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| Research

Use of allogeneic cortical granulate for external surgical sinus floor elevation

| Case report

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| Industry report

Sinus augmentation with atelo-collagenated bovine bone graft Hypro-Oss



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Dr Roland Hille

Dear colleagues,

If you are one of those who want to include field-tested and innovative implantological treatment concepts to your office and, furthermore, you wish to learn about the decisive criteria for practical techniques and materials, I am sure we will see each other at the 44th International Annual DGZI Congress on 26 and 27 September 2014 in Düsseldorf, Germany. We chose this special congress venue as Düsseldorf forms the international centre of an innovative region with a high entertainment factor.

Advanced education will usually demand some of your spare time, but with our DGZI training courses, you will have much fun and easily-applicable knowledge in exchange, ensuring both the success of your dental office and content patients.

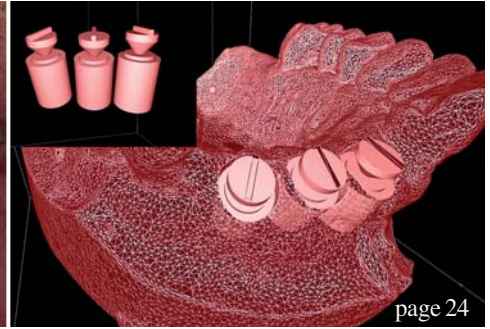
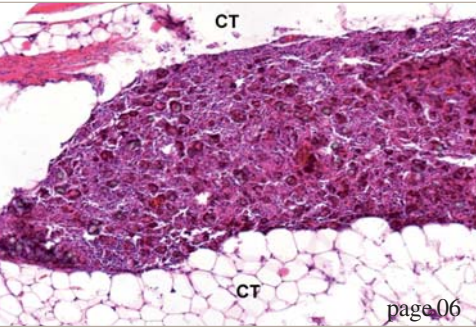
Only you can influence this business factor, and it's the best marketing tool to gain new patients. DGZI offers you opportunities which include e-learning curriculums and master study courses that you shouldn't miss! As in the previous years, our discussion panel DGZI Kontrovers will be used for an active exchange among the speakers and their audience. This year's motto is "Stone-Age Implantology vs. Computer Games" encourages to discuss technology by posing questions such as "Which products are necessary?", "Which products are mandatory?" and "What are my general options?". In addition, we will also discuss high-level implantology which makes do without high-end technology, as each patient deserves an individual treatment concept.

Again we have assembled more than 30 speakers from Germany and around the world who will provide you with new ideas and innovative concepts.

Don't miss out on this year's International Annual DGZI Congress! Its personal atmosphere, combined with an extensive dental exhibition, will guarantee that you can "learn from the best" and enjoy immediate success. I am looking forward to seeing you in Düsseldorf!

Warm regards,

Prof. (CAI) Dr Roland Hille
DGZI Vice President and Scientific Director



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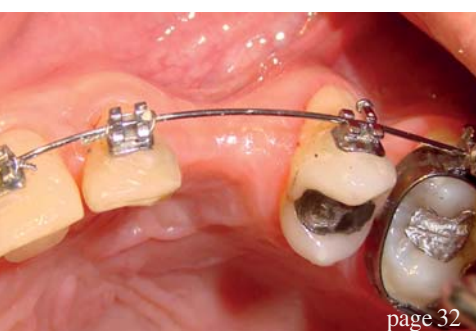
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Injectable bone substitute based on β -TCP granules

Results from an *in-vivo* analysis in Wistar rats

Authors_M. Barbeck, J. Lorenz, C. Landes, R.A. Sader, C.J. Kirkpatrick & S. Ghanaati, Germany

_Introduction

In the recent years biomaterial research has focused on developing a reliable and safe alternative to autologous bone for augmentation in case of a reduced local bone amount. As autologous bone has osteoinductive, osteoconductive and osteogenic properties, it is postulated to be the gold standard in peri-implant hard tissue augmentation.¹ Xenogenic bone substitutes, originating from animals of different species and processed in different steps, are well researched and accepted from both surgeons and patients.² Alloplastic bone substitutes from synthetically manufactured hydroxyapatite (HA), beta-tricalcium phosphate (β -TCP) or a mixture of these two compounds have been reported to be biocompatible, degradable and osteoconductive.³⁻⁷

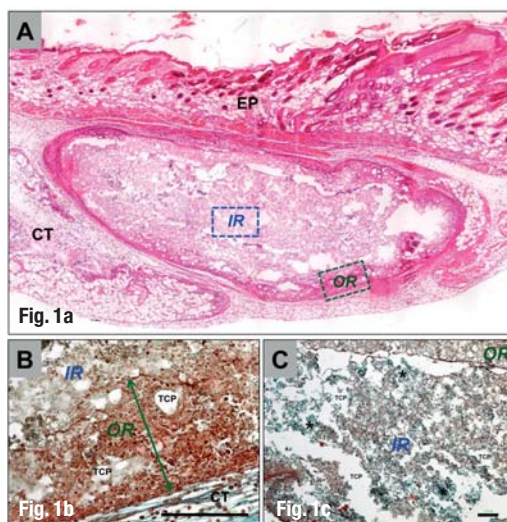
During integration in the host tissue, parameters such as the potential induction of an inflammatory response, the biomaterial vascularisation and degradation play an important role.⁸⁻¹⁴ By modifying the chemical and physical characteristics of a biomaterial, i.e. its chemical composition and its surface structure morphology and porosity, it seems to be possible to tailor alloplastic bone substitute materials individually to specific requirements.⁹ From a number of *in vitro* and *in vivo* trials it is known that beside the chemical composition, the granule size also has a significant impact in the degradation behaviour of synthetic bone substitute materials. Granules with a mean size larger than 500 μm and a low porosity are more slowly degraded and resist the ingrowth of connective tissue in the implantation bed more than granules smaller than 50 μm .^{9,12,15-17} However, small granules might be more suitable for different kinds of defect classes.

With a combination of small, pure-phase β -TCP granules, which serve as bioactive fillers, and a carrier matrix of methylcellulose (MC) and hyaluronic acid (HY), the fast degradation of the small granules and the connective tissue influx might be prevented by the aqueous phase. All three components, the β -TCP, the MC and the HY are known to be biocompatible^{2-6,18-25} and have optimal mechanical and regulating properties, which are favourable for tissue engineering and regeneration.²⁰⁻³⁵ Additionally, biomaterial might also be easier to handle, as it is paste-like and therefore injectable into the augmentation site.

The aim of the present study was to investigate the inflammatory response, as well as the overall integrity within the implantation bed, the degradation behav-

Fig. 1 The tissue reaction to the triphasic bone substitute material at day 3 after implantation:

- a) a total scan of the bone substitute, which was located within the connective tissue (CT: connective tissue; EP: Epidermis; OR: outer cell-rich region; IR: inner region) (H&E-staining, total scan, 100x magnification);
- b) the infiltration of mononuclear cells into the outer region (Movat's pentachrome staining, 400x magnification; scale bar = 100 μm);
- c) inner region (IR), in which the β -TCP granules (TCP) were embedded (asterisks) (Movat's pentachrome staining, 100x magnification; scale bar = 100 μm).





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Fig. 2 The tissue reaction to the triphasic bone-substitute material at day 10 after implantation:

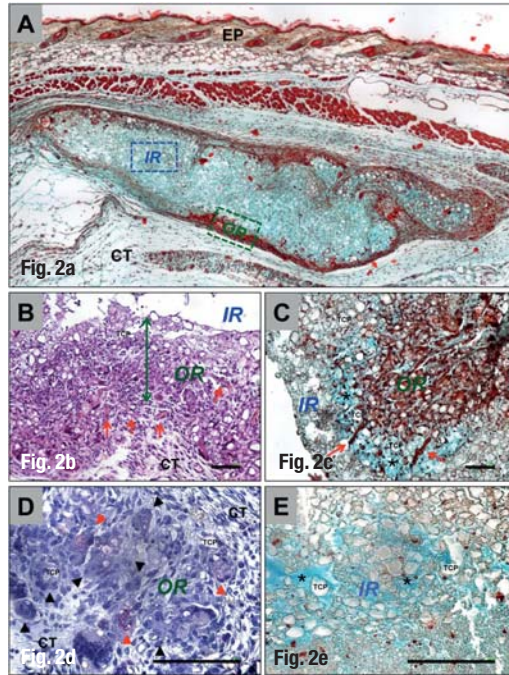
a) an overview of the total implant area by means of a total scan. (H&E-staining, total scan, 100x magnification);

b) the outer region (OR, double head arrow), which was distinguishable from the inner region (IR). (red arrows: vessels; arrow heads: giant cells; H&E-staining, 200x magnification; scale bar = 100 μ m);

c) ingrowth of connective tissue into the outer region of the implanted paste-like bone-substitute material. (red arrows: vessels; red asterisks: polymer solution; Movat's pentachrome staining, 400x magnification; scale bar = 100 μ m);

d) multinucleated giant cells within the outer region; red arrow heads: TRAP positive multinucleated giant cells; black arrow heads: giant cells without TRAP activity (TRAP-staining, 400x magnification; scale bar = 100 μ m);

e) inner region of the implantation bed. (arrows: mononuclear cells; asterisks:) aqueous polymer solution (Movat's pentachrome staining, 200x magnification; scale bar = 100 μ m).



our and the vascularisation of a new paste-like bone-substitute material composed of β -TCP, methylcellulose (MC) and hyaluronic acid (HY) by means of histological and histomorphometrical analysis. Therefore, the cellular tissue reaction to this new bone substitute material was investigated in the subcutaneous implantation model in Wistar rats during an observation period of 60 days. Three groups with (a) subcutaneous implantation of pure, solid β -TCP, (b) subcutaneous injection of sodium chloride, and (c) a sham operated animals served as controls.

Material and methods

Bone substitute material

In the present study an injectable bone substitute paste made from crushed pure-phase β -TCP, methylcellulose and hyaluronic acid was investigated. The manufacturing process of sintering and crushing results in ceramic particles with a size of $<63 \mu$ m, which were mixed with an aqueous polymer solution in a ratio of 70 wt% ceramics and 30 wt% polymer solution.

Study design

With approval from the Committee on the Use of Live Animals in Teaching and Research of the State of Rhineland-Palatinate, Germany, 90 female, 5-week-old Wistar rats were divided in three groups and received implantation of the above mentioned injectable β -tricalcium phosphate bone substitute material (group 1) and pure, solid β -TCP granules (group 2). For control, ten animals underwent an operation with an injection of sodium chloride (group 3) and another 20 animals (group 4) underwent preparation of subcutaneous pockets without biomaterial implantation. At 3, 10, 15, 30 and 60 days, the animals were sac-

rificed by an overdose of ketamine and xylazine and according to a previously described method^{9, 36-39} the bone substitute material was explanted and processed for histological and histomorphometrical analysis.

Tissue preparation

The extracted samples were fixed in 4% formalin, cut into segments of 4 mm thickness, decalcified, dehydrated in alcohol and embedded in paraffin. Afterwards the samples were cut with a microtome in sections of a thickness of 4 μ m and stained as follows: the first section was stained with haematoxylin and eosin (H&E), the second section with tartrate-resistant acid phosphatase (TRAP) to identify osteoclast-like cells, while the third and fourth section were used for immunochemical staining with ED-1 antibody (for cells of the monocyte-macrophage lineage). A fifth slide was stained with Movat's pentachrome to visualise connective tissue ingrowth within the implantation bed and a seventh slide was stained by von Kossa/Safranin-O staining for identification of calcium and calcium phosphates.^{9, 36-41}

Histological and histomorphometrical investigation

After staining, the sections were investigated by independent investigators with a diagnostic microscope (Nikon, Tokyo, Japan) and the tissue-biomaterial interaction within the implantation bed and the peri-implant tissue was examined histomorphometrically using the NIS-Elements software (Nikon, Tokyo, Japan). The total number of vessels and their area on each slide were determined and related to the total implantation area. Thereby, for each time point, a mean number of vessels per square millimetre and a mean total vessel area could be determined. The results of the quantitative analysis were presented as mean \pm standard deviation with differences considered significant if p-values were <0.05 (* $p < 0.05$) and highly significant if p-values were <0.01 (** $p < 0.01$).

Results

All the animals in each group survived the surgical procedures and the postoperative observation period without complications. No signs for severe inflammatory response were observed.

Tissue reaction to β -TCP granules

Beginning on day 3, the β -TCP granule group material induced penetration of phagocytes, macrophages and connective tissue fibres, resulting in a poorly vascularised fiber and fibroblast rich granulation tissue, which had completely penetrated the implantation bed at day 15. At day 30 and 60 only few remnants of the bone substitute granules were obvious. The vascularisation of the implantation bed remained low, presenting no significant differences in

the aforementioned vascularisation parameters to the results of the two control groups (Figs. 7a-d, 8a & b):

Tissue reaction to paste-like β -TCP solution

Within the implantation bed of the triphasic paste-like β -TCP at day 3, the bone-substitute material appeared as a compact structure. The implanted material could be divided in compact outer surface and an inner core. A large number of phagocytes, lymphocytes, a few plasma cells and eosinophils and connective tissue fibres started to penetrate the outer surface without reaching the inner core. Therefore neither vessels nor connective tissue or organic structures were found in the central parts of the implantation bed (Figs. 1a-c).

At day 10 the separation within the biomaterial was still present. The outer structure contained an active granulation tissue, with an increased vascularisation by newly formed vessels, while the inner core, comparable to day 3, was still populated by very few mononuclear cells (Figs. 2a-e).

At day 15, the degradation of the outer structure proceeded. The granulation tissue formed around the biomaterial was rich in vessels and contained more multinucleated giant cells than at day 10. In the inner core still less connective tissue fibres and mononuclear and especially multinuclear cells were detectable compared to the outer regions (Figs. 3a-d).

The implantation bed showed total integration of the inner and outer part of the implanted biomaterial at day 30. TRAP positive multinucleated giant cells dominated the fiber and vessel rich granulation tissue. The former outer region had been transformed into a connective tissue with very few phagocytes and rich in fibres, while the inner core of the implant had been transformed into a richly vascularized granulation tissue (Figs. 4a & c).

To the end of the observation at day 60 the degradation of the biomaterial, mainly by multinucleated giant cells continued. In areas, where biomaterial remnants were still present, granulation tissue was still present, while in parts where the biomaterial was already completely degraded, it was replaced by adipose and connective tissue. Remaining granules were surrounded by phagocytes, i.e. macrophages and multinucleated giant cells (Figs. 5a & c, 6a-d).

Histomorphometric results

Histomorphometric investigation of the explanted biomaterials was performed to determine the vascularisation within the implantation bed at different time points of biomaterial integration. At day 3 a mild vascularisation within the three phasic injectable

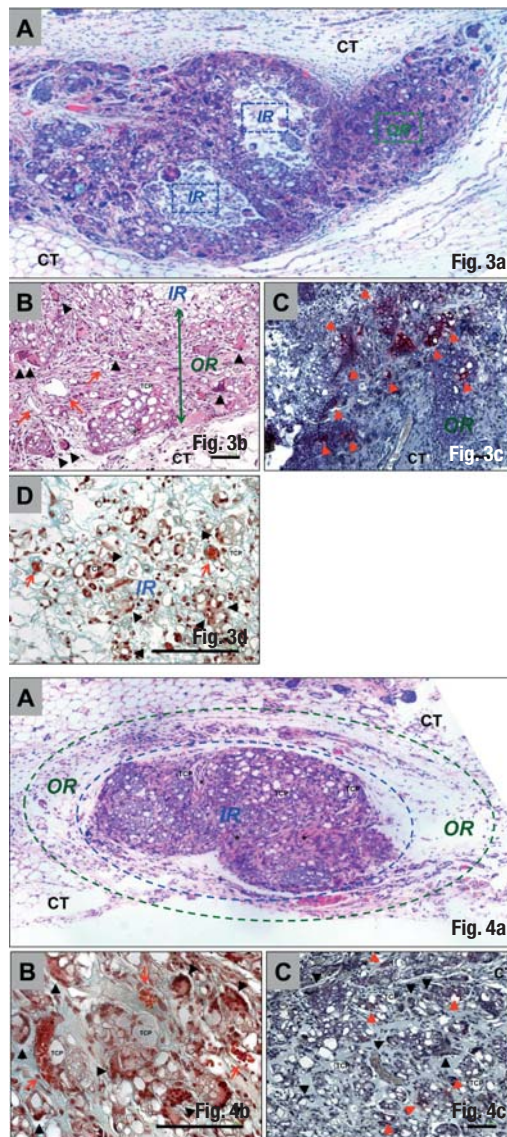


Fig. 3 The tissue reaction to the triphasic bone-substitute material at day 15 after implantation; a) overview of the implanted material within the subcutaneous connective tissue (CT). (H&E-staining, total scan, 100x magnification); b) outer region (OR, double head arrow), with a unique granulation tissue (red arrows: vessels; arrow heads: multinucleated giant cells; (H&E-staining, 200x magnification; scale bar = 100 μ m); c) TRAP activity in multinucleated giant cells (red arrow heads; TRAP staining, 200x magnification; scale bar = 100 μ m); d) the composition of the inner region (IR) of the implanted material. (arrow heads: multinucleated giant cells; red arrows: vessels; black arrows: mononuclear cells (Movat's pentachrome staining, 400x magnification; scale bar = 100 μ m).

Fig. 4 The tissue reaction to the triphasic bone-substitute material at day 30 after implantation; a) total scan of the implant region. Inner circle with few bone substitute remnants (asterisks: granulation tissue; H&E staining, total scan, 100x magnification); b) the former inner region transformed into a granulation tissue. (red arrows: vessels; arrow heads: multinucleated giant cells; Movat's pentachrome staining, 400x magnification; scale bar = 100 μ m); c) differential TRAP expression at this time point shown by TRAP-negative and TRAP-positive multinucleated giant cells (black arrow heads: TRAP- negative multinucleated giant cells; red arrow heads: TRAP- positive multinucleated giant cells; TRAP-staining, 200x magnification; scale bar = 100 μ m).

β -TCP biomaterial, which was significantly higher than in the β -TCP granule group, was observed (** $p < 0.01$, Figs. 8a & b). At days 10, 15, 30 and 60 significantly higher values for percent vascularisation and vessel density in the β -TCP paste were observed compared to the solid β -TCP and the two control groups (sham operation and sodium chloride). These data indicated a maturing of the vessels within the implant. A detailed overview of the significance levels between the different groups at each time point is given in figure 8a & b.

