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ceramic implants

international magazine of ceramic implant technology

research
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create silent inflammation in jawbone

case report
A metal-free solution for restoring natural aesthetics

interview
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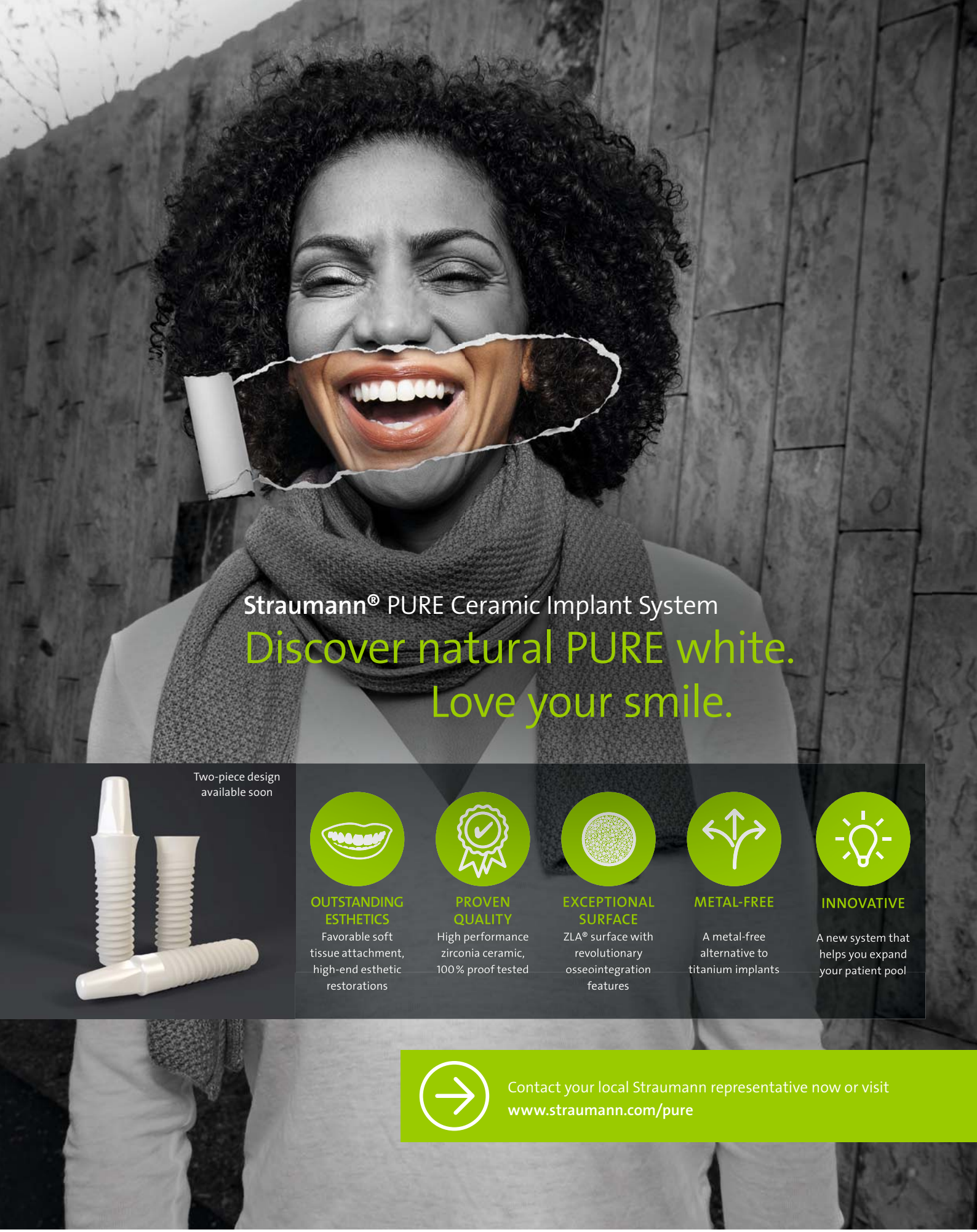

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Georg Isbaner

Editorial Manager

Scientific evidence and clinical outcomes—the facts count

There are not many luminary figures that greatly influence future generations through their inventive spirit, humanity and visionary power. Prof. Sami Sandhaus undoubtedly was one of those people. Like no other, he paved the way for modern ceramic implantology. He was invited as a guest of honour by the European Society for Ceramic Implantology (ESCI) to its first congress, but passed away at the biblical age of 92 a week before the event began.

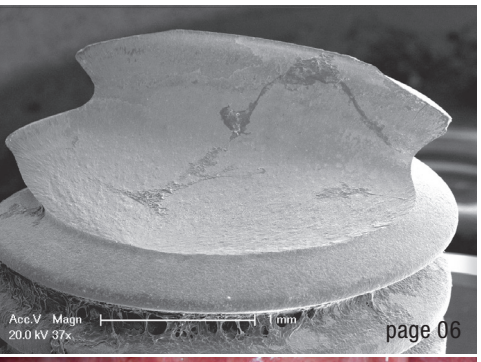
Prof. Sandhaus's path was one of research and science, and fortunately, the younger generation is gratefully continuing his legacy. In the most recent past, dental manufacturers and courageous clinicians have helped elevate the still rather young discipline of ceramic implantology. Gradually, the first ten-year data of university studies is emerging, and this research was showcased at the ESCI congress, as well as at the events held earlier this year by the European Academy of Ceramic Implantology (EACim), the International Academy of Ceramic Implantology (IAOCI) and the International Society of Metal Free Implantology (ISMI). Science is the bedrock on which ceramic implants as a recommended treatment modality rest.

Even if the available amount of scientific data is still quite modest, evidence in clinical practice is already available in great abundance. This brings us to this issue of *ceramic implants—international magazine of ceramic implant technology*, in which I am pleased to say that the most experienced clinicians in this medical field have shared their knowledge and expertise with us. Some of them have already placed thousands of ceramic implants and have been working with these metal-free systems for over ten years now. They all share a conviction that ceramic implants are a patient-friendly implant option—regardless of whether used for single-tooth restorations or complete prostheses.

In addition, the recent advancements made in ceramic implantology bring another aspect back in focus: the general health of the patient. Patients who wish to receive implant surgery often come to the dentist with systemic and/or immunological impairments. In some cases, metal-free oral rehabilitation is an essential part of the improvement process. The reasons for this are manifold and need to be investigated further in the future. Thanks to ceramic implants, however, the biological principles of oral health are beginning to be better understood in connection with general health. This is in keeping with the philosophy of Prof. Sandhaus.

Wishing you a great read,

Georg Isbaner



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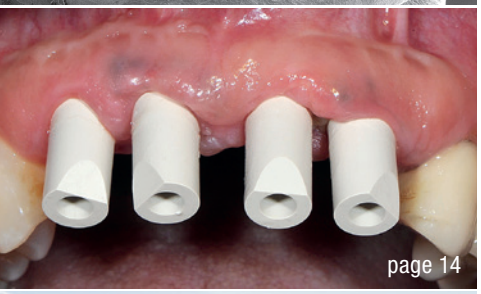
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Aspects of zirconia

Phase transformation and its clinical relevance

Prof. Dr med. dent. Michael Gahlert, Germany

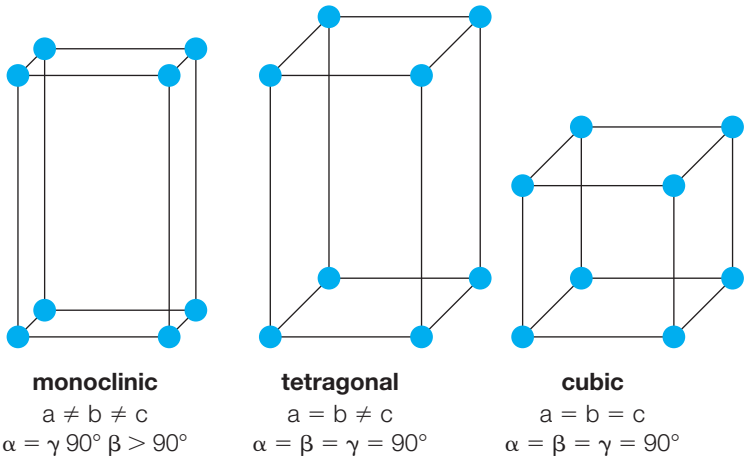


Fig. 1a: The addition of yttrium to zirconium dioxide induces the stabilisation of different phases of the material structure.

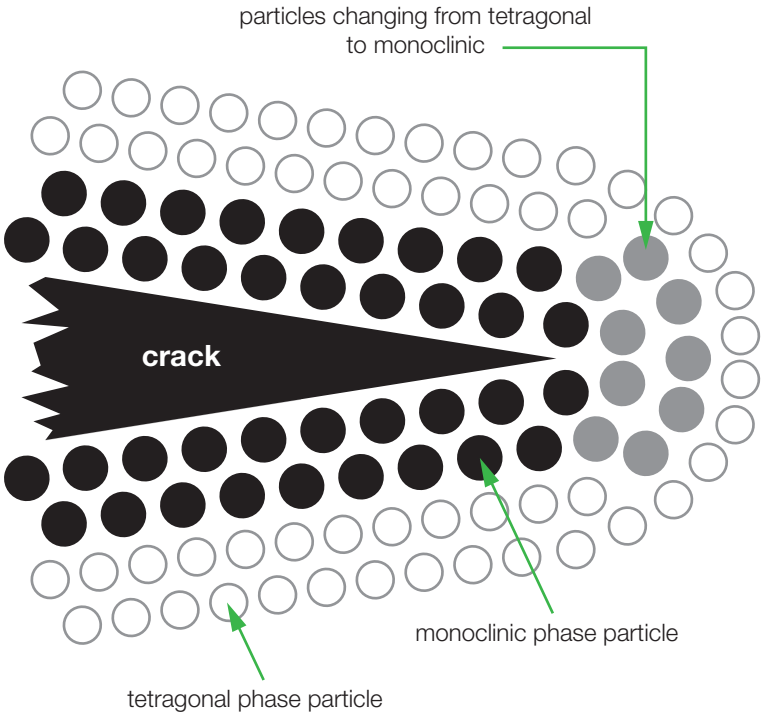


Fig. 1b: Transformation from a tetragonal phase to a monoclinic phase of the material structure of zirconium dioxide.

On fracture susceptibility

The material-specific condition of zirconia implants right after the final industrial manufacture, as found by clinicians in the packaging and used by their patients, is referred to as the tetragonal phase condition of zirconium dioxide. “Tetragonal phase” refers to the most stable and resistant condition of ceramic implants that clinicians naturally desire for the safest and most durable treatment for their patients. It is guaranteed through stabilisers such as yttrium oxide, which are added in minute quantities to the starting material during industrial production. Phase transformation is the transition from the fracture-resistant tetragonal phase to the monoclinic, fracture-prone phase. Phase transformations of the material structure must be expected when grinding zirconium dioxide with rotating instruments. Uncontrolled grinding with, for example, coarse-grained diamonds and insufficient cooling of the material results in micro-cracks within the outer surface layer of the material and in the underlying material structure.

This phase transformation is associated with volume expansion and can stop the propagation of mechanically induced micro-cracks in the material structure. However, there are limits to this “self-healing mechanism” of zirconium dioxide. Once the unique compensatory capacity has been exceeded, micro-cracks in the microstructure remain, which can favour the unwanted introduction of water. This, in turn, can lead to an uncontrolled ageing process and consequently to instabilities in the material structure, a fatal development with regard to the tensile strength of the material zirconium dioxide. It thus becomes apparent that incorrect handling of the material has clinical relevance. This example shows that metallic materials are not comparable with ceramic materials. The grinding of titanium is not as clinically relevant, compared with zirconium dioxide. It would be a great mistake to draw conclusions about the processing of ceramic materials from metal processing.

A brief history of zirconia

During the first stage of development of zirconium dioxide implants at the beginning of the 2000s, high blasting pressure and large particles were used to micro-roughen

Fig. 2: Fractured zirconia implant #11. **Fig. 3:** Crown with coronal fracture end of the ceramic implant. **Fig. 4:** Electron-microscopic image of the fractured implant (Prof. Susanne Scherrer, University of Geneva, Switzerland). **Fig. 5:** Detailed electron-microscopic image of the origin of the fracture with radial propagation over the cross-sectional area (Prof. Susanne Scherrer, University of Geneva, Switzerland). **Fig. 6:** Detailed electron-microscopic image of the micro-crack formation on the surface of the ceramic implant caused by processing blasting to generate micro-roughness (Prof. Susanne Scherrer, University of Geneva, Switzerland).

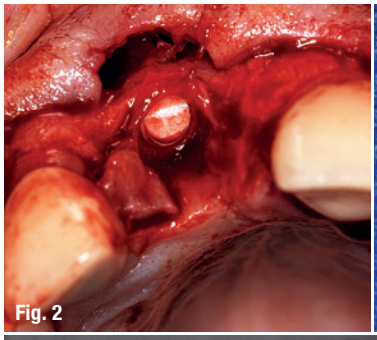


Fig. 2

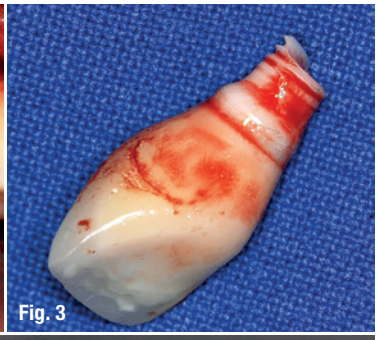
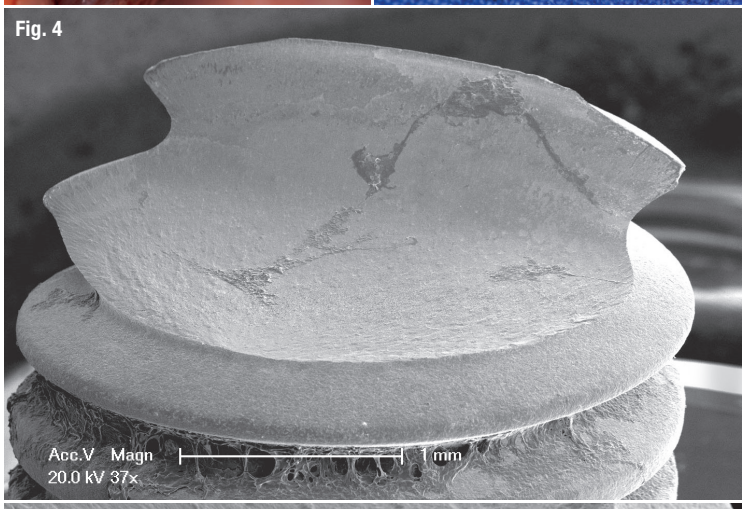
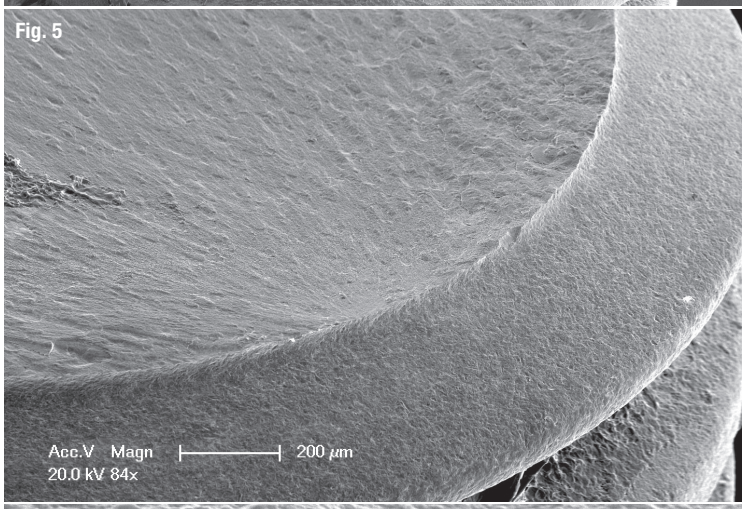
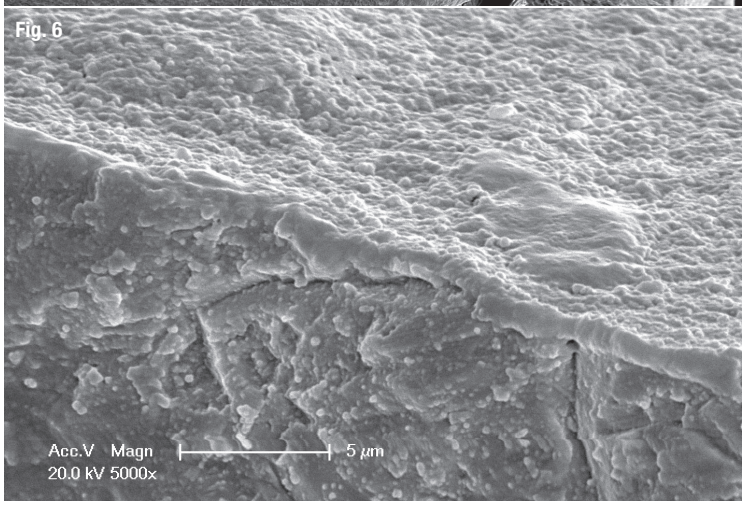


Fig. 3







the surface of zirconium dioxide. As a result of this ambitious industrial production process, micro-cracks were found in the surface structure of ceramic implants, which in one case or another led to later fractures under high occlusal forces caused by teeth grinding or chewing, for instance. Even today, a great number of fractures of ceramic implants can be traced back to an improper industrial manufacturing process or the later mechanical handling by the dentist. The process according to which the micro-roughness of the surface of a zirconia implant is achieved has changed over the decades with each stage of evolution of the material and with the newly acquired knowledge about phase transformation. Nevertheless, there are still no industrial standards and therefore different manufacturing techniques that assess these aspects differently. For example, an implant manufacturer offers a lifetime material-specific guarantee for ceramic implants, provided that the implants are not ground by the dentist.

about the author

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Why titanium implants create silent inflammation in jawbone

Drs Johann Lechner, Germany & Sammy Noumbissi, USA

In dentistry, one of the most established methods is the replacement of lost or missing teeth with titanium (Ti) implants. However, investigators have found that Ti implants can induce inflammation in the surrounding tissue over time, leading to the expression of certain mediators known to cause chronic diseases through a constantly stimulated immune system.[1–4] These triggers lead to the activation of signalling pathways which favour a predisposition to the development of cancer and autoimmune diseases.[5] Signalling messengers like cytokines carry instructions and are received by those cells with specific receptors which are able to recognise them. In earlier publications, we defined this chronic inflammatory process as fatty-degenerative osteonecrosis in the medullary spaces of the jawbone (FDOJ).[6,7] We started a study to elucidate the transition from acute trauma during the insertion of dental implants to chronic inflammation of the jawbone. Herein, we attempt to define the role of cytokines in areas of FDOJ surrounding implants in a cohort of patients with immune system disorders. We propose the following hypothesis: Ti implants may be a possible contributor to the development of chronic inflammation of the jawbone extending beyond the local condition of peri-implantitis.

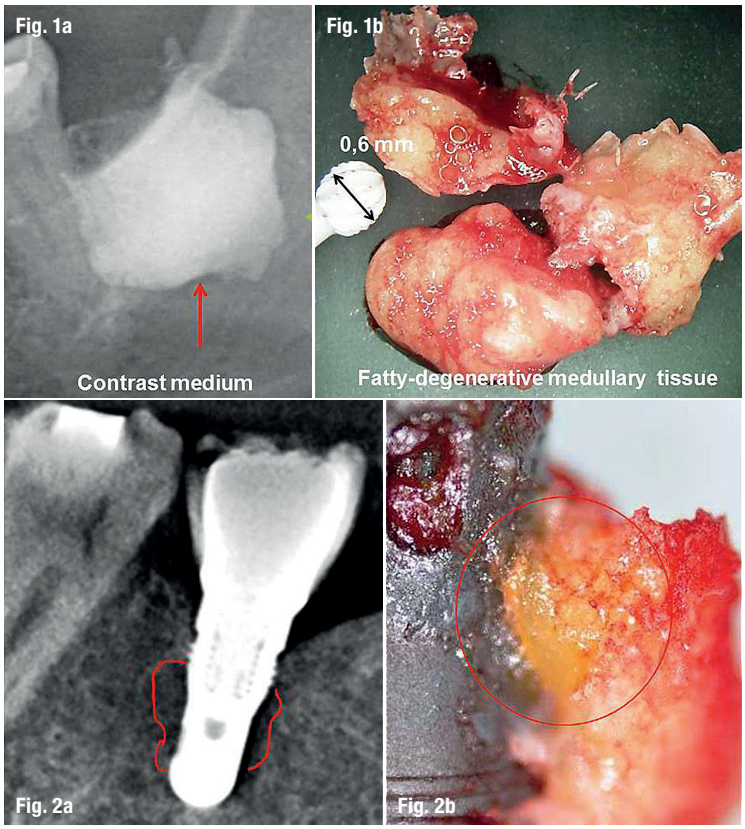

Fig. 1: Contrast medium in affected cavity after curettage **(a)** and jawbone sample of fatty and osteolytic degenerated bone marrow **(b)**. **Fig. 2:** Titanium implant in area #46 as shown in the CBCT scan **(a)**; fatty-degenerated tissue attached directly to the titanium implant **(b)**.

We selected a group of patients with well-osseointegrated Ti implants and with clinical symptoms of immune system disorders: seven with rheumatic arthritis, three with neurodegenerative diseases (including chronic fatigue syndrome and multiple sclerosis), one with ovarian cancer and three with atypical facial pain/trigeminal neuralgia. A second mandatory inclusion criterion for the Ti implant group was local diagnosis of FDOJ apically and in areas surrounding Ti implants. All patients were required to have a CBCT scan and measurement of the bone density of the jawbone using trans-alveolar ultrasound technology (TAU). TAU is useful for establishing the presence of FDOJ.[8] In a healthy control group (n = 19), samples of healthy jawbone were removed in the form of drill cores during routine dental implantation surgery. The use of bisphosphonate medication was the main exclusion criterion.

Clinical features of FDOJ: Definition and diagnostic criteria

FDOJ is a lesion similar to that found in long bones, also primarily defined as “bone marrow edema” and “chronic non-suppurative osteomyelitis”.[9,8] The softening of the bone marrow in FDOJ is very distinct, such that the marrow space may be suctioned out or curetted once the cortical bone has been removed. These hollow spaces, also known as “cavitations” are filled with fatty-degenerated adipocytes which have undergone dystrophic changes accompanied by demyelination of the bony sheath of the inferior alveolar nerve. Figure 1 shows a specimen of predominantly fatty transformation of the jawbone. The extent of the FDOJ lesion in the jawbone is indicated in the radiographic image with a contrast medium.

Dissolved titanium particles in the jawbone

After reports in the literature concerning dissolved Ti particles in the surrounding bone,[10–13] we analysed five of the 14 jawbone samples from the group with FDOJ and Ti implants for levels of dissolved Ti. The amount of dissolved Ti in them ranged from 3,200 to 50,600 µg/kg with a median value of 24,200 µg/kg (± 20,029 SD; Fig. 3). As we were unable to find an average maximum content of dissolved Ti which is regarded as biocompatible and acceptable in the literature, we defined the maximum dissolved Ti in healthy bone as 1,000 µg/kg of body weight, which is fourfold higher than the accepted level of all other heavy metals as described in the relevant literature (< 250 µg/kg).

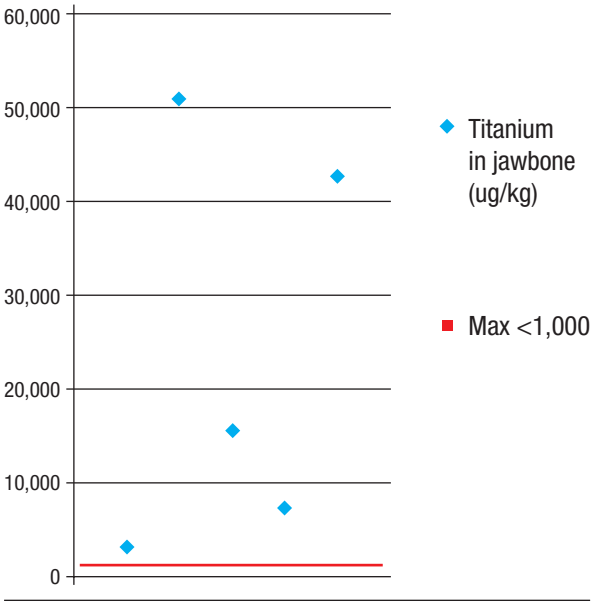

Fig. 3: Distribution of dissolved titanium in jawbone surrounding titanium implants in five cases of fatty-degenerative osteonecrosis of the jawbone.

Titanium dissolution in jawbone and TNF-α expression

Ti particles may dissolve and induce immunological reactions in the body and release systemic messengers. A study presented by Nakashima et al. elucidated the mechanisms of macrophage activation by Ti particles from implant materials and identified the cytokine-bound signalling activated by metal alloy implants via released particles.[14] Macrophages of patients were exposed to particles of Ti alloys taken from the connective tissue surrounding hip implants. Exposure of macrophages to Ti alloy particles *in vitro* over a period of 48 hours resulted in a 40-fold increase in the release of tumour necrosis factor alpha (TNF-α) and a sevenfold increase in the release of interleukin-6 (IL-6).

Analysis of cytokine expression in samples of FDOJ

To discern the cytokine patterns found in the jawbone of patients from the corresponding author's dental practice, 14 patients with diagnosed FDOJ in Ti implant sites had surgery on the affected area, including the removal of existing Ti implants. All of the patients displayed FDOJ in the bone marrow adjacent to neighbouring Ti implants, which was similar to FDOJ samples as described previously in the literature[15,16]. FDOJ tissue directly attached to a Ti implant was investigated and the cytokine profiles were evaluated. The corresponding CBCT image in Figure 2 displays no, or only minor, abnormalities in contrast to the significant area of yellowish and softened cancellous bone directly attached to the Ti implant surface. At the IMD Institute for Medical Diagnostics (www.imd-berlin.de/labor), the FDOJ samples were measured for cytokine expression. As we have shown in several previous publications,[6,7] the defining characteristic of FDOJ regions is the overexpression of the pro-inflammatory messenger RANTES (regulated upon activation, normal T-cell expressed and secreted), also known as chemokine C-motif ligand 5 (CCL5). The mean values of the 19 samples of healthy jawbone (blue columns) and the results of the multiplex analysis of the seven cytokines in the FDOJ and Ti implant cohort (red columns) are shown in Figure 4. Figure 5 presents an example of the type of morphology of FDOJ samples removed from areas adjacent to Ti implants which were collected and subsequently analysed for seven cytokines.

