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Georg Isbaner

Editorial Manager

Ceramic implantology in times of a pandemic

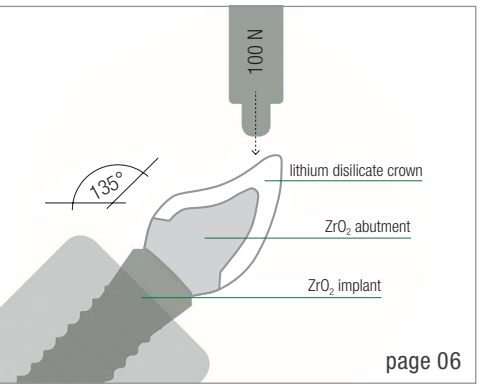
Ceramic implantology has never been this multifaceted. The users are able to choose from a great repertoire of one- and two-piece implant systems by acknowledged vendors and manufacturers. Especially the two-piece implant systems promise great prosthetic variety and flexibility, otherwise only known from titanium systems. Multi-unit implant-supported works are now feasible for specific indications. Of course, all of that requires a high degree of education and training for the users to understand and master the advantages and limitations inherent in the system of the respective ceramic implant concept.

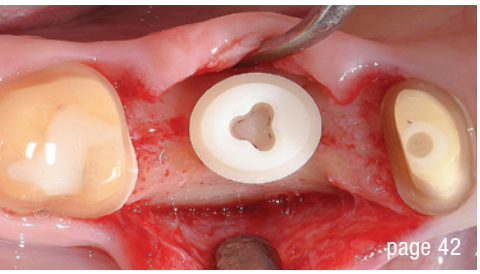
This leads me onto the main issue of this preface: the global pandemic caused by COVID-19. Under normal circumstances, numerous colleagues, experts and industry partners of ceramic implantology would have met at larger conventions in the upcoming days and weeks. They would have learned from each other, talked to each other, laughed and made plans for the future to ultimately better their abilities for the benefit of their patients. The new cooperations between expert associations would have been fleshed out. Unfortunately, all of that is currently not easily possible in the light of global restrictions on travel and larger gatherings. We fall back on phone calls, video chats, online tutorials and extensively reading journals. In many countries, dental offices have grinded to a halt, with sometimes grievous economic consequences for owners, employees and patients. On top of that, scarcely any other profession is at a higher risk of being infected with the coronavirus as dental specialists and their assistants. Everyone is aware that the pandemic will change all areas of human coexistence. A, if not the prominent position is reserved for medicine and dentistry. The ramifications alone for patient management regarding hygiene measures and reducing the patients' and employees' risks of contagion will be a watershed.

It will be all the more important that dental specialists can offer their patients therapy options that are gentle and support the immune system. Our current knowledge about ceramic implants suggests that the material-specific properties exhibit good tolerability. So far, no adverse immune responses to zirconium dioxide are known.

On that note, I wish you an enlightening read and that you, your families and your fellow employees will weather this crisis well.

Sincerely yours, Georg Isbaner





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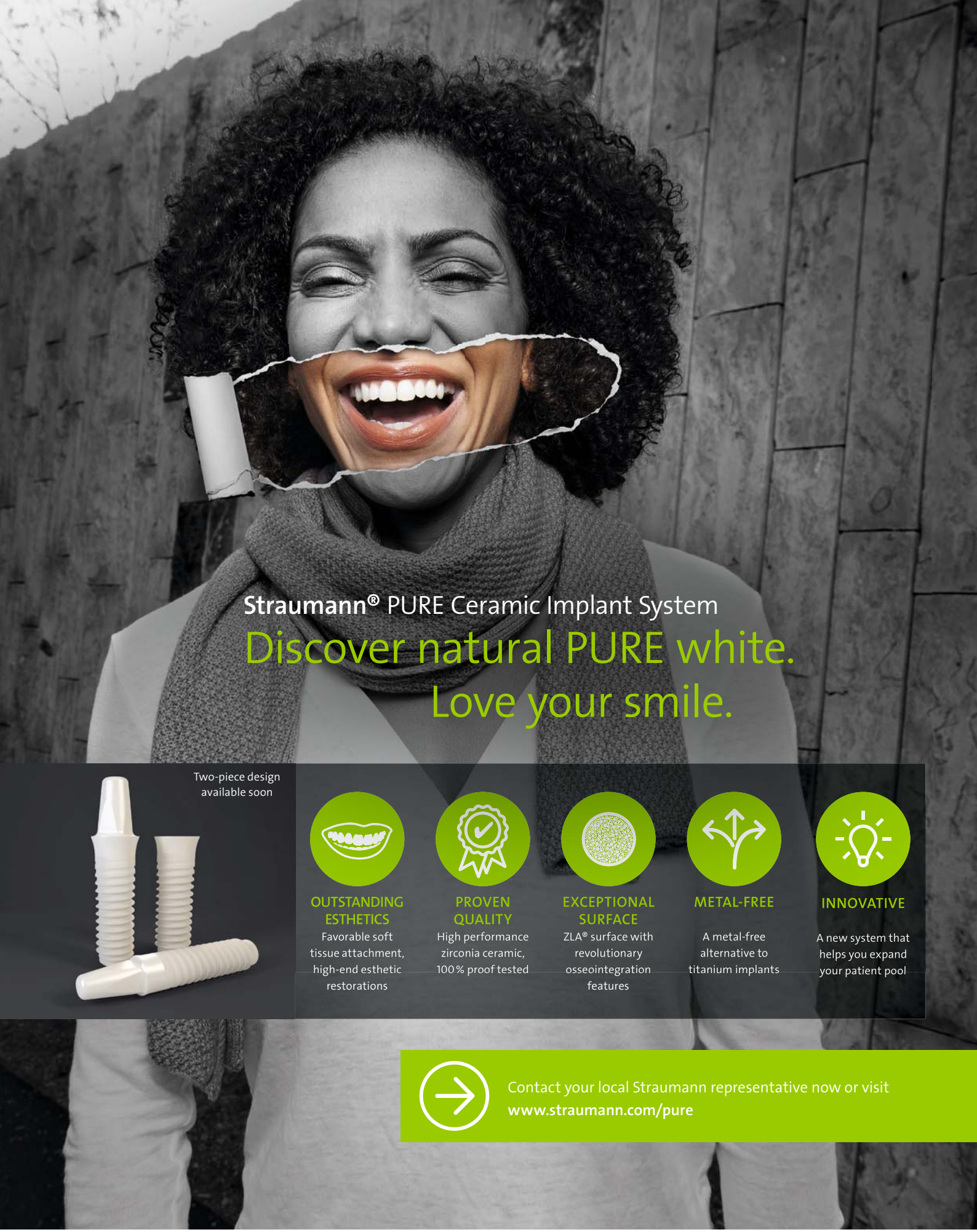

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Prosthetic complications after artificial ageing

A study with two-piece zirconia implants

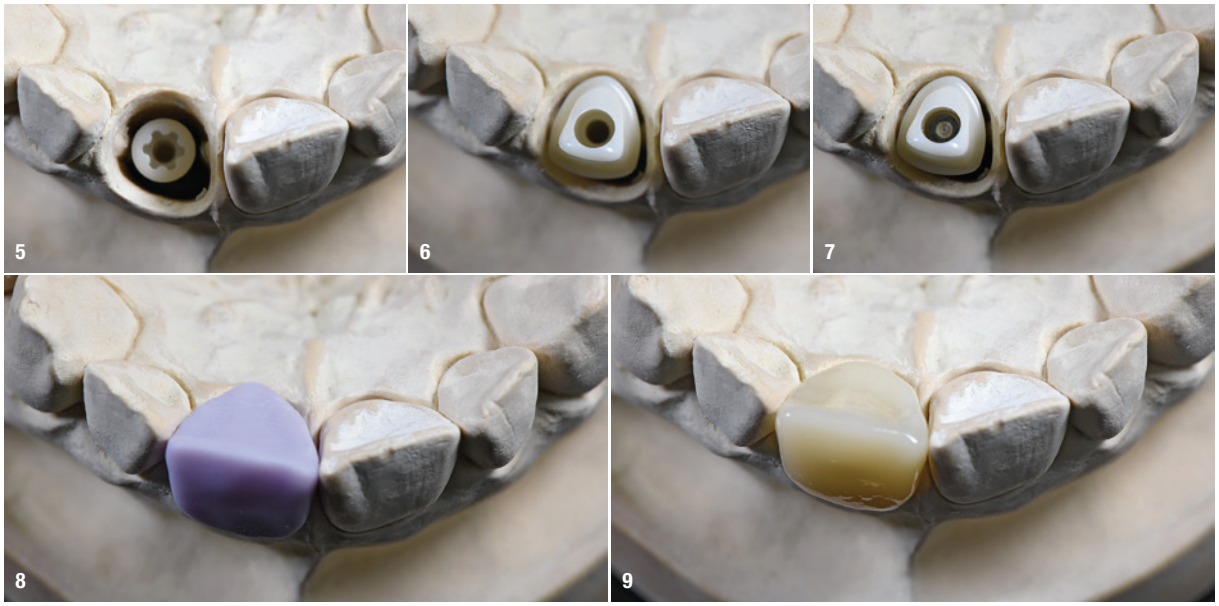
Dr Manuel Reinisch (lead author), Dr Martin Koller, Dr Elisabeth Steyer, Prof. Karl Glockner, Prof. Norbert Jakse & Prof. Michael Payer (co-authors), Austria

Currently, the majority of ceramic implants used are one-piece implant systems, which, however, have some limitations and disadvantages.[1,2] One-piece implants cannot always be inserted in the optimal orientation and require angulation correction to enable prosthetic restoration. In addition, one-piece implants are subjected to soft tissue and chewing forces immediately after insertion. These reasons motivated the development and manufacture of two-piece ceramic implants.

Several two-piece ceramic implants are already available on the market, but only limited clinical evidence is available for these systems. Currently, a large proportion of two-piece ceramic implants have a bonded implant–abutment connection. While bonded zirconia abutments have promising clinical results,[3,4] there is uncertainty about the long-term stability of the adhesive bond between the implant and abutment and the biological effects of adhesive residues in the area of the gingival sulcus.

Concerning two-piece screw-retained ceramic implants, *in vitro* studies showed higher fracture rates compared to two-piece titanium implants or one-piece zirconia implants.[5] The weak location for increased fracture susceptibility is the area directly around the abutment screw. Further studies are needed to indicate the ideal connection design for two-piece screw-retained zirconia implants.

Manufacturing of the crown: Fig. 1: Zirconia implant inserted instead of missing tooth #21 in an exemplary upper jaw tooth model. **Fig. 2:** Zirconia implant region #21 fitted with an individualised zirconia abutment. **Fig. 3:** Lithium disilicate crown after milling. **Fig. 4:** Lithium disilicate crown after sintering.



Manufacturing of the crown: Fig. 5: Zirconia implant inserted instead of missing tooth #21 in an exemplary upper jaw tooth model. **Fig. 6:** Zirconia implant region #21 fitted with an individualised zirconia abutment. **Fig. 7:** Abutment screw tightened at 25 Ncm. **Fig. 8:** Lithium disilicate crown after milling. **Fig. 9:** Lithium disilicate crown after sintering.

Additionally, the exact influence of different cementation and crown materials on the loading capacity of two-piece screw-retained zirconia implants is still uncertain.[1,6] Further preclinical evidence for the prosthetic restoration of two-piece screw-retained zirconia implants is required to provide practical recommendations for clinical use. The aim of this *in vitro* study was to investigate the survival rate and the relationship between prosthetic complications and the type of crown fixation after dynamic loading of CAD/CAM-fabricated anterior monolithic lithium disilicate crowns mounted on two-piece screw-retained zirconia implants.

Materials and methods

Twenty two-piece screw-retained zirconia implants (4 mm in diameter and 12 mm in length; CERALOG Hexalobe®, CAMLOG) were each fitted with an individualised zirconia abutment (Figs. 1 & 2, Figs. 5–7) and embedded in acrylic resin (Fig. 10). The abutment aspect was optically scanned, and a standardised upper left incisor-shaped ceramic crown was designed (Figs. 11 & 12). Twenty lithium disilicate crowns were milled, sintered and mounted on the implants (Figs. 3 & 4, Figs. 8 & 9) either with an adhesive resin composite cement (Multilink Automix®, Ivoclar Vivadent; Group A, n = 10) or with a resin modified glass ionomer cement (FujiCEM 2®, GC; Group B, n = 10). All samples underwent thermomechanical loading at an angle of 135° (Fig. 13) to simulate an aging of five years (TCML; TC: 5 °C and 55 °C, 3,000 cycles, 2 min/cycle; ML: 100 N, 1,2 x 106 cycles). The evaluation of prosthetic complications was compared with the Mann-Whitney-U-Test. The significance level was set to $\alpha = 0.05$.

Results

The 5-year survival rate of both groups (n = 20) after artificial ageing was 95 % (Fig. 13). One abutment of Group

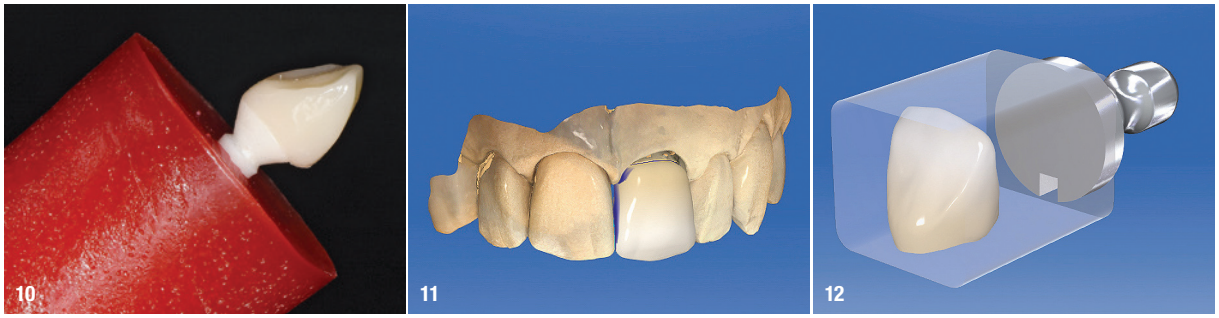


Fig. 10: Specimens embedded in blocks of epoxy resin at angle of 45°. **Figs. 11 & 12:** Designing of a standardised upper left incisor-shaped crown using CAD-software.

B fractured after 1,123,200 cycles. All specimens in both groups had grinding facets. In group A grinding facets had an overall mean appearance of 639,360 ± 200,106 cycles with no significant difference ($p > 0.05$) to group B with 483,840 ± 208,800 cycles (Fig. 14). None of the samples showed cracks, fractures or decementations of the crown.

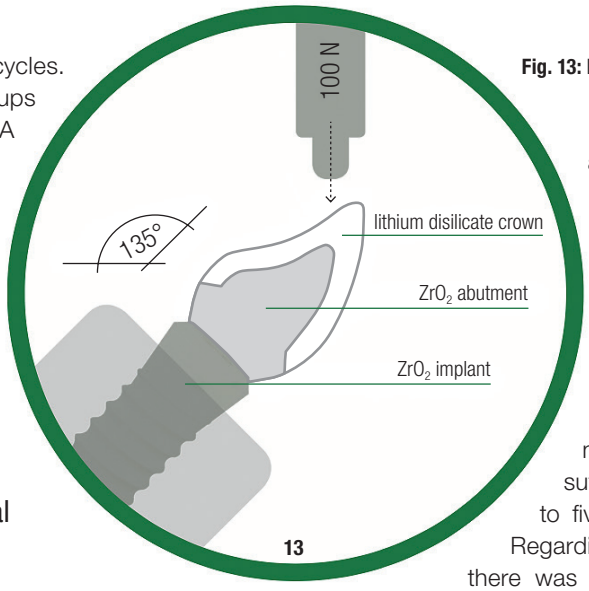


Fig. 13: Dynamic loading setup.

Conclusions and clinical implications

Of course, long-term, clinical, randomised trials are one of the best ways to generate reliable data. But it is necessary to implement preclinical study designs that simulate clinical conditions before clinical trials are conducted. Thermomechanical loading of implants, abutments and crowns offers a suitable method for this. Within the limitations of this preclinical trial it can be concluded that CAD/CAM-fabricated anterior monolithic lithium disilicate crowns mounted on two-piece screw-retained zirconia implants should provide sufficient resistance at least up to five years of intra-oral forces. Regarding prosthetic complications, there was no statistical difference between using an adhesive resin composite compared to a resin-modified glass ionomer cement for crown cementation.

It can be assumed that different manufacturing methods or design properties of two-piece screw-retained ceramic implants lead to variable fracture behaviour under load. A generalisation for two-piece screw-retained ceramic implants does not yet seem to be possible. Further studies are needed.

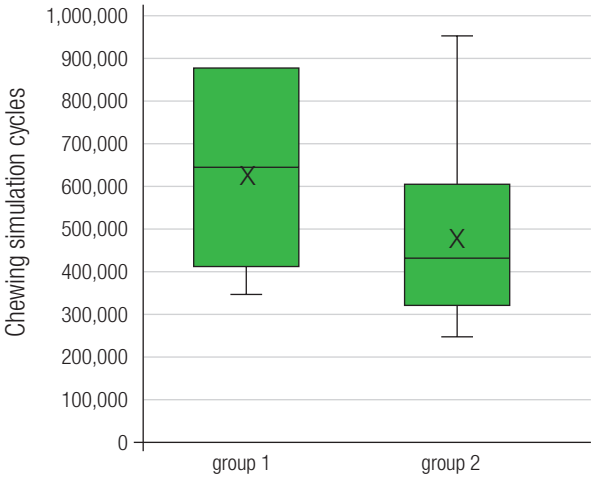


Fig. 14: Incidence of grinding facets during dynamic loading in the chewing simulator.

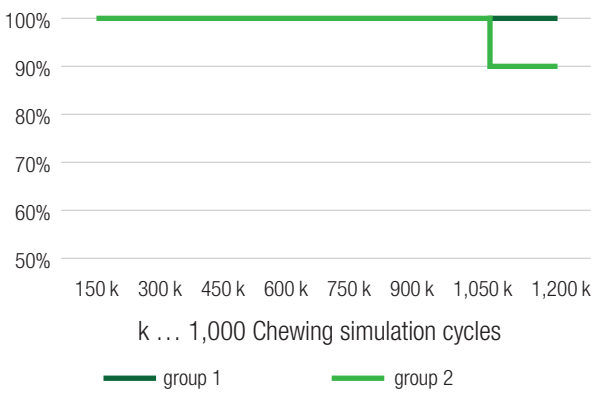


Fig. 15: Survival rates for the different cementation methods.

Literature

about the author

Dr Manuel Reinisch studied medicine and is now a student in the last year of dentistry at the Medical University of Graz. He is a member of the European Society for Ceramic Implantology (ESCI). In addition, he is doing a master's degree in medical ethics and the master's programme in implantology and periodontology at the Medical University of Vienna.

contact

Dr Manuel Reinisch
Medical University of Graz
Division of Oral Surgery and Orthodontics
Department of Dental Medicine and
Oral Health
Billrothgasse 4
8036 Graz, Austria
manuel.reinisch@stud.medunigraz.at

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Biological guided bone regeneration and ceramic implants

The first of a two-part series

Dr Karl Ulrich Volz, Dr Stephanie Vergote, Dr Rebekka Hueber & Dr Josephine Tietje, Switzerland;
Dr Tobias Wilck & Prof. Shahram Ghanaati, Germany

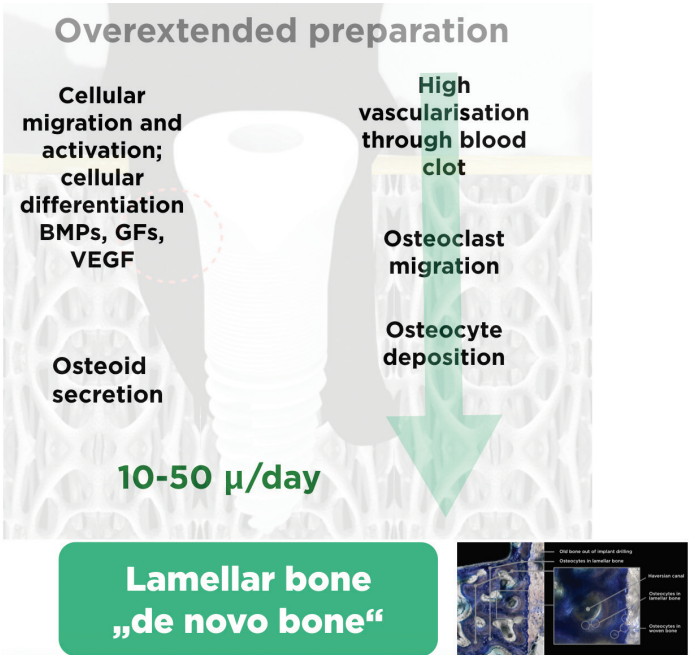
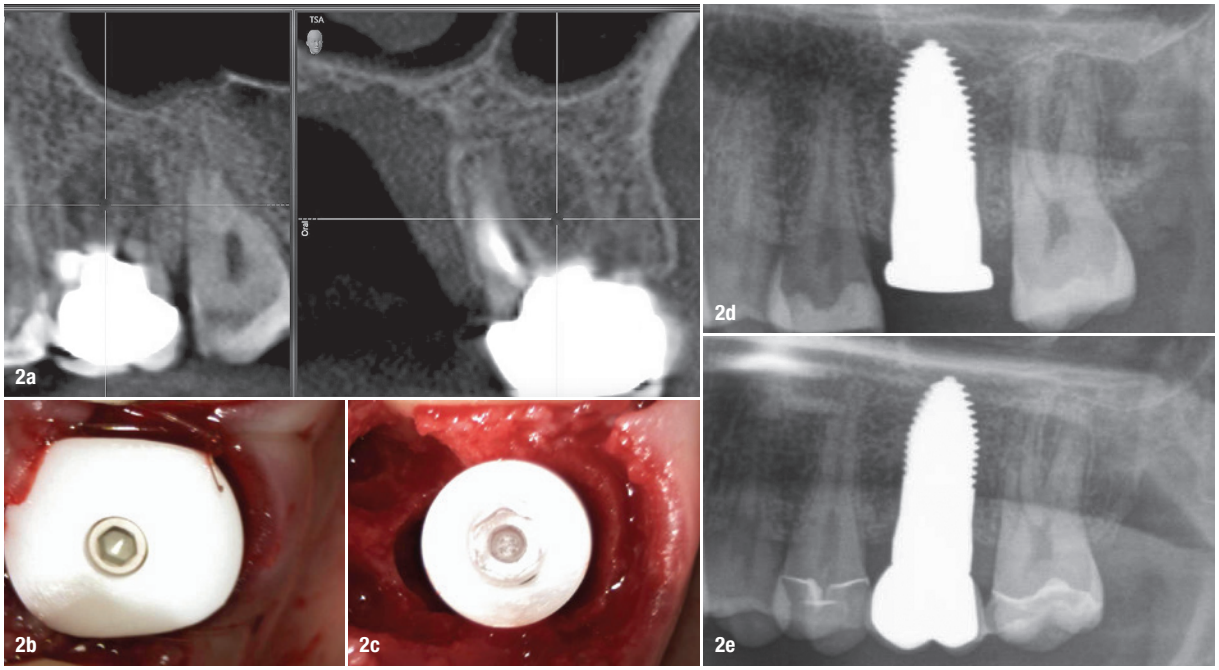


Fig. 1: Overextended implant bed preparation allows the growth of de novo bone, inter alia by a high rate of cellular migration. BMPs = bone morphogenetic proteins; GFs = growth factors; VEGF = vascular endothelial growth factor.

Ceramic implants consist of high-performance ceramic zirconium dioxide. As the material is present in its oxide state, it no longer reacts chemically,[1] does not exhibit free-binding electrons and is inert.[2] Temperatures above 2,600 °C or the application of hydrofluoric acid are necessary to change the material. The low affinity with plaque, the lack of thermal and electrical conductivity, and the resistance to corrosion are great benefits of zirconium dioxide over titanium.[1–8] While titanium stimulates the release of TNF-α and interleukin-1β and apparently osseointegrates the implant towards chronic inflammation with a type of encapsulation, these messenger substances are not activated during the healing process of zirconium dioxide. Brånemark assumed that titanium implants achieve true non-reactive osseointegration. Today, we know that this is not the case.[1,9–12] Zirconium dioxide heals absolutely inert, shows as high a bone-to-implant contact as titanium does and achieves genuine osseointegration.[13–19]

In the case of titanium, abrasion occurs with high friction when the implants are inserted, and as a result of the process of (bio)corrosion, titanium dioxide particles are released into the surrounding hard and soft tissue, activating macrophages.[20–28] This activation leads to the aforementioned release of TNF-α and interleukin-1β, which results in local reactions and chronic systemic inflammation (silent inflammation). The activation of osteoclasts triggers bone resorption in the sense of periimplantitis.[29] Since zirconium dioxide does not corrode, macrophage activation with this material is probably not expected. Bone resorption around ceramic implants occurs rarely, but is mainly caused by very high insertion torques. This has a particularly fatal effect with ceramic implants, as they are poor thermal conductors. The frictional heat generated on the implant's surface during insertion is not conducted to its core. Therefore, the ceramic implant from Swiss Dental Solutions, developed by Dr Karl Ulrich Volz, is designed in such a way that all friction and stability are obtained from the apical part, and its deep and aggressive thread makes it impossible to overheat the cortical bone if the drilling protocol is applied correctly.

