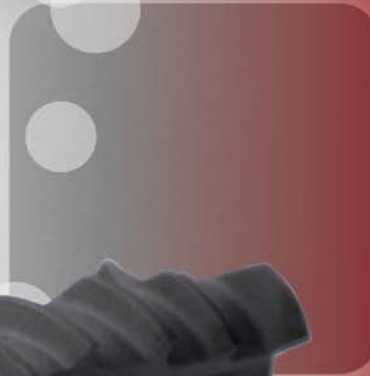


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Implantology in the year of IDS



Prof Dr Dr Frank Palm

The 34th International Dental Show (IDS) in Cologne is just around the corner, bringing with it a challenging test for the international dental market. This dental show continues to grow, with approximately 1,900 exhibitors from 55 countries presenting their products in ten exhibition halls this year. We wait to see if an economic rebound has taken place, and if certain undesirable developments have been corrected.

The implantology market in particular suffered from volatility triggered by the financial crisis, and it is still not clear whether the industry can return to double digit growth rates in 2011. Considering the positive developments in the industry in the autumn of last year, and the high attendance numbers at this year's congresses and trade shows, many implantologists are optimistic. In particular, implant suppliers are keen to make a new start, and the IDS should provide a glittering display of innovations and numerous product launches. Digitalization in implantology, from 3-D diagnosis, digital dental impression-taking and computer-aided planning and navigation, through to prosthetic restorations manufactured by means of CAD/CAM, are likely to be the center of attention. Moreover, new and further developments in implant materials and designs, as well as new approaches to solutions for regenerative techniques will play an important role.

These developments provoke our curiosity, though it is clear that we cannot expect an "optimal solution" for all medical indications and a "golden standard" in implantology in the near future. Rather, many factors are important when it comes to finding the best solution for each individual case. Limiting factors on the patient's part e.g. funding, time, personal requirements, physical and psychological capacities, and most of all the skills of the dentist, are the most important criteria. Without the expert skills of a competent and experienced implantologist the best technique is useless. As an association of experts, it is our job to expose colleagues to this topic more intensely, and to ensure that the existing high standards in implantology are maintained in future.

Like all other important implantological associations, DGZI will be present at the IDS with its own stand, and we would be pleased and look forward to meeting you.

Prof Dr Dr Frank Palm
President of the DGZI
(German Association of Dental Implantology)

Chief Physician, Department of Oral and Maxillofacial Surgery,
Clinical Center Constance, Germany



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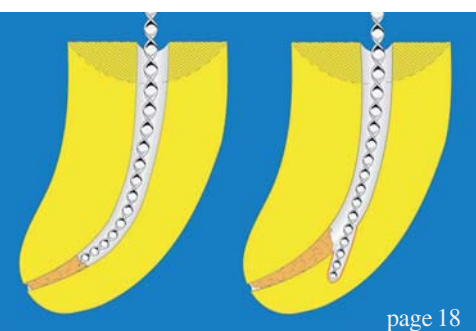
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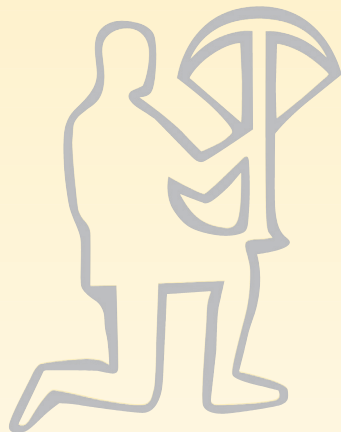
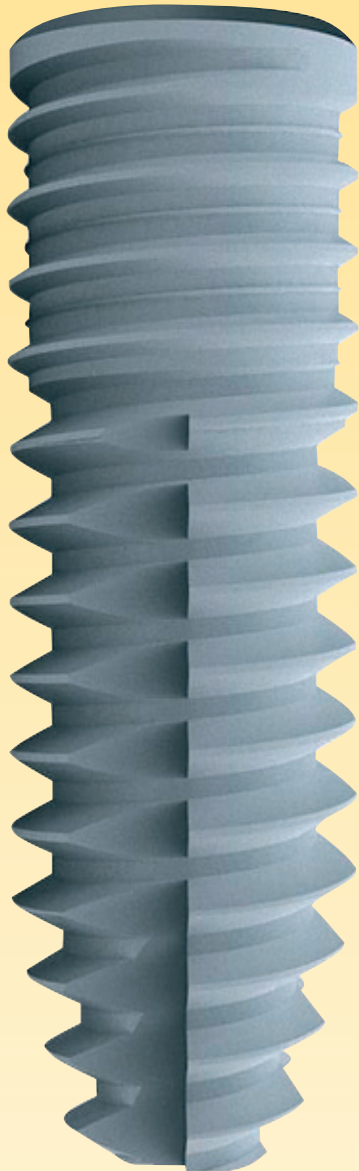




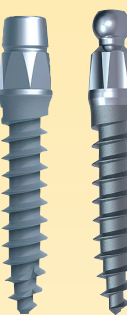
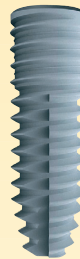
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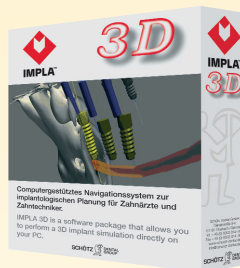


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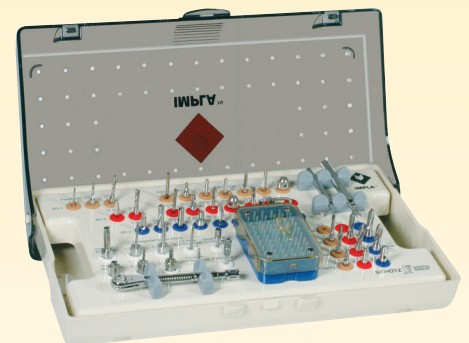
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Biomechanical finite element analysis of **small diameter** and **short dental implant**

Authors _Istabrak Hasan¹, Dr Friedhelm Heinemann², Maria Aitlahrach¹ and Prof Dr Christoph Bourauel¹

Abstract

Short and mini dental implants have been widely used as treatment alternatives in certain selected clinical situations. However, a profound scientific analysis of the mechanical and biomechanical impact of the reduced length and diameter of these implant geometries has not been published until now. Using finite element analysis, a series of different experimentally designed short and mini implants have been analysed with regard to their load transfer to the alveolar bone and have been compared to respective standard commercial implants. Mini implants have been inserted in an idealised bone bed representing the anterior mandibular jaw region and loaded with a force of 150 N. An immediate loading condition was assumed and analysed using the contact analysis option of the FE package MSC.Marc/Mentat. Short implants were inserted in an idealised posterior bone segment and loaded in an osseointegrated state with forces of 300 N. Clearly increased bone loading was observed for the short

and mini dental implants compared with standard implants, clearly exceeding the physiological limit of 100 MPa. The determined biomechanical characteristics could explain the slightly increased failure rate of short and mini dental implants.

Introduction

The loss of crestal bone around dental implants has been reported to be influenced by many factors. These include surgical trauma, implant abutment microgap, bacterial infection of peri-implant tissues and biomechanical factors related to loading. Factors that affect the load transfer at the bone implant interface include the type of loading, material properties of the implant and prosthesis, implant geometry, surface structure, quality and quantity of the surrounding bone, and nature of the bone-implant interface.⁹ There are many dental implant designs available on the market for specific clinical applications: standard implants, short implants with wide diameter and implants with small diameters. All are available in different geometries, thread configurations (if any) and thread depth (Fig. 1).

After tooth loss, however, severely atrophic residual alveolar ridges are fairly common, especially in patients who have been edentulous for a long period of time. Posterior areas of the maxilla and the mandible are areas where clinicians have greater anatomical limitations. Reduced alveolar bone height very often represents a contraindication to implant therapy, unless a procedure such as ridge augmentation or sinus floor elevation is performed. Although widely utilised, these techniques imply greater morbidity, longer treatment times and higher costs. The sinus cavity in the maxilla and alveolar nerve proximity in the mandible are clinical situations where short implants could be considered as an alternative treatment option. Numerous

Fig. 1 Overview of some available commercial short and mini implants.

Fig. 2 Loading direction of the numerical models. A mini implant (2.5 x 15 mm) inserted in an idealised bone block with a cortical thickness of 1.2 mm (left) and a short implant (5.5 x 7 mm) inserted in an idealised bone block with a cortical thickness of 0.5 mm (right).



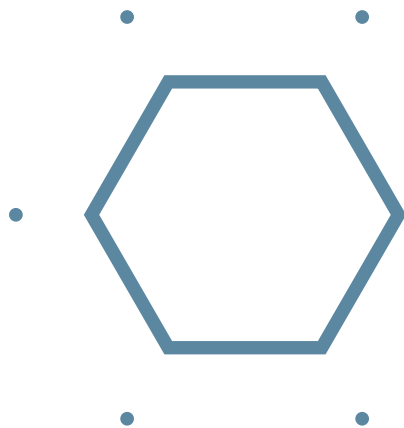
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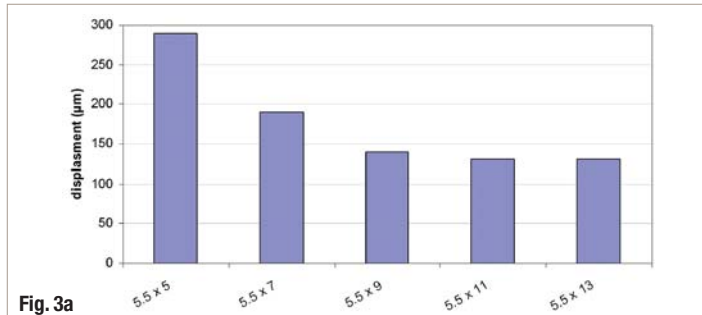


Fig. 3a

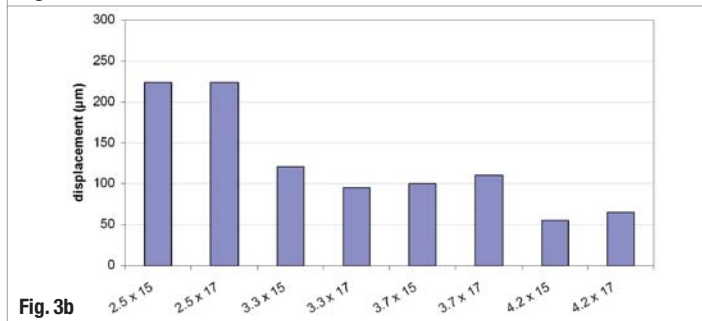


Fig. 3b

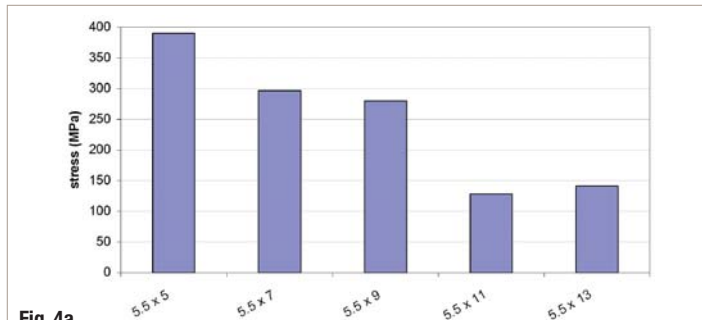


Fig. 4a

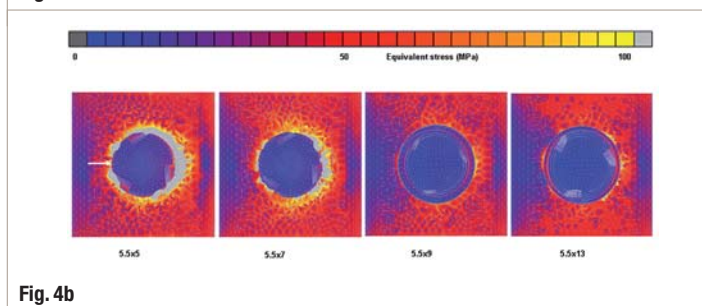


Fig. 4b

Fig. 3 Implant displacements obtained for (a) the short implants and the corresponding standard implants after loading of 300 N in 308 from the implant axis, (b) the MDIs and the corresponding standard implants after loading of 150 N in 308 from the implant axis.

Fig. 4 Total of equivalent stress obtained for the short implants and the corresponding standard implants. (a) Maximum values obtained at the cervical region of the alveolar bone, (b) occlusal view of the stress distribution. The arrow indicates the direction of the applied load.

short implants might have improved over the past few years.

In addition to standard and short implants, there are the implants of smaller diameters, which are called mini dental implants (MDIs). Those are generally 2.75 mm to 3.30 mm in diameter, and they are frequently used in cases of limited bone volume. Several MDIs exist with even smaller diameters, ranging from 1.8 mm to 2.4 mm.^{28,29} In the beginning, the main application of MDIs was to serve as the remedy and provisional instrument for insertion of provisional restorations during the osseointegration phase of conventional standard (larger diameter) endosseous implants.^{1,2,12} The assumption was that MDIs are unable to provide functional load of im-

plant supported prostheses.^{2,11} In the course of time, it was observed that those implants osseointegrated very well clinically.¹² It became clear that, in combination with a minimally invasive implant insertion protocol for the MDIs, they could provide a satisfactory prosthodontic rehabilitation effect.^{12,29}

The advantage in use of MDIs is the minimally invasive, single stage placement procedure^{2,11} in comparison to the procedure for conventional implants (diameter 3.5 and wider). The philosophy of MDI insertion is a minimally invasive technique of inserting the implant into the bone through a small opening of the soft tissue, but not a prepared bone site.¹¹ Therefore, the bone damage and bone wound during implantation is minimised. Bleeding and postoperative discomfort are reduced¹² and healing time is shortened. It is recommended to load such implants immediately.² The purpose of the present study was to numerically analyse the biomechanical differences of short and narrow (mini) dental implants to the standard ones according to their clinical applications. This study tested some of the available geometries for the narrow as well as short implants. The magnitude of micromotion of implants was investigated, in addition to the magnitude and distribution of stresses and strains in the alveolar bone around the implants.

Materials and methods

A total of 13 three-dimensional finite element (FE) models were developed: two models for short implants, three for the corresponding standard implants, two for mini implants, and finally six models for the corresponding standard implants (Table I). The geometries of the implants were constructed from the CAD/CAM data that were generated and provided by a Dental Implant company and subsequently fed into the FE program MSC. Marc/Mentat 2008. According to several previous studies¹⁵, the tetrahedral element type (4-nodes) was selected for model generation and the bone in its two components (cortical and cancellous bone) was meshed using a coarsening factor of 1.5 mm to gradually enlarge the tetrahedral element size from the implant contact region (0.2 mm) to the external surface (0.5 mm). As in the previous studies, the non-linear incremental Full Newton-Raphson solver was used¹⁵ running on a small Dell server cluster (Power Edge 1950, 20 cores, 40 GB RAM).

Implant geometries of group 1 (short implants)

Two short implants were investigated with a diameter of 5.5 mm and a length of 5 mm and 7 mm, respectively. Three commercially available standard

implants served for comparison: 5.5x9 mm, 5.5x11 mm, and 5.5x13 mm. According to their clinical applications, full osseointegrated condition was considered for the numerical analysis of the above-mentioned models. Young's modulus of the different components was chosen to match the bone quality in the anatomical regions (mandibular and maxillary posterior bone) where the short implants are typically inserted: 110 GPa for the implants, 20 GPa for cortical bone, and 300 MPa for cancellous bone. Typically, short implants are inserted in the posterior jaw region, thus the cortical layer in the idealised bone model had a thickness of 0.5 mm.

_Implant geometries of group 2 (mini implants)

Two mini implants were studied with a diameter of 2.5 mm and a length of 15 mm and 17 mm, respectively. Six commercially available standard implants were used as a reference: 3.3x15 mm, 3.7x15 mm, 4.2x15 mm, 3.3x17 mm, 3.7x17 mm, and 4.2x17 mm. According to their clinical applications, immediate loading condition was considered for the numerical analysis of the mini implant models. This has been done by considering a contact situation at the bone implant interface. A Coulomb friction model with a coefficient of friction of 0.5 was selected for the contact analysis.¹⁵

Young's modulus of the different structures was chosen to be 110 GPa for the implants, 20 GPa for cortical bone, and 1,000 MPa for the cancellous bone. Typically, mini implants are inserted into the anterior mandibular jaw region, thus the cortical layers had a thickness of 1.2 mm.

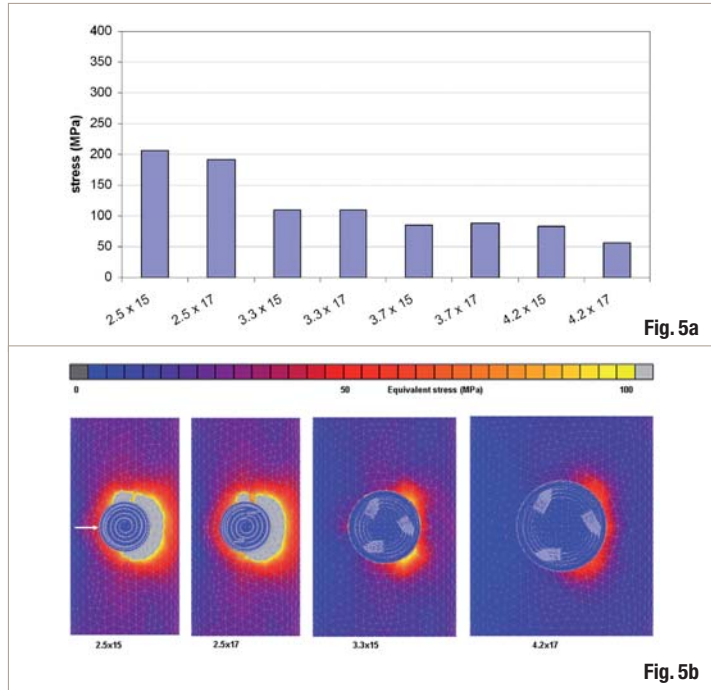


Figure 2 displays the idealised bone segments with the inserted implants. The mini implants were inserted into the bone segments (left) such that the screw threads did touch the cortical bone. Short implants were combined with an idealised bone segment that ensured sufficient distance to the basal cortical layer to simulate adequate distance to the nerve canal. For the whole 13 models, implants were subjected to a load at an angle of 308 from the implant axis. Loading direction was adjusted analogous to the ISO standard 1480118. The magnitude of the applied force was 300 N for comparing group 1 and 150 N for comparing group 220. The end faces were constrained in all three degrees of freedom (Fig. 2).

Fig. 5 Total of equivalent stress obtained for the MDIs and the corresponding standard implants. (a) Maximum values obtained at the cervical region of the alveolar bone, (b) occlusal view of the stress distribution. The arrow indicates the direction of the applied load.