FDOJ is similar to silent or subclinical inflammation without the typical signs of acute inflammation. In chronic inflammation, the local production of inflammatory cytokines, such as TNF-α and IL-1/6, overwhelms regulatory and compensating mechanisms, contributing to the formation of FDOJ in the bone marrow. This phenomenon of an intramedullary source of RANTES/CCL5 (R/C) overexpression appears to be more widespread than dentists and physicians previously presumed. The surgical debridement of FDOJ areas, however, may halt the induction of R/C signalling pathways and thus possibly inhibit the progression of associated symptoms.[17,7]

Why is this such an enigma in dentistry?

In previous research, we demonstrated the non-visibility and lack of obvious radiographic signs of FDOJ, which make it difficult to obtain an accurate diagnosis using common dental radiographs.[18] As a result, the existence of FDOJ and its systemic implications are largely neglected in today's dentistry. While conventional radiography is limited in its ability to properly reveal FDOJ, other means of identifying the presence of FDOJ are available. To aid the practitioner in diagnosing the bone marrow softening occurring within FDOJ lesions, a computer-assisted TAU device is available.[19] TAU has proven to be

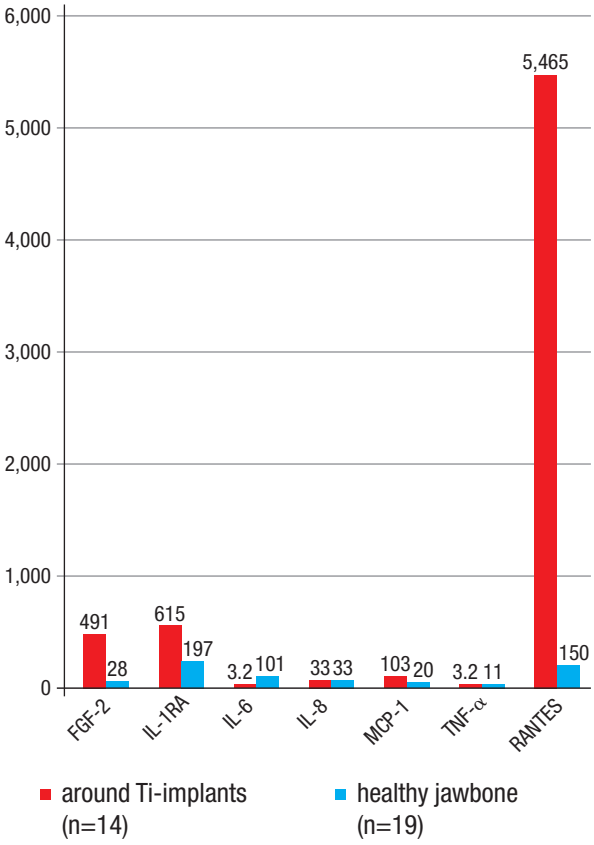

Fig. 4: Analysis of seven cytokines in the cohort with FDOJ of the jawbone and titanium implants (red columns), compared with the healthy jawbone group (blue columns). FGF-2 = fibroblast growth factor 2; IL-1RA = interleukin-1 receptor antagonist; IL-6 = interleukin-6; IL-8 = interleukin-8; TNF-α = tumour necrosis factor alpha; RANTES = regulated upon activation, normal T-cell expressed and secreted.

significantly superior to radiography for the detection of microscopically confirmed FDOJ. In numerous publications, the efficiency and reliability of TAU in the diagnosis and imaging of FDOJ has been presented.[20] Owing to these diagnostic difficulties, FDOJ is underdiagnosed by dentists in general. It should be noted that while radiographs in most cases fail to diagnose FDOJ the overexpression of pro-inflammatory signalling pathways in corresponding FDOJ areas is present and detectable as shown in Figure 4. This phenomenon is crucial in the discussion about silent inflammation.

Case study of high titanium dissolution in jawbone

This case study highlights the problem of the deceptive reassurance that radiographs appear to provide in relation to the fact that there is possible release of Ti particles to the peri-implant environment. The radiograph of a Ti implant in area #15 showed no suspicious reactions and the implant could be viewed radiographically and mechanically as a successful one. In contrast, Figure 6 shows, after explantation of the Ti implant, a blackish metallic precipitate in the alveolus along the bony grooves formed by the threads of the removed Ti implant. When the jawbone containing this precipitate was analysed by spectral analysis for heavy metal content (Figs. 6 & 7), the value for Ti was increased by a factor of 50, with an assumed limit value of < 1,000 µg/kg of body weight. The osseous tissue surrounding the implant thus contained 50 times the acceptable limit of Ti.

Sensitisation of immune system by titanium implants

TNF-α, a pro-inflammatory cytokine, is released at the beginning of almost every immune response based on individual sensitisation to Ti. Thus, TNF-α plays a key role in the failure of many implants in the case of genetic incompatibility.[1,21,22] In addition to the particles released from implant wear, Ti sensitisation is the result of increased pro-inflammatory reactivity of non-specific immune cells (tissue macrophages and monocytes), which in some patients occurs after contact with particulate debris, that is, Ti particles. Such particles (diameter of 1–10 µm) are consistently released into the environment surrounding implants through mechanical abrasion and chemical, bacterial and galvanic corrosion,[23] resulting in hyper-inflammatory conditions.[24] Sterner et al. investigated the effects of alumina ceramic, zirconia ceramic and Ti particles of varying size and concentration on TNF release in a human macrophage system.[25] It was found that in a direct comparison of alumina and Ti particles of the same size and concentration, Ti stimulated significantly higher TNF-α distributions. Zirconia did not induce significant TNF-α secretion.

Earlier, we demonstrated the solubility of Ti particles in the jawbone with reference to several images: after contact with such Ti particles, tissue macrophages release pro-inflammatory cytokines as part of an inflammatory reaction.[24] The extent of the release of pro-inflammatory cytokines is determined by polymorphisms in the genes of the respective cytokines and thus varies individually. Jacobi-Gresser et al. found that patients with implant loss or peri-implantitis showed significantly more pronounced genetic predisposition to inflammation, as well as markedly elevated positive immunological test results with overactivation of TNF-α and IL-1β.[22] Thus, the two cytokines TNF-α and IL-1 are the key mediators of a local but also systemic inflammatory response.[26] The extent to which the pro-inflammatory cytokines are released after contact with Ti oxide particles differs individually. The basis for supernatant reactions is found in individually occurring polymorphisms in the genes for the pro-inflammatory cytokines TNF-α and IL-1 and the anti-inflammatory counterpart IL-1 receptor antagonist.[27]

Secondary RANTES/CCL5 expression driven by TNF-α in FDOJ

The question arises as to whether there is an induced or synergistic interaction between the inflammatory TNF-α mediators secreted around Ti implants and the highly

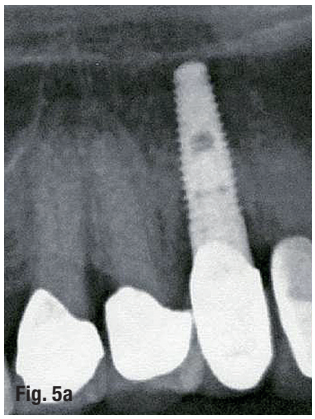
Fig. 5a

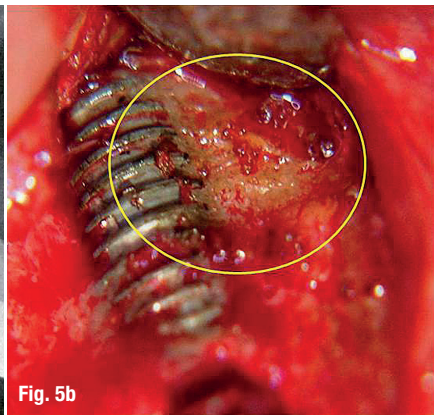
Fig. 5b

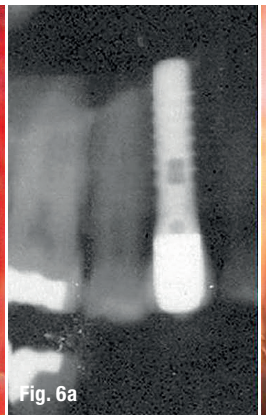
Fig. 6a

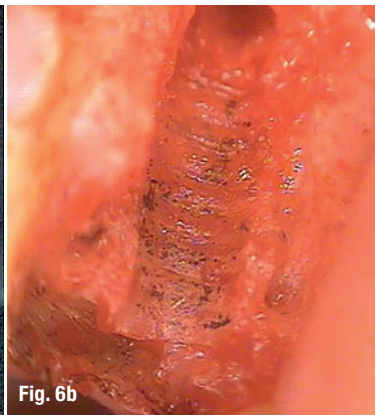
Fig. 6b

Fig. 5: Attachment of fatty-degenerative bone to titanium implant (area #13; **b**); radiograph does not indicate inflammatory bone loss or significant peri-implantitis **(a)**. **Fig. 6:** Radiographic image prior to removal of titanium implant from area #15 **(a)**; alveolar bone with precipitation of titanium particles **(b)**.

overexpressed R/C levels found in our previous research. Secretion of inflammatory cytokines mediates the systemic effects of adipose tissue inflammation. R/C expression dramatically increases in inflammatory sites.[28] Studies show the ability of Ti wear particles in a human bone marrow cell culture to induce a significantly higher release of pro-inflammatory and osteolytic mediators, which are responsible for the aseptic loosening of implants.[29] Beyond these findings based on TNF-α, our previous research points towards the next step of the process, namely the possibility of mediator cascades by R/C overexpression as found in FDOJ. Reduced blood flow and capillary density followed by ischemia in the medullary spaces of jawbone may lead to a hypoxic situation.[30] Adipocytes and the necrotic parts of fat cells are considered to be immunologically active. In understanding FDOJ, R/C and immune system disorders, the role of these immune effects is relevant. While pro-inflammatory cytokines such as TNF-α and IL-6 are distributed early on during the acute stage of an injury or tissue infection, chemokines like R/C may be activated at a later time. They may play a crucial role in the transition of acute pain into a more chronic phenomenon. In conjunction with tissue damage or infection, ischemia-induced chemokine expression causes an increase in inflammatory cytokines.[31] R/C expression was spontaneous and continuous in most samples of mature adipocytes from omental and subcutaneous deposits, and hypoxia and ischemia caused an approximately 36 % increase in R/C. Human adipocytes express R/C and can thus be identified as a new cellular source of this messenger.[32,33] The network of cytokine effects between TNF-α and the hyperactivated R/C cascades found in FDOJ (Fig. 8) has not yet been fully investigated.

Why is RANTES/CCL5 overexpression possibly connected to systemic diseases?

Pro-inflammatory signalling mediators such as R/C in particular affect the organism systemically and may result in chronic inflammatory processes or provoke further pathophysiological mechanisms. It is generally accepted that an imbalance between cytokines and their specific inhibitors is characteristic of chronic inflammatory conditions.[34] FDOJ represents a new inflammatory cellular response phenomenon in that the cytokines are not triggered by the presence of bacteria or viruses. This is supported by the fact that levels of typical acute pro-inflammatory cytokines such as TNF-α and IL-6 are not found to increase in this process. These acute cytokines are found to be absent in the FDOJ samples. Accordingly, we have hypothesised that R/C signalling is a chronic disturbance that may contribute to the development of chronic inflammation. The absence of acute inflammation in FDOJ denotes the subclinical and hidden proliferation of chronic immunological processes driven by R/C. High levels of the inflammatory cytokine R/C are found in the ageing stem cell milieu.[35] In the case of breast cancer, there is evidence of a synergistic osteo-immunological reaction to Ti implants, as TNF-α is an activator of the R/C promoter for mesenchymal stem cells in the tumoural environment of breast cancer via its signal transduction pathway.[36] The TNF-α stimulation of the mesenchymal stem cells led to a dose-dependent increase in the expression of R/C in the tumour.[37] Research on R/C and rheumatoid arthritis shows the same mechanism: in non-stimulated synovial fibroblasts, the expression of mRNA was not detectable for R/C.[38] R/C-activated chondrocyte functions are associated with joint inflammation and cartilage degradation in rheumatoid arthritis. IL-1β and TNF-α also induce the production of R/C, which is overexpressed in arthritic joints.[39,37] The stimulatory chain from TNF-α and IL-1β to R/C can also have a patho-genomic effect in cardiovascular diseases.[40]

Implantation and possible cytokine cascades

Perala demonstrated the induction of TNF-α *in vitro* after co-incubation of native implant material, which ensures that immunogenic particles are released from the materials.[41] Concerning cytokine expression in the context of an implant and the associated phases of healing, the analysis during different stages of implantation reveals several new phases of cytokine-triggered signalling pathways:

1. The Ti implant is placed in an ischemic area of subclinical FDOJ owing to the radiographically inconspicuous nature of FDOJ and the absence of alternative methods of measuring bone density. The systemic effect hitherto is subclinical and therefore free of symptoms.

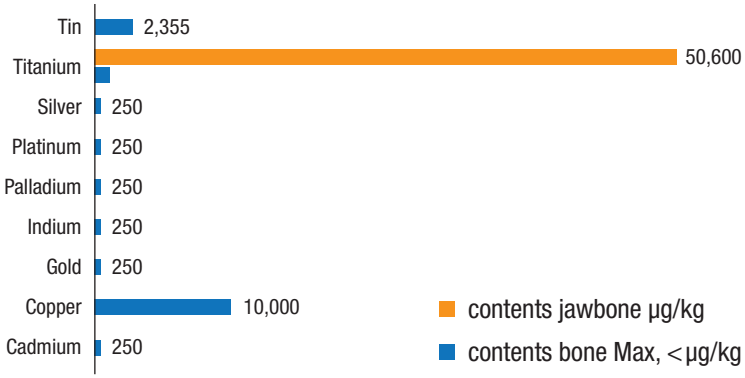

Fig. 7: Titanium content in the jawbone (area #15) as determined by spectral analysis.

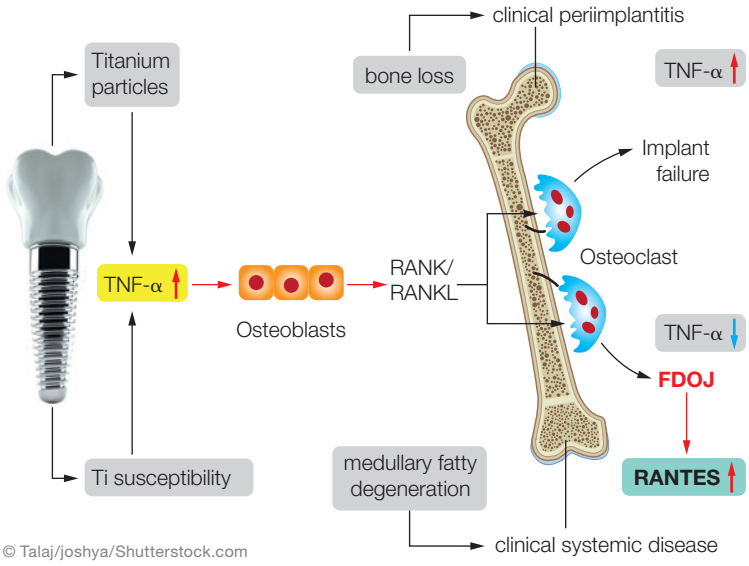

Fig. 8: Possible side effects of titanium implants, resulting either in bone loss and implant failure (shown in the upper pathway: TNF-α up) or in medullary fatty-degenerative osteonecrosis with no implant loss but systemic interference by RANTES/CCL5 overexpression (shown in the lower pathway: TNF-α down and RANTES up). TNF-α = tumour necrosis factor alpha; RANK = receptor activator of nuclear factor κB; RANKL = RANK ligand; FDOJ = fatty-degenerative osteonecrosis of the jawbone; RANTES = regulated upon activation, normal T-cell expressed and secreted.

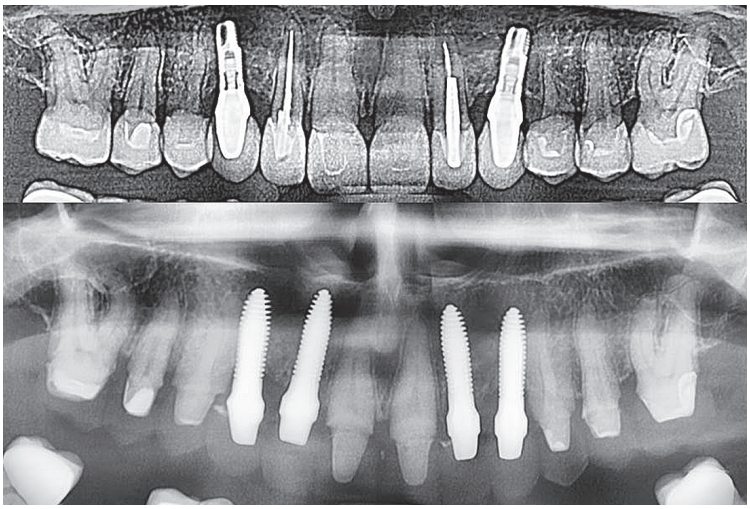

Fig. 9: In this case, replacement of titanium implants and root fillings with ceramic implants all in one session cured the female patient (38 years old) of Alopecia areata (spotty balding).

2. The acute wound setting initiated by the insertion of an implant in which the surgical trauma induces the release of acute cytokines creates inflammatory cascades via TNF-α, IL-6 and IL-1β expression.
3. Ti particles provoke expression of TNF-α at a later stage of wound healing.
4. In the medium to long term, TNF-α expression provokes increased secretion of R/C.

Here, the problems for clinicians include the following: (a) the clinical stability of the Ti implant leads to the misdiagnosis of an apparently inflammation-free osseointegration; (b) the radiographic and clinical inconspicuousness of Ti implant; and (c) the systemic symptoms of an immune system disorder are not directly related to the Ti implant because they occur only after a certain amount of time. As a result, an osteo-immunological scenario in the case of implantation is conceivable, as shown in Figure 8. Immediate replacement of Ti implants by non-dissolving ceramic implants gives a perspective for the integrative treatment of patients with chronic immunological diseases (for an example, see Figure 9).

Conclusion

Our data provides some evidence for the immunological relationship between Ti implants and FDOJ. A purely clinical assessment of Ti implants is insufficient. Radiographs also fail to indicate the derailed mediator process (cytokines and interleukins) triggered by Ti implants. Consequently, the evaluation and indication of Ti implants must also be viewed from a systemic perspective. In failing to recognise this, detrimental local and systemic health consequences may occur in the host that are concealed by the apparent success of a "stable implant". As far as we know, this study is the first to describe clinically the possible connection between Ti implants and FDOJ as a vector or cause of so-called silent inflammation. Removal of Ti implants and surgical debridement of surrounding FDOJ areas may diminish R/C-overexpressed signalling pathways and thus possibly reduce inflammatory input.

Editorial note: This article is a shortened version of the following open-access publication: Lechner J, Noumbissi S, von Baehr V. Ti implants and silent inflammation in jawbone—a critical interplay of dissolved Ti particles and cytokines TNF-α and RANTES/CCL5 on overall health? EPMA J. 2018 Jun 8;9(3):331–43.

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Literature

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Treatment of an edentulous space with a digital workflow

Two-piece ceramic implants in the aesthetic zone

Prof. Heinz Kniha, Thomas Lassen & Dr Kristian Kniha, Germany

More and more dentistry students, individuals working in dental care, dental science and dental technology, as well as university lecturers, are now encountering modern zirconia implants. The subject of zirconia implants not only polarises patients, but is also hotly debated at international congresses and in respected scientific publications. Irrespective of this, the amount of evidence-based *in vivo* data concerning zirconia implants continues to grow. On the one hand, the ceramic surface allows a very pleasing aesthetic result to be achieved, especially in the soft-tissue region. Studies with a follow-up period of three years have shown that hard tissue remains stable and that there is even a statistically significant enlargement of the interdental papillae.[1–3] On the other hand, an experimentally induced mucositis study has shown that titanium implants prompt a greater inflammatory immune response to plaque accumulation with regard to specific inflammatory markers (interleukin-1 beta values, total bacterial count and sample volumes of *Tannerella forsythia* and *Prevotella intermedia*).[4,5] These clinical insights into zirconia implants lead us to hope that the risk of peri-implantitis too can be minimised with the lower incidence of mucositis. Initially, single-piece zirconia implants were restored with cement-retained prostheses.

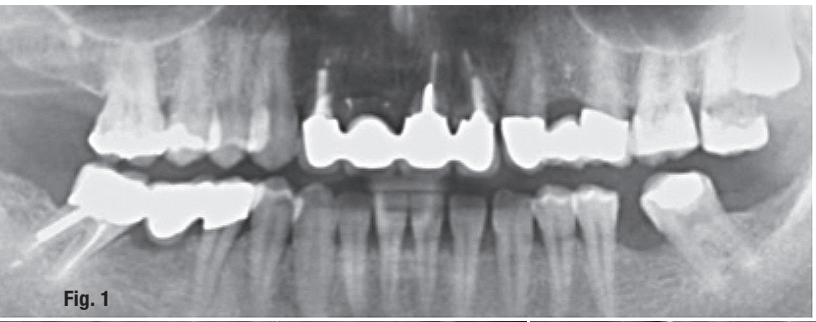
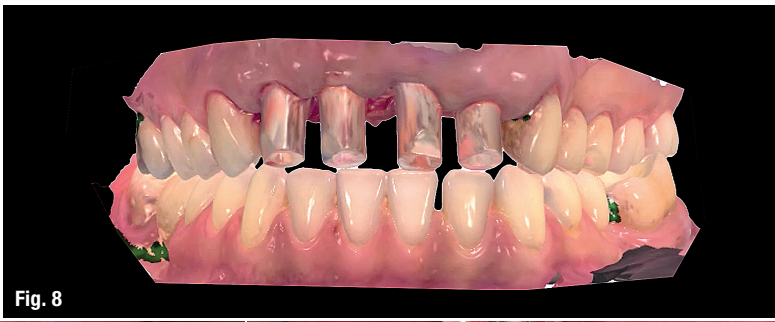


Fig. 1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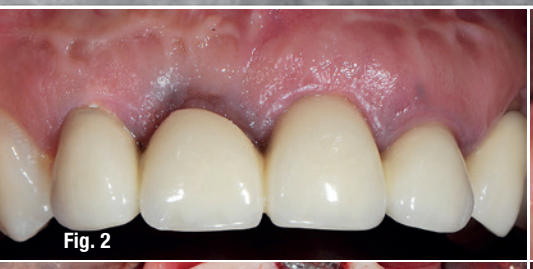
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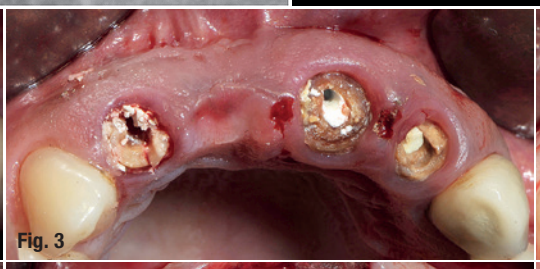
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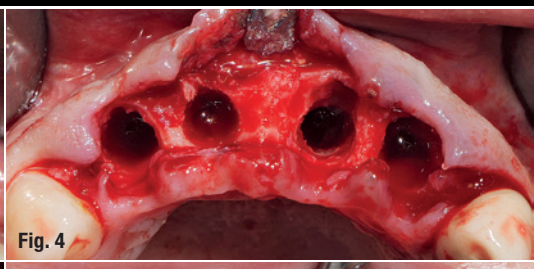
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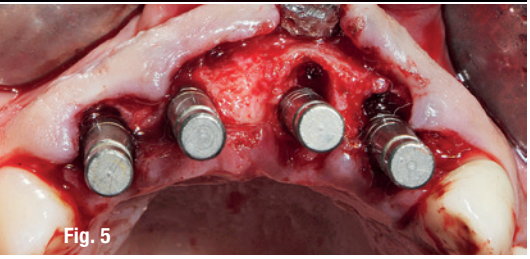
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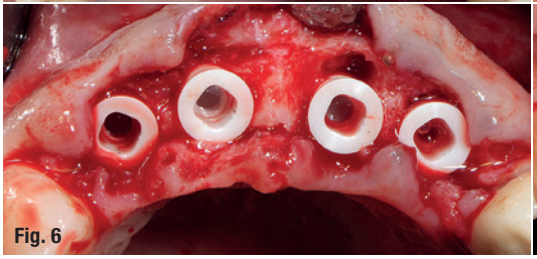
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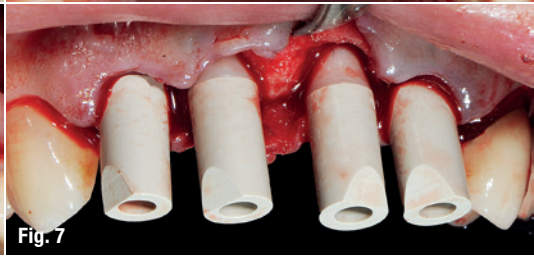


Fig. 7

Fig. 1: Radiographs showing root fillings and post-and-cores in teeth #12, 21 and 22. **Fig. 2:** Visible scarring after apicectomy and dark-coloured gingiva in region #11. **Fig. 3:** Secondary caries in the hopeless abutment teeth. **Figs. 4–6:** Immediate implantation of two-piece zirconia implants in regions #12, 11, 21 and 22. **Figs. 7 & 8:** An intra-op digital impression of the two-piece implants was taken.

Now, two-piece implants allow screwed connections between the prosthesis and implants. The following case describes the clinical application of two-piece zirconia implants in an extensive anterior reconstruction in combination with digital procedures.