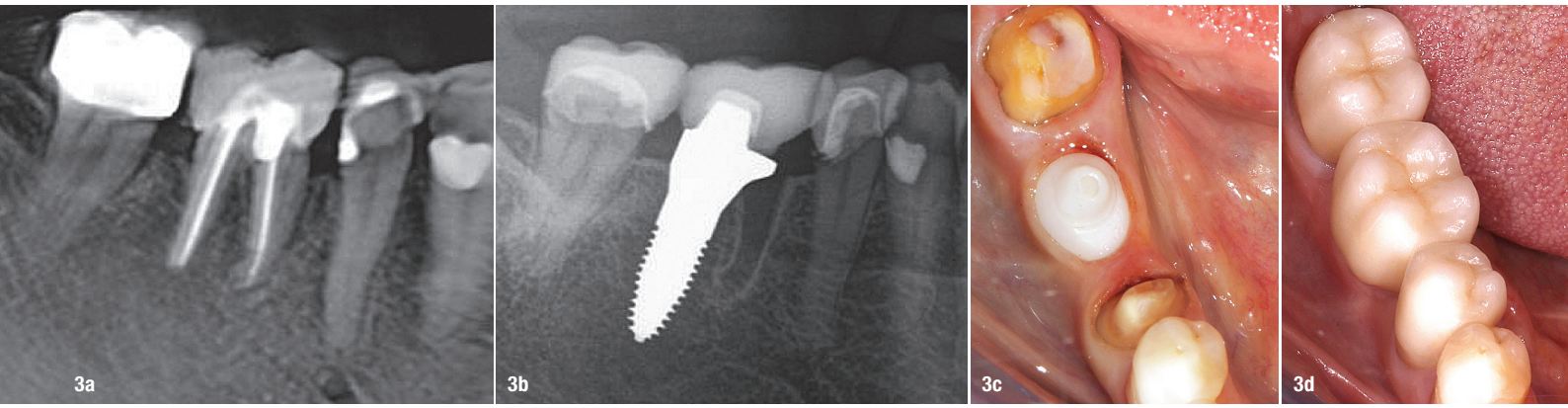
In the crestal part of the bone, the last drill, the countersink, is used for overextended preparation, thus avoiding any pressure of insertion in this sensitive and less vascularised area.[30] The aggressive apical thread allows the implant to be re-torqued to > 35 Ncm in more than 80 % of cases in the case of connective tissue healing. In such cases, the implant will osseointegrate with more than 95 % certainty, since the very thin layer of connective tissue between the implant and the bone will differentiate back to bone owing to the inertia of the material. This understanding of the physical, biological and immunological properties of zirconium dioxide is very important when one considers bone reconstruction measures. In general, the need for such measures has significantly



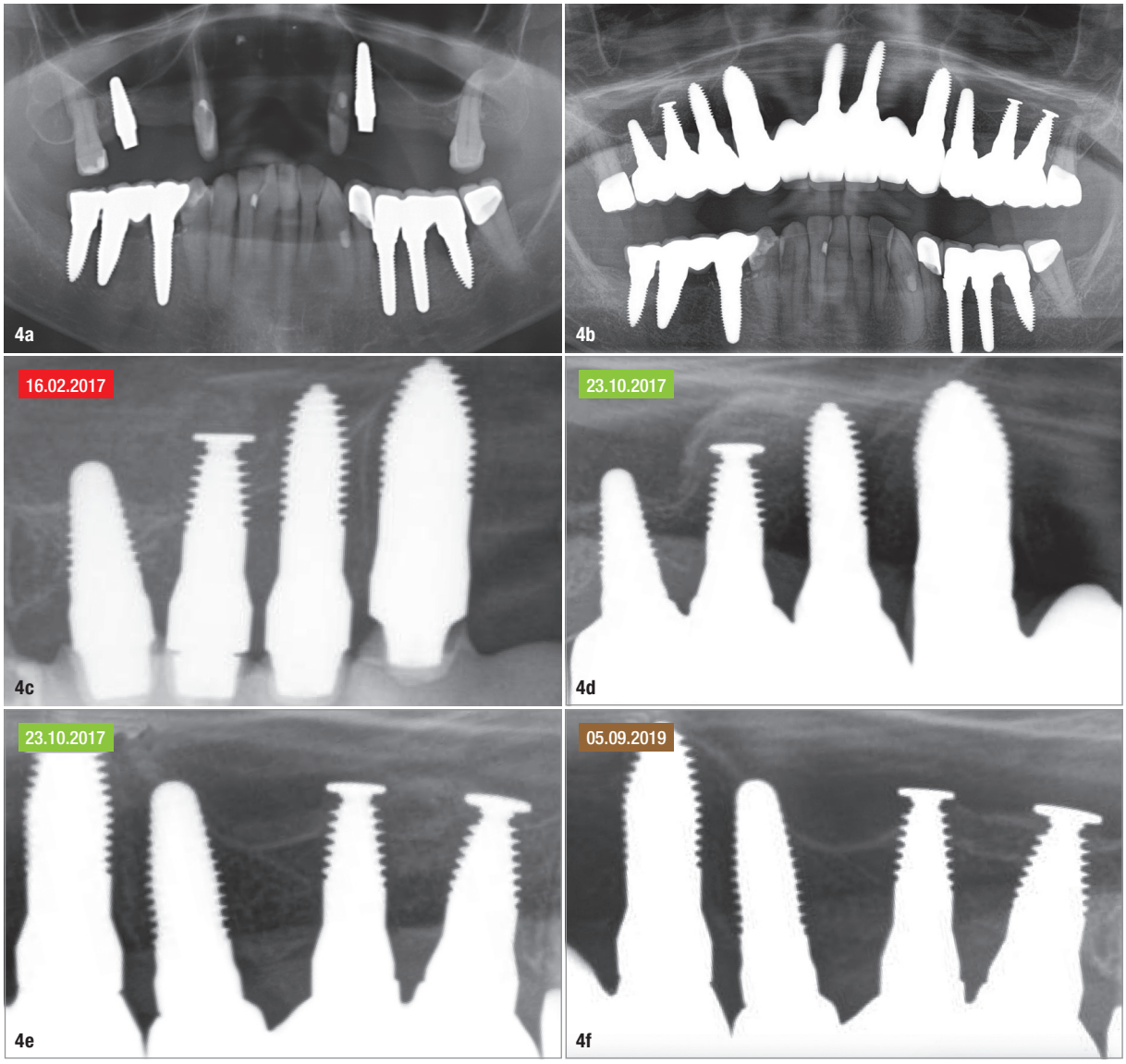
Figs. 2a–e: Section of the pre-op CBCT of tooth #26 with pronounced apical inflammation **(a)**. Intra-oral image of the ceramic implant in region #26, showing the vestibular bony defect **(b)**. Intra-oral image of the implant in region #26 with the ceramic disc placed to obtain the umbrella effect **(c)**. Post-op radiographic control of the implant in region #26 after a four-month healing phase **(d)**. Post-op radiographic control of the implant in region #26 after prosthetic restoration **(e)**.

decreased in the clinics of the authors, since immediate implants can be placed in almost all cases owing to the properties of zirconium dioxide. Even in previously highly inflamed areas, zirconium dioxide does not tend to cause further inflammation if a conscious monitoring protocol (SWISS BIOHEALTH CONCEPT) is followed. However, there are still many patients who have lost significant bone volume as a result of tooth extractions in the past and therefore require bone reconstruction. In the following, we will present the corresponding measures applied in the Swiss Biohealth Clinic with an emphasis on the use of autologous materials.

Patients who request ceramic implants usually do not accept synthetic or secondary materials of animal origin, but would like to be treated completely with autologous materials. In our concept, the only exception is the use of live donor bone, since it is completely resorbed within a few weeks and replaced by well-vascularised localised bone. Basically, all augmentation techniques date back to the tentpole and umbrella principle described in 1998 in a case report by Hämmerle and Karring.[31] In this report, bone regeneration did not work because of the material used but despite it, because the periosteum has an osteoinductive potential that should remain unharmed.[32] For



Figs. 3a–d: Retained primary tooth #45 and endodontically treated tooth #46 with chronic periapical periodontitis **(a)**. Implant placement in regions #46 (SDS 1.0; diameter: 4.6 mm; length: 11.0 mm; balcony) and 45 (SDS 1.0; diameter: 4.6 mm; length: 11.0 mm) and immediate fixed temporary restoration **(b)**. Intra-oral image of the implants in regions #45 and 46 after a healing phase of four months and preparation of the tulip section **(c)**. Prosthetic restoration of the implants in regions #45 and 46 with all-ceramic crowns **(d)**.



Figs. 4a–f: Pre-op panoramic radiograph showing vertical resorption in regions #16 and 26 **(a)**. Panoramic radiograph taken after the prosthetic restoration of all implants in the upper and lower jaws **(b)**. Radiographic control of the first quadrant after implant placement **(c)**. Visible gain of bone in regions #13–16 after an eight-month healing phase **(d)**. Radiographic control of the implants in regions #26 and 27 after 1.5 years **(e)**. Radiographic control of the implants in regions #26 and 27 at the follow-up in 2019 **(f)**.

this reason, relieving incisions and periosteal slits should be avoided. Rather an incision in the gingival margin should be made and the brushing technique according to Dr Alain Simonpieri should be employed.

The newly built bone described in the case report by Hämmerle and Karring biologically beats every bone block or secondary augmentation material, since it is *de novo* bone, healthy and well-vascularised lamellar bone. Any filling material in the cavity created in the form of a bone block or granules, of animal or synthetic origin, is an obstacle to angiogenesis, which in turn is a prerequisite for the formation of bone callus. The same laws apply to the sinus cavity, since the Schneiderian membrane also has an osteoinductive function.[33–35] All materials we have placed there over the last 30 years have been used exclusively to keep the Schneiderian membrane at a distance and thus create a mechanically stable cavity. According to the biological laws, this cavity will eventually fill with new bone.[36] However, a paradox must also be considered here: the more densely a filler is packaged into the raised cavity, the less space there is for angiogenesis. Thus, the goal of any biologically finalised guided bone regeneration (GBR) is to create a mechanically stable cavity that should be filled with platelet-rich fibrin (PRF) membranes and blood as carriers of information, and possibly with autologous bone chips. This is also the basis of the Khoury technique,[37] in which the space for the newly formed bone is limited by cortical bone plates and a rapidly resorbable bone substitute

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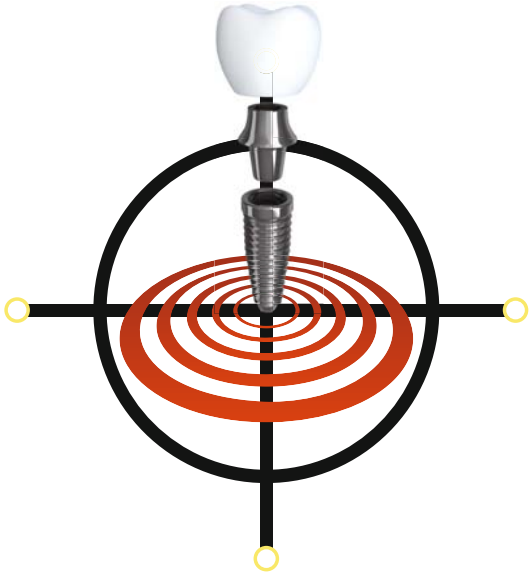

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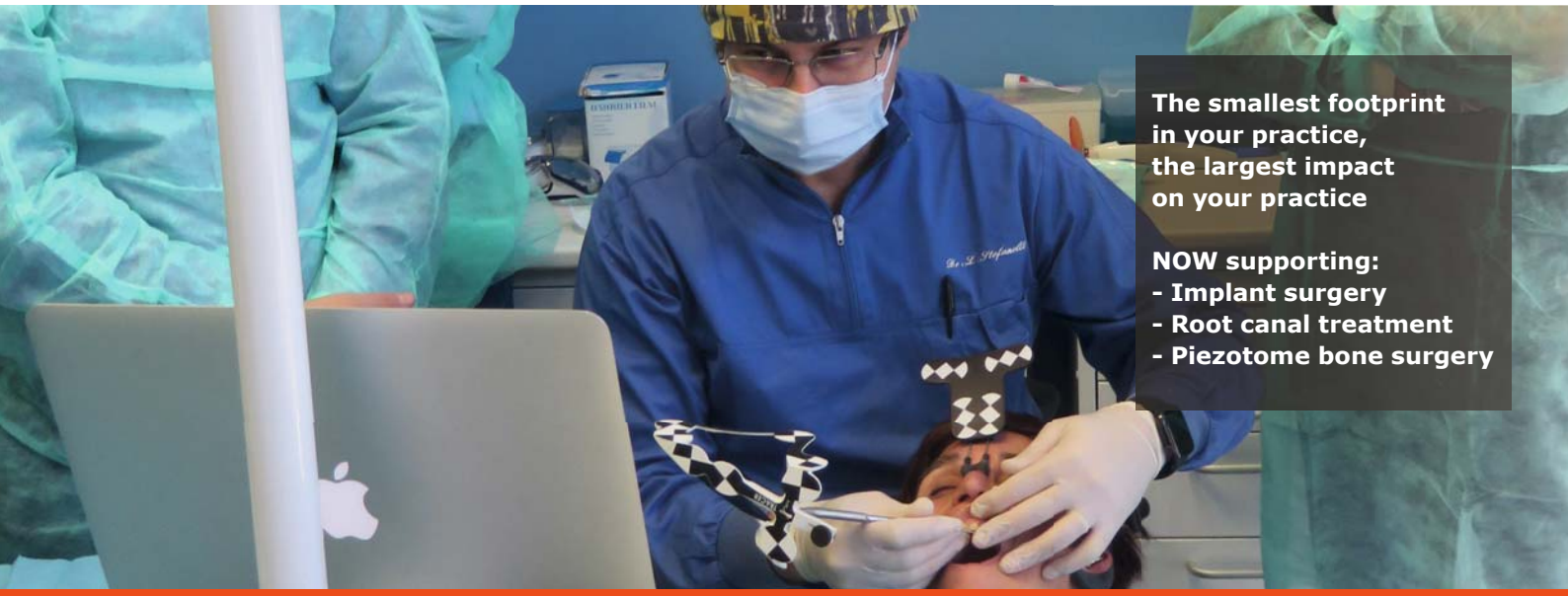

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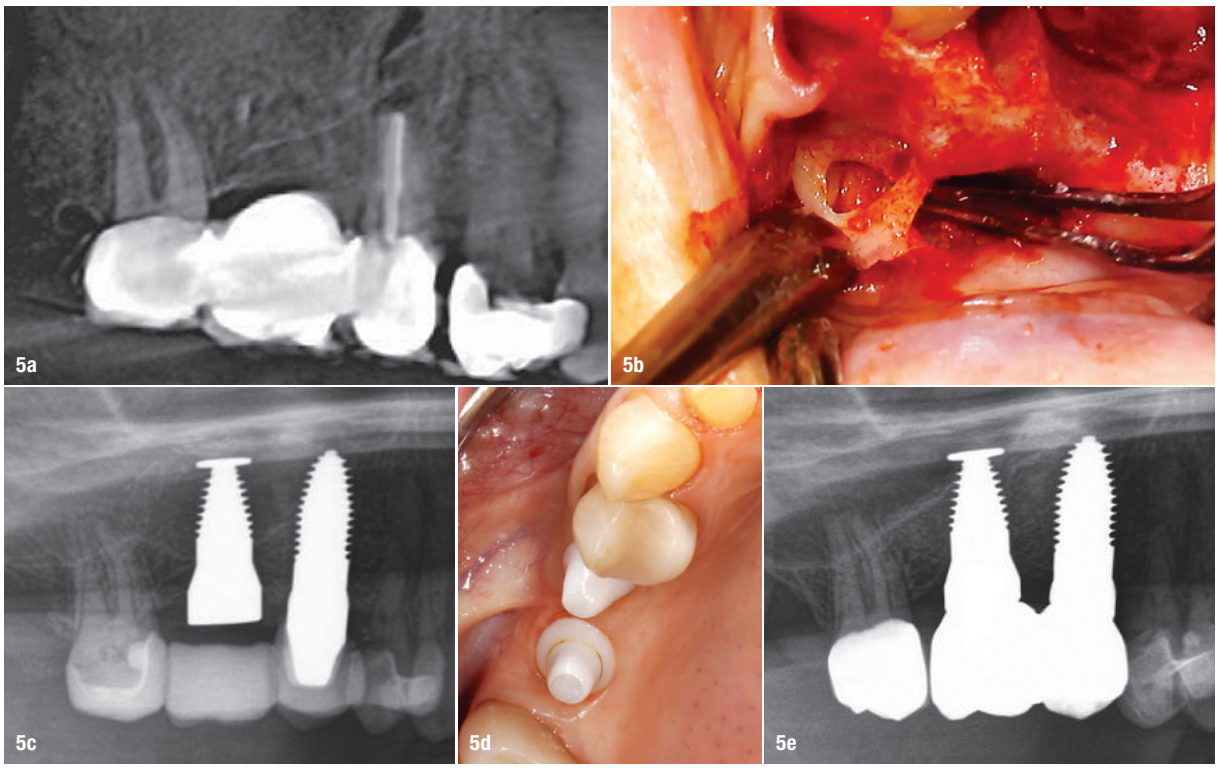
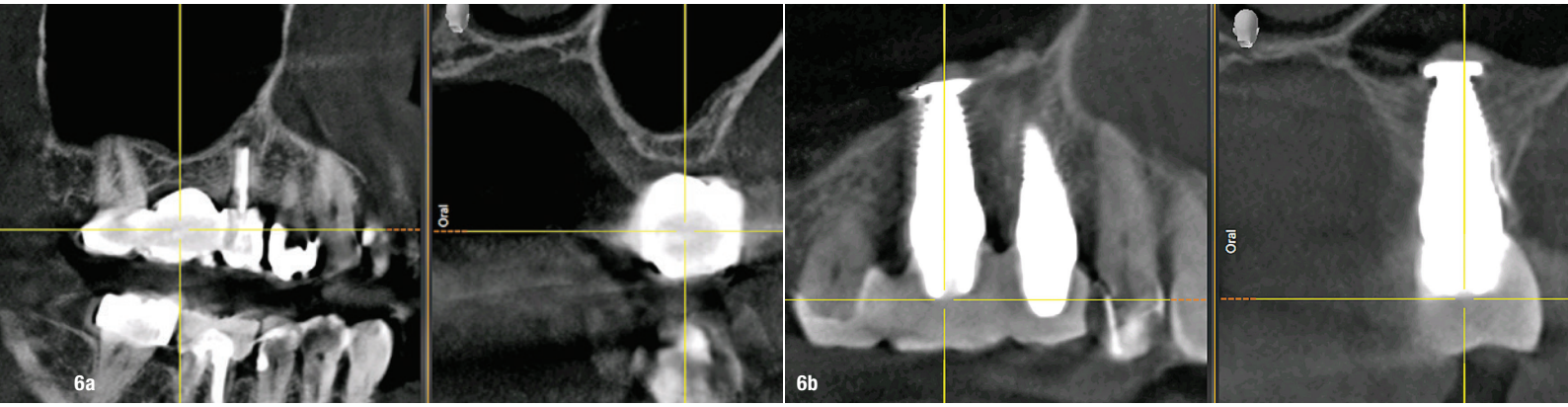


Figs. 5a–e: Pre-op CBCT scan of regions #16 and 15 showing chronic periapical periodontitis in region #15 **(a)**. Intra-op image of regions #16 and 15 **(b)**. Post-op radiographic control of the implants in regions #16 and 15 **(c)**. Implants in regions #16 and 15 prior to prosthetic restoration **(d)**. Radiographic control of the implants in regions #16 and 15 after prosthetic restoration with all-ceramic crowns **(e)**.

material is introduced into the cavity, or dispensing bone substitute material, only a blood clot or PRF membranes fill the cavity.

In recent years, it has been shown that, especially in the posterior jaw, augmented bone blocks are completely resorbed or partially resorbed up to 2–28 %, which is related to the fact that the bone block itself causally prevents angiogenesis in the cavity it occupies. In the posterior mandible, this problem is particularly evident, since posteriorly from the mental foramen, the blood circulation comes almost exclusively from the central and not from the peripheral. From its central origin, it is almost impossible for the inferior artery to grow thorough the coronal compacta into the bone block.[38–45] The concept of biological GBR is to create a large hollow space, which should be kept mechanically stable for at least four weeks and should not collapse under the periosteum or the Schneiderian membrane. We have this situation with each immediate implant placement, especially when an aggressive apical thread anchors the implant to the bottom and therefore primary stability is achieved over not



Figs. 6a & b: Pre-op CBCT scan of regions #16 and 15 showing chronic periapical periodontitis in region #15 and vertical bone loss in region #16 **(a)**. Post-op CBCT scan after a six-month healing phase showing a considerable increase of bone around the implants in regions #16 and 15 **(b)**.

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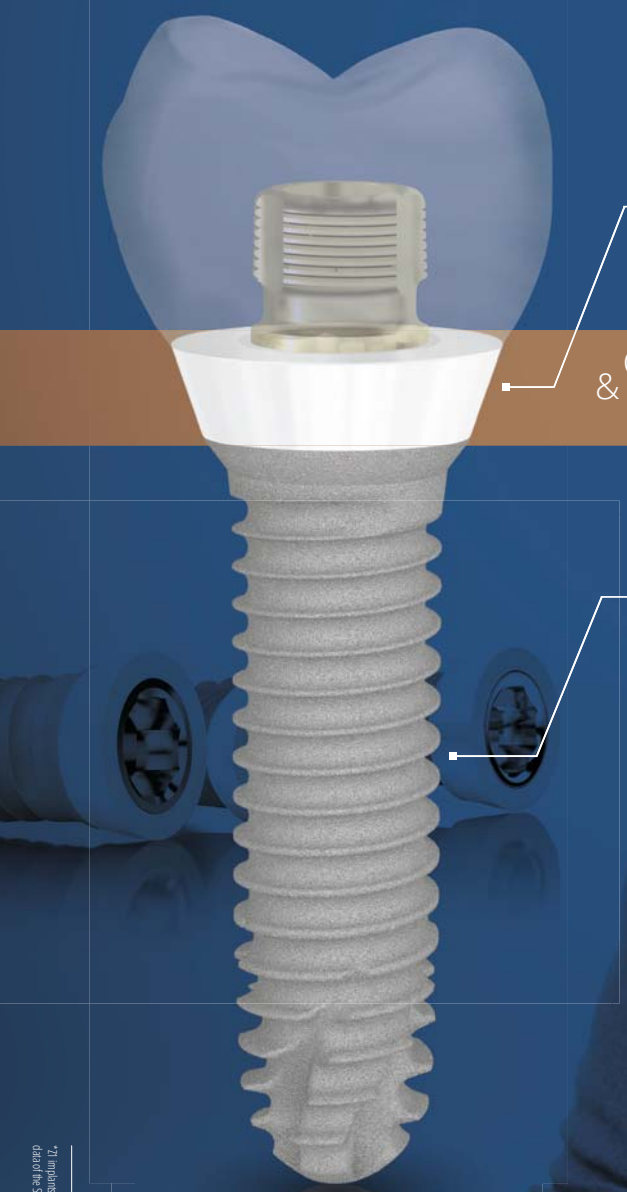

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only the width but also the length. Ideally, the implant should have a wide tulip, which achieves the largest possible shadow effect and therefore an umbrella effect.

Figure 1 explains the mechanisms that take effect in the immediate placement of an implant with simultaneous application of the principle of the healing chamber.[46,47]

Special techniques of biological GBR

Disc abutment

The already described technique in which the implant resembles a tentpole is enhanced by the use of a disc abutment, increasing the shadow effect of the implant tulip by screwing on a wide ceramic disc of zirconium dioxide to cover the alveolus. The implant itself is stabilised only by an internal elevation of the sinus floor and is anchored by the apical part of approximately 2 mm and by the aggressive thread (Figs. 2a–d). The postoperative radiograph shows complete bony filling with *de novo* bone over the complete 14 mm length of the implant (Fig. 2e).

Balcony implants

Balcony implants are mostly used as immediate implants and increase the shadow either to one side (in case of an asymmetric insertion) or both sides (when placed symmetrically as a double balcony; Figs. 3a–d).

Sinus implants

Dr Karl Ulrich Volz introduced a new type of implant in 2017 with the intention of applying the tentpole and umbrella principle in the sinus cavity and dispensing with secondary materials (Figs. 4a–f).

The umbrella effect of the disc at the apical end of the implant is enlarged by the authors by placing the lateral bone cover over it. This is enclosed in two PRF membranes and inserted between the Schneiderian membrane and the apical part of the implant. Thus, the formation of vital and perfectly vascularised lamellar bone can be facilitated without the use of secondary materials. This technique also reduces costs, considerably, as no additional positions are required for secondary materials, membranes or screws. This technique should be used with a residual bone height of 3–5 mm, depending on the width of the alveolar crest and density of the existing bone. Stable fixation of the sinus implant is an absolute requirement here.

Application of autologous bone

A possible site for harvesting autologous bone is the healthy cortical part of the tubercle region. In addition, using the Safescraper, it is possible to easily obtain 2 cm^3 of cortical bone chips in the lateral maxillary sinus. This allows perforations to be closed vestibularly, as well as in the maxillary sinus. The maxillary sinus can be filled with these chips in addition to the insertion of PRF membranes. At the same time, the alveolar crest can be raised vertically and widened laterally (region #16; Figs. 5a–e).

Figures 6a & b show in an impressive way the possible gain in bone volume when applying this technique.

Literature

contact

Dr Karl Ulrich Volz
SWISS BIOHEALTH CLINIC
Brückenstr. 15
8280 Kreuzlingen, Switzerland
Phone: +41 71 6782000
www.swiss-biohealth.com

Author details

Prof. Shahram Ghanaati
Universitätsklinikum Frankfurt
Theodor-Stern-Kai 7
60590 Frankfurt am Main, Germany
Phone: +49 69 63013744
shahram.ghanaati@kgu.de

Author details

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Quality deficiencies of sterile packaged implants

Sterile and yet dirty?

Dr Dirk U. Duddeck, Germany

In 2019, the FDA released two decades of previously unpublished data and 2.1 million reports of failed dental implants from which more than 100,000 reports referred to 2018 alone. Most of these failures related to a lack of osseointegration, raising major concerns among dentists in the US and abroad as the number of additional unreported losses is likely to be much higher. Comments made by manufacturers, regarding these figures, focus on patients with unfavourable clinical preconditions and even blame dentists for their lack of experience and training. Is this the whole truth?

Alarming results—also for ceramic implants

In a recent study, conducted by the non-profit CleanImplant Foundation in collaboration with the Charitè–University Medicine Berlin, more than 100 different sterile-packaged implants—including ceramic and titanium implants—from 80 implant brands were analysed. SEM imaging and elemental analysis (EDS) were performed in an officially accredited testing laboratory, according to DIN EN ISO/IEC 17025. Almost every second implant sample that was unpacked under cleanroom conditions and analysed in the SEM showed considerable contamination, i.e. unwanted particles originating from the manufacturing, handling or packaging of the implant. These contaminants on sterile packaged implants, especially organic particles from the manufacturing or packaging process, can cause an uncontrolled foreign body reaction resulting in osteoclastogenesis, leaving rough areas of the implant surface exposed to bacterial colonisation.[1,2] Significant amounts of foreign particles were detected on the sterile implant surfaces, with not only iron, chromium, molybdenum, copper, tin, tungsten and nickel but also major organic contamination.