Model	Loading condition	No. of elements	No. of nodes
Comparing group 1			
Shorty 5.5 x 5 mm	Delayed loading	116,167	22,315
Shorty 5.5 x 7 mm	Delayed loading	127,367	24,176
tioLogic 5.5 x 9 mm	Delayed loading	146,890	27,990
tioLogic 5.5 x 11 mm	Delayed loading	152,218	28,764
tioLogic 5.5 x 13 mm	Delayed loading	162,185	30,377
Comparing group 2			
Mini 2.5 x 15 mm	Immediate loading	151,851	34,870
Mini 2.5 x 17 mm	Immediate loading	179,773	41,481
tioLogic 3.3 x 15 mm	Immediate loading	127,569	27,685
tioLogic 3.3 x 17 mm	Immediate loading	141,938	30,925
tioLogic 3.7 x 15 mm	Immediate loading	136,560	29,650
tioLogic 3.7 x 17 mm	Immediate loading	148,259	32,245
tioLogic 4.2 x 15 mm	Immediate loading	145,351	31,427
tioLogic 4.2 x 17 mm	Immediate loading	167,624	20,393

Table 1 Description of the numerical models used in the study and their loading conditions.

Table 1

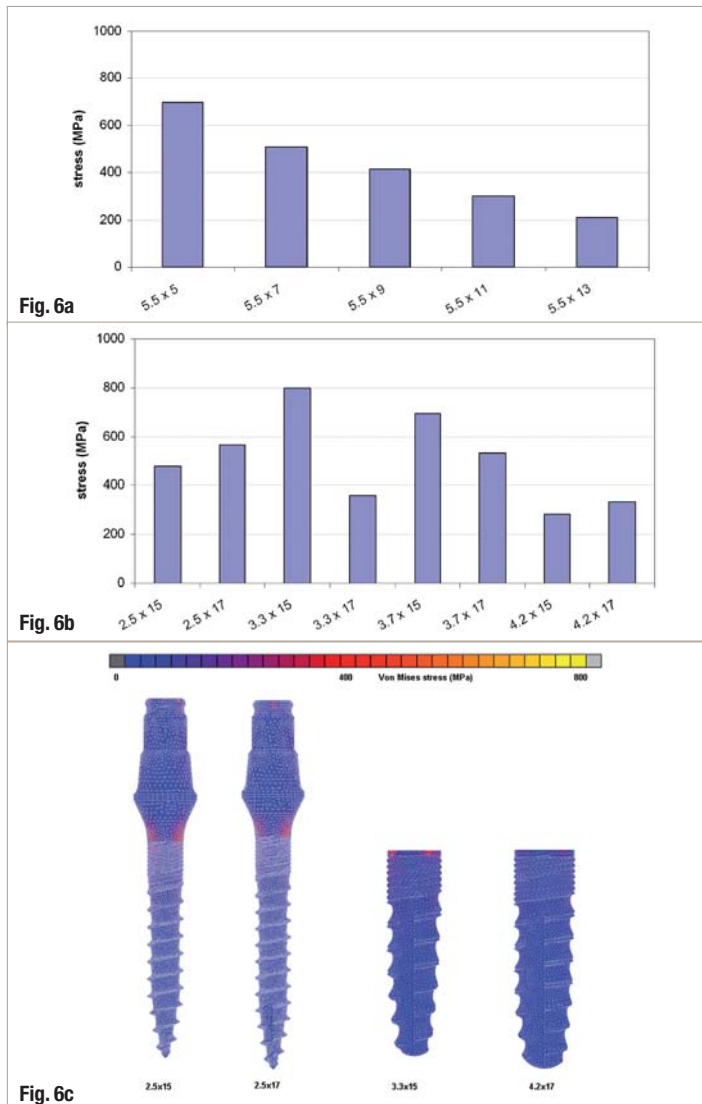


Fig. 6a

Fig. 6b

Fig. 6c

Fig. 6 Von Mises stress values obtained for (a) the short implants and the corresponding standard implants, (b) the MDIs and the corresponding standard implants, (c) stress distribution of the MDIs and standard implants.

tact artefacts. Correspondingly, maximum stresses in the implants were determined in the second inner implant element layer to omit artefacts due to the force application, and cancellous bone strains followed the same strategy as applied in cortical bone stress determination.

The highest displacement at the abutment was observed with the shortest implant (290 mm, implant: 5.5x5 mm). By increasing the length of the short implants, the displacement noticeably decreased (Fig. 3a). Regarding the MDIs, the displacement was higher with the small diameter (223 mm) than with the wide diameter implants (65–120 mm, Fig. 3b). Determined cortical bone stresses of the short implant FE models are displayed in Figure 4. The stress was higher with short implants than with the standard implants. Moreover, stress distribution was wider and covered more area of the cortical bone with the standard implants than with the short implants (Figs. 4a and b). Figure 5a and b display the cortical bone stresses determined with the mini im-

plant FE models. The stress was higher with the MDIs (206 MPa, Ø2.5 mm) than with the wider diameter implants (57–109 MPa, Ø3.3–4.2 mm). The magnitude of the stress decreased by increasing the diameter of the implant. Additionally, the distribution of the stress was wider with the MDIs than the standard wide diameter implants (Figs. 5a and b). Concerning the stress in the short implants, a decrease of the maximum stress was observed by increasing the length of the implants (700 MPa for 5.5x5 mm and 213 MPa for 5.5x13 mm, Fig. 6a). However, the maximum stress values obtained for the MDIs and standard implants showed a non-uniform behaviour (Fig. 6b) due to interplay of multiple factors, such as implant diameter, implant length, and screw configuration. Nevertheless, the stress distribution covers a wider region in the case of the MDIs than for the standard implants (Fig. 6c).

Highest strain values (22,000 and 16,000 µstrain) were determined with the short implants (5.5x5 mm and 5.5x7 mm) and decreased by increasing the length of the implants (8,000 µstrain, 5.5x13 mm). A more homogeneous strain distribution was observed by increasing the length of the implants (Figs. 7a and b). The strain was higher with the MDIs than with the wide diameter implants (3.3–4.2 mm) and the strain distribution was more homogeneous by increasing the diameter of the implants (Figs. 8a–b).

Discussion

In addition to conventional dental implants, there are so called short and mini implants for certain clinical applications. Even for these implants, there are numerous different commercial geometries available on the market. Based on this, the purpose of this study was to numerically analyse selected dimensions of short and mini implants and compare them to the conventional standard implants, to determine whether limit dimensions for the length and the diameter of a dental implant can be postulated. The analysis was based on the FE method and included stress and strain distributions in the bone around the implants, implant stresses, and implant micromotions.

One of the limitations of the present study was that the anatomical situation could of course not be reproduced perfectly. An idealised bone geometry as an implant bed was used and differentiation between the anterior and posterior jaw segments was accomplished by consideration of only the cortical layer thickness and the cancellous bone quality, i.e., the respective Young's modulus. Together with further typical limitations of an FE study, a predictability of 20% can be assumed for the presented results. Short implants offer several surgical advantages



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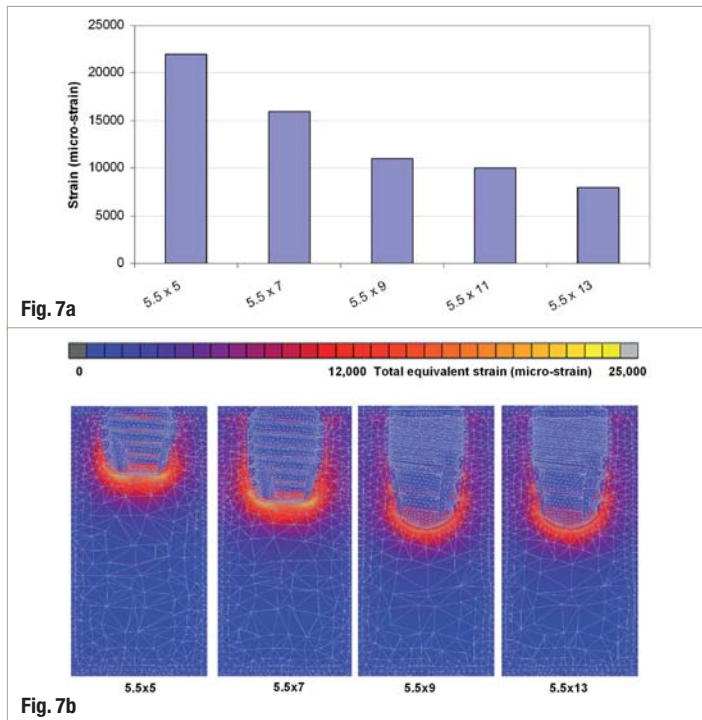


Fig. 7 Equivalent of total strain obtained for the short implants and the corresponding standard implants. (a) Maximum values obtained, (b) strain distribution.

compared to longer implants. The use of short implants in the posterior jaw region reduces the need for bone augmentation procedures prior to or in conjunction with implant placement in the maxilla and the mandible. Shorter implants reduce the surgical risk of sinus perforation or mandibular paresthesia, with an overall reduction in surgical complications. Owing to the decreased length of the drills and implants, the osteotomy preparation implies less risk of overheating the bone. Insertion of drills and implants are also easier in small intra arch spaces. In the case of apical root proximity short implants can be the only possible choice. From the patient's point of view, shorter implants reduce treatment time, discomfort, and overall costs related to graft procedures. All these factors make short implants a highly attractive restorative option. In a recent study, Hagi and coworkers¹⁴ concluded that dental implant surface geometry is a major determinant in how well the implants perform in short lengths, which were defined in that study as being shorter than 7 mm. Threaded implants showed higher failure rates in short vs. longer length, sintered porous surfaced implants performed well in short lengths. Moreover, various researchers using FE analysis have demonstrated that horizontal and vertical occlusal forces placed on implants were distributed primarily in the crestal bone, rather than along the entire implant-bone interface. These findings led the Lum group to conclude that short implants serve as favourable as longer implants.^{17, 21, 22} Implant diameter should also be considered as an important clinical variable. It has been suggested that increasing implant diameter could compensate for decrease of length. Himmlova

and colleagues showed that an increase in the implant diameter decreases the stress around the implant neck more than an increase in the implant length, as a result of a more favourable distribution of the simulated masticatory forces.¹⁶

Concerning the strain, the values obtained with the short implants were relatively high (above 10,000 μ strain) in comparison with long implants (up to 5,000 μ strain). The same behaviour was observed for implant displacements. Short implants have a displacement of approximately 290 μ m. This behaviour could be explained by discussing the material properties and cortical bone thickness that were used in this analysis which were based on the typical region for the clinical application of these implants (posterior region), where the bone quality is poor. The retention of the implants was mainly at the cortical layer which had a thin thickness of 0.5 mm, whereas the rest of the implant length was in the cancellous bone which had a low stiffness of 300 MPa, causing a high deformation range.

The present study confirms these results. Short implants showed higher stress values than long implants and less homogeneous distribution than long implants. However, the magnitude of stresses was clearly above the physiological ranges as suggested by Frost.⁸ Maximum physiological stresses and strains defined by Frost are in the regions of 100 MPa and 3,000 μ strain for cortical and cancellous bone, respectively. Consequently, the presented results indicate a high-risk of overloading the bone in certain selected cases. Nonetheless, although several studies in the literature have shown that short implants have risk factors and therefore higher failure rate compared to longer implants,^{19, 27, 36} several recent studies seem to prove the good long-term prognosis of short implants. It has also been shown that the crown/implant ratio does not seem to be a major risk factor in the case of favourable force orientation and load distribution. Tawil and coworkers in 2006 evaluated the bone loss around short implants (> 10 mm) and concluded that these implants are a long-term viable solution in sites with reduced bone height even when the prosthetic parameters exceed the normal values but under force parafunction control.³² Gentile et al.¹⁰ estimated the survival rate of short (5.7 mm in length) Bicon dental implants and compared it to Bicon implants of greater length (8 mm and longer). The authors reported no difference in the short implant survival rate when compared to implants of greater length. Essential condition for all implant uses, consequently mini implants as well, is successful osseointegration that can be confirmed only with the long-term studies of success and survival of MDIs under load in masticatory function. Shatkin et al.²⁹

in their retrospective analysis over 5 years of 2,514 MDIs which equally supported fixed and removable prostheses found the overall implant survival rate of 94.2%. Initial stability is important for the successful osseointegration and high implant success rate. It is stipulated with bone quality, implant design, and surgical technique that is used.⁵ Some authors^{3,4} recommend bone drilling to the depth of only one-third of the length of the MDI. The obvious reason is the dense bone structure of the mandible of the treated patient, but such dense bone structure contributed to the good initial stability of the implanted MDIs. The study of Balkin *et al.*², in which they used a histological analysis, revealed that the quality of the osseointegration of MDIs could be compared with the quality of larger diameter implant osseointegration. Ertugrul and Pipko⁵ in their *in vitro* study revealed that implants of larger diameter are more stable under lateral forces than MDIs.

Implant displacements obtained in the present study are in agreement with these observations. MDIs showed a displacement of 223 mm, whereas the wider diameter implants of the same length had a displacement range of 55–120 mm. A similar observation was for the strain, MDIs had strains of 19,000–24,000 μ strain, whereas wider diameter implants had strains of 3,000–11,000 μ strain. Moreover, the stress within the implants was higher and widely distributed at the cervical one-third of the MDIs than for wide implants. In total, this could be one of the reasons to explain the failure case with small diameter implants²⁶ such as atypical implant location, extreme divergence of implant axes, infection, implant rejection, and poor prosthesis fit. Usually, dental implants are made of titanium Grade 4 or 5. The ultimate strength for these alloys is given to be around 550 MPa (Grade 4) and 900 MPa (Grade 5), fatigue limits of 425 MPa (Grade 4) and 510 MPa are listed. Consequently, the fatigue limit is exceeded in certain cases, indicating the risk of permanent loading fracture in the case of implants with a reduced diameter.

_Conclusions

Short and mini implants have significant clinical advantages. However, from a biomechanical point of view it seems that the bone loading around short and mini implants is increased compared to standard implants. Additionally, the presented results show that there is an increased risk of overload and fracture for mini implants, especially when titanium Grade 4 is used. Consequently, considering an increased number of implants is recommended when short or mini implants shall be inserted. A detailed biomechanical analysis of various clinical sit-

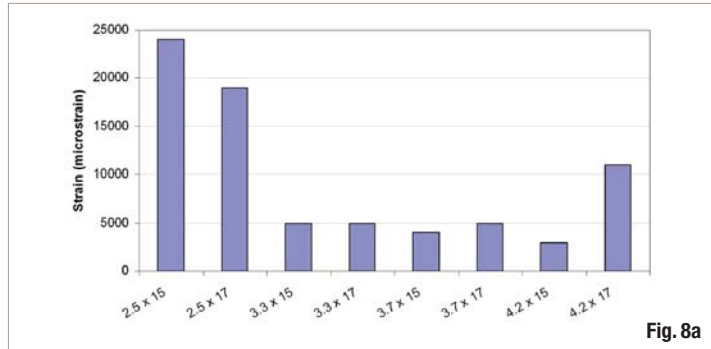


Fig. 8a

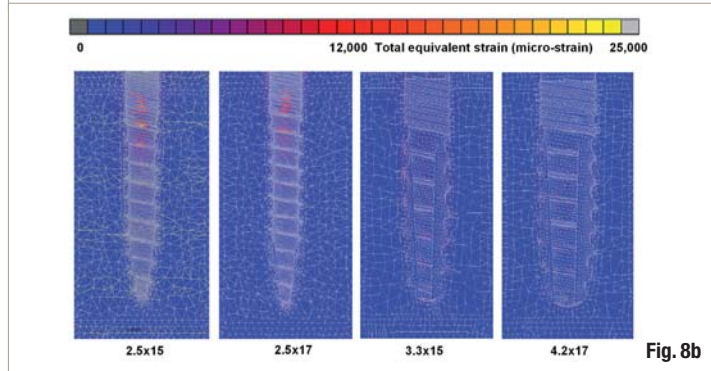


Fig. 8b

uations will be performed to determine the necessary number of implants in these clinical situations.

Fig. 8 Equivalent of total strain obtained for the MDIs and the corresponding standard implants. (a) Maximum values obtained, (b) strain distribution.

_Acknowledgements

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How reliable is **immediate implant insertion** after tooth extraction?

A prospective clinical longitudinal study

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Fig. 1 Bone dust harvested from the extraction socket

Fig. 2 Schematic drawing of extraction socket and implant.

Fig. 3 Fresh extraction socket after atraumatic surgical procedure (female, 56-year-old).

Fig. 4 Flapless implant insertion immediately after tooth extraction (Thommen Element 4,2).

Fig. 5 The use of bone dust harvested from the bore hole.

Fig. 6 Provisional immediately after implant insertion.

Abstract

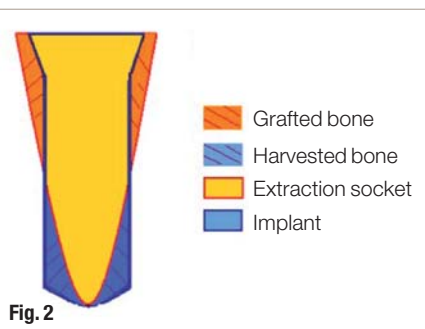
Between 2001 and 2009 115 screw implants were inserted into fresh single root extraction sockets. The follow-up period ended at least 6 month after prosthetic treatment. In this prospective clinical multicenter study the results of two-piece titanium implants (Straumann, Thommen) and one-piece zirconium dioxide implants (Z-Systems) were compared in terms of osseous and soft tissue findings. Titanium implants showed the best ratio of osseo-integration (96%) in comparison to zirconium dioxide implants (72,7%), whereas all implants had a comparable success rate in terms of peri-implant

soft tissue outcome at the end of the follow-up period.

Background and aim

Conventional insertion of screw-shape implants is usually performed following a variable time interval after tooth extraction and bone healing of the extraction socket. On the contrary, immediate insertion is done immediately after extraction.

Here the incongruence between extraction socket and implant has to be taken into account. The choice of the implant size should avoid creating a





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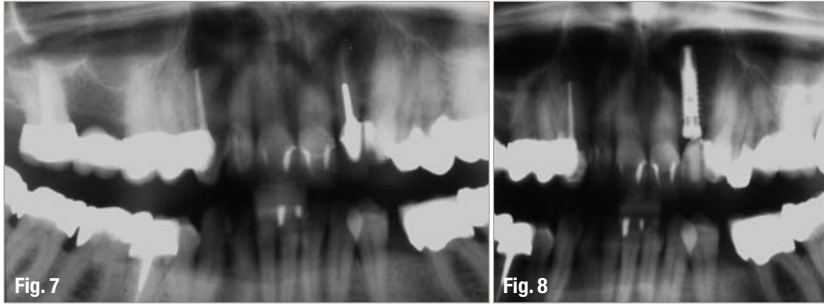


Fig. 7 X-ray prior to extraction of 22.
Fig. 8 X-ray immediately after implant insertion, correct position of the titanium implant (Thommen Element 4,2).

too "large bone jumping distance", in general not more than 1,5 mm.¹

During the implant insertion process it is easily possible to gain a certain amount of bone dust, which can be squeezed into the gap between implant and alveolus (Figs. 1 & 2).