Patient case

Baseline

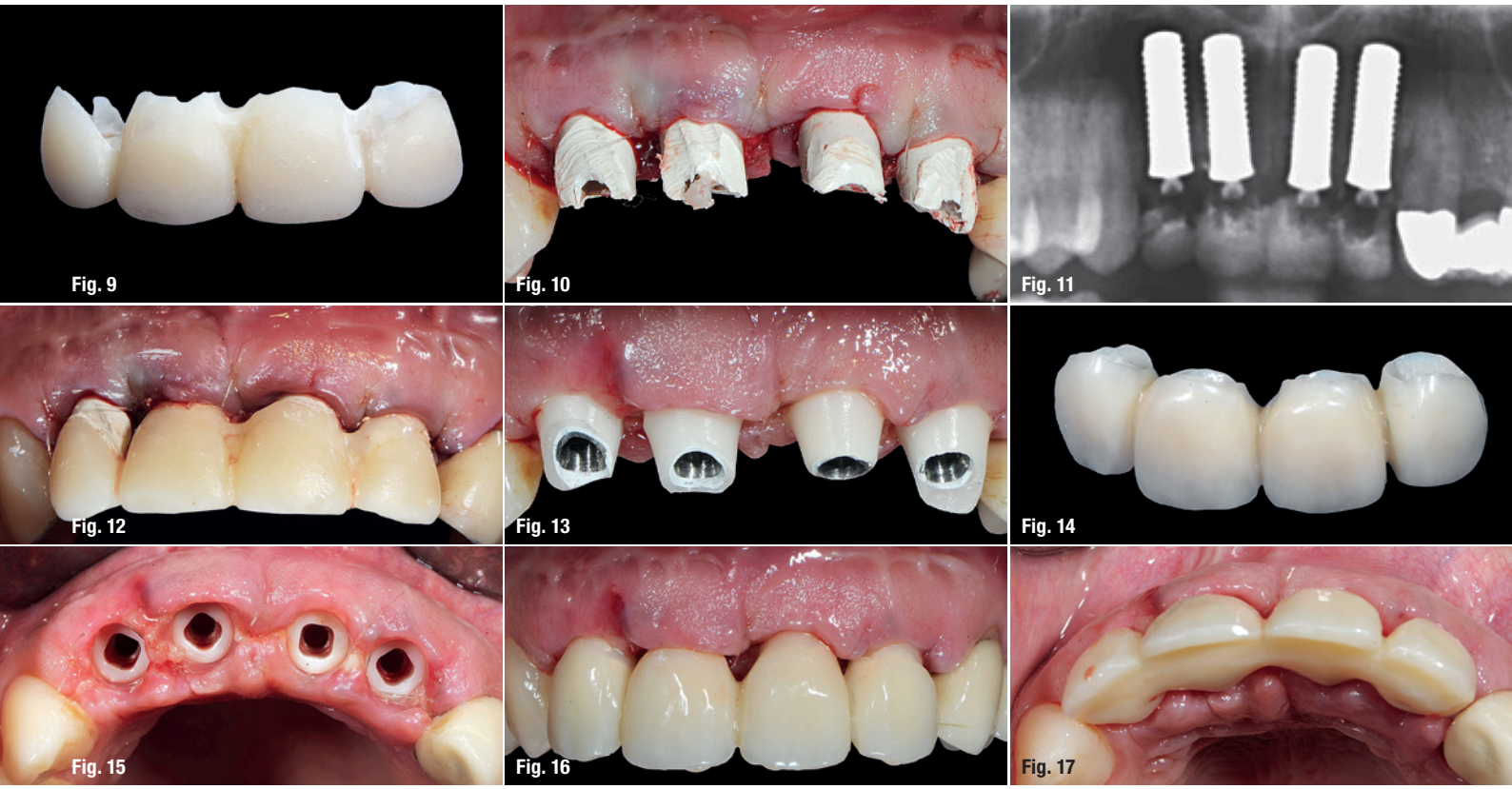
This is a clinical case of a 34-year-old healthy woman. The baseline showed a splinted bridge extending from tooth #12 to tooth #22, where tooth #11 had been replaced with a bridge unit. Radiographs showed root fillings and post-and-cores in teeth #12, 21 and 22 (Fig. 1). Scarring after apicectomy and dark-coloured gingiva in region #11 were noted (Fig. 2). Clinically, there was a loosened bridge with secondary caries in the hopeless abutment teeth (Fig. 3). The procedure was explored with the patient and the various treatment options were discussed. The patient wanted a permanently fixed restoration for which the healthy adjacent teeth in positions #14 and 13 should not be ground down. With this in mind, to close the gap, four zirconia implants restored with screw-retained crowns with palatal screw access holes was agreed with the patient. The patient exhibited excellent oral hygiene. All conditions for immediate implantation with immediate treatment (without immediate loading) were met.

Surgical procedure

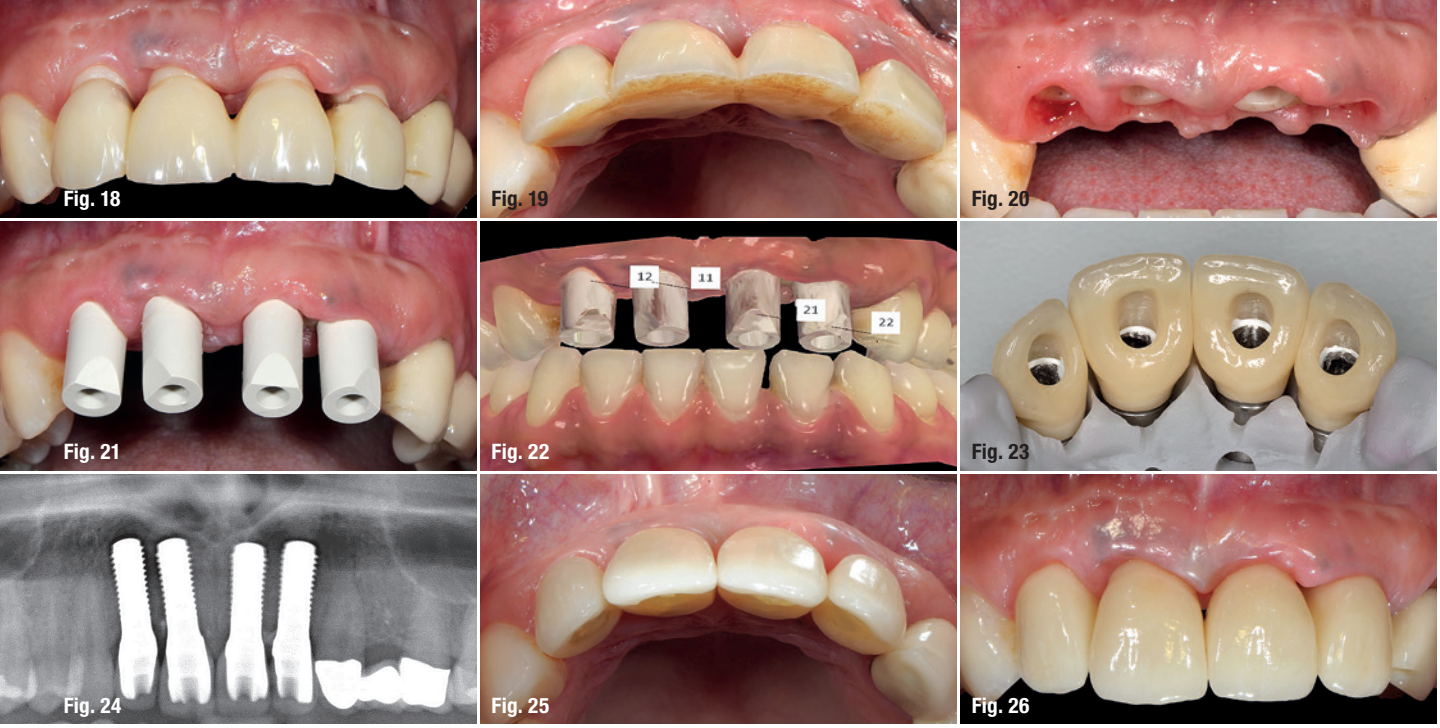
A pickup impression was taken so that chairside temporary restorations could be produced after the implantation. First, teeth #12, 21 and 22 were extracted atraumatically. After tooth extraction, the situation was not inflamed and there was sufficient bone available to allow immediate implantation of two-piece zirconia implants (PURE implants, with the ZLA surface, Straumann) in regions #12, 11, 21 and 22 while maintaining primary stability (Figs. 4–6). This was achieved with a minimally invasive approach via a marginal incision without vestibular release. Scan bodies allowed an intraoperative digital impression of the two-piece implants to be taken (TRIOS 3, 3Shape; Figs. 7 & 8). The digital data set was then sent via the Internet to the laboratory to produce temporary crowns.

Prosthetic restoration

Wound closure was performed with single interrupted sutures. All scan bodies were shortened and transformed into provisional telescopic solutions. The temporary crowns were made with Luxatemp (DMG Chemisch-Pharmazeutische Fabrik) based on the existing pickup



Figs. 9–12: The temporary crowns, which were made based on the existing pickup impression, were provisionally cemented to the anchoring elements. **Figs. 13–17:** Clinical situation at the second appointment seven days after the implant surgery. The dental restorations were produced by the Thomas Lassen dental laboratory.



Figs. 18–22: Another digital impression of the intra-oral situation was taken. **Fig. 23:** The definitive implant prostheses. **Figs. 24–26:** The radiographic and clinical situation six weeks post-op.

impression. These were then provisionally cemented to the anchoring elements with Temp-Bond (Kerr Dental, Figs. 9–12). During the cementing process, it was essential that no material was pressed into the periodontal gap. Postoperative radiographic follow-up was performed in line with the cementation protocol (Fig. 11). The temporary restorations were taken out of occlusion, and the patient was instructed not to bite off food with her incisors in the next three months, but rather to spread the masticatory force to the posterior region.

All the dental restorations were produced by the Thomas Lassen dental laboratory (Figs. 13–17). The sutures were removed as standard on the seventh day postoperatively. In the same appointment, the chairside temporary restorations were replaced with aesthetically high-quality temporary restorations made of composite in the form of a crown block. Provisional bonding was achieved with Temp-Bond on the screw-retained zirconia mesostructures. After a total healing phase of three months, there was a significant harmonisation of the soft-tissue situation. Another digital impression of the intra-oral situation was taken so that the final crowns could be produced (Figs. 18–22). The CAD/CAM-supported workflow allows simple and time-saving procedures using modern materials. The definitive implant prostheses consisted of screw-retained customised CAD/CAM-milled zirconia frameworks which were bonded with the angled Variobase abutments in the laboratory and then veneered (Fig. 23). The radiographic and clinical situation six weeks after implantation showed stable bone progression and irritation-free, pale membranes (Figs. 24–26).

Conclusion

Two-piece zirconia implants allow reliable anterior reconstruction with predictable outcomes. The individual soft-tissue conditioning can start directly after implantation. The digital workflow in particular supports the optimum shaping of the peri-implant soft tissue with ceramic materials and accelerates interdisciplinary processes. It is evident that there is an increase in the size of the interdental papillae in the first three years. For this reason, the interdental spaces should be physiologically designed from the outset as part of the prosthetic treatment.

Literature

about the author

Prof. Heinz Kniha is a Munich-based oral surgeon working in a joint practice together with Dr Karl Andreas Schlegel. He is highly specialised in implant dentistry and is an internationally prominent figure in research on zirconia implants. He studied dentistry and human medicine at the Friedrich-Alexander-University Erlangen-Nürnberg and University Hamburg, and completed his education as a specialist in maxillofacial surgery under the supervision of Prof. Dieter Schlegel at the Medical Center of the University of Munich. Today, being the author of many scientific articles, he is frequently invited to lecture at dental conferences on an international level.

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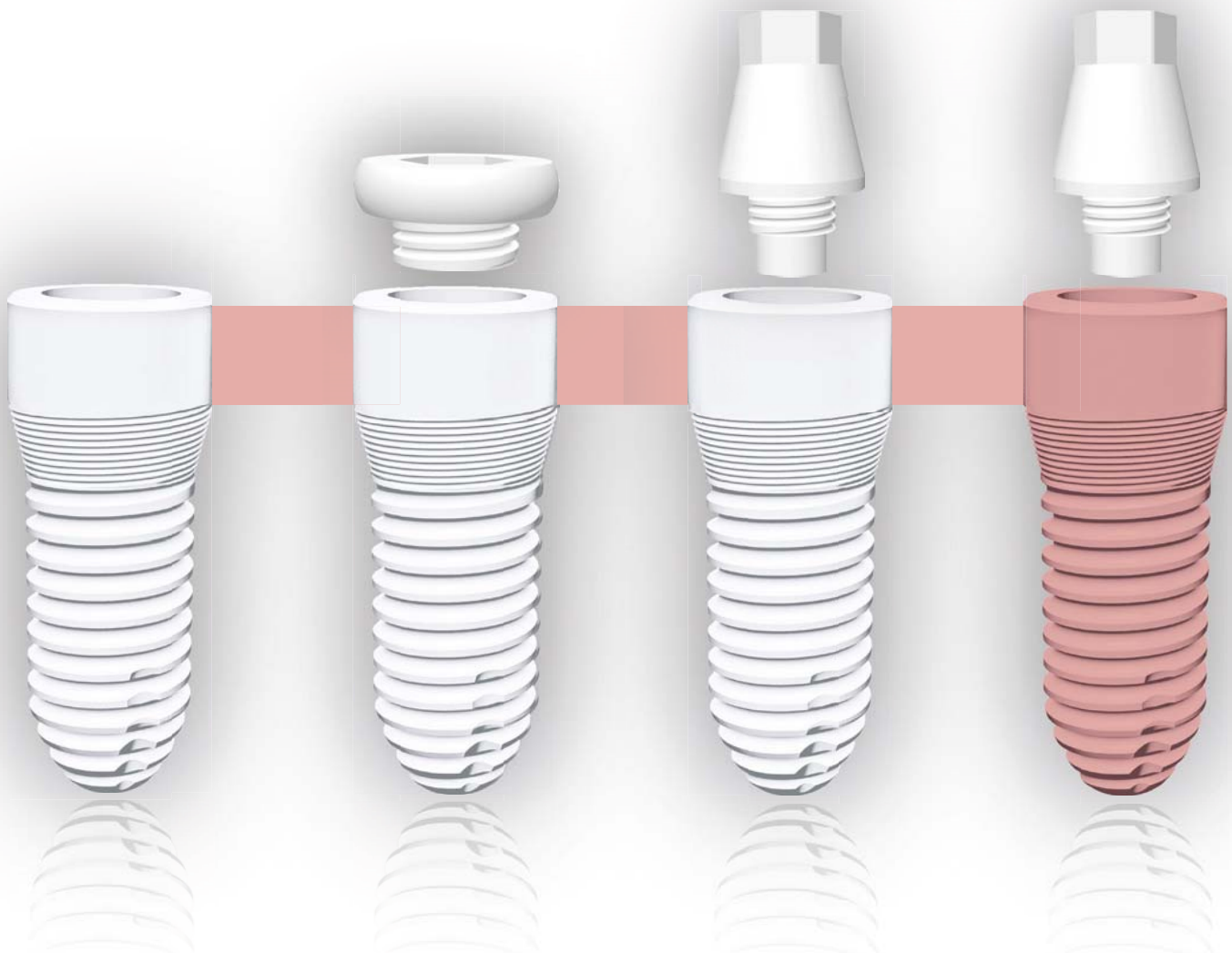

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A metal-free solution for restoring natural aesthetics

Dr Jens Tartsch, Switzerland

Ceramic dental implants have established a strong presence in general implant dentistry. Patient demand for metal-free solutions is increasing, and the development of new materials, micro-rough surfaces and improved treatment protocols has enabled clinicians to use ceramic dental implants as a reliable treatment alternative to titanium implants. The patient should be informed about the advantages and disadvantages of both material options, and involved in decision-making if a ceramic implant is presented as a treatment option. This procedure is standard in our dental office, shown by the following case report.

Clinical situation and treatment planning

A 57-year-old female patient presented at our clinic in May 2018. She asked for restoration of her premolar and molar sites after extraction. The teeth had been

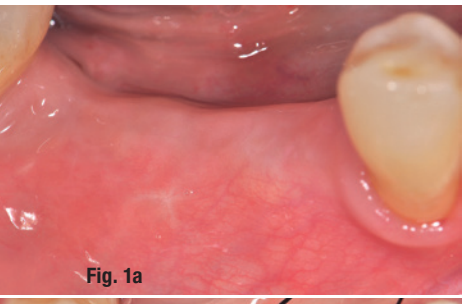
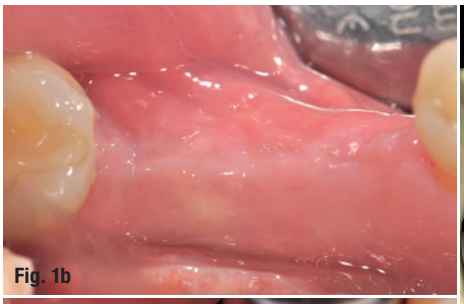


Fig. 1a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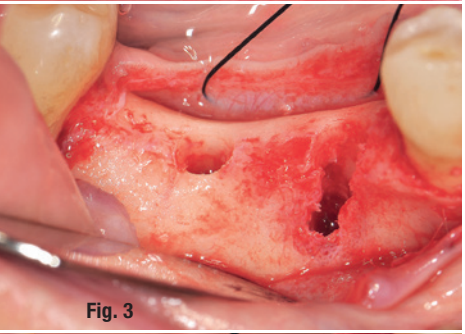
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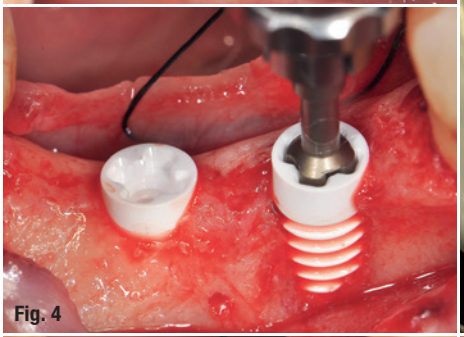
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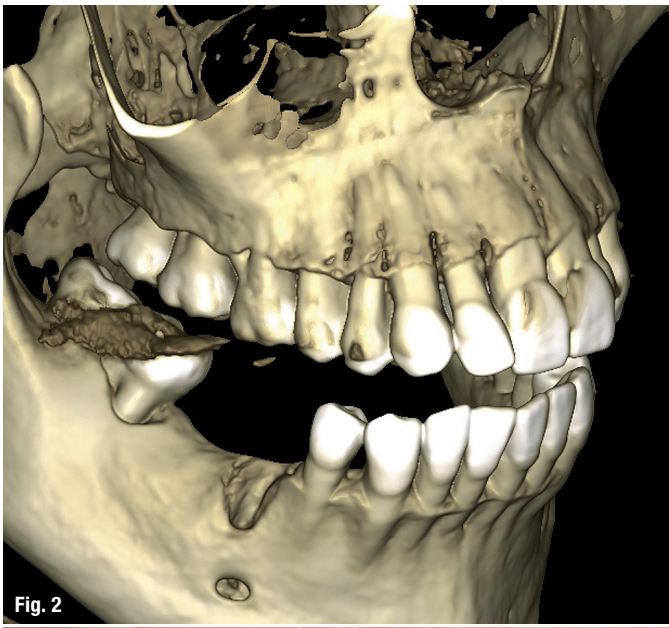
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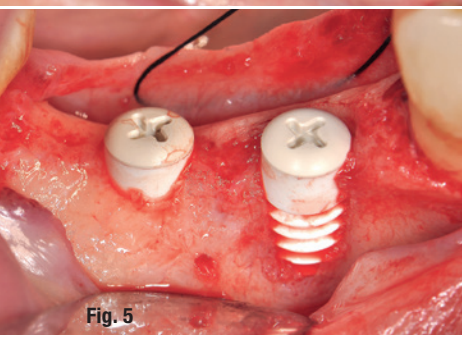
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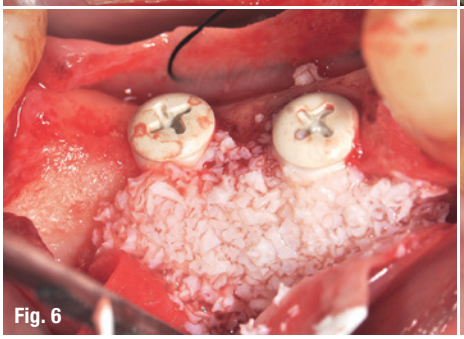
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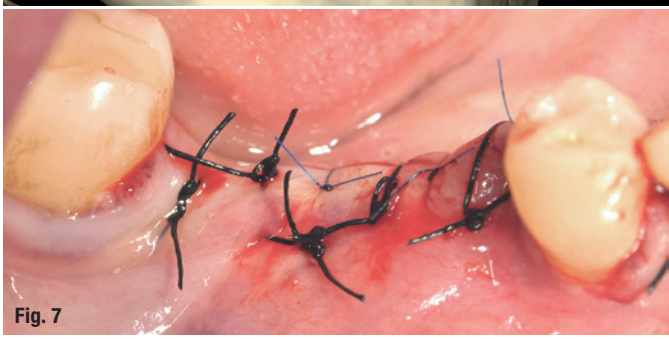


Fig. 7

Figs. 1a & b: Healed sites after extraction of teeth #45 and 46, three months and one year, respectively, before surgery. **Fig. 2:** A pre-op CBCT scan showed a lateral defect near site #45. **Fig. 3:** Suitable bone for implant insertion in site #46 and a lateral defect at site #45. **Fig. 4:** Manual insertion of a NobelPearl implant using the NobelPearl Inter-X implant driver after preparation of sites. **Fig. 5:** NobelPearl Inter-X cover screw *in situ*. **Fig. 6:** Horizontal augmentation using deproteinised bovine bone. **Fig. 7:** With a two-piece implant system, primary wound closure is possible.

extracted elsewhere three months (tooth #45) and one year (tooth #46) before her visit (Figs. 1a & b). The radiographic examination showed a single lateral dehiscence defect at site #45 and a fully healed site #46 (Fig. 2). The patient was informed about ceramic implants as an alternative to titanium implants and the NobelPearl tapered dental implant system (Nobel Biocare) as a metal-free solution. After a detailed explanation and discussion, the patient decided on this treatment option. The main reason for her decision was the prognosis of less inflammation of the peri-implant tissue with ceramic implants. The disadvantage of less long-term evidence compared with titanium implants was taken into account. After an initial hygiene phase and the periodontal treatment of tooth #47 by root planing, the implant surgery was performed in July 2018.

Surgical and restorative protocols

After cleaning of the alveolar bone, a suitable bone level for implant insertion in site #46 was established and a lateral defect at site #45 was observed (Fig. 3). NobelPearl tapered dental implants of 4.2 mm in diameter and 10.0 mm in length with NobelPearl Inter-X straight abutments were used in the clinical procedure (Fig. 4). Both implants were inserted 0.6 mm supra-crestally at a torque of 30 Ncm. Primary stability was good. The implants were covered with Inter-X cover screws *in situ* (Fig. 5). The buccal surface of implant #45 remained within the bone contour (three-wall defect), thus the lateral defect could be easily augmented with deproteinised bovine bone (Bio-Oss, Geistlich) and a membrane (Bio-Guide, Geistlich) following the standard clinical procedure (Figs. 6 & 7). After smoothening a periosteal incision, primary wound closure could be achieved. Three months after surgery, the restorative process began (Figs. 8–10) with re-entry by small single roll flaps at each implant site and placement of 3 mm NobelPearl healing abutments. The soft tissue was healthy and keratinised around the healing abutments when open-tray impression taking was performed after two weeks. A monolithic zirconia crown was selected as the prosthetic solution. For stability, and because of the augmentation at site #45, the crowns were splinted.

After removal of the healing abutment (Fig. 11) and try-in of the NobelPearl abutments, the screw channels were sealed with Teflon and the abutments were prepared for cementation (Figs. 12–14). To achieve a tension- and bending-free connection between the restorations and the implants, the zirconia restorations were cemented intra-orally to the abutments according to the standard procedure using RelyX Unicem (3M ESPE). Teflon was removed through the screw channel and the entire restoration was removed again as a whole piece. The cement could then be easily removed and the final restorations polished. After this cleaning, the restorations were reinserted and the VICARBO screws were torqued to 25 Ncm according to the guidelines. The screw channels were closed again using Teflon tape (Fig. 15) and finally covered with composite (Figs. 16 & 17). The total treatment time was four months.

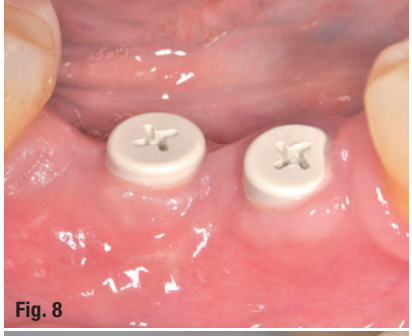


Fig. 8

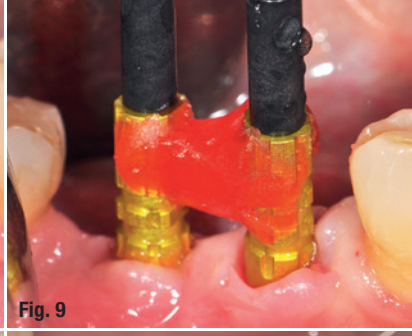
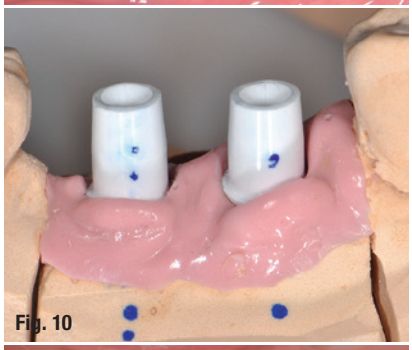


Fig. 9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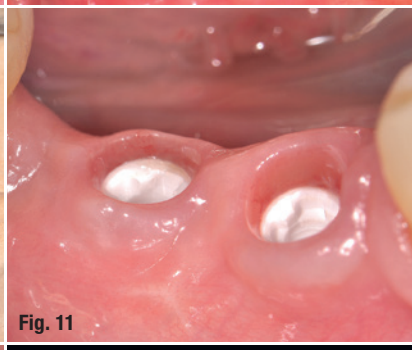


Fig. 11


Fig. 12


Fig. 14

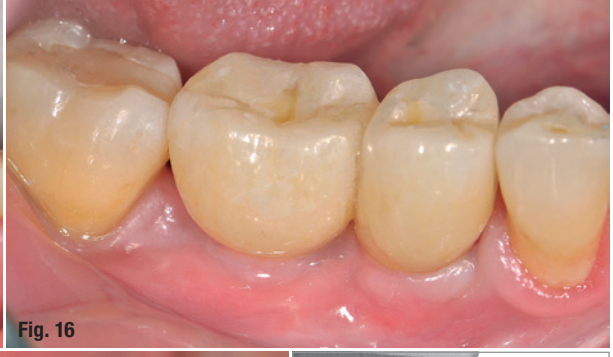

Fig. 13

Fig. 8: Healthy soft tissue two weeks after re-entry. **Fig. 9:** NobelPearl Inter-X open-tray impression coping placed on implants and fixed for precision. **Fig. 10:** Abutments placed on the master cast with a gingiva mask. **Fig. 11:** Healthy and thick keratinised peri-implant mucosa seen after removal of the NobelPearl Inter-X healing abutment. **Fig. 12:** The screw channels were sealed with Teflon and the NobelPearl abutments prepared for cementation. **Figs. 13 & 14:** Final restorations and abutments before insertion.

