berlin, Germany
Solcoseryl Dental Adhesive Paste, Solco, Grenzach-Wyhlen, Switzerland

Bone filters
Autogenous Tissue Collector, Biomet 3i, Palm Beach, USA
Bone Collector, Anthogyr Implants, Sallanches, France
Bone Collector, Imtec, Ardmore, USA

Nails and tacks
Bone Tack - 3 und 5 mm, Imtec, Ardmore, USA
Frios Nails, Friatec, Mannheim, Germany
Membrane Nails, JMP Dental, Heiligenhaus, Germany

Implants
Brånemark System, Nobel Biocare, Kloten, Switzerland
Neoss Implant System, Neoss Ltd., Harrogate, United Kingdom
Nobel Replace Select Straight, Nobel Biocare, Kloten, Switzerland
NobelActive, Nobel Biocare, Kloten, Switzerland
3i Implant System, Biomet 3i, Palm Beach, USA
SOS Implant, Osteoplant, Posen, Poland

Provisional Implants
Arrow Titanium Implant, Alpha-Bio, Tikva, Israel
Immediate Provisional Implant (IPI), Nobel Biocare, Kloten, Switzerland
K.S.I. Bauer screws, Bad Nauheim, Germany

Regenerative bone substitutes
Biogran, Biomet 3i, Palm Beach, USA
Bio-Oss, Geistlich, Wolhusen, Switzerland
Cerasorb, curasan, Kleinostheim, Germany
OSTIM, Heraeus Kulzer, Hanau, Germany
NanoBone, Dentaurum, Ispring, Germany
Tutodent microchips, Tutogen Medical, Neunkirchen am Brand, Germany
Tutoplast cancellous bone, Tutogen Medical, Neunkirchen am Brand, Germany
BioSeed, BioTissue Technologies, Freiburg, Germany
Puros, Zimmer Dental, Freiburg, Germany

Membranes
Atrisorb, TOLMAR, Fort Collins, USA
Bio-Gide, Geistlich, Wolhusen, Switzerland
Bio-Tape, Geistlich, Wolhusen, Switzerland
Gore-Tex, Gore, Flagstaff, USA
OsseoQuest, Gore, Flagstaff, USA

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Ossix, Biomet 3i, Palm Beach, USA
Parasorb Resodont, Resorba Medical, Nürnberg, Germany
Resolut membrane, Gore, Flagstaff, USA
Tutodent Membrane, Zimmer Dental, Freiburg, Germany
Vicryl Mesh, Johnson & Johnson/Ethicon, Norderstedt, Germany
Mucograft, Geistlich, Wolhusen, Switzerland

Suturing material
Gore-Tex sutures CV-6, Gore, Flagstaff, USA
Mopylen 6-0, Resorba Medical, Nürnberg, Germany
Surgipro, Covidien, Mansfield, USA

Surgical and prosthetic devices
Osseocare, Nobel Biocare, Kloten, Switzerland
Osstell Mentor, Osstell, Göteborg, Sweden
Torque Controller, Nobel Biocare, Kloten, Switzerland
PACT, Cumdente, Tübingen, Germany
Osseoset 200, Nobel Biocare, Kloten, Switzerland

Prosthetics

Cements (definitive and provisional)
AGC Cem, Wieland Dental, Pforzheim, Germany
Cavit G, Espe, Seefeld, Germany
Roeko Gutta-percha white, Coltene/Whaledent, Langenau, Germany
Harvard Cement, Harvard Dental International, Hoppegarten, Germany
ImProv, Nobel Biocare, Kloten, Switzerland
TempBond, Kerr, Rastatt, Germany

Dental impression materials
Exabite II NDS, GC, Bad Homburg, Germany
Exaflex, GC, Bad Homburg, Germany
Examix, GC, Bad Homburg, Germany
Impregum, 3M ESPE, Seefeld, Germany
Imprint SBR, 3M ESPE, Seefeld, Germany
Permadyne, 3M ESPE, Seefeld, Germany
Silicone putty, Orbis dental, Offenbach, Germany

Self-polymerizing resins
Pattern Resin, GC, Bad Homburg, Germany
Trim, Bosworth Company, Skokie, USA
Visco-gel, Dentsply/De Trey, Konstanz, Germany
Protemp, 3M ESPE, Neuss, Germany

Dental technology

Articulators
SAM 2, SAM Präzisionstechnik, Munich, Germany
Artex Typ TK, Girrbach, Pforzheim, Germany

Deep-drawn foils
Erkodur deep-drawn foils and base plates 1.5 mm (hard), Erkodent, Pfalzgrafenweiler, Germany
Erkolen 1.0 mm (elastic), Erkodent, Pfalzgrafenweiler, Germany

Abutments

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CeraOne, Nobel Biocare, Kloten, Switzerland
CerAdapt, Nobel Biocare, Kloten, Switzerland
EsthetiCone, Nobel Biocare, Kloten, Switzerland
Micro Mini, Biomet 3i, Palm Beach, USA
Neolink, Neoss, Harrogate, United Kingdom
Standard, Nobel Biocare, Kloten, Switzerland
TiAdapt, Nobel Biocare, Kloten, Switzerland
PEEK abutments, Neoss, Harrogate, United Kingdom
SOS-EBF (Eccentric Bar Fixation) Abutment, Osteoplant, Posen, Poland

Individual trays
Gebdi tray material, light-curing, Gebdi Dental, Engen, Germany
LC-Tray, Roos Dental, Mönchengladbach, Germany
Gematray-LC, Gema Dental, Breisach, Germany

Gingival masks
Gi-Mask, Coltene/Whaledent, Langenau, Germany
Gingitech, Ivoclar Vivadent, Schaan, Liechtenstein
Vestogum, 3M ESPE, Seefeld, Germany

Acrylate plastics
Formatray (for bite plates), Kerr, Rastatt, Germany
Metalprimer II (bonding), GC, Bad Homburg, Germany
Palapress colorless (for surgical templates), Heraeus Kulzer, Hanau, Germany
Ropak UV P (pink), Bredent, Senden, Germany
Selectaplus (for prostheses), Dentsply/Degudent, Hanau, Germany

Ceramics
AllCeram, Dentsply/Degudent, Hanau, Germany
Finesse All-Ceramic, Dentsply/De Trey, Konstanz, Germany
Procera, Nobel Biocare, Kloten, Switzerland

Microscrews
Pontilock, ZL, Breckerfeld, Germany

Technical water-cooled turbine handpiece
Shape-Air, Nobel Biocare, Kloten, Switzerland

Locking attachments
Degusafe, Degussa, Hanau, Germany
MK1, MK1 Dental Attachment, Bockhorn, Germany

3D planning programs
SimPlant, Dentsply/De Trey, Konstanz, Germany
co-DiagnostiX, Straumann, Basel, Switzerland
Med3D, Med3D Implantology, Heidelberg, Germany
NobelClinician, Nobel Biocare, Kloten, Switzerland

Surgical 3D templates
SurgiGuide, Dentsply/De Trey, Konstanz, Germany
NobelGuide/NobelClinician,, Nobel Biocare, Kloten, Switzerland
GonyX, Straumann, Basel, Switzerland

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