Since consecutive bone remodeling processes after extraction lead to a reduction of the buccal crest, it is of advantage to place the implant whenever possible in a palatal respectively lingual position. An atraumatic surgical procedure is of high importance. To avoid additional bone loss a flapless operation is recommended. However, despite atraumatic extraction technique the resorption of buccal bone follows its own rules.^{2,3,4,5,6}

Conventional techniques with titanium screw implants show a successful longterm outcome between 94–96% independent from the manufacturer.⁷

The aim of this investigation was to assess, whether immediate implant placement after extraction leads to a success rate comparable to delayed (2 months) or late (4–6 months) insertion.

Fig. 9 Implant loss by manufacturer.

Fig. 10 Pocket depth 4–6 month after tooth extraction i.e. implant insertion.

Fig. 11a Periimplant soft tissue immediately before insertion of the crown (male, 58-year-old) (Straumann RN 4,1).

Fig. 11b Periimplant soft tissue with crown.

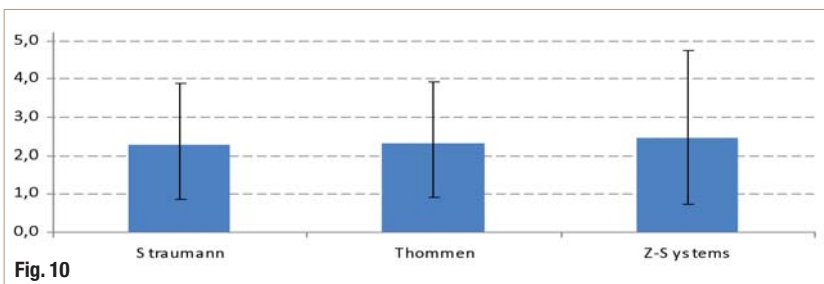


Fig. 10



Fig. 11a

Fig. 11b

_Materials and methods

Between February 2001 and January 2010 120 screw shaped implants were inserted into single root extraction sockets in 109 patients, 78,3 % of them following flapless procedures (Figs. 3 & 4). 115 of the implants could be examined during the follow-up period (drop out = 4,1 %).

104 two-piece titanium (75 Straumann and 29 Thommen) and 11 one-piece zirconium dioxide implants (Z – Systems) were used.

Small periapical granulomas were not excluded from immediate implant insertion, but meticulously drilled out. The patient sample included 9 smokers (less than 10 cigarettes per day), 4 Patients with hepatitis B, 3 patients with diabetes mellitus (oral antidiabetics) and 1 Patient with inapparent HIV-infection.

The implants were placed utmost in a palatal or lingual position respectively. Bone remodeling after extraction had to be taken into account.⁸

The incongruence between extraction socket and implant surface was spanned by using autogenous bone dust/cancellous bone from the bore-hole (Fig. 5).

In none of the cases immediate loading of the implants was performed. Provisionals were fixed at the neighboring teeth (Fig. 6) whenever possible. Removable dentures were adapted to the situation required. In the case of zirconium dioxide implants resin splints were used to touchless shield the one-piece implant.

Regular clinical examination of stability and peri-implant soft tissue status was performed 1, 2, 3, 4 and 16 weeks after implant insertion, final assessment 6 month after definitive prosthetic loading. Radiological examination was done before tooth extraction, immediately after implant insertion (Figs. 7 & 8), after osseo-integration of the implants and not earlier than 6 months after prosthetic treatment.

_Results

7 of 115 implants (6,1 %) were lost during the osseous healing period, whereas later no implant loss occurred until now. The survival rate of Straumann titanium implants (n = 75) was 96,0%, of Thommen titanium implants (n = 29) 96,6% and of Z-Systems zirconium dioxide implants (n = 11) 72,7% (Fig. 9). No differences between the 3 implant types were found in the soft tissue. The mean pocket depth (PD) was 2,3 mm (Fig. 10). No peri-implantitis with

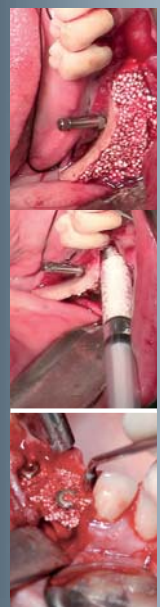
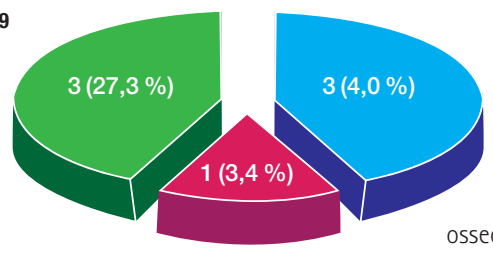


Fig. 9



■ Z-Systems ■ Thommen ■ Straumann

pathological secretion or bleeding occurred. X-ray evaluation indicated similar results in position and osseous healing of the implant types examined.

After osseo-integration the majority of the implants was covered by single crowns (57,4 %) (Fig. 11), followed by fixed bridge-work (21,3 %) and support of removable dentures (21,3 %).

_Discussion and Conclusions

Immediate insertion of titanium screw-shape implants resulted in a success rate comparable to delayed or late insertion.⁷ The suboptimal results obtained with the small sample of one-piece ceramic implants were, in 2 cases, due to insufficient protection during the healing phase. In the authors opinion this was not due to the implant system. It can be only speculated, whether the different roughness of titanium and zirconium-dioxide implants has contributed to the significant worse results (early loss) of the latter. However, the small number of zirconium dioxide implants in this study does not allow a final conclusion.

After osseo-integration all implant types showed similar clinical and radiological results. The important advantage of immediate implant insertion for the patient is the time gain of the faster prosthetic loading. The remodeling processes of the alveolar bone have to be taken into consideration already at implant insertion planning.

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

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Untying the Gordian Knot: An evidence-based endo-implant algorithm (Part I)

Author_Dr Kenneth S. Serota, USA



Figs. 1a & b Previous endodontic therapy on tooth #14 had failed; the clinician chose to correct the problem with a microsurgical procedure on the mesio-buccal root. This procedure failed over time as well (sinus tract). Radiographic and clinical evidence indicate the developing apical lesion.

The root-canal system was reaccessed, the untreated canal identified, the entire system debrided, disinfected and after interim calcium hydroxide therapy, obturated. One year later, the lesion had healed. While the retrograde amalgam remained in the root end, its presumed ability to seal a complex apical terminal configuration effectively was ill considered. Everything leaks in time; re-treatment is always the first choice for resolution of an unsuccessful endodontic procedure, where possible.

Study the past, if you would divine the future.

—Confucius

The endodontic implant algorithm provides highlights in the assessment and identification of determinant factors leading to endodontic failures, in order to help in the decision-making process, whether it is adequate to implement a new endodontic approach versus extraction and replacement with dental implants.

—Confusion

_Over the years, endodontics has diminished itself by enabling the presumption that it is comprised of a narrowly defined service mix; root-canal therapy purportedly begins at the apex and ends at the orifice. Nothing could be further from the truth. It is the catalyst and precursor of a multivariate continuum, potentially the foundational pillar of all phases of any rehabilitation (Figs. 1a–c).

Early diagnosis of teeth requiring endodontic treatment, prior to the development of peri-radicular disease, is critical for a successful treatment outcome.¹

Aesthetics, function, structure, biologics and morphology are the variables in the equation of optimal oral health. Interventional or interceptive endodontics, restorative endodontics, the re-engineering of failing therapy, transitional endodontics and surgical endodontics encompass a vast scope of therapeutic considerations prior to any decision/tipping point to replace a natural tooth.

Everything we do as dentists is transitional, with the exception of extractions. No result is everlasting, none are permanent; thus our treatment plans must reflect this reality. Artifice versus a natural state is not a panacea for successful treatment outcomes (Figs. 2a–d).

In 1992, funding from the Cochrane Collaboration was obtained for the UK Cochrane Centre based in Oxford to facilitate the preparation of systematic reviews of randomised trials of health care.² The Cochrane Systematic Review is a process that involves locating, appraising, and synthesising evidence from scientific studies in order to provide informative empirical answers to scientific research questions.

In 1952, the enterprising son of an inventor named Ron Popeil created infomercials using 30- to 120-second television spots to sell his inexpensive array of useful products, including the Pocket Fisherman and the Veg-O-Matic food slicer. The singular goal of an infomercial was to have the viewer phone immediately and place his or her order—no waiting weeks, months or even years for the lofty marketing goals of branding to pay off. Somewhere along the way, dentistry morphed the two concepts. Nowhere is this becoming more apparent than in the debate on the endodontic implant algorithm. "We have met the enemy ... and he is us." (*The Pogo Papers*)

Scientific doctrine is the cornerstone of endodontic therapeutics. However, of late, anecdotal testimony has become the default setting for new paradigms to justify endodontic treatment modalities and an encomium to technological advances. The strength of the arch of this or any specialty's integrity and relevance must rely on a keystone of randomised clinical trials and evidence-based treatment outcomes. Expert opinions reflected through the looking glass of business models or global tours cannot replace stringently controlled clinical assessments distilled from exacting independent investigations. Science cannot be applied through a McLuhanistic rear-view mirror of technology. The two must symbiotically occupy the same space regardless of whether that is antithetical to the Pauli Exclusion Principle, one of the most accepted laws of physics: no two objects can simultaneously occupy the same space.

In December 2004, Salehrabi and Rotstein³ published an epidemiological study on endodontic treatment outcomes in a large patient population. The outcomes of initial endodontic treatment by general practitioners and endodontists participating in the Delta Dental Insurance plan on 1,462,936 teeth of 1,126,288 patients from 50 states across the US were assessed in an eight-year timeline. Subsequent to non-surgical endodontic treatment over this period 97% of teeth were retained in the oral cavity. The combined incidence of untoward events, such as re-treatments, apical surgeries and extractions, was 3% and occurred primarily within three years from the completion of treatment. Analysis of the extracted teeth revealed 85% had no full coronal coverage. A statistically significant difference was found between covered and uncovered teeth for all tooth groups tested, which is consistent with the findings of numerous investigations.⁴⁻⁶

The purpose of this publication is to evaluate current trends and perceptions pertaining to the standard of care in endodontics and provide an evidence-based consensus on their relevance and application. Part II will address the algorithm by which sacrifice of natural structures for ortho-biological replacements can be



Fig. 1c—"Listening to both sides of a story will convince you that there is more to a story than both sides." (Frank Tyger). The endodontic implant algorithm ensures that philosophy does not obscure pragmatism and expediency does not denigrate adaptive capacity.

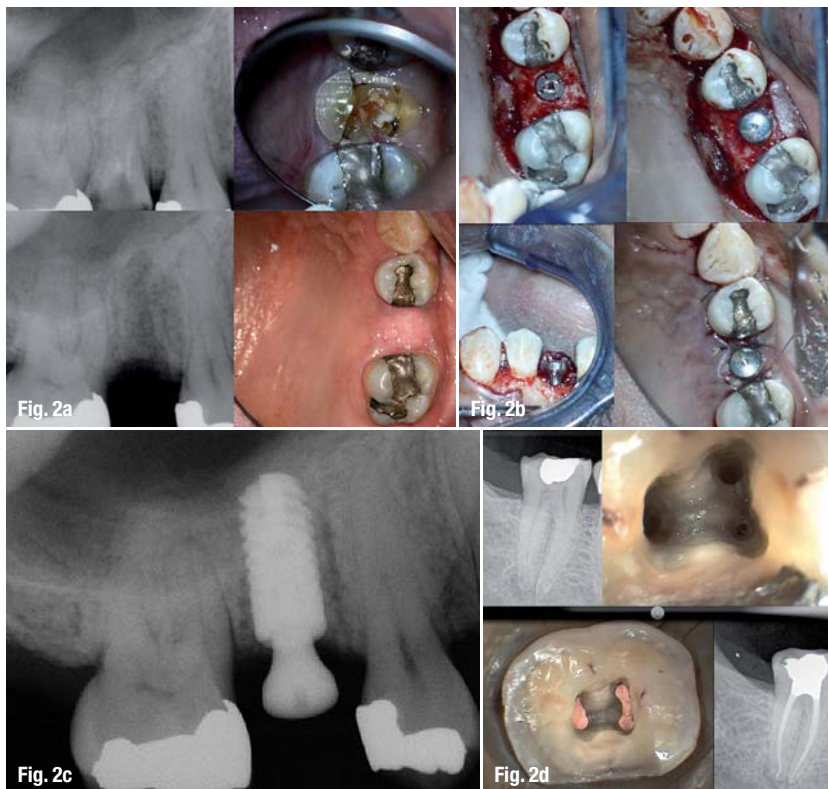
validated and the engineering principles and designs that best mimic clinical dictates.

Evolutionary paradigm shifts

Three surveys have been conducted with the membership of the American Association of Endodontists since the late 1970s. The first reflected what is now an anachronistic view of emergency procedures and the standard of care defining non-surgical therapy during that period.⁷ The second, done prior to the technological advances of the last decade of the twentieth century, was hallmarked by a dramatic decrease in leaving pulpless teeth open in emergency situations and a significant decline in the use of culturing prior to obturation.⁸

The report on the second survey indicated that the concept of *debridement and disinfection* versus *cleaning and shaping* was now the focus of the biological therapeutic imperative and the need for expansive microbial strategies was recognised as being of paramount importance (Fig. 3). The primary pathophysiological vectors of pulpal disease and the myriad complexity of the root-canal system had always been understood; as the century closed, clinicians were provided with new tools and technology to expand the boundaries and limitations of endodontic treatment procedures (Figs. 4a & b).

Root-canal infections are polymicrobial, characterised predominantly by both facultative and obligate anaerobic bacteria.⁹ The necrotic pulp becomes a reservoir of pathogens; toxic consequences and their resultant infection are isolated from the patient's immune response. Eventually, the microflora and their by-products will produce a peri-radicular inflammatory response. With microbial invasion of the peri-radicular tissues, an abscess and cellulitis may develop. The resultant inflammatory response will initiate a protective and/or immuno-pathogenic effect. Additionally, it may destroy surrounding tissue, resulting in the five classic signs and symptoms of in-



Figs. 2a & b Tooth #4 was determined to be non-salvageable. It was removed, the socket stimulated to regenerate and in four month's time an ANKYLOS implant inserted, a sulcus former placed and the tissue closed over the site to allow for osseointegration to occur.

Figs. 2c & d The choice of a natural tooth versus an ortho-biological replacement will increasingly be a powerful force in dental treatment plans. The temptation to select one or the other based on expediency versus complexity, on marketing versus science, will be the sine qua non of the standard of comprehensive care.

Fig. 3 The degree of complexity of the root-canal system has been understood for most of the past century. The failure to negotiate the labyrinthine ramifications of the root-canal system has purportedly been a function of technical limitation rather than comprehension and yet, it took until the mid-1970s to appreciate that thermo-labile condensation of an obturating material could demonstrate a greater occlusive degree of the system than any other modality.

flammation: calour, dolour, rubor, tumour and penuria. Patient evaluation and the appropriate diagnosis/treatment of the source of an infection are of utmost importance.

Patients demonstrating signs and symptoms associated with severe endodontic infection (Table I) should have the root-canal system filled with calcium hydroxide and the access sealed. In the event of copious drainage, the access can be left open for no longer than 24 hours, the tooth then isolated with rubber dam, the canals irrigated and dried and calcium hydroxide inserted into the root-canal space, and the access sealed.¹⁰

The antibiotic of choice for peri-radicular abscess remains Penicillin VK; however, recent studies have reported that amoxicillin in combination with clavulanate (1 gm loading dose with 500 mg q8h for seven days) was a more effective therapeutic regimen.¹¹

Systemic antibiotic administration should be considered if there is a spreading infection that signals failure of local host responses in abating the dispersion of bacterial irritants, or if the patient's medical history indicates conditions or diseases known to reduce the host defence mechanisms or expose the patient to higher systemic risks. Antibiotic treatment is generally not recommended for healthy patients with irreversible pulpitis or localised endodontic infections (Table II). Numerous studies with well-defined diagnosis and inclusion criteria have failed to

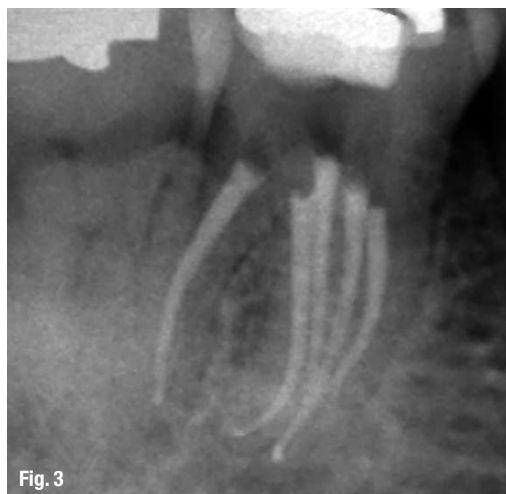
demonstrate enhanced pain resolution beyond the placebo effect.^{12,13}

The sophistication of endodontic equipment, materials and techniques has been steadily iterated and innovated since the second survey. The microscope first introduced to otolaryngology around 1950, then to neurosurgery in the 1960s, is now the standard of care for the voyage into the microcosmic world of the root-canal system. Recursions in the micro-processing technologies of electronic foraminal locators begat unprecedented accuracy levels, improved digital radiographic sensors and software-enhanced diagnostic acumen, and ultrasonic units with a variety of tips designed specifically for use when performing both non-surgical and surgical endodontic procedures minimised damage to coronal and radicular tooth structure in the effort to locate the pathways of the pulp. The treatment outcome of non-surgical root-canal therapy currently is far more predictable than at any other period in our history.

_Diagnosis

Of all the technologic innovations embraced by endodontics, digital radiography should have generated the greatest impact; however, its value remains limited in diagnosis, treatment planning, intra-operative control and outcome assessment. Flat-field sensors still require three to four parallax images of the area of interest in order to establish better perception of depth and spatial orientation of osseous or dental pathology. These 3-D information deficits, geometric distortion and the masking of areas of interest by overlying anatomy or anatomical noise are of strategic relevance to treatment planning in general and endodontics specifically (Figs. 5a & b).¹⁴

Cone-beam computed tomography (CBCT) produces up to 580 individual projection images with isotropic sub-millimetre spatial resolution enhanced



by advanced image receptor sensors. It is thus ideally suited for dedicated dento-maxillofacial CT scanning. When combined with application-specific software tools, CBCT can provide a complete solution for performing specific diagnostic and surgical tasks. The images can be re-sliced at any angle, producing a new set of reconstructed orthogonal images, and studies have shown that the scans accurately reflect the volume of anatomical defects. The limited volume CBCT scanners best suited for endodontics require an effective radiation dose comparable to two or three conventional peri-apical radiographs and as such are set to revolutionise endodontics (Fig. 6).^{15,16}

Three-dimensional pre-surgical assessment of the approximation of root apices to the inferior dental canal, mental foramen and maxillary sinus are essential to treatment planning. The ability of CBCT to diagnose and manage dento-alveolar trauma using multiplanar views, the determination of the root-canal anatomy and number of canals, the detection of the true nature and exact location of resorptive lesions and the discovery of the existence of vertical and horizontal fractures outweigh concerns about the degree of ionising radiation and the risks posed.¹⁷ Provided CBCT is used in situations in which the information from conventional imaging systems is inadequate, the benefits are essential for optimisation of the standard of care.