Clinical outcomes

The result was beautiful, and the patient was highly satisfied at the one-year follow-up (Figs. 18 & 19). No in-


Fig. 15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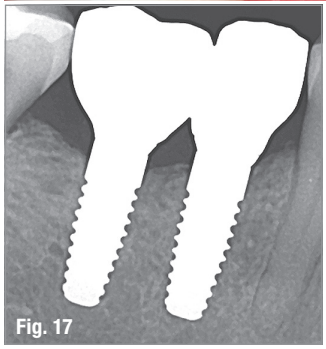
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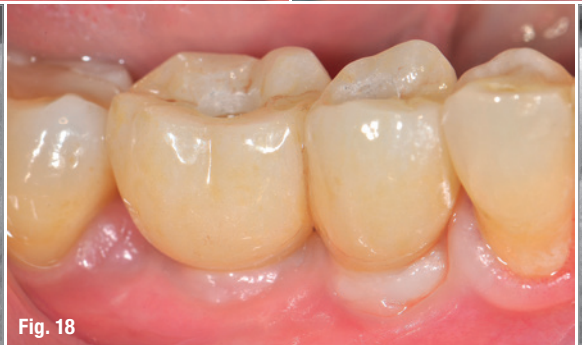
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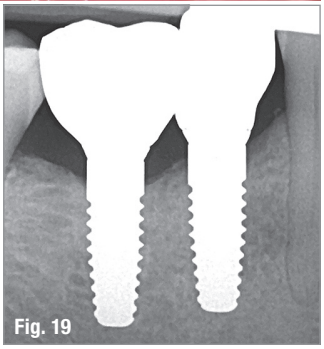
Fig. 19

Fig. 15: For the final installation of the restorations, the screws were torqued to 25 Ncm and the screw channels were closed again with Teflon tape. **Fig. 16:** Final restorations *in situ* after screw channel closure and sealing with composite. **Fig. 17:** Control radiograph after delivery of the restorations. **Fig. 18:** Excellent aesthetics at the one-year follow-up. Note the healthy soft tissue and natural-looking restorations. **Fig. 19:** The one-year follow-up radiograph showed a stable bone level.

flammation or prosthetic problems occurred during the follow-up period. The result in this case was a metal- and cement-free, screw-retained and reversible restoration. If problems such as chipping or subsequent colour adjustments were to become obvious, these could be easily corrected and revised—like with titanium implants.

Conclusion

The NobelPearl tapered dental implant system is designed for a broad range of indications, from single units to multiple units. It performed extremely well in the case presented, carrying splinted crowns after bone augmentation of defective bone. The surgical and prosthetic protocols are comparable to those of titanium implants. These are important factors for the successful integration of a new dental implant system in the daily dental practice. Our main reasons for using the NobelPearl tapered dental implant system in the case presented were as follows:

- NobelPearl is designed to support a natural soft-tissue appearance, especially for patients with a thin mucosal biotype.[1] Zirconia generally shows lower plaque accumulation[2] and bacterial adhesion[3,4] than does titanium.
- The surface of NobelPearl is micro-rough and hydrophilic for successful osseointegration, while the implant collar is partially machined, designed for excellent soft-tissue attachment and a low inflammatory response.[2]
- NobelPearl provides a mechanical strength advantage. It is made of alumina-toughened zirconia, which yields improved hardness, bending strength and toughness compared with tetragonal zirconia polycrystals.[5]
- NobelPearl offers great restorative flexibility owing to its two-piece reversible, cement-free internal connection design.
- The primary stability of the implant is good, as a result of having a non-self-cutting tapered body, and the clinical protocol is comparable to that of titanium implants.
- It is a metal-free solution, as even the screw is made of a carbon fibre-reinforced polymer designed for a strong ceramic-to-ceramic connection, which is highly biocompatible.

Literature

about the author

Dr Jens Tartsch received his degree in dentistry from Freie Universität Berlin in 1992. He practises at his own private dental clinic in Kilchberg in Switzerland. He is President of the European Society for Ceramic Implantology and a member of the board of the Swiss Society for Anti-Aging Medicine and Prevention. He is an international educator and published author on the topics of ceramic implantology and immunology in dentistry, as well as oral and maxillofacial surgery. His research and clinical interests are immunology in dentistry, ceramic implant dentistry and metal-free restorations, as well as aesthetic dentistry. He also lectures on national and international level.

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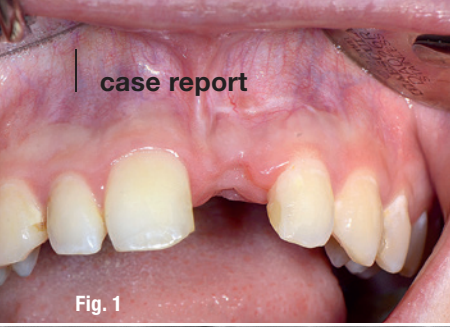
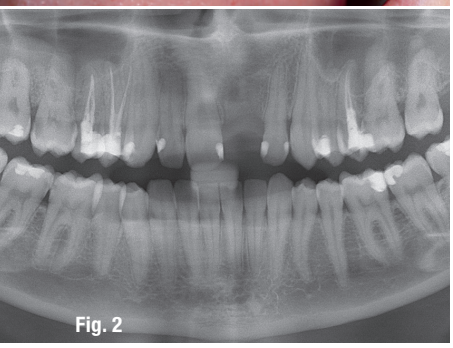


Fig. 1



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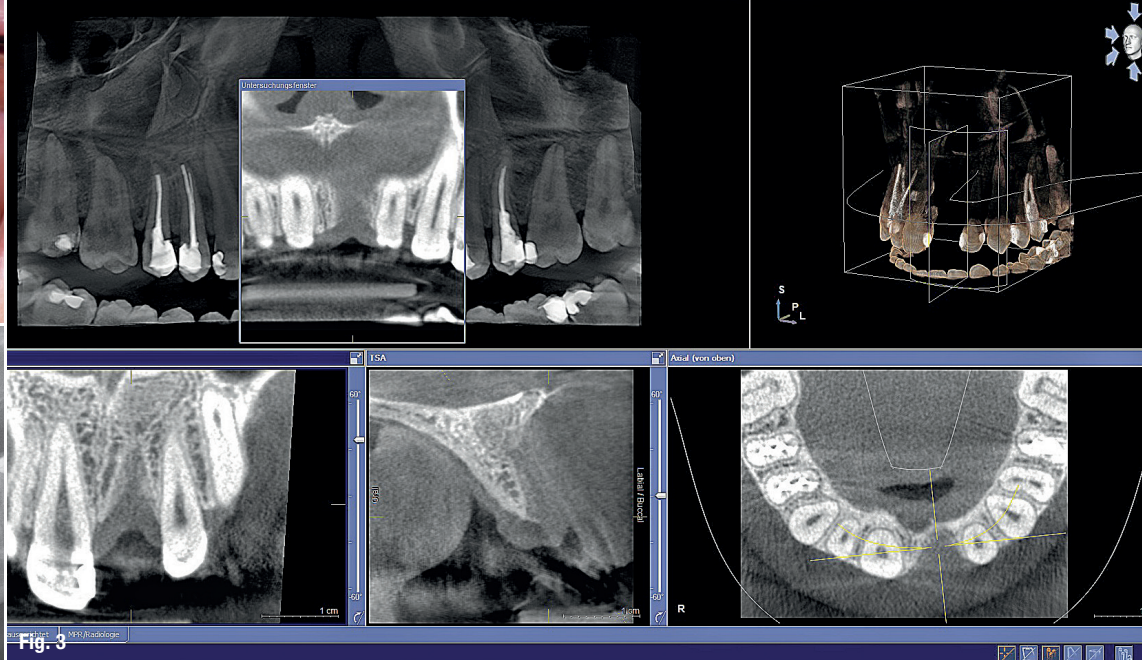


Fig. 3

Fig. 1: Pre-op clinical situation. **Figs. 2 & 3:** Radiograph and CBCT evaluation of the initial clinical situation.

Restoration after augmentation in the maxillary anterior region

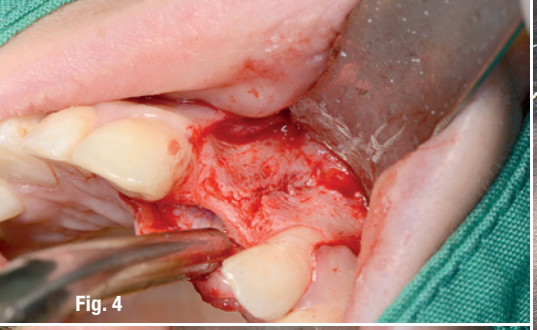
Dr Falk Nagel, Germany

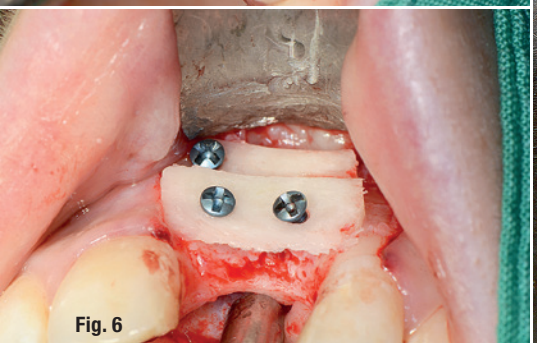
The implant treatment of a tooth gap in the anterior region of the upper jaw with a high bone deficit represents a special challenge in surgical practice. It requires comprehensive knowledge of the handling and modes of action of different products for hard-tissue regeneration, as well as of adequate surgical techniques and materials in order to achieve a stable and sufficiently dimensioned bone bed for aesthetic soft-tissue management. The following describes an elaborate surgical concept with a two-stage procedure to fulfil a patient's wishes for implant restoration with a highly compromised bone bed. Due to the reduced soft-tissue irritation of zirconium dioxide, the decision was made to insert a two-piece ceramic implant to meet the requirements for preservation of peri-implant mucosa.

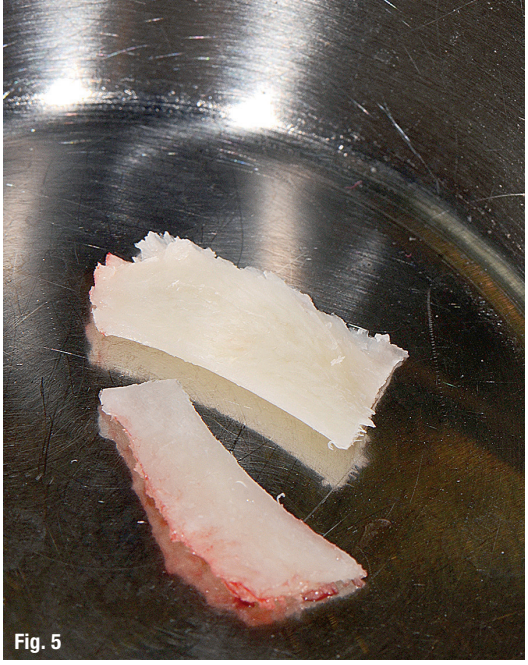
Case presentation

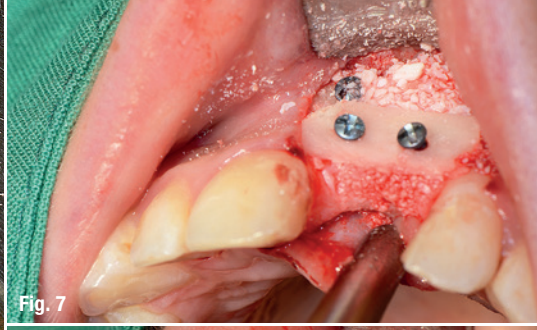
In May 2017, a 24-year-old female patient with an anterior gap was referred to our practice. After a trauma in the form of root canal therapy and a root tip resection about ten years before, tooth #21 was repeatedly treated, having suffered multiple occurrences of apical inflammation. After recurring acute apical osteitis with a fistula and a suspected longitudinal fracture, the anterior tooth had been extracted some time ago by her family dentist. At the time of extraction, the entire buccal bone lamella had already been resorbed. Examination with a blunt probe only confirmed a soft-tissue deposit in the root area. Alveolar stabilising measures were obsolete owing to acute inflammation at the time of extraction. The general medical history was inconspicuous, as was the dentition situation from a functional point of view. After healing of the inflammatory bone bed, the entire buccal bone lamella was resorbed after ten weeks. Despite patient education and regular professional tooth cleaning, the approximal space plaque index showed only moderately good oral hygiene with a score of 35. The periodontal screening index (PSI) is part of the routine examination in our practice. It serves as a supplement to visual diagnostics and offers both the dentist and the patient the guarantee that serious periodontal diseases will not be overlooked and that appropriate therapy will be administered. In this patient's case, the PSI was increased, being a score of 2. This score requires regular recall every six months, when both professional tooth cleaning and the PSI must be performed, the latter to check the current status.

The patient explicitly requested restoration of the single tooth gap with an implant only. She rejected grinding of the adjacent teeth for a bridge restoration or an adhesive prosthesis. Her aesthetic demand for a harmonious overall situation was not superficial. Oral hygiene was still in need of improvement (Fig. 1). After the extraction socket had healed without volume maintenance,









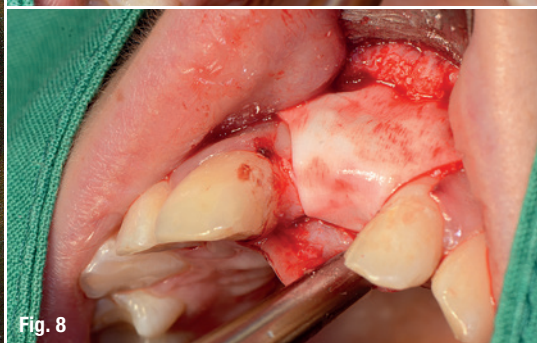


Fig. 4: Intra-op view of the alveolar ridge. **Fig. 5:** Two bone blocks were taken intra-orally. **Fig. 6:** View of the bone regeneration procedure. **Fig. 7:** Bone augmentation material was inserted. **Fig. 8:** The site was covered with a double-layered resorbable membrane.

a pronounced hard- and soft-tissue deficit appeared in the area of the missing anterior tooth. The 3D resorption of the alveolar bone was exactly depicted in the CBCT scan, which made it possible to calculate the vertical and horizontal volume to be built up in order to achieve a stable implant bed (Figs. 2 & 3). The patient and the referring colleague were informed that the implantation had to be performed in two stages owing to the complex restorative needs.

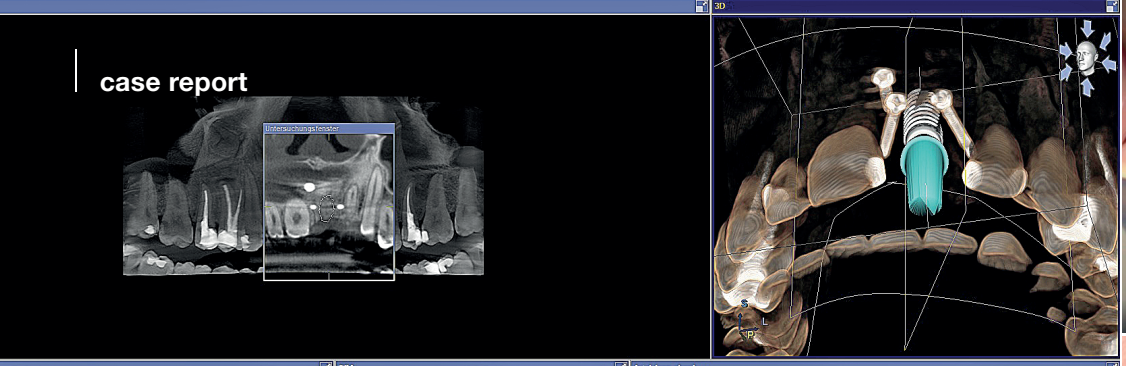
Complex bone augmentation

The morphology of the presenting bone defect significantly determined the choice of materials and surgical methods for anatomical reconstruction of the alveolar ridge.[1–3] In the case of a defect of this magnitude, guided bone regeneration techniques with bone grafting substitutes and membranes are limited owing to the mechanical instability and the associated poor regenerative capacity of the augmentation at the recipient site. For these reasons, the bone block or shell technique with autologous bone was opted for. A crestal primary incision with a slightly palatal orientation and divergent relieving incisions were made to allow good access to the surgical site. A raspatory was used to prepare a mucoperiosteal flap deep into the mucolabial fold. This must be sufficiently mobilised with the appropriate splitting technique in order to be able to cover the voluminous graft without tension (Fig. 4). Two bone blocks were taken intra-orally from the area of the oblique line of the mandible on the right after the need at the defect site had been clinically re-examined (Fig. 5). The two bone blocks were fixed vestibular to the receptor site of region #21 with long osteosynthesis screws (KLS Martin) to act as rigid autologous support (Fig. 6).[3–5] The free spaces between the bone block and the jawbone were precisely filled with a mixture of bone chips collected during block fitting and a slowly resorbed bone grafting substitute (Bio-Oss, Geistlich Biomaterials; Fig. 7).

In order not to compromise the healing process and to ensure good blood penetration, it is vital that the bone mixture lies close to the recipient site and the bone shells.[3] The structure was covered with a resorbable membrane (Bio-Gide, Geistlich Biomaterials) in a double layer (Fig. 8) to protect it from the ingrowth of soft tissue. Subsequently, the mobilised mucoperiosteal flap could be sutured tension-free over the augmentation site. During the healing process, it is essential to avoid any pressure loading that could lead to movement of the augmentation. Therefore, the patient was provided with a removable prosthesis that was very well supported against tilting movements. The prosthesis base was first hollow-ground and relined as required during the regular check-ups. The patient received an antibiotic dose of 1,000 mg of Augmentin, a combination of amoxicillin (875 mg) and clavulanic acid (125 mg), for perioperative infection prophylaxis one hour before augmentation and was advised to take the same dose three times a day postoperatively over a total of seven days.

Surgical procedure

Four months after the complex bone reconstruction, a reversible two-piece screw-retained ceramic implant (CERALOG Hexalobe, CAMLOG) was inserted. Owing to the thin gingival type and the reduction of the risk of gingivitis and mucositis, zirconium dioxide shows certain advantages over titanium, especially in the implant shoulder area. The decisive factor in the choice of implant was the screwability of the abutments. During implant planning, the CBCT scan showed a sufficiently dimensioned bone volume to be able to insert the implant (diameter of 4.0 mm and length of 12 mm; Fig. 9). The implant was to be placed epicrestally. When positioning the implant in this way, it should be noted that the implant is sculptured to a diameter of 4.5 mm to the implant–abutment interface. Furthermore, 1.8 mm of vestibular bone wall is required for long-term maintenance of stable peri-implant hard tissue.



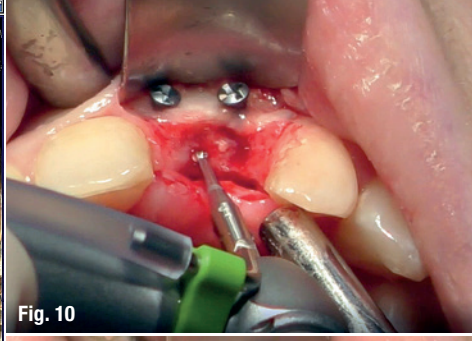
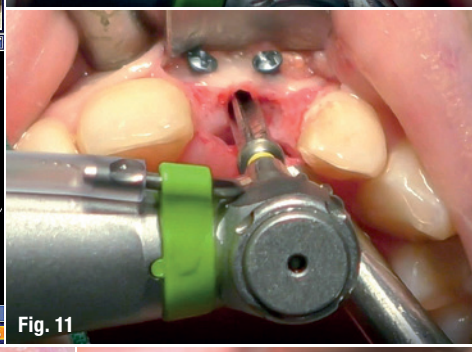


Fig. 10

Fig. 9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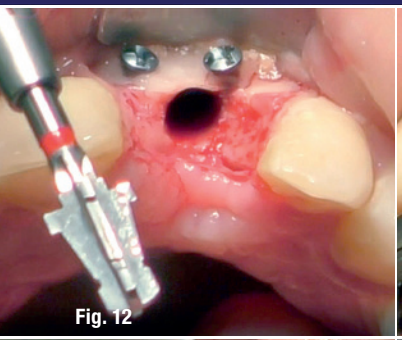
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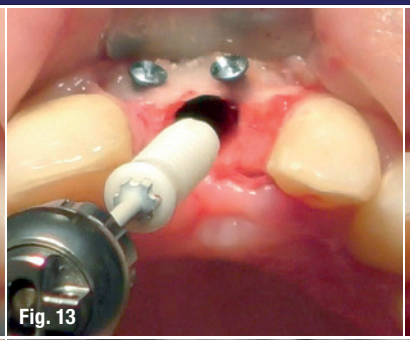
Fig. 13

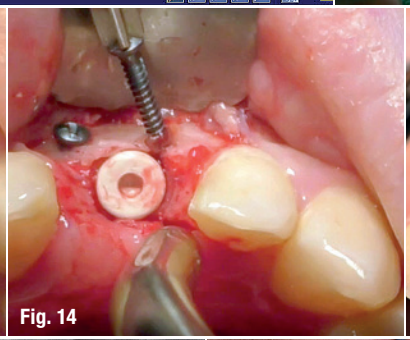
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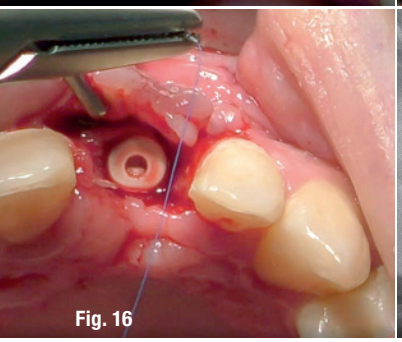
Fig. 15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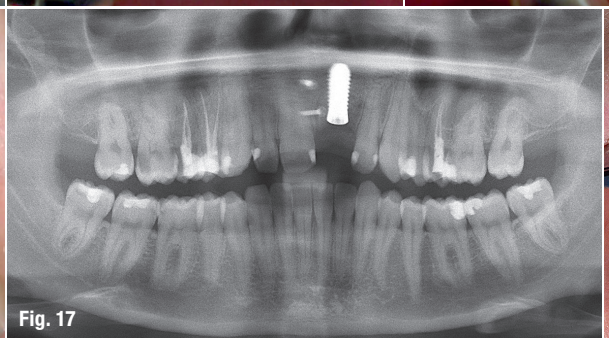
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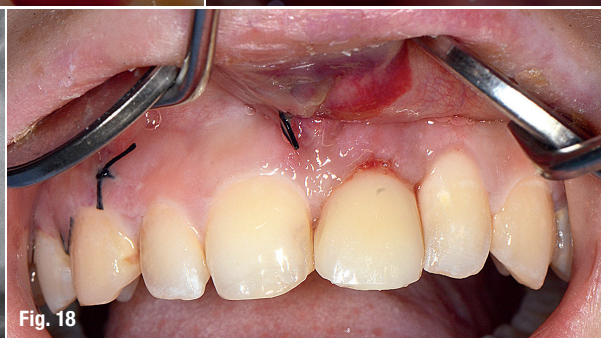
Fig. 18

Fig. 9: CBCT after the bone regeneration procedure. **Figs. 10–12:** The osteotomy was prepared by means of a rose drill. **Figs. 13 & 14:** The implant was inserted and covered with a healing cap. **Figs. 15 & 16:** One of the three osteosynthesis screws was removed, and the soft tissue was sutured. **Fig. 17:** Radiograph taken after the implant surgery. **Fig. 18:** View of the removable restoration.

The bone was exposed using a palatally orientated crestal incision. Predominantly rebuilt stable bone was found. After the implant position had been marked with a rose drill, the implant bed was prepared in accordance with the protocol (Figs. 10 & 11). The osteosynthesis screws remained *in situ* for prophylactic stabilisation of the bone shell. The bone contour was widened according to the tulip-shaped implant shoulder, and the thread was cut (Fig. 12). Despite a bone quality of D3, it is necessary to pre-cut the thread of a ceramic implant because the material is not thermally conductive, unlike titanium. Without pressure and at low rpm, the implant was inserted flush with the bone and closed with a healing cap (Figs. 13 & 14). Owing to the biological osseointegration process of a ceramic implant, it should heal covered at complete rest without any pressure. The surgeon removed one of the three osteosynthesis screws and performed saliva-tight suturing of the soft tissue with single button sutures (Figs. 15–17). The patient left the practice with the ground removable restoration (Fig. 18), instructions to cool the surgical area well and to eat only soft food in the next few days, and an antibiotic (Augmentin, 875 mg, for three days).