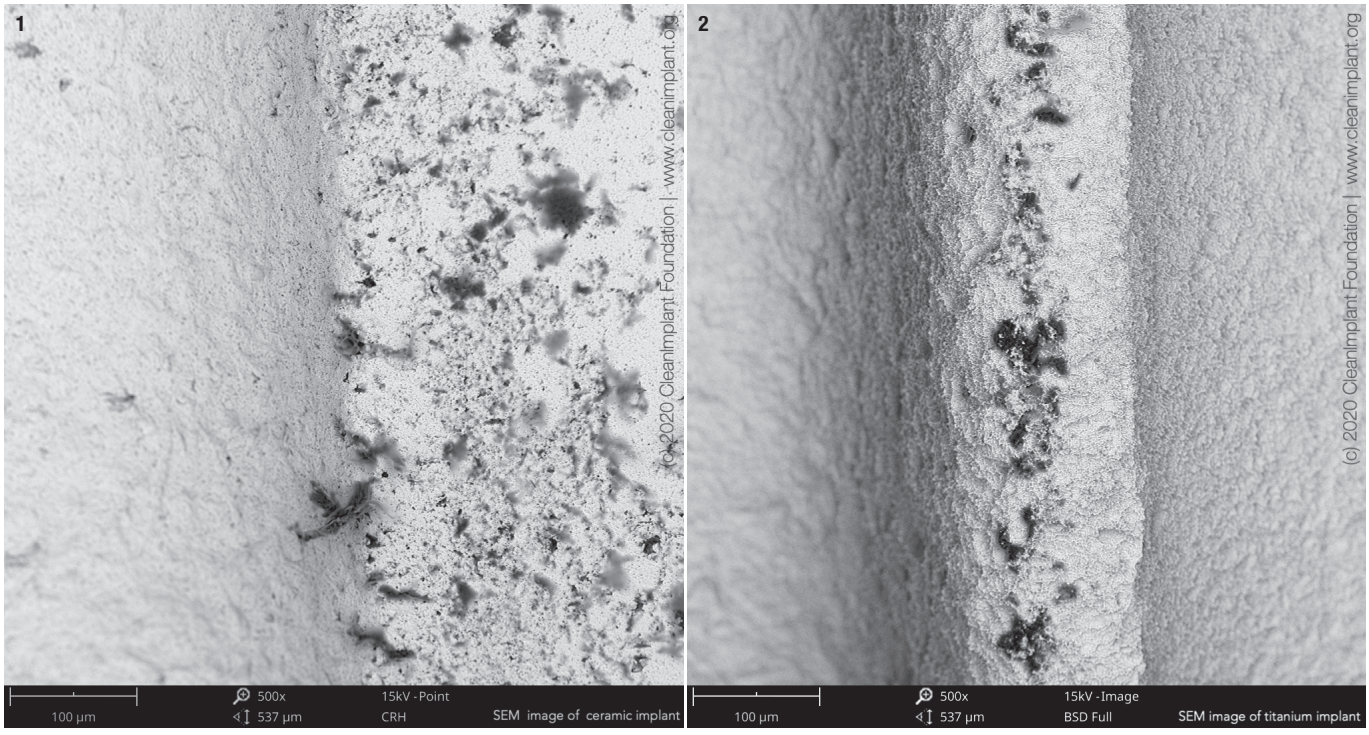


Fig. 1: Numerous organic particles (black) on a ceramic implant (SEM 500 x). **Fig. 2:** Organic particles (black) on outer thread of titanium implant (SEM 500 x).

Additional analysis of these organic contaminants, using time-of-flight secondary ion mass spectrometry (ToF-SIMS), revealed thermoplastic materials, synthetic polymers, polysiloxanes and even dodecylbenzene sulfonic acid (DBSA). DBSA is found in washing detergents and is a hazardous surfactant, according to the United States Environmental Protection Agency (EPA). It is noteworthy that all implants analysed carried the FDA label or CE mark. The results showed that neither the national label for market approval nor the size or name of a manufacturer could guarantee that implant surfaces are free of significant impurities. Clinicians should think twice before considering adding zirconia implants to their portfolio just because they are white and promised to be biologically beneficial. Organic particles from 1 to 100 µm in diameter were also found on ceramic implant samples (Fig. 1).

Instead of only blaming inexperienced clinicians or patients with unfavourable preconditions for the high number of FDA-documented implant losses, it should be considered that contaminants on sterile packaged implants—in other words a lack of quality and "sterile dirt" that is technically avoidable—may also play a significant role in the incomplete osseointegration of dental implants, bone loss in the early healing phase and even the failure of implants.

Quality seal creates safety

As a consequence of the obvious lack of quality control in implant manufacturing, the CleanImplant Foundation introduced a globally recognised test procedure in 2017. The independent organisation published a consensus-based guideline with thresholds leading to the award of the "Trusted Quality Mark" (the consensus paper is available at www.cleanimplant.org). This test procedure and process of analysis always requires the testing of five implant samples of the same type. At least two of these implants are obtained directly from dental practices on a random basis, so that factory manipulation or the dispatch of particularly clean test samples can be ruled out.

Before the seal of approval can be awarded, two members of CleanImplant's Scientific Advisory Board independently review the results of the technical analysis that have to meet the current criteria as well as the clinical documentation of the implant system that has to give proof of a survival rate of at least 95 per cent over more than two years.[3,4] Profs. Tomas Albrektsson, Ann Wennerberg, Florian Beuer, Jaafar Mouhyi, Hugo de Bruyn and Drs Luigi Cannulo and Michael Norton, past president of the AO, form the Scientific Advisory Board that is responsible for the peer-review process. Their signatures on the final CleanImplant Trusted Quality seal guarantee an unbiased quality assessment.

Time to avoid risks and build trust

In these extraordinary times when patients avoid medical treatments due to possible infection and many dentists even fear for their economic existence, it is more important than ever for practitioners to give their patients the confidence that only safe and high-quality medical products are used. Within a few months, more than 80,000 dentists have joined the CleanImplant Foundation's quality initiative on Facebook alone. Every month, well over 1,000 users search for reliable information on clean implant systems on the project's website. Dentists and implantologists, who want to build trust and inform their patients about the cleanliness of implants in use in their clinic, can join the project and request a personalised certificate—a convincing sign that conveys confidence in the waiting room or even on the clinic's website.

The current alarming situation of factory-made contaminated dental implants presents two different risks. For the patient, contaminants can induce an uncontrolled foreign body reaction with peri-implantitis, bone loss or even the failure of an implant, thus compromising the clinical outcome and the patient's expectation. On the other hand, practitioners unknowingly using dirty implants have to deal with the risk of patient lawsuits for dental malpractice. Both risks are avoidable.

Literature

about the author

Dr Dirk U. Duddeck studied biology and dentistry and specialised in implantology. He is a guest researcher at the Charité–University Medicine in Berlin, founder and managing director of the non-profit CleanImplant Foundation.

contact

Dr Dirk U. Duddeck
CleanImplant Foundation
Am Brandenburger Tor
Pariser Platz 4a
10117 Berlin, Germany
duddeck@cleanimplant.org
www.cleanimplant.org

Author details

Zirconium-dioxide as preferred material for dental implants

A narrative review: Part I

Profs. Curd M. L. Bollen[1,2] & Maher Al-Masri[3]

[1] Professor for Implant Dentistry at the College of Medicine & Dentistry (Ulster University in Birmingham, UK);
[2] EACIm Ambassador to the UK and The Netherlands; [3] Professor and Dean at the College of Medicine & Dentistry (Ulster University in Birmingham, UK)

Introduction

In a recent survey in Europe of >250 people, by a respected dental implant company; most patients indicate to prefer a ceramic implant (35 %) over a titanium implant (10 %) to replace a tooth in their mouth, whereas 55 % had no specific preference in the latter. Presently however, the implant market is still dominated by titanium implants (>95 %) and therefore ceramic implants are still considered as a sort of niche product in implant dentistry for the moment. But things are changing…

1

Dentistry, in particular implant dentistry, is constantly in evolution and what was pioneering yesterday is generally accepted today and probably outdated tomorrow. Researchers and scientists all over the world continue to look for new materials or enhance the characteristics of the available ones, in order to achieve better aesthetics, better manageability and/or better clinical results. This search occasionally leads to fundamental changes in current treatment paradigms. Whereas 30 years ago, dentists were still trained to use greyish, toxic amalgam to repair cavities caused by caries, today all these cavities are restored with white composite materials. This evolution not only banished the toxic mercury from the patient's mouth, but also addressed the aesthetic aspect of these dark grey fillings. Today, we have a wide variety of products to repair caries or to replace old fillings for higher aesthetic demands. Several other examples in dentistry are available, but as always, also in the early phase of composite as a restorative material, there are supporters and opponents of these novelties. Because dental professionals normally tend to be quite conservative, a large majority believed that amalgam would remain for always the gold standard as a filling material. Only the many evidence-based scientific reports and extensive publicity helped composites to become generally accepted over time. Meanwhile, amalgam is kept out of every modern dental practice.

2

A same sort of evolution is now slowly taking place in the field of dental implants. Although commercially pure titanium is still the gold standard to produce dental implants, there is now an important transition to manufacture implants from inert and more biocompatible materials.[1] In the early days of implant dentistry, Prof. Sami Sandhaus experimented with the implant material

Fig. 1: The late Prof. Sami Sandhaus, a pioneer in the field of ceramic implantology. **Fig. 2:** The German chemist Martin Heinrich Klaproth (1743–1817; Source: http://www.sil.si.edu/digitalcollections/hst/scientific-identity/explore.htm).

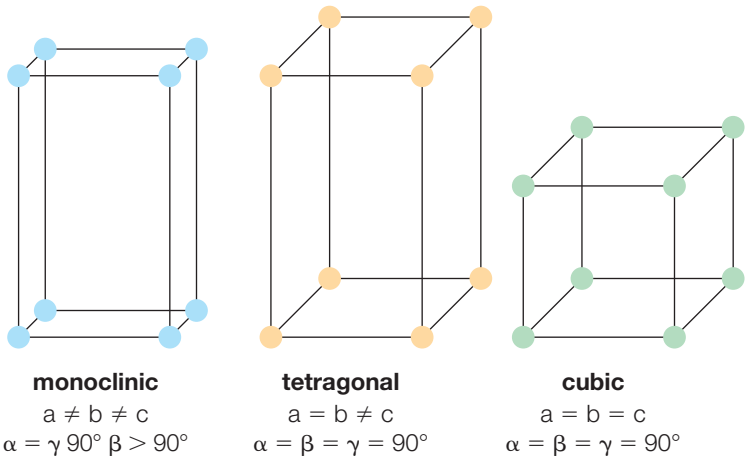
alumina (Fig. 1).[2] Due to insufficient tensile strength, this material was abandoned early, despite its high biocompatibility and clear aesthetic benefits.[3] Sandhaus was the absolute pioneer in ceramics as implant material. In the sixties of last century, he developed the Crystaline Bone Screw (CBS): the first 100 % metal-free and biocompatible dental implant. In the current group of used biomaterials, zirconia exhibits the best mechanical properties. Next to the biological advantages, zirconia also offers the possibility of working with significantly more aesthetic prosthetic solutions. Although zirconia is already used for decades in other medical disciplines (e.g. orthopaedics) and is scientifically well established, there is actually still a significant lack of sufficient peer-reviewed scientific research, in implant dentistry.

Fortunately, times seem to change since established implant companies are now manufacturing their own ceramic implant-lines, or bought small ceramic dental implant companies: Straumann® (Pure Ceramic®), Nobel Biocare® (NobelPearl®) and CAMLOG (CERALOG). Next to these 3 big companies, there are the smaller brands: Z-Systems®, Zeramex®, ZiBone®, Ceraroot®, TAV® Dental, SDS® etc. For many clinicians, ceramic implants represent a valuable alternative for expanding their patient base, especially in cases with challenging aesthetic demands and in cases where patients request metal-free dentistry or a complete bio-holistic approach.[4] Recently, a number of scientific professional organisations have developed around this specific theme: EACim (European Academy of Ceramic Implantology); ISMI (International Society of Metal Free Implantology; IAOCI (International Academy of Ceramic Implantology); and ESCI (European Society for Ceramic Implantology). The objective of all these societies is to establish dental implants, made of ceramics, on the basis of scientific and evidence-based foundations, as a reliable supplement and a meaningful extension of the treatment spectrum in addition to titanium implants.

History

Zirconium was first discovered by the German chemist Martin Heinrich Klaproth in 1789 (Fig. 2). Afterwards, Klaproth also discovered uranium (1789) and cerium (1803). He described them as separate elements, although he did not obtain them in the pure metallic state. Zirconium is the chemical element with the symbol Zr and with the atomic number 40 (Fig. 3). The name zirconium is taken from the name of the mineral zircon (related to Persian “zargun”: gold-like or as gold). Zircon is the most important source from zirconium. Zircon is found primarily in Australia, Brazil, India, Russia, South Africa and the US. Worldwide resources exceed 60 million tonnes. The annual production is approximately 900.000 tonnes. Zirconium is a by-product of the mining and processing of the titanium minerals ilmenite and rutile, as

Fig. 3: Zirconium. © magnetix/Shutterstock.com



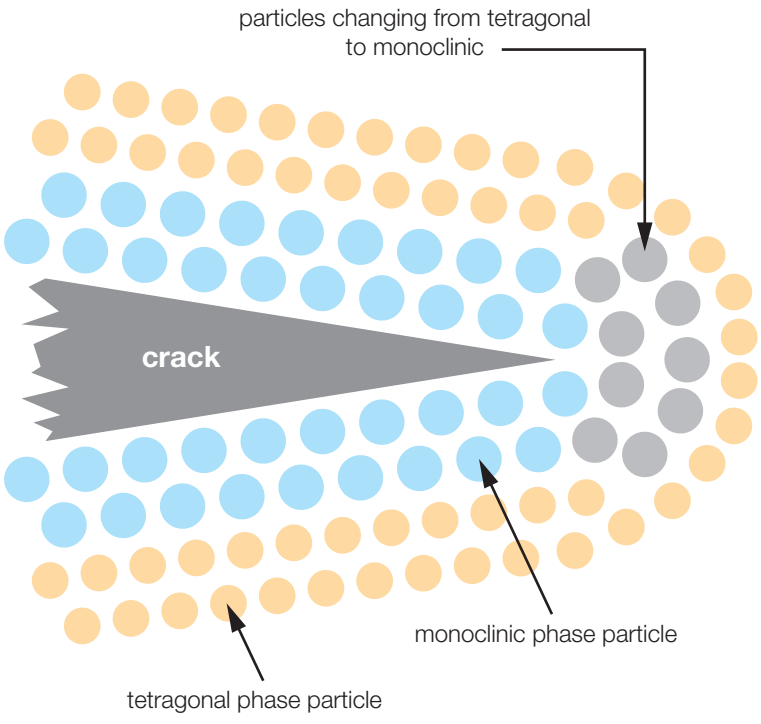


Fig. 4: The different phases of zirconia.

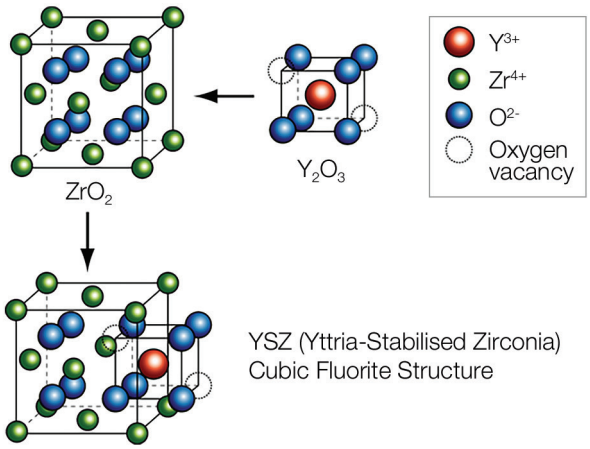


Fig. 5: The structure of YTZP (Source: http://www.doitpoms.ac.uk/tlplib/fuel-cells/printall.php).

well as of tin mining. Zirconium (40 Zr) is a lustrous, grey-white, very strong transition metal that closely resembles Hafnium (72 Hf) and to a lesser extent … Titanium (22 Ti). Zirconium is in industry mainly used as a refractory and opacifier, although small amounts are used as alloying agent for its resistance to corrosion.

Composition

Like all other transition metals, zirconium forms inorganic (zirconium-dioxide) and organo-metallic (zirconia-dichloride) compounds. There are five isotopes in nature, three of which are stable. The inorganic zirconium-dioxide (ZrO_2) is called zirconia. It is often used in aerospace or as a cutting tool in the watch industry and in surgery.[5] Moreover, zirconium-bearing compounds are used in many biomedical applications: not only in dentistry (crowns, implants and abutments), but also in orthopaedics (knee and hip replacements) and ENT (middle-ear ossicular chain reconstruction). Although zirconium has no biological role, the human body contains on average 250 milligrams of zirconium, with an average intake of 4,15 mg/d.[6]

Zirconia has excellent mechanical properties, such as high resistance to scratching and corrosion and a high resistance to load.[7] It is a very stable product and it is highly biocompatible. One distinguishes three different crystalline phases for zirconia (Fig. 4): a monoclinic phase, a cubic phase and a tetragonal phase. The phase is temperature dependent: monoclinic below 1,170 °C, tetragonal between 1,170 °C and 2,370 °C, and cubic above 2,370 °C. The trend is for higher symmetry at higher temperatures, as is usually the case. A small percentage of the oxides of calcium or yttrium stabilise in the cubic phase. The tetragonal form is the clinically used form. Yttrium, a chemical element with the symbol Y and atomic number 39 (39 Y, a silvery metallic transition metal), is generally added to improve the stability. This creates a bio-inert material with even higher mechanical properties: it is 6 times harder than stainless steel! That is why it is sometimes called (wrongly) ceramic steel.

The Yttrium-Tetragonal-Zirconia-Polycrystal (YTZP) shown in Figure 5, has even more interesting biological characteristics: it is electrically neutral and does not conduct electricity nor radiation; it has low thermal conductivity and high thermal shock resistance; and it is chemically totally stable.[8] Because of all these criteria, zirconia is an excellent material for medical and dental applications.

Editorial note: In the second part of this article, which is to be published later this year in the 2/20 issue of ceramic implants*, further material-specific aspects of zirconia will be discussed in depth, a market overview will be given, and a prognosis for future developments will be made.*

Literature

about the author

Prof. Curd Bollen obtained his DDS in 1992 at the Catholic University Leuven, Belgium. In 1996, he received his PhD and in 1997, he finished his M.Sc. in Periodontology & Implantology. In 2016, he completed the MClinDent programme at the University of the Pacific in the US. As for his active clinical work, Prof. Bollen specialises in periodontology, implantology and halitosis. He recently joined the College of Medicine & Dentistry in Birmingham, UK, as an Associate Clinical Professor.

contact

Prof. Curd M. L. Bollen
Ulster University in Birmingham
College of Medicine and Dentistry
32 – 34 Colmore Circus
Birmingham
B4 6BN
United Kingdom
Phone: +44 121 3459847
c.bollen@comd.org.uk

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Surgical aspects of two-piece ceramic implants

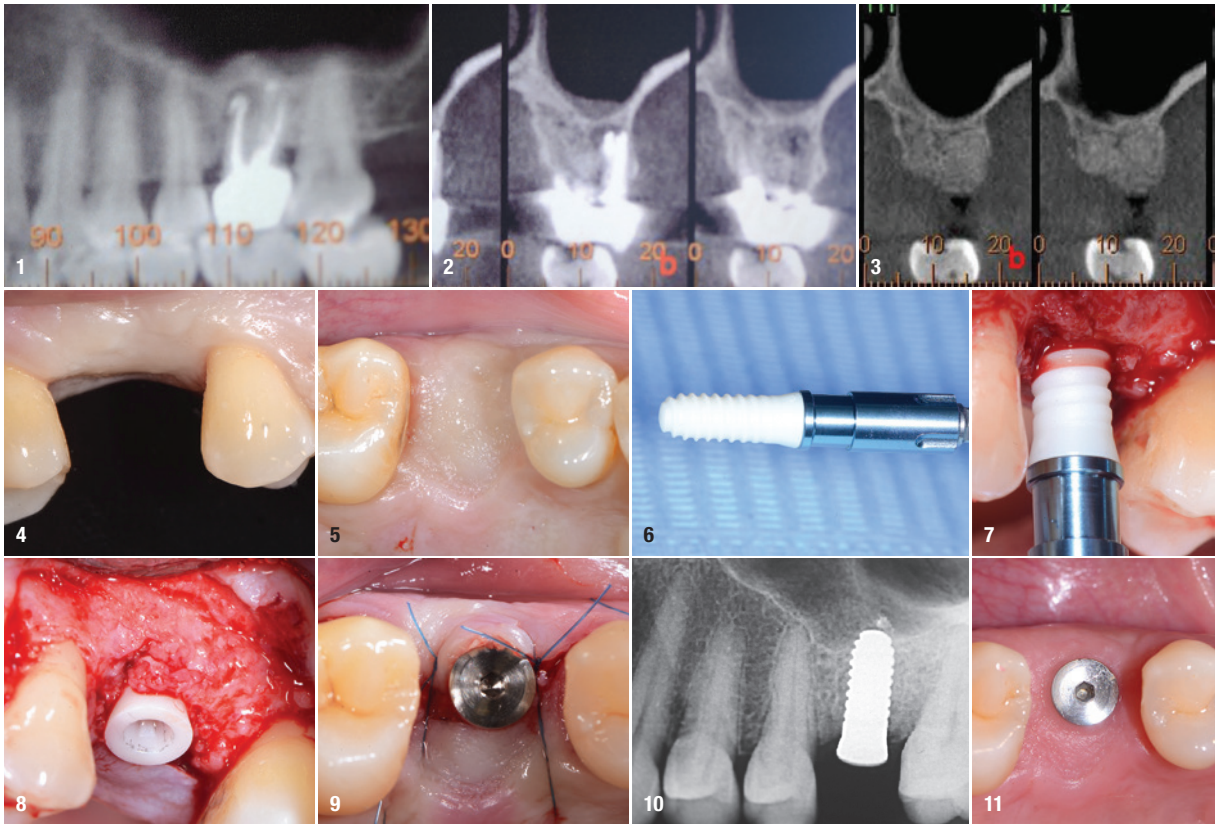
A solution in compromised bone sites

Dr Bernard Dahan, DCD, Israel

Introduction

Ceramic or zirconia implants have appeared in the literature for more than 30 years and have been proposed as a solution for replacement of teeth in edentulous areas. Clinical studies have also shown positive results, as opposed to with titanium implants. Throughout the last decade, ceramic implants have become a part of our implant treatment plans. Besides the aesthetic advantage, the significant interest in zirconia implants is related to its good soft-tissue response. This material seems to have greater biological acceptance by the body, which could lead to a decline in peri-implantitis cases. However, more research is needed to confirm this hypothesis.

To avoid mechanical obstacles, the first generation of zirconia implants was only available as a one-piece implant configuration. However, this specific implant was not suitable for clinical situations with a bone deficiency (quality or quantity), for instance in immediate implant placement procedures, in cases of a lack of bone volume or reduced primary stability, and in cases in which there was no indication for immediate loading with a one-piece implant. In recent years, a novel ceramic implant with a two-piece design has appeared, giving the



Case 1—Figs. 1 & 2: Radiographs before the extraction (first stage). **Figs. 3–5:** Healing of the socket preservation. **Figs. 6 & 7:** Implant insertion. **Figs. 8–10:** End of surgery. Two-piece ceramic implant at tissue level. **Fig. 11:** Successful tissue integration at two months.

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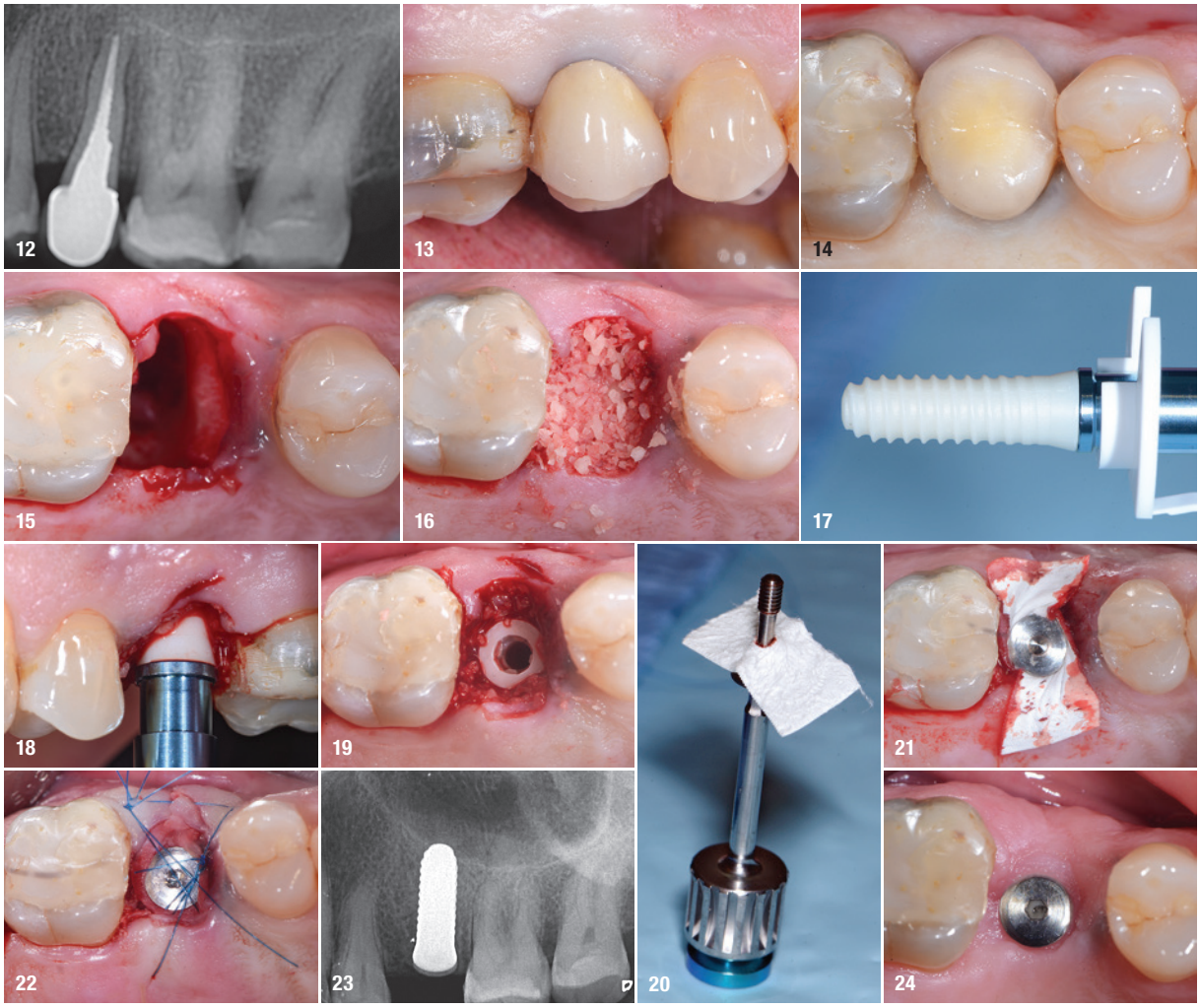

Case 2—Figs. 12–14: Hopeless tooth. **Fig. 15:** Atraumatic extraction. **Fig. 16:** Bone allograft for socket preservation. **Figs. 17–19:** Two-piece ceramic implant placement at tissue level. **Figs. 20–22:** Collagen membrane placement and suture. **Fig. 23:** Radiograph showing successful tissue integration at two months. **Fig. 24:** Successful tissue integration at two months.

opportunity to treat situations of deficient bone support and to allow healing without loading. In the following, five clinical cases involving surgery with two-piece ceramic implants are described.