Patel reported that peri-apical disease can be detected sooner and more accurately using CBCT compared with traditional peri-apical views and that the true size, extent, nature and position of peri-apical and resorptive lesions can be accurately assessed.¹⁸ Using a new peri-apical index based on CBCT for identification of apical periodontitis, peri-apical lesions were identified in 39.5% and 60.9% of cases by radiography and by CBCT, respectively ($p < 0.01$).

Simon et al. compared the differential diagnosis of large peri-apical lesions with traditional biopsy. The re-



Fig. 4b

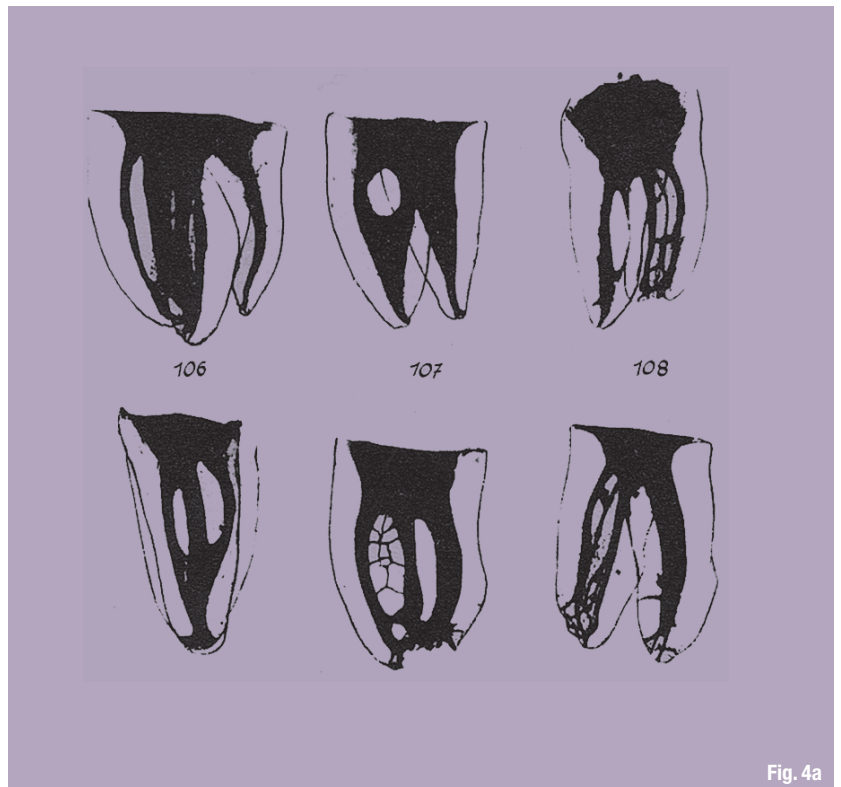


Fig. 4a

sults suggested CBCT might provide a faster method to differentially diagnose a solid from a fluid-filled lesion or cavity, without invasive surgery.^{19,20} In spite of the presence of artefacts, the learning curve related to image manipulation and the cost, CBCT will invariably be the accepted standard of diagnostic care and treatment planning in endodontics in the very near future.

Access

An improperly designed access cavity will hamper facilitation of optimal root-canal therapy. If the orientation, extension, angulations and depth are inaccurate, retention of the native anatomy of the root-canal space becomes precarious. The requirements of access cavity design can be achieved by conceptual and technical regression of the existing configuration to that which one would logically expect to have seen prior to the insults of restoration, function and ageing. If tertiary dentine were perceived as 'irritational dentine' or dystrophic calcification considered 'decay', the chamber outline could be used to blueprint an inlay configuration for the access design that literally replicates the virgin tooth (Fig. 7).

Removal of the existing restoration in its entirety and/or preliminary preparation of the coronal tooth structure for the subsequent full coverage restoration will identify decay, fractures, unsupported tooth structure and expose the anatomy of the underlying root trunk periphery, which assists in discovery of the spatial orientation and morphology of the roots. The pulp

Fig. 4a Panel of anatomic preparations from the classic work by Walter Hess (*The Anatomy of the root canals of teeth of the permanent dentition*, London, 1925).

Fig. 4b In order to determine the number of root canals and their different morphology, ramifications of the main root canals, location of apical foramina and transverse anastomoses, and frequency of apical deltas, 2,400 human permanent teeth were decalcified, injected with dye and cleared (Vertucci FJ, 1984).

Figs. 5a & b Flat-field sensors provide a sense of the extent of osseous pathology; however, the peri-apical radiographic image corresponds to a 2-D aspect of a 3-D structure. Peri-apical lesions confined within the cancellous bone are usually not detected. Thus, a lesion of a certain size can be detected in a region covered by a thin cortex, whereas the same size lesion cannot be detected in a region covered by thicker cortex.



chamber ceiling and pulp stones can be peeled away with a football diamond bur to identify grossly the primary orifices.

Micro-etching (Danville Materials) the floor of the chamber, perhaps the most underused of all access tools, is invaluable in the exposure of fusion lines and grooves in order to identify accessory orifices. Troughing with ultrasonic tips of any design is used solely to trace fusion lines, not affect gross removal. The use of ultrasonics to 'jackhammer' pulp stones is simply too risky as one approaches the floor of the chamber, particularly if there are no water ports on the tips. Orifice lengthening and widening enables straight-line glide path to the apical third. The strategic objective is not to impede the file, stainless-steel or NiTi rotary along the axial walls with minimal dentine removal (Figs. 8a & b).

It is equally important to produce a high-quality coronal restoration at the time of sealing the root-canal system.^{21,22} Despite research supporting the effectiveness of coronal barriers and the need for immediate placement as a component of the completion phase of root-canal treatment, a universally accepted protocol does not exist.

Schwartz and Fransman described a clinical strategy for coronal sealing of the endodontic access preparation that lists the following considerations in the protocol: use bonded materials (4th generation (three-

step) resin adhesive systems are preferred because they provide a better bond than the adhesives that require fewer steps); the etch and rinse adhesives are preferred to self-etching adhesive systems, if a eugenol-containing sealer or temporary material is used; self-etching adhesives should not be used with self-cure or dual-cure restorative composites. When restoring access cavities, the best aesthetics and highest initial strength are obtained with an incremental fill technique using composite resin. A more efficient technique that provides acceptable aesthetics is to bulk fill with a glassionomer material to within 2 to 3 mm of the cavo-surface margin, followed by two increments of light-cure composite and, if retention of a crown or bridge abutment is a concern after root-canal treatment, post placement increases retention to greater than the original state (Fig. 9).²³

Irrigation

The complex anatomy of the root-canal space presents a daunting challenge to the clinician who must thoroughly debride and disinfect the corridors of sepsis in order to achieve a successful treatment outcome (Fig. 10). In addition, the absence of a cell-mediated defence (phagocytosis, a functional host response) in necrotic teeth means the micro-organisms residual in tubuli, cul-de-sacs and arborisations are mainly affected by the redox potential (reduction potential reflects the oxidation-reduction state of the environ-

Tables I & II Derived from Baumgartner (*Antibiotics and the Treatment of Endodontic Infections*, Summer 2006).

Indications for adjunctive antibiotics	Conditions not requiring adjunctive antibiotics
Fever > 100°F	Pain w/o signs and symptoms of infection
Malaise	Symptomatic irreversible pulpitis
Lymphadenopathy	Acute periradicular periodontitis
Truismus	Teeth with necrotic pulps and radiolucency
Increased swelling	Teeth with a sinus tract (chronic periradicular abscess)
Cellulitis	Localised fluctuant swellings
Osteomyelitis	

Table I

Table II



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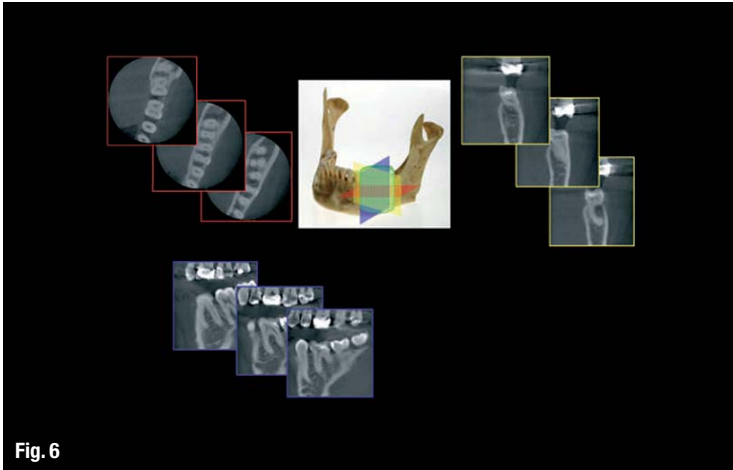


Fig. 6

Fig. 6 All CBCT units provide correlated axial, coronal and sagittal multiplanar volume reformations. Basic enhancements include zoom or magnification and visual adjustments to narrow the range of gray scale, in addition to the capability to add annotation and cursor-driven measurement.

Fig. 7 Strategic extension of the access perimeter is too often undervalued in terms of successful endodontic treatment outcomes. The shape of the chamber must be regressed to its native state to ensure that axial interference is negated as an instrument traverses the length of the root-canal space.

Fig. 8a Dystrophic calcification confounds even the most experienced clinician. The key to identification of the orifices is to regress the inner space using the continuum, cusp tip, pulp horn and canal orifice. In lieu of an ultrasonic tip, which tends to chop the stone and scatter debris, gross removal is best done with a diamond bur in a high-speed handpiece. The fine removal of residue can be done with a multi-fluted carbide bur to trace the fusion lines.

Fig. 8b Keeping the chamber wet with alcohol improves optics and highlights colour disparities. The most important tool for orifice identification in addition to dyes is a micro-etcher. The satin finish produced highlights the disparity between the natural tooth structure of the floor and the secondary and tertiary dentine of the calcified orifice.

ment—aerobic microflora can only be active at a positive E_h , whereas strict anaerobes can only be active at negative E_h values) and availability of nutrients in the various parts of the root canal.²⁴

While our knowledge of persistent bacteria, disinfecting agents and the chemical milieu of the necrotic root canal has greatly increased, more innovative basic and clinical research is required in order to optimise the use of existing methods and materials and develop new ones to prevent and treat apical periodontitis.

Varying degrees of sterility of the root-canal space are achieved by mechanistic removal, the chemical reactivity and fluid dynamics of irrigants and their introduction to the canal space; however, the protocols used today cannot predictably provide sterile canals. As none of the elements of endodontic therapy (host defence system, systemic antibiotic therapy, instrumentation and irrigation, inter-appointment medicaments, permanent root filling, and coronal restoration) can alone guarantee complete disinfection, it is of utmost importance to aim for the highest possible quality at every phase of the treatment.

In the classic study by Sjogren et al., 55 single-rooted teeth with apical periodontitis were instrumented and irrigated with sodium hypochlorite and root filled. Peri-apical healing was followed-up for five years. Complete peri-apical healing occurred in 94% of cases that yielded a negative culture. In cases in which the samples were positive prior to root filling, the success rate of treatment was just 68%—a statistically significant difference. These findings emphasise the importance of eliminating bacteria from the root-canal system prior to obturation. This objective cannot be reliably achieved in a one-visit treatment of necrotic pulps because it is not possible to eradicate all infection from the root canal without the support of an inter-appointment antimicrobial dressing.²⁵

Sodium hypochlorite (NaOCl) is the most widely used irrigating solution. It is a potent antimicrobial agent and lubricant that effectively dissolves pulpal remnants and organic components of dentine, thus preventing packing infected hard and soft tissue into the apical confines. Hypochlorous acid (HClO) is the active moiety responsible for bacterial inactivation. NaOCl is used in concentrations varying from 0.5 to 5.25%; the *in vitro* and *in vivo* studies differ significantly in terms of the effectiveness of the range of concentrations as *in vitro* experiments provide direct access to microbes, higher volumes are used and the chemical milieu complexity of the natural canal space are absent as compared to *in vivo* experimentation. Siqueira et al. found no difference (*in vitro*) between 1%, 2.5% and 5% NaOCl solutions in reducing the number of bacteria during instrumentation.²⁶ What has been demonstrated is that the tissue dissolving effects are directly related to the concentration used.²⁷

Perhaps the most misunderstood aspect of NaOCl irrigation is the need for the quantities of irrigation re-



Fig. 7



Fig. 8a



Fig. 8b



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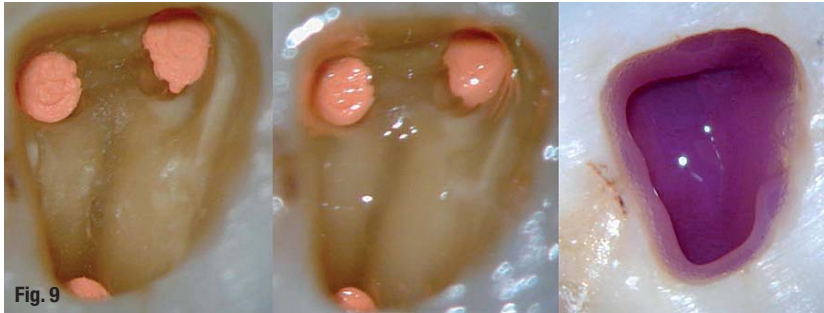


Fig. 9 Micro-etching ensures the removal of oils and debris, and the elimination of the residue in fusion lines and fissures. Routine dentine bonding is then performed. The composite selected in this instance is PermaFlo Purple (Ultradent Products, Inc.), which enables differentiation of restoration and tooth structure should re-entry be necessary.

quired due to the morphological and anatomical variations in the volumetric size of the root-canal anatomy. Siqueira et al. demonstrated that regular exchange and use of large amounts of irrigant should maintain the antibacterial effectiveness of the NaOCl solution, compensating for the effects of concentration.²⁸ Numerous devices have appeared in the endodontic armamentarium to address this situation:

EndoVac (Discus Dental): a negative pressure differential device designed to deliver high volumes of

chelators; however, they have little if any antibacterial activity.

Several studies have demonstrated that citric acid in concentrations ranging as high as 50% were more effective at solubilisation of inorganic smear layer components and powdered dentine than EDTA. In addition, citric acid has demonstrated antibacterial effectiveness.

Technology and innovation will not negate the need for optimal preparation (debridement and disinfection) to eliminate microbial content and its impact on a necrotic root-canal system. We as a discipline need to improve; however, endodontics has shown its commitment to endless reinvention. In time, this will restructure the role of natural teeth in foundational dentistry, currently diminished by the market forces of implant-driven dentistry.

Ortho-biological replacement is not a panacea as random clinical trials increasingly show; the severity of peri-implantitis lesions demonstrates significant variability and as such no treatment modality has shown superiority. The pendulum will continue to swing as the endodontic implant algorithm becomes increasingly multivariate.

irrigation, agitation techniques and devices

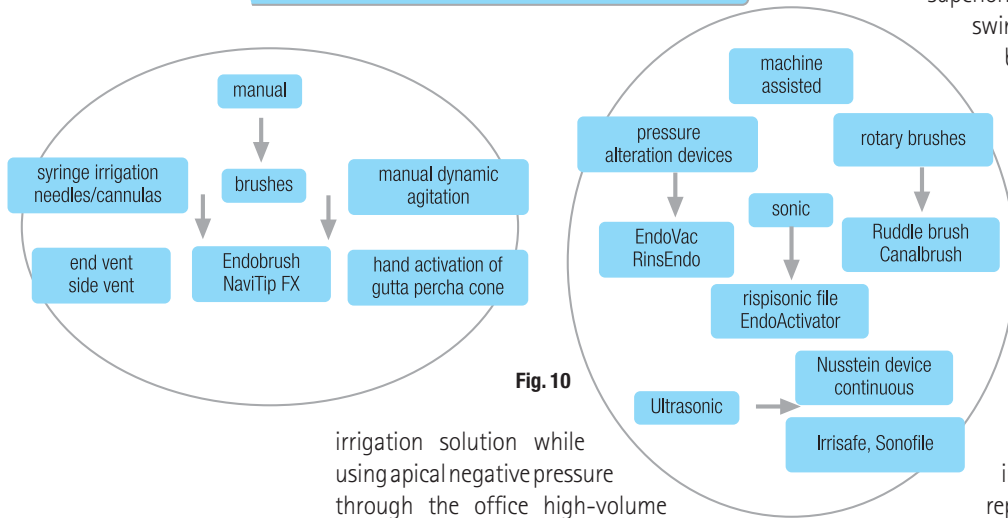


Fig. 10

irrigation solution while using apical negative pressure through the office high-volume evacuation system;

Negative Pressure Safety Irrigator (Vista Dental): device is similar to EndoVac;

Rinsendo (Air Techniques): uses pressure suction technology; 65 ml of irrigant are automatically drawn from the attached syringe and aspirated into the canal (pressure created is lower than manual irrigation); and

Vibring (Bisco Canada): sonic flow technology facilitates enhanced irrigation through the myriad complexities of the root-canal system (Fig. 11).

NaOCl cannot dissolve inorganic dentine particles and thus prevent smear layer formation during instrumentation.²⁹ Chelators, such as EDTA and citric acid, are recommended as adjuvants in root-canal therapy. It is probable that biofilms are detached with the use of

Microstructural replication—obturation

Steven Covey is known for his book *The Seven Habits of Highly Effective People*. The habit most applicable to endodontics is the second one: "begin with the end in mind". The implication of this vision with regard to idealising the final shape of the root-canal system in order to ensure that the obturation represents a totality is profound. The root canal is negative space and as such recovery of its original unaffected form is the sine qua non of obturation or more descriptively, microstructural replication.

Perhaps the most significant example of negative space recovery is Michelangelo's statuary for the funerary chamber of Pope Julius II. Four unfinished sculptures speak eloquently to this process: the figure was outlined on the front of the marble block and then Michelangelo worked steadily inwards from this side, in his own words "liberating the figure imprisoned in the marble". This is an exacting description of debridement and instrumentation of the root-canal space prior to root filling after a myriad of pathologic vectors have destroyed the dental pulp, and altered the morphology/topography of the system (Fig. 12). Incomplete filling of the debrided and sculpted root-canal space is one of the major causes

of endodontic failure.³⁰ Until recently, *in vitro* testing (dye leakage, fluid transport, bacterial penetration, glucose leakage) was used to evaluate the sealing efficacy of endodontic filling materials and techniques by assessing the degree of penetration/absorbance of these tracers.³¹⁻³³

Unfortunately, leakage studies are limited static models that do not simulate the conditions found in the oral cavity (temperature changes, dietary influences, salivary flow). Given the historic dominance of *in vitro* testing, the clinician must be cautious in extrapolating study findings to the clinical situation, regardless of manufacturer's claims.³⁴ This reliance on invalid testing protocols diminishes the mono-block assertions applied to the new generation of adhesive obturating materials proposed as the replacement material for gutta-percha.³⁵

Gutta-percha was introduced to dentistry by Edwin Truman in 1847.³⁶ The concept of thermo-labile vertical condensation of gutta-percha was originally described by Dr J. R. Blaney in 1927.³⁷ The defining article on obturation remains Dr Schilder's classic on filling the root-canal space in three dimensions, published 40 years later.³⁸

Logically, one cannot physically fill the root canal in two dimensions; however, one can fill the root-canal space badly in three dimensions. This does not disprove Dr Schilder's exposition, but it does demonstrate that words can easily be misconstrued and alter perspective once they become, as Kipling said, "the most powerful drug of mankind". Ironically, Schilder's article came seven years prior to his treatise on cleaning and shaping the root-canal system, which even to this day remains the iconic standard.