Temporary and final restorations

The implant was uncovered four months after placement, several check-ups and professional tooth cleaning. A minimally invasive stab incision allowed the coping to be pulled out of the implant. An impression of the implant was taken to create a temporary crown. A master cast with a removable gingival mask was fabricated, a PEKK abutment was inserted and a previously fabricated shell temporary was polymerised onto

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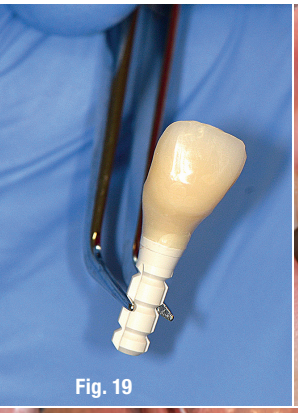
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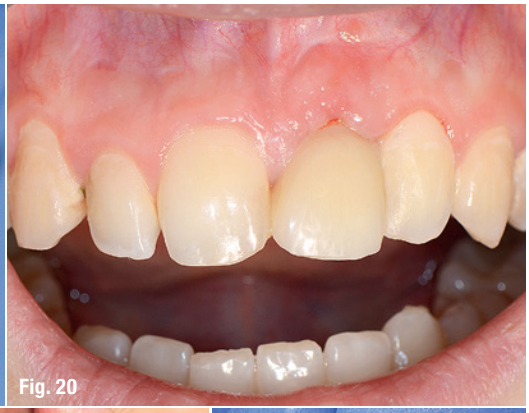
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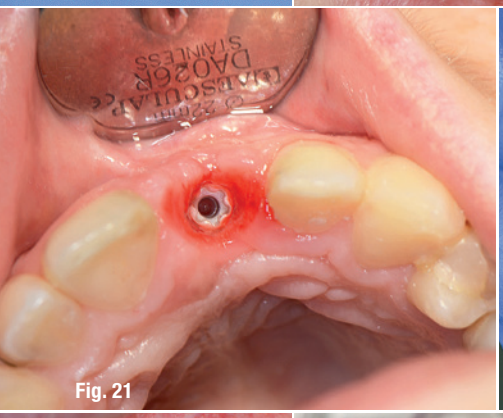
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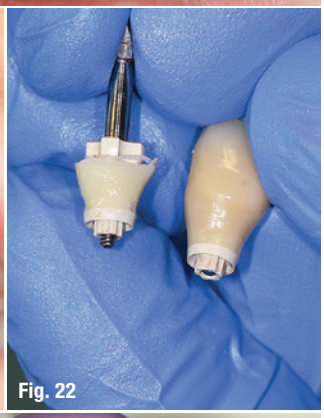
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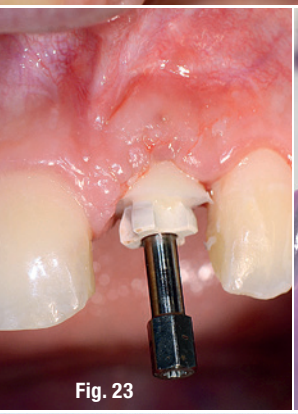
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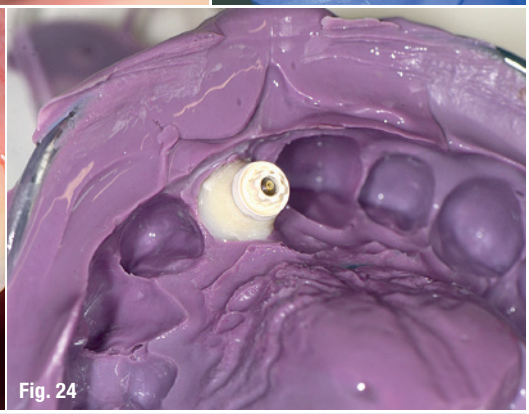
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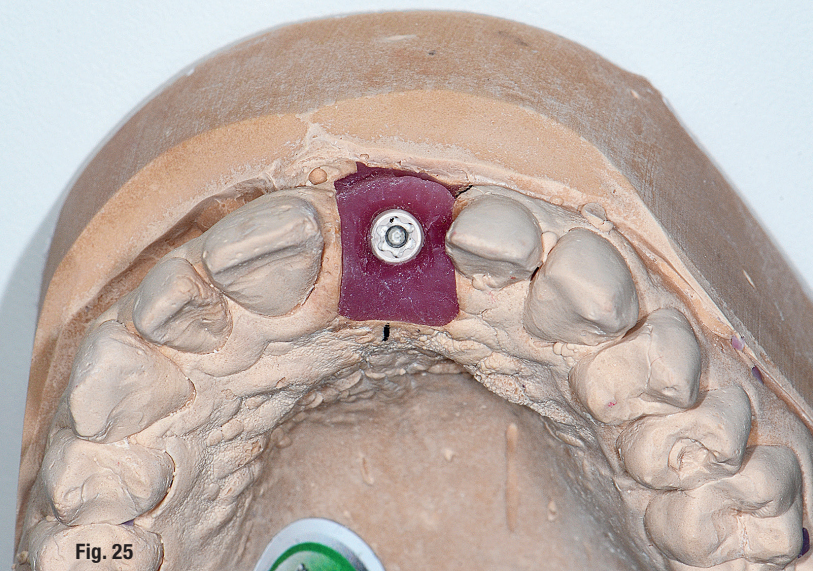
Fig. 25

Figs. 19 & 20: A PEKK abutment was inserted and a previously fabricated shell temporary was polymerised onto it. **Fig. 21:** Occlusal view of the implant. **Fig. 22:** View of the customised impression posts. **Figs. 23–25:** The customised impression post was placed and an impression was taken.

it using a deep-drawn splint (Figs. 19 & 20). The optimal positioning of the implant caused the screw access channel to lie palatally. The temporary restoration was removed and the crown–abutment transition was filled with flowable resin, finished and polished. To form a stable marginal gingiva, the crown emergence profile was designed concave and undersized. The proximal contact points were 4–5 mm above the alveolar ridge. This provides sufficient support for the interdental papillae to allow optimal formation. Eight weeks after insertion of the temporary crown, a stable attached gingiva and a harmonious anatomical course of the gingival margin were observed (Fig. 21).

In an interview with the patient, the interdisciplinary team agreed on aesthetic details to determine the shade of the final restoration. An all-ceramic crown was to be cemented onto an individualised CAD/CAM-fabricated full zirconium dioxide abutment. In order to transfer the crown emergence profile exactly to the master cast, the dental technician fixed the shape by screwing the temporary crown to a laboratory implant and taking a silicone impression. He removed the crown, screwed on an impression post for the open impression and filled the crown profile in the silicone key with acrylic. The customised impression post was placed in the mouth and an impression of the entire jaw was taken (Figs. 22–25). The dental technician fabricated the model and quickly waxed the temporary crown using the silicone key. He scanned the model, the implant position and the wax-up, and sent the abutment design data to DEDICAM, CAMLOG's CAD/CAM fabrication service provider.

The milling and sintering of the internal implant geometry are extremely technically sensitive and can only be optimally fabricated by the manufacturer. Special attention was paid to the position of the crown–abutment transition. It was placed circularly about 1 mm below the gingival margin to ensure that the cement could be removed exactly from the sulcus. A zirconium dioxide framework was fabricated on the abutment in the laboratory and individually veneered with appropriate ceramic materials (Figs. 26 & 27). On the day of placement, the temporary implant crown was unscrewed and the abutment placed and fixed with a gold screw at a torque of 15 Ncm. The screw access hole was closed with a clip and the all-ceramic crown was cemented onto it after a functional and aesthetic check (Figs. 28–30). Both the treating team and the patient were satisfied with the final result of the complex case. It was desirable to increase the patient's commitment to oral hygiene.

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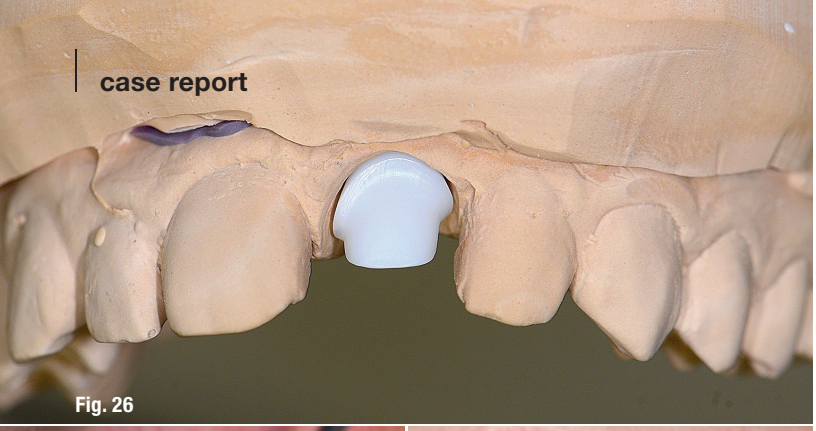
Fig. 26


Fig. 27


Fig. 28


Fig. 29

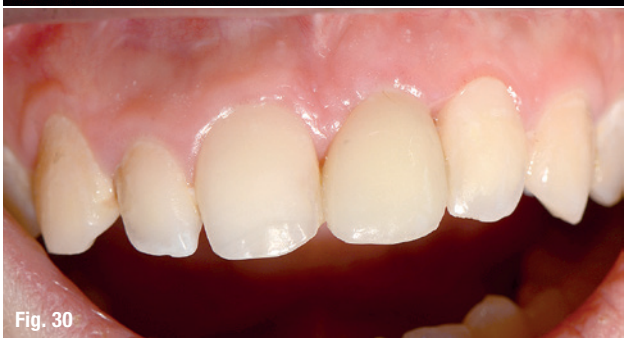
Fig. 30

Figs. 26 & 27: A zirconium dioxide abutment was made by DEDICAM. **Figs. 28–30:** The all-ceramic crown was cemented onto the screw access hole.

Conclusion

Minimally invasive procedures are worthwile, for which the focus in the referral practice would basically have to be on adequate alveolar management after tooth extraction. In the present case, however, there was an area of acute inflammation. Examination with a blunt probe showed resorption of the entire buccal bone lamella before extraction, so that alveolar management was only possible to a limited extent. Especially in the aesthetic anterior region, the alveolar bone resorbs very strongly without volume-preserving measures such as socket preservation. The natural degradation process then often requires complex surgical procedures for implant placement, not only at the augmentation site but also at the extraction site. This bone augmentation is necessary because centripetal resorption with aesthetic defects can occur if implants are not sufficiently surrounded by bone, resulting in implant loss.

Zirconium dioxide implants are an alternative to titanium implants. The material is particularly suitable for thin gingival types with an increased risk of gingivitis owing to its colour,[6] good compatibility with hard and soft tissue, and lower plaque accumulation. One advantage of the implant system used is the true two-part nature of the reversible screw-retained prosthetic components.[7] The CERALOG Hexalobe implant can therefore osseointegrate covered and without vertical or horizontal masticatory loading. This overcomes a decisive limitation of previous one-piece ceramic implants, which must be protected from pressure and shear forces, especially in the first weeks of the healing phase. Furthermore, the micro-rough surface of CERALOG implants is absolutely clean, since both the external geometry and the surface texture are produced by the manufacturing process of ceramic injection moulding. The implant is pressed into a mould, fed into the sintering and hot isostatic pressing process, and not further processed. In addition to restorations on standardised PEKK abutments, the DEDICAM digital manufacturing service offers the possibility of aesthetic restorations on individually fabricated one-piece zirconium dioxide abutments.

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about the author

Dr Falk Nagel studied dentistry at the universities of Heidelberg and Dresden. From 1998 to 2003, he practised at the outpatient clinic for prosthodontics of the Technische Universität Dresden. In 2009, he was board certified by what is today the Deutsche Gesellschaft für Prothetische Zahnmedizin und Biomaterialien (German society for prosthodontics and biomaterials). Since 2010, he has been practising as a specialist for oral surgery and since 2012, he has been running a specialist practice for prosthodontics and oral surgery. He is a published author and is frequently invited to give lectures at dental events.

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Digital workflow with a metal-free surgical guide and zirconia implant

Dr Saurabh Gupta, India

In recent years, ceramic implants have become an attractive and reliable alternative to titanium implants. With the advancement of digital implant dentistry and increasing use of metal-free surgical guides, there should be reliable guided surgery options available to place such implants.[1–3] There are different kinds of surgical guide designs available in the current market. The ideal guide should be produced defect-free; should offer precision, a perfect fit and high primary stability; and should aid exact reproduction of the planning.[4] Furthermore, the surgical guide should be robust and thus not be affected by transport, storage and sterilisation. In addition, the guide design should allow clear visual inspection and easy irrigation. Finally, the use of this guided system should not lead to an increase in the cost of the operation.[5–8] Companies manufacturing guided systems for dental implant placement offer surgical guides of almost similar design: they are tooth-, mucosa- or bone-supported, and mostly made out of resin, and drilling and implant holes are placed within the body of the guide itself. These drilling holes usually receive metal sleeves of various diameters to guide successive drills.[9,10] In this case report, we used a metal-free fully guided system (2ingis) for the placement

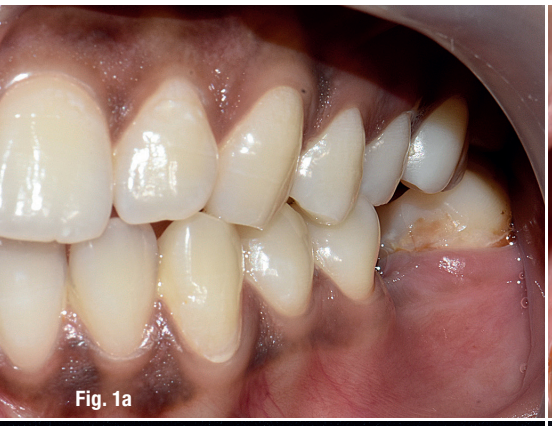


Fig. 1a

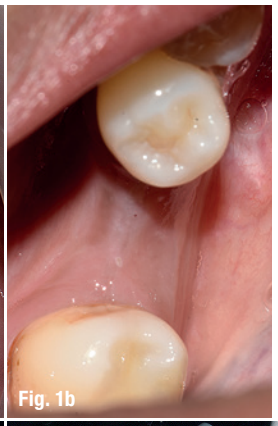


Fig. 1b


Fig. 2a

Fig. 2b

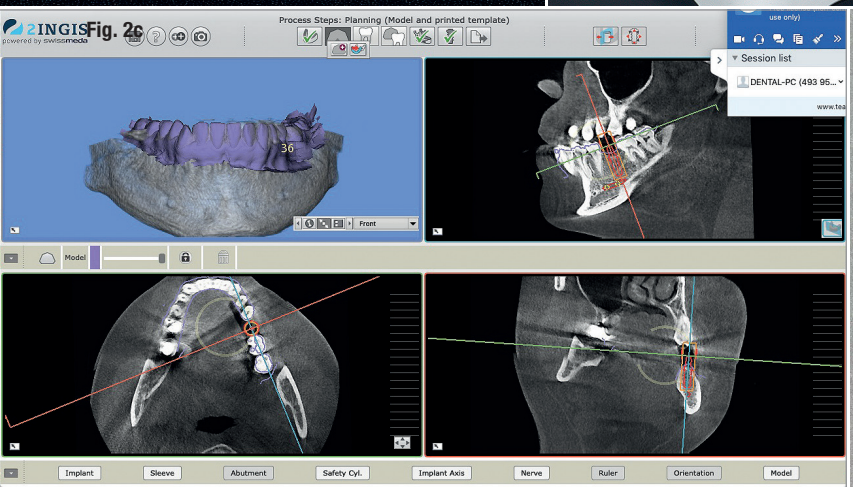
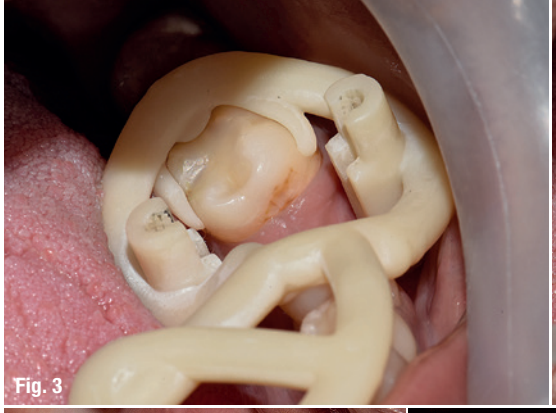
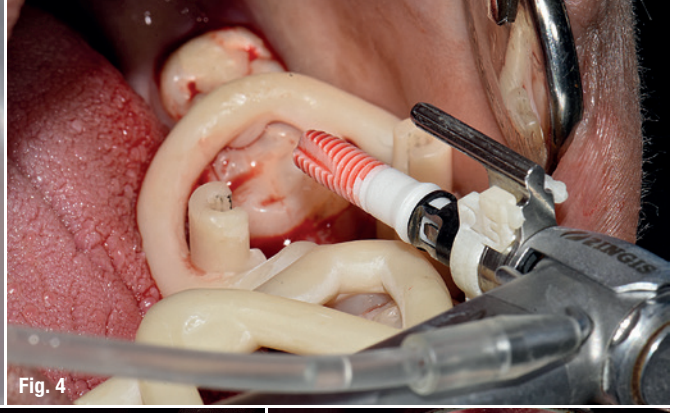


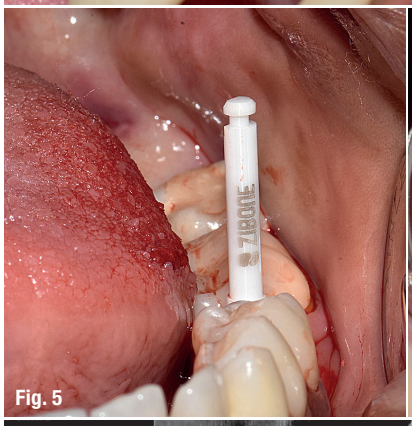
Fig. 2c

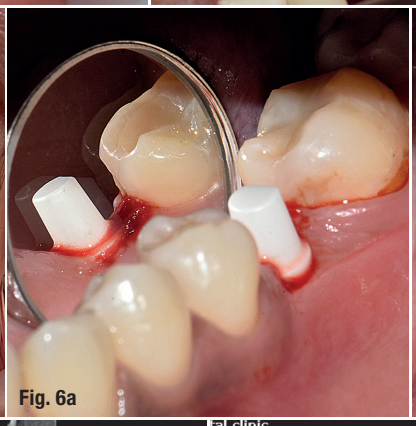
Fig. 2d

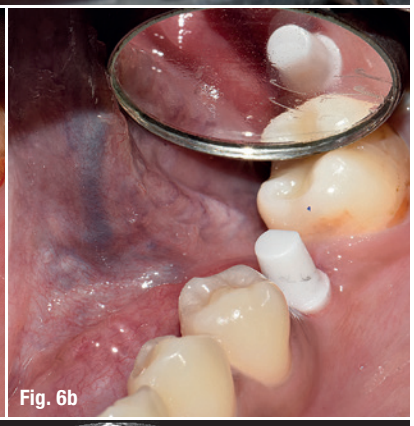
Figs. 1a & b: Missing tooth #36. **Figs. 2a–d:** Digital planning with SMOP software.

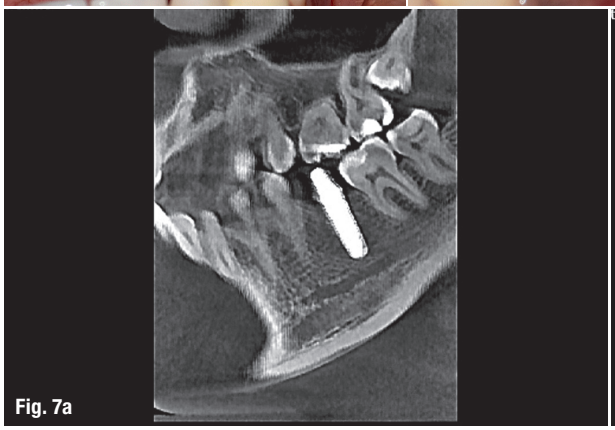












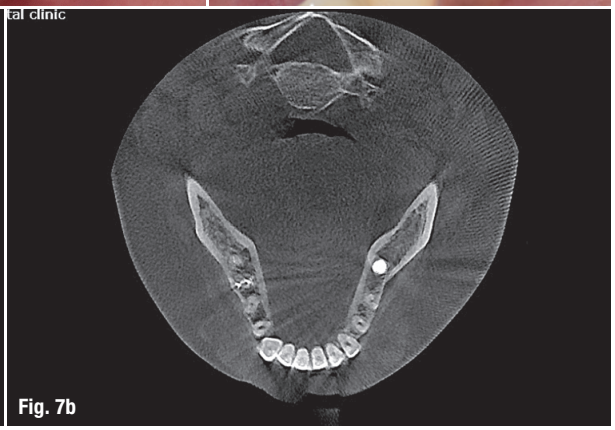


Fig. 3: Stabilisation of guide. **Fig. 4:** Implant placement. **Fig. 5:** Ideal position of implant. **Figs. 6a & b:** Immediately post-op **(a)**; seven days post-op **(b)**. **Figs. 7a & b:** CBCT scan.

of a ZiBone zirconia dental implant (COHO Biomedical Technology) for missing tooth #36 (Figs. 1a & b).

Planning phase

The manufacturing of the surgical guide was done using CAD/CAM technology. The design of the guide was first worked out on a computer with CAD software (SMOP, Swissmeda) after the DICOM and STL files had been uploaded (Figs. 2a–d). Guide stability by dental supports was sought preferentially. Finally, the surgical guide was printed in try-in resin using a NextDent 3D printer (3D Systems).

Surgical phase

During the surgical phase, flapless surgery was performed and the specific surgical kit (2ingis) was used along with the instruction manual provided. It included a contra-angle handpiece (W&H) with guide forks of different lengths (depending on the patient's mouth opening, the edentulous span and the depth of drilling). It also has depth wedges, a ring with two arms (to be inserted into the guide tubes in the same way as for the drilling guide fork) to guide the implant holder during manual placement of the implant, a metal trephine to cut the gingival tissue, and zirconia drills which allow flattening of the bone crest and performing of the initial drilling (pilot drill), respectively. Zirconia drills were then used for the rest of the drilling sequence, using depth wedges when necessary. The instruction manual was followed, which listed the drills needed throughout the surgery phase. With the surgical guide remaining in place, the implant was placed with the contra-angle handpiece in the planned site with good primary stability, and the desired torque of 35 Ncm was achieved (Figs. 4–6b).

Prosthetic phase

The provisional restoration was prepared and fixed soon after intra-oral scanning (TRIOS, 3Shape) of the abutment part of the zirconia implant (Fig. 8). The crown was

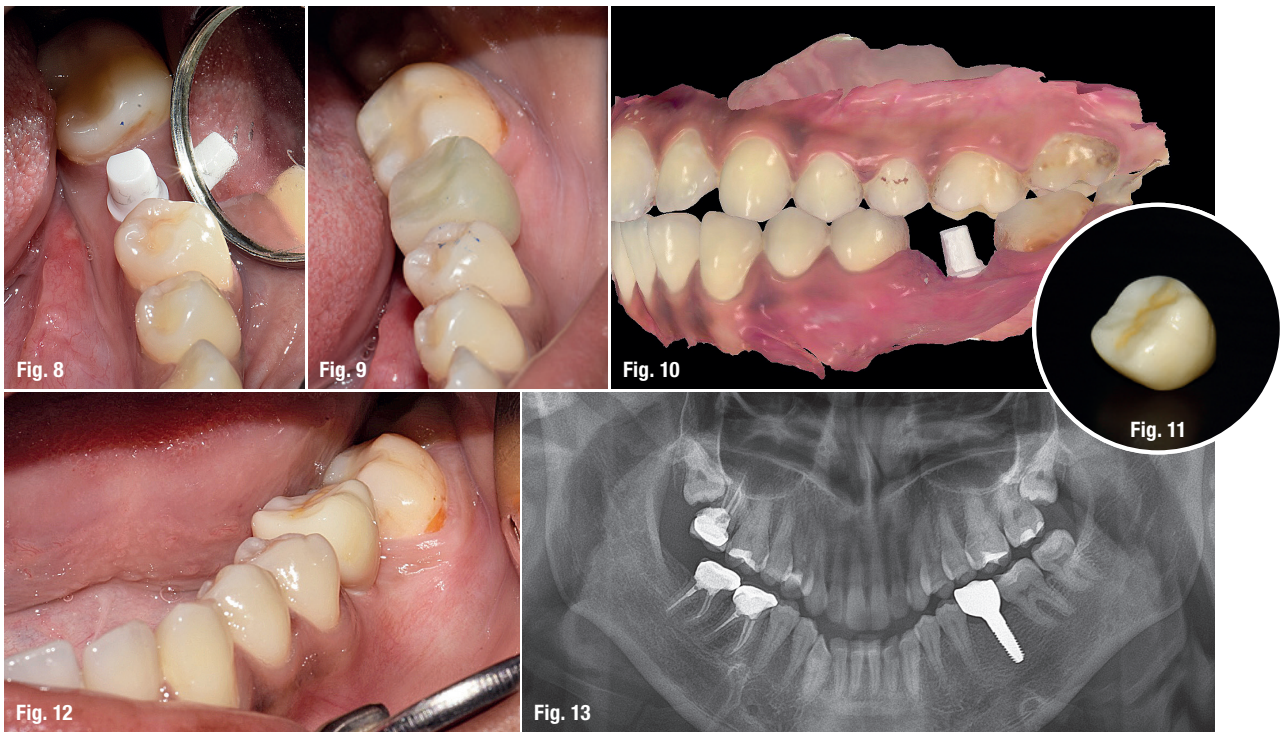


Fig. 8: Provisional restoration. **Fig. 9:** Twelve weeks post-op. **Fig. 10:** Intra-oral scan. **Fig. 11:** Monolithic crown. **Fig. 12:** Final crown *in situ*. **Fig. 13:** Final radiograph.

kept out of occlusion, and strict instructions were given to the patient. The osseointegration process was successful, and the implant was planned for restoration using a permanent monolithic zirconia crown (3M) after 12 weeks (Fig. 9). The TRIOS intra-oral optical scan was retaken with the provisional restoration seated (Fig. 10). The final monolithic crown was then designed, milled and prepared according to a completely digital workflow (Fig. 11). The crown's intaglio surface and the implant's abutment surface were cleaned and primed with a coating of Z-Prime Plus (BISCO) and was later cemented with a self-adhesive resin cement (3M ESPE). Extra cement was carefully removed using dental floss soon after the final crown had been cemented. The occlusion of the crown was checked with articulating paper. The patient was well satisfied with the treatment procedure with respect to both form and function (Figs. 12 & 13).