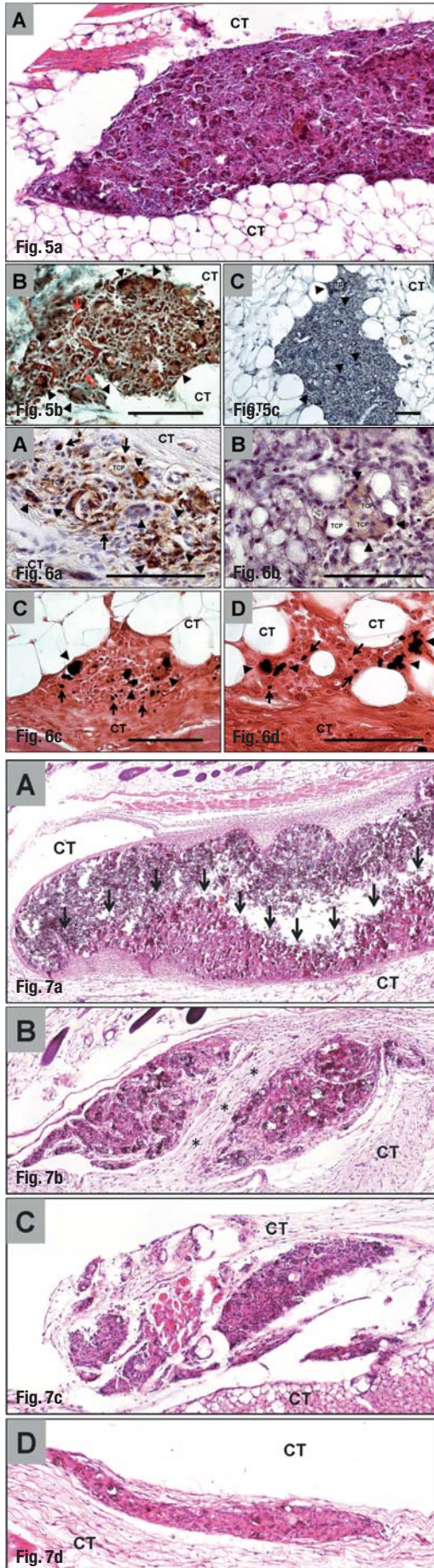
_Discussion

In the present study the tissue reactions to a paste-like bone substitute material composed of β -TCP, methylcellulose and hyaluronic acid was investigated in the subcutaneous implantation model in Wistar rats over 60 days. Implantation of pure solid β -TCP, injection of sodium chloride and sham operation served as controls. The primary focus of histological and his-

Fig. 5 The tissue reaction to the triphasic bone-substitute material at day 60 after implantation; a) total scan of the implant area (H&E staining, total scan, 100x magnification); b) the remaining granulation tissue, i.e., vessels (red arrows), macrophages and multinucleated giant cells (arrow heads); (Movat's pentachrome staining, 400x magnification; scale bar = 100 μ m); c) only TRAP-negative giant cells (arrow heads) were detectable at this time point (CT = connective tissue, TCP = β -TCP granules) (TRAP staining, 200x magnification; scale bar = 100 μ m).

Fig. 6 The immuno- and histochemical analysis of the cellular degradation of the triphasic bone-substitute material; a) overview of the implantation bed at day 60. (arrows: macrophages; arrow heads: multinucleated giant cells; ED-1 staining, 400x magnification); b) higher magnification showing a single multinucleated giant cell (arrow heads; ED-1 staining, 600x magnification; scale bar = 100 μ m); c and d) The implantation bed at day 60, in which mononucleated (arrows) and multinucleated giant cells (arrow heads) were involved in the cellular degradation of the β -TCP granules (black granules) (Von Kossa/Safranin-O staining); C: 200x magnification; D: 600x magnification; scale bar = 100 μ m).

Fig. 7 The tissue reaction to the β -TCP granules used in the control group; a) implantation bed at day 10. (arrows: tissue ingrowth covering approximately half the area of the implantation bed; H&E staining, total scan, 100x magnification); b) implantation bed at day 15. (asterisks: granulation tissue divided by bridges of connective tissue; H&E staining, total scan, 100x magnification); c) implantation bed at day 30. (asterisks: fragmentation within single islands by connective tissue bridges; H&E staining, total scan, 100x magnification); d) implantation bed at day 60. Almost complete degradation of the β -TCP granules (H&E staining, total scan, 100x magnification).



tomorphometrical analysis was on the characterisation of the cellular response to the bone-substitute material, its stability and the vascularisation of the implantation bed.

The histological analysis showed the triphasic biomaterial remaining in a bulk-like structure with an inner core and an outer ring for up to 30 days. A wall of vessel-rich granulation tissue was formed at the tissue-biomaterial interface on the outer wall, which the initial degradation seemed to originate from. The aqueous solution seemed to hold the bone substitute material in the inner core and prevent it from early ingrowth of connective tissue. At the end of the study period the inner region becomes invaded by more degrading cells, which penetrated towards the β -TCP granules. β -TCP is a well-established bone substitute material which is highly biocompatible, cellular degradability and supports osseointegration and osteoconduction.³⁻⁶ Therefore, the analysis of the pure solid β -TCP granules showed early invading of the biomaterial granules by mono- and multinucleated phagocytes, i.e., macrophages and giant cells from the peri-implant tissue. It is known, that these cells are expressed in the foreign body response and take part in the biomaterial degradation process.⁸

The histomorphometric analysis of the extracted and processed samples revealed significantly higher vascularisation within the paste-like triphasic β -TCP group compared to the pure β -TCP group. This increased vascularisation started in the outer core and was initiated by multinucleated giant cells within the implantation bed.^{8,9}

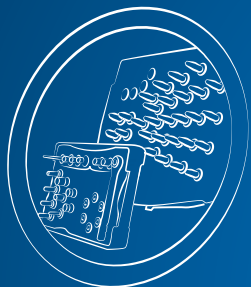
By physicochemical changes in material characteristics, such as size, porosity and shape, synthetic bone substitute can be individually tailored to achieve an optimal level of inflammation and vascularisation in order to regulate bone tissue regeneration.^{9,39}

Origin of the bone substitute material as well as production and processing parameters, such as sintering temperature, play an important role in material stability. Hydroxyapatite (HA) is known to be more stable than β -TCP.³⁻⁵ Fast degradation results in the risk of connective tissue ingrowth in the implantation bed of β -TCP augmentation material, which might compromise osteoconduction. Another approach to enlarge material stability is the here presented combination of β -TCP, Methylcellulose and Hyaluronic acid, which leads to a divided inner and outer structure of the biomaterial and inhibits the connective tissue ingrowth between the granules in the inner core. The concept of a paste-like material combines not only the advantages of different material classes, but also simplifies the augmentation process by a minimally-invasive insertion. Cellulose, used in this study as aque-



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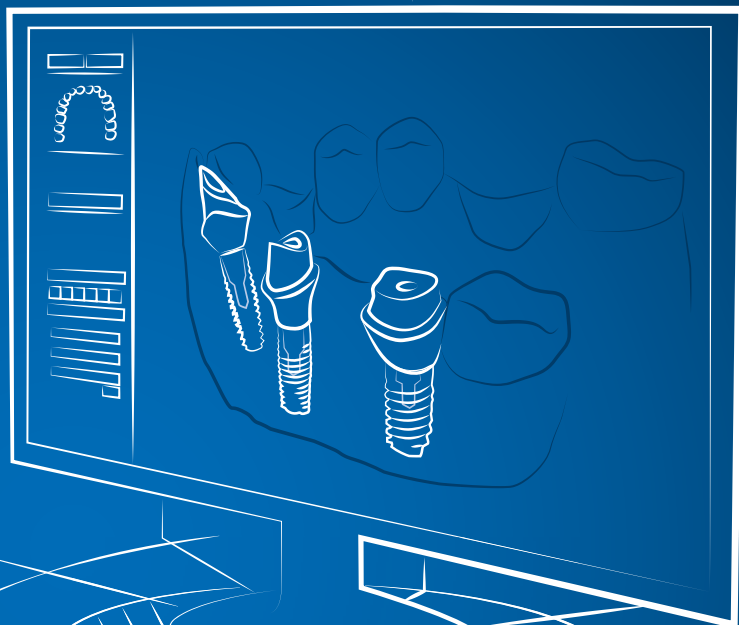
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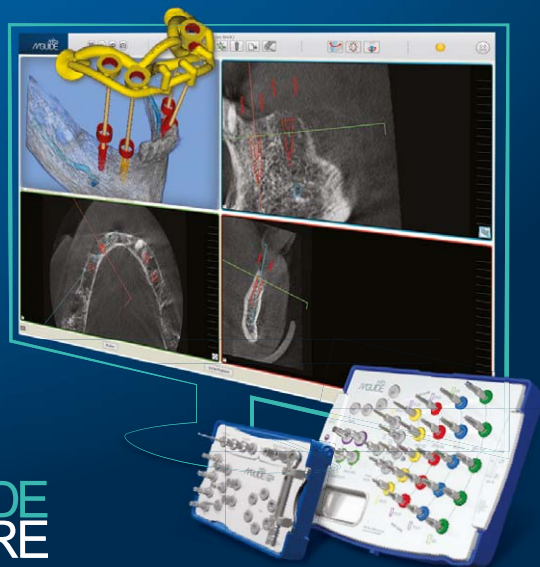
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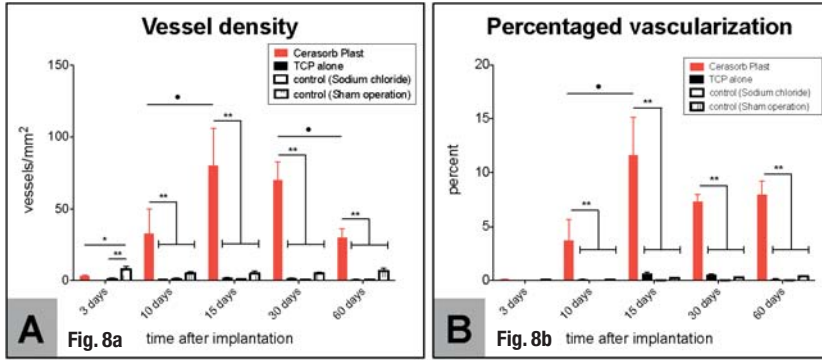


Fig. 8 Histomorphometrical analysis of the vascularization of the implantation beds of the triphasic paste-like bone-substitute material group and the three control groups, i.e., animals with β -TCP granules, sham-operated animals, and animals injected with saline: a) vessel density and (b) percentage vascularisation (*/** = interindividual statistical significances, •/•• = intraindividual statistical significances).

ous matrix for the β -TCP granules, is a well-known and -researched polymer from wood fibres and part of vegetable cell walls.^{18, 19} In orthopaedic surgery, the hydroexpansivity of cellulose is used for cellulose-based implants to delay the resorption of bone substitute defects.^{18-22, 42, 43}

Hyaluronic acid, the third component of the investigated injectable bone substitute material, is a linear polymer of repeating disaccharide units composed of D-glucuronic acid and N-acetyl-D-glucosamine and can be found in many tissues of the human body, such as skin, cartilage and the vitreous humour, and is well-suited to applications in tissue regeneration.^{23-25, 31-35}

In different studies investigating HY, the binding capacity, the ability to communicate with cell surface receptors and to modulate the inflammatory response, contributing to the stabilisation of the granulation tissue matrix within the implantation bed were shown.⁴⁴⁻⁴⁶ In tissue engineering the mechanical stability, osteoconductivity and the ability to promote the migration and differentiation of osteoblasts make HY suitable for bone tissue augmentation.^{23, 25, 47, 48} From the histological and histomorphometrical results it can be concluded, that both cellulose and HY contribute in a synergistic way to the hydroexpansivity, to the mechanical stability of the implant and to control the connective tissue ingrowth towards the central part of the biomaterial. Another advantage of the triphasic bone substitute material presented in this study is its injectability. In combination with its hydroexpansivity, all parts of the defect can be reached by the biomaterial minimal-invasively. Further, the lifetime and the stability of the biomaterial is enhanced and the connective tissue ingrowth is decelerated.

In previous trials paste-like bone-substitute materials with other compositions and qualities have shown promising results and positive influence on bone regeneration.⁴⁹⁻⁵¹ The results of the present study support the assumption that injectable bone-substitute materials with the above-mentioned components can be used as osteoconductive filling mate-

rials for reliable and successful bone tissue augmentation.

Conclusion

In the present study, the tissue reaction to a triphasic paste-like bone substitute material of β -TCP, cellulose and hyaluronic acid was investigated in the subcutaneous implantation model in Wistar rats over a time period of 60 days. Implantation of pure solid β -TCP, injection of sodium chloride and sham operation served as controls. By histological and histomorphometrical methods, the cellular reaction, the inflammatory response and the vascularisation within the implantation bed were analysed.

The combination of β -TCP, Cellulose and Hyaluronic acid was shown to generate a two phasic bulk with an inner core of β -TCP granules and an outer core of an aqueous solution, which inhibited the premature ingrowth of connective tissue in the intergranular space within the first 30 days. Further, and in contrast to the control groups, the outer structure induced the formation of multinucleated giant cells, which resulted in a higher vascularisation of its implantation bed.

Concluded, the combination of small β -TCP granules, cellulose and hyaluronic acid is a new, promising concept for a bone substitute material that can be easily applied via minimally invasive surgical techniques.

Acknowledgements

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Use of allogeneic cortical granulate for external surgical sinus floor elevation

Author_Dr Phillip Wallowy & Dr Karam Kass-Elias, Germany

_Introduction

This study aimed to assess the effectiveness of external sinus floor elevation in 36 patients with severely atrophic posterior maxillae using allogeneic freeze-dried cortical granulate (Osteograft®, ARGON Medical). Implants were placed in a second session after a mean time of 7.6 months. As the study shows, the use of allogeneic cortical granulate in external sinus augmentation showed successful clinical results combined with great properties. It seems to be a reliable material for reconstruction of a severely atrophic posterior maxilla. It presents a good alternative to autogenous bone in sinus augmentation because of good ossification, less morbidity, unlimited availability, shorter duration of surgery as well as lower costs.

Implants preparation by sinus floor elevation

In order to sufficiently install dental implants in atrophic maxilla, preparative surgical procedures are often necessary. Successful osseointegration of implants depends on a suitable quantity and quality of surrounding bone. One of these procedures is the sinus floor elevation. First described by Tatum and

Boyne^{1,2}, it presents a very common preprosthetic surgery in dentistry. A grafting material is placed between the sinus floor and the lifted sinus membrane, resulting in an augmentation of vertical bone. Various articles have been published describing different grafting materials.³⁻⁶ Implants are installed in a second operation if primary stability of the implants cannot be achieved. A minimum bone height of four to five millimetres is necessary to fulfil the criteria of primary stability.⁷ Less bone height results in the necessity of a two-step approach.

Usage of allogeneic bone

Present gold standard is the use of autogenous bone, defined by donor and acceptor being the same individual.^{8,9} It presents osteoconductive, osteoinductive and osteogenetic properties.⁸⁻¹⁰ However, at the same time it requires additional surgery, associated with corresponding risks, complications and additional morbidities. Also, duration and therefore cost of surgery rise. Harvesting bone from extraoral sites, e.g. the iliac crest, also demands general anaesthesia. In some cases, autogenous bone is limited.¹¹⁻¹⁴ Due to existence of various disadvantages, alternative graft-

Fig. 1_Sinus with elevated membrane.

Fig. 2_Allogeneic bone soaked in blood.



ing materials with similar properties are sought after. One option to overcome these disadvantages of autogenous bone is the usage of allogeneic bone. The purpose of the following study is to evaluate the use of allogeneic particulate cortical bone for the surgical elevation of the sinus membrane in order to successfully install dental implants. The properties of allografts are described and a case report of failure surgery is analysed.

Material and methods

Patients

In the period between July 2008 and October 2010, 36 patients (19 females and 17 males) with an average age of 54 years underwent surgery at the Dorow Clinic in Waldshut, Germany. All patients suffered from a severe maxillary atrophy (bone height less than four millimetres), making augmentation necessary for successful installation of dental implants. External sinus membrane elevation was carried out as exclusive surgical technique. Allogeneic particulate cortical bone was used as grafting material in all patients. In each case, implants were installed in a second intervention. A cone beam computer tomography (CBCT) was created preoperatively to display the bony structures and precisely evaluate augmentative

surgery indications. In this study, success was defined as the ability to install dental implants in the augmented sites. Certainly, the desired criterion of success ought to be the success of the subsequent prosthetic treatment after years of follow-up. Due to our being only one part of the medical referral chain, we have not been able to keep track of all patients involved in this study. Also, not all patients have yet been restored prosthetically. Additionally, we have been using allogeneic bone grafts in our clinic for only a few years now. As a consequence, the focus of this study lies exclusively on augmentation itself.