The Washington Study by Ingle indicated that 58% of treatment failures were due to incomplete obturation.³⁹ The corollary is obvious: teeth that are poorly obturated are invariably poorly debrided and disinfected. Procedural errors such as loss of working length, canal/apical transportation, perforations, loss of coronal seal and vertical root fractures have been proven to affect the integrity of the apical seal adversely.^{40,41}

The Toronto Study that evaluated success and failure of endodontic treatment at four to six years after completion of treatment found that teeth treated with a flared canal preparation and vertical condensation of thermo-labile gutta-percha had a higher success rate when compared with step-back canal preparation and lateral compaction. Highlighting the vertical condensation of warm gutta-percha obturation technique as a factor influencing success and failure simply confirmed a perspective evident to most endodontists from years of clinical empiricism.

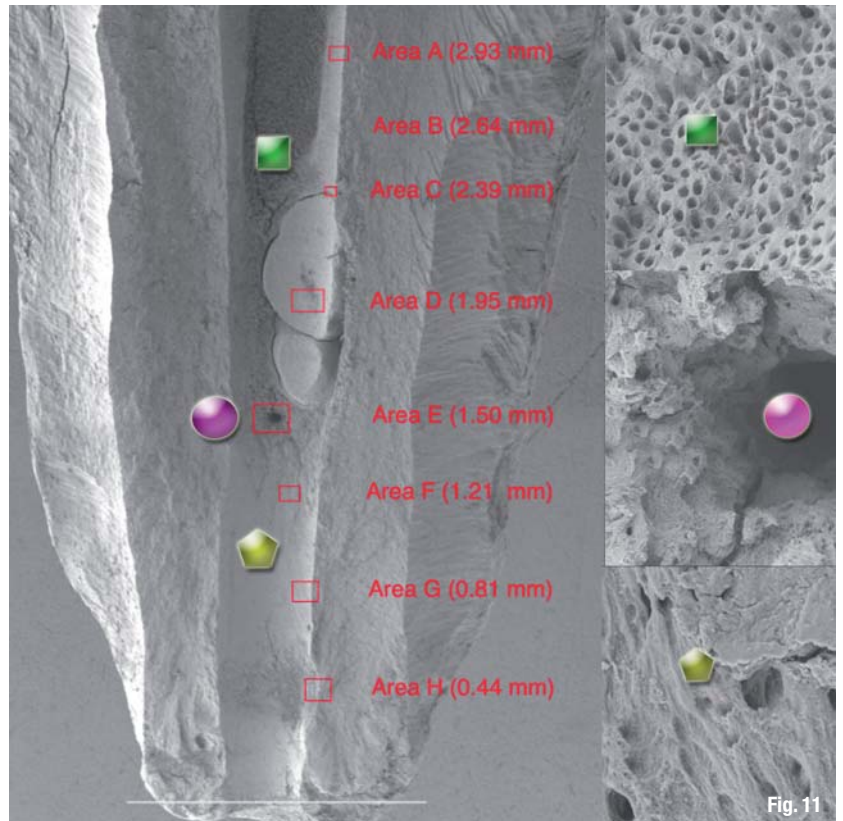


Fig. 11

There is a never-ending array of obturation materials, delivery systems and sealers appearing in the marketplace. Each is hallmarked by proprietary modifications and each is heralded as the most significant iteration in obturation since the previous one; today, we practice with a sad truism—marketing inexorably directs science. However, gutta-percha in combination with a myriad of sealers and solvents remains the primary endodontic obturating material. The dominant systems remain carrier-based obturation (Thermafil,

Fig. 11_ Numerous researchers have demonstrated that the concept of keeping the apical foramen as small as practical does not mean a size #20 or 25 file. This Schilderian concept should read as *small as the apical morphology permits* in order to ensure that the free flow of irrigant to the apical terminus enables more definitive cleaning of the apical segment of the root-canal space.



Fig. 12

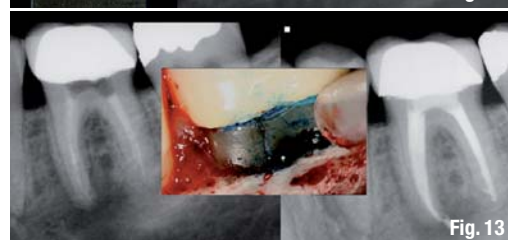


Fig. 13

Fig. 12_ The artist/clinician recognises that negative space surrounding an object is equally important as the object itself. In the case of root-canal therapy, the positive space is alterable but must be created in balance with the encompassing negative space to ensure morphological integrity.

Fig. 13_ While there is no meta-analysis to elucidate this concern, the incidence of fracture of the mesial root of mandibular molars has been shown to have a significant correlation to cusp fracturing.

Tulsa Dental Specialties), Continuous Wave Compaction Technique (Elements Obturation, SybronEndo) and Thermoplastic Injection (Obtura III Max, Obtura Spartan).

Resilon (RealSeal, SybronEndo), a high-performance industrial polyurethane, was developed as an alternative to gutta-percha. There are scattered studies that demonstrate that Resilon exhibits less microbial leakage⁴² and higher bond strength to root-canal dentine⁴³, reduced peri-apical inflammation⁴⁴ and enhanced fracture resistance of endodontically treated teeth when compared with gutta-percha⁴⁵

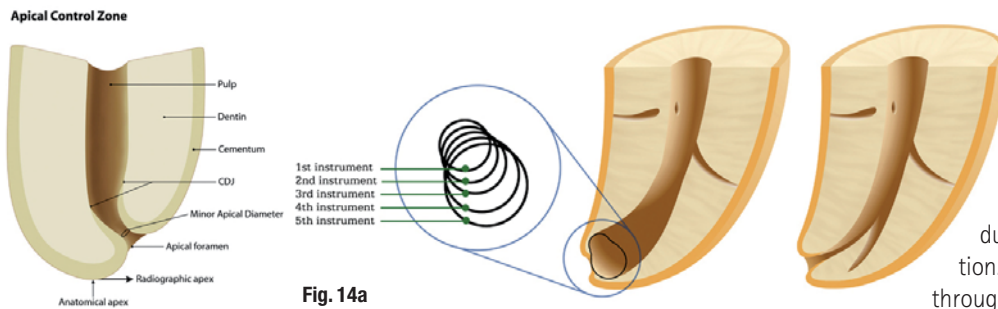


Fig. 14a

Fig. 14a On left, the working length has two reference points, coronal and apical. Failure to maintain patency at the minor apical diameter will cause loss of the apical reference point as a result of blockage, or ellipticisation of the foramen.

(Fig. 13). Other studies have reported undesirable properties associated with Resilon, including low push-out bond strength⁴⁶ and low cohesive strength plus stiffness.⁴⁷ In addition, Resilon did not achieve a complete hermetic apical seal.⁴⁸ These results indicate that a more appropriate material for root-canal obturation still needs to be developed. There is still no obturation method or material that produces a leak-proof seal. A material that is bio-inductive and promotes regeneration, a smart nano-material that can adapt to the ever-changing microenvironment of the canal system is essential, but to date, remains elusive.

All polymers demonstrate melt temperature and flow rate. Both gutta-percha and Resilon demonstrate a viscoelastic gradient that manifests as a dynamic rheological birefringence in the moulded state. Dependent upon the molecular weight of the source material (without the opacifiers, waxes and modifiers), gravimetric measurements of the time-temperature-transformation diagram of any moulding compound can be constructed. In the thermoplastic world of today, this has engendered an increase in the weight of the mass of obturating material and an improvement in the bacterial seal. This applies to carrier-based obturation techniques, Continuous Wave Compaction Technique and Obtura III obturation without cone placement.

_Instrumentation

The steps required for debridement and disinfection of the root-canal space are sequential and interdependent. Aberration of any node in the process

affects the others, leading to iatrogenic damage and potentially, treatment outcome failure. The most common distortion of native anatomy is ledging; canal curvature exceeding 20 degrees was shown to produce ledging of mandibular molars 56% of the time in a cohort of undergraduate students.⁴⁹ Dentine chips pushed apically by instrumentation incorporated with fragments of pulp tissue will compact into the apical third and the foraminal area causing blockage, altering the working length due to the loss of patency (Figs. 14a & b).

Apical patency is a technique in which the minor apical diameter of the canal is maintained free of debris by recapitulation with a small file through the apical foramen.⁵⁰ The most predictable method is to use a designated patency file regularly throughout the cleaning and shaping procedure in conjunction with copious irrigation. A #0.08 K-file passively moved through the apical terminus without widening it is most effective; it will refresh the NaOCl at the terminus as the action of the file going to the point of patency produces a fluid dynamic. Regrettably, loss of working length remains a common adverse event during endodontic therapy, especially amongst less experienced clinicians. Its major cause is the formation of an apical dentine plug. Therefore, establishing apical patency is recommended even during treatment of canals with vital pulp.⁵¹

Historically, numerous techniques have been advocated for canal preparation (balanced force, anti-curvature, double-flare, modified double-flare); however, step-back⁵² and crown-down⁵³ are the most universally accepted. Experience has shown a crown-down preparation will cause fewer procedural errors (apical transportation, elbow formation, ledging, strip perforation, instrument fracture). The preliminary removal of coronal dentine (pre-enlargement—treating the apex last) minimises blockage and enables an increasing volume of irrigant penetration, thereby sustaining working length throughout the procedure.⁵⁴

The balanced-force shaping philosophy is integral to the crown-down approach. Its premise is that instruments are guided by the canal structure when rotational/anti-rotational motion (watch winding) is used. Changing the direction of rotation controls the probability that instruments will become overstressed and thus ensures that the cutting of structure occurs most efficiently.⁵⁵ Endodontists have long appreciated what the science reported, that the balanced-force hand instrumentation technique produced a cleaner apical portion of the canal than

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Fig. 14b The volume of irrigant necessary to prevent apical blockage is indeterminate. While NiTi rotary instrumentation has minimised this to a significant degree, a slurry of dentine mud is always a risk factor to be monitored.

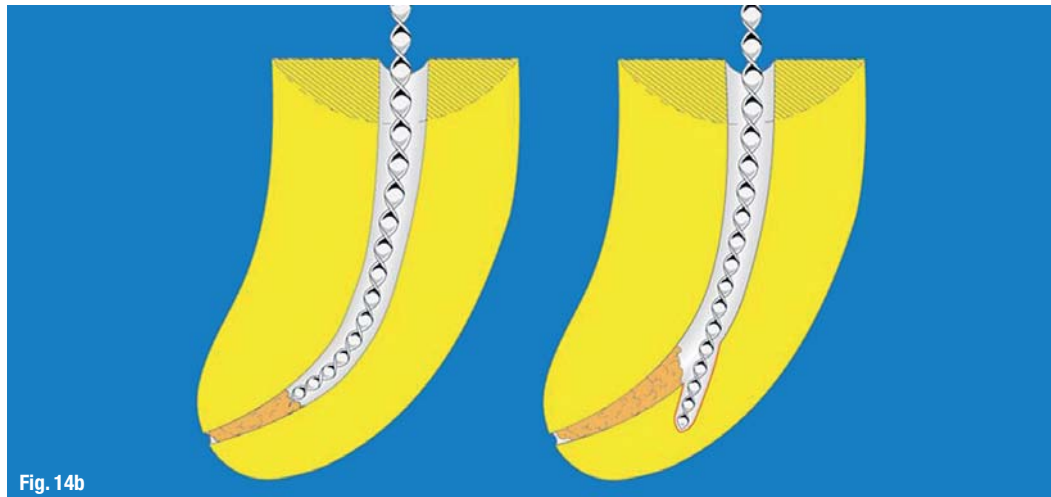


Fig. 14b

other techniques (Fig. 15).^{56,57} As discussed below, I remain committed to hand filing in order to refine apical third shaping and creating an enhanced apical control zone taper. Two distinct phases are required for the preparation of canals with NiTi rotary files. It is essential that, no matter the protocol used, a reservoir of NaOCl be maintained and replenished repeatedly in the strategically extended access preparation. The coronal portion of the canal space is explored with small-sized K-files to establish a glide path for the rotaries to follow. The taper of NiTi files, regardless of manufacturer, induces a crown-down effect in the straight portion of the canal. After the coronal and middle third segments have been opened and repeatedly irrigated with NaOCl, a sequence of small K-files can progress apically, ultimately defining patency, confirming the topography of the accessible canal space and its degree of curvature. A second 'wave' with the NiTi rotaries is then used to effect deep shape, approximating the working length, and depending upon the configuration of the apical third, to enlarge the terminus to the gauged apical size and initiate the taper of the apical control zone.⁵⁸ This is a basic concept. It is inherent in all templated protocols that each tooth is different, and modifications to the process are always necessary as a function of the tooth morphology.

Fig. 15 Rheology is a science that addresses the deformation and flow of matter. The biochemistry of filling material, its viscosity gradient, the lubricating effect of sealer and optimal thermal application are only as effective as the flow characteristics of the shape created and its degree of cleanliness.

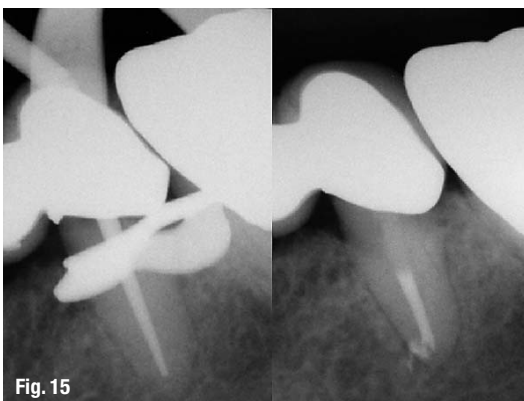


Fig. 15

The apical control zone is defined as a matrix-like region created at the terminus of the apical third of the root-canal space. The zone demonstrates an exaggerated taper from the spatial position determined by an electronic foraminal locator to be the minor apical diameter. Whether this is linear or a point determination is a function of histopathology. The enhanced taper at the

terminus creates a resistance form against the condensation pressures of obturation and acts to prevent excessive extrusion of filling material during thermolabile vertical compaction.

All NiTi systems are modelled upon a single or multiple taper ratio per millimetre of file length. Figure 16a demonstrates the metrics of the F1, F2, F3 finishing files of the ProTaper Universal System (my preference). These files demonstrate a common taper in the last 4 mm of the file, which in the vast majority of situations corresponds to the length of the apical third of the root-canal space. As shown, the 0.07 taper of the F1 (0.20 tip), the 0.08 taper of the F2 (0.25 tip) and the 0.09 taper of the F3 (0.30 tip) produce the corresponding diametral dimension indicated each millimetre back from the apical terminus, if the crown-down protocol built into this multiple taper file system is adhered to. If the shape of the internal micro-morphology of the root complex were epidemiologically similar, then imprinting of the canal preparation would be logical. Unfortunately, such is not the case.⁵⁹

Figure 16b demonstrates that the use of hand files in the apical third can alter the preliminary shape created by the NiTi files. Hand files have a 0.02 taper (along the shaft of the file, the diameter increases by 0.02 mm per mm of length—a 0.20 file with 16 mm of flutes would measure 0.52 mm at the coronal end of the flutes). In the example shown, a #20 file is positioned at the minor apical diameter. Careful positioning of a series of file within the last millimetre can produce a 0.2 mm or 20% taper with no undue disruption of the native anatomy. Schilder's precept for shaping was to keep the apical foramen as small as practically possible. Whatever file approximates the minor apical diameter, in conjunction with hand filing, the apical control zone created will enhance the apical seal, as the rheological vectors of compaction and condensation have a greater lateral volume of displacement at the terminus.

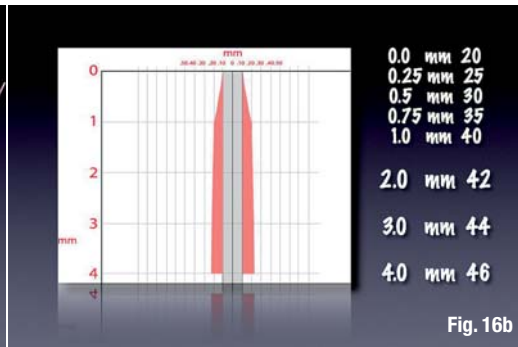
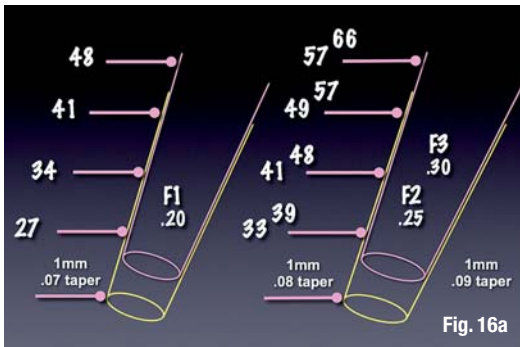


Fig. 16a_The ProTaper Universal System consists of two shaping files that address the planes of geometry of the coronal and middle thirds of the root-canal space. There are five finishing files that include tips sizes: 20, 25, 30, 40 and 50. Tapers range from 0.06 to 0.09 through the series. A thorough understanding of the metrics is essential for the preparation of the myriad variations in internal micro-morphology of the root-canal space and the assurance of minimal iatrogenic impact.

Fig. 16b_Modification of taper in the last millimetre of the apical terminus exaggerates the constriction or minor apical diameter. Thermo-labile vertical condensation has been shown to enhance successful endodontic outcomes. The matrix effect of the apical control zone enhances the gravimetric density of the required hermetic apical seal and enables more material to flow into the region to occlude fins, cul-de-sacs, deltas and lateral arborisations.

A risk-assessment algorithm

If the biological parameters that mandate endodontic success are adhered to, in almost all cases, treatment outcomes will be successful. The endodontic implant algorithm processes the array of contributing factors leading to endodontic failure, in order to determine whether to implement a re-engineered endodontic approach or to extract and replace the natural tooth with an osseointegrated implant. It finds the greatest common divisor amongst the degree of coronal breakdown of the involved or adjacent teeth, the quality and quantity of the bone support and tissue condition, and the engineering demands to be born by the tooth or teeth in question, and assesses the occlusal scheme and the patient's aesthetic and functional expectations of treatment.