Cases

Case 1: Implant placement in regenerated bone (two-stage approach)

The implant insertion was preceded by endodontic treatment, which had failed. The first stage of implant treatment involved tooth extraction and socket preservation by means of an allograft and a collagen membrane. Six months after the initial treatment, a two-piece ceramic implant was inserted into the bone, which had regenerated at that point, as part of the second treatment stage (Figs. 1–11).

Case 2: Immediate implant placement

The clinical diagnosis revealed a cracked premolar. As a consequence, atraumatic extraction was carried out. Immediate placement of a two-piece ceramic implant at tissue level was done along with socket preservation (allograft bone substitute and a resorbable collagen membrane). No loading was done at that point (Figs. 12–24).

Case 3: Implant placement combined with lateral bone augmentation (guided bone regeneration) via a simultaneous approach

The site in the mandibular molar area presented with an alveolar crest too narrow for predictable implant placement without augmentation. Two-piece zirconia implants were placed simultaneously with lateral bone augmentation using an allograft and a resorbable collagen membrane (Figs. 25–34).

Case 4: Implant placement in molar area with guided tissue regeneration

A patient with an infrabony defect came to the practice explicitly demanding a zirconia implant in the molar area. Thus, a two-piece zirconia implant was inserted, and at

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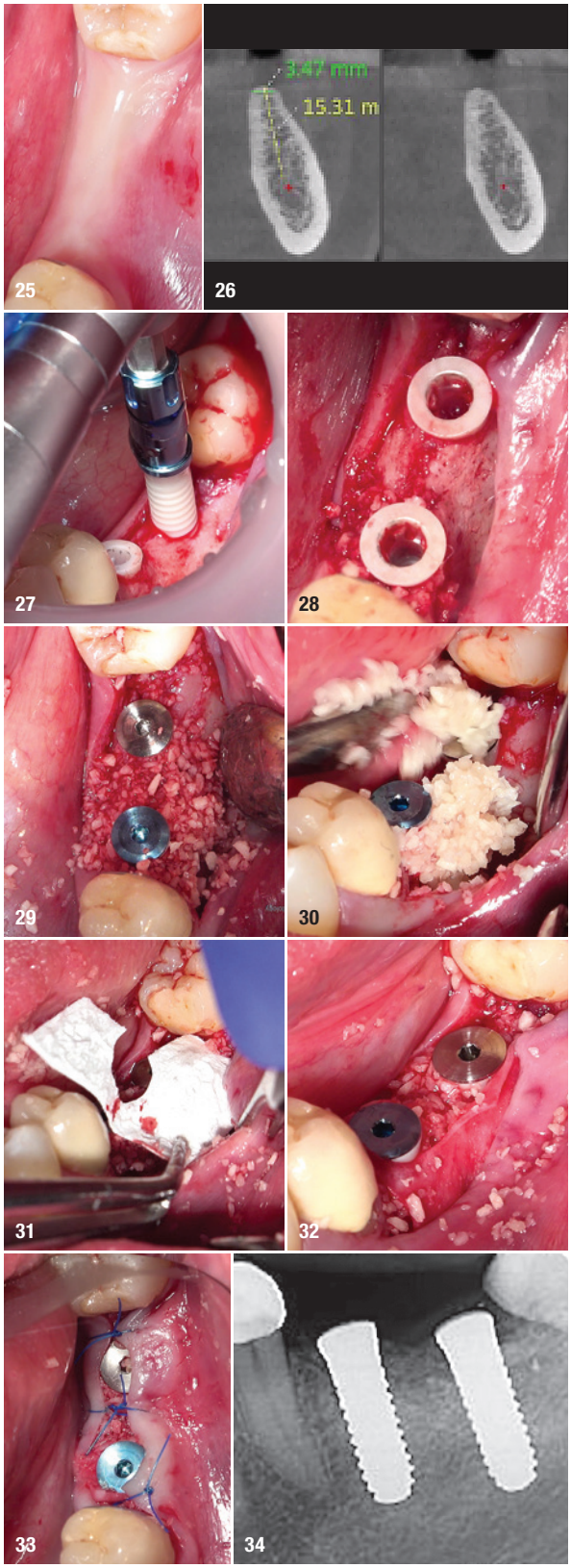
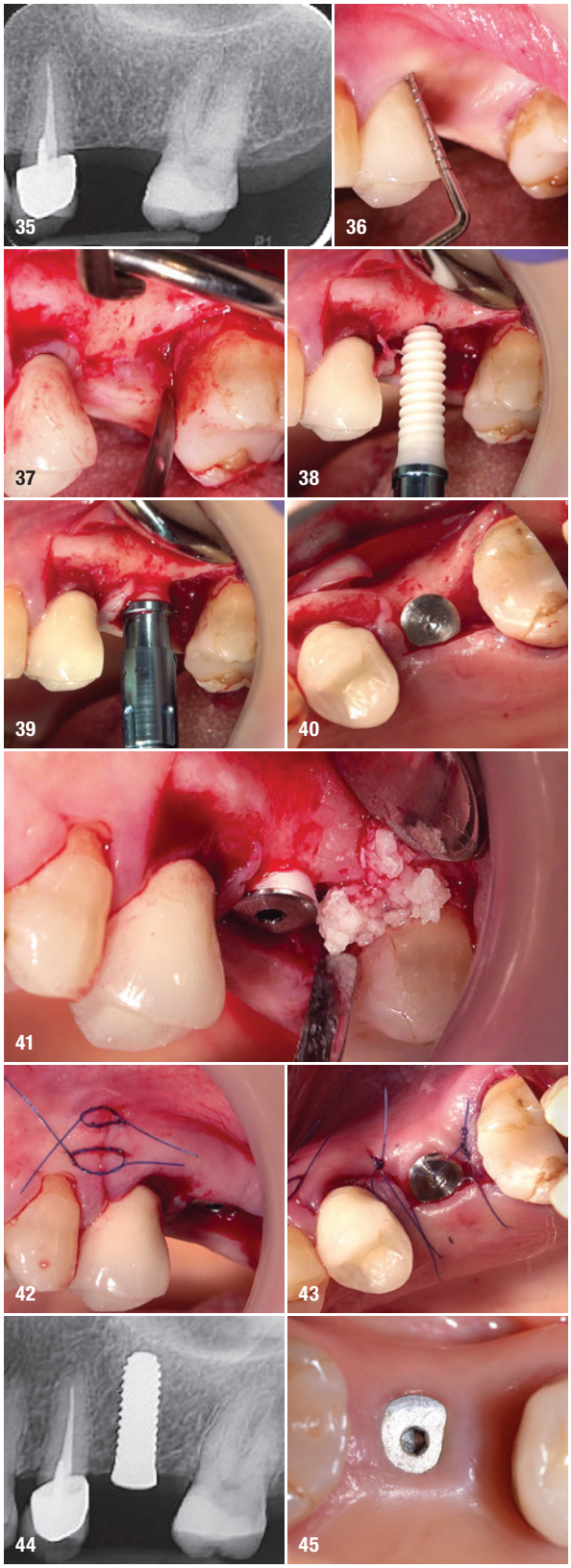
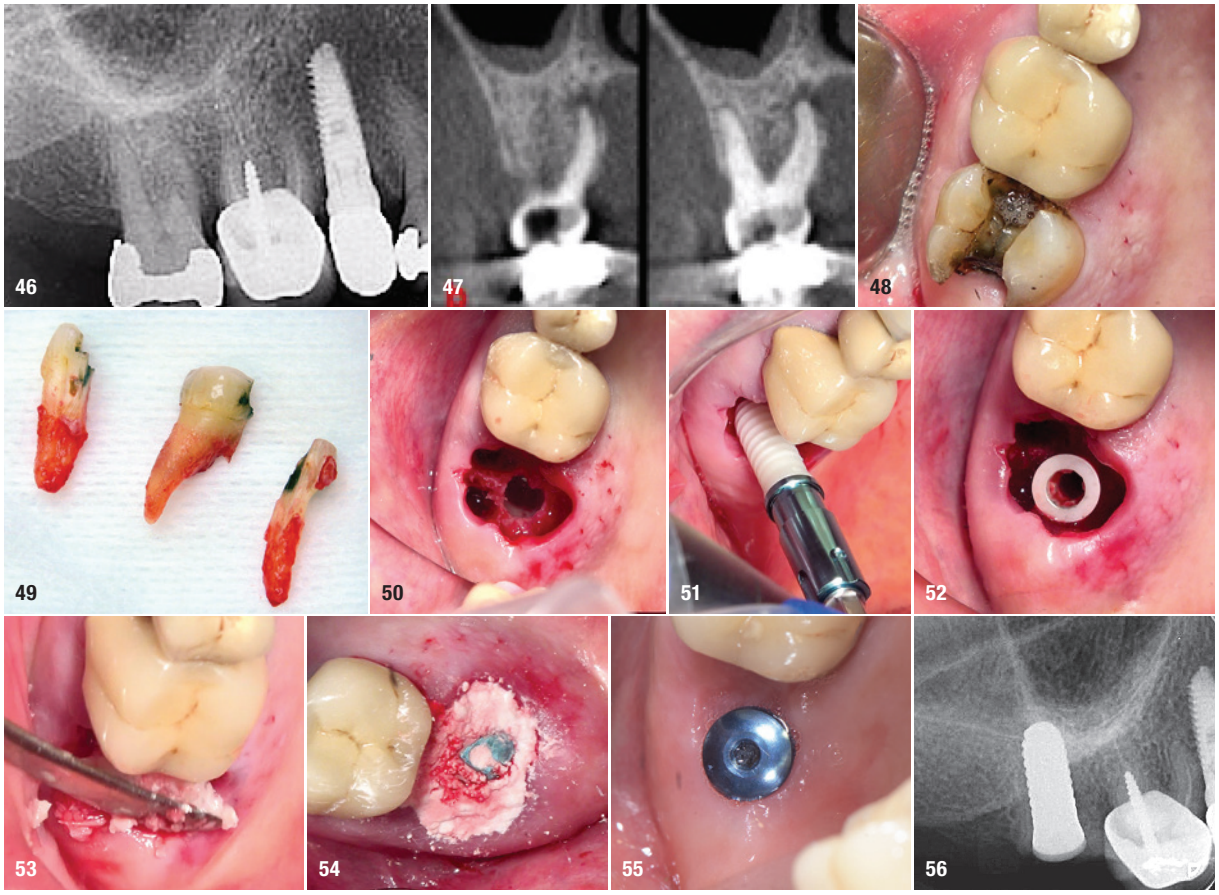


Case 3—Figs. 25 & 26: Narrow edentulous area compromised for implant placement. **Figs. 27 & 28:** Two-piece ceramic implant placement at tissue level. **Figs. 29 & 30:** Lateral bone augmentation (guided bone regeneration) with allograft bone substitute at the time of the implant placement. **Figs. 31–33:** Placement of a collagen membrane as a barrier and sutures. **Fig. 34:** Control radiograph at two months.



Case 4—Figs. 35 & 36: Edentulous molar area before implantation. **Fig. 37:** Exposure of the periodontal defect (the mesial aspect of the second molar). **Figs. 38–40:** Two-piece ceramic implant placement at tissue level. **Fig. 41:** Bone grafting and guided tissue regeneration at the mesial aspect of the second molar. **Figs. 42 & 43:** Micro-sutures. **Figs. 44 & 45:** Control radiograph and good integration of the ceramic implant in the environment.



Case 5—Figs. 46–48: Compromised maxillary second molar (crack and endodontic complication). **Fig. 49:** Atraumatic extraction, preserving the interradicular septum. **Fig. 50:** Osseodensification technique with Densah burs using the interradicular septum. **Figs. 51 & 52:** Two-piece ceramic implant placement. **Figs. 53 & 54:** Allograft bone substitute and biphasic calcium sulphate protection. **Figs. 55 & 56:** Tissue integration and control radiograph at two months.

the same time, the infrabony defect was treated by means of a bone allograft and Emdogain (Straumann). No loading was done at this stage (Figs. 35–45).

Case 5: Immediate implant placement with the osseodensification technique

Diagnostics found a furcation, and a compromised prognosis for the maxillary second molar involved was made because of an interradicular crack. The tooth was gently removed, keeping in place the interradicular septum into which the implant was planned to be inserted. The osseodensification technique was performed by means of Densah burs (Versah), allowing successful stabilisation of the implant at tissue level. Allograft bone substitute and biphasic calcium sulphate were used for socket preservation. After eight weeks, we could observe and appreciate the successful integration of the ceramic implant into the surrounding tissue (Figs. 46–56).

Conclusion

In conclusion, it can be argued that ceramic implants are increasingly becoming a part of the armamentarium of the Implantologist. The one-piece implants seem to have a better indication in favourable bone conditions. However, the two-piece ceramic implant will find its indication for compromised bone situations.

about the author

Dr Bernard Dahan obtained his dental degree in 1976 at the University of Toulouse in France and obtained his specialisation in periodontics from Aix-Marseille University in France in 1978. Today, Dr Dahan concentrates his activity on bone regeneration, implantology, microsurgery and laser therapy and is in charge of the Private Academy training centre in Haifa in Israel.

contact

Dr Bernard Dahan
78 Sderot Moria
34613 Haifa, Israel
Phone: +972 4 8343333

Author details

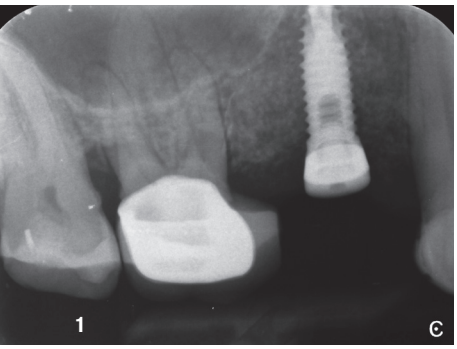
The key to optimal implant aesthetics

Dr Kunal Shah, UK

Initial clinical situation

A 58-year-old male patient presented with a dental gap where tooth #15 had been missing for many years. He had been recommended to the practice by another patient. He was fit and healthy with an unremarkable medical history. Having undergone extensive restorative treatment in the past, the patient was very aware of the different procedures that are currently available to restore teeth. As such, the challenge of this case was to effectively manage the patient—the restorative aspect of treatment was crucial to success, especially as the patient had high expectations of the overall result. All treatment options were discussed with the patient, including the advantages and disadvantages of each. The patient chose a dental implant, as he preferred a fixed solution. The different types of implants available were then discussed with him, including bone and tissue level systems. It is important for clinicians to explain treatment options to this level of detail, as patients need to know what each dentist can offer them and/or what else they could access through professional referral. Many patients are also very conscious of what will be put in their mouths.

As improved aesthetics could be achieved with its zirconia collar design, the patient decided on the Z1 implant system from TBR Dental. This was the most superior, yet cost-effective, option compared with the alternatives offered. As the Z1 is a tissue level system, the surgical site does not have to be reopened for the implant to be accessed in order for the clinician to remove the cover screw and replace it with a healing abutment. This saves the patient from having to attend an additional appointment for this, thereby maximising on valuable chair time. Furthermore, the Z1 enables the clinician to place the implant in one surgical step, which helps optimise operating room planning and sterilisation protocols, making the Z1 much more convenient for patient and practitioner. The versatility of the Z1 also optimises stock management for practices and helps to minimise maintenance treatments for patients. In addition, the Z1 itself was more affordable than the other implant systems that were offered to the patient in this case, providing further cost-saving benefits. Modern patients are increasingly more price-conscious, so they need solutions that can achieve the best clinical outcomes while meeting their budget.



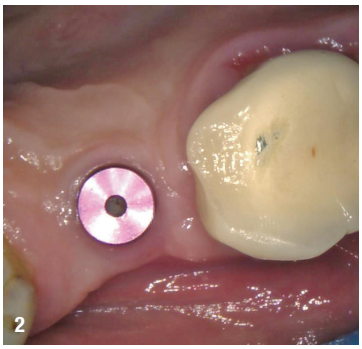


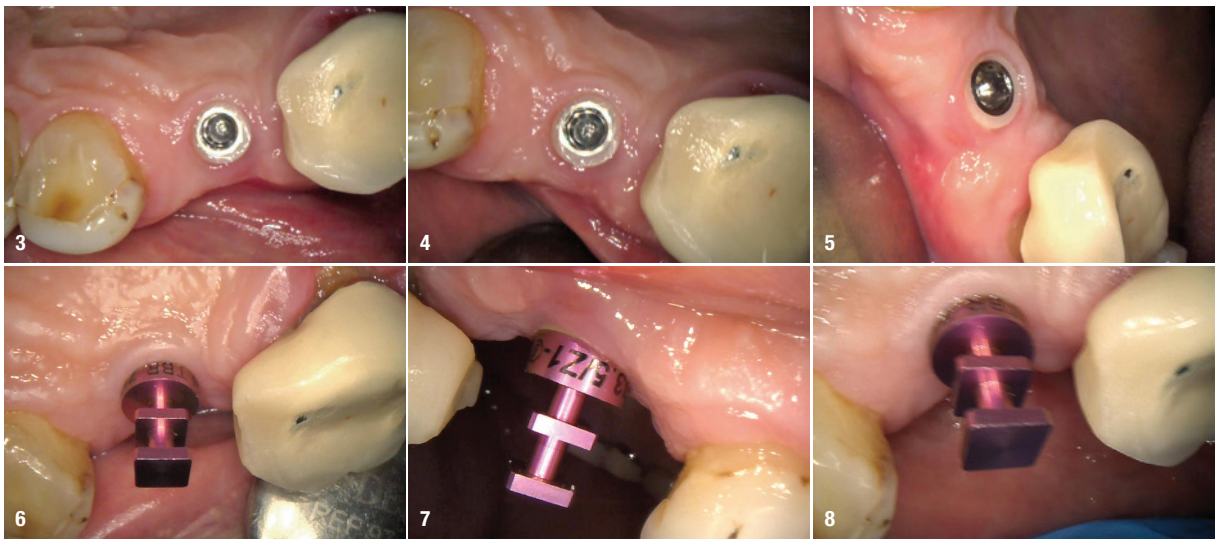
Fig. 1: Periapical radiograph showing the Z1-infinity implant in position #15 at the three-month review. **Fig. 2:** Intra-oral photograph showing the Z1-infinity implant with a cover screw in position #15.

Treatment planning

Standard treatment planning protocols were followed. This involved taking a cone beam computed tomography scan to assess the sinus and bone level, as well as to provide a 3D view of the proposed surgical site for improved visualisation. A comprehensive assessment confirmed that there was adequate width and height of bone to place an implant. Digital software ensured that the treatment planning process was very precise. A 4.0 x 10.5 mm tissue level Z1 implant was planned for, as this solution provides excellent aesthetics and, in this case, did not require a bone grafting procedure prior to surgical placement. Every aspect of treatment was discussed with the patient before informed consent was obtained for treatment to begin.

Implant placement

Surgery proved to be unremarkable. A delayed implant placement protocol was followed, which involved making a small incision in the gingiva and raising a flap. The surgical site was cleaned and prepared for the implant to be placed successfully and achieve primary anchorage. The zirconia collar was sunk 1 mm into the bone to pro-



Figs. 3–5: Intra-oral photograph showing the Z1-infinity implant with the cover screw removed. **Figs. 6–8:** Intra-oral photograph showing the Z1-infinity implant with a SwissClip impression coping for the closed-tray approach.

vide additional stability and boost aesthetics by promoting a good emergence profile. This was accomplished by using the countersink drill in the implant kit. A healing cap was not required owing to the transgingival nature of the implant and the design of the zirconia collar, so a cover screw was placed post-surgery. The surgical site was then assessed before the patient was sent away with appropriate post-surgery care instructions to take anti-inflammatories and antibiotics to aid the healing process and prevent infection.

Restoration

After a healing period of three months, the implant was evaluated and found to have achieved excellent stability (Fig. 1). The soft tissue around the implant was also pink with no inflammation, indicating that it had healed well and was healthy (Fig. 2). The cover screw was removed (Figs. 3–5) in order to fit a TBR SwissClip impression coping (Figs. 6–8). This is a very efficient and convenient solution that is quicker than traditional methods of taking an impression, as it simply clips on to the implant. A closed-tray impression was taken, alongside a digital scan, which were both sent to the laboratory to produce a screw-retained IPS e.max crown (Ivoclar Vivadent). The patient chose an implant-retained crown that was a whiter shade than his existing restorations, as he was keen to replace these in the future.

The patient later returned to the practice for the placement of the definitive restoration. The porcelain-fused-to-metal crown was seated (Figs. 9–11) and the access hole was sealed with PTFE tape, before being filled with a temporary dressing (Fig. 12). After a week, this was removed and the crown tightened to 25–30 Ncm. The screw access hole was then sealed with PTFE tape and composite. Clinical and radiographic assessments after implant restoration showed optimal aesthetics and osseointegration (Fig. 13). The patient was very happy with the final outcome.

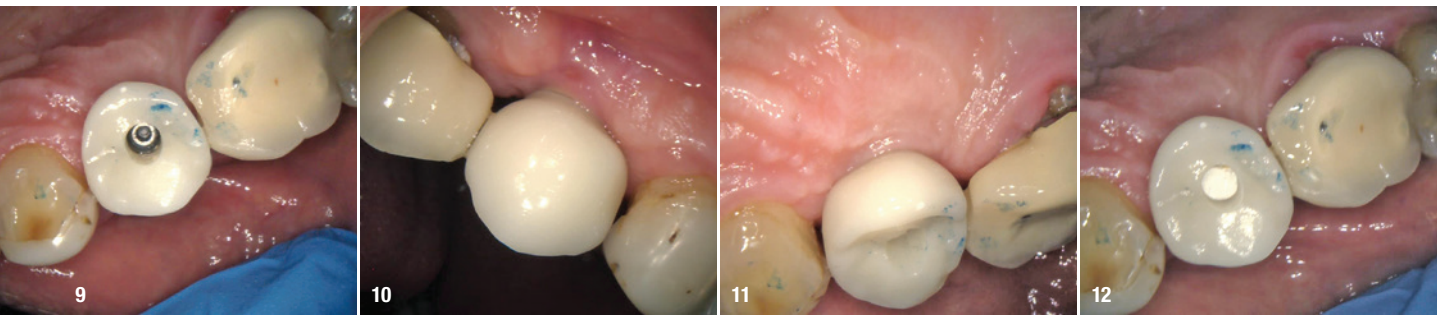


Fig. 9: Intra-oral photograph showing the screw-retained implant crown seated. **Fig. 10:** Intra-oral photograph showing the screw-retained implant crown seated, buccal view. **Fig. 11:** Intra-oral photograph showing the screw-retained implant crown seated, palatal view. **Fig. 12:** Intra-oral photograph showing the screw-retained implant crown seated with PTFE tape to protect the access hole.

Discussion

In this case, the zirconia collar of the Z1 acted as a healing abutment for the implant to encourage gingival flaring and soft-tissue healing for a good gingival profile to develop. This meant that a cover screw could be fitted to the implant and left for three months to achieve excellent osseointegration. Simultaneous healing of the hard and soft tissue further emphasised the time-saving benefits that the Z1 provided throughout this case. The zirconia collar also promoted gingival attachment and served as an antibacterial shield to the crestal bone to prevent iatrogenic inflammation and infection.[1,2] This is the only implant system that encourages natural gingival growth, whereas other solutions tend to result in gingival recession over time. Moreover, there are fewer surgical steps involved with placing the Z1, as the clinician does not need to reopen the surgical site to access the implant for the restorative phase of treatment.

Conclusion

The success of a dental implant is always based on planning treatment correctly. It is also important to offer an implant solution that caters to the needs of the patient. Together, these elements can ensure outstanding results, as was demonstrated in this case. The unique design of the Z1 enabled placement of the implant at tissue level, thus minimising the number of surgical steps required, which ultimately ensured treatment was less invasive and more convenient for the patient.

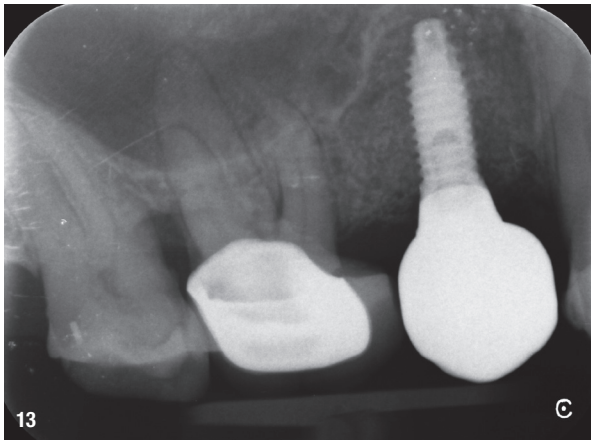


Fig. 13: Post-op periapical radiograph showing the screw-retained implant crown seated.

Literature

about the author

Dr Kunal Shah is the principal of LeoDental in London. He graduated from the University of Birmingham in the UK, was selected as a finalist for Young Dentist of the Year—South in the Dental Awards 2018 and has the accolade for the best implant and imaging clinic in London in 2018. He has a keen interest in the topics of digital dentistry, implantology and restorative dentistry specific to direct resin composites and impression materials, and has published several articles in the professional press and lectured internationally. Dr Shah is also a clinical mentor for students on the year-long postgraduate implant course at LeoDental in conjunction with SmileTube.tv.

contact

Dr Kunal Shah
LeoDental
Bell Lane Dental Practice
19 Bell Lane, Hendon, London
NW4 2BP, United Kingdom
Phone: +44 20 82033155
referral@leodental.co.uk
www.leodental.co.uk

Author details

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Immediate restoration with one-piece zirconia implants

Fabricating removable interim prostheses

Dr Kazuhiko Okamoto, Prof. Shuji Ohkawa, Dr David Ashley & Prof. Yung-Tsung Hsu, Japan & USA

Introduction

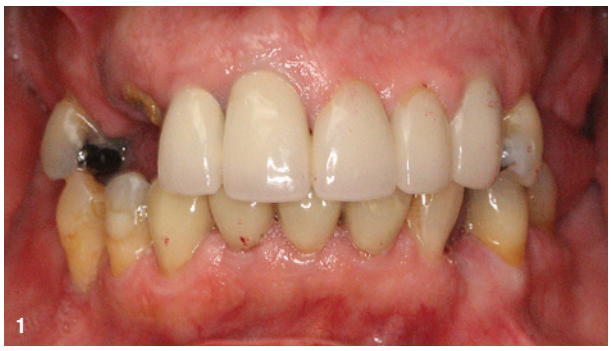
Zirconia implants have been recommended as a possible alternative to traditional titanium implants.[1] Compared with titanium implants, zirconia implants show favourable results regarding biocompatibility, soft-tissue reaction and aesthetic outcomes.[2,3] Although two-piece zirconia implants are available in the market, the long-term prognosis of this design is still unknown.[4,5] One-piece zirconia implants have demonstrated satisfactory results;[6,7] however, with the one-piece design, there are significant challenges for both clinicians and patients during the healing time. For clinicians, occlusal forces may be applied to the implants before they are osseointegrated. This increases the risk of failure if the forces are too great or if the initial implant stability is less than ideal.[8] For patients, the main concerns are related to maintaining aesthetics and function during the healing time.