Grafting material

In all cases allogeneic bone transplants were used. All grafts were obtained from ARGON Medical, the German distributor for allogeneic dental transplants processed by the German Institute for Cell and Tissue Replacement (Deutsches Institut für Zell- und Gewebeersatz, DIZG). The DIZG uses a peracetic acid-ethanol sterilisation (PES) procedure on its transplants. This validated procedure proves to be a reliable method for the sterilisation of human bone transplants.^{11, 15-17} After thorough cleaning of blood and fat tissue by using sterile water under high pressure, the bone is scoured by chloroform and ethanol. Then the actual sterilisation is performed under low pressure

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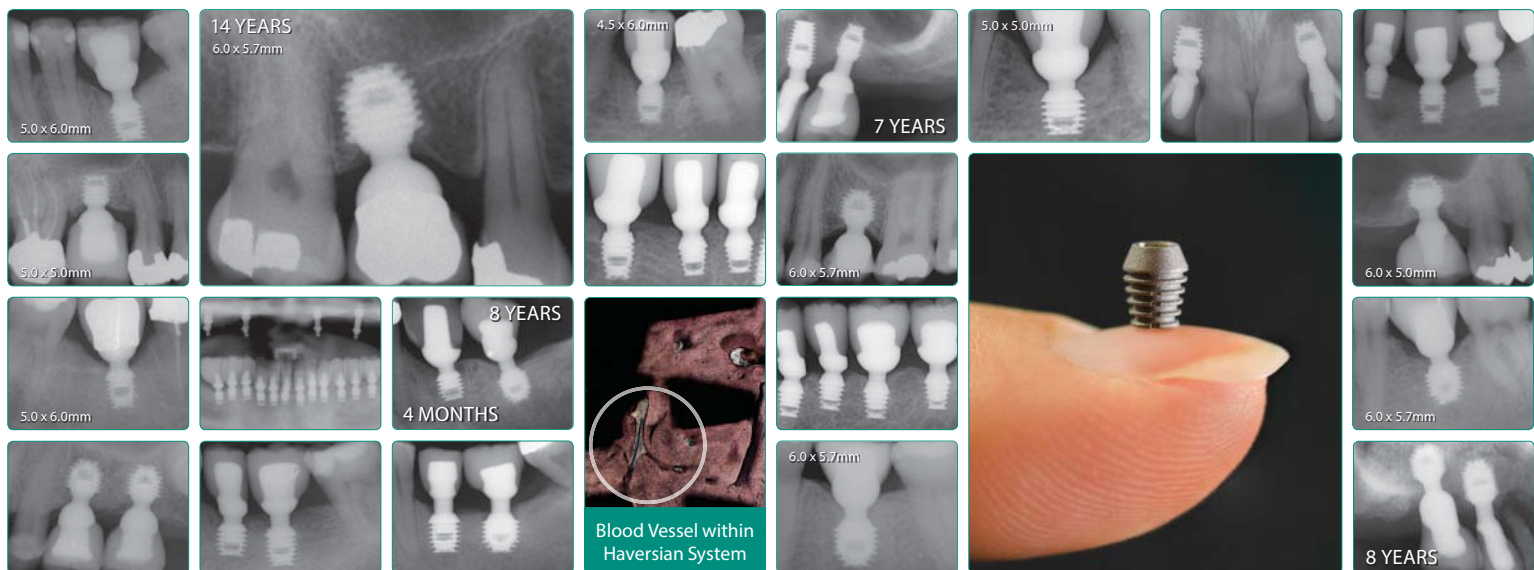
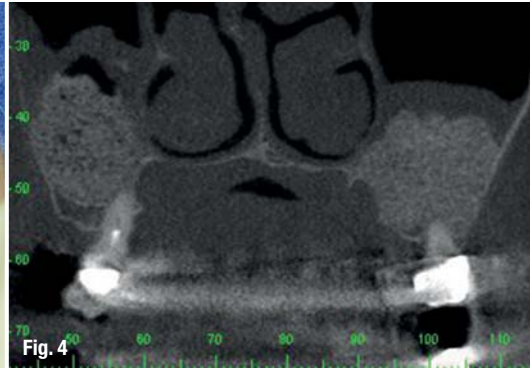
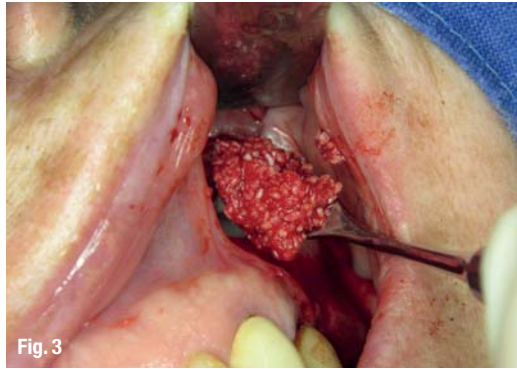


Fig. 3_Placing allogeneic bone in sinus.

Fig. 4_DVT after augmentative surgery.



(200 mbar). Therefore, the bone is covered with peracetic acid. Ethanol is used to reduce the surface tension. After four hours of vacuum-incubation, a buffer agent is applied. Eventually, the grafts are freeze-dried and packaged aseptically. Processing demonstrably inactivates HI-Virus 2, Hepatitis A-Virus, Polio-Virus, Pseudorabies-Virus as a model for Human Herpes-Virus, Porcine Parvo-Virus as a model for Human Parvo-Virus B19 and Bovine Diarrhoe-Virus as a model for Hepatitis C-Virus. Also a reduction in the titer of viable micro-organisms (*Staphylococcus aureus*, *Enterococcus faecium*, *Pseudomonas aeruginosa*, *Bacillus subtilis*, *Clostridium sporogenes*, *Mycobacterium terrae*, *Candida albicans* as well as spores of *Bacillus subtilis* and *Aspergillus niger*) below the detection level is achieved.¹⁰⁻¹³

Surgical technique

Preoperatively, an antibiotic was given intravenously (2.000 mg Amoxicillin with 200 mg clavulanic acid). All patients received a prescription for an antimicrobial prophylaxis (875 mg Amoxicillin with 125 mg clavulanic acid; twice a day for five days) and analgesic (600 mg Ibuprofen; as needed). Local anaesthesia was performed by using a minimum of 4 ml of high-dose articaine (1:100.000). A crestal incision was made on the alveolar ridge with vertical releases into the vestibule if needed. A full-thickness mucoperiosteal flap was created to gain access to the anterior wall of the maxillary sinus. A rectangular-shaped osteotomy is cut into the lateral antral wall by means of rotating instruments, revealing the sinus membrane. The inferior horizontal segment was kept 3-4 mm above the floor of the sinus in order to help keeping the grafting material in place in the floor of the sinus. The exposed membrane with the covering adherent bone was carefully elevated with special instruments following the usual procedure (Fig. 1). The bone flap was displaced inward with the carefully lifted Schneiderian membrane, forming the new floor of the maxillary sinus. Space was created in the primary floor of the sinus for the grafting material. If tearing of the Schneiderian membrane occurred, repair was carried out with a layer of resorbable collagen (Osteogide®, ARGON Medical, Germany). The

grafting material (Osteograft®, ARGON Medical, Germany) was soaked in venous blood taken from the antecubital fossa for five minutes and placed underneath the sinus membrane and lightly condensed towards the sinus floor (Figs. 2 and 3). An absorbable collagen membrane was also placed onto the bony window. A complete and strainless wound closure was performed by means of sutures. Clinical and radiographic examinations were done during the post-operative phase, mostly by means of CBCT or orthopantomogram. Sutures were removed after 14 days.

Results

All data is presented in Table 1. 36 patients underwent external sinus floor augmentation surgery using allogeneic bone as grafting material. In 35 cases implants were able to be installed in a second intervention (97.2% success). After a mean time of 7.6 months, implants were installed. In only one case the grafting material was lost and had to be removed in additional surgery (2.8% failure). Not all implants were installed in our clinic. Many patients are referred to our clinic only for augmentation, implants are then installed elsewhere. However, it is known to us that implants definitely were installed in these patients, just not the exact date. Therefore these dates are not included in our study. Mean time of follow-up after augmentation is 18.2 months. Mean time of follow-up after implantation is 11.1 months.

Discussion

This study confirms previous results showing that allogeneic bone grafts work excellent as bone substitute and manage to build up healthy and well-dimensioned bone suitable for uncompromising installation of dental implants.^{10,18-22} Main point of criticism regarding allogeneic bone grafts are the often-quoted fears of possible transmission of disease and antigenicity. These potential disadvantages were studied to a large extent.^{11,15-17} Using the modern PEST-sterilization procedure, they are practically non-existent. An inactivation of potential viruses, bacteria, fungi and spores takes place by means of interna-

Patient	Sex	Date of birth	Age	Complication	Augmentation date	Implants installed	Implantation date	Healing time	Follow-up A	Follow-up B
1	f	29.07.1957	53	no	23.02.2010	yes	23.08.2010	6	12	6
2	m	08.09.1955	55	no	19.02.2009	yes	09.11.2009	8	24	15
3	f	30.12.1956	54	no	12.02.2010	yes	08.10.2010	7	12	4
4	m	23.10.1937	73	Graft lost	30.05.2009	no	***	***	***	***
5	f	02.12.1976	34	no	01.07.2010	yes	28.01.2011	6	7	1
6	f	19.08.1987	23	no	20.07.2009	yes	18.01.2010	5	19	13
7	m	08.07.1953	57	no	15.09.2009	yes	23.02.2010	5	17	12
8	f	05.09.1959	51	no	07.01.2010	yes	20.11.2010	10	13	3
9	m	15.06.1951	59	no	23.11.2009	yes	05.08.2010	8	15	6
10	f	11.12.1955	55	no	07.11.2008	yes	17.12.2009	13	27	14
11	f	15.08.1950	60	no	06.05.2009	yes	15.12.2009	7	21	14
12	m	11.01.1958	53	no	20.01.2009	yes	01.09.2009	7	25	17
13	m	26.12.1957	53	no	10.12.2008	yes	17.06.2009	6	26	20
14	f	16.04.1951	59	no	07.07.2008	yes	03.02.2009	6	31	24
15	f	05.03.1945	65	no	13.07.2009	yes	06.07.2010	11	19	7
16	m	10.02.1969	42	no	17.03.2009	yes	21.09.2009	6	23	17
17	f	28.04.1943	67	no	29.09.2008	yes	23.02.2009	4	28	24
18	f	17.02.1956	55	no	01.09.2009	yes, alio loco	***	***	17	***
19	f	12.05.1947	63	no	21.12.2009	yes, alio loco	***	***	14	***
20	m	24.02.1967	44	no	26.10.2010	yes, alio loco	***	***	4	***
21	m	18.09.1932	78	no	14.05.2009	yes	18.11.2009	6	21	15
22	m	28.09.1969	41	no	12.03.2009	yes	03.08.2009	4	23	18
23	f	22.11.1952	58	no	22.07.2010	yes	24.01.2011	6	7	1
24	f	26.10.1952	58	no	14.03.2009	yes	08.08.2009	4	23	18
25	m	06.07.1949	61	no	18.05.2009	yes	21.10.2010	17	21	4
26	f	17.02.1943	68	no	08.07.2008	yes	02.02.2009	6	31	24
27	m	19.04.1954	56	no	12.11.2009	yes	01.09.2010	9	15	5
28	m	10.10.1961	49	no	08.05.2009	yes, alio loco	***	***	21	***
29	f	25.10.1950	60	no	15.09.2009	yes, alio loco	***	***	17	***
30	f	03.02.1978	33	no	01.12.2009	yes, alio loco	***	***	14	***
31	m	01.05.1968	42	no	09.09.2009	yes	22.02.2010	5	17	12
32	m	27.01.1964	47	no	24.02.2009	yes	22.06.2010	15	24	8
33	f	24.02.1963	43	no	30.11.2009	yes	30.11.2010	12	14	2
34	m	24.12.1952	58	no	09.12.2009	yes, alio loco	***	***	14	***
35	f	04.11.1957	53	no	25.02.2010	yes	08.10.2010	7	12	4
36	m	26.06.1947	63	no	21.04.2010	yes	08.12.2010	7	10	2

tional standardised and validated processing.¹¹ Since 1985, over 250.000 PES-sterilized allogeneic bone grafts of the DIZG have been transplanted. Since today, there has been no report about transmission of disease or immunologic response.

PES sterilisation for bone regeneration

Regarding biologic properties, the grafts show osteoconductive as well as osteoinductive characteristics. Various studies report unanimously that PES sterilization shows no significant effects on reduction of osteoinductive properties on allogeneic bone grafts.²³⁻²⁶ After PES-sterilisation, following growth factors are detectable amongst others: BMP-2, BMP-4, IGF-1, TGF- β 1, VEGF and PDGF.²⁶ It is well known that these growth factors have the ability to promote bone regeneration.²⁷ Additionally, there is no

limitation regarding procurement. Any quantity and quality can effortlessly be acquired. Figure 4 shows an example of the amount that is possible in augmentation. It is doubtful that such results can be economically managed with autogenous bone or other bone substitutes. The costs are relatively low and therefore such grafting results are reasonable, establishing a situation for an uncompromising, prosthetic-based implant placement. Also, grafts have a shelf-life of five years.

Case of failure surgery

One graft was lost and removed in second surgery. It is unlikely that immunologic response or transmission of disease was reason for loss of graft. In this case a bilateral sinus floor augmentation was performed and only one side caused problems. Figure 4 shows

Table 1 Patients, follow-up and complications.

m = male

f = female

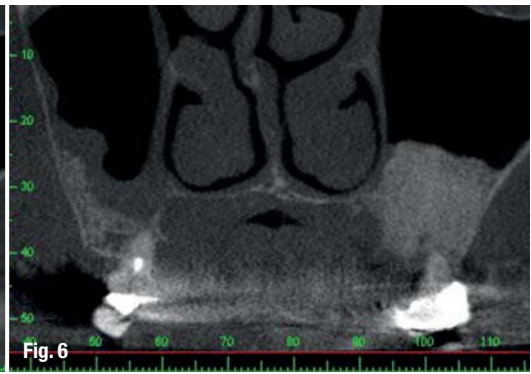
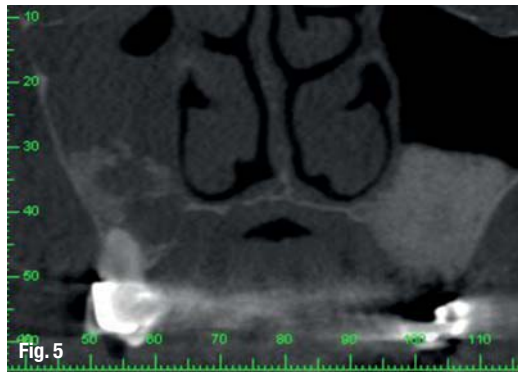
Healing time = time between augmentation and implantation in months

Follow-Up A = Follow-up in months after augmentation

Follow-Up I = Follow-up in months after implantation

Fig. 5 Right sinus totally shadowed with infected graft.

Fig. 6 Remains of graft and slightly thickened membrane.



the result of augmentation two days after surgery. A swelling of the sinus membrane exists on both sides; additionally a haematoma is visible on the right side. Two weeks after surgery, a light swelling of the right posterior maxillary area appeared and the patient felt a discomfort at the surgical area. Radiologic examination revealed infection of the right sinus (Fig. 5), indicating an immediate removal of the graft. The other side healed normally and showed clinically and radiologically no signs of infection or rejection.

Removal of graft in additional surgery

Sinus floor augmentation is in fact a very predictable procedure and complications are rare.^{7, 28, 29} Failures can be caused by perforation of the sinus membrane, excessive bleeding, infection of the grafted tissues e.g. with saliva, wound dehiscence, and lack of aseptic conditions.³⁰⁻³³ Infected sinuses should be treated immediately. Different studies show success in treatment with antibiotics and local debridement or on the other hand complete surgical removal of the graft combined with high dosage administration of antibiotics.^{30, 34, 45} We decided to completely remove the graft in an additional surgery. Saline irrigation had been performed for over one week due to chronic sinusitis and antibiotics were prescribed (875 mg Amoxicillin with 125 mg clavulanic acid; twice a day for five days). The infected sinus was successfully treated leaving sparse remains of grafting material (Fig. 6). We see the reason for failure in a known massive perforation of the sinus membrane. The inserted membrane possibly did not cover the entire perforation. Repeating surgery was planned but the patient decided not to undergo this procedure. This case presents another advantage of allogeneic bone. If failure occurs, repeating surgery is not as extensive as using autogenous bone and can be more excusable from a patient's point of view.

Postoperative follow-up

The postoperative follow-up ranges to 18.2 months from first augmentative surgery and 11.1 months from installation of dental implants. Only patients with successfully installed implants were considered in this issue. A longer range has not been

analysed yet, due to the relatively recent implementation of the grafting materials. The short period of follow-up might stand out as a possible point of criticism of this study. But considering the relatively quick remodelling time (compared with some xenogenic bone substitutes), a longer period may not actually be necessary for the discussion of this fact. Histologic studies show already after six to nine months of healing time vital, newly formed bone with sparse remaining allograft particles without evidence of acute inflammatory infiltrate.³⁶⁻³⁹ Allogeneic bone grafts show analogous histologic characteristics as autogenous bone chips.¹⁹ Allogeneic bone is completely transformed into patient's own bone tissue.⁴⁰ However, further studies must discuss the relevance on long term success of dental implants in allogeneic grafts.

Conclusion

Our experience and the results of various studies show that the use of allogeneic bone grafts for bone augmentation of the atrophic alveolar ridge works successfully. After a period of healing, the resulting bone is equal to autogenous bone. And additionally, we see more advantages in the use of allogeneic bone than in autogenous bone.

Editorial note: A list of references is available from the publisher.

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Complete prosthetic restoration in a patient with cleft palate

Authors Dr Michael Peetz & Dr Thomas Hitz

Introduction

Have you already performed lots of full-mouth restorations? Do you always know immediately what the optimal solution is? The majority of dentists, in all honesty, answer 'no' to these questions, since patients seldom have only an isolated problem. Uncertain prognosis for existing teeth, poor oral hygiene or oral and systemic comorbidities can make choosing the right treatment a real challenge. Here, extensive clinical knowledge is called for. With the new e-learning platform *Dental Campus*, you can extend your clinical knowledge with the help of case studies of varying complexity. Benefit from the experiences of other clinicians, discuss cases with

your peers and collect continuing medical education credits at the same time, regardless of time or place. *Dental campus* contains numerous, uniformly structured case studies. From the initial findings to the maintenance therapy treatments, you can follow all details step-by-step. Thanks to interactive platform features, you can discuss each treatment step with the dentists who actually treated the patients as well as with other practitioners in the forum. In the following, we present a *Dental Campus* case with a highly complex initial situation.

You will find the complete case under: www.dental-campus.com/cases/complete-rehabilitation-of-a-cleft-patient

Fig. 1 Screenshot of the initial findings. The case presentation simulates the situation on the desk of the practitioner.

Fig. 2 Initial clinical findings.

Fig. 3 Intraoral radiographs at initial exam.

Figs. 4a & b Intraoral wax-up with corrected vertical dimension.