The reasons for tooth extraction may include, but are not limited to, crown-to-root ratio, remaining root length, periodontal attachment levels, furcation status, periodontal health of teeth adjacent to the proposed fixture site and non-restorable carious destruction. In addition, the clinician must consider questionable teeth in need of endodontic treatment, teeth requiring root amputations, hemi-sections or advanced periodontal procedures with a questionable prognosis, and pulpless teeth fractured at the gingival margin with roots shorter than 13 mm. These teeth will require endodontic treatment, crown lengthening, post/cores and crowns; however, their longevity is much in doubt with these parameters.⁶⁰

Practitioners are ethically obligated to inform patients of all reasonable treatment options. It is the patient's attitude, values and expectations that are integral to the risk assessment algorithm. Poor motivation to retain a tooth mandates extraction, not clinical intervention, whereas high motivation advocates non-surgical intervention or surgery. The process of planning, presentation and acceptance of dental treatment plans is always dominated by the duality of emotion and pragmatism associated with cost. Where it becomes specious is the side-by-side dollar comparison of restoring a natural tooth or placement of a fixed bridge etc. in contrast to ortho-biological replacement

of a debilitated tooth. Far too often the comparison of purported treatment outcome percentages are based upon corporate affiliation and/or fiduciary bias, or are simply too narrow a parameter to suggest comparable alternatives. With the treatment options available to an experienced endodontist, only very few structurally sound teeth need be removed.

Benjamin Disraeli said: "Expediency is a law of nature. The camel is a wonderful animal, but the desert made the camel". The endodontic implant algorithm raises the question: Does science drive the market, or does the market drive science. "All truths are easy to understand once they are discovered; the point is to discover them," Galileo said. Time and forbearance will bear witness to the discovery of the salient and relevant truths that guide the endodontic implant algorithm.

Editorial note: This article was been published first in roots 1/2010. A complete list of references is available from the publisher.

_about the author

implants



Dr Kenneth S. Serota graduated from the University of Toronto in 1973 and was awarded the George W. Switzer Memorial Key for Excellence in Prosthodontics. He received his Certificate in Endodontics and Master of Medical Sciences degree from the Harvard-Forsyth Dental Center in Boston.

A recipient of the American Association of Endodontics Memorial Research Award for his work in nuclear medicine screening procedures related to dental pathology, his passion is education, and most recently e-learning, and rich media. Dr Serota provided an interactive endodontic programme for the Ontario Dental Association from 1983 to 1997 and was awarded the ODA Award of Merit for his efforts in the provision of continuing education.

The author of more than 60 publications, Dr Serota is on the editorial board of *Endodontic Practice*, *Endo Tribune* and *Implant Tribune*. He founded ROOTS, an online educational forum for dentists from around the world who wish to learn cutting-edge endodontic therapy, and recently launched IMPLANTS (www.rximplants.com) and www.tdsonline.org in order to provide dentists with a clear understanding of the endodontic-implant algorithm in foundational dentistry.

Implant therapy of edentulous sites

Authors _ Balint Török, Istvan Gera, Agnes Meszaros & Peter Windisch, Hungary

_Deep periodontal defects with advanced bone loss of the buccal cortical plate represent a challenge for periodontal treatment in the upper front region. Literature data suggest that one and two-wall periodontal defects do not have tendency for complete periodontal regeneration and bone fill (Eickholz *et al.* 1996, 1998, 2000). Remaining residual pockets can also jeopardize the long term result of periodontal treatment (Matulienė *et al.* 2008). Tooth extraction in the upper front region even without any periodontal defect will result in certain amount of oro-vestibular and eventually vertical shrinkage of the original soft tissue contour (Schropp *et al.* 2003). Due to bone remodelling appropriate implant placement cannot be achieved in most of the cases. Socket preservation and different alveolar site developments are used to offset this unfavourable feature (Camargo & Lekovic, 2004; Lekovic & Kenney, 1997). It is obvious that the application of one of these techniques can be of great importance when tooth extraction is being considered at periodontally compromised teeth with advanced buccal plate involvement. It is not clear that ridge preservation procedures are effective in limiting horizontal and vertical ridge alterations in postextraction sites. Comparing the clinical and histological results obtained by different preservation techniques there is no literature data to support the superiority of one technique over another (Darby *et al.*, 2009). Nevertheless each preservation technique provided better results than natural socket wound healing (Barone *et al.* 2008). The effect of extraction site

development on the changes of attachment level of neighbouring teeth has not been clarified yet.

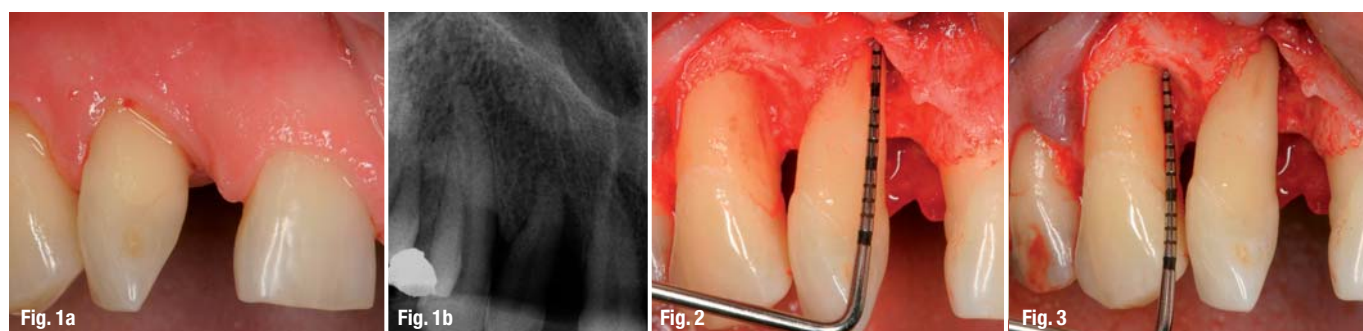
While supraalveolar periodontal regeneration is still unpredictable (Sculean *et al.*, 2004) vertical ridge augmentation has been successfully demonstrated in several publications (Barboza EP, 1999; Urban & Jovanovic, 2009; Merli & Lombardini, 2010; Beitlitum *et al.*, 2010). Treatment of vertical ridge deficiencies has been performed in edentulous areas without neighbouring teeth demonstrating advanced periodontitis. It was suggested that natural teeth with advanced periodontitis, may impose a risk for an infection of the augmented site and of membrane exposure originating from the neighbouring periodontally compromised teeth (Karoussis *et al.*, 2003; Hoffmann *et al.*, 2007). Nevertheless in certain clinical situations, teeth presenting deep intrabony defects are located in close vicinity of the compromised alveolar ridge.

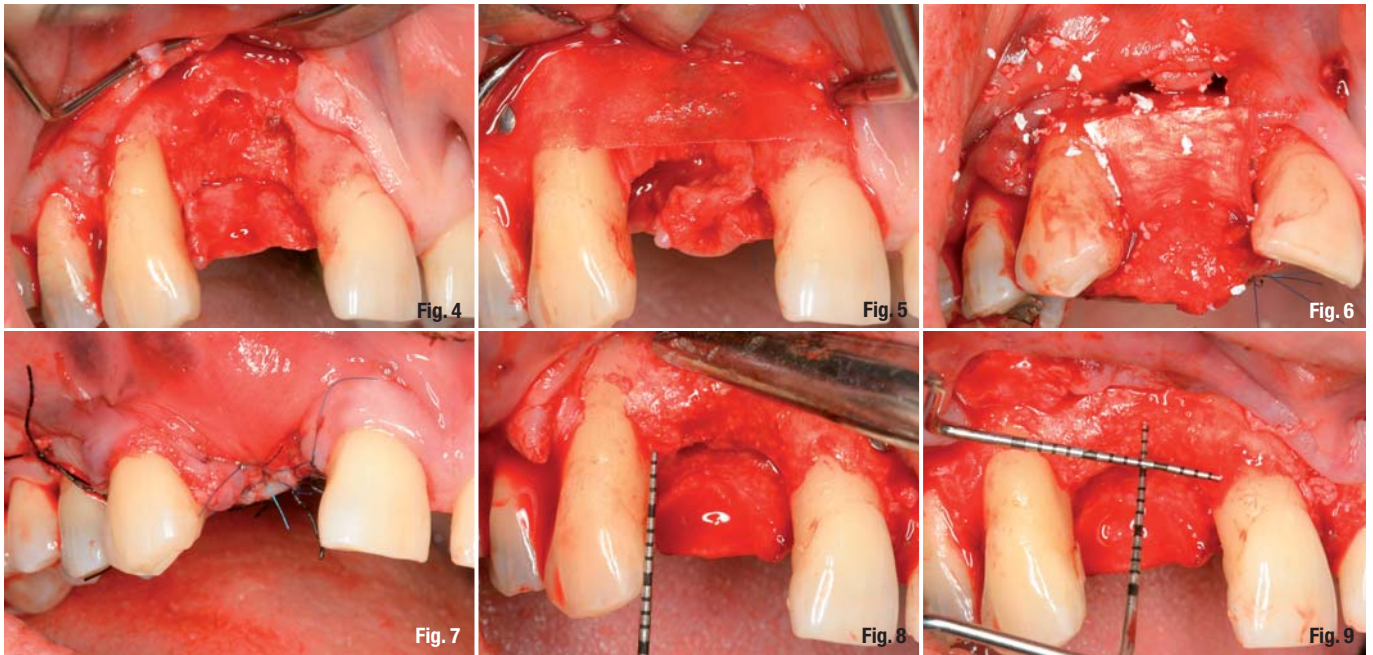
In these particular cases, it is of clinical interest to simultaneously reconstruct both the intrabony periodontal defect and the resorbed alveolar ridge, thus allowing proper insertion of dental implants. For those implant patients having a history of chronic periodontitis it is inevitably important to reduce periodontal pockets at natural teeth to 3 mm and even below to facilitate proper individual plaque control and to reduce the chance of periodontal reinfection (Carnevale *et al.*, 2007). The importance of proper implant positioning

Fig. 1a _ Clinical view of tooth 12 prior treatment with similar recession on tooth 13. Distal papilla of 11 is missing.

Fig. 1b _ Standardized X-ray at baseline. The #12 tooth has a deep intrabony defect on the mesial aspect.

Fig. 2 & 3 _ Advanced periodontal breakdown at the upper right lateral incisor. The bony defect involves the buccal plate of bone. The neighbouring tooth has also intrabony periodontal defect.





and adequate amount and quality of periimplant hard and soft tissues have to be considered to maintain long term stability around implants. Therefore, the aim of the present cases was to evaluate the effect of a new step-by-step surgical technique designed to simultaneously reconstruct resorbed alveolar ridge and the adjacent located intrabony defect to achieve a predictable clinical outcome and adequate peri-implant tissue stability.

Materials and methods

Three patients exhibiting chronic periodontitis with localized advanced periodontal bone loss were referred to the Department of Periodontology, Semmelweis University, Budapest, for comprehensive periodontal therapy. All three patients were middle aged Caucasian males (51, 50 and 49 years-old), systemically healthy and had never been smokers. Each patient presented at least one deep advanced periodontal bony defect in the upper front region. After initial therapy teeth were considered to be hopeless because of their disadvantageous pathomorphology. Before tooth extraction each patient had completed basic cause related periodontal therapy including full mouth scaling and root planning and oral hygiene training. Before surgery all exhibited high standards of oral hygiene. Treatment plan consisted of tooth removal followed by extraction site development (Surgery 1), and soft tissue augmentation (Surgery 2), and implant placement with simultaneous ridge augmentation (Surgery 3) and abutment connection with non resorbable membrane removal (Surgery 4). The following parameters were measured at baseline, immediately before augmentation procedure and 11–20 months after implant placement: plaque index (PI),

gingival index (GI), bleeding on probing (BOP), probing depths (PD) around the neighbouring teeth at 6 sites, gingival recession (GR), clinical attachment level (CAL) with a millimetre calibrated periodontal probe (PCP-UNC 15, Hu-Friedy, Chicago, IL, USA) and also intra-surgical direct measurements: the level of periodontal bone of neighbouring teeth, the width and height of the alveolar ridge. Standardized radiographs were taken with the long cone parallel technique preoperatively, between surgeries and postoperatively; for qualitative assessment of bone height.

The combined surgical technique

Surgery 1

Tooth extraction with extraction site development

Following tooth removal a full thickness flap was raised up to the mucogingival line and beyond a partial thickness flap was mobilised with a horizontal extension thus allowing a tension free soft tissue management and wound closure. This flap design let the operator to evaluate and treat the periodontal defects around the neighbouring teeth. A combined alveolar site preservation technique was used with a slow resorbable membrane (Resolut Adapt LT 2530, Gore-Tex®, Newark, DE, USA) fixed with titanium pins (Ti-pins; DENTSPLY Friadent, Mannheim, Germany) to cover the missing part of the buccal plate and to maintain the original form of the earlier arch. Following an appropriate-sized connective tissue graft was removed from the palatal mucosa by using the Hürzeler technique (Hürzeler & Weng, 1999). The harvested tissue was trimmed and sutured (5.0 non-absorbable polyamide monofilament, Braun AG, Tuttlingen, Germany) to the inner surface of the partial thickness mu-

Fig. 4 Clinical situation immediately after tooth extraction.

Fig. 5 & 6 A long term biodegradable membrane is fixed on the buccal aspect with titanium pins. Then the defect was filled with bovine derived xenograft (BDX) (BioOss) and covered with collagen membrane.

Fig. 7 Tension-free wound closure after alveolar socket preservation.

Fig. 8 The reentry revealed that the intrabony defect of the neighbouring tooth has also been filled with new bone.

Fig. 9 The horizontal dimension of the implant site is already satisfactory but its vertical dimension needs further augmentation.

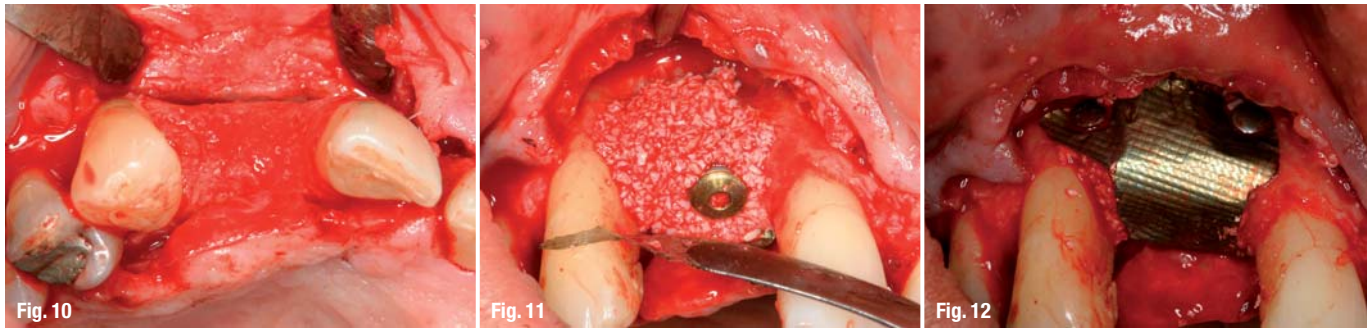


Fig. 10_ The horizontal dimension of the implant site is already satisfactory but its vertical dimension needs further augmentation.

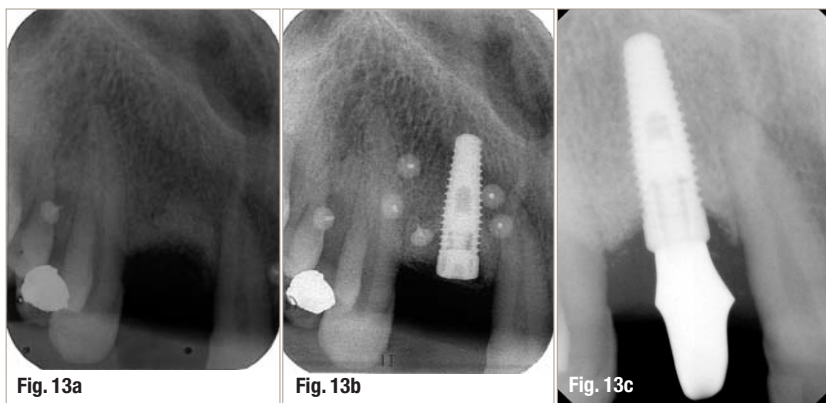
Fig. 11 & 12_ Surgery 2: implantation with simultaneous hard tissue augmentation using a BioOss and titanium membrane.

cosal flap. Additionally the oral flap at the earlier tooth removal site was covered by a connective tissue graft with an epithelial collar. The periodontal defect and the edentulous ridge were either filled and overfilled vertically and horizontally with BDX (Bio-Oss®, particle size 0.25 to 1.0 mm, Geistlich AG, Wolhusen, Switzerland) (Case 1 and 3) or no bone grafting material was used (Case 2). After grafting, a biodegradable collagen membrane of porcine origin (Bio-Gide®, Geistlich AG, Wolhusen, Switzerland) was trimmed and adapted over the graft (Case 1 and 3). Finally the buccal mucoperiosteal and the oral "CTG reinforced" flaps were re-positioned by avoiding any extra flap mobilizing procedure and closed with vertical mattress sutures (5.0 non-resorbable polyamide monofilament, Braun AG, Tuttlingen, Germany).

**Surgery 2
Soft tissue augmentation**

Following the above mentioned procedures if the width of the keratinized soft tissue allowed proper coverage after augmentation procedure simultaneous augmentation and implant placement was performed. If the thickness and the width of the alveolar mucosa were not sufficient to provide predictable primary wound healing during hard tissue augmentation procedure, soft tissue augmentation was performed prior to implant placement. A free autogenous soft tissue graft or a xenograft (Alloderm®, BioHorizons, Birmingham, AL, USA) was used in order to gain enough keratinized gingiva and deepen the vestibule at the implant area using a modified tunnel technique

Fig. 13a-c_ Radiological follow up of the augmented site development.
a) Standardized X-way prior to implant placement. Radiographical bone fill can be seen in intrabony defects of the neighbouring teeth.
b) Radiological view after 9 months healing of implant placement and simultaneous hard tissue augmentation.
c) The platform shifted abutment is fixed to the implant.



(Azzi *et al.* 2009). The tissue harvesting technique has already been described before.

**Surgery 3
Implant placement with simultaneous hard tissue augmentation**

One implant (Straumann Bone Level, Straumann AG, Waldenburg, Switzerland, and Nobel Replace Tapered Effect, Nobel Biocare, Gothenburg, Sweden) was inserted with simultaneous 3-D hard tissue augmentation using BDX and a non-resorbable membrane (Titanium membrane—FRIOS® Boneshield; DENTSPLY Friadent®, Mannheim, Germany) or a slow resorbable membrane (Resolut Adapt LT2530, Gore-Tex®, Newark, DE, USA) was fixed over it. A tension free wound closure was achieved in all cases resulting in primary wound healing.