Conclusion

In conclusion, the metal-free surgical guide stands out from other guided systems and appears to be a significant advancement in the field of guided implant surgery. In this case report, the wide-open design of this guide allowed unrestricted irrigation and visual control under conditions comparable to those of surgeries performed without surgical guides. There was no friction of the zirconia drills on the surgical guide, which would have damaged it or contaminated the drilling hole with sleeve particles torn from the guide. This metal-free guided system seems to be ideal for placement of zirconia dental implants.

Literature

about the author

Dr Saurabh Gupta is an oral and maxillofacial surgeon from India. He is a private practitioner working as Clinical Director at the Digital Dental Design Clinic & DVG's lab (3M authorized) in India. He is Education Director/Board Member of the International Academy of Ceramic Implantology (IAOCI) and part of the Zirconia Implant Research Group (ZIRG) in the US. In addition, he is a fellow and an ambassador for the Clean Implant Foundation in Germany. At present, he is involved in many research studies on zirconia implant materials and digital dentistry.

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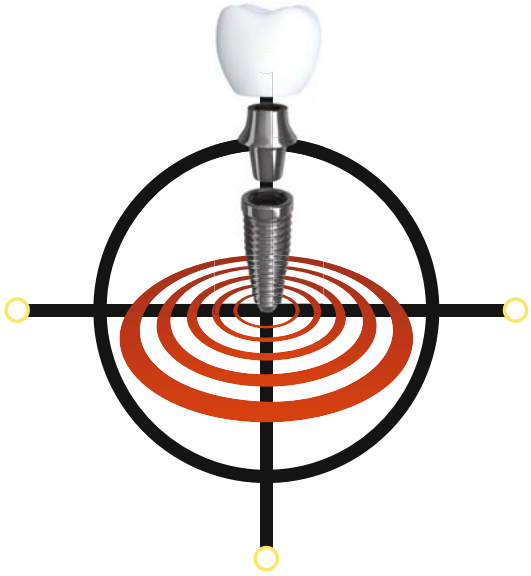

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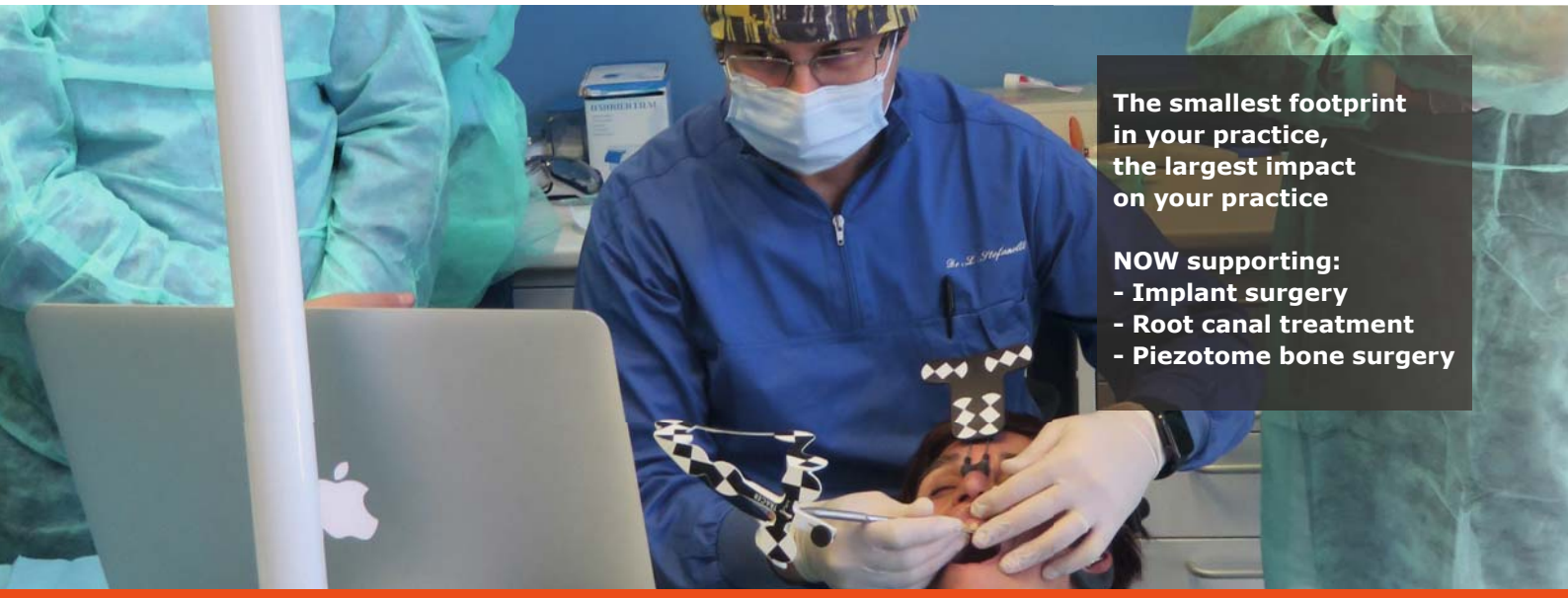

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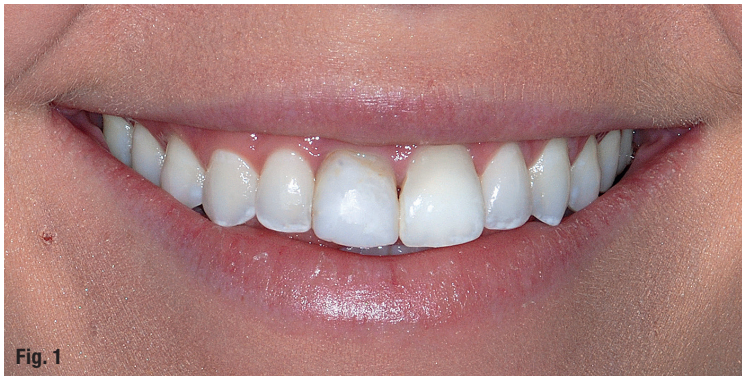
Immediate restoration of one-piece zirconia implants

Enhancing natural soft-tissue aesthetics

Drs Paul S. Petrungaro & Peyman Raissi, USA

One of the most challenging situations that the dental implant clinician faces, even with recent advancements in implant surgical protocols, is achieving natural soft-tissue contours around dental implants placed in the maxillary aesthetic zone.[1–5] Discoloration and recession of the marginal tissues around titanium dental implants placed, not only in the aesthetic zone, but at other sites requiring tooth replacement as well, have been complications associated with that classification of implant material for years, and their occurrence has been well documented in the dental literature.[6–8] Bone loss around the affected implant generally is associated with these soft-tissue complications.[6–8] Incorporating state of the art, minimally invasive, immediate restoration protocols, can drastically reduce these potential complications associated with titanium dental implants, especially in the maxillary aesthetic zone, however, the risk potential for tissue complications remains significant.[9–11]

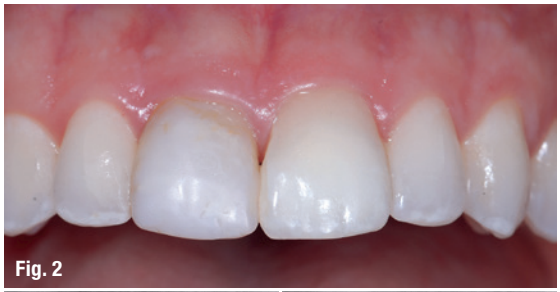
Utilising conventional two-piece implant designs introduces a connection between the implant and abutment complex. It has been well documented in the dental literature that a micro-gap area exists and can be an introductory point for bacterial invasion into the peri-implant environment, becoming an impetus for crestal bone loss and the initial event for peri-implantitis formation.[12–15] Comparisons of zirconia custom abutments vs stock/custom titanium abutments has demonstrated a reduced occurrence of bacterial plaque adhesion and biofilm formation present on zirconia abutments compared to titanium.[16–19] Removing the micro-gap connection by utilising a one-piece implant design, can help reduce this concept, however ads a more complex surgical technique in regards to initial implant stability, and the trajectory of implant placement in both angulation and spatial arrangement for optimal implant restorative and biological success.[20]

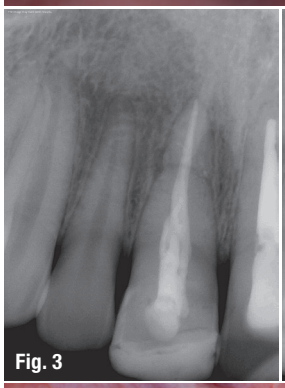


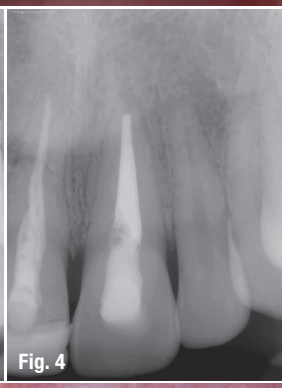
Case 1—Fig. 1: Pre-op smile.

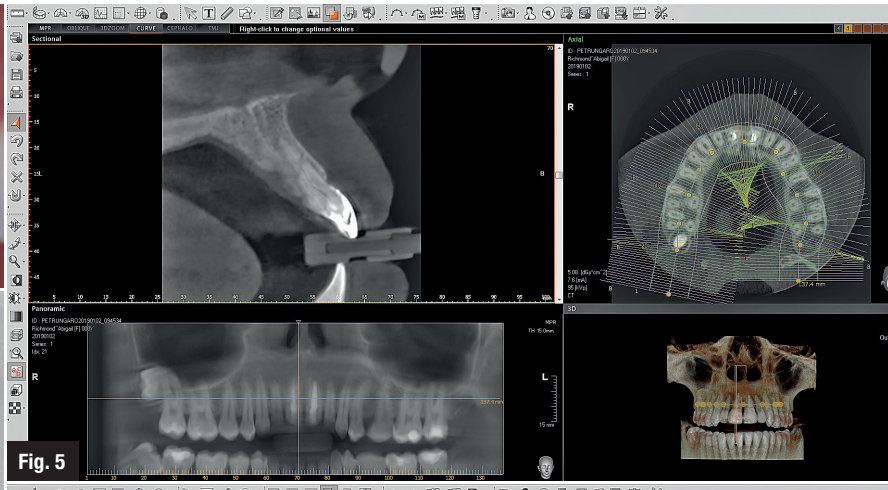
Incorporating a one-piece implant can reduce some of these issues, however presents additional challenges.[20,21] One of these challenges is the positioning, trajectory and depth of placement of the coronal portion of the one-piece implant and the facial aspect of the scalloped abutment design. Without understanding the correct threadtime of the placement of the implant into the osteotomy, the incorrect position of the facial aspect of the scalloped buccal portion of the abutment can easily be in an inappropriate position leading to compromised interdental bone and soft-tissue contours. This can then lead to aesthetic complications, both in soft tissue and the final ceramic restoration aesthetics as well. One-piece zirconia implants offer a definitive solution to the micro-gap issue observed with two-piece implant designs, plus the benefits of zirconia as a dental implant material.[20,21] Additionally, with various implant design features that offer aggressive thread patterns in the apical portion of the implant itself, achieving initial stability in extraction sites is more predictable.

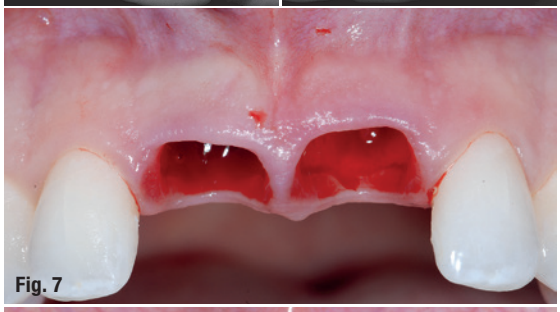
The positioning of the platform aspect of the abutment portion of the one-piece zirconia implant, in close proximity to the critical soft-tissue area in respect to the emergence profile and facial gingival margin of the pre-existing gingival tissues offers benefits over the titanium one-piece implant designs.[20,21] Obviously the warmth of zirconia in relation to thin and/or thick biotype of tissue is a definite benefit for soft-tissue aesthetics when compared to titanium.[22] Additionally, depending on the one-piece implant selected, the ability to prepare the abutment/collar or on the implant portion of the one-piece implant allows a level of flexibility to manage placement

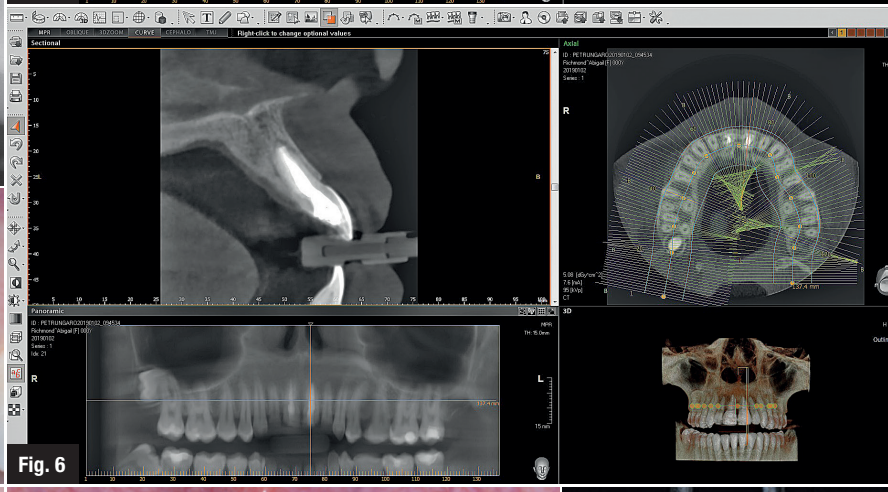


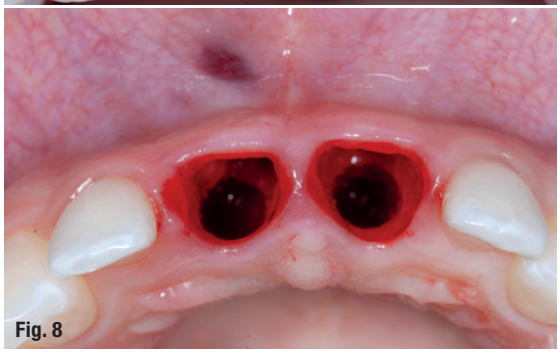


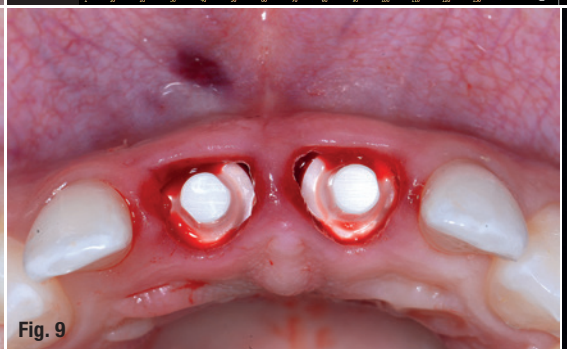


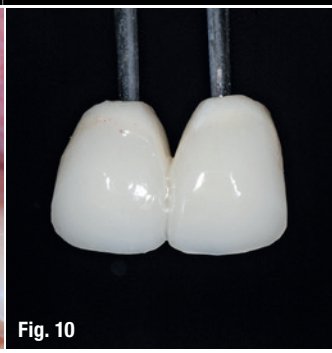










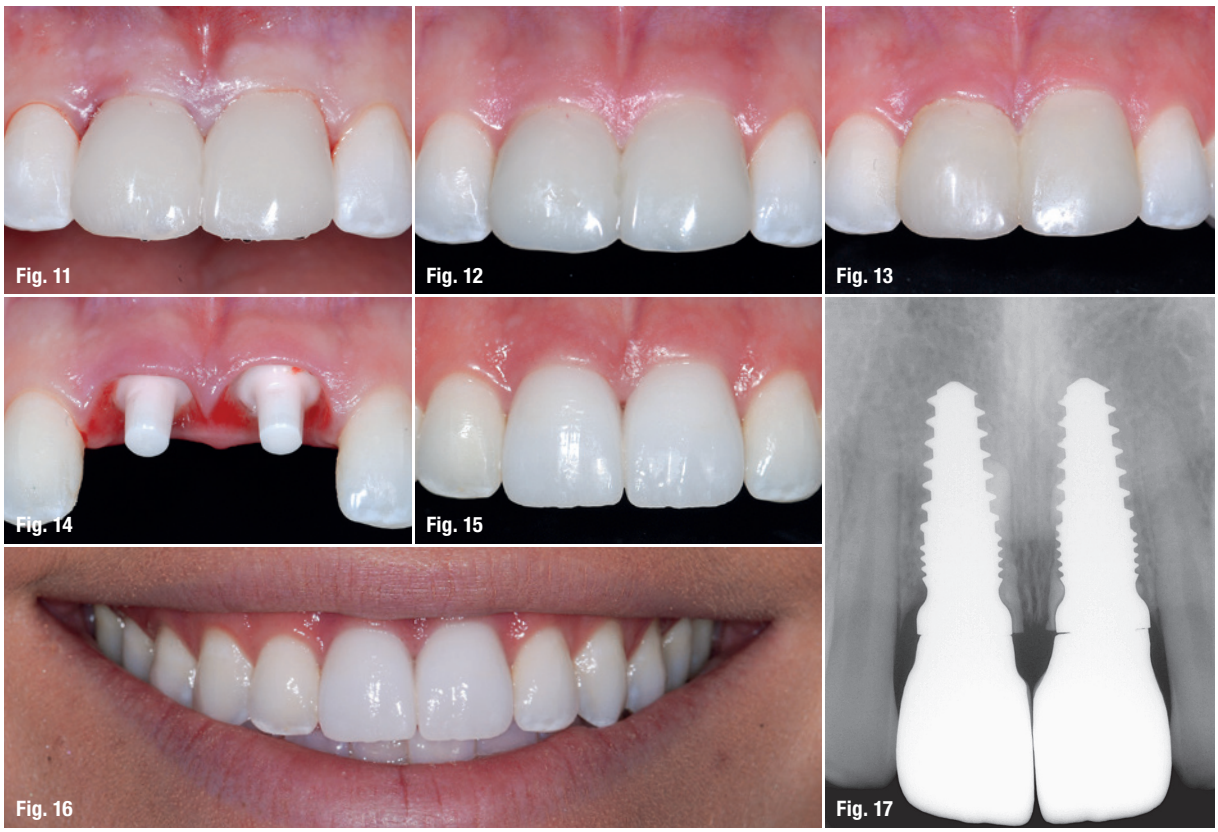


Case 1—Fig. 2: Pre-op clinical view of maxillary right and left central incisors. **Fig. 3:** Pre-op periapical radiograph, right central incisor. **Fig. 4:** Pre-op periapical radiograph, left central incisor. **Fig. 5:** Pre-op CT scan, right central incisor. **Fig. 6:** Pre-op CT scan, left central incisor. **Fig. 7:** Atraumatic tooth removal, maxillary right and left central incisors. **Fig. 8:** Atraumatic site preparation, maxillary central incisors. **Fig. 9:** Minimally invasive placement, Z-Systems one-piece tapered screw implants. **Fig. 10:** Immediate provisional restoration.

irregularities in regards to depth of placement, and spatial arrangement in regards to trajectory and angle of emergence of the one-piece implant.[20]

Case 1

A 30-year-old, non-smoking female, presented for removal of failing maxillary central incisors (Figs. 1 & 2). The past history included trauma to the maxillary anterior, root canal treatment at both central incisors, and presently, a horizontal fracture at the right central incisor (Fig. 3). Figures 3 and 4 demonstrate the pre-treatment digital peri-apical views while Figures 5 and 6 demonstrate the pre-treatment CT scan views of the maxillary right and left central incisors, respectively. The patient was interested in zirconia implants, and the final aesthetic result was of paramount importance to her, in addition to a sound biologic foundation present for long term success. Pre-treatment planning consisted of study models, diagnostic waxing of the central incisors and



Case 1—Fig. 11: Immediate postoperative clinical view. **Fig. 12:** Seven-day postoperative view. **Fig. 13:** Four months post-op. **Fig. 14:** Aesthetic soft-tissue emergence profile contours. **Fig. 15:** Case complete clinical view, maxillary central incisors. **Fig. 16:** Case complete smile. **Fig. 17:** Case complete periapical radiograph.

surgical stent fabrication. After evaluation of the patient's intra-oral tissues, CT scans and periapical radiographs, the decision to proceed with a minimally invasive surgical approach with immediate provisional restoration, and a one-piece zirconia implant design offered the best opportunity to ensure the foundations for natural aesthetics in this critical area.

After a pre-surgical administration of an appropriate antibiotic (Augmentin 875 mg, started the day prior to surgery), the patient presented for the immediate tooth replacement procedure. Administration of an appropriate local anaesthetic was given, and the maxillary right and left central incisors were removed atraumatically (Fig. 7) and both sites thoroughly debrided by mechanical curettage and rotary instrumentation. Placement of the surgical guide, TempStent II surgical guide system, preceeds initial site preparation.[23,24] From our pre-treatment planning, and due to the width of the central incisors, the decision was to prepare the sites to receive 5.0 diameter one-piece implants. Final site preparations can be observed in Figure 8. Placement of two, 5.0 x 12 mm, Z-Systems one-piece tapered screw implants, was performed by minimally invasive surgical protocol, achieving an initial torque of 45 Ncm at both central incisor sites (Fig. 9). The defects on the facial aspect of the implants to pre-existing buccal plate defects were managed by a combination of autologous platelet-rich fibrin and Osseolive grafting material (curasan).

Conversion of the TempStent II surgical guide system allows for the fabrication of the immediate provisional restoration (Fig. 10). Cementation with a strong temporary cement, and thorough removal of any excess material was then completed. The immediate postoperative clinical view can be seen in Figure 11. A seven-day postoperative clinical view can be seen in Figure 12. Please note the natural soft-tissue emergence profile and papillary contours present at this postoperative time frame. Figure 13 demonstrates the four-month postoperative clinical view, and prior to final abutment level impressions. Figure 14 demonstrates the natural soft-tissue emergence profiles obtained from the minimally invasive, immediate placement and provisionalisation procedure. The case complete clinical view can be seen in Figure 15. Please note the natural soft-tissue contours, maintained throughout the entire procedure. Additionally, please note the gingival health facial to the zirconia implants at both central incisors.

The case complete smile view can be seen in Figure 16, please note the patient is undergoing at home bleaching

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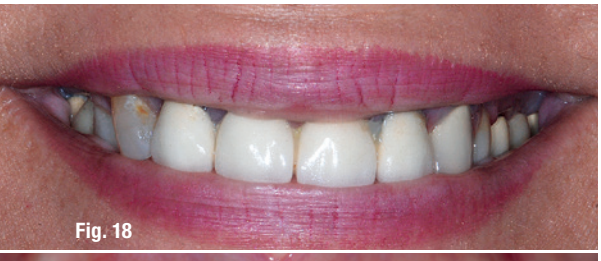
procedures to lighten her natural tooth colour. Following prescribed procedures adhered to in the author's clinical practice, all implant restorations are seated with provisional cement for 3–6 months, preceding final cementation. Figure 17 demonstrates the case complete digital periapical radiograph, prior to final cementation. Please note the interdental bone contours maintained throughout the entire procedure.

Case 2

A 49-year-old non-smoking female patient presented for treatment of a maxillary arch terminal dentition (Fig. 18). A past history of multiple teeth treated with root canals, post and core build-ups and crown and bridge resulted in fractured teeth, poor aesthetics and marginal periodontal disease. The patient elected to undergo tooth removal, placement of dental implants simultaneously, and wanted natural tooth replacement. Additionally, the patient had concerns regarding the dark hue at the gingival margins of the maxillary restorations, and requested this to not be present in the final implant restorations (Figs. 19 & 20). The pre-treatment CT scan can be seen in Figure 21. Please note the serial view of the right lateral incisor, with the total loss of the buccal plate, and fractured root. The pre-treatment plan was to remove all maxillary teeth, excluding the natural pre-existing right canine, which exhibited health periodontally and structurally. One-piece zirconia implants were planned to be placed at selective sites throughout the maxillary arch by minimally invasive means, with minimally invasive bone grafting procedures and immediate provisionalisation of the zirconia implants at placement.