If the initial stability after the implant placement is ideal and there are enough adjacent teeth to prevent heavy contact, immediate placement of an interim restoration on the implant is possible.[9,10] However, when multiple implants are placed in scattered positions or when there is a distal extension situation, the loading on the implants should be delayed to allow for better bone and soft-tissue healing. For two-piece designs, implants can be submerged and uncovered after osseointegration is achieved. For a one-piece implant, a prosthesis should be offered to provide aesthetics and function during the healing time. In addition, this prosthesis should provide protection of the implants to avoid occlusal contact before sufficient osseointegration has occurred. In these situations, a removable interim dental prosthesis (IDP) could be suitable. Compared with a fixed IDP, a removable one may be less stable and comfortable; however, for one-piece dental implants, this prosthesis meets the needs mentioned and offers ease of adjustment and removal for cleaning by patients.

The fabrication of a removable prosthesis supported on one-piece implants is different from the conventional technique. The replacement of the missing teeth must meet the traditional tooth arrangement requirements; in addition, any occlusal contact on the implants should be avoided to protect the implants from loading before osseointegration. A space between the intaglio surface of the removable IDP and the implants is necessary for this purpose. This prosthesis also must be fabricated in a short period, preferably in the dental office immediately after surgery. This article presents a case report with a technique for fabricating a removable IDP supported on one-piece zirconia implants immediately after surgery.

Case report

A 65-year-old female patient presented with a fractured tooth under an existing metal framework removable par-



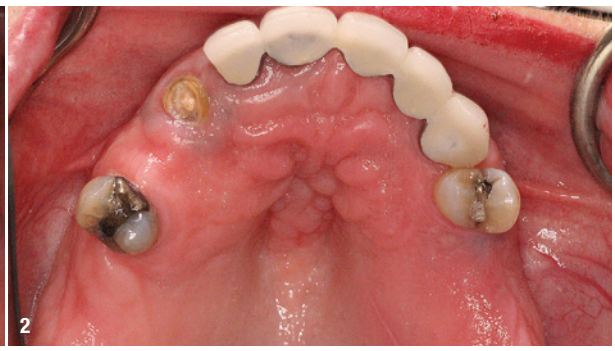


Fig. 1: Frontal view, before surgery. **Fig. 2:** Maxillary arch, occlusal view.

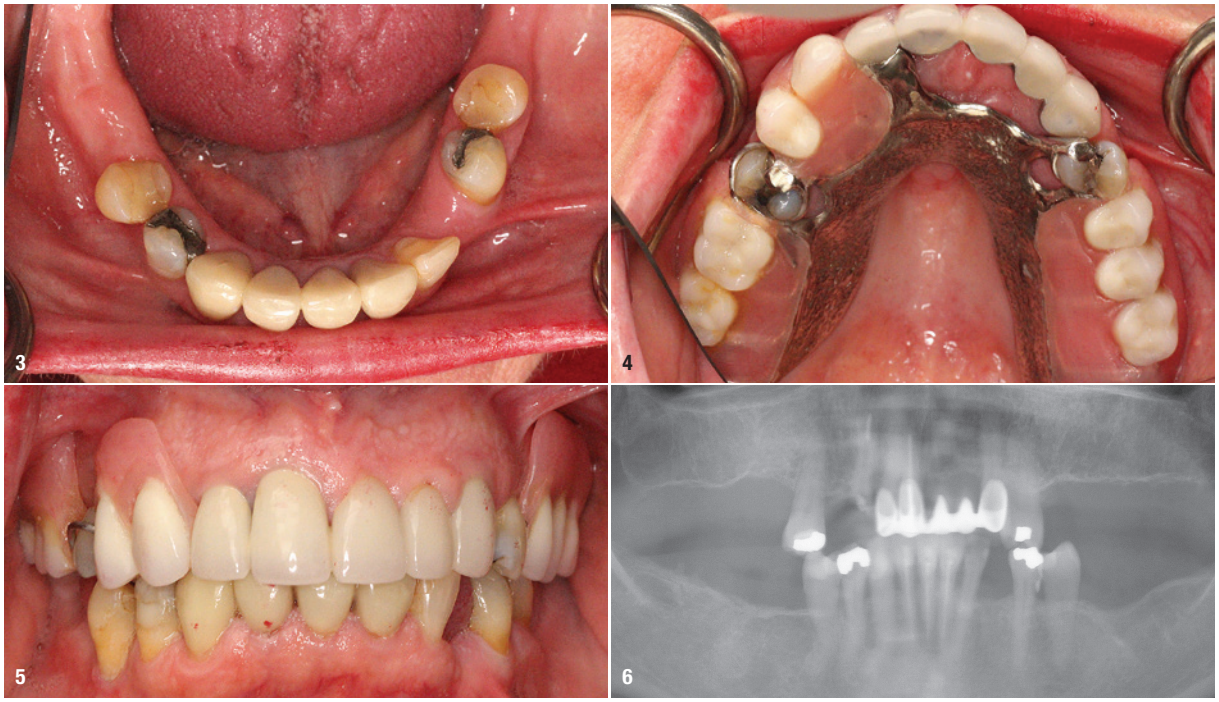


Fig. 3: Mandibular arch, occlusal view. **Fig. 4:** Maxillary arch with the removable partial denture. **Fig. 5:** Frontal view with the partial denture in position. **Fig. 6:** Panoramic radiograph, before surgery.

tial dental prosthesis and requested that it be examined for implant treatment. Her chief complaints were that, in the past, the teeth that had had contact with the hooks from the denture had become loose and needed to be extracted, and she wanted to do something to avoid becoming edentulous. Intra-oral examination revealed a remaining maxillary right second premolar and a left first premolar. An existing fixed metal–ceramic dental prosthesis using the right lateral and central incisors and left canine as abutments to replace the missing left central and lateral incisors was observed (Figs. 1–6). The patient was not interested in any treatment on the mandibular arch although there were several missing teeth. After evaluation with CBCT and discussion with the patient, a decision was made that the non-restorable canine root would be removed and zirconia implants would be placed in the edentulous areas and the extraction site immediately.

An impression was taken with the existing removable partial dental prosthesis in position. Two holes were created on the impression tray to stabilise the partial dental prosthesis when taking the impression.[11] The partial dental prosthesis was removed from the impression, and the impression material was trimmed with scissors to remove the thin and unsupported parts (Fig. 7). The impression was poured with a Type IV dental stone (Silky-Rock, Whip Mix), and a vacuum-formed matrix was made with a clear plastic material (thermoforming material, 0.020 in.; Henry Schein; Fig. 8).[12]

Local infiltrations with 2 % lidocaine with 1:100,000 adrenaline were given, and the retained canine root was removed. The zirconia implants (ZiBone, COHO Biomedical Technology) were placed with a flapped procedure using a surgical kit provided by the implant manufacturer.

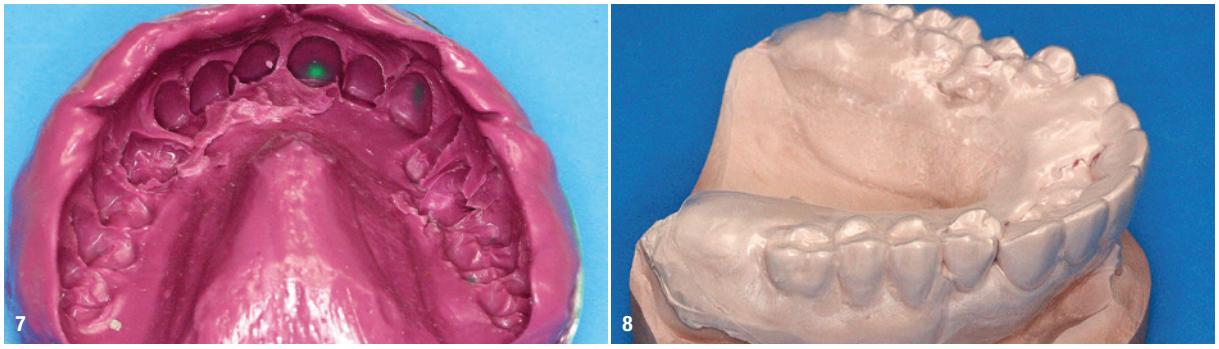


Fig. 7: Impression of the upper arch with the partial denture in position. **Fig. 8:** Vacuum-formed matrix on the cast.

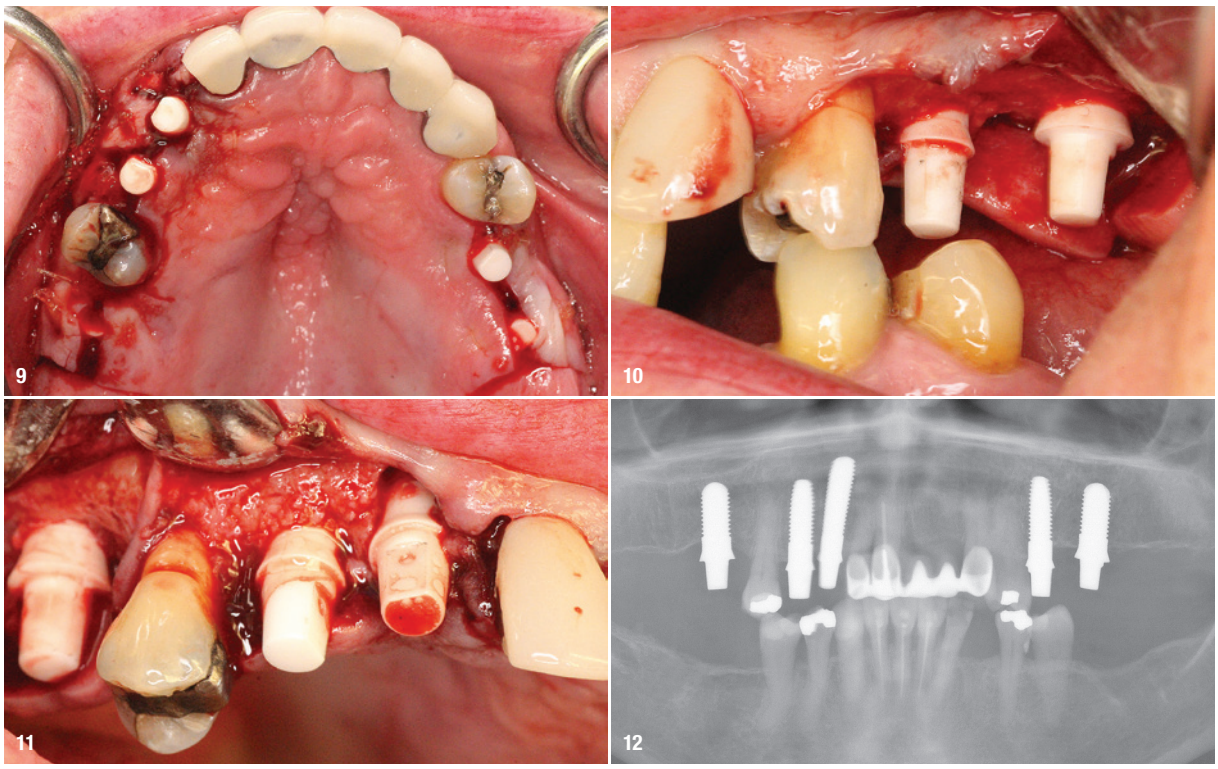


Fig. 9: Implant placement in the maxillary arch, occlusal view. **Fig. 10:** Implants on the maxillary right side, buccal view. **Fig. 11:** Implants on the maxillary left side, buccal view. **Fig. 12:** Panoramic radiograph, after surgery.

The remaining root was removed. Implants were placed in the areas of the right first molar (Ø 5.0 × 11.5 mm), right second premolar (Ø 4.0 × 11.5 mm), right canine (Ø 4.0 × 14.5 mm), left second premolar (Ø 4.0 × 11.5 mm) and left second molar (Ø 5.0 × 11.5 mm; Figs. 9–12). The final insertion torques were between 25 and 40 Ncm. The facial side of the socket in the right canine area was filled with bone grafting material (MinerOss Cortical, BioHorizons) and covered with a membrane (AlloDerm, BioHorizons) after the implant was inserted. The wound was closed with synthetic resorbable sutures (4/0 Monocryl, Ethicon). Amoxicillin (500 mg, four times daily for two weeks) and an oral rinse with 0.12 % chlorhexidine were prescribed for postoperative care.

After the surgery, an occlusal record with a polyvinylsiloxane (PVS) material (Regisil PB, Dentsply Sirona) in the centric relation position was taken. The maxillary and condylar relationships were transferred to a semi-adjustable articulator with a facebow record. Plastic impression posts (COHO Biomedical Technology) were inserted on to the abutments (Fig. 13). The impression was made with a PVS impression material (Aquasil Ultra Monophase, Dentsply Sirona). The tray with the impression material

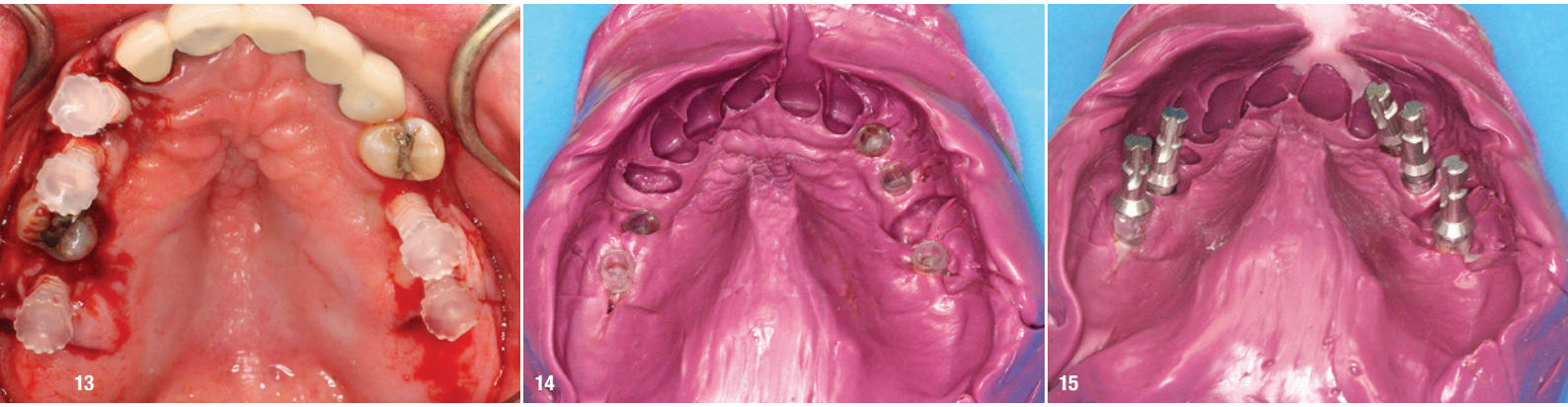


Fig. 13: Impression posts on the implant abutments. **Fig. 14:** Impression with the impression posts in position. **Fig. 15:** Analogues inserted into the impression posts.

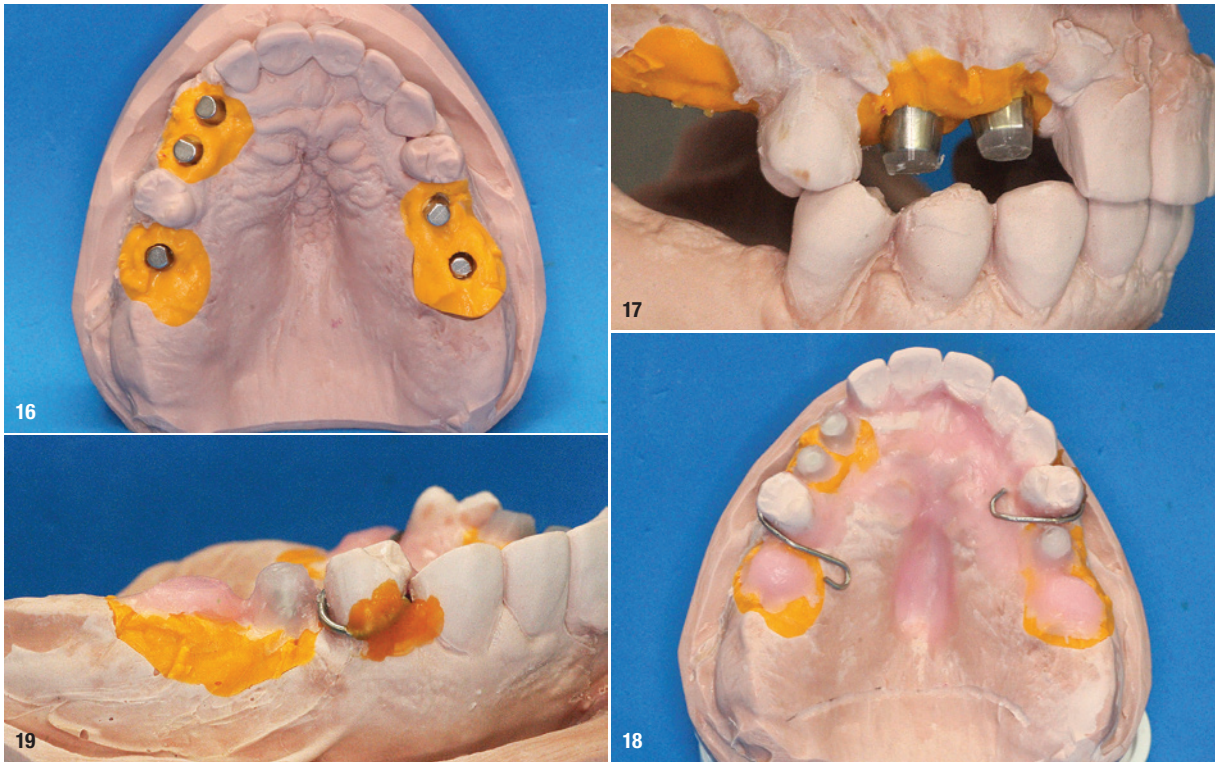


Fig. 16: Cast with the analogues and soft-tissue replica. **Fig. 17:** Clearance between the opposing surfaces and cut plastic impression posts. **Fig. 18:** Wax covering the analogues. **Fig. 19:** Wrought wire secured on the tooth with sticky wax.

was removed after the PVS had polymerised (Fig. 14). Implant analogues were inserted into the impression posts (Fig. 15). A thin layer of lubricant (Vaseline, Unilever) was painted on to the impression material around the impression post and analogue assemblies. A low-viscosity PVS impression material (Aquasil Ultra XLV, Dentsply Sirona) was injected to create the soft-tissue replica around the implants on the definitive cast (Fig. 16). The impression was poured with a Type IV stone (Silky-Rock). A beading groove was carved on the definitive cast at the distal palatal area. The maxillary cast was mounted using the occlusal record. Plastic impression posts were inserted on to the implant analogues and were trimmed to a minimum clearance of 0.5–1.0 mm from the opposing occlusal surfaces (Fig. 17). The lateral surfaces of the impression posts were covered with a baseplate wax. Undercuts on the adjacent teeth and irregular surfaces on the stone cast were blocked out with the wax. Wrought-wire clasps were secured on the buccal and facial surfaces of the selected abutment teeth with a sticky wax (Figs. 18 & 19). Several relief cuts on the abutments with clasps were created on the vacuum-formed matrix (Fig. 20). This matrix was placed on the stone cast to evaluate the occlusal relationship and tooth replacement position. A tooth-coloured autopolymerising acrylic resin (Jet Acrylic, Lang Dental Manufacturing Company) was mixed and filled into the areas of missing teeth of the matrix and immediately placed over the stone cast. The articulator was closed to maintain the occlusal relationship (Fig. 21).

After the tooth-coloured acrylic resin had polymerised, the matrix was removed and a pink autopolymerising acrylic resin was mixed to cover the palatal and buccal areas (Fig. 22). This cast was placed in a pressure pot with warm water for 20 minutes. After the acrylic resin had polymerised, the acrylic dental prosthesis was removed from the cast and additional acrylic resin was added to fill the defects on the acrylic resin base. The prosthesis was trimmed and polished. A pressure-indicating paste (PIP, Keystone Industries) was applied to the intaglio surface to evaluate the heavy-contact areas and was relieved by an acrylic bur. The occlusion was adjusted until there was no lateral contact and only light centric contact from the opposing teeth. A low-viscosity PVS impression material (Aquasil Ultra LV, Dentsply Sirona) was injected into the intaglio teeth areas, and the prosthesis was placed intra-orally. The patient was asked to occlude and grind the teeth heavily (Fig. 23). After the impression material had polymerised, the acrylic dental prosthesis was removed and any contact between the acrylic base and the implant abutments was removed. This procedure was repeated until a space between the abutment and the acrylic base could be ensured. The fit and aesthetics of the IDP were evaluated (Figs. 24 & 25). Instructions on post-delivery home care, including insertion and removal, wearing the IDP to protect the implants when eating, and cleaning were given to patient. The patient was scheduled for 24-hour, one-week, one-month and two-month follow-up appointments. At each

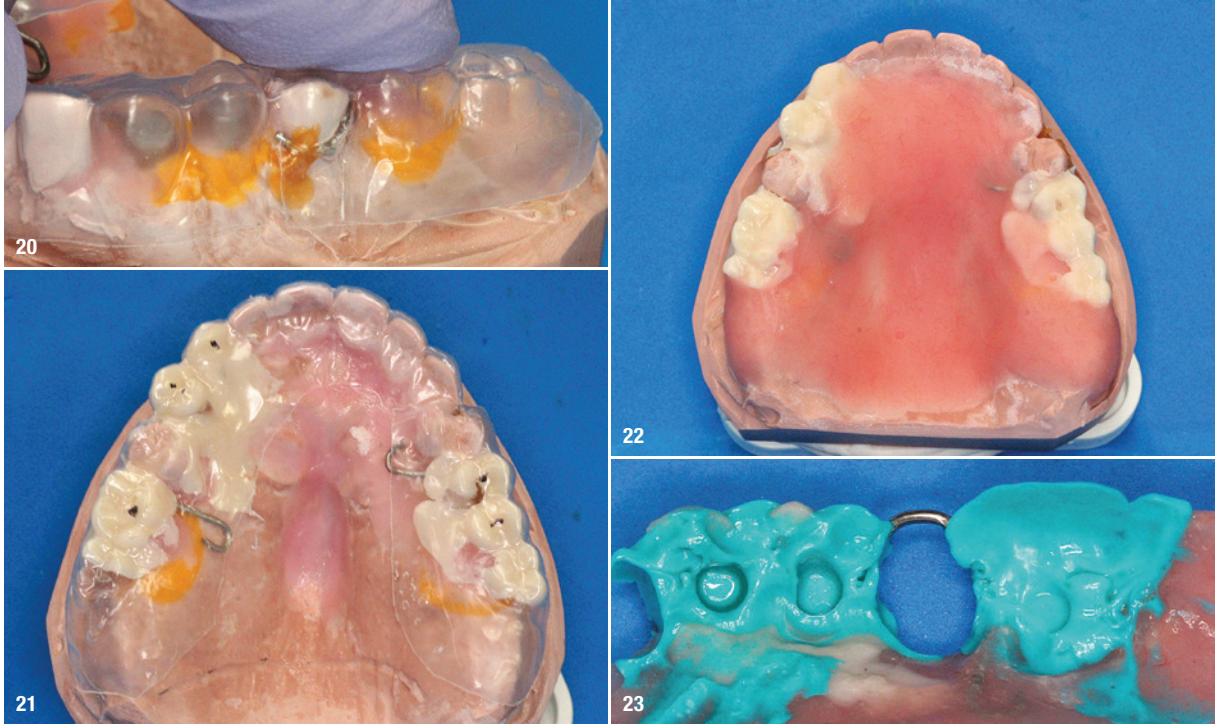


Fig. 20: Vacuum-formed matrix on the cast. **Fig. 21:** Tooth-coloured acrylic resin on the cast. **Fig. 22:** Pink acrylic resin on the palatal area. **Fig. 23:** PVS as a space indicator.

appointment, the low-viscosity PVS impression was used to ensure a space between the acrylic base and the implant abutment.

Discussion

The zirconia implants used in this case were implants fabricated with yttria-stabilised tetragonal zirconia polycrystals. Compared with two-piece zirconia implants, one-piece implants have less risk for bacterial accumulation at the gap between the abutment and implant and better fracture strength. Immediate replacement of an extracted tooth in the maxillary aesthetic zone with a zirconia implant has been documented as a feasible treatment option.[13] Immediate loading on one-piece titanium or zirconia implants may result in a higher failure rate and bone loss;[14, 15] therefore, a protective device must be provided to patients to avoid loading, especially for one-piece zirconia implants.