**Surgery 4
Abutment connection with non resorbable membrane removal**

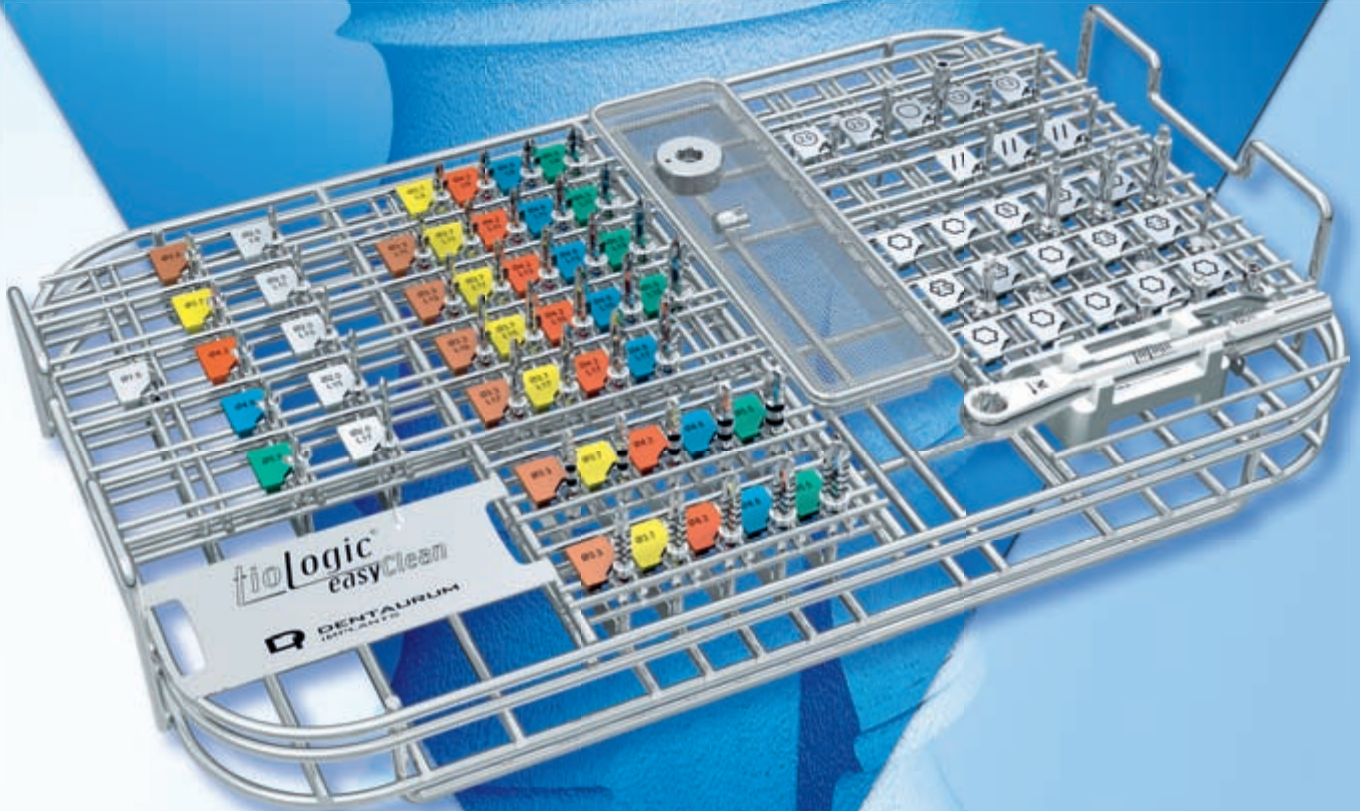
The same split thickness flap design was applied for non-resorbable membrane removal and abutment connection.

After surgery patients were instructed to take antibiotics (Augmentin, 3 x 625 mg/day for 1 week). Post surgically mechanical plaque control was not performed in the surgical and adjacent area and chemical plaque control was maintained with a 0.2% chlorhexidine solution twice daily (Corsodyl, GlaxoSmithKline). Sutures were removed at 14 days after surgery. Additional recall appointments including supragingival professional tooth cleaning were scheduled biweekly for the first 6 postoperative weeks. Prior tooth extraction each patient received a resin bond prefabricated bridge to provide immediate provisional prosthodontic reconstruction after tooth extraction. Finally all patients received fixed prosthodontic restoration i.e. PFM crowns on each implant.

_Case 1 (Figs. 1-14)

A 51 years-old male patient was referred with generalized periodontitis for a comprehensive periodontal treatment. At the upper right lateral incisor an ad-

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Fig. 14a & b Post treatment view of the final PFM crown in place surrounded by optimal and harmonious soft tissues.

vanced periodontal defect was registered with tooth mobility III (see the standardised X-ray, Fig. 1a–b). Deep periodontal pocket depths were assessed on the adjacent teeth. After flap elevation a two-wall crater-like defect was found on the mesial aspect of the tooth with a missing buccal bony plate (Fig. 2 & 3). After tooth extraction the previously described step-by-step technique was carried out (Fig. 4–7). As a result of surgery 1, completed with a soft tissue augmentation, the alveolar ridge configuration allowed the implant placement with simultaneous further augmentation (Fig. 8–12). During abutment connection the 3-D reconstruction of alveolar ridge was observed around the previously supracrestally placed implant. This surgical approach allowed a re-entry procedure of adjacent periodontal defects, they presented bone fill and complete regeneration of earlier one-wall defects. After soft tissue healing a screw retained temporary crown was placed in situ to form an ideal emergence profile for further three months. This situation was then transferred to the cast to make the permanent PFM crown. See the final restoration on Fig. 14.

Case 2 (Figs. 15–17)

A 54 years-old male patient presented an advanced vertical bony defect on the mesial aspect of the right upper central incisor with excessive tooth mobility (Fig. 15). After tooth extraction an alveolar site development was performed in the same way like described before without any bone substitute material. The second surgical phase was the previously described soft tissue augmentation. During surgery 3 implant placement with simultaneous hard tissue augmentation was proceeded by. As an augmentation material BDx was used covered by a slow resorbable membrane. The

Fig. 15 The tooth 11 has got a deep one-wall bony defect that after extraction would cause tissue collapse influencing also the periodontal status of the neighbouring teeth.



width and height of the alveolar ridge became sufficient to promote long term stability for the implant borne restoration (Fig. 16a & b, 17).

Case 3 (Figs. 18–20)

The third case is a 49 years-old male patient who presented the left upper lateral incisor with an advanced horizonto-vertical bony defect on its mesial aspect (Fig. 18). Following tooth extraction an alveolar ridge preservation was performed and implant placement with simultaneous augmentation as described before. The augmentation material was BDx covered by a titanium membrane (Fig. 19). The final soft tissue augmentation was followed by the prosthodontic rehabilitation, a PFM crown was established (Fig. 20).

Results

After the cause related periodontal therapy the patients developed proper individual oral hygiene measures. Each patients' gingival and plaque index was under 20%, the mean of PI was 7,7%, and 12,7% of GI, respectively. At baseline the mean periodontal PD of the neighbouring teeth was 3,97 mm, GR 0,88 mm and CAL 4,78 mm. After the healing of the 3rd stage the neighbouring teeth's PD was 2,55, GR 2,13 and CAL 4,58. The clinical parameters showed slight improvement although the number of cases does not offer any statistical analysis. The intrabony component of the adjacent teeth is being eliminated clinically and radiologically and during re-entry. Optimal hard and soft tissue conditions were found around implants.

Discussion

The long term success of implant therapy depends on the adequate volume of bone around the implant site. The lack of mineralized tissue is an unfavourable condition for a predictable implant therapy (Lekholm *et al.*, 1986). Another key factor for maintaining the alveolar crest level around implant is the quantity and morphology of the covering soft tissues. Implant therapy in the aesthetic zone needs a comprehensive consideration of several contributing factors. In periodontal patients implant placement is even more challenging. Periodontally compromised teeth often show disadvantageous bone loss, especially if the buccal bony plate is missing. For achieving predictable healthy periodontal conditions tooth extraction cannot be avoided. Several techniques and materials have recently been developed for the purpose of extraction socket preservation. There are controversial data in the literature concerning the possible role of bone fillers in alveolar socket preservation. Several different techniques have been described to achieve this goal. There is a substantial ambiguity in the literature regarding the predictability of these kind of techniques. Several



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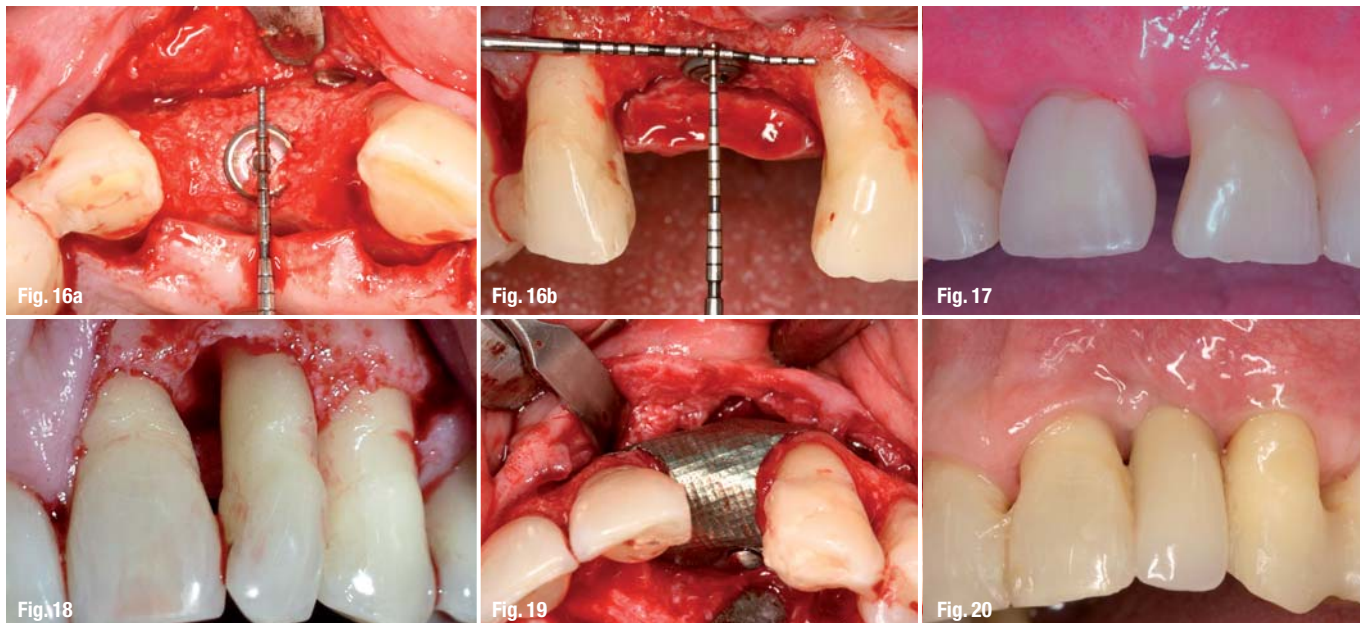


Fig. 16_ The optimally positioned implant in 3-D regenerated bone.

Fig. 17_ The final result.

Fig. 18_ The morphology of the osseous defect after flap elevation.

Fig. 19_ The optimally positioned Ti-membrane covering the augmented area.

Fig. 20_ The final prosthetic rehabilitation.

authors report positive findings on the effect of bone substitutes (Froum *et al.*, 2002). Different animal studies (Araújo & Lindhe, 2009; Fickl *et al.*, 2009) suggest that bone filler materials can to a certain extent retard or modify the resorption of the buccal bone. It is also the matter of discussion whether these grafting materials in the alveoli have an active role in the modulation of alveolar bone formation or they only slow down the vestibular bone resorption (Araújo & Lindhe, 2009). Other studies suggest the utilization of membranes. The biodegradable membranes have recently been increasingly applied because of its incorporation in the host tissues and providing better soft tissue healing. If it is exposed to the oral cavity the healing is less compromised and the risk of infection is low (Lekovic *et al.*, 1997, 1998). Tooth extraction always presents conditions where a complete wound closure is questionable. If the membrane is not able to maintain enough space for regeneration it should be supported with some grafting material (Case 3). Similar ridge configuration was achieved when using bone fillers (see our Case 1) or without any bone substitute (see our Case 2) (Chiapasco *et al.*, 2006).

The use of non-resorbable membrane became the gold standard for GBR with a need of 3-D reconstruction of the edentulous ridge (Simion *et al.*, 2007). One of the disadvantages of this technique that the gingival flaps should be sutured over the membrane in a way that a primary wound healing without any flap dehiscence could be achieved. Membrane exposure may severely compromise wound healing and also the consecutive regeneration and final treatment outcomes (Hämmerle *et al.*, 1998). The soft tissue coverage is a prerequisite for the management of hard tissue augmentation and for the final aesthetics of the implant borne restoration. The three demonstrated clinical

cases showed favourable hard and soft tissue alteration during the third surgery. During this step-wise surgical approach we managed to develop an ideal implant position in all the three dimensions covered by the required amount of hard and soft tissues (Buser *et al.*, 2004). Literature data suggest that survival and success rate of implants partially or fully placed into augmented bone is comparable to implants placed into non regenerated alveolar ridges (Mayfield *et al.*, 1998; Zitzmann *et al.*, 2001b). The biological mechanism of the alveolar regeneration is not fully investigated and understood and the role of this issue in the healing of neighbouring teeth's periodontal intrabony defects even needs further examination.

Conclusion

This stepwise series of surgical techniques could be successfully applied for correcting sever ridge deficiencies and also can facilitate the comprehensive regenerative therapy of periodontal defects at adjacent teeth.

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

<u>contact</u>	implants
<p>Dr Peter Windisch DMD, PhD Associate professor Departement of Periodontology Semmelweis University, Budapest 1088 Budapest, Szentkiralyi u 47, Hungary</p> <p>Phone/Fax: +36 1 267 4907 peter.windisch@gmail.com</p>	

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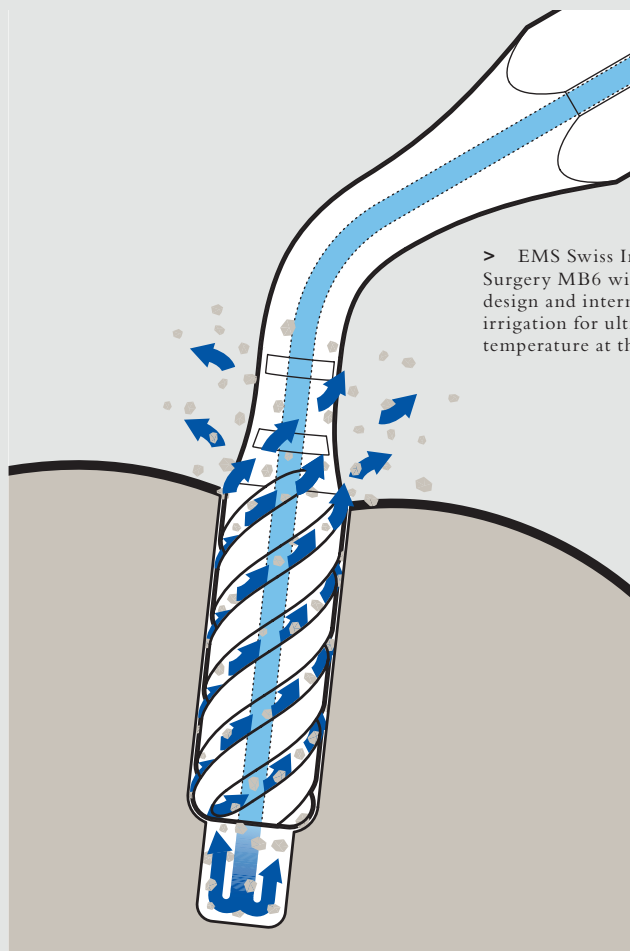
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AIAI Annual Meeting 2010 in Tokyo

Author_Dr Tomohiro Ezaki



The Annual Meeting of AIAI was performed in Tokyo/Japan from November 6–7. Total number of participants was around 500 people.

On November 6, Authority and Clinical Examination for dentist; 32 people took Exam, Implant authorization Hygienist; 4 people took Exam, Implant authorization technician; 1 person took Exam, Implant Coordinator; 8 people took Exam, were performed. Clinical, Implant authorization Hygienist, Implant authorization technician were done by written examination. Authority was by written and oral examination.

On November 7, it was scientific part all day and number of lectures about studies and case reports of implantology were performed four different rooms.

Before starting the lectures in the morning, the President of AIAI, Dr Naotaka Sugiyama, announced a lot of information and activities the association had this year. He also talked about the participation of the board members of AIAI at the DGZI Congress in Berlin/Germany last October. AIAI and DGZI confirmed the partnership for information exchange of scientific part and technical information in implantology for today and the future.

AIAI's President promoted to the audience to participate in DGZI Congress 2011 in Cologne/Germany.

Figs. 1 & 2_At the Reception in the morning.

Figs. 3 & 4_Authority and Clinical written examination.

Figs. 5 & 6_This is main hall.

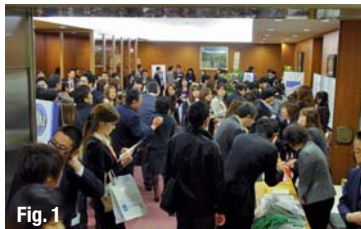


Fig. 1



Fig. 2



Fig. 3



Fig. 4



Fig. 5



Fig. 6



Figs. 7 & 8_Announcement from President of AIAI to many people.
Figs. 9 & 10_Sinus symposium.
Figs. 11 & 12_Lectures for hygienists and dental technicians.
Figs. 13_The seminar of the hands on for dental technician also was hold in other room.
Figs. 14 & 15_Social Gathering Party.

Many friends and colleagues of AIAI will take part, too because it will be possible to have Japanese simultaneous interpretation for the lectures. In addition, he called to the AIAI-members which are having authority or a clinical certificate of AIAI in Japan, to become Expert and Specialist of DGZI. In Germany and in Japan it is so venerable to hold such a certificate of DGZI.

The AIAI Annual Meeting 2010 was opened under the main topic "Implant treatment to connect tomorrow". The Sinus Symposium was held as one of the topics for this meeting in the morning on November 7. AIAI called five lecturers for this symposium: four top-level Japanese clinicians and one from Korea—with high technical points of sinus lift operation and studies. They presented their superior clinical cases besides failure cases which were so intelligibly.

The contents of those lectures had a key to lead us to a successful operation and a final implant stage. They also gave us the latest technology and knowledge of implantology relative to the sinus floor elevation. A few lectures for hygienists and dental technicians were held in the other rooms.

Meeting participants gave us a pat on the back at the social gathering party. We also had powerful confidences from good answers of the questionnaire of this meeting. This successful meeting contributed to our goals and we look forward to the future of the AIAI. We were so happy that a lot of people were pleased with us in this society and we learned many things from the lectures in this meeting. Some of the lecturers told us to try to present their knowledge and technology of sinus lift or implantation at the DGZI Congress in Germany.

AD

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International Osteology Symposium in Cannes

An interview with Prof Mariano Sanz & Prof Daniel Buser

_The next International Osteology Symposium is being held from April 14–16, 2011, in Cannes. What will the symposium be offering to practitioners and scientists? The international chairmen of the symposium, Mariano Sanz and Daniel Buser, respond to questions in an interview.

_Another International Osteology Symposium is now being held after 4 years. What are the main topics of interest?