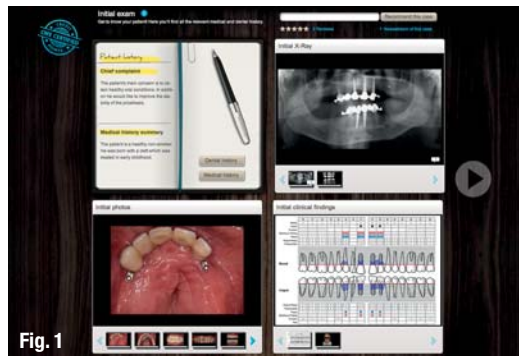


Fig. 1



Fig. 2



Fig. 3



Fig. 4a

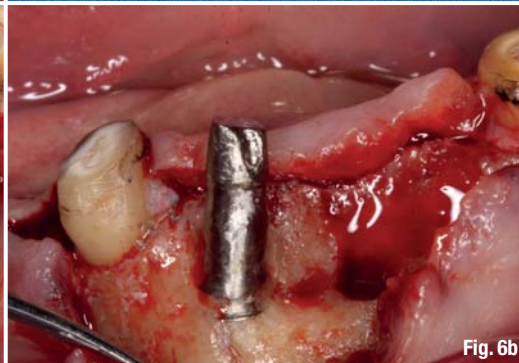
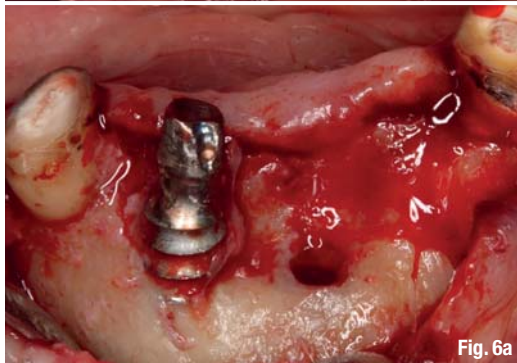


Fig. 5_Maxilla: Extracted canine and explanted implants.

Figs. 6a & b_Mandible: An implant is explanted, the remaining implant is cut and left *in situ*.

_Initial examination

The patient, a healthy non-smoker, presents with anterior residual dentition (Figs. 1 & 2). He wishes to have improved oral health and increased stability of his prosthesis. At birth he had a cleft palate, which was treated in childhood. All teeth are missing except 13, 33 and 43, 13 and 43 have been endodontically treated. Four years earlier, in the context of a complete prosthetic restoration, implants were set in positions 11, 21, 22 and 41, 42. Upper and lower jaws have received combined fixed and removable solutions. The patient has an open bite in the anterior region, deficiently short incisors in the upper jaw and an unstable occlusion in the posterior region. Periodontitis is evident and found to be serious in the mandible and moderate to severe in the maxilla. Insufficient oral hygiene has led to plaque accumulation with resulting gingivitis. There are pronounced recessions around the implants with exposed machined and partially exposed rough surface areas. Radiologically, peri-implantitis at implants (Bauer screws) 11, 21, 22 is diagnosed (Fig. 3) with suspicion of a foreign body in region 26. Region 13 shows a failing edge of the crown. Mesial lesions in the crown are detected in region 31, 41.

_Interactive diagnosis

Would you recommend a conventional or implant-supported solution for this patient? Or would you opt for root caps in the lower jaw? View the findings of this complex case in detail online.

Compose your own prognosis for each tooth with just a few mouse clicks and create your own treatment plan with the help of the digital dental chart. Then compare your plan with those of other users as well as with the actual treatment choice and discuss it in the forum.

_Treatment

The patient is supplied with a removable prosthesis, supported by four implants in the maxilla and two root caps in the mandible.

a) Hygiene phase

After taking the impressions, the vertical dimension in the wax-up is raised (Fig. 4). In the maxilla, the bridge is removed and implants are explanted, tooth 13 is extracted due to a major loss of substance (Fig. 5). Implant 31 is explanted while implant 41 is treated by implantoplasty whereby the coronal aspect is removed (Fig. 6). An explanation would endanger the preservation of tooth 43, due to its location. For this reason, the endosseous portion is left below the cortical bone level. The patient is immediately supplied with a temporary prosthesis. To select the optimal aesthetic tooth shape, two alternative setups for the maxilla are created.

b) Surgical phase

Implant restorations in the maxilla are performed using computer-assisted navigation (Figs. 7-9). The lacking keratinised mucosa is reconstructed in the maxilla with a palatal graft and a ro-

Fig. 7 The radiographic template is placed in the mouth for the CBCT scan: the Lego brick (yellow) is used as the reference mark.

Fig. 8 Computer-aided planning of implant placement.

Fig. 9 Lifted flap with proper placement and fixation of the surgical template.

Fig. 10 Missing mucosa is reconstructed with palatal grafts and rotation flap.

Fig. 11 The remaining implant in the lower jaw presents with a bone defect. It is cut and left *in situ*.

Fig. 12 The initial diagnostic set-up must be adapted to the altered mucosal contour.

Figs. 13a & b Cementation of root caps.

Figs. 14a & b Final maxillary prostheses.



Fig. 7



Fig. 8

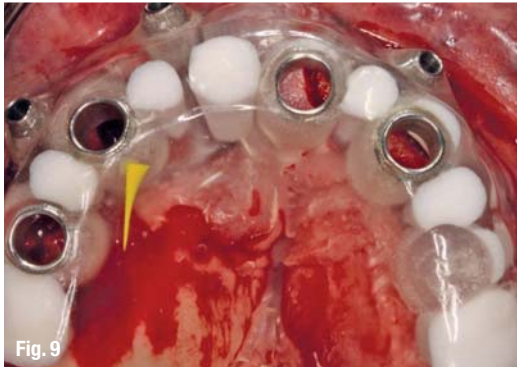


Fig. 9

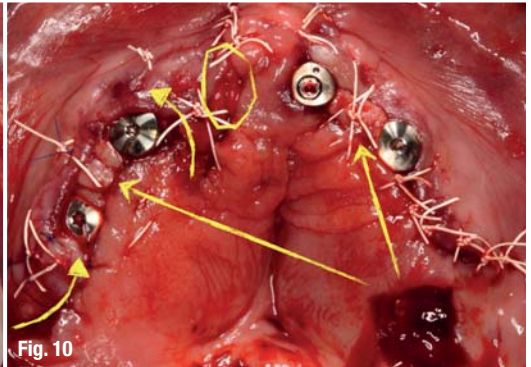


Fig. 10

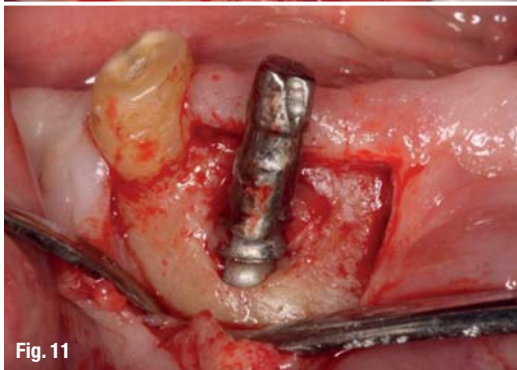


Fig. 11



Fig. 12



Fig. 13a



Fig. 13b



Fig. 14a



Fig. 14b



Fig. 15

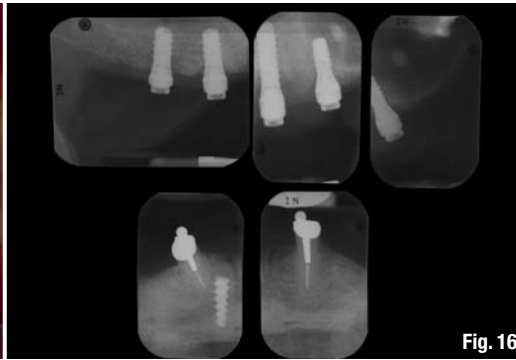


Fig. 16



Fig. 17a



Fig. 17b

Fig. 15_Final clinical results.
Fig. 16_Final radiological findings.
Figs. 17a & b_Clinical situation before and after therapy: optimised tooth alignment and smile line.

tational flap (Fig. 10). After lifting the flap, the remaining mandibular implant reveals bone loss, due to an inadequately inserted implant (Fig. 11). The implant is cut and left *in situ* to avoid creating a large bone defect by explantation.

c) Prosthetic restoration

The canines are supplied with root posts. The original diagnostic setup is adapted to the altered soft tissue structure. The prosthetic restoration is shown in part in Figures 12 to 14. You can follow the detailed procedure online, documented with numerous images.

Join in the discussion

The patient adapted well to the new prosthesis. He was pleased with the stability and aesthetic appearance (Figs. 15–17).

The case described here provides an example of a case documentation found on *Dental Campus*. Extensive background information and detailed description of the individual treatment steps enable you to understand the treatment planning and implementation, and to translate this into high practical value for your own practice. Unlike other online platforms, *Dental Campus* is characterised by a clear, well-structured design with high practical relevance and interactive capability. The learning content can be tailored individually. In addition to the case library, system-independent online lectures provide current, comprehensive expertise. Associated with each presentation you will

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How do you rate the choice of treatment and the final results in the presented case? Register as a user, discuss the treatment with your dental colleagues and gain two CME credits for working on the case. [_](#)

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Optimized implant planning: DICOM-STL matching

Author_Dr Frank Schaefer, Dr Dagmar Schaefer & Dr Mike Zäuner, Germany

_Introduction

On the basis of three-dimensional X-ray images, in the 1990s the first software programmes allowed a navigated insertion of dental implants. But the digitisation of dental processes started even earlier, namely in the mid-1980's. Imaging techniques allowed the production of components based on virtual construction. Today, this principle is well established both in the dental-clinical field and especially in the dental laboratory. Meanwhile, 3-D data sets of objects are created not only by normal camera shots, but there are also special 3-D scanners in use. In particular, today's desktop scanners are so precise in their resolution accuracy that they are able to exactly reflect the real model or oral situation. Simultaneously with the capturing process, different methods have been developed to transfer the acquired 3-D data sets back to reality. While initially this was a milling and prototyping process, currently

the sintering and printing processes are favoured. For a long time, navigated implantology and 3-D scanning has been developed in parallel, where at best surgical templates were fabricated by prototyping on basis of X-ray data sets.

Goal: optimal implant position

In recent years, the matching of 3-D X-ray data sets (DICOM) and 3-D model data sets (STL) has begun. The goal was and still is to find the optimal surgical and prosthetic implant positions for navigated insertion to provide an optimal solution for the patient. In addition, the production of temporary dentures and in individual cases an immediate treatment is so much better and much more reliable and predictable. At the same time, an objective quality control of both the planning and the result is practicable through matching of DICOM and STL data sets. By means of some case studies, we show which diagnostic and technical possibilities have been feasible since the establishment of the diagnostics and navigation system CTV in 2005 in the following article.

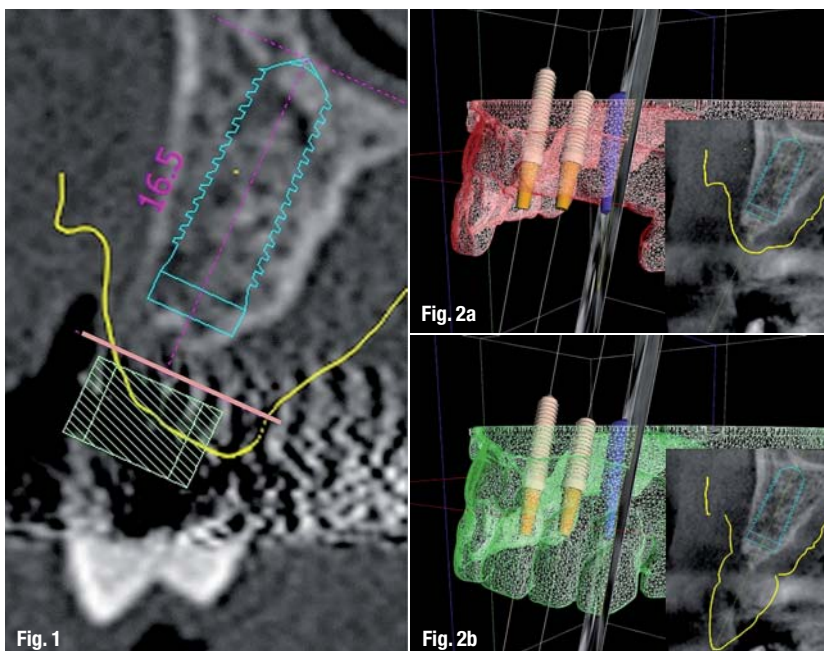
_Implant planning with CTV

X-rays are subject to the laws of physics. Therefore, all the resulting images are generally afflicted with an error regarding distortion, diffraction and interference. Because these errors have their origin in the radiological density changes of the object, some areas cannot be represented or are misrepresented. Particularly critical are movement-induced distortions in CBCT images. They cannot be completely avoided or even predicted. A further increase in accuracy solely from radiological data does not seem to be possible currently. The solution is to collect additional data by using independent methods to achieve a "rectification" and detail enhancement through combination with the radiological data. For example, the line of the gingiva and other surface structures in the 3-D X-ray image cannot be traced precisely. The solution here is the correct matching

Fig. 1 _Planned implant with full-guided drill sleeve; gingiva line set by the clinician according to X-ray image (pink); by matching obtained with the situation model – real – gingiva line (yellow).

Fig. 2a _Virtual matching in 3-D X-ray; planned implants with a situation model (red). Image cut: orthogonal ridge section with gingiva line (yellow) from the situation model.

Fig. 2b _Virtual matching in 3-D X-ray, implants planned with aesthetics wax up (green); image: orthogonal ridge section with tooth line (yellow) of aesthetic wax up.



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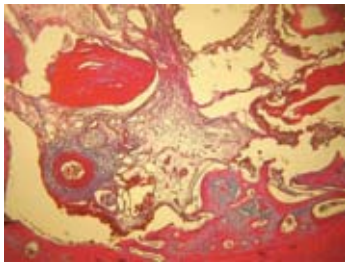
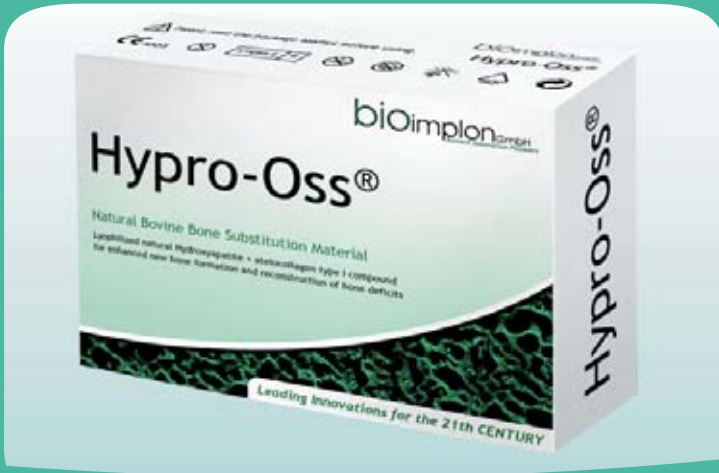
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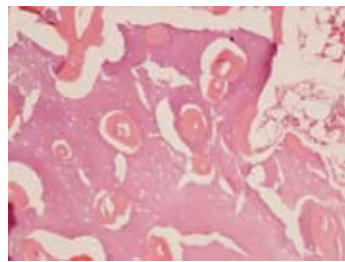
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user reported: no swelling or hematoma complications after sinus lifting or other implantation procedures



Histology after 4 weeks.



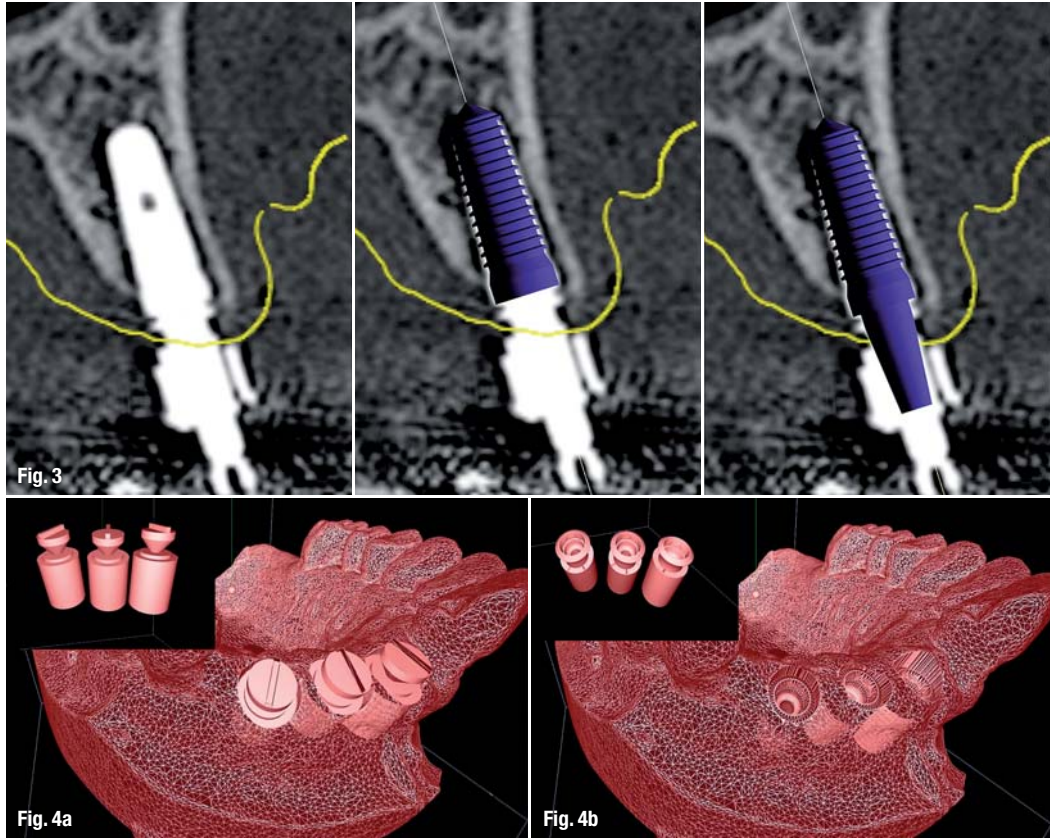
Histology after 14 weeks.



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Fig. 3 Post-surgical matching; inserted implant (left), transition with virtual implant (middle), with virtual implant with abutment (right); from gingiva line situation model (yellow).
Fig. 4a STL mesh of situation model with inserted drilling sleeves; drilling sleeves separately (top left).
Fig. 4b STL mesh of situation model with laboratory implant analogs; laboratory implant analogs separately (top left).



of DICOM data sets with the digital capture of the associated surface structures, e.g. anatomical model. With the situation model the real surface profile is obtained. If an aesthetic modelling (wax-up) is scanned and matched additionally, the planned position of the implants both in axial direction as well as in mesial/distal orientation can be determined optimally (Figs. 1, 2a & b).