Preoperative administration of oral antibiotics precedes the initial surgical visit. Fabrication of a diagnostic waxing of the TempStent II surgical guide/provisionalisation system was completed for the maxillary arch.[23,24]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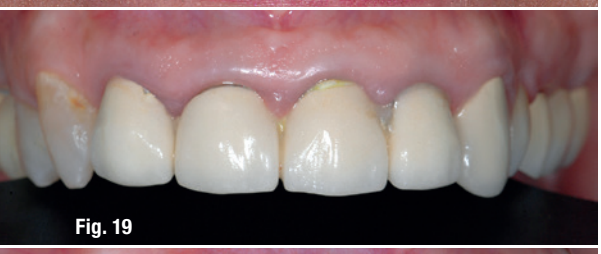
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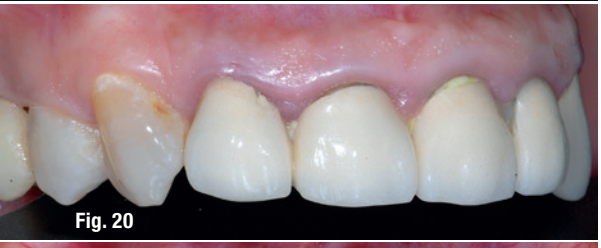
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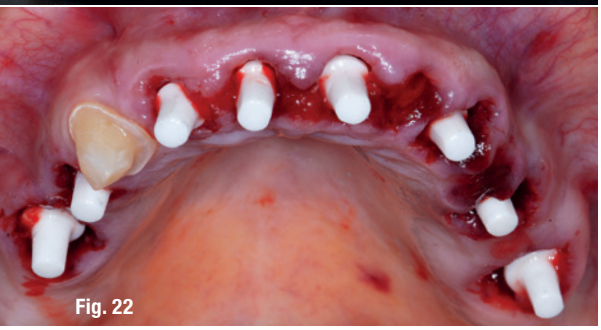
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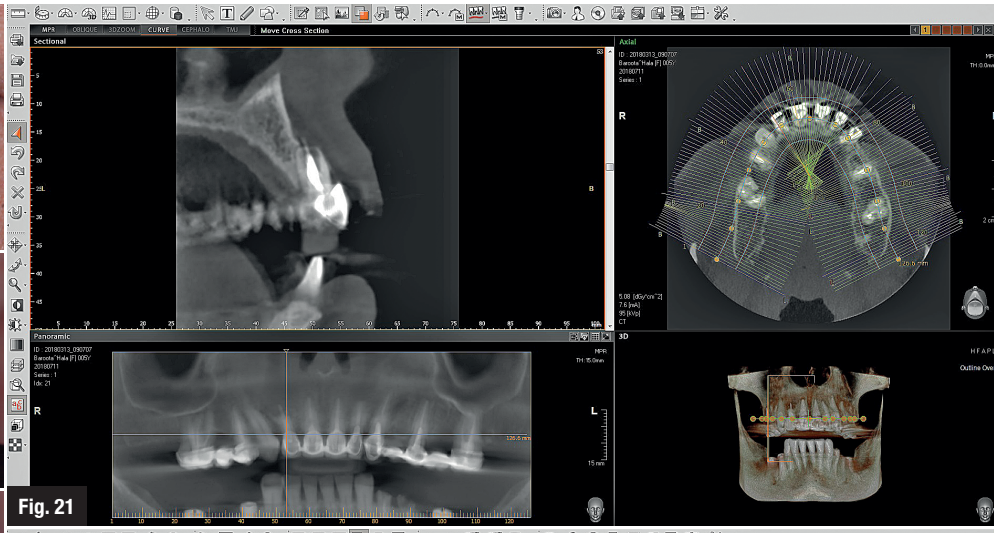
Fig. 21

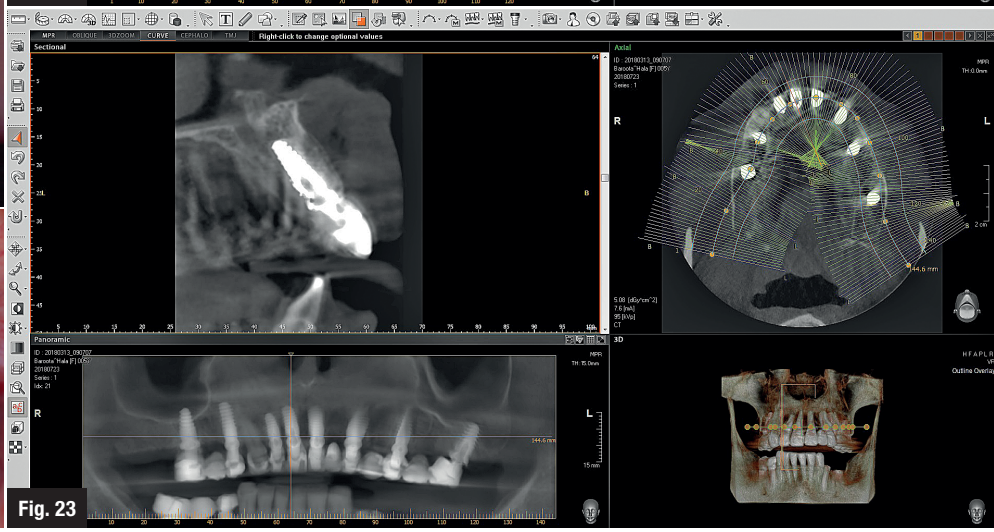
Fig. 23

Case 2—Fig. 18: Pre-treatment smile view. **Fig. 19:** Pre-treatment clinical view, maxillary anterior. **Fig. 20:** Pre-treatment clinical view, maxillary right lateral view. **Fig. 21:** Pre-treatment CT scan. **Fig. 22:** Minimally invasive implant placement maxillary arch, Z-Systems one-piece tapered screw implant design. **Fig. 23:** Immediate post-op CT scan.

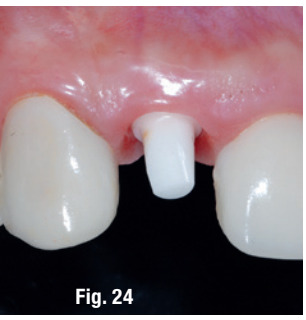
Fig. 24

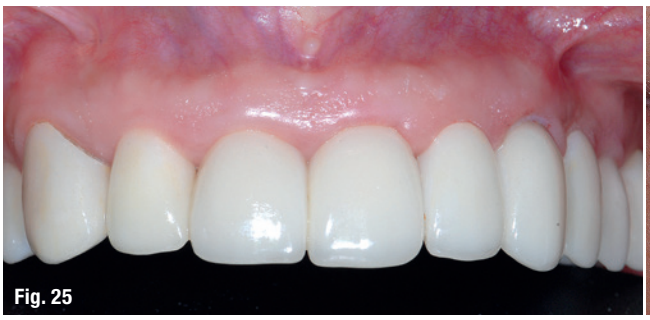
Fig. 25

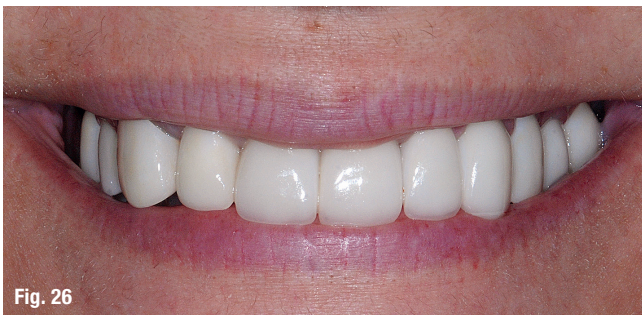
Fig. 26

Case 2—Fig. 24: Natural emergence profiles obtained, right lateral incisor. **Fig. 25:** Case complete clinical view, maxillary arch. **Fig. 26:** Case complete smile view.

After administration of an appropriate local anaesthetic, all remaining maxillary teeth, with the exception of the maxillary right canine, were removed by atraumatic techniques, and the sites thoroughly debrided by mechanical and rotary instrumentation ensuring all remnants of periodontal ligament and granulation tissue were removed. Insertion of the TempStent II surgical guide system allowed for efficient site preparation. Following a soft bone drilling sequence, eight one-piece zirconia tapered screw implants (Z-Systems' ceramic implant system) were inserted achieving initial torque values between 40–45 Ncm. The implants consisted of 4–5 mm diameter, 10–12 mm in length at the sites in the maxillary arch (Fig. 22).

Peri-implant defects at the facial aspects of the implants placed by minimally invasive protocols were grafted with autologous platelet-rich fibrin and 1–2 mm particle size allogeneic mineralised cancellous bone graft material. Conversion of the TempStent II surgical guide system into the immediate provisional restoration, and the emergence profiles, and contact point relationships were customised in the provisional restoration. The provisional restoration was then cemented with a strong provisional cement. The immediate postoperative CT scan can be seen in Figure 23. The provisional restoration was utilised for five months. Final all zirconia restorations were then fabricated by abutment level impressions. Figure 24 demonstrates the natural soft-tissue emergence profiles realised from the minimally invasive, immediate restoration procedure. Figure 25 demonstrates the final restorations across the maxillary arch, initially cemented with provisional cement. Figure 26 demonstrates the case complete smile view.

Discussion

The incorporation of zirconia dental implants into the armamentarium of tooth replacement procedures, especially in the aesthetic zone, offers a superior soft-tissue response, less plaque and biofilm affinity and superior soft-tissue gingival aesthetics when compared titanium. One-piece implant designs can effectively remove the micro-gap issue between the implant and abutment complex. Utilising a zirconia material that allows for modification to the abutment, the platform of the abutment and/or implant itself offers additional flexibility to solve angulation and/or spatial positioning irregularities. The author recommends additional clinical studies to further substantiate the effectiveness of zirconia as an alternative to titanium in dental implant procedure.

Literature

about the authors

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Two-piece implants restored in the maxilla and mandible

Dr Witalij Kolbe & DT Artur Wolf, Germany

Introduction

These days, ceramic implants are enjoying increasing popularity. This is not least due to a steadily growing patient awareness of metal-free solutions and their manifold advantages over titanium implants. These advantages cannot be ignored. For one thing, zirconia implants offer outstanding biocompatibility. The tissue around an implant made of zirconium dioxide, a bio-inert material, attaches to it quickly and heals without being susceptible to inflammation. Thus, the risk of developing peri-implant conditions later on is significantly reduced. In addition, many patients like zirconia because of its superior, tooth-like aesthetics, being white and translucent, compared with the rather dark shimmer of titanium. The two-piece implant used in the following case combines all these advantages in one implant system.

Initial clinical situation

A 70-year-old female patient presented to the outpatient consultation with the wish for a complete, new metal-free treatment of the maxilla and the mandible. The clinical and functional findings revealed inadequate old restorations in both the upper and lower jaws, as well as functional disorders of the craniomandibular system. After

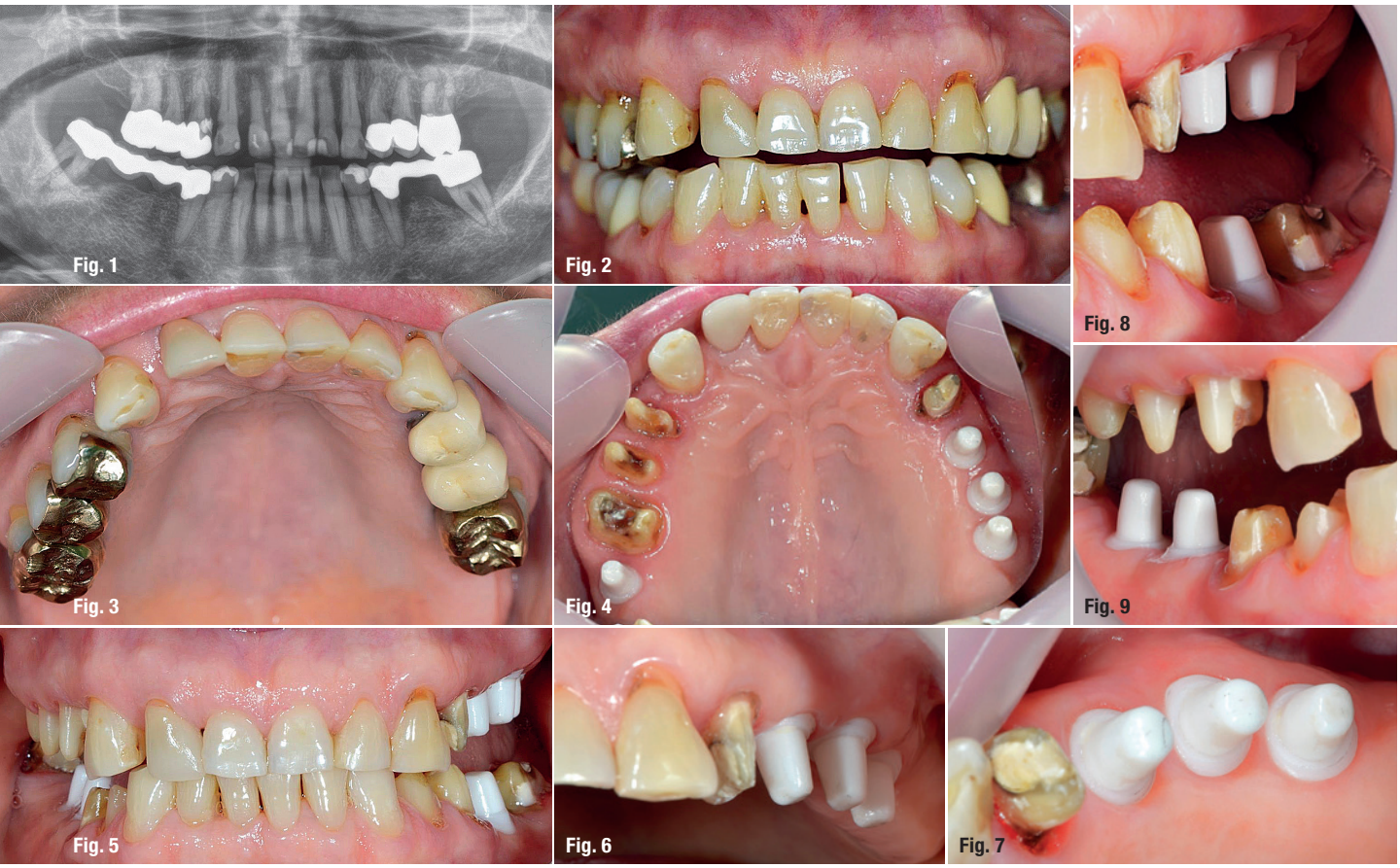

Fig. 1: Pre-op radiograph of the initial clinical situation. **Fig. 2:** Frontal view of the old restorations. **Fig. 3:** Occlusal view of the old restorations. **Figs. 4–9:** View of the implants and abutments after an osseointegration period of four months.

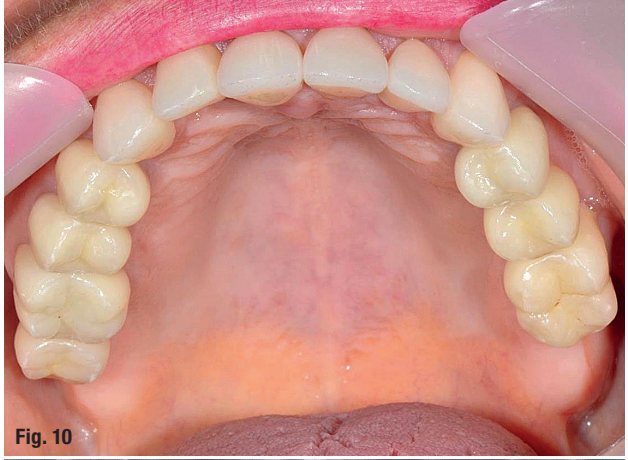
Fig. 10

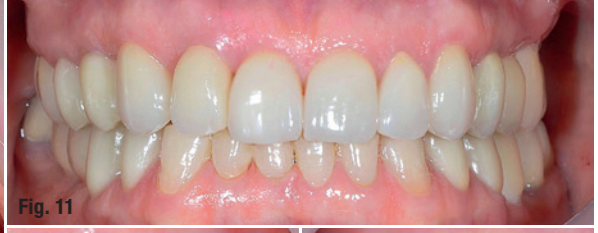
Fig. 11


Fig. 12


Fig. 13

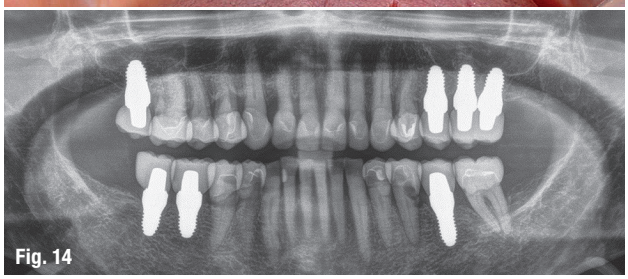
Fig. 14


Fig. 15

Figs. 10–13: Clinical situation after placement of the definitive restorations. **Fig. 14:** Radiograph taken at the follow-up after four years. The implants had healed completely without any signs of bone resorption. **Fig. 15:** The final smile four years after definitive restoration.

the patient had been informed in detail about the various restorative possibilities, she opted for a metal-free complete restoration with two-piece ceramic implants in the areas of the missing teeth and the teeth that could not be saved and needed to be extracted.

Surgical procedure

After a detailed clinical functional analysis and radiographic evaluation, a treatment plan was developed (Figs. 1–3). In a first step, the old insufficient restorations were removed and conservative, periodontal and surgical measures were performed. In a subsequent step, long-term temporary dentures for the upper and lower jaws were fabricated based on the function analysis data. Thereafter, the unsalvageable teeth (teeth #25 and 26) were extracted. The implantation was then performed with two-piece ceramic implants (AWI, WITAR Consulting) according to the WITAR drilling protocol in areas #17, 25, 26, 27, 36, 46 and 47. During the healing of the ceramic implants, the patient wore a long-term temporary denture, which was ground with the support of manual therapy until a clinically symptom-free situation of the craniomandibular system was achieved.

After a complication-free osseointegration phase of four months (Figs. 4–9), the implants in the maxilla and mandible were prepared for prosthetic restoration according to the WITAR protocol. An impression was taken, and bite registration and bite transfer procedures were performed. The generated data for the restorations was then transferred to the dental laboratory, where the workpieces for the definitive restoration were prepared. Once the patient had tried them on in her mouth, the complete definitive work was corrected, fired and completed by the dental technician. The definitive restorations were then placed in the patient without any complications (Figs. 10–13).

Summary

The tissue around the two-piece AWI implants healed transgingivally. The placement of the abutments, which were made of zirconia that had not undergone hot isostatic pressing and had no holes for screws, was both physically and psychologically minimally invasive for the patient. The subsequent preparation was performed, and the impression was taken directly inside the patient's mouth. While the high-strength implant made of hot isostatic pressed zirconia resists compressive forces, the specially developed AWI full abutment counteracts tensile forces. The AWI implant, in combination with the abutment, ensures a completely sealed connection. The metal-free restoration described here was performed four years ago. To this day, there are no pathological peri-implant findings in the regions of the inserted implants (Fig. 14). The restorations remain functional, stable and aesthetic (Fig. 15).

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Biological dentistry and ceramic implants

Full-mouth rehabilitation

Dr Dominik Nischwitz, Germany

A 32-year-old patient took to social media to find out about biological dentistry and ceramic implants. Having long suffered from chronic complaints, she was looking for a new treatment option. Her medical history revealed the following problems: chronic Lyme disease, hemopyrrollactamuria, enlarged liver and spleen, numerous swollen lymph nodes on the neck, urination and major digestive problems, as well as several food intolerances. Her alternative health practitioner (a naturopathic doctor) established a connection to the oral cavity using a kinesiological muscle test (Autonomic Response Testing, developed by Dr Dietrich Klinghardt). The following case study focuses on biological dentistry as an alternative and promising therapeutic option.

Medical history and findings

During the initial dental examination, a conservative and prosthetically insufficient adult dentition was shown (Figs. 1–6b). In the functional analysis, the bite had dropped sharply, which was reflected in muscular imbalances of the head and neck muscles and dysfunctional temporomandibular joints. All the third molars, as well as teeth #17 and 26, had already been extracted. The bridge on teeth #25–27 needed restoration, and all the posterior teeth had abraded composite fillings. Teeth #14, 12, 11, 22, 37, 36 and 46 had gradually undergone amalgam removal, owing to recurrent pain and hypersensitivity, though to no avail. The patient complained of apical pressure and pain in the areas of teeth #12, 11 and 22. Teeth #36, 35 and 46 were bite-sensitive, and the gingiva was swollen and painful and bled easily upon probing. On CBCT imaging, inadequate root fillings with apical osteitis in teeth #14, 22, 36 and 46 were observed. Osteolytic bone (ischaemic bone disease) was also seen in the areas that had contained the third molars, which had been removed without systemic preparation. Since the patient had previously dealt with the issue of neuromodulatory triggers and the associated disruptive autonomic regulation and stress symptoms, only a maximal biological remediation of the oral cavity was considered for her.

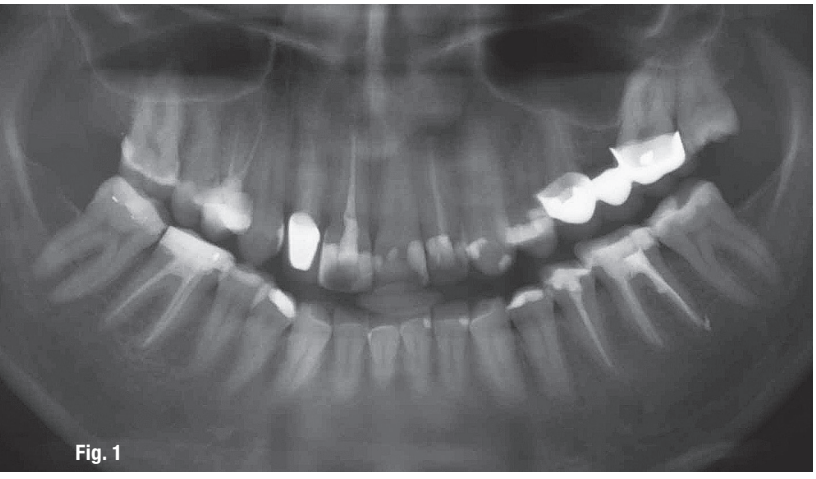


Fig. 1: Initial pre-op radiograph.

Biological dentistry

On these issues, it is necessary to look beyond the scope of the conventional dentistry doctrine. This is mainly based on the dental craft and still rarely considers medical basics regarding immunology, toxicology and the autonomic nervous system. Root canal therapy, for example, is initially a pure pain treatment. The tooth is merely considered a chewing organ, and the connection to the whole body is not in the foreground. Chronic inflammation throughout the body can lead to a number of problems through the chronic activation of the hypothalamic–pituitary–adrenal axis, the stress axis. The activation of the stress axis, also known as fight or flight syndrome, serves to provide energy in the short term, for example to run away from danger. Everyone is familiar with the feeling ahead of an examination: the mouth dries up, the pupils widen, the heart beats faster, the blood is moved out of the organs into the muscles and the ability to concentrate decreases. Adrenaline is pumped through the veins. One would rather run away than take the examination. In the acute case, this is not a problem, as all processes are regulated in a relatively quick manner once the danger has been averted. In the animal world, one can observe this very well: a lion attacks a zebra herd, and as soon as an animal has been lacerated, the herd

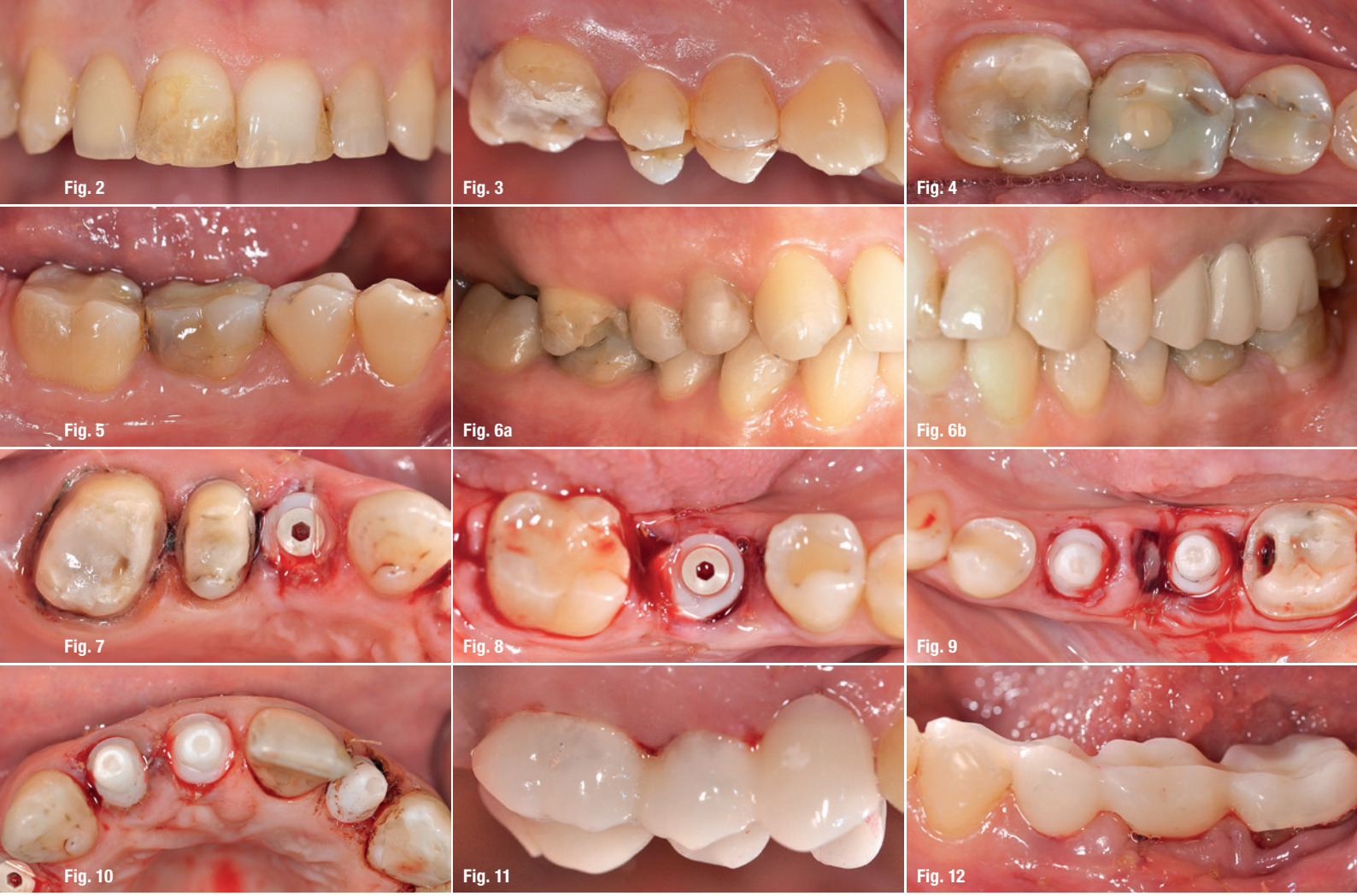


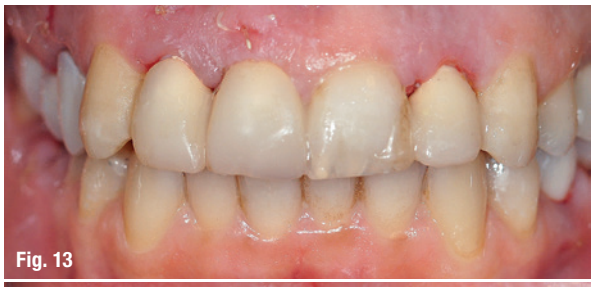
Fig. 2: Pre-op frontal view of the maxilla. **Figs. 3 & 4:** Views of the initial clinical situation. **Figs. 5–6b:** Lateral views of the initial clinical situation. **Figs. 7–9:** Occlusal views post-op. **Fig. 10:** View of the maxillary arch showing the implants in regions #11, 12 and 22. **Figs. 11 & 12:** Lateral views of the long-term provisional protheses.