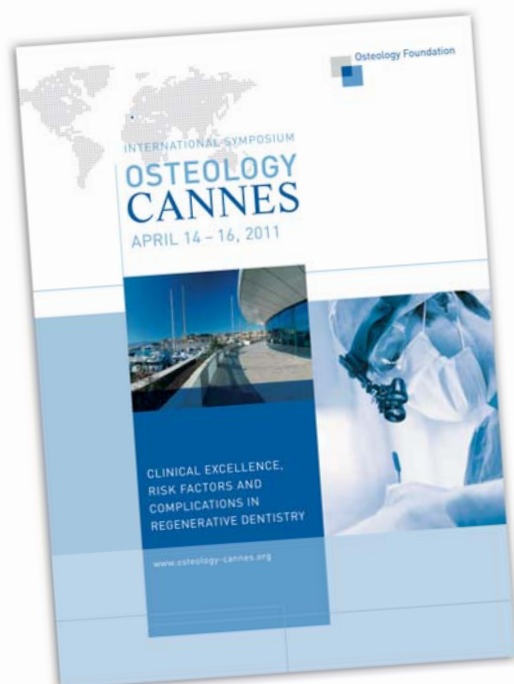
Prof Buser: We have chosen for the symposium the main topics "Clinical Excellence, Risk Factors and Complications". Nowadays bone regeneration is the standard of care in implant dentistry. In un-critical cases implant surgeons can treat small to mid-size defects such as apical fenestration or crestal dehiscence defects with high predictability to achieve successful outcomes. It is very important, that the clinician can correctly assess risk factors

and integrate them into treatment planning in more complex cases.

Prof Sanz: Our patients not only want functional results, they also want beautiful smiles. The

“The motto of the Osteology Foundation is Linking Science with Practice”

Prof Mariano Sanz



right proportions between beautiful teeth and gums is what makes a nice smile and that is precisely what our patients are looking forward. We therefore need to balance the importance of risk factors and complications with techniques aimed to achieve aesthetic results. This is the reason why the field of soft tissue management has gained an important impetus in the last few years, both in implantology and periodontology. At Osteology in Cannes we will be discussing new therapeutic approaches, new biomaterials and improved surgical techniques to augment both hard and soft tissues, both around teeth and dental implants, in order to rebuild what the oral diseases have destroyed.

_Just to get back to the topic of complications. What significance does the topic now have in regenerative procedures?

Prof Buser: As the number of inserted implants has significantly increased in the past 10 years, the number of complications such as peri-implantitis also rises. Therefore, a section of the programme in

Cannes deals exclusively with the topic of peri-implantitis. Well-known experts will be reporting on the prevalence, risk factors and pathogenesis of the disease. They will demonstrate what surgical and non-surgical therapies are indicated for what cases and they will show when regenerative treatments promise success.

Prof Sanz: Besides the occurrence of peri-implant infections and complications, we will discuss other multiple sources of complications and most importantly, how to diagnose and how to treat them. Complex therapeutic procedures, such as soft tissue augmentation, guided bone regeneration or sinus floor augmentation will be discussed in the context of the treatment of complicated cases. Special emphasis will be placed in how to prevent complications and how to achieve the best possible outcomes.

_The Osteology symposia are well-known for their high scientific standard. Is Osteology in Cannes sufficiently practice-oriented?

Prof Sanz: Absolutely! The motto of the Osteology Foundation is "Linking Science with Practice", and we consistently make this happen in our symposia. Science provides the basis for new therapeutic concepts, but the wide usage of these concepts in practice cannot be widespread until this

and the audience will be discussing exciting complex cases.

_What else is on the programme in Cannes?

Prof Buser: The programme embraces a broad selection of indications in implantology and periodontology. We will be discussing whether new findings cast doubt upon well established treatment concepts, and what new therapies and products could be reliably used in daily practice in the future.

As ever at the Osteology symposia, we not only offer participants a top-class, exciting scientific programme, but also an exceptional atmosphere and a fascinating social programme. Osteology in Cannes is making another guest appearance on one of Europe's most beautiful coasts. This guarantees inspiring days at the congress. Our colleagues should not miss that highlight in 2011!

For more information:

www.osteology-cannes.org

Editorial note: The interview was led by Dr Birgit Wenz, Switzerland.

“We will be discussing what new therapies and products could be used in the future”

Prof Daniel Buser

treatment option or product has been sufficiently tested and backed up by scientific data. The presentation of new scientific data has, therefore, always taken an important place at the Osteology Symposia Programmes. We strongly believe that only well informed practitioners would be able to provide optimum treatments for their patients. But we do not overlook the practical applications of current therapies. On the pre-congress day there is a large selection of practical hands-on courses and theoretical workshops. In this Osteology Symposium we have also organized an interactive clinical forum in which top-class experts

_about the interviewees

implants



Professor Daniel Buser is professor and chairman at the Department of Oral Surgery and Stomatology, and executive chairman of the School of Dental Medicine at University of Bern in Switzerland. His main interest is in membrane-protected bone regeneration. He is an internationally well-known scientist and speaker. He is currently President of the ITI Foundation, the Swiss Implant Foundation and a member of the Osteology Foundation Board.

He is an internationally well-known scientist and speaker. He is currently President of the ITI Foundation, the Swiss Implant Foundation and a member of the Osteology Foundation Board.



Professor Mariano Sanz is professor of Periodontology at University Complutense in Madrid. He is much in demand as a scientist and international speaker in the field of periodontological and aesthetic soft tissue regeneration.

He is in the editorial board of various international peer-reviewed journals and is a member of the Osteology Foundation Board.

Manufacturer News

Produits Dentaires

A trend-setter bows out

No false modesty, the concept is brilliant: a bone filling material which is injectable, hardening in situ, ready-to-use, fully synthetic, completely resorbable and finally replaced by bone, all this without using a membrane. The miracle product!

PD (Produits Dentaires SA, Switzerland) started ten years ago the development for the dental industry of a brushite bone regeneration product stemming from the Swiss Federal Institute of Technology in Lausanne. Five years later, in 2006, the result, PD VitalOs Cement, was launched on the market. During five years of commercialization, we have convinced numerous users of the concept, especially among those believing that the solutions presently available are not quite satisfying yet. However, a concept change often implies to revise the way of thinking and working. Now the implied change has not always been accepted and the number of users reached so far is not sufficient to achieve sales

figures covering the costs. This is the reason why, today, PD decides to stop manufacturing VitalOs.

So, was the concept not that brilliant? Not at all, it was and remains brilliant. But it may be that it was too ambitious, or simply ahead of the times.

What can we learn from such an experience? Obviously, that the miracle product does not exist yet. On the other hand, it is certainly possible to find the adequate and performing product for each clinical indication or situation. For VitalOs, the clinical results are exceptional in specific situations in immediate implantation, as well as for horizontal ridge distraction. However, the restricted indications also limit the revenue, and the latter turns out to be insufficient, at least in the model followed so far. VitalOs is a product that would most make sense inside a complete bone regeneration portfolio, with each product dedicated to a specific indication where it performs best.

Well then? What will happen with the product?

Maybe another manufacturer will show interest to integrate it into its product portfolio? It's difficult to say this today. At least, the concept will

leave traces, some are already visible today, looking at the increasing number of products presented in syringes, ready-to-use, and even some with hardening properties.

For the time being, we would like to thank warmly all the partners that took part in the project, especially the users who took the time to understand the product and to adapt their way of working in order to get the best possible results. We also would like to address our very special thanks to the opinion leaders who set up and ran the studies, and presented their results in articles or in presentations during congresses.

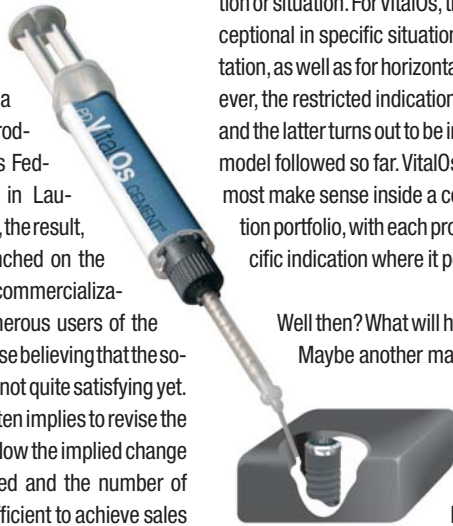
PD focuses now strategically on its core business (www.pdsa.ch), and wishes that the users who adopted the product will find in the future a product issued from the concept they have stuck to.

Christian Pittet, Product Manager
Marc Fehlmann, CEO

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BEGO Implant Systems

Mediterranean Implantology Symposium 2011

"Implantology—the complete state-of-the-art: from planning to final rehabilitation"—the first BEGO Mediterranean Symposium—will take place on 20 and 21 May 2011. Be sure to make a note of this date now. The number of delegates at this exclusive event will be restricted to 300.

On both days, delegates will receive an up-to-date overview of the implant issues affecting ambitious implantologists and which are currently being discussed worldwide. The topics range from 3-D implant planning and surgical navigation to complicated augmentation techniques and CAD/CAM in implant prosthodontics, to name but a few.

15 top-class international speakers will give interesting, in-depth explanations of the scientific background to the topics. The speakers from seven different countries (Spain, Turkey, Germany, the Netherlands) include Prof Dr Dr Schultze-Mosgau (Jena), Prof Dr Wainwright (Düsseldorf), Dr. Fernandez (Ibiza, Barcelona), Dr Abboud (Bonn), PD Dr Dr Rothamel (Cologne), Prof Dr Artunc (Izmir). The symposium will take place in the renowned 5-star Dolce Hotel (www.dolce.com) in Sitges (36 km south-west of Barcelona). In addition to the mentally enriching symposium, delegates with a keen interest in sport can partake in some physical exercise on the golf course adjacent to the hotel or in the large spa in Sitges. The delegate fee for the two-day symposium is €350, which includes catering during the day and a certificate of attendance.

There is an additional charge of €80 for the Friday evening event. You can save €60 if you register early, not later than the end of January 2011. The symposium will be conducted in English.

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Implant Direct

Combined Implant and Abutment Businesses

Sybron Dental Specialties, Inc., and Implant Direct Int'l Inc. announced that they have entered into a definitive purchase agreement pursuant to which Sybron Dental and Implant Direct will combine their implant and abutment businesses into a single operation to be named Implant Direct Sybron Int'l. The combined business will be led by Dr Gerald Niznick, president and founder of Implant Direct.



Dan Even, President of Sybron Dental Specialties' stated, "Implant Direct has created a unique value proposition in the implant industry by being able to offer high quality, innovative dental implant products at affordable prices through its state-of-the-art manufacturing facility in Los Angeles, California. Under

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Dr Niznick's continued leadership, this acquisition, in combination with Sybron Implant Solutions and Attachments International, strengthens Sybron's position in the implant industry and offers Implant Direct the opportunity to accelerate sales growth of what is already the fastest growing company in the implant industry." Dr Niznick added, "I am very excited to be a part of Sybron, which has a 100 year history of providing service, quality and innovation to dental professionals. With our exceptional manufacturing and product development capabilities, together we will broaden the opportunities for dentists and patients around the world to enjoy the benefits of high.

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TURKISH SOCIETY of ORAL IMPLANTOLOGY

VII. Symposium



AUSTRIAN SOCIETY of ORAL IMPLANTOLOGY

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Dr. Serdar Yalçın
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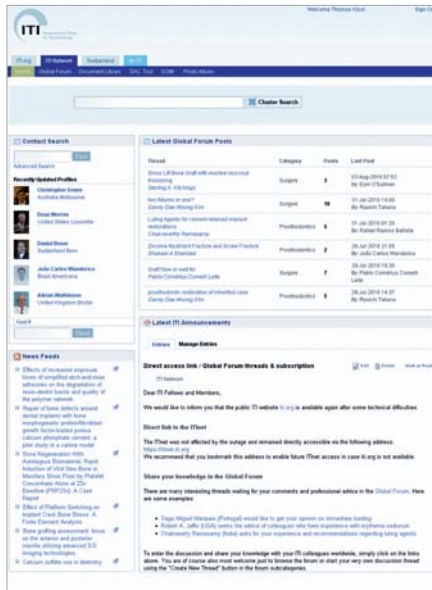


- **6 days** accomodation (all inclusive) and attendance fee: Euro 810 -per person
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ITI

The ITI launches a global online portal for its membership

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, has announced the successful launch of the ITInet—its new online portal. The ITInet is a unique platform that supports knowledge exchange and networking and also offers continuously updated content and interactive services. The ITI with its membership of more than 8,000 provides free access to the ITI. Users share their expertise while at the same time extending their personal network of contacts on a worldwide basis. Various discussion forums are available at a global and national level. ITI Fellows and Members can not only participate in or observe clinical discussions on current topics, but can also start new discussions threads or ask the opinion of colleagues on, for example, potential treatment options in concrete cases. Each of the 26 ITI country Sections also



has its own forum in which local topics of interest can be discussed in the country's own language. In addition, each ITI Fellow and Member is provided with a personal area for their individual use. As with other social networks, users can extend their per-

sonal network on a long-term basis by making contact with colleagues and friends within the ITI.

The ITInet also offers a powerful cluster search facility that draws on various scientific resources and delivers its results dynamically by subject area. This new technology allows users to carry out targeted research simply and effectively in a wide variety of areas. The platform is rounded off with an online version of the highly successful reference volume "Glossary of Oral and Maxillofacial Implants" and literature updates six times a year as well as RSS feeds from other scientific resources. Overall, the ITInet offers an excellent opportunity for users to benefit from the collective knowledge of the ITI community worldwide.

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 4052 Basel, Switzerland
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 www.iti.org

EMS

Piezon Master Surgery with three new instrument systems

Since it was introduced, Piezon Master Surgery—based on Piezon technology—has had a remarkable track record in many practices. Today, EMS has expanded the clinical scope of application of the Piezon Master Surgery product range. With an enhanced product offering—and special instruments such as Sinus System and Implant System—practitioners have access to technologies allowing them to work even more efficiently.



With Piezon Master Surgery, additional application-specific instruments are now available: a total of four perio instruments especially designed for resective and regenerative periodontal surgery, five advanced surgical instruments for gentle and uniform sinus lifts, as well as six special fully diamondcoated instruments for implant applications with dual cooling system and extraefficient debris evacuation.

These instruments are seen as particularly suitable for four clinical applications: implant site preparation following extraction, im-

plant site preparation following splitting of the alveolar ridge, implant site preparation in the posterior tooth area, and implant site preparation in compromised areas, such as a narrow alveolar ridge. In principle, instruments can be used at low OP temperature of no more than 33 degrees centigrade. They provide drilling efficiency and precision in the maxillary area.

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 www.ems-dent.com

Dentaurum Implants

Planning for safe implant placement

Modern 3-D imaging processes such as DVT and CT give users a better view of existing jaw structures and bone conditions before a surgical procedure, allowing them to determine the ideal implant position and design the optimum protocol. The tioLogic® pOPosition navigation system has been designed to work with imaging processes and 3-D planning software for guided preparation followed by placement of tioLogic® implants. If the indication allows it, tioLogic® implants can be restored immediately with previously fabricated prosthetics. The tioLogic® pOPosition includes specially designed instruments and accessory components for preparation of the bone site and implant placement. The



sleeves for the tioLogic® pOPosition system are made of titanium and guarantee accurate guidance of the drills. The bone is atraumatically prepared to the specified implant length while gradually widening the diameter. Working with the tioLogic® pOPosition has been designed to be simple and safe for users with the inclusion of many specially designed details such as the ability to adjust the handle of the internal sleeves in three dimensions for work in restricted spaces or the silicone ring that fixes the internal sleeves in position during the procedure.

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Nobel Biocare

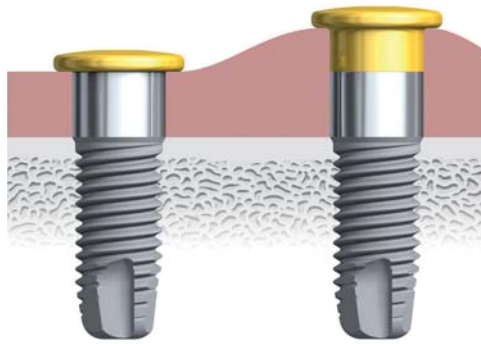
Versatile and easy-to-use

Backed by more than 40 years of successfully treating edentulous patients, Nobel Biocare introduces another versatile product for implant-supported overdenture solutions.



Replace Select TC¹ is a two-piece implant with a 3 mm high, extended machined collar, which enables platform access at tissue level (Fig. 1). Simultaneously, its color-coded internal tri-channel connection facilitates accurate and quick restorative component identification and placement. Moreover, the body of Replace Select TC is derived from Brånemark System™ MKIII implants, making it well-suited for all bone types and

one-stage treatment protocols, with excellent clinical results. In a retrospective study with an average three year follow-up, Replace implants with 3 mm collars demonstrated a cumulative survival rate of 99.2%.²



To facilitate immediate temporization using existing dentures, a new healing screw was developed for Replace Select TC—designed to prevent soft tissue overgrowth (Fig. 2). Two different screws are available to accommodate soft tissue thickness and facilitate intraoperative flexibility: 1 mm and 3 mm height variants.

Final prosthetics can be attached to Replace Select TC using any Nobel Biocare overdenture solution: Locator Abutment®, Ball Abutment, Gold Abutment Bar/Gold Coping Bar and NobelProcera Implant Bar Overdenture. By using Replace Select TC implant treatment times can be reduced, which usually leads to increased patient satisfaction. Replace Select TC should be considered the overdenture solution implant of choice for both surgical and prosthetic management options.

¹ TC = Tissue Collar.

² Two clinics placed 132 Replace Select Straight implants with 3 mm machined collar in 48 edentulous patients using one-stage surgery, loaded after 9 to 12 weeks with an overdenture solution (preliminary data from external study 2010–938).

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Degradable Solutions

World premiere at IDS

IDS 2011 will see the first presentation worldwide of the biphasic calc-i-oss® crystal by Degradable Solutions, a product consisting of 100% synthetic



bone replacement particles (60% HA, 40% pure-phase β-TCP) exhibiting a rotund, interconnected and highly porous shape. calc-i-oss® crystal is the logical complement of easy-graft® CRYSTAL. It is especially useful in large defects, which can be filled with calc-i-oss® crystal first, then covered with easy-graft® CRYSTAL. In the same manner, autologous bone or bone morphogenetic proteins (BMP) may also be introduced into the region to be augmented and a stable coverage of the defect is ensured. easy-graft® CRYSTAL and easy-graft®

CLASSIC are good examples of successful product maintenance. Its special handling continues to win over more and more supporters, enjoying numerous well-documented examples of long-term success. In contact with blood, the material will take only a few minutes to solidify into a porous body that has the same shape as the defect, which will often render membrane coverage unnecessary. The difference between easy-graft® CLASSIC and easy-graft® CRYSTAL is in their chemical composition, making them suitable for different indications. “Classic” easy-graft® consists mainly of β-TCP. It is fully resorbed by the body and replaced by bone. By contrast, easy-graft® CRYSTAL is only partially resorbed. It consists of coated biphasic calcium phosphate (40% β-TCP, 60% HA). The hydroxyapatite fraction remains integrated in the bone, ensuring sustained volume stability.

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