3-D data matching

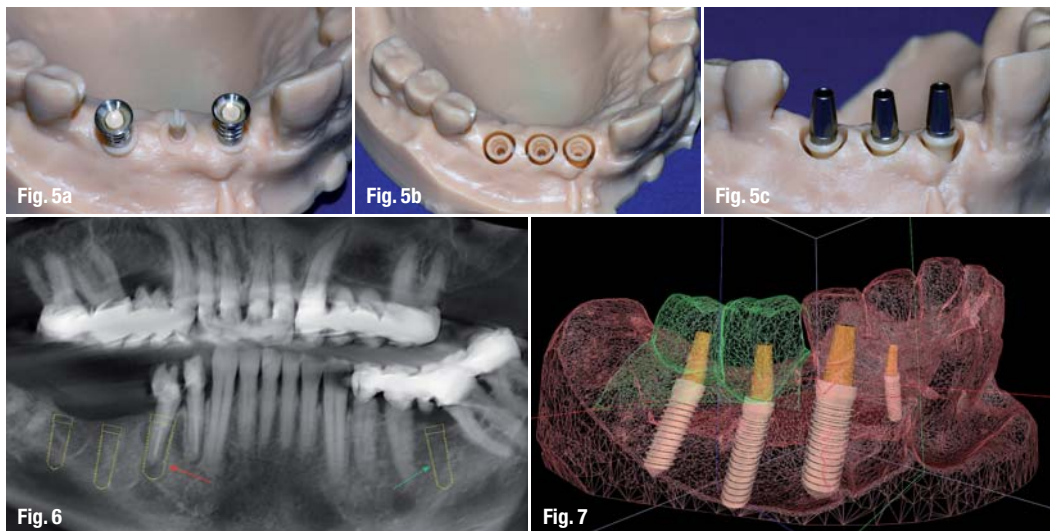
The comparison of the real positions of the inserted implants in the jaw with the virtual planning

is done by matching the 3-DX-ray planning capturing with the post-op 3-D picture. Here it is irrelevant whether the planning and the post-op 3-D capturing come from the same device type (DVT/CT) or not. This method also allows for a standardised follow-up (Fig. 3).

DICOM and STL data matching

For the manufacturing of surgical templates, for models to produce temporary restorations in navigated implantations and planning of definite dentures (backward-planning) matching data sets from

Fig. 5 Model replica of SLT-data set with: a) surgical drilling sleeves on fabricated guides, b) designed laboratory implant analogs, c) implemented real abutments.
Fig. 6 Calculated OPG from CBCT data and planned implant positions; arrows: planning under still existing dentures.
Fig. 7 Situation 4th quadrant of Figure 6 including planned implant positions and abutments (parallelised). Mesh of the situation model (red) and wax-up (green).

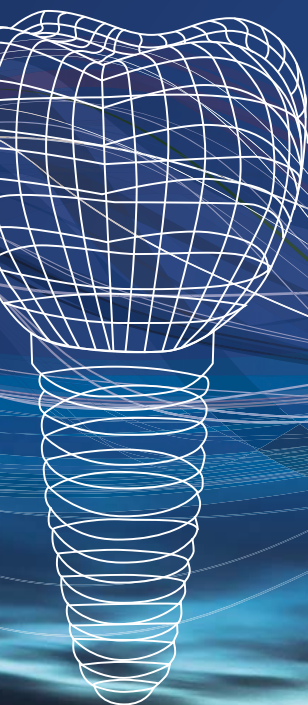


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Fig. 8a_STL mesh of the situation model of Figure 6 with designed drilling sleeve guides, even under existing dentures (regio 36, 44/45).

Fig. 8b_Replication model resulting from Figure 8a with drill sleeve guides.

Fig. 8c_Model replica with attached surgical drilling guides (Steco) in preparation of the production of surgical drilling template.



DICOM and STL data are used. Virtual models can be designed with exactly positioned sleeves for full-guided systems and or with laboratory analogues of the planned implants. This range can be extended, provided that the STL data sets of components to be designed are available, such as implant abutments. The thus created virtual model is transferred by milling, printing, sintering, etc. back to reality and can then be used e.g. in the laboratory for the production of temporary dentures or surgical guides. The more accurate the replications process the better the models (Figs. 4a–b, 5a–c).

Complex planning

For complex planning, even when there is not an optimal bone situation and accompanying surgical services (e.g. sinus lift) are needed, the matching processes of the CTV system support the surgeon. By virtual articulation of the scanned models and matching with the X-ray data, a position and axial direction of the planned implants and their subsequent supra structure in relation to the remaining dentures or natural teeth are determined and other accompanying, necessary surgical procedures can be pre-planned (Figs. 9a–g).

Safe implant-planning

It is also possible to safe implant-planning make with still incorporated metal structures, even if the X-ray image at these locations with radiation artifact areas is insufficiently evaluable. In the described case, the usage of a non-optimal DVT had been assumed, due to extensive metal restorations. Alternatively, the structures would have to be removed. Because of many opportunities in the CTV system, a virtual planning for minimally invasive, navigated implantation is almost unrestricted. (Figs. 6–8c)

Comprehensive matching process

Last but not least, quality controls, such as of the finished surgical drilling template, are carried out with these comprehensive matching processes. In order to achieve this, the template is scanned and matched as best as possible with the planning images for covering. Ideally, there are no deviations. If differences occur, the implantologist must decide whether he can use this template or a new preparation will be necessary. In this way, failures in implantation and subsequent prosthetic treatment are avoided (Figs. 10a–e, 11a–c).

Fig. 9a_Matching: situation model (red), wax-up (green), the opposing jaw (yellow) and DICOM dataset using virtual articulator; planned implant positions (orange line: gingiva).

Fig. 9b_Hidden situation model; situation as seen in Figure 9a.

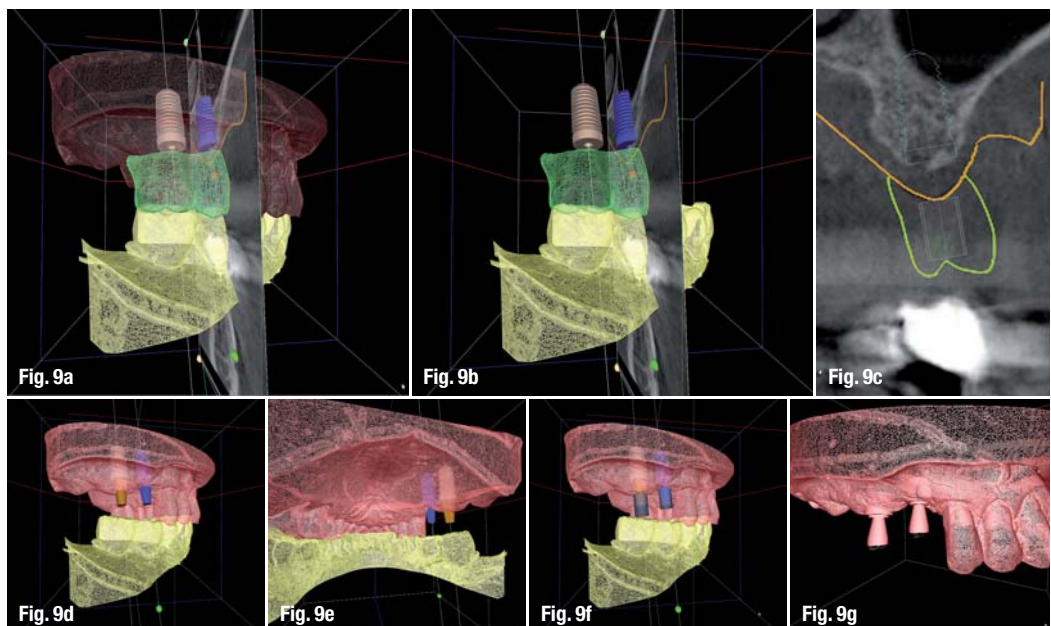
Fig. 9c_Situation of Figure 9a: orthogonal slice with planned implant to planned full-guided drilling sleeve; gingiva line (orange); wax-up contour (green).

Fig. 9d_Situation model (red) with the opposing jaw (yellow) in the virtual articulator and the planned implant positions and parallelised abutments.

Fig. 9e_Situation in Fig. 9d, posterior view.

Fig. 9f_Situation model (red) with the opposing jaw (yellow) in the virtual articulator with the planned implant positions, parallelised abutments and position for drilling sleeves (full-guided).

Fig. 9g_STL mesh with drilling sleeves for the production of the replica model (surgical template).



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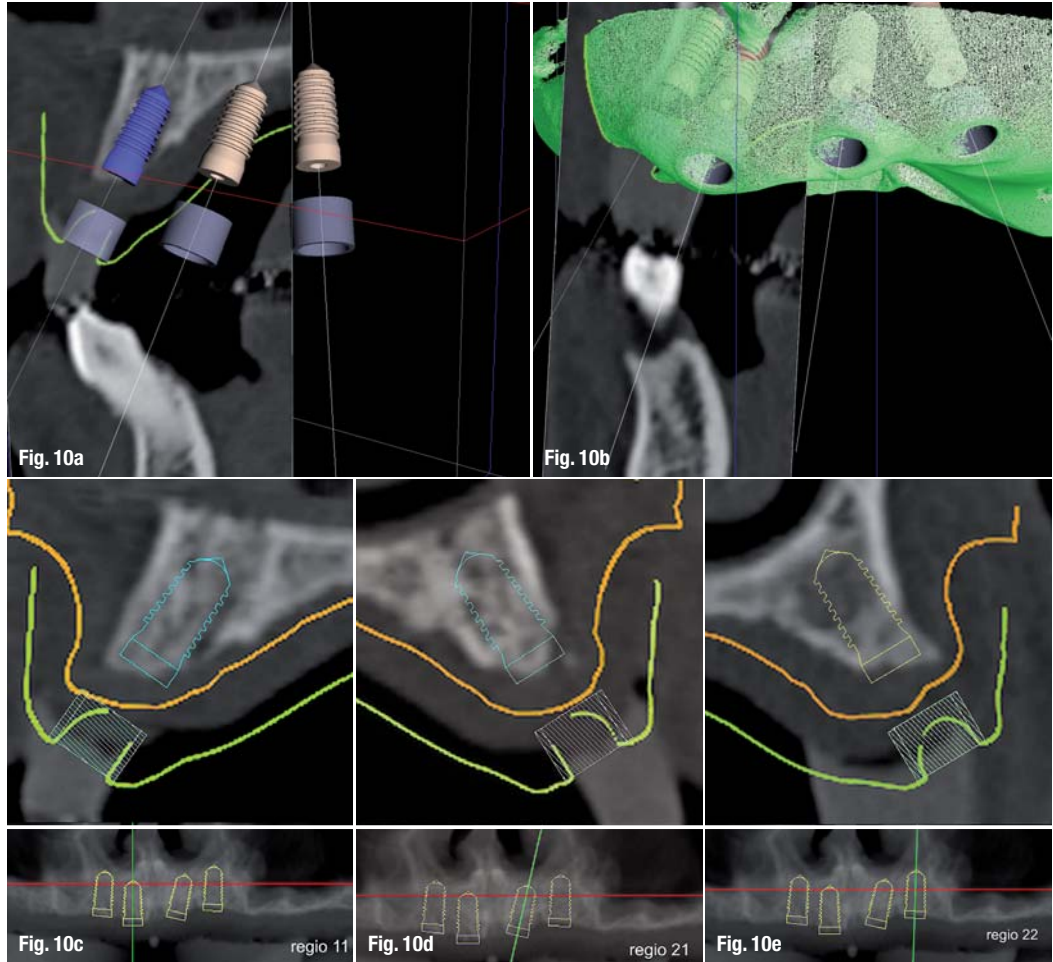
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Fig. 10a_STL mesh of the real drilling template (green) and DICOM data with the planned implants maxillary anterior region.

Fig. 10b_Planned implant positions of maxillary anterior area with evaluated positions for drill sleeves (full-guided) and surface line of the scans of the real drilling template (green, regio 11).

Fig. 10c-e_Orthogonal cross-sectional images with planned implants (aqua), associated full-guided drilling sleeves (dark green), orange line: surface profile (gingiva) of situation model, green line surface during the scan of the template: line "based" on the virtual sleeve edges.



Conclusion

The procedures for overlay of DICOM and STL data contained in the CTV system allow a comprehensive planning of implant positions regarding surgical, prosthetic and aesthetic aspects. Due to the diversity of options, shortcomings of X-ray or model data sets can be fairly settled. This method eliminates the need of a special transfer device for the implementation of the design positions from the virtual to the real world. Thus, the described approach is independent from the existing dental infrastructure as the data exchange with freely selectable machining centres can be done via internet. The goal is to enable a consistent minimally invasive

surgical-implantological procedure, to reduce failure rates and to meet the often high demand for prosthetics and aesthetics from the patient's perspective.

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Dr Frank Schaefer & Dr Dagmar Schaefer

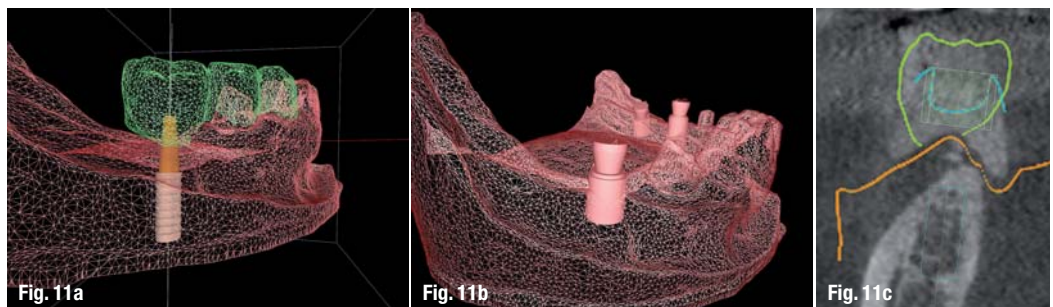
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Tel.: +49 361 3468914 (4230713)
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Fig.11a_STL mesh of situation model (red) and wax-up (green) with the planned implant and abutment.

Fig.11b_STL mesh with designed drilling sleeves of the replica model for the production of the surgical guide.

Fig. 11c_Orthogonal cross section regio 45 with planned implant and sleeve position; orange line: surface profile situation model (gingiva); green line: surface contour wax-up; aqua line: real surface of drilling template.



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Surgical procedures with **minimally-invasive** autologous bone block graft

Including a tomographic analysis after 48 months

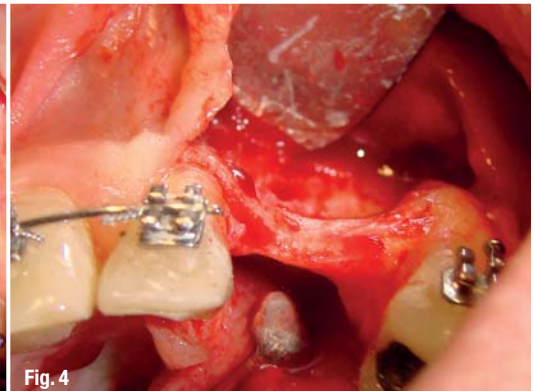
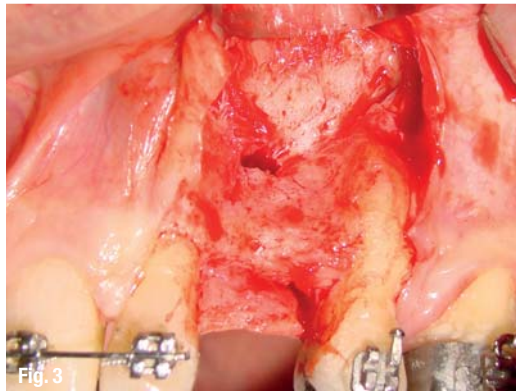
Author Prof. Dr Sergio Alexandre Gehrke, Brazil

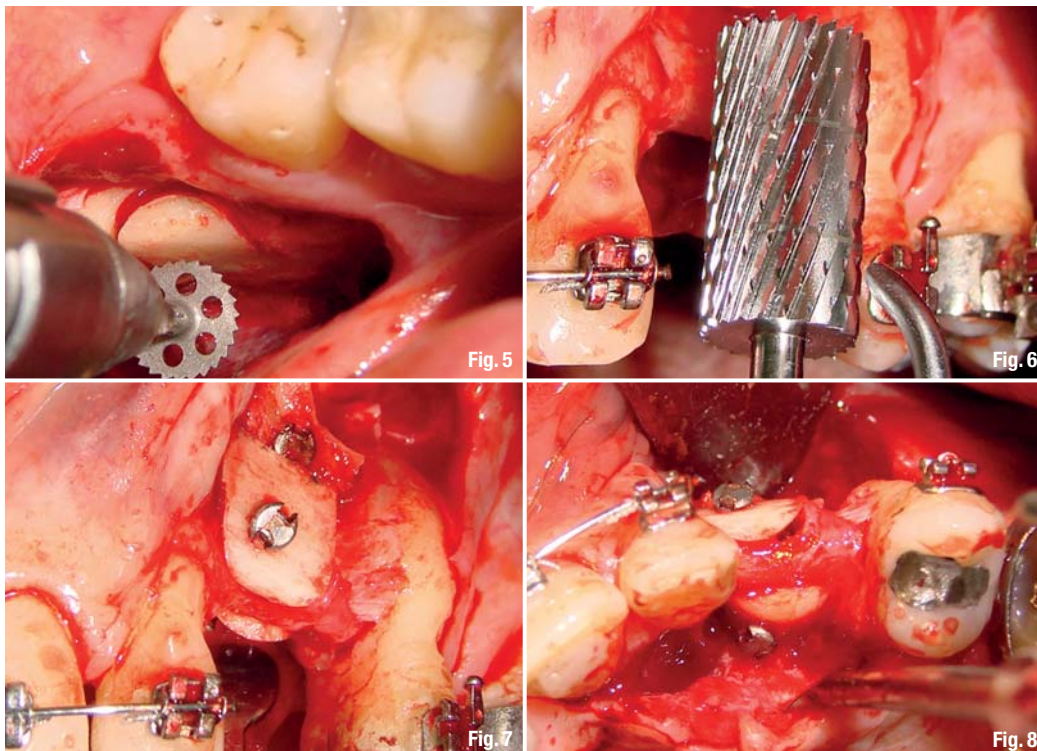
Autologous bone blocks were combined with a synthetic tricalcium phosphate (TCP) bone graft substitute to reconstruct the alveolar ridge in the region of the maxillary left canine. On re-opening for implant placement, the majority of the bone graft substitute had been replaced by newly formed bone and the bone blocks, although still discernible from the surrounding hard tissue, had been integrated into the host bone. Four years after surgery, the site was evaluated using CBCT. The results demonstrated preservation of the height and volume of the grafted area.