A removable IDP could be fabricated before surgery; however, this prosthesis must be relieved intra-orally, and it will take too much time when multiple implants are placed. In addition, it will apply too much force on

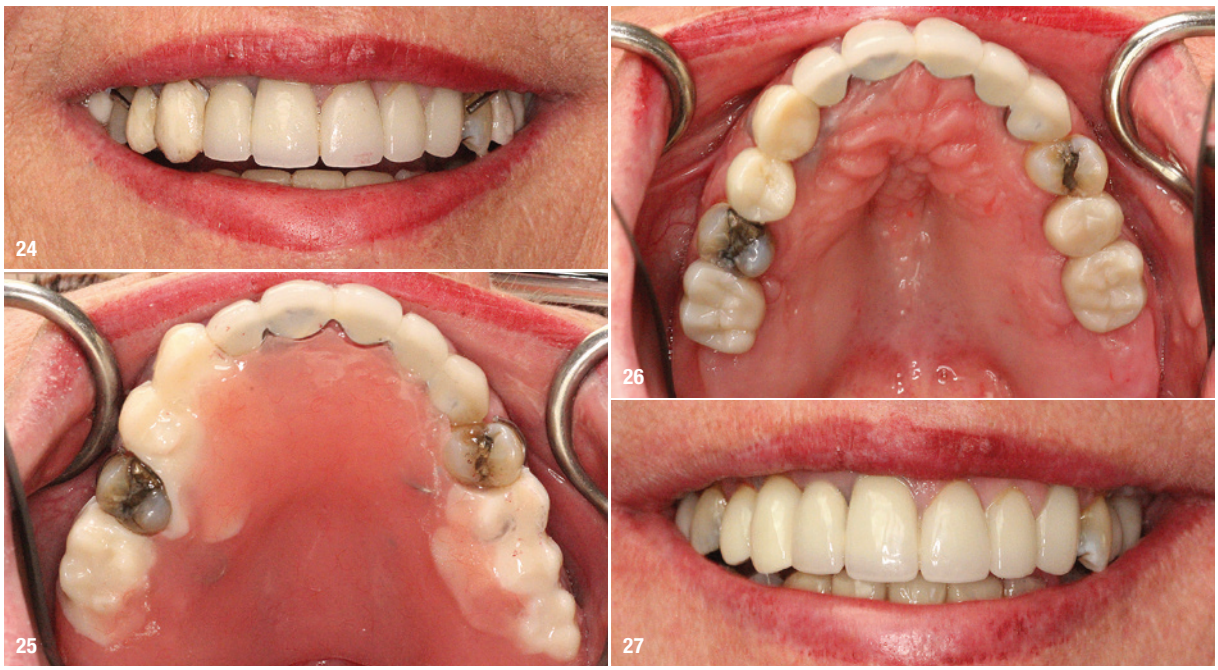


Fig. 24: Final prosthesis, front view. **Fig. 25:** Final prosthesis, occlusal view. **Fig. 26:** The definitive restorations, occlusal view. **Fig. 27:** The definitive restorations, frontal view.

the implant abutment before the denture base is fully relieved. A prefabricated removable prosthesis will not fit into a cast made after the surgery. Furthermore, the flapped surgery will change the soft tissue and the prefabricated prosthesis will create heavy pressure, not only on the implants but also on the soft and hard tissue around the surgical sites. The impression posts provided by the manufacturer are taller than the occlusal plane; therefore, additional PVS impression material should be loaded in the tray to ensure coverage of the soft tissue and palate. If the tray flange is too short to record the vestibular area, the height of the impression posts can be reduced or the tray flange extended with a light-activated composite resin material (Triad, Dentsply Sirona).

There are several advantages to using a vacuum-formed matrix to fabricate denture teeth. The position of the matrix can be moved slightly to accommodate the implant abutments. In addition, the contour of the teeth can be easily adjusted to create the best aesthetic results. After the matrix has been removed, the occlusal surfaces can be added to create the contacts. A disadvantage of the acrylic resin teeth is colour matching with the adjacent teeth. The shade can be modified by using the shade modifier (Minute Stain, George Taub Products).

Once the tooth-coloured acrylic resin polymerises, the acrylic resin must not be removed from the cast because the baseplate wax on the cast may prevent the acrylic resin from seating in the previous position. The adjacent stone teeth may also be broken when removing the acrylic resin from the cast. Ideally, the tooth-coloured acrylic resin will cover the wrought-wire clasps at this time. Although the wrought-wire clasps may be visible and compromise the aesthetics, the clasps will provide better retention for the prosthesis and minimise the lateral movements of the prosthesis. After the wound healing, the IDP will seat in a different position from that on the day of fabrication. It is very important to follow-up with the patient and use low-viscosity PVS to ensure that there is enough clearance between the abutments and the prosthesis. Occlusal contacts also need to be re-evaluated at the follow-up visits.

In this article, the authors used the impression posts as spacers for the clearance of the implant abutments. The advantage is ease of ensuring adequate clearance with the impression post. One can use the wax to cover the analogues, but the amount of wax over the analogues must be verified. The manufacturer adds a spacer part in its products and this will simplify this procedure. The technique presented in this article could be done chairside immediately after the surgery. The wrought-wire clasps can be fabricated before the surgery, but must be carefully evaluated on the cast with implant analogues to ensure clearance from the analogues. The relief cuts on the matrix will accommodate the space for the clasps and sticky wax.

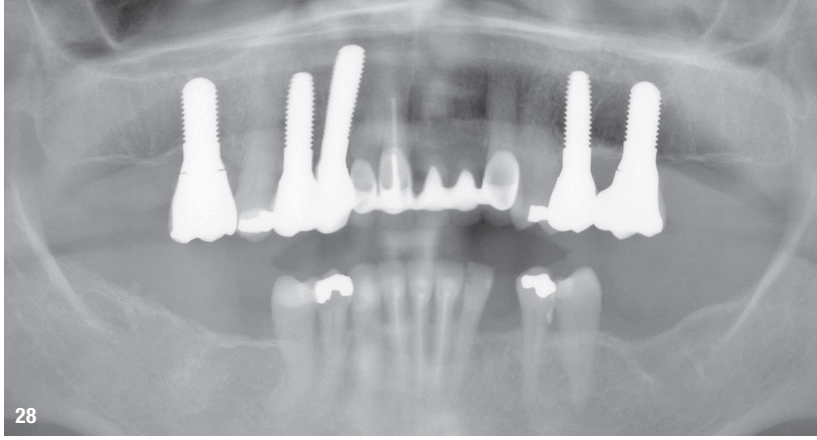


Fig. 28: Control radiograph of the definitive restorations.

Conclusion

A removable IDP should be considered as a treatment of choice when immediate loading on a one-piece implant is not the first option of treatment choices. The technique presented in the article provides clinicians with an easy reference for fabricating a device for aesthetics, function and protection before the definitive prosthesis can be delivered.

Literature

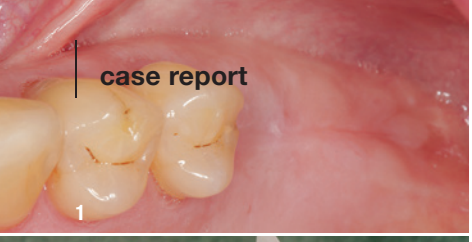
about the corresponding author

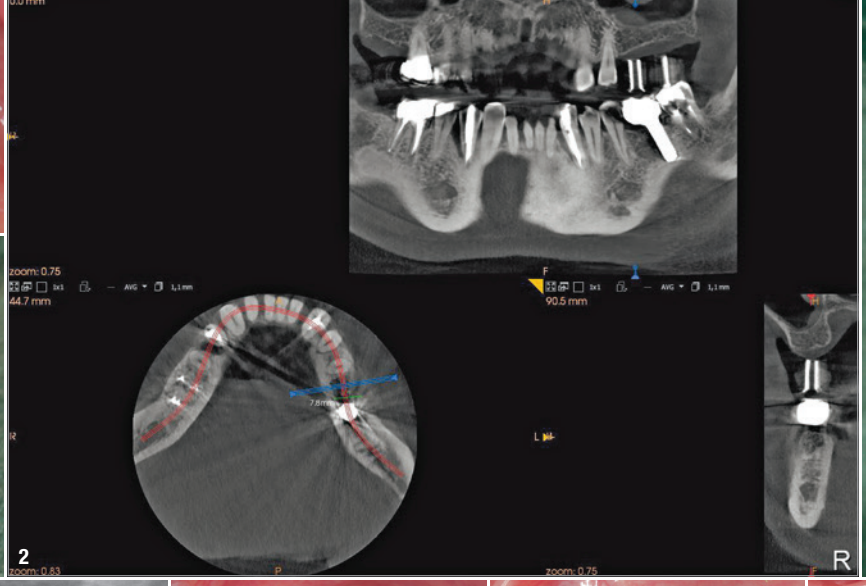
Dr Yung-Tsung Hsu is a US-based prosthodontist in Birmingham, AL, who has been involved in many clinical implant studies. He obtained his DDS degree from Chung-Shan Medical University (CSMU) in Taiwan in 1988 and a DMD degree from the University of Alabama at Birmingham (UAB) in 2010. He studied Advanced Prosthodontics at New York University and completed the programme in Graduate Prosthodontics at the UAB School of Dentistry. Dr Hsu published many articles in peer-reviewed journals about his studies and innovative techniques in prosthodontics.

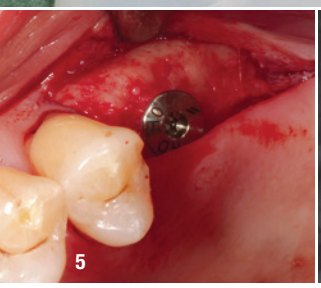
contact

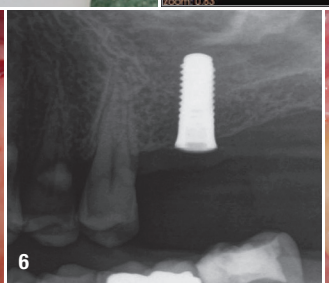
Dr Yung-Tsung Hsu
Division of Prosthodontics
Department of Restorative Sciences
School of Dentistry
University of Alabama at Birmingham
1919 7th Ave South, Room 534
Birmingham, AL 35294, USA
Phone: +1 205 9752284
ythsu@uab.edu

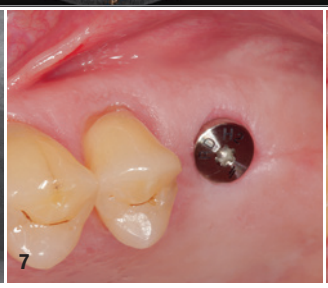
Author details











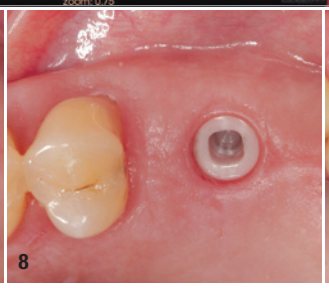


Fig. 1: Free-end situation in regions #26 and 27. **Fig. 2:** Preoperative three-dimensional planning. **Figs. 3 & 4:** Straumann® PURE Ceramic Implant. **Fig. 5:** Surgical situation with cover screw. **Fig. 6:** Post-op radiograph. **Fig. 7:** Situation after exposure. **Fig. 8:** Healthy marginal gingiva. **Fig. 9:** Taking an impression with an open impression post.

Single-tooth restoration of an upper molar with a ceramic implant

Dr Frank Hoffmann, Germany

Baseline

A 60-year-old man presented with a free-end situation in regions #26 and 27 which had been this way for about eight years. Three years ago, a PURE Monotype was successfully implanted in position 36 and fitted with a prosthetic restoration. His dental hygiene was excellent and region 36 was not irritated in any way. The patient now wanted to treat position 26 with a ceramic implant without major surgical intervention. 3D imaging (CBCT) showed sufficient transverse bone and a vertical height of approximately 5–6 mm to the maxillary sinus and thus, the use of a two-piece implant with an internal sinus lift was planned. The poor vertical bone supply and the reduced quality compared with the lower jaw would have posed a risk for successful osseointegration, if a single piece implant with transgingival healing had been selected. In preparation of the treatment a mild basal mucosal membrane swelling was checked by an ENT specialist and the patient performed nasal irrigation on a daily basis.

Surgical procedure

Following local anaesthesia, a crestal incision was made with only minimal mobilisation of the mucoperiosteal flap. For the internal sinus lift (performed according to the Summers technique), the pilot marking stops approximately 1 mm short of the margin of the maxillary sinus and is then widened with various osteotomes (Straumann Institute) depending on bone availability and quality. Here, it is essential that the Schneiderian membrane is regularly checked via a “Nasal patency test” to ensure that it is not perforated during the procedure. Following the successful preparation of the bony bed, an implant size 4.1/10 mm was inserted with very good primary stability. This was followed by wound closure with 5/0 monofilament sutures. After

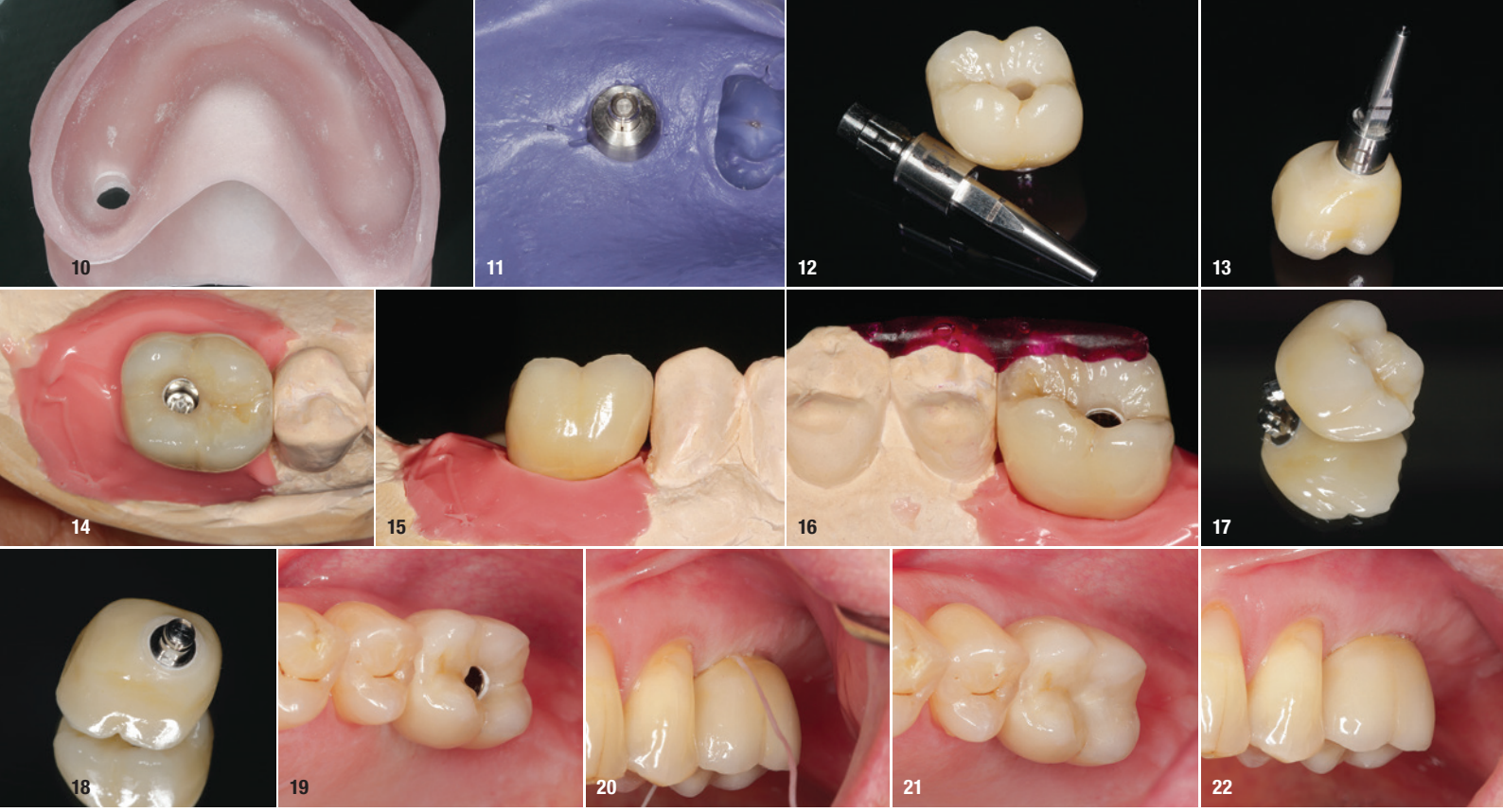


Fig. 10: Ideal customised tray. **Fig. 11:** Impression. **Fig. 12:** Zirconium crown & PUREbase on implant analogue. **Fig. 13:** Fit from basal direction. **Figs. 14 & 15:** Model situation. **Fig. 16:** Customised bonding aid. **Fig. 17:** Finished restoration. **Fig. 18:** Clean bond between base and zirconium crown. **Fig. 19:** Try-in. **Fig. 20:** Check efficient hygiene capacity. **Fig. 21:** Final result with occlusion. **Fig. 22:** Final result.

four months the minimally invasive exposure was performed with application of the gingiva former.

Prosthetic procedure

The implant position was transmitted to the dental laboratory with a customised open tray impression procedure and a stable polyether material. The alignment of the implant allowed a trans-occlusal screw-retained, veneered zirconia crown to be produced on a bonding base. What sets the construction apart is the fact that the metal on the bonding base is completely encased in zirconium in the finished construction. This demands outstanding technical precision and the use of a special “bonding aid” in the laboratory. For the first try-in of the crown in the patient we initially only secure the crown temporarily to the bonding base. This ensures that it is easily removed and can be refired if any correction is required. If the crown is completed in terms of the shade and shape, it is important to ensure that the final bonding is exactly in the same position on the bonding base as the previous try-in. To do this we produce a plastic key. Before the crown is integrated the hygiene capacity is checked and the restoration is tested to ensure that in future no traumatic forces can be exerted on it in occlusion and articulation. After applying the necessary torque, the screw channel is filled with Teflon tape and occlusion is achieved with composite.

Conclusion

The reduced bone availability in the posterior region of the maxilla demands that the implantology is adapted. The internal sinus lift technique is the established minimally invasive approach, although this harbours a risk in the healing phase for single-piece implants, depending on the volume and quality of the residual bone. The PURE implant is a perfect solution in this case, as optimum healing can be achieved with a submerged approach. In combination with the tried and tested, slightly modified Variobase, a functionally and aesthetically pleasing outcome is achieved.

about the author

Dr Frank Hoffmann is a Hamburg-based specialist in implant dentistry, periodontics, and aesthetic dentistry. He obtained his degree in dentistry at Hamburg University in 1988 and completed his PhD in 1989. Since 1991, he is leading his own practice in Hamburg in Germany, which has been growing through adding partners. He is a speaker since 2013 and leads practical study groups in implantology. He is a member in various dental expert societies.

contact

Dr Frank Hoffmann
Borgweg 15 B
22303 Hamburg, Germany
Phone: +49 40 6965970
www.borgweg.de

Author details

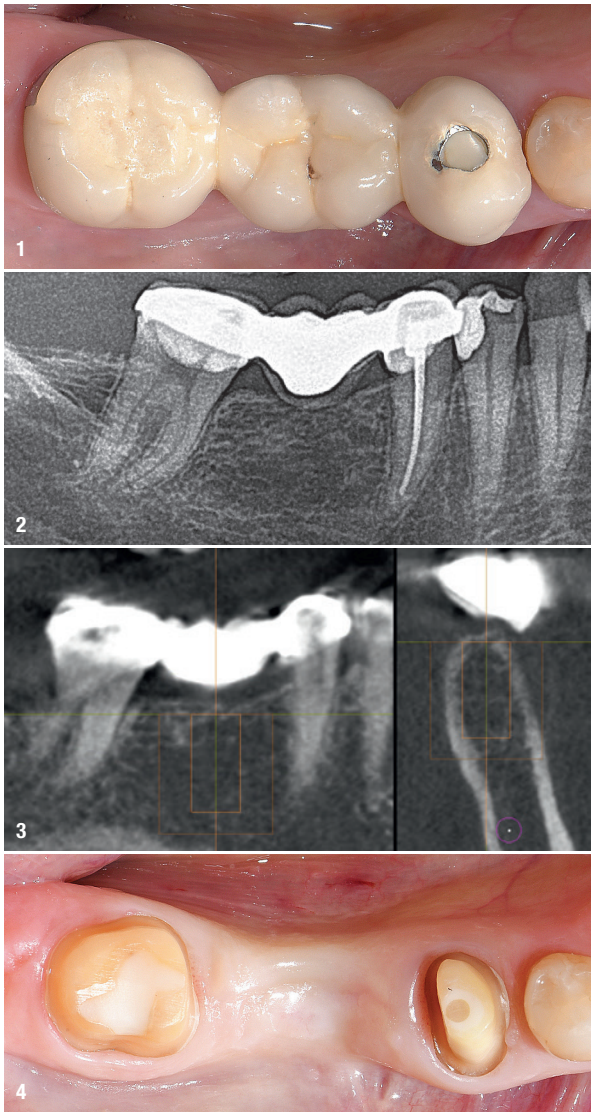
Patent™ zirconia implant system

A case report

Dr Sebastian Horvath, Germany

Introduction

Growing health concerns of patients have led to an increasing demand of metal-free restorations. The same is true for dental implants. As dental professionals it is our goal to fulfil this demand of our patients in the most predictable way. When it comes to implant treatments the two most crucial aspects regarding a treatment success are the osseointegration of the implant and the prosthetic workflow. The Patent™ implant system features a novel zirconia implant design with an innovative prosthetic connection. In a prospective cohort study by Becker et al. 2017, the Patent™ implant system was evaluated for posterior single tooth applications with good results. The survival rate was 95.8 % after two years. A very positive soft tissue response was also reported. This is in line with what was reported by Brüll et al. 2014, in a 3-year retrospective follow-up. The following case report shows the replacement of a lower molar using the Patent™ zirconia implant system.



Initial situation

A 54-year old female patient presented at the author's office, asking for a general restoration of her teeth. As a part of this complex case the lower right quadrant was restored (Figs. 1 & 2). The treatment of this area is the subject of this case report. The patient reported that the old restoration was placed about 20 years ago after tooth #46 was lost due to endodontic complications. A few years after the placement of the restoration tooth #45 was endodontically treated through the placed restoration. Now the patient reported an increasing sensitivity on tooth #47 due to ill-fitting margins. It was planned to restore the area with two all-ceramic crowns on teeth #45 & 47, and an implant-retained restoration in site #46. The implant-retained restoration was preferred to a new fixed dental prosthesis in order to reduce the load on the endodontically treated tooth #45 and to reduce future risks by incorporating an endodontically treated tooth in a larger restoration. Initially, a CBCT was made in order to evaluate the bone volume in the edentulous areas and to evaluate existing root canal treatments.

Pre-treatment

The CBCT revealed sufficient bone volume in site #46 to place an implant (Fig. 3). A custom implant was designed in order to get the optimal transgingival design for this in-

Fig. 1: Initial situation in the lower right quadrant. The patient reported about increasing sensitivity on tooth #47. **Fig. 2:** Initial radiograph showing the lower right quadrant. Note the ill-fitting margin distal on tooth #47. **Fig. 3:** A CBCT revealed sufficient bone volume in site #46 to place an implant. **Fig. 4:** Clinical situation prior to the surgery.

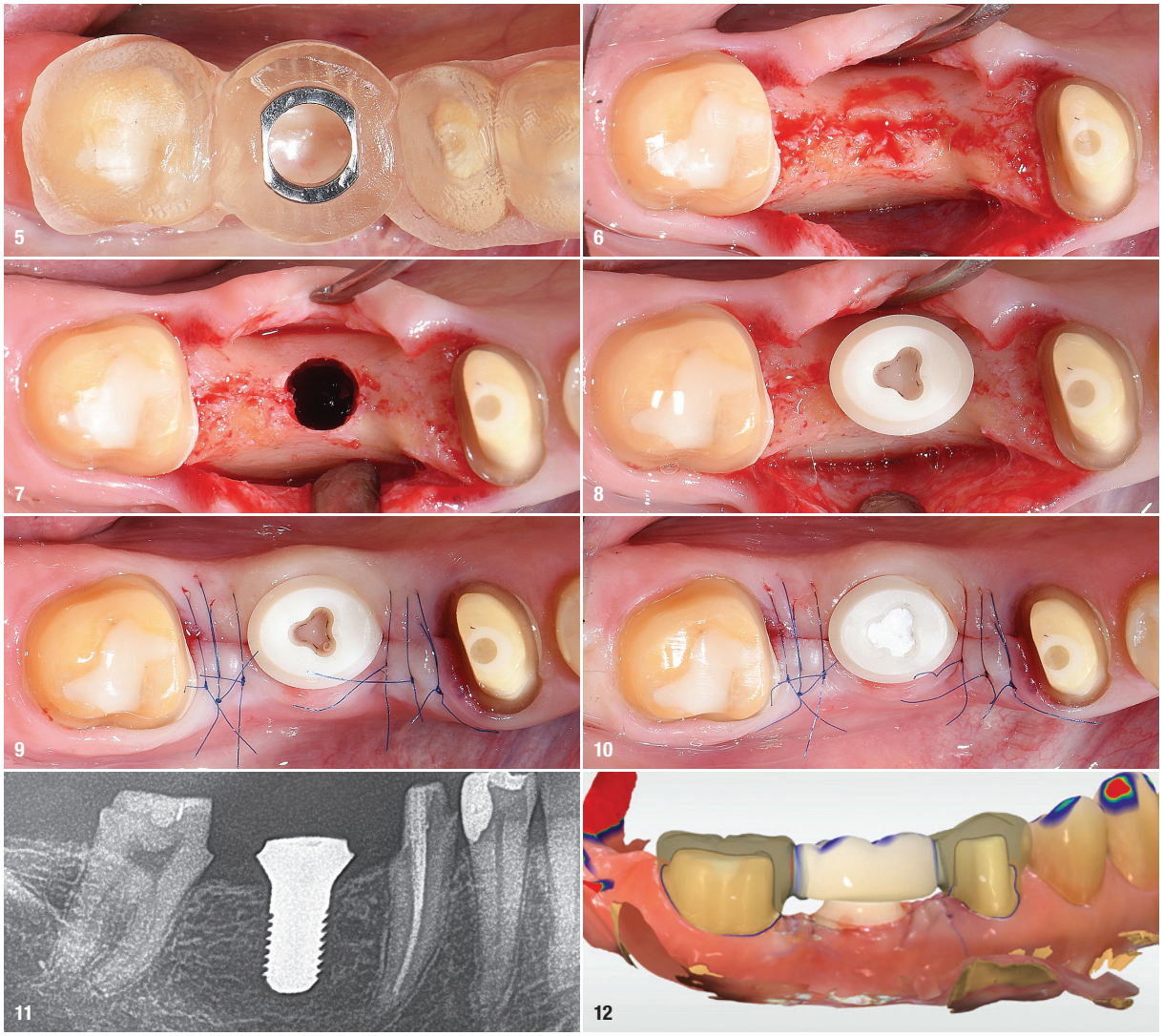


Fig. 5: The placed surgical guide. **Fig. 6:** A full-flap was elevated to gain access to the bone. **Fig. 7:** The osteotomy was performed using the drilling protocol for hard bone. **Fig. 8:** The custom-planned zirconia implant was placed and a sufficient primary stability of 30 Ncm achieved. **Fig. 9:** Wound closure. **Fig. 10:** The prosthetic connection was sealed using Teflon tape. **Fig. 11:** Radiographic evaluation of the implant position. **Fig. 12:** In the area of the newly placed implant the provisional restoration was planned as a flat pontic towards the implant with a distance of about .1 mm between the implant and the provisional restoration.

dividual case. The intrabony part of the implant had the dimensions 4.5 x 9 mm. The old fixed dental prosthesis was removed and tooth #45 built-up with a post and core restoration. Subsequently, a digitally planned provisional restoration was fabricated and placed. The scan for the provisional restoration was further used for the fabrication of a surgical guide. For this, the scan was matched to the CBCT on the contralateral posterior teeth and the anterior teeth as they remained unchanged from the initial situation.