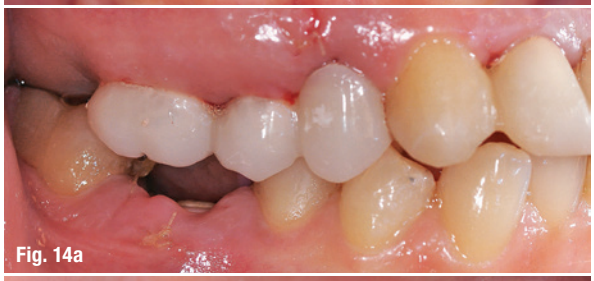
becomes relaxed again. But what if the stress axis is chronically activated? Any stressors, whether triggered by chronic inflammation in the body, food intolerances, or stress at work, lead to the activation of the adrenal gland. These small glands found above our kidneys react by increasing the formation of cortisol, epinephrine and norepinephrine. Cortisol, the stress hormone, is a catabolic hormone that has an immunosuppressant effect. The raw material is cholesterol, from which all sex hormones are produced. If too much cortisol is produced in the long term, this results in what is referred to as "pregnenolone steal" in functional medicine, since the raw material is in this case being used for the production of cortisol instead of sex hormones.

As a result, long-term activation of the stress axis often results in a burn-out syndrome: the adrenal glands become burned out and can no longer produce cortisol, epinephrine and norepinephrine. The patient becomes chronically tired and his or her libido drops. Other symptoms of prolonged stress by cortisol overproduction on the whole organism include chronic inflammation of the gastrointestinal tract with ulceration and leaky gut syndrome; general excitability, anxiety or even depression; sleep disorders and neuromuscular complaints, such as increased bruxism; difficulty in concentrating; fatigue of unclear cause; excessive sweating; a general immune deficiency with frequent infections due to chronic fatigue of the adrenal glands (burn-out); and autoimmune and thyroid diseases. It is also called sympathetic tone. Chronic stress is the main challenge in today's epidemic of chronic diseases. The sympathetic nervous system becomes overloaded, and the parasympathetic part is blocked. However, our regeneration is significantly dependent on the activation of the parasympathetic nervous system. This supplies all abdominal organs and is responsible for the excretion, relaxation and detoxification functions. The trigeminal nerve also carries parasympathetic fibres. It is overstimulated by chronic inflammatory processes in the jawbone. Each nerve is capable of transporting any toxin, microorganism or immunocytokine into the brain stem or basal ganglia via retrograde axonal transport. This mechanism was already described by A.D. Speransky in the 1930s and by Stoertebecker in the 1970s. The latter experimented with mercury in the oral cavity and was able to show axonal transport to the trigeminal ganglia and other head ganglia within 24 hours after exposure. The aim, as in the present case, is to find and eliminate the cause of the chronic stress. In biological dentistry, the consistent rehabilitation of all oral interference (neuromodulatory triggers) is referred to as the "all-in-one" concept.

Planning and therapy

Protective measures included the removal of the metal-based ceramic bridge on teeth #25–27, the surgical removal of the osteonecrotic areas of the jaw that had previously contained the third molars (regions #18, 28, 38 and 48) and immediate implantation with ceramic implants (Short Cut Concept, developed by Dr Karl Ulrich Volz) in the areas of the previously root canal therapy-treated teeth (teeth #14, 12, 11, 22, 36, 35 and 46), as well as intraoperative impression taking of the teeth and implants for the production of laboratory-produced long-term provisional protheses with integrated bite lift. Based on the Vitamin D3 and low-density lipoprotein (LDL) cholesterol levels at the time, as well as other blood tests, the patient prepared for a dietary change (Food Design, developed by the author) and a targeted orthomolecular micronutrient protocol four weeks before the planned treatment (BHP Supreme, developed by the author), in order to optimally support her body with the right nutrients for bone regeneration and wound healing. A diet of a great deal of sugar, wheat and cows' milk products, as well as food intolerances and toxins or vitamin and nutrient deficiencies, leads to a general inflammatory tendency of the body. In this case, Vitamin D3, zinc, magnesium and omega-3 fatty acids were lacking for the structure and the regeneration of tissue. The body is often overwhelmed with healing processes by this deficiency situation—it switches, to hibernation mode, in which the body is not able to build new tissue, as it simply lacks the nutrients to do so. After four weeks of a dietary change and the micronutrient protocol, the patient presented with a preoperative Vitamin D3 value of 90 ng/ml and an LDL value of less than 1.2 g/l and thus had the ideal prerequisites for this complex biological treatment.





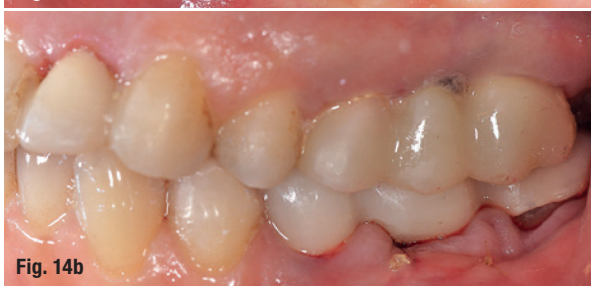


Fig. 13: Post-op frontal view of the long-term provisional protheses in the maxillary arch. **Fig. 14a:** Lateral view of the occlusion of the right side post-op. **Fig. 14b:** Lateral view of the occlusion of the left side post-op.

Surgical intervention

On the day of the surgery, the patient was given a single dose of an intravenous antibiotic (Sobelin Solubile 600, Pfizer) for infection prevention. In addition, 8 mg of dexamethasone (Dexa inject, Jenapharm) and a high-dose vitamin complex and mineral infusion were administered. Parallel to the intravenous treatment, 12 ampoules of blood were taken from the patient to produce Choukroun advanced platelet-rich fibrin (A-PRF) plasma membranes. The all-ceramic implant system (SDS 1.1 and 2.0, SDS Swiss Dental Solutions) used is made of yttrium tetragonal zirconia polycrystals, has a particularly aggressive thread design. Both the one-piece and two-piece implants have a pronounced tulip-shaped area of 3 mm in height in order to maintain and support the optimal biological width of the gingiva. The shoulder diameter at soft-tissue level is 5.0 mm for the reduced-diameter implant and 6.0 mm for the 4.6 mm implant. The two-part implant is virtually a reduced one-piece implant, which is extended above the gingiva, only after healing. The actual implant is completely inserted into the bone, even in the reduced-diameter variant, unlike comparable titanium implant systems. Depending on the height and texture of the gingiva, the implant may also be inserted a little deeper or more shallowly if a gingiva of more than 3 mm is present. This flexibility allows the surgeon to use implants of 7–15 mm in length with a single system. In particular, the tulip can be prepared so that the practitioner can operate completely under anatomical conditions. Especially in the areas of immediate implants, axial inclinations are unavoidable, because the implant should be positioned in the middle of the alveolar ridge, and in most cases, this does not correlate with the anatomical positioning of the teeth. It is therefore possible to correct the axial inclination by preparing the implant already during the surgical phase and thus intraoperatively producing an individual abutment. An axial deviation of up to 20° can be achieved without problems by the pronounced prosthetic platform.

The immediate implantation was performed under local anaesthesia in regions #12, 11, 22, 36 and 35, with one-piece implants. Only in regions #14 and 46 were two-piece implants used. In region #14, a 5.4 x 14.0 mm implant had to be used owing to the extensive apical

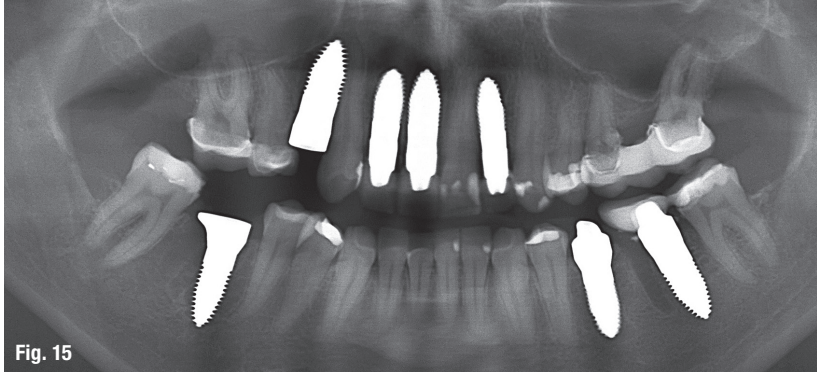
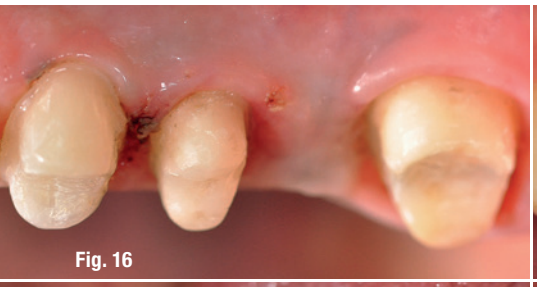
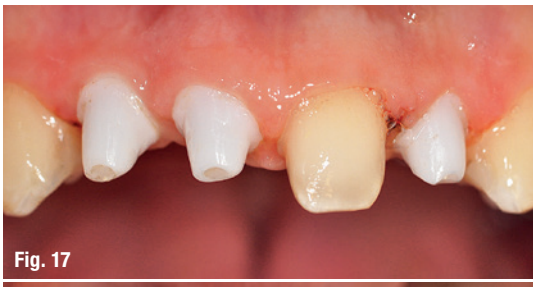


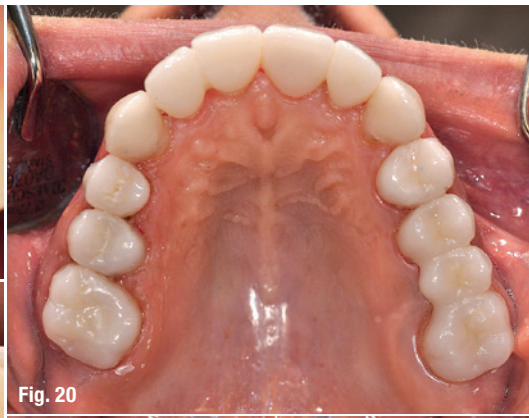
Fig. 15: Radiograph post-op.

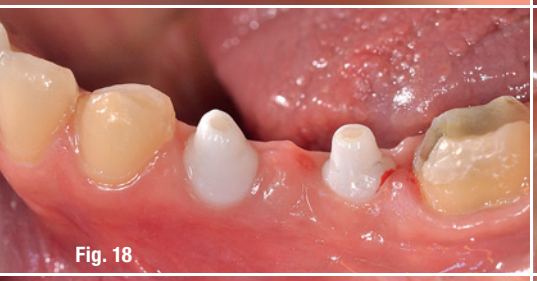
osteolysis. The hold was generated by the 6 mm wide tulip and did not allow for any immediate loading. In region #46, an asymmetrical balcony implant was chosen, and it was inserted into the mesial root socket and primary stability was obtained. The distal root socket was lined with an A-PRF membrane, and above the implant, an A-PRF plasma membrane was used. No provisional was made because the implant was mainly stable only at the apical threads, and therefore it would have been too risky to load it directly. In region #36, a 4.6 x 14.0 mm implant was inserted, while a 5.4 x 14.0 mm implant was inserted into the distal root socket of region #46, for which primary stability was achieved for both at a torque of 35 Ncm. The alveoli were lined with an A-PRF membrane for socket preservation. In order to form more attached gingiva, a membrane was placed under the buccal mucosa in all implant areas, and the flap was fixed with deep mattress sutures, approximately 5 mm below the cut edge, to ensure absolute positional stability of the periosteum and freedom from tension of the flap. This technique is crucial for the blood circulation and thus the preservation and development of the bone. In regions #12, 11 and 22, 14 mm implants were also used. In region #11, a 5.4 x 14.0 mm implant was inserted. Oval one-piece implants were used in the regions of the lateral incisors and premolars to cope with the oval cross section of the maxillary lateral incisors while still achieving primary stability at a torque of 35 Ncm. All the implants achieved primary stability at a torque of about 35 Ncm.

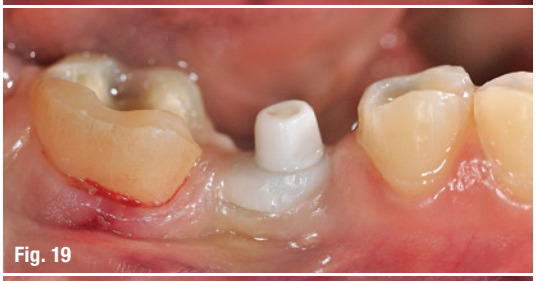
The immediate implantation alone had already enabled the bone to be activated. Since one usually drills beyond the socket, osteolytic bone areas are often found here, and these are not treated through conventional tooth removal. This was equally the case with the present patient. The perfect cleansing of these chronic inflammatory areas is absolutely crucial from a medical point of view, for the health of the patient on the one hand and for the osseointegration of the ceramic implants on the other. After the mechanical cleaning of the alveoli, disinfection with ozone and a neural therapeutic solution is done. Since zirconia implants heal only in absolutely healthy bone, attention should also be paid to osteolytic lateral lacunae and generally yellow bone areas (which

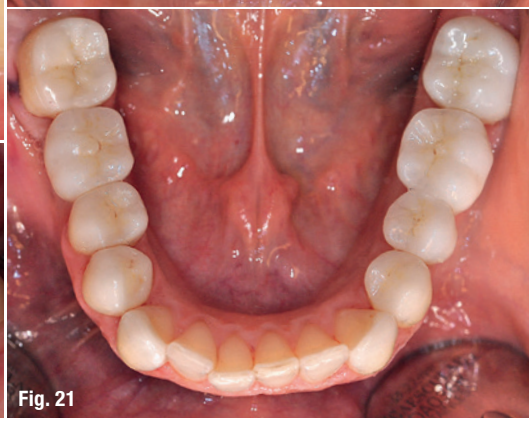


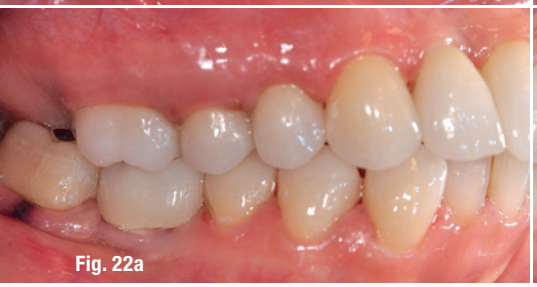












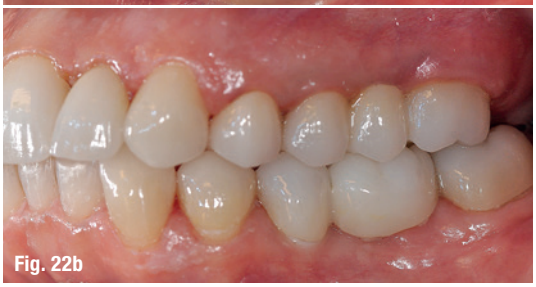


Fig. 16: Lateral view of the clinical situation after the healing period. **Fig. 17:** Frontal view of the implants after the healing period. **Fig. 18:** Lateral view of the implants in regions #35 and 36. **Fig. 19:** Lateral view of the implant in region #46. **Fig. 20:** Occlusal view of the maxillary arch. **Fig. 21:** Occlusal view of the mandible arch. **Fig. 22a:** Lateral view of the occlusion of the right side. **Fig. 22b:** Lateral view of the occlusion of the left side.

Fig. 23

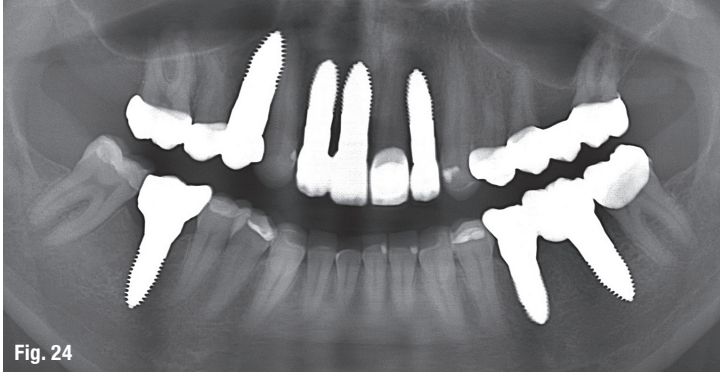


Fig. 24

Fig. 23: The final result right after insertion of the definitive restorations. **Fig. 24:** Post-op radiograph.

indicates LDL—fatty degeneration of the bone is a sign of chronic inflammation). Brånemark warned, "Yellow bone, no implants". In order to counteract non-healing, this examination process is extremely important. The bite lift was produced asymmetrically and was done on the long-term provisional protheses extending from region #16 to region #14 and from region #37 to region #34. The two-piece implants were inserted at the gingival level. This procedure represents the optimal solution in the non-aesthetic but functionally riskier area. Six weeks after surgery, the patient reported again for a follow-up. All the implants showed a positive sound probe. Thereafter, the final prostheses were discussed.

Prosthetic restoration

Five months after the implantation, the implants were exposed, and the teeth were again prepared for the ceramic denture in finishing touches and moulding processes. The impression for the definitive denture was taken three weeks later together with the dental technician. Two days later, the definitive crowns were placed. The partial crowns and veneers for teeth #13, 21, 23, 24, 34, 33, 43, 44, 45 and 47 were seated adhesively using an acid-etching technique and flowable composite. The remaining all-ceramic crowns and bridges in regions #16–14, 12, 11, 22, 25–27, 37–35, and 46 were conventionally seated with a glass ionomer cement. The occlusion and articulation were adjusted in canine guidance and the prostheses fitted to the ceramic implants in minimal infraocclusion to compensate for the natural motility of the teeth and to protect the ceramic implants. All intra-oral photographs were taken immediately after the insertion (Fig. 23). For this reason, the gingiva seems to be somewhat irritated. To check the dentures and the bone, a panoramic radiograph was taken (Fig. 24).

Overall health improvements

In this case, treatment according to the concept of biological dentistry had a substantial beneficial effect. The patient no longer had chronic pain, bite problems or hypersensitivity in the tooth area. The patient had an increased appetite and no longer had indigestion, subjective intolerances of any food or the urge to urinate frequently. The cervical lymph nodes were reduced in number and size. Her spleen was no longer enlarged. She also showed an altered nail pattern, from short and brittle to strong nails, a sign of improved nutrient absorption.

Summary

Based on this patient case, one can see both the overall health component of biological dentistry and the high-end craft. This is the perfect symbiosis between the classic daily work of the dentist and the indispensable medical work. Surgically speaking, the optimal time for implantation, in my opinion, is the time of tooth extraction. The implant acts as an optimal socket preserver, supporting bone and soft tissue. In contrast to the conventional procedure with tooth extraction, requiring an interim prosthesis and a long waiting time, the time and expense for immediate implantation are significantly reduced for the patient, not to mention the reduced pain. With one- and two-piece all-ceramic implants, it is now also possible to perform riskier immediate implantation in the posterior region without the need for elaborate and unpleasant protective measures. Of course, the surgical protocol is crucial. Particular attention is paid to the thorough cleaning and disinfection of the surgical area to be restored with zirconia implants, as these only heal in perfectly healthy bone. This protocol includes targeted nutritional change, preliminary orthomolecular support, local disinfection with ozone and neural therapy, and immunological support with high-dose intravenous vitamins and minerals. An oral antibiotic can thus be completely dispensed with in most cases.

about the author

Between 2003 and 2008, **Dr Dominik Nischwitz** studied dentistry at the University of Tübingen, and he specialised in biological dentistry and ceramic implants. He is the founder of DNA Health & Aesthetics, a centre of biological dentistry in Tübingen. He serves as President of the International Society of Metal Free Implantology.

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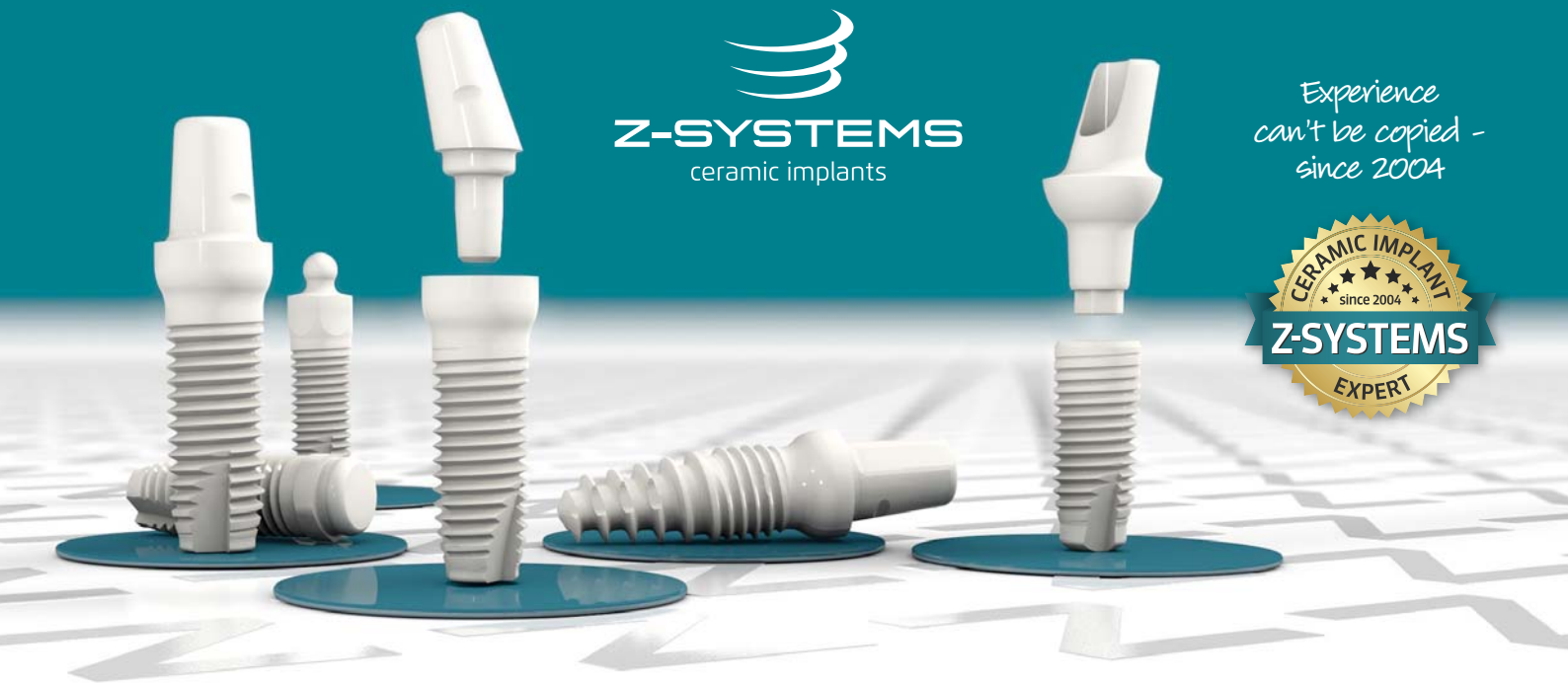

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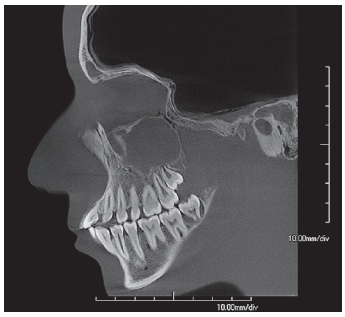
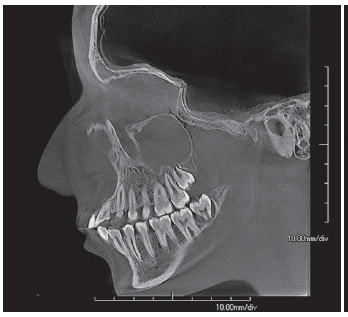
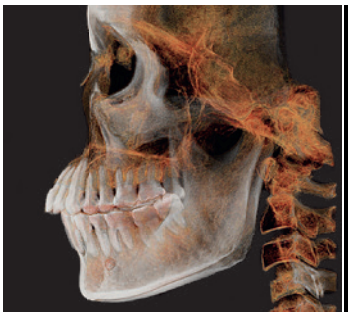


100 µm voxel size.



74 µm voxel size (PreXion3D EXPLORER).



3D image with a 150 x 160 mm field of view.

With many 3D-imaging systems today, good image quality is usually accompanied by high radiation exposure. Developed specifically for the European and US-American market, the new CBCT system PreXion3D EXPLORER offers the highest possible image quality at the lowest possible radiation levels. With a specifically controllable pulse generator, radiation is generated only when necessary to achieve the highest imaging quality. For a 20-second-long scan in ultra-HD 3D-mode, radiation exposure is only between 4.4 and 5.8 seconds. For a 10-second-long scan in standard scan 3D-mode, it is a mere 3.2 seconds. The small voxel size enables a more detailed representation of even the finest hard and soft tissue structures in ultra-High Definition. The short image reconstruction times ensure a seamless workflow. The PreXion3D EXPLORER convinces with easy handling and extensive planning programmes that cover the entire range of indications. With the 3D-analysis function, fields of view (FOV) sizes of 50 x 50, 150 x 80 and 150 x 160 mm can be generated, offering numerous flexible diagnostic options for oral surgery, implantology, periodontology, endodontics, orthodontics, and general dentistry.

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COHO Biomedical Technology

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