Introduction

Dental rehabilitation of partially or totally edentulous patients with oral implants has become a routine treatment modality in the last few decades and offers reliable long-term results.¹⁻⁴ However, unfavourable local conditions of the alveolar ridge due to atrophy, periodontal disease or trauma sequelae may provide insufficient bone volume or unfavourable vertical, horizontal, and sagittal intermaxillary relationships, which may render implant placement impossible or undesirable

Figs. 1 & 2 Initial clinical situation and CT view of the critical bone defect in the canine area.
Figs. 3 & 4 After opening the flap, the large resorption was verified.





Figs. 5 & 6_ Removal of the blocks using the Transfer-Control kit.

Figs. 7 & 8_ The blocks were positioned and fixed; two on the buccal side and one on the palatine side.

from a functional and aesthetic viewpoint. A reduced amount of bone in the surgical area, in terms of height and width, due to atrophy of the maxillae can determine the success of the implant.⁵ The atrophic maxillary ridges can be treated with bone grafts, followed by osseointegrated implants to obtain aesthetic and functional oral rehabilitation. In order to overcome this problem, various methods to augment the bone volume of deficient sites have been described: inlay or onlay bone grafts, guided bone regeneration, split ridge/ridge expansion techniques, and alveolar distraction osteogenesis are common methods to re-establish and correct intermaxillary relationships and produce adequate bone morphology and volume for implant placement.^{6,7} Autologous and non-autologous options are available for vertical and horizontal bone deficiencies, but autologous bone grafts have the advantage of providing osteogenic cells to the recipient site.^{8,9} When a limited amount of bone is needed, local grafts harvested from the mandibular symphysis or ramus have been used extensively.¹⁰⁻¹³ However, when less traumatic surgeries are possible, combination with biomaterials is a good choice. A large variety of biomaterials are available in the market, such as calcium phosphates. Materials such as TCP are osteoconductive because osteoblasts adhere to them and deposit bony tissue on their surface. The biomaterial forms a scaffold for closing the bony defect.¹⁴ Calcium phosphates have a high affinity for proteins (such as bone morphogenetic proteins).¹⁵ The pores of these bioceramics have a filter effect and accumulate the growth factors from the surrounding body fluid inside the micropores.¹⁶ Osteoclasts resorb bone or other resorbable calcium phosphate materials by releasing

acids to dissolve the mineral portion. This action forms resorption lacunae¹⁷ by dissolving the inorganic calcium phosphate components of the vital bone or graft. Materials degrade owing to their physical characteristics or mechanical forces, or they can be dissolved hydrolytically by fluids in the body milieu.¹⁸ Bone substitute materials are intended to be implanted during a surgical procedure and over time become a part of vital bone. Hydroxyapatite materials made of bovine bone, processed or partially synthetic, are not ideal bone grafting materials because they are non-resorbable.¹⁹ Moreover, the risk of disease transmission cannot be totally excluded. This case report aims to demonstrate the viability of the combination of autologous bone blocks and calcium phosphate granules for grafts in the restoration of a critically atrophied maxilla, reducing the amount of bone to be removed from the donor site. A control CBCT scan four years after the graft is shown in order to evaluate the long-term performance of this graft.

_Case report

A 52-year-old male patient presented with a missing upper left canine at the dental clinic of the Bioface Institute (Santa Maria, Brazil). According to the patient's report, several unsuccessful orthodontic traction attempts were made to provoke eruption of the impacted tooth. Then, surgery was performed to remove the canine; during the procedure, a large quantity of bone tissue had to be removed, leaving the area with quite a large defect, as shown in Figs. 1 and 2. Based on these preoperative examinations, severe resorption in this

Figs. 9 & 10_The Calc-i-oss™ particles were placed to fill the spaces between the blocks.

Figs. 11, 12 & 13_Images of implant placement after 6 months. There was adequate neoformation in the areas where the Calc-i-oss™ (arrows) was inserted.

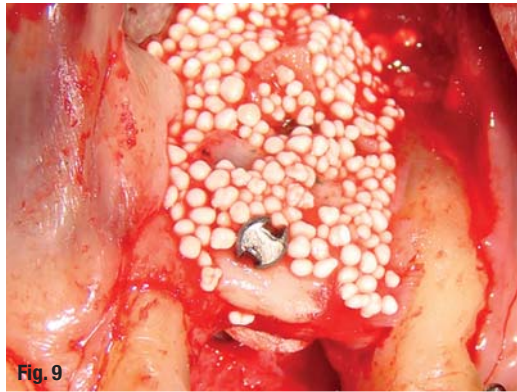


Fig. 9

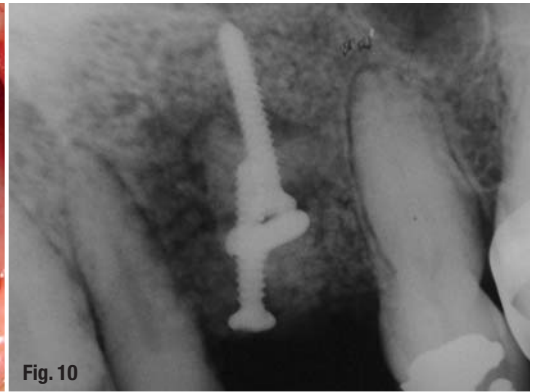


Fig. 10

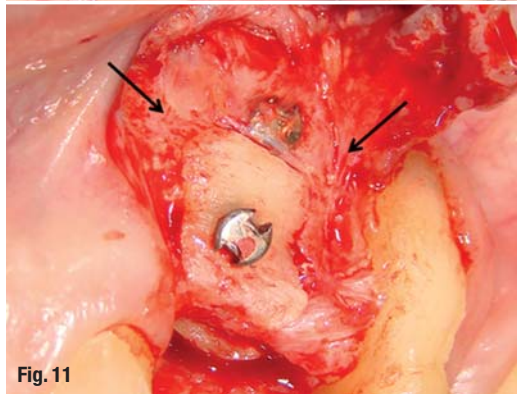


Fig. 11

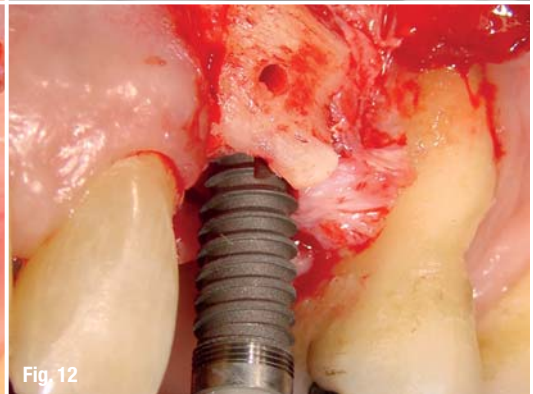


Fig. 12

area was diagnosed, which prevented the placement of a dental implant. The patient was advised to undergo a bone grafting procedure using autologous bone harvested from the mandibular ramus in conjunction with a synthetic biomaterial. Subsequently, implant placement and prosthesis were planned. In the first step, the maxillary area was surgically prepared. Figs. 3 and 4 show the massive bone loss in this area. Once the donor site was exposed (ramus mandibular), osteotomy was performed using a trephine and a saw of the Transfer-Control kit (Hager & Mesinger GmbH, Neuss, Germany) under abundant irrigation with sterile saline solution (Figs. 5 and 6); 3 bone blocks were removed from the mandibular ramus, and these blocks were then placed in the recipient site and held in place with screws (Figs. 7 and 8). The spaces between the blocks were filled with synthetic calcium phosphate bone granules (Calc-i-oss™, Degradable Solutions AG, Switzerland) with particle sizes averaging at 500 - 1000 µm (Fig. 9). The granules provide resorption protection and produce a smooth outline. The mucosa was sutured with 5-0 nylon. Sutures were removed on the 10th postoperative day, and a control radiograph was performed (Fig. 10). Clinically, there was a normal inflammatory reaction after surgery in this area. Six months after augmentation of the alveolar ridge, a conical implant (4.0 mm x 13 mm) with an internal hexagon was placed (Implacil De Bortoli Ltda, São Paulo, Brazil) (Figs. 11, 12 and 13). Three months after implant placement, the site was reopened and an immediate temporary crown was installed to conform the mucosa. After tissue healing, the permanent crown was placed. The patient was educated

and motivated, and thorough oral hygiene instructions were provided. Four years after the installation of the prosthesis, a control tomography to evaluate the behavior of the grafted bone tissue was performed; this allowed the maintenance of bone in the vestibular portion of the implant to be evaluated (Figs. 14 and 15).

Discussion

The utilisation of dental implants sometimes requires an increase in the amount of bone in the implant site. The technique to be used when reconstructing a bone defect is largely at the surgeon's discretion; however, certain situations demand particular techniques. Furthermore, the selection of a minimally invasive technique must always be considered. Autologous bone has been considered the gold standard biomaterial for bone grafts because its characteristics are similar to the lost bone and it is the only biomaterial with osteogenic, osteoinductive and osteoconductive properties.²⁰ However, it requires two surgeries, one for harvesting of the bone and one for grafting, increasing the trauma and sometimes the cost of treatment. Although excellent clinical and histological outcomes have been demonstrated with the use of bone substitute materials as synthetic scaffolds,^{21,22} some types of bone defects cannot be repaired with these materials because of local mechanical instability and defect size. Therefore, in cases in which large amounts of bone are required, autologous bone is considered the first choice and can be harvested from sites such as the iliac crest, tibia, skull or mandible.²³⁻²⁶ In cases in which the required increase in

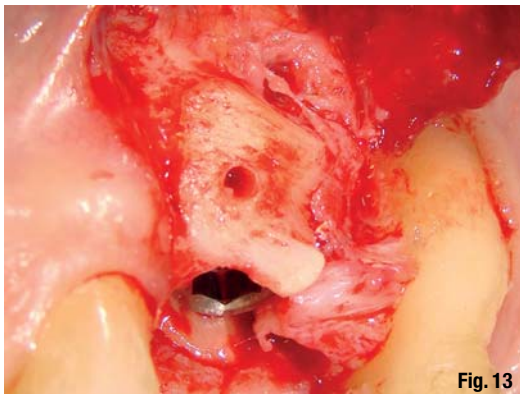


Fig. 13



Fig. 14



Fig. 15

Figs. 14 & 15 _Photograph and tomography image after 4 years; maintenance of bone in the palatine and vestibular portions of the implant is illustrated (yellow arrow).

volume is very high and critical because of very severe bone loss, especially sites in which most of the new bone tissue will receive and support the implant load, autologous bone blocks stabilised by screws are the more suitable and predictable material for the graft. Mandibular bone with its predominantly cortical micro-architecture exhibits a small volume loss and achieves good integration after a short healing period.²⁷⁻²⁹ In comparison with cortical bone grafts, autologous cancellous bone grafts have been thought to be more osteogenic because spaces within their structure allow the diffusion of nutrients and thereby limited revascularisation by micro-anastomosis of the blood vessels.³⁰⁻³² A cancellous graft is a good space filler, but it does not supply substantial structural support. Because only the endosteal and osteoblasts cells on the grafts' surface survive the transplant, a cancellous graft basically behaves as an osteoconductive substrate.³³ This effectively supports the ingrowth of new blood vessels and the infiltration of new osteoblasts and osteoblast precursors.³³ Cancellous grafts do not provide direct structural support, but they quickly integrate. Within six to twelve months, they finally reach a structural strength that is equivalent to that of cortical grafts.³⁴ Several authors have observed that cortical bone grafts will maintain their volume better than cancellous bone grafts will.^{35, 36} Cancellous bone grafts revascularise much more quickly than cortical bone grafts do; however, cortical bone is much stronger.³⁷ The combination of cortical and cancellous bone in grafts promotes early vascularisation and maximum graft maintenance.³⁸ Thus, beta-TCP (β -TCP) was used in this case because it

promotes resorption similar to cancellous bone and cortical bone was harvested from the mandibular ramus. Structurally, porous β -TCP has a compressive strength and tensile strength similar to cancellous bone.³⁹ Studies have suggested that the morbidity when harvesting bone from the mandibular symphysis is higher than when harvesting from the retromolar region,^{29, 40-43} and very few complications with intra-oral bone harvesting occur at the lateral ramus/corpus of the mandible. The lack of adaptation of bone blocks in the recipient site or the presence of gaps can cause the interposition of fibrous tissue.⁴⁴ Therefore, filling these spaces is necessary and autologous bone scrapings,⁴⁵ platelet-rich plasma⁴⁶ or biomaterials can be used for this purpose.⁴⁷ Furthermore, bone graft substitutes are used to prevent resorption and to produce a smooth outline. The use of bone graft substitutes reduces the amount of bone to be harvested from the donor site and thereby improves post-operative recovery. In the case presented, which was followed for four years, it was observed that the material (calc-i-oss) was replaced by new bone formed through the integration of the autologous blocks, facilitating better adaptation in this area.

Conclusion

The principal problems regarding the use of autologous bone for regeneration are limited availability and donor site morbidity; therefore, there is a need for bone graft substitutes. The combination of small autologous blocks with β -TCP offers a good alternative for reconstruction in critical areas and reduces post-operative complications. In the case presented, excellent bone volume was observed after four years.

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Sinus augmentation with atelo-collagenated bovine bone graft Hypro-Oss™

Author_Dr Amir Gazmawe, Jerusalem

_Introduction

Xenograft materials are widely used for sinus augmentation and guided bone regeneration for increasing the availability of bone for optimal implant placement and reconstruction of bone defects. Atelo-peptidation of Hypro-Oss is an enzymatic process that is used to eliminate the antigenic telopeptide sequence of the bovine collagen chain in the bone granules and thus eliminates the immune response by using the atelo-collagenated bovine bone graft in augmentation procedures in humans. The non-immunogenic bovine collagen (atelo-collagen) goes through the process of lyophilization, which is a process of dry-freezing using sublimation that directly converts the frozen water in HYPRO-OSS™ to vapor without passing through the intermediate liquid phase. The dry-frozen materials become highly absorbent and can be stored at room temperature. Hypro-Oss™ is composed of 30% collagen type I free

of telo-peptide (atelo-collagen) with native osteoinductive elements (TGF, BMPs, IGFs) and 70% native osteoconductive bovine Hydroxyapatite components. The advantage of the lyophilized bovine atelo-collagen in Hypro-Oss™ as presence of sufficient amount of collagen type I that is essential for the turnover of bone and other bone growth peptides, such as PDGF, IGF 1, IGF 2 and TGF beta. It confers the inductivity of bone formation and gives this kind of Xenograft material an advantage upon the heated ceramic xenograft which contains zero amount of organic material and growth factors due to the heating procedures.

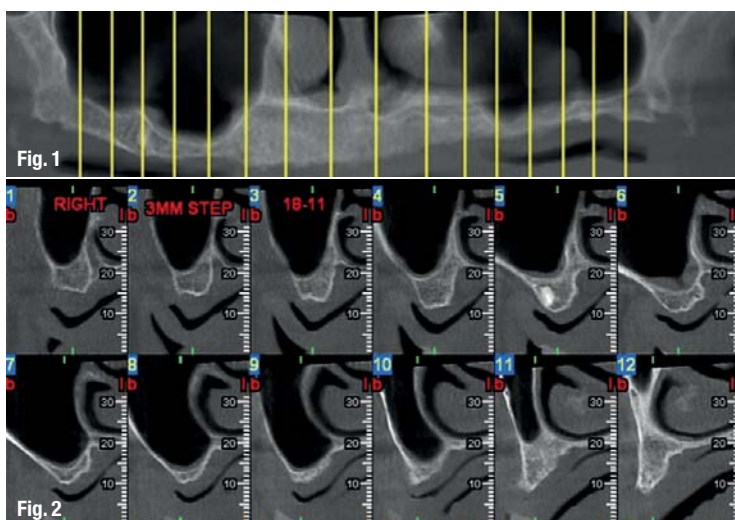
This study will evaluate the effect of bovine lyophilized atelo-collagen containing xenograft (Hypro-Oss™, Bioimplon GmbH, Germany) in sinus augmentation procedure using clinical evaluation of handling, short term healing, implantation parameters, histological screening of the augmented site 24 weeks post-augmentation and follow up until osseointegration is completed for the final loading.

_Case presentation

A 70-year-old edentulous lady with drug-stabilised hypertension has unstable maxillary complete denture. The patient was interested in fixed partial denture. Clinical evaluation of the maxilla presents atrophic ridges, unstable removable complete denture and need for massive lip support due to the atrophic jaws, in the mandible implant supported overdenture. Radiographic evaluation demonstrates the lack of bone at vertical and horizontal dimension, low sinus floor about 1–3 mm of residual bone at the sinus posterior area, the sinus anatomy is regular, no septum or membrane impairments was recorded using i-cat CT tomography scanning.

Fig. 1 Panoramic X-ray shows the atrophic maxillary ridges and the insufficient thin bone of the molar area of maxilla.

Fig. 2 i-CAT tomography of the posterior maxilla shows 2-4 mm of available bone.



Methods and materials

First stage was augmentation of the sinus floor according to the cardwell-luc approach after mid crestal incision and flap raised with releasing incision at the canine area, cutting the buccal wall of the sinus with sinus lateral elevation kit of Zimmer Dental. After membrane elevation filling the sinus volume with lyophilised atelo-collagenated bovine bone graft (Hypro-Oss™, Bioimplon GmbH), grain size 0.5–1.0 mm, filling 3 cc of material in each sinus, Saline was added five minutes before using the xenograft. The lateral window was covered with resorbable membrane that contains absorbable sterile bovine atelo-collagen (99.9% collagen type I free of telo-peptide), Hypro-Sorb M™, Bioimplon GmbH. The site was sutured with 3-0 silk sutures. Amoxicillin 500 mg TID with 250 mg of metronidazole TID was recommended for seven days after surgery.