Implant placement

The fit of the surgical guide was evaluated prior to the surgery (Fig. 5). Following local anaesthesia, a full-flap in site #46 was elevated to gain access to the bone (Fig. 6). The incision was performed centrally on the ridge in order to evenly space out the attached gingiva on the lingual and buccal sides. Subsequently, a guided osteotomy was performed according to the manufacturers recommendations (Fig. 7). The drilling protocol for hard bone was used, which includes a cortical drill and a screw tap. The implant was placed and a sufficient primary stability of 30 Ncm was achieved (Fig. 8). The insertion torque was measured electronically during the placement of the implant. The incision was closed and the prosthetic connection sealed using Teflon tape (Figs. 9–11). A new, digitally planned provisional restoration was fabricated (Fig. 12). In the area of the newly placed implant the provisional restoration was planned as a flat pontic towards the implant with a distance of about .1 mm between the implant and the provisional restoration. This design facilitated good cleaning in the following weeks and also ensured that the implant was unloaded during healing. Sutures were removed ten days postsurgery. Healing was uneventful.

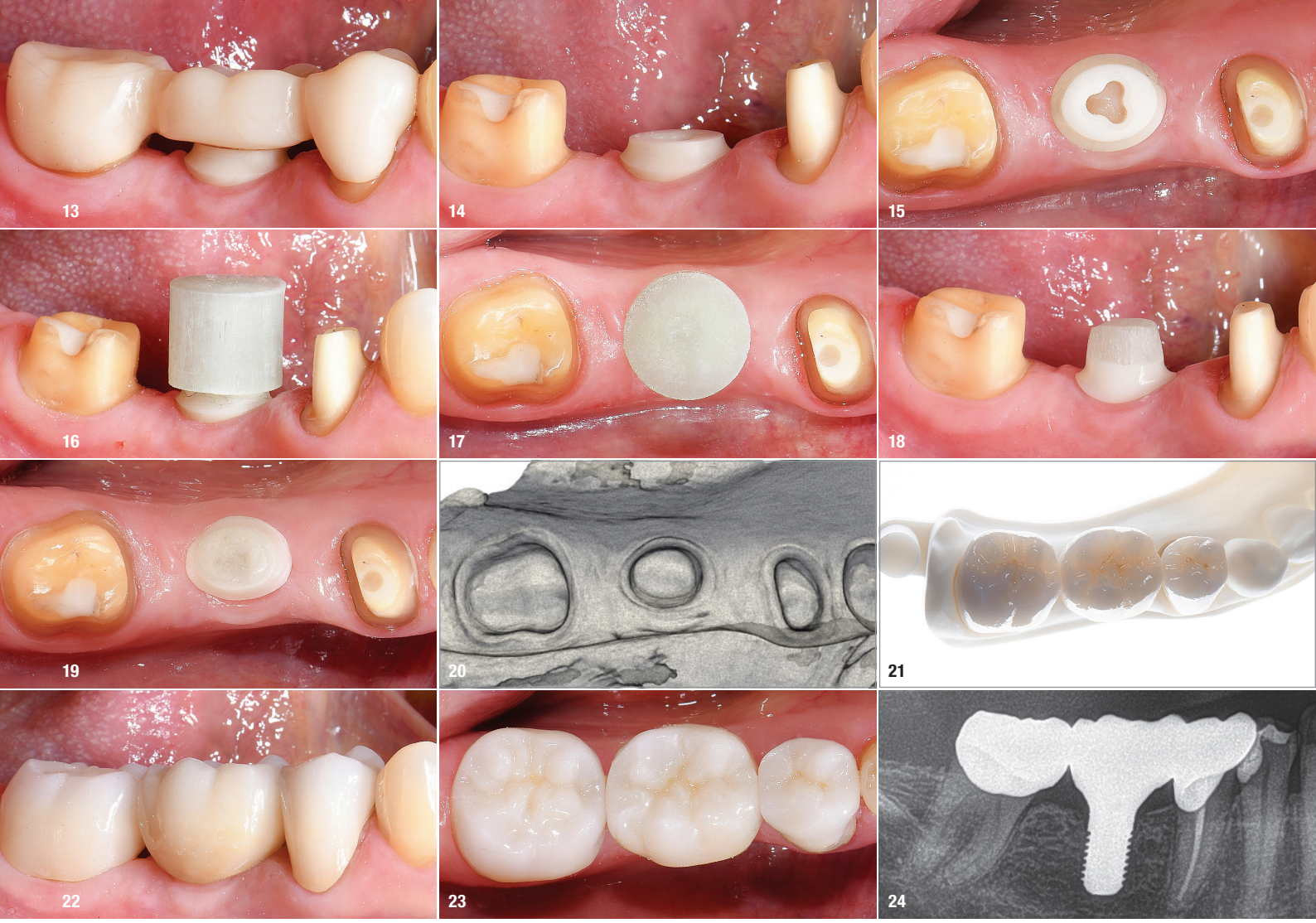


Fig. 13: Clinical situation three months after implant placement. Healing was uneventful. **Fig. 14:** The implant was stable and the soft tissue presented itself as healthy. **Fig. 15:** Occlusal view. **Fig. 16:** For the prosthetic reconstruction a glass fibre post and core assembly was adhesively cemented on the implant. **Fig. 17:** The post and core assembly is pre-fabricated and tightly fits into the implant connection. **Fig. 18:** Following this build-up, the implant was prepared for a full-crown restoration just like a natural tooth. **Fig. 19:** Occlusal view. **Fig. 20:** An intra-oral scan was performed for a lab-side prosthetic workflow. **Fig. 21:** Three monolithic zirconia crowns were fabricated (Ceramics: MDT Claus-Peter Schulz). **Fig. 22:** Intra-oral view of the treatment result. **Fig. 23:** Occlusal view. **Fig. 24:** Radiographic evaluation of the treatment result.

Prosthetic reconstruction

The prosthetic phase was commenced three months after implant placement. The provisional restoration was removed and final preparations performed on the abutment teeth. Following an uneventful healing phase, the implant was stable and the periimplant soft tissue healthy (Figs. 13–15). For the prosthetic reconstruction a glass fibre post and core assembly was adhesively cemented on the implant (Figs. 16 & 17). The post and core assembly is pre-fabricated and tightly fits into the implant connection. Following this build-up, the implant was prepared for a full-crown restoration just like a natural tooth (Figs. 18 & 19). An intra-oral scan was performed and three monolithic zirconia crowns fabricated using a lab-side workflow (Figs. 20 & 21; Ceramics: MDT Claus-Peter Schulz). The final restorations were cemented. Figures 22 to 24 show the final treatment result.

Literature

about the author

Dr Sebastian Horvath specialises in aesthetic-restorative dental treatments. He works together with his wife and father in a joint practice in Jestetten, Germany. He studied dentistry at Freiburg University, where he also obtained his doctorate. He then worked at Freiburg University Hospital as a research assistant and completed a training as a listed specialist for prosthodontics. Dr Horvath teaches at the University of Pennsylvania, USA, and Düsseldorf University Hospital, Germany.

contact

Dr Sebastian Horvath
Bahnhofstraße 24
79798 Jestetten, Germany
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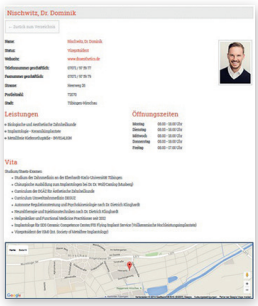

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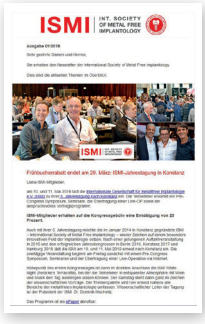

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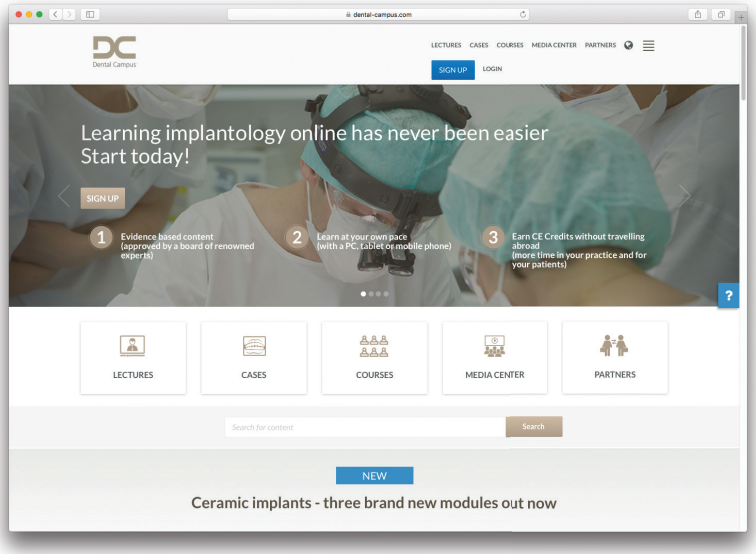
The Ceramic Excellence Program is an online training programme for the use of the CERALOG® ceramic implant system. It takes place on an innovative online platform: Dental Campus. The content of the Dental Campus educational programme is provided by an international network of teaching centres. It is reviewed by a global independent committee of renowned experts and divided into different modules that cover the entire field of implantology.



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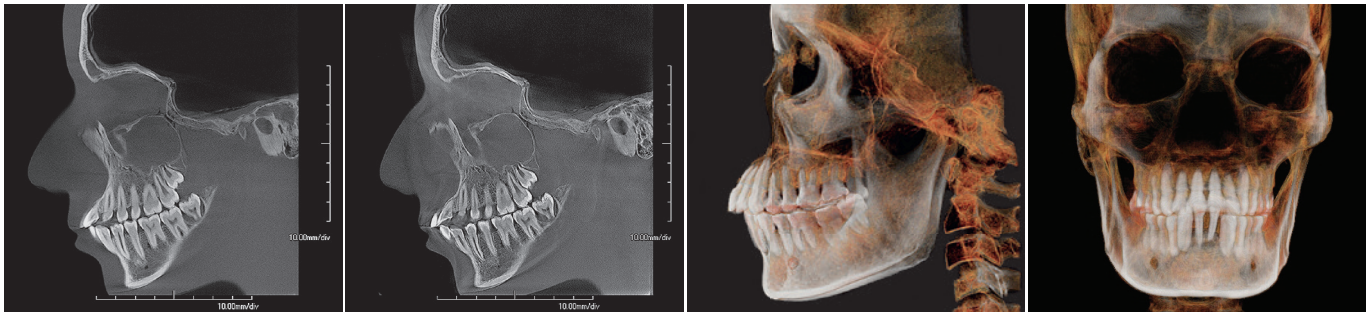

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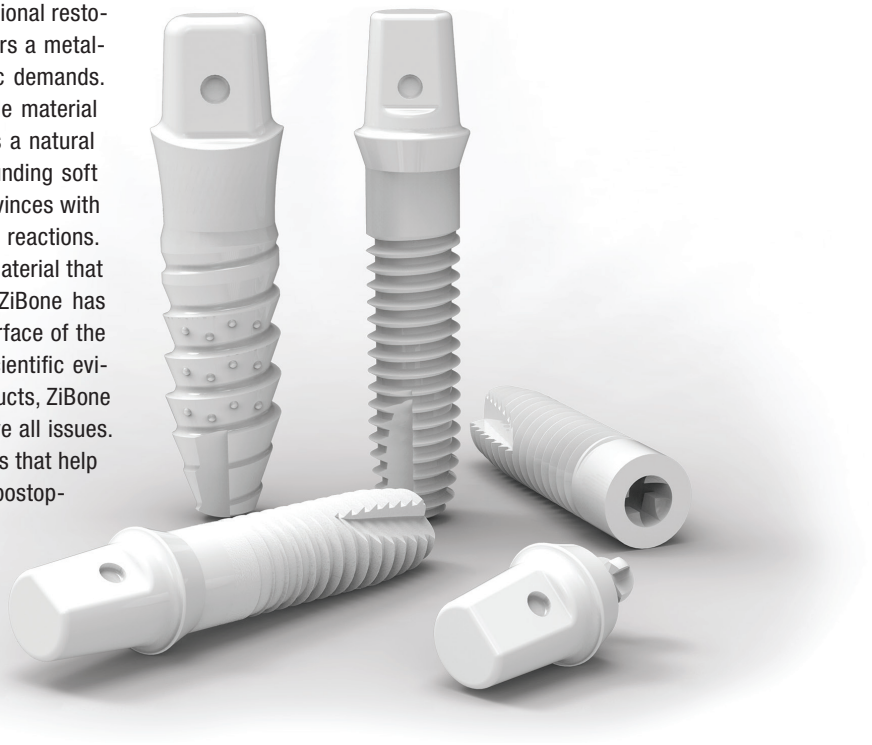

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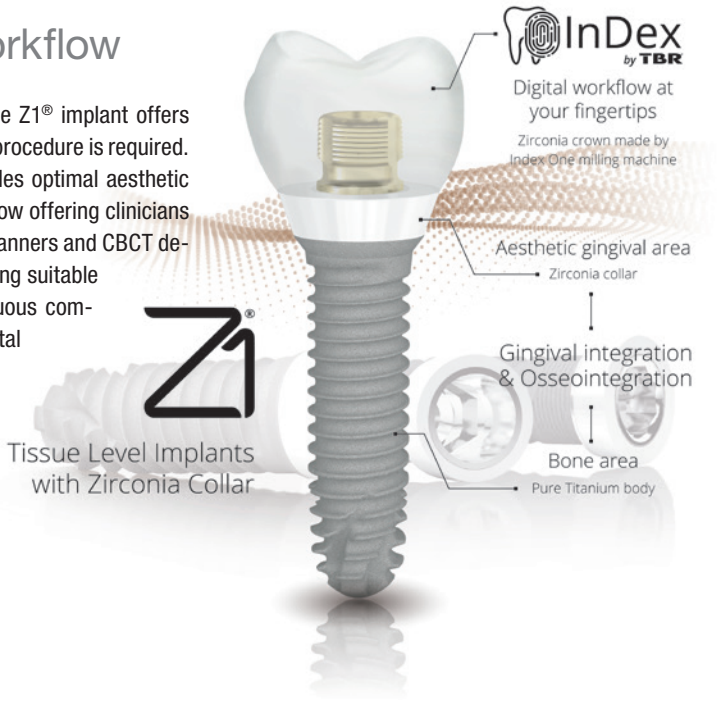

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Holbeinstraße 29 · 04229 Leipzig · Germany · Phone: +49 341 48474-201 · s.schmehl@oemus-media.de

A new solution in the field of digital workflows

Fig. 1: Adrian Hunn was elected new CEO of Dentalpoint at the beginning of 2020.

In this interview, new Dentalpoint CEO Adrian Hunn talks about the new competence centre for Zeramex Digital Solutions and master dental technician Peter Hölldampf, laboratory manager at the Germany-based machining centre Geiger Dentaltechnik, a close partner of Zeramex, discusses material-specific aspects of zirconium dioxide.

Mr Hunn, the company Dentalpoint, which owns the Zeramex brand, opened its new competence centre for Zeramex Digital Solutions last year. There are probably at least some users, dental technicians and dentists who have not heard of it yet. Can you explain exactly what a competence centre is and how the customer can benefit from it?

Hunn: The market is demanding new solutions in the field of digital workflows, so it is a logical step for the R & D department at Zeramex to find new ways, approaches and, ultimately, solutions for our two-part and 100 % metal-free systems to meet this demand. And our R & D department has done a great job in this regard over the past two years. We are now able to offer fully customised and 100 % metal-free solutions from the new Zeramex Digital Solutions competence centre. Our customers now have the possibility of sending digital data to our competence centre by secure data exchange, which enables them to order, for instance, customised abutments directly from us. But that is by no means all. Our product portfolio embraces fully customised abutments, one-piece monolithic crowns, and custom-made crowns with and without screw holes for ZERABASE abutments, all made to the highest degree of precision. Whether for restorations of anterior or posterior teeth, we have the perfect solution for each and every situation. In addition, customers can choose to have their crowns ready coloured and glazed. A 3D-printed model can also be produced on request so that the practitioner can check the restoration before insertion and show it to the patient as a tangible model. Of course, every order comes as standard with the required 100 % metal-free VICARBO screw. In addition to the direct implementation of the orders, our competence centre offers advice in the field of data processing and in the selection of the perfect product for the individual needs of the customer.

> “In the near future, the competence centre will certainly provide users with innovations as well as enhancements of existing products.”

It has been a few months now since Zeramex Digital Solutions was first launched. How much has the new competence centre appealed to users and how strong is the demand?

Hunn: As I pointed out earlier, the ordering process is very simple and uncomplicated and therefore runs very smoothly. This meant that, at start-up, only minor changes to the ordering process were necessary. The simplicity with which customers can get high-quality, customised and, above all, metal-free solutions adapted

to the specific gingival situation generated a great deal of very positive feedback. This interest, combined with the fact that the demand for digital solutions is already very great, made it possible for us to achieve an even better start than we expected. Customers and users with whom we have long-standing, close relationships naturally knew about our project at an early stage and were involved in product and process optimisation. Not only did they support us in this project, but they also confirmed that there will almost certainly be great demand for the new competence centre in future.

The word "future" brings us to the next question. Will the digital workflow at Zeramex offer even more options in future? Are you already working on further developments in the Zeramex Digital Solutions department, and if so, what form will these take?

Hunn: I thought you might put this question to me [laughs]. Indeed, there are product enhancements that are already in development and, in some cases, almost completed. In the near future, the competence centre will certainly provide users with innovations as well as enhancements of existing products. Of course, I cannot yet tell you exactly what these will be. In addition to the product, delivery times are an issue. We are already working intensively on offering the customer shorter delivery times as soon as possible. The aim is that, in future, Zeramex Digital Solutions products will be received by the customer within two days of placing the order.

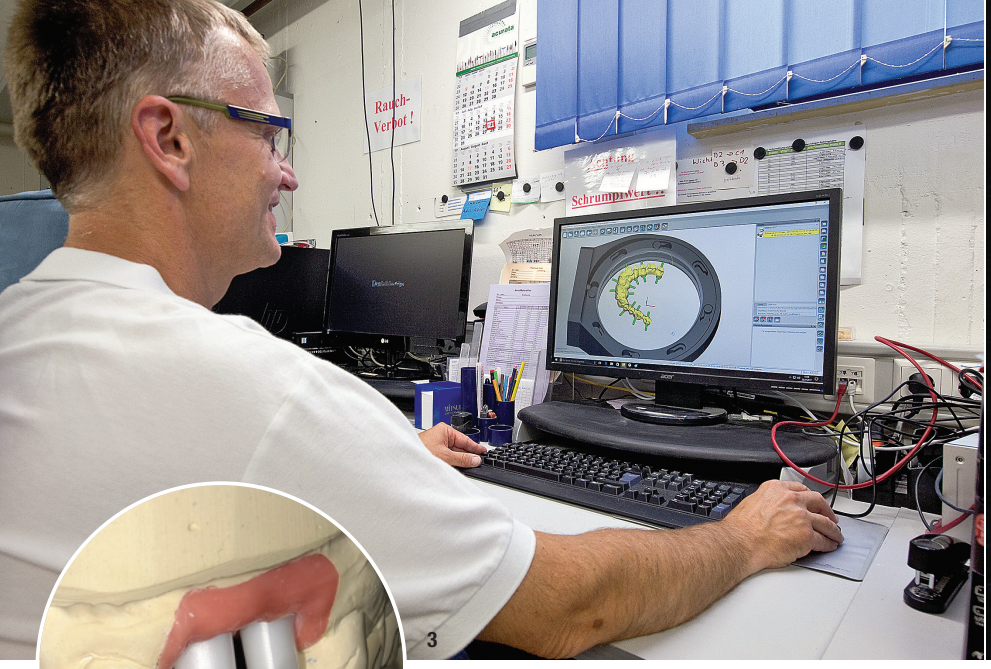
Mr Hölldampf, you are the laboratory manager at Geiger Dentaltechnik, one of the longest established machining centres in southern Germany and a close partner of Zeramex. In 2000, your laboratory was the first in Germany to use 3M ESPE to implement a pilot project for milling zirconium dioxide with CNC machines which operated on a CAD/CAM basis. What can you tell us about this material, the machining process and your experience with it?

Hölldampf: Yes, that was very exciting back then. Zirconium dioxide was still in its infancy, and when 3M, then ESPE, came to us to test this new process, we were initially quite sceptical about whether it would work. In the test phase, we realised that the material zirconium dioxide was unique and functioned really well and that it would, therefore, be possible to do quite a lot with it. Of course, zirconium dioxide has its pitfalls, and there are a few things to consider when preparing and machining it. At the end of the day, zirconium dioxide is a ceramic. This means that you have to carefully investigate factors like stability values, connector cross sections for bridges and the creation of the correct substrate for subsequent veneering ceramics. There are many factors that come into play. Extremely precise processing must be ensured over all the manufacturing steps. In the past, full-ceramic restorations were really only possible using pressed ceramics or the hot isostatic pressed variant. Milling in the green state, however, was a complete innovation. This new approach was gentle on the material, the machine and the milling tool. In addition, it was possible to achieve much more detailed and precise results.

It is said that stability is still an issue with zirconium dioxide. You have been working with this material for over 20 years. What is your opinion about its stability?

Hölldampf: Zirconium dioxide is a very hard material. If we take a gold crown for comparison, it is much more forgiving in terms of chipping. This is because gold is much more malleable than ceramic. For the ceramic process, this means that an absolutely perfect impression is required in advance. If uncertainties are already present in the impression, this can lead to inaccuracies, and there is a risk of parts of it breaking off. Since pressure cannot be used to apply zirconium dioxide restorations, a perfect fit must be assured. A gold matrix is more forgiving. Because zirconium dioxide is such a hard material, the product has to be extremely precise and a perfect fit, as I said. The fit is the absolutely crucial. In the further course of machining, it is also important to process it carefully without pressure and with the right cooling. Especially in the area of the geometry of implant connections, it is important to use extremely stable ceramic material. The pressure on a natural tooth is simply very different from that on an implant. An implant is firmly anchored in the bone and allows practically no further movement.

Fig. 2: Peter Hölldampf is the laboratory manager at Geiger Dentaltechnik, one of the longest established machining centres in southern Germany.



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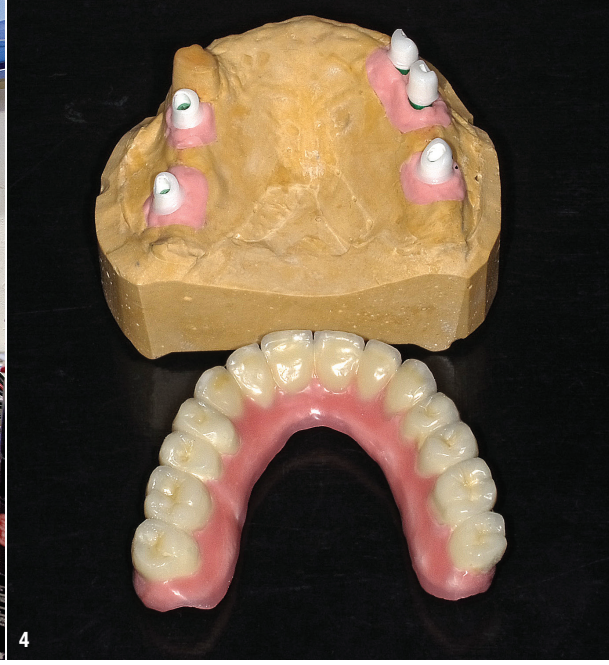

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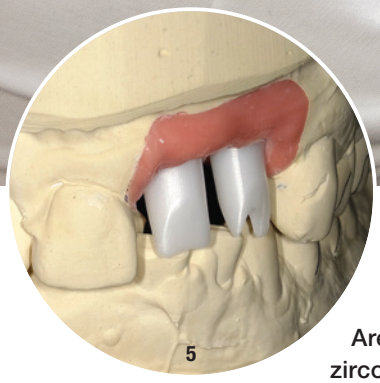

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Figs. 3–5: ZERAMEX Digital Solutions offers customised and completely metal-free abutments, crowns and even one-piece monolithic crowns.

Are there still problems with fitting with zirconium dioxide, and does this require a lot of reworking?

Hölldampf: Actually, this is no longer really the case. Above all, owing to improvements in the software in recent years, it is now possible to work much more precisely in scanning and then digitally designing the implant. As a result, significantly less reworking has been required in recent years.

> "Especially in the area of the geometry of implant connections, it is important to use extremely stable ceramic material."

Zeramex Digital Solutions offers customised and completely metal-free abutments, crowns and even one-piece monolithic crowns. To what extent have you, in the laboratory, been able to benefit from these innovations?

Hölldampf: The issue is really the connection geometry of the abutment, that is, the prosthetic restoration of the dental implant. Milling this connection geometry in zirconium dioxide is highly problematic, since no manual post-machining should be carried out in this area. Only a perfect first-time fit in the transition area will provide a product that functions perfectly. Because this connection geometry is milled directly by the Zeramex Digital Solutions competence centre, you have to be able to simply count on it being a perfect first-time fit. And this means that we immediately get a super-functioning product in original manufacturer quality that we can use to create our custom restorations.

Are there comparable products on the market with regard to customised abutments or customised monolithic crowns?

Hölldampf: In the past few years, we have had products from various zirconium dioxide implant manufacturers. I would say that there are comparable products, yes, but there have never been other products where you can safely assume there will never be complications when it comes to fitting in the patient's mouth. In Zeramex, we have found a partner whose product simply works. The product is carefully considered and planned down to the last detail and perfectly harmonised with other components. The system is logically structured, all parts fit together perfectly, and the great thing for us is that we can rely on finding the best solution for every job, regardless of the size. We have never had any other product in our laboratory that comes close to the quality of Zeramex.

contact

Adrian Hunn
Dentalpoint
Bodenäckerstr. 5, 8957 Spreitenbach, Switzerland
Phone: +41 44 3883636
info@zeramex.com

Peter Hölldampf
Geiger Dentaltechnik GmbH
Gottlieb-Daimler-Straße 3
73529 Schwäbisch Gmünd, Germany
Phone (laboratory): +49 7171 9806-11
Phone (milling centre): +49 7171 9806-29
info@geiger-dentaltechnik.de
millingcenter@geiger-dentaltechnik.de

ISMI and IAOCI join forces

Drs Sammy Noumbissi (US) and Karl Ulrich Volz (Switzerland) are two of the most experienced surgeons worldwide when it comes to modern one-piece and two-piece ceramic implants. In the past 20 years, the two combined have successfully placed several thousand ceramic implants. Moreover, they are the founding presidents of the first two international expert societies for ceramic implantology—the International Academy of Ceramic Implantology (IAOCI) and the International Society of Metal Free Implantology (ISMI). *Ceramic implants* had the opportunity to interview the two about future joint activities.

Editorial note: The ISMI initially planned to hold its 2020 annual congress in May in Berlin, for the first time in cooperation with the IAOCI. Owing to the current COVID-19 pandemic, however, the decision was made to postpone the event to 2021 and it is now set to take place on 7 and 8 May 2021 in Düsseldorf. For more information, contact the organiser at events@oemus-media.de.

Drs Noumbissi and Volz, you two have been friends and colleagues for many years. Now, the IAOCI has also officially joined ISMI as an educational partner for its 2021 annual congress. What's the main reason behind you two joining forces?

Dr Volz: Sammy, whom I extremely respect as a great surgeon, ambitious teacher and very honest friend, is truly committed to pushing the paradigm shift regarding ceramic implants forward. He dedicates and commits himself entirely to his expert society, the IAOCI. Yet, ceramic implants represent only a small share of the entire dental implant market. It thus makes a lot of sense to join forces and to support each other in our activities and conferences. ISMI will be organising congresses in the German-speaking countries and in northern Europe, and the IAOCI will take care not only of the US but also of Latin America, Africa, Australia and possibly Asia.

Dr Noumbissi: We have worked and supported each other as individuals but also as associations for the last ten years. The IAOCI from its creation had global ambitions, which we continue to work toward achieving. ISMI had the fortune of being founded and led by Ulrich, who is a man with a broad vision and a lot of perseverance. We are joining forces at this stage because a lot of the groundwork laid by ISMI and the IAOCI to educate our colleagues and the general public is now yielding positive results. I can confidently say that, had we not had the courage and temerity to push forward with our respective goals, ceramic implants would not have drawn the attention and interest we are seeing now. If you look at the ceramic implant market today, it constitutes no more than 2 % of the global implant market, as manufacturers are just starting to understand that there is a demand and even a need for metal-free implants. Therefore, as the leaders in the field, we thought that it would be best to join forces to adequately educate the world on ceramic implants, because we believe that there is a need for a uniform and organised message. Academic institutions, researchers and the industry respond better to firmly established and well-organised groups. This is why we now offer ISMI and IAOCI members a dual membership programme and we aim at aligning our educational initiatives more strongly in the future on the basis of shared educational standards. Against this background, ISMI's Curriculum for Biological Dentistry is now also fully recognised by the IAOCI.

IAOCI | International Academy of Ceramic Implantology

Dr Noumbissi, you formed the IAOCI in 2011. What were the reasons for founding an academy that is solely dedicated to ceramic implants?

Dr Noumbissi: When I introduced ceramic implants in my practice, I was one of ten or 15 dentists in the Americas who were placing ceramic implants. Even though I am a trained implantologist, the start was not easy because there were no firm guidelines, and documentation was scarce and was for the most part produced by manufacturers of the few systems available at the time. Ceramic implants, although they look like their counterparts, require a tremendous amount of attention to detail in all phases of treatment. Biology, physiology and immunology, to name just a few, are important factors to take into consideration if one wants to be successful with ceramic implants. Furthermore, research findings and unbiased literature were hard to come by. There was a big void for the early adopters, so we had to learn from one another and do so quickly, because the demand for metal-free implants was and continues to be mainly driven by patients, rather than dentists. The only way to meet these initial challenges was to organise ourselves.

Many clinicians would approach me and Ulrich asking for training courses and resources. These are some of the few reasons that played a great part in the creation of the IAOCI; we wanted to create an environment in which dentists could freely share with one another their experiences, but above all get proper training and knowledge about ceramic implants. We wanted to create an ecosystem in which clinicians, manufacturers and researchers could exchange, communicate and contribute to one another's growth. Seven years into the academy's existence, we created the Zirconia Implant Research Group, whose objective is to give some direction to the science, improvement and development of ceramic implants. ISMI has done the same: they—in some cases collaboratively with the IAOCI—are conducting important research projects across the globe in order to properly document and scientifically consolidate daily clinical facts long proven and accepted by early adopters and clinicians.

ISMI | INT. SOCIETY OF METAL FREE IMPLANTOLOGY

Dr Volz, founded in 2014, ISMI is the first expert society for ceramic implants in Europe. What is ISMI's approach to modern-day dentistry?

Dr Volz: Dental implantology actually started with ceramic implants, and Prof. Willi Schulte, the inventor of the first ceramic implants, wrote me a personal letter shortly before he passed away in which he said that, at the beginning, he received no approval to compare his ceramic implants with titanium implants because at that time the relevant ethics committee didn't expect them to be safe. Titanium intolerance is expected to be somewhere between 10 and 25 %, and according to the 2006 European Consensus Conference, the rate of peri-implantitis is around 50 %. This peri-implantitis tsunami has become one of the main topics at all mainstream implantology congresses. Even the U.S. Food and Drug Administration launched an investigation in November 2019 not only into amalgam but also into metal-containing implants. According to the latest studies, ceramic implants are at least as good as their titanium counterparts in terms of osseointegration, success rate, bone loss and overall stability. They even outperform them significantly in terms of soft-tissue reaction and aesthetics, and no intolerance or peri-implantitis occurs with them. Employing ceramic implants as an alternative in the daily practice has become a feasible option for many well-known surgeons all over the world, especially those with an affinity for biological dentistry, which I predict will become a new megatrend in dentistry in the future. Prof. Ghanaati also states that we dentists need to put an increasing focus on biology in dentistry. ISMI is an organisation which not only ad-

dresses ceramic implants as its main topic, but focuses on biology and immunology as well.

Comparing the situation of ceramic implants in the early days, when you started working with them, to today's ceramic implantology, what are the main differences? Are there any at all?

Dr Volz: Of course, there are! When I started placing my first ceramic implants back in 2000, I had only a few followers. Both the majority of dentists and the industry considered me a threat, and I was verbally attacked after all my lectures at orthodox forums. Only last year there was a great change, since all the big titanium companies launched their own ceramic implant systems. When I talked at the first ceramic congress of the renowned NEUE GRUPPE in Cologne, there was a clear consensus at the end of the event that identified ceramic as rightly comparable to titanium—and even better when it comes to aesthetics and soft-tissue reaction. At my lecture at the German Association of Dental Implantology (DGZI) conference one month later in Munich, I was well received and had the feeling of having advanced from being an outsider to being an insider.

Dr Noumbissi: When I started placing ceramic implants, they were only available in one-piece configuration and their surfaces were either sandblasted or acid-etched. The options were limited. The last six years has seen a rapid evolution in both the manufacturing and design of zirconia implants. We now have two-piece implant systems with screw-retained abutments. We can now treat partially and completely edentulous patients. The success rates of ceramic implants are now on par with those of titanium implants. For me, the major change has been patient preparation and case planning. Ceramic implants, by virtue of the material, require healthy bone as a precondition for achieving good and consistent results. Healthy bone and healing can only be found in healthy patients, especially from a systemic point of view.

How have your peers reacted when introduced to the handling of ceramic implants for the first time?

Dr Volz: Most of them were quite critical at first, which is due to the deeply entrenched misunderstandings they adopted over the last decades regarding ceramic implants, but once they begin to understand that ceramic is different, much easier to handle and safer, they tend to become enthusiastic about ceramic implants and their biological approach. If you gave me just two hours, I would be able to convince any surgeon. The benefits are just so obvious.

Dr Noumbissi: The most difficult obstacles for a clinician are first to get past the fact that implants made of ceramic can endure the rigours of the oral environment, second to understand that it is a better and safer material to be implanted, and third to understand that, before he or she considers placing a ceramic implant, he or she should apprise himself or herself of the patient's general health. In my view, it is a transition a clinician must be willing to make because, although the actual placement of ceramic implants is the same as with titanium implants, they are most successful when planning includes the patient as a whole. Finally, once the implants have been placed and are ready to be restored, dentists almost always marvel at the health and quality of soft tissue around the implants. Then they realise that they are working with very special material.

Patients' happiness and their feedback play a crucial role in evaluating whether treatment has been successful or not. How have your patients reacted after being treated with ceramic implants?

Dr Volz: If you ask patients what kind of material they prefer to be used in their mouths, they will almost always go with the metal-free option. This is backed by a survey that was done by Straumann, which showed exactly this result. For one thing, patients feel better after being treated with non-metal solutions, owing to a positive effect on psychoneuroimmunology. In addition, by following the biological approach, patients mostly feel better overall. They show fewer holistic symptoms, and they have more energy in general. At our clinic, we are currently conducting a study to prove these changes by measuring various parameters before and after treatment: HRV is measured with a validated device, and eye vision, length of the telomeres and mitochondrial function are measured by means of validated programmes. Moreover, we administer a validated medical symptoms questionnaire. When comparing the photographs of patients' faces before and after their treatment, one can see that they look totally different. These results were presented for the first time at a joint meeting in Dallas in March where the top four biological dental and medical organisations have been working together. Actually, this event was the trigger to talk to the president of the IAOCI, Sammy, in order to join forces and make us stronger together.

Drs Volz and Noumbissi, thank you for your time.

contact

International Society of Metal Free Implantology e.V.
Lohnerhofstraße 2
78467 Konstanz, Germany
www.ismi.me

International Academy of Ceramic Implantology
3820 Northdale Blvd, #205A
Tampa, FL 33624, USA
www.iaoci.com

Ceramic implantology in Europe

Initiating change and creating synergies

In 2018, the European Academy of Ceramic Implantology (EACim) was founded to help promote advancements in ceramic implantology in Europe. In this interview with ceramic implants, EACim President Dr Giancarlo Bianca elaborates on the need for an additional expert society dedicated to zirconia implants.

Dr Bianca, thank you for your time. In 2018, you and your colleagues founded the EACim. As President of one of the most ambitious projects in recent ceramic implants initiatives, can you tell us what the EACim stands for and what its goals are?

Implantology is a European innovation and the ceramic implant has been European ever since its development by Prof. Sami Sandhaus in 1968 and since its current evolution of the zirconia implant. We, the six founding members of this European academy, are private practitioners, teachers or lecturers with at least ten years of experience in the practice of zirconia implants. Our objectives are to develop clinical research and to share experiences with as many as possible of those colleagues who are interested in and who wish to practise ceramic oral implantology. We wish to be able to influence the industrial development of these products and to create confraternal links between practitioners from different European countries, with ambassadors in each of them to help federate the whole academy.

These objectives will be based on three developmental axes: (1) training through congresses, workshops, universities or private teaching in ceramic implantology as an alternative to titanium; (2) the sharing of our clinical experiences in order to evaluate current zirconia implant systems or influence those in development, so that the voices of clinicians can be heard by the industrialists involved in research and development; and (3) the initiation of multicentre clinical studies.

Fig. 1: From left: Dr Simon Tordjman (EACim Vice President), Dr Philippe Duchatelard (EACim Partnership Manager), Dr Fabrice Baudot (EACim Scientific Leader), Dr Stéphanie Gouiran (EACim Treasurer), Dr Franz-Jochen Mellinghoff (EACim Ambassador for Germany), Dr Pascal Eppe (EACim Secretary), Dr Giancarlo Bianca (EACim President) and Dr Pascal Valentini (EACim Honorary President).

Fig. 2: EACim President Dr Giancarlo Bianca at the 2019 EACim congress in Paris.

Why do you deem it necessary for ceramic implantology to have dedicated institutions, as opposed to the ones associated with titanium implant systems?
We do not exclude any partnership with recognised companies in the field of metallic implantology—they are essential for the development of implantology, and we are members of some of them—but there is a need to allow the emergence of a practice of zirconia implantology and develop its specificities and its influence. It seems to us judicious that it should have its own identity. This should avoid confusion and improve the effectiveness of the message. It's the same for the written press, don't you think?

The EACim is quite an active community with numerous educational events throughout the year. What are the key aspects of the EACim's educational profile?
The main educational profile is to bring together practitioners who use zirconia implants and to give a voice to the most experienced and recognised for their skills in this field through forums such as our annual congress. Here, fundamental and clinical aspects are discussed and workshops held to address practical matters.

What are the major challenges that ceramic implantology is facing at the moment?
Zirconia implantology began in the 1990s with monobloc implants that limited the mechanical risk of fracture but complicated the surgical protocol. According to recent studies, this type of implant is the closest to the natural root and presents little risk of bacterial contamination, but this monobloc form necessarily limits the indications. The challenges are to be able to carry out the greatest number of clinical cases with ceramic implants, to have the same designs as those for titanium, with the same mechanical reliability, and to have the possibility of making all types of screw-retained prostheses on ceramic supports. Important also is the development of the digital workflow from surgery to prosthesis delivery, knowing that zirconia implants are well adapted to optical impression taking and CAD/CAM prostheses, and the development of static and dynamic navigation systems adapted for the optimisation of ceramic implant surgery.

What do you predict for ceramic implantology in five to ten years from now?
In terms of the market share of ceramic implants compared with titanium implants, it will certainly grow faster than the overall implant market as more patients embrace the concept of metal-free implants. This entails a choice of ceramic material that is more inert in the mouth and more suitable for patients with immune hypersensitivity or periodontal disease and for patients with autoimmune diseases. There are projections from various institutions giving a growth of 20 % at five years and 30 % at ten years, but the current differential in volumes of ceramic implants compared with titanium is significant. We are noticing the beginning of practices that focus on this type of implant. This is the case for a number of practitioners in our academy who have already made the choice of using ceramic implants exclusively.

The 2nd EACim Congress was initially scheduled to take place in Brussels in Belgium this coming spring, but has now been postponed to 2021 owing to the travel and other restrictions that have arisen from the COVID-19 pandemic. Have you already agreed on a new date?
We very much regret that we were unable to hold the very much anticipated 2nd EACim Congress in Brussels this spring. However, the current situation has left us no choice but to postpone the conference until next year, as is the case with many other professional societies at the moment. The new date for the 2nd EACim Congress will be 16–17 April 2021. We sincerely hope that the current situation will soon change for the better and that we can start preparing for next year's congress full of vim and vigor.

contact

European Academy for Ceramic Implantology
65 Avenue du Prado
13006 Marseille, France
Phone: +33 4 91530105
www.eacim-ceramic-implantology.com


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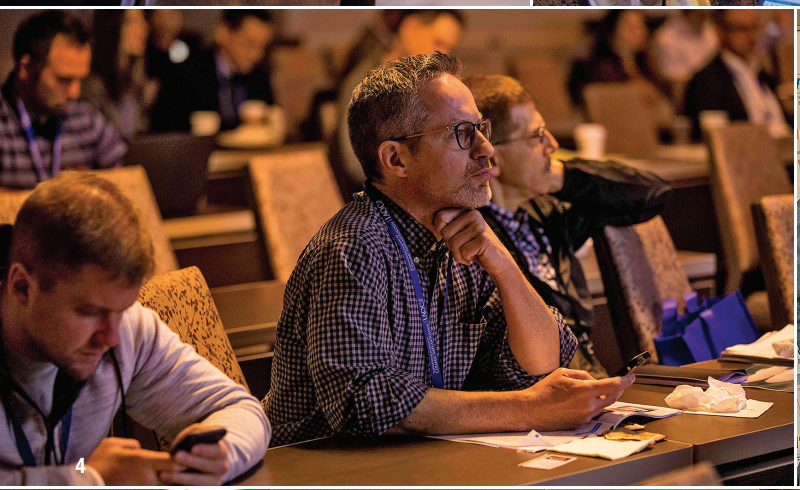
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A look back at the 9th Annual Congress of the IAOCI

Dr Sammy Noumbissi, USA

Under very challenging and difficult circumstances, the 9th Annual Congress of the International Academy of Ceramic Implantology (IAOCI) took place from 14 to 16 March in New Orleans, Louisiana, USA. This year the theme was "Ceramic Implants: A New Reality in Implantology". We were excited about being able to facilitate and provide a business-to-business networking component to this event where OEM ceramic manufacturers were matched; those who attended were able to come to agreements with future and prospective ceramic implants manufacturers and distributors.

Despite the difficult circumstances imposed on us by the COVID-19 pandemic, the event was a success as we reached our goal to provide a programme that was a good balance of scientific research and evidence as well as clinical experiences from our speakers and the workshop programmes. For the first time we introduced a poster competition, we received 26 entries of which 22 were accepted and 16 were presented. We unfortunately lost our largest single contributors from the Universities of Milan and University of Chiety-Pescara in Italy who were not able to travel for obvious reasons. Understandably our attendance was also affected by the pandemic but nevertheless we received attendees from across the United States, as far as Turkey, some countries from the Middle East and Africa. We are thankful to all the attendees, speakers, exhibitors and sponsors who despite the circumstances came from far and near to make this unique event a success during these challenging times.

As we look ahead to our 10th Anniversary in 2021, which is going to take place at the Paris Hotel in Las Vegas from 20 to 23 May, we have gathered an A-list or speakers and scientists to come and share their experiences with us. For this event we will return with the poster presentation competition this time with two separate tracks: one clinical and the other for scientific research on implantology-related ceramics and bioceramics. Our objectives remain to continue to increase our ever-growing attendance and membership and continue to introduce a metal-free implantology in an organised and well-structured manner to the broader dental community.

In light of the confinement we have all had to observe around the globe, the IAOCI has been providing and will continue to host webinars on ceramic implant and implant related topics. The Academy's growth, exposure and visibility continues to rise. We have now created committees that eligible existing and new members can join and become active in order to enable the academy to pursue its vision and goals for the future. We invite you to visit our new website www.iaoci.com to see more information on our upcoming events and how you can be part of this organisation.

contact

Dr Sammy Noumbissi
DDS, MS, PA
President of the IAOCI
801 Wayne Avenue, Suite #G200
Silver Spring, MD 20910, USA
sammy@iaoci.com

Fig. 1: Dr Varo Boyer (USA) at the 9th IAOCI World Congress. **Fig. 2:** IAOCI President Dr Sammy Noumbissi (USA) welcomed the attendees to the March event. **Fig. 3:** Dr Karl Ulrich Volz (Switzerland) hold a lecture titled "Ceramic is easier, but different." **Fig. 4:** With an attending audience from numerous different countries, the congress was a great success. **Fig. 5:** The event featured an industry exhibition from selected partners. **Fig. 6:** The scientific programme was delivered by internationally renowned speakers.

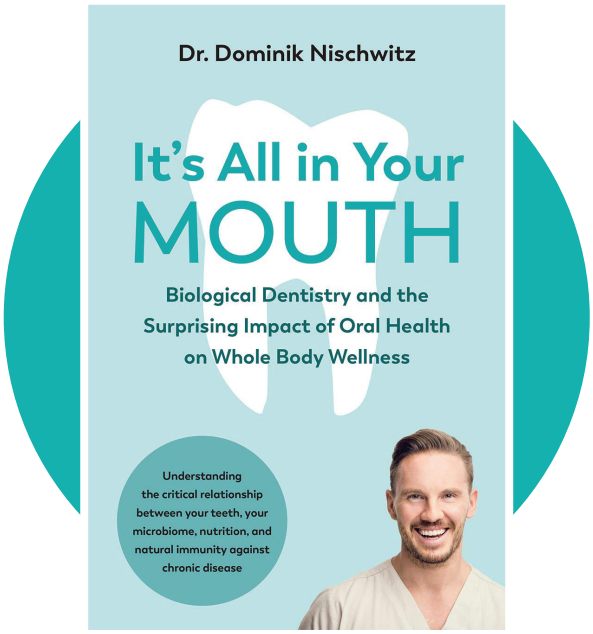
Change in leadership at

SDS Swiss Dental Solutions

In late 2019, the dental implant manufacturing company SDS Swiss Dental Solutions was merged with the SWISS BIOHEALTH CLINIC to form the SWISS BIOHEALTH GROUP. Against this backdrop, Dr Karl Ulrich Volz handed over his management duties to Joachim Amann, who had previously been active as Regional Sales Manager for Straumann, and who will now serve as CEO of SDS Swiss Dental Solutions, starting at the beginning of 2020. According to Dr Volz, Joachim Amann will "[…] use his professional skills to bring the crucial areas of marketing and sales to peak performance." In addition, this change in leadership will allow Volz to

focus more strongly on his personal strengths, which include up to twenty immediate implant surgeries each day, lecturing activities around the globe, considerable research efforts, and publishing endeavours. Amann commented in an interview with the German language news outlet *ZWP online*: "[…] we are looking to expand the reach of our SDS zirconia implants and our SWISS BIOHEALTH CONCEPT on both a national and an international level." For more information, go to www.swissdentalsolutions.com.

Source: SDS Swiss Dental Solutions



The key to a healthier life

Starts in your mouth

American health professionals are beginning to discover what their European counterparts have long understood: Many common chronic conditions—obesity, stroke, diabetes, Alzheimer's, heart disease, cancer, among others—often have their origins in the mouth. In a groundbreaking new work, German dentist Dr Dominik Nischwitz presents the principles of biological dentistry along with emerging scientific research on the mouth's vital role in the body's microbiome—a key to whole body wellness. Challenging conventional dental wisdom that teeth are separate from the rest of the body, and conventional dental practices that often cause more harm than good, *It's All in Your Mouth* delivers the latest research about the microbiome and the mouth, critical information on the dangers of root canals and amalgam filling, the important role of nutrition in oral health and hygiene, and a clarion call for a new approach to dentistry. Sensible, holistic, and humane, *It's All in Your Mouth* presents a necessary new approach to natural immunity to chronic disease and integrating dental hygiene with whole body wellness. The book was published in the US on 18 March 2020.

Source: Chelsea Green Publishing

Zeramex Expert Days 2020

An event "Made in Switzerland"

Do I need to offer ceramic implants at my practice? How do they tie in with the strategy at my practice? What are the benefits for my patients? If these are the kind of question you ask yourself, then the Zeramex Expert Days, to take place on 20 and 21 November 2020, are perfect for you. Meet experienced users and learn about the benefits of Zeramex implants. At Dentalpoint, we are committed to identifying the shortcomings of ceramic implants, so that we can develop the Zeramex implant system as a unique and metal-free system. Our team will show you the capabilities of Zeramex, new features of the system, and exactly what lies at the heart of our success: our in-house manufacturing that uses the latest technologies and meets the highest quality standards. We have also arranged the perfect end to your visit to our headquarters in Spreitenbach—a cosy evening of typical Swiss ambience and local cuisine. For more information, go to www.zeramex.com.

ZERAMEX

Source: Dentalpoint/Zeramex

FDA investigates into

Metals used in medical devices

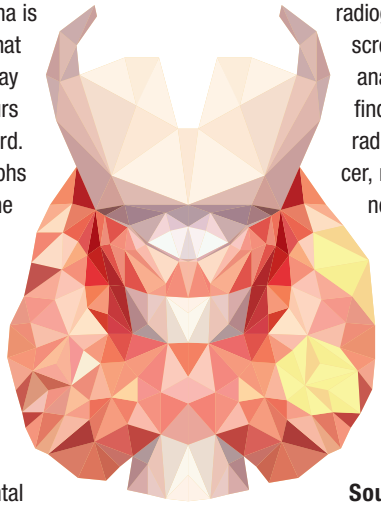
Metals and metal alloys are commonly used in implanted medical devices and in inserts like amalgam dental fillings, and these materials are sometimes in contact with parts of the body for extended periods of time. Part of the FDA's evaluation to determine whether a medical device is safe and effective involves reviewing information about metals and other materials used in the device. The FDA have received adverse event reports that note biological responses to certain metals used in medical devices. Based on their evaluation, they believe the current evidence, although limited, suggests some individuals may be predisposed to develop a local or systemic immune or inflammatory reaction when exposed to certain metals contained in select implantable devices. Reported systemic symptoms include fatigue, rash, joint and muscle pain, and weakness. To better understand how patient respond to materials used in medical device implants and harness that information to improve the safety of devices in patients, the FDA is working to engage the public—in particular, scientists, patients, and health care providers—and industry stakeholders to determine the current state of the science, critical gaps in the existing science, and what approaches the FDA should consider.

Source: Food and Drug Administration (FDA)

Dental radiographs might pose

Potential hazard to human health

The incidence of thyroid cancer and meningioma is increasing globally. New research has found that repeated exposure to dental radiographs may increase the risk of thyroid cancer and tumours in the tissue covering the brain and spinal cord. The researchers concluded that dental radiographs should, therefore, be prescribed only when the patient has a specific clinical need and not as a standard part of routine dental evaluation. Prof. Anjum Memon, Chair in Epidemiology and Public Health Medicine at Brighton and Sussex Medical School, believes that some of the factors that contribute to the increase in thyroid cancers are increased surveillance and dental screening, and over-diagnosis. Dental professionals should thus maintain dental radiographic records in order to avoid unnecessary screenings. In the systematic review and meta-analysis, Memon and his team summarised the findings of previously published studies on dental radiographic exposure and the risk of thyroid cancer, meningioma and other cancers of the head and neck. According to Memon, current UK, European and USA guidelines have already stressed the need for thyroid shielding during dental radiography. The study, titled "Dental X-rays and the risk of thyroid cancer and meningioma: A systematic review and meta-analysis of current epidemiological evidence", was published online on 14 October 2019 in *Thyroid*.



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Source: Dental Tribune International

Congresses, courses and symposia

EAO Congress 2020

8–10 October 2020
Berlin, Germany
www.eao.org

50th DGZI International Annual Congress— Visions in Implantology

6–7 November 2020
Bremen, Germany
www.dgzi-jahreskongress.de

2nd EACim Congress

16–17 April 2021
Brussels, Belgium
www.eacim-ceramic-implantology.com

6th Annual Meeting of ISMI

7–8 May 2021
Düsseldorf, Germany
www.ismi-meeting.com

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Publisher
Torsten R. Oemus
oemus@oemus-media.de

CEO
Ingolf Döbbecke
doebbecke@oemus-media.de

Members of the Board
Jürgen Isbaner
isbaner@oemus-media.de

Lutz V. Hiller
hiller@oemus-media.de

Editorial Council
Dr Michael Gahlert (Germany)
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Editorial Manager
Georg Isbaner
g.isbaner@oemus-media.de

Editorial Office
Johannes Liebsch
j.liebsch@oemus-media.de

Executive Producer
Gernot Meyer
meyer@oemus-media.de

Product Manager
Timo Krause
t.krause@oemus-media.de

Art Director
Alexander Jahn
a.jahn@oemus-media.de

Designer
Sandra Ehnert
s.ehnert@oemus-media.de

Theresa Weise
t.weise@oemus-media.de

Customer Service
Marius Mezger
m.mezger@oemus-media.de

Published by
OEMUS MEDIA AG
Holbeinstraße 29
04229 Leipzig, Germany
Tel.: +49 341 48474-0
Fax: +49 341 48474-290
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