Follow up including clinical examination was held once every two weeks and later once a month to evaluate the healing process. Radiographic examination was done at week 24 to evaluate the bone volume and a second surgery was done where implants were placed at the sinus area using flap elevation. The implant site was prepared using trephine drills



Fig. 3

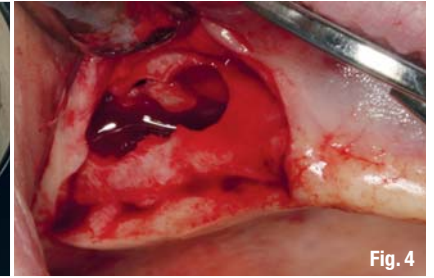


Fig. 4

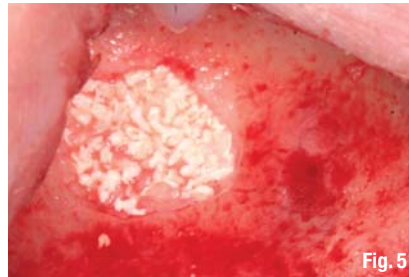


Fig. 5

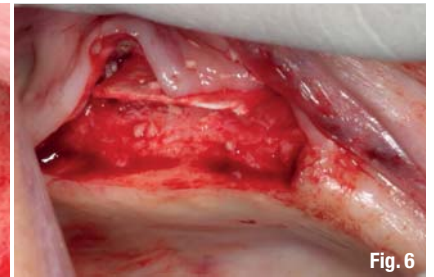


Fig. 6

2.5 mm diameter proceeded by drills according to implantation accepted protocol in addition to buccal approach biopsy using 4.5 mm trephine between implants and then filling biopsy defect with Hypro-Oss xenograft and Hypro-Sorb M membrane. The bone biopsies were sent to histological examination, placing implants at the prepared sites measuring the insertion torque-by-torque wrench tool. The histo-

Fig. 3 Hypro-Oss™-granules.

Fig. 4 Lateral window for sinus augmentation (Caldwell-luc approach).

Fig. 5 Hypro-Oss™ filling.

Fig. 6 Hypro-Sorb M™ membrane covering.

AD

*become an author
for "implants"*

[PICTURE ©SURYAVAKI]



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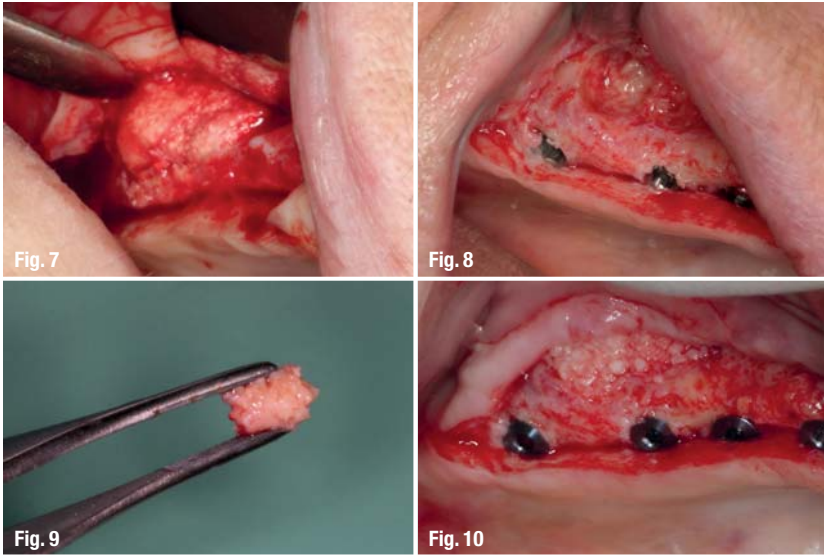


Fig. 7 24 weeks post augmentation.
Fig. 8 Implants placement and biopsy site (buccal wall).
Fig. 9 Hypro-Oss™ biopsy.

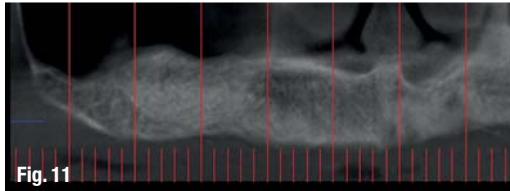


Fig. 11

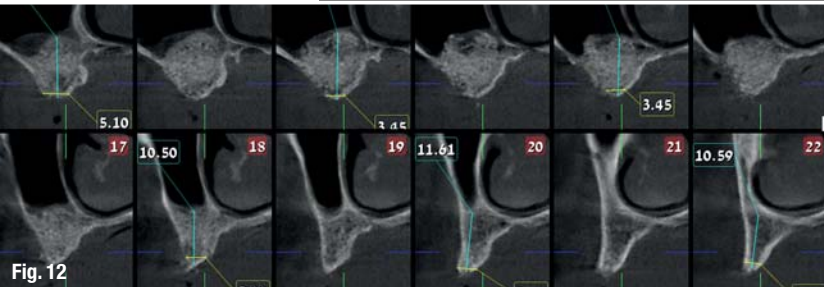


Fig. 12

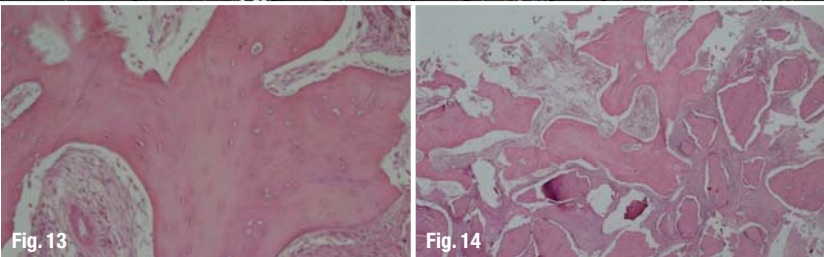


Fig. 13

Fig. 14

Fig. 10 Restoring the buccal biopsy site with Hypro-Oss™.
Fig. 11 Panoramic X-ray 24 weeks after augmentation shows radiographic similarity to type II natural bone.
Fig. 12 i-CAT tomography shows the new bone formation, new bone available for implant 11–13mm).
Fig. 13 Histological slides show new bone formation, multi-lacunae of osteoblast and, lamellar bone, x100 magnification.
Fig. 14 Histological slides show new bone formation, multi-lacunae of osteoblast and, lamellar bone, x20 magnification.

logical examination included freezing and H&E staining, examination using light microscopy. Three implants used in this case were root form spiral SLA coated implants. After implant incursion, implant covers were connected and the flap was sutured using 3-0 silk sutures. Amoxicillin 500 mg TID with 250 mg of metronidazole TID was recommended for seven days after surgery.

Results

The bovine lyophilized atelo-collagen containing Xenograft (HYPRO-OSS™, Bioimplon GmbH) was used for filling the Sinus. This material was hydrated with 0.9% Saline before the implantation and consequently the material was pasty with excellent han-

dling properties. Haemostatic effect appears immediately after placing into the operation site. Hydration increased the volume of the grafting material and there was no tension on sinus membrane while condensation of the grafting material. Placing the membrane (Hypro-Sorb M™) was easy, good handling, cutting, good capillary effect and stable at the site of surgery. Follow up a week after surgery presented very good healing, minimal swelling; no membrane exposure or flap opening, good wound integration or minimal discomfort for patient was reported in the following days after the two surgeries.

The bone height of the new bone was 11–1 mm at the right sinus (2–3mm of natural bone), the density of the bone was similar to Bone type II. Insertions torques of the tree implants placed at the right sinus were metered by manual torque wrench and found to be 28–30 Ncm. The histological slides demonstrated a large volume of high quality bone tissue and minimal connective tissue. New bone matrix and few old bone materials were seen in large magnification.

Conclusion

Lyophilized atelo-collagenated Xenograft (Hypro-Oss™) that is composed of 30% collagen type I free of atelo-peptide (atelo-collagen) with native osteoinductive elements (TGF, BMPs, IGFs) and 70% native osteoconductive bovine Hydroxyapatite components, can be used as an efficient inductive bone grafting material for guided bone regeneration and sinus augmentation. This work can show that this Xenograft has several advantages due to the production process that preserves the organic elements as bone growth factors that are responsible for accelerating the bone regeneration period and resulting in optimal bone quality and volume for optimising implant placement. Good bone density was approved by high implant insertion torque and high volume of calcified tissue in histological slides. The clinical and radiographical properties of the new bone are similar to natural type II bone. In addition to these advantages, a good handling during surgery, good healing and minimal post-surgical complications are also concluded upon this case.

_contact	implants
<p>Dr Amir Gazmawe DMD specialist in Prosthodontics Hadassah University—Dental Faculty Jerusalem</p>	

“The trend towards the medium-price range has accelerated”

Source_DT Asia Pacific

Following previous investments in Brazil, Germany and Spain, Straumann recently announced that it has bought convertible bonds worth US\$30 million from MegaGen, one of the largest dental implant solution providers in South Korea. At the recent World Symposium of the International Team for Implantology in Geneva in Switzerland, on behalf of *Dental Tribune Asia Pacific, implants magazine* Managing Editor Georg Isbaner had the opportunity to talk to Frank Hemm, a member of Straumann's executive management board, about the investment and how it will affect his company's position in the Asia Pacific region.



Implants magazine Editorial Manager Georg Isbaner (left) spoke with Frank Hemm about Straumann's position in the Asia Pacific region.

(Photo: Henrik Schröder, OEMUS MEDIA AG)

According to analysts, South Korean manufacturers are expected to dominate the market for dental implants in Asia in the years to come. Is this projected development the main reason for your investment in MegaGen?

South Korea is one of the largest markets for implants in terms of volume. More than two million implants are placed every year and local manufacturers are looking to expand into other Asian markets with high potential. China is a good example, where the market is still comparatively small but under-penetrated and growing quickly.

In these markets, the premium implant segment, where Straumann has been and still is very active, is growing less dynamically than the medium- and low-price segments are. We see the same trend in other markets, like Brazil, where companies like Neodent sell higher volumes than premium providers do. Two years ago, we had to ask ourselves whether we could address the non-premium segment with our existing brand or whether we needed a second brand. We decided on the latter and purchased a 49 per cent stake in Neodent. As an established brand in the region, MegaGen gives us a foothold in the Asian "value" (medium-price) segment. The convertible bond approach means that we have the option to gain a majority stake in 2016 with a managed low risk.

Straumann has always provided premium dental implants backed by solid scientific evidence and serv-



ice excellence. These key differentiators make it necessary to use a separate brand strategy to address customers who are willing to accept lower standards and who want to pay less for implants. The value segment is growing exponentially and developing a new brand from scratch would simply take too much time and too many resources, which is the reason we chose to invest in other established companies.

Both companies have said that they will continue to operate separately. Still, do you expect any synergies to arise from this partnership?

It is important to keep both businesses completely separate to ensure that customers do not think that Straumann is MegaGen and vice versa. The only synergies we see are in supporting the value brand companies to enter selective markets, and in sharing back-office functions, like infrastructure, information technology or accounting. Everything else is handled by each company independently. Straumann products are certainly produced in Straumann facilities and this will continue to be the case in the future.

Is there the risk that you might be creating more competition for yourself with this investment?

We would not have taken this step if the market situation had not required it. The trend towards products in the medium-price range has accelerated and there

is already strong competition, even without MegaGen. We are not adding more competition; rather, we are competing where we could not compete as Straumann.

What position is your company generally aiming for in the Asia Pacific region?

We aspire to market leadership in the region. We are not there yet, partly because our Roxolid implants with the SLActive surface are not yet available in the larger markets. We recently received approval for SLActive Tissue Level implants in Japan and the sales figures demonstrate the extent of the potential of our innovative technologies.

Achieving a leading position in Asia will certainly have a positive influence on our global position.

What requirements will have to be fulfilled for you to exercise the option to convert and acquire a majority stake in MegaGen in 2016?

We are keeping a close eye on the company's development. MegaGen is a relatively new enterprise. It is growing dynamically and has many ambitions that still have to be realised. We also want to see how the market develops and the extent to which MegaGen can penetrate certain areas.

The company's valuation is another item on our radar. If our expectations are met, we can convert the bonds into shares in 2016 or require repayment with interest. That is the flexibility that this option allows us.

Should you decide to convert the bonds into stock, another large international implant conglomerate would be created. Is it only possible to survive in the long run as a large market player?

The implant market is still very fragmented and the market share of larger corporations is actually declining. There are hundreds and hundreds of smaller providers, often founded by dental clinicians, which come and go because they do not have the capability to expand internationally. Few companies succeed in making this jump and remaining in the market for a longer period.

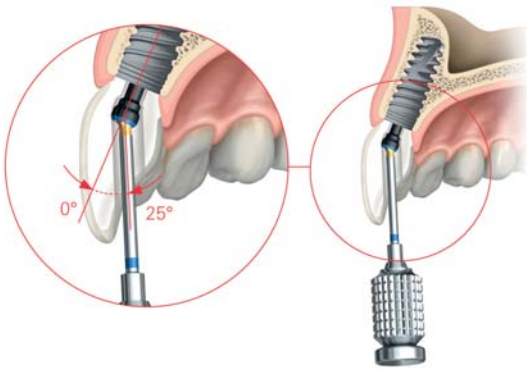
Unlike in some industries, scale in the dental implant industry does not have inherent returns. What we are seeing is a consolidation in a larger context, as many distributors have started to include implants in their portfolios with the aim of becoming one-stop shops. This development needs careful scrutiny because implants involve other factors that only we as specialists can deliver.

Thank you very much for the interview.

Manufacturer News

Nobel Biocare

New angulated screw channel concept and tooling



Clinicians will not have experienced this one-of-a-kind solution before. The innovative combination of the NobelProcera Angulated Screw Channel (ASC) abutment and Nobel Biocare's unique new Omnigrip tooling solve two typical challenges clinicians often face: buccal screw access holes that limit restorative options in the anterior and difficult access in the posterior region from lack of vertical space.

Available in zirconia for Nobel Biocare implants with conical connection, the abutment can be designed with an angulated screw channel of up to 25 degrees from the axis of the implant. Clinicians using the superior Omnigrip friction-based pick-up function gain peace of mind as the screwdriver easily grips the screw at any angle within the available range. The intense grip keeps the screw in position making it less likely to drop while adjusting the insertion angle and finding the first threads for fixation.

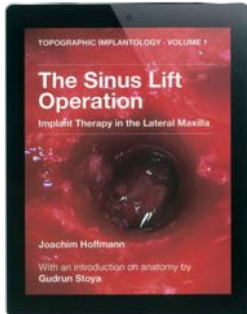
Nobel Biocare Deutschland GmbH

Stolberger Straße 200
50933 Köln, Germany
www.nobelbiocare.com

Dentaurum Implants

Multimedia iBook for implantologists

The first book of the series "Topographical implantology"—"The sinus lift procedure — implant therapy in the lateral maxilla"—is available for iPad and Mac now. Apple's new operating system Mavericks presented at the end of 2013 includes the free software iBooks. The textbook for implantologists can also be viewed and saved on Mac computers now. So far, iBook was only available for iPad. The iBook by Dr Joachim Hoffmann from Jena, Germany, deals with surgery techniques for the lateral maxilla—on more than 100 pages (incl. 40 videos in HD quality with explanations by the author, 170 images, various animations and links). The iBook is divided into twelve chapters. The anatomical basics are covered by Dr



Gudrun Stoya from the Anatomical Institute of the Friedrich Schiller University in Jena, using demonstration videos and preparations from the institute collection with detailed descriptions. The chapters on clinical and radiological diagnostics, surgical procedures and solutions for complications are covered by Dr Hoffmann using video material from the film collection of the IMPLANTarium. The training tool is available in German and English and can be downloaded on iTunes or iBook for iPad or Mac.



Dentaurum Implants GmbH

Turnstr. 31
75228 Ispringen, Germany
www.dentaurum-implants.de

MIS

Ratchet wrench for implant placement

The new MIS ratchet wrench is designed as a universal tool for placing and adjusting dental implant abutments and screws for a wide range of sizes. This lightweight, durable ratchet wrench features a sleek mono-block design, with no lever, complex contours or mechanical components that would require disassembly and re-assembly.



"It's a real time-saving tool"

Elad Ginat, Products Manager at MIS Implants, explains: "It's a real time-saving tool, with a streamlined shape that prevents the accumulation of contaminants like blood or saliva. This ratchet wrench is ideal for easy cleaning for a safer procedure." The new ratchet wrench was developed to be a simpler and more efficient tool than the earlier model. It effectively reduces the number of tools in the portfolio, operating as an insertion tool for various implant models, as a direct key mechanism or as a screw driver.

The ratchet, along with an assortment of newly designed tools, comes as standard in many updated MIS surgical kits now. This includes a special time-saving insertion key that allows for both manual operation and use with the ratchet—making it easier for doctors to determine whether torque is being applied or released; both visually or by touch.

MIS Implants Technologies GmbH

Simeons carré 2
32423 Minden, Germany
www.mis-implants.com

DENTSPLY Implants

Implant System based on natural dentition

DENTSPLY Implants introduces the next step in the continuous EVolution of the ASTRA TECH Implant System. The Implant System EV is designed with a

site-specific, crown-down approach based on the natural dentition for increased surgical simplicity, flexibility and restorative ease. The foundation of this evolutionary step is the ASTRA TECH Implant System BioManagement Complex, well documented for its long-term marginal bone maintenance and aesthetic results provided by the combination of the key features: the OsseoSpeed surface, MicroThread, Conical Seal Design and Connective Contour. The main objective of the new system is to further improve system logic, robustness and user friendliness. Simplicity without compromise has permeated the evolution of the Implant System EV.



DENTSPLY Implants
Steinzeugstraße 50
68229 Mannheim, Germany
www.dentsplyimplants.com

Straumann

More than pure esthetics. The natural and strong solution.

Straumann's innovative ceramic implant, which was presented at the EAO last October, has completed its controlled market release. Based on the positive feedback and clinical results (97.6% success and survival rates¹), which has been be pre-



sented in Geneva at the ITI World Symposium, the implant is now generally available to customers in Europe under the brand name Straumann® PURE. The implant has exceptional esthetic properties with a translucent ivory color like natural tooth roots. It has a specially-developed ZLA® surface to enhance and shorten the healing process and to provide highly predictable osseointegration. Its manufacture involves several innovations including a test procedure to assure the stability of every implant.

Bicon Dental Implants

Simple. Predictable. Profitable.



With the plateau design, cortical like bone forms around and between each plateau. This Haversian bone allows for the routine use of 5.0 mm short implants.

The sloping shoulder provides the necessary room for bone to support interdental papillae that are gingivally aesthetic. Bicon's 360° of universal abutment positioning provides for the revolutionary cementless and screwless Integrated Abutment Crown™, which consistently provides for a non-metallic aesthetic gingival margin.

Since 1985, the Bicon Dental Implant System has offered dentists a proven solution for missing dentition.

The Bicon implant design comprises plateaus, sloping shoulders and a bacterially-sealed, 1.5° locking taper implant to abutment connection.



Bicon Dental Implants
Arborway 501
Boston, MA 02130, USA
www.bicon.com

¹ Gahlert M, Kniha H, Weingart D, Schild S, Eicholz P, Nickles K, Borman K-H, Prospective Open Label Single Arm Study to Evaluate the Performance of Straumann Ceramic Implants Monotype CIM (Zirconium dioxide) in single tooth gaps in the maxilla and mandible. EAO 2013, Poster 252, Clin. Oral Impl. Res. 24 (Suppl. s9), 2013, p. 123.

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Welcome

Fig. 1_ The ITI welcomed participants from all over the world to its 12th symposium with the headline "Knowledge is key".



Biggest international implant dentistry meeting to date

ITI World Symposium 2014 with 4,200 participants

The International Team for Implantology (ITI), a leading academic organization dedicated to the promotion of evidence-based education and research in the field of implant dentistry, welcomed more than 4,200 participants from 84 countries to its global flagship event, the ITI World Symposium. Held under the heading "Knowledge is key", the meeting took place in Geneva, Switzerland, between April 24 and 26, 2014.

_ITI programme

After a brief excursion into outer space, presented by keynote speaker Claude Nicollier, Switzerland's first and only astronaut, the scientific programme guided the audience back down to solid ground with a practically oriented offering of lectures, presentations and panel discussions. The latest scientific findings aligned to the ITI philosophy of evidence-based treatment served as the basis for

all the presentations that came under the three main topics: "Digital implant dentistry", "Prevention and management of biological and technical complications" and "New approaches, challenges and limitations in aesthetics".

The scientific programme was supplemented by a half-day Pre-Symposium Corporate Forum presented by industry leaders Straumann, Morita and Geistlich as well as a research competition and an attractive social programme that offered ample opportunity for networking and a chance to talk to key opinion leaders. An extensive industry exhibition with 50 exhibitors allowed participants the possibility to find out about the latest products related to their daily work. "Our main theme 'Knowledge is key' underlines the importance the ITI assigns to evidence-based information for use in daily clinical practice," said Dr Stephen Chen, Chair of the Scientific Programme Committee. "This applies not just to



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Fig. 7



Fig. 8



Fig. 9

Fig. 2 As congress partner, the Straumann AG informed the participants about their latest products.

Figs. 3 & 5 Participants had much opportunity to connect with colleagues from all around the world in a cosy atmosphere.

Fig. 4 Prof. Dr David Cochran, President of the ITI, presented the new e-learning platform ITI Online Academy.

Fig. 6 Dr Stephen Chen, Chair of the Scientific Programme Committee, spoke about maintenance of the ridge post-extraction and its risk for aesthetics.

Figs. 7 & 9 During the three-day congress the participants were offered a scientific programme with practically oriented lectures, presentations and panel discussions.

Fig. 8 Prof. Dr Daniel Buser, former ITI President.

the ITI World Symposium, but also very particularly to our new e-learning platform, the ITI Online Academy, which we were able to showcase during the meeting for the first time."

ITI Online Academy

The Symposium provided a tailor-made opportunity to present a preview of the soon-to-be launched ITI Online Academy—planned to be the most innovative and complete e-learning platform worldwide. With its user-oriented approach, the ITI Online Academy offers a broad and continuously expanding curriculum of learning modules designed for every level of expertise. It is supplemented by cases, videos and lectures as well as a wealth of

free content such as assessments geared to identifying individual strengths, weaknesses and gaps in knowledge. "We are very proud of our new e-learning platform as we believe it goes further than any other offering currently available," commented Prof. Dr David Cochran, ITI President (Abb. 4). "Not only does the curriculum cover implant dentistry in its entirety, but the system is also designed to adapt dynamically to the user and propose further learning pathways based on the gaps and weaknesses identified." Twelve demo workstations were available to participants of the ITI World Symposium 2014 to test-drive the Online Academy and provide valuable user feedback. The Academy will be launched later this year. The next ITI World Symposium takes place in 2017. _



Fig. 1



Fig. 2



Fig. 3

More than 120 implantologists met for the International Bicon Symposium

Fig. 1_The International Bicon Symposium took place in the picturesque tourist town Taormina/Sicily.

Fig. 2_The lectures were focused on the subject "Avoiding augmentative measures by application of short implants".

Fig. 3_ There was also time to share some expertise: Dr Vincent J. Morgan (left), president of Bicon, Prof. Dr Rolf Ewers and Prof. Dr Mauro Marincola (right) in a conversation.

Fig. 4_ More than 120 implantologists from eleven countries met for the symposium.

Fig. 5_ Dr Vincent J. Morgan, president of Bicon, and Prof. Dr Rolf Ewers.

Fig. 6_ Prof. Dr Mauro Marincola and Jürgen Isbaner, executive board of OEMUS MEDIA AG.



Fig. 4



Fig. 5



Fig. 6

_On the subject "Avoiding augmentative measures by application of short implants", an international symposium for implantology was held. The event took place in the picturesque tourist town Taormina/Italy on 26 April 2014. More than 120 implantologists from eleven countries met for the symposium in Sicily. Scientific head of the event was Prof. Dr Mauro Marincola/Rome, Italy.

The lectures were focused on questions about avoiding augmentative measures by application of ultrashort implants as well as minimally invasive implantological concepts.

In this context, among others it was discussed whether long implants were necessary in case of reduced bone material and how short implants need to be in the immediate loading. In addition to Prof. Dr Marincola, Prof. Dr Rolf Ewers/Vienna, Austria, and Dr Frank Kistler/Landsberg am Lech, Germany, belonged to the speakers team.

The meeting was already a foretaste for the 30th anniversary that Bicon is going to celebrate with three major scientific events in 2015. On the first weekend in May 2015, Bicon jubilee congresses will be held in Munich, Germany; Boston, USA, and Rome, Italy.

Minimally invasive **treatment concepts** in Lucerne

Author _Jürgen Isbaner, Chief editor DT D-A-CH

The 6th Swiss Biomaterial Days, which took place on 9 and 10 May 2014 in Lucerne, were dedicated to future-oriented, minimally invasive treatment concepts. Located on the northwestern tip of Lake Lucerne, the event provided its 150 participants from all over Europe with a complex scientific programme and top-level speakers.

Prof. Dr Walter Lückerath/University of Bonn, Germany, who held the scientific chair of the congress, stated in his invitation, "We are obliged to our patients to strive for less invasive procedures, so that treatment becomes less strenuous. With this in mind, we chose the topics and speakers for the 6th Swiss Biomaterial Days with a focus on minimally invasive concepts".

The pre-congress "Guidor Matrix Barrier" was directed by Prof. Dr Dr Erich Wintermantel. Parallel workshops on augmentation, periodontology, oral surgery and aesthetics started at noon, along with the main congress.

The key element of less or non-invasive treatment concepts is minimally invasive surgery. Therefore, Prof. Dr Dr Wilfried Engelke's speech dealt with the transfer of medical approaches—small incisions and endoscopy—to oral surgery and implantology. Dr Mario Kirste, Dr Minas Leventis and Prof. Lückerath showed how modifications of contemporary surgical or clinical procedures for the maintenance of the alveolar ridge can help simplify clinical procedures, thus reducing side effects of the treatment. Prof. Dr Ashish Kakar and Dr Antonio Flichy illustrated how immediate implantation can help reduce the number of sur-



Fig. 1

gical procedures. Prof. Dr Else Marie Pinholt's speech dealt with the microstructures of periimplant hard tissues after augmentation with bone substitutes.

Fig. 1 _The Lucerne venue.

In addition, minimally invasive concepts should include new or recently discovered surgical approaches, offering the chance to complement or replace invasive techniques. Dr Dr Karl-Heinz Heuckmann and Prof. Kakar's workshops showed the participants how subperiosteal tunnel techniques can be applied successfully as minimally invasive techniques in lateral ridge augmentation. Often, the least invasive approaches are those which manage without surgery. In this context, PD Dr José Gonzales gave demonstrated non-surgical approaches to periodontal treatment concepts for patients with systemic diseases.

Fig. 2 _Team Sunstar Guidor, Germany, CEO Dr Gerhard Pötsch (middle).

Fig. 3 _Prof. Dr Walter Lückerath (2nd from left) and congress participants during the pre-congress.

Fig. 4 _Prof. Dr Dr Erich Wintermantel during the pre-congress.



Fig. 2



Fig. 3



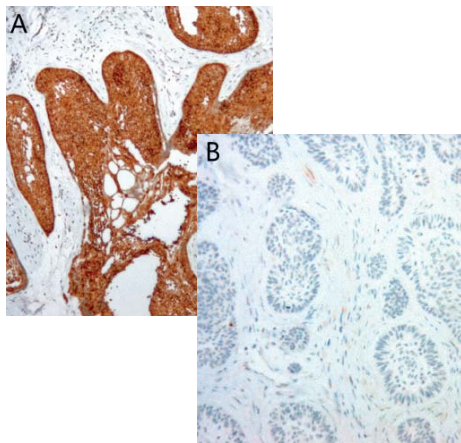
Fig. 4

Researchers find

Mutation in jaw tumour

A Finnish team of researchers has discovered a gene mutation in ameloblastoma, which is a tumour of the jaw. The finding could significantly improve treatment, as a targeted drug for the mutation in question already exists. Ameloblastoma is an odontogenic tumour with a high tendency to recur after treatment. It is most often found in the posterior region of the mandible.

Ameloblastomas are treated with surgery, often resulting in tissue deficiencies in the jaws and the loss of several teeth. A suitable drug therapy could



reduce the need for surgery and the recurrence of ameloblastoma; however, finding such a treatment requires a better understanding of the pathogenesis of the tumour. Researchers have been searching for the mutation that causes ameloblastoma for decades, and this mutation has now been found in a patient living in the eastern part of Finland.

The team who made the discovery includes researchers from the University of Turku and the University of Eastern Finland. According to the leaders of the team, Professor of Medical Biochemistry Klaus Elenius at the University of Turku and Professor of Oral Diagnostic Sciences Kristiina Heikinheimo at the University of Eastern Finland, the finding is a scientific breakthrough.

The significance of the finding is further emphasised by the fact that it has direct implications for treatment, as a targeted drug for the mutation in question already exists.

Annual meeting of

European and North America prosthetics



The Academy of Prosthodontics held its 2014 international congress in Europe for the first time in collaboration with the Swiss Society for Reconstructive Dentistry. About 500 participants joined the event in Bern in Switzerland, at which leading experts in prosthetics from the US met up with their European colleagues to discuss their treatment philosophies. Founded in 1918, the Academy of Prosthodontics is one of the oldest specialty organisations in prosthetic dentistry. Its annual meeting usually takes place in the US or Canada. This year, however, the organisers opted for the congress centre at the Kursaal Bern, the largest conference

complex and event venue in the region. The two-day scientific programme saw practice-related clinical lectures by expert panellists from both sides of the Atlantic. Twenty speakers from the US and Switzer-



land, as well as from Italy, Germany, Spain and the UK, elaborated on the essential principles of modern prosthetics in dentistry, including digitalisation and aesthetic aspects of conventional and implant prosthetics. The lectures were held in English. However, simultaneous interpreting was available in French and German. Alongside the scientific programme, attendees had the opportunity to visit the congress dental exhibition.

Metal 3-D printing helped

Rebuild motorbike crash survivor's face

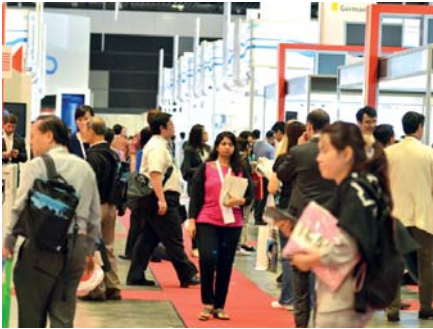
The Belgian company LayerWise produced patient-specific titanium implants as part of a pioneering facial reconstruction. Motorcyclist Stephen Power was severely injured in an accident near Cardiff, UK. A specialist team successfully dealt with all facial injuries, with the exception of his left cheek and eye socket. The patient's cheekbone was too far out and his eye was sunk in and dropped. Due to the close proximity of critical and sensitive anatomical structures, the team applied the latest 3-D computer-aided practices by PDR and innovative 3-D printing of the titanium implant and fixation plate by LayerWise. The company manufactured the implant and fixation plate in medical-grade titanium (Ti6Al4V ELI) in accordance with the ISO 13485 standard, produced the floor plate, and polished its upper surface to minimize friction with soft tis-



sues. The floor plate was fixated to the zygomatic bone through the plate's dedicated slip with attachment holes. After his recovery, Stephen Power experiences the results of the surgery as 'totally life changing'. Instead of using a hat and glasses to mask his injuries, he is now able to do day-to-day things, go and see people, walk in the street, and even go to any public areas.

IDEM Singapore 2014 was

A record-breaking success



This year's IDEM Singapore demonstrated why it is Asia's leading dental trade fair and scientific conference with record breaking numbers of exhibitors, conference tracks and attendees. The event saw more than 500 exhibitors from 38 countries showcasing the latest innovations in clinical dentistry, dental technology and patient care across every segment of the dental market, covering restorative and preventive treatments, surgical procedures and equipment, orthodontics, endodontics, periodontics and laboratory tools. The IDEM Singapore trade fair was the first ever to fill both floors of exhibition space covering 16,000 sqm. The trade fair and conference welcomed 7,842 partic-

ipants from 61 countries over three and a half days. IDEM Singapore is increasingly seen as the gateway to Asia for dental manufacturers and distributors wishing to break into Asian markets and this was reflected in the high number of first time exhibitors; 170 or 30 per cent were new to IDEM Singapore this year.

The conference theme this year was "Dentistry—The Future Is Now" with the programme focusing on the future of dentistry, addressing the challenges and the procedural and technical advances in the various fields of dentistry. The trade fair and conference welcomed 7,842 participants from 61 countries over three and a half days. IDEM Singapore is increasingly seen as the gateway to Asia for dental manufacturers and distributors wishing to break into Asian markets. The increased representation from countries in the Asia-Pacific region such as Australia, Cambodia, Taiwan, Hong Kong, Korea, Japan, New Zealand, Myanmar and Sri Lanka, highlighted another trend: IDEM Singapore, long considered the event where East meets West, is now also increasingly seen as the gathering point for different parts of the East to meet each other. The next edition will be staged from April 8 – 10, 2016.

Researcher patented

New bacteria fighting agent

Researchers at the University of Washington's School of Dentistry have received a patent for a new way of using titanium-based materials to control bacterial infections. They believe that the substances could be used in a patient's mouth after dental procedures to reduce the risk of infection or in mouthwashes and toothpastes to limit bacterial growth prophylactically. Over several years, the researchers have studied titanates and peroxo-titanates, inorganic compounds that can inhibit bacterial growth when bound to metal ions. They found these substances to be effective against endodontic, periodontic and cariogenic bacteria, indicating that these substances could be incorporated into gels or solutions that can be applied by dentists after treatments such as root canals or dental fillings. Dr Whasun Oh Chung, research associate professor at the school, explained that metals have been known to have antibacterial properties, but when used in concentrations high enough to be effective, they also carry the risk of toxic side effects. Using the new agent, however, therapeutic benefits can be achieved with less risk of toxicity.

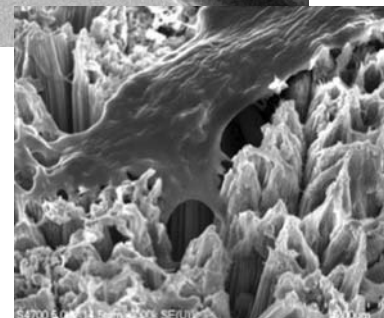
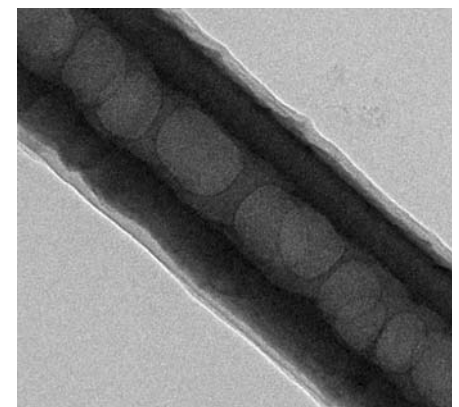


Currently, the researchers are conducting human trials. They expect to finish them in spring. If proven effective, the new agent could even be used in narrowly targeted treatments for internal organs, as well as in dental or medical materials and devices, Chung said.

Future dental implants could be

Made from nanotubes

A scientist at Michigan Technological University is in the process of using nanotechnology to create better, longer-lasting dental implants. "Dental implants can greatly improve the lives of people who need them," said Tolou Shokuhfar, an assistant professor of mechanical engineering. "But there are two main



issues that concern dentists: infection and separation from the bone." Shokuhfar says implants with a surface made from titanium dioxide nanotubes can battle infection, improve healing, and help dental implants last a lifetime. "We have done toxicity tests on the nanotubes, and not only did they not kill cells, they encouraged growth," she said. The nanotubes can also be a drug delivery system. Shokuhfar's team loaded titanium dioxide nanotubes with the anti-inflammatory drug sodium naproxen and demonstrated that it could be released after implant surgery. That assures that the medicine gets where it's needed, and it reduces the chances of unpleasant side effects that arise when a drug is injected or taken orally. To fight infection, the nanotubes can also be laced with silver nanoparticles. Shokuhfar and her team have received a provisional patent and are working with two hospitals to develop the technology and license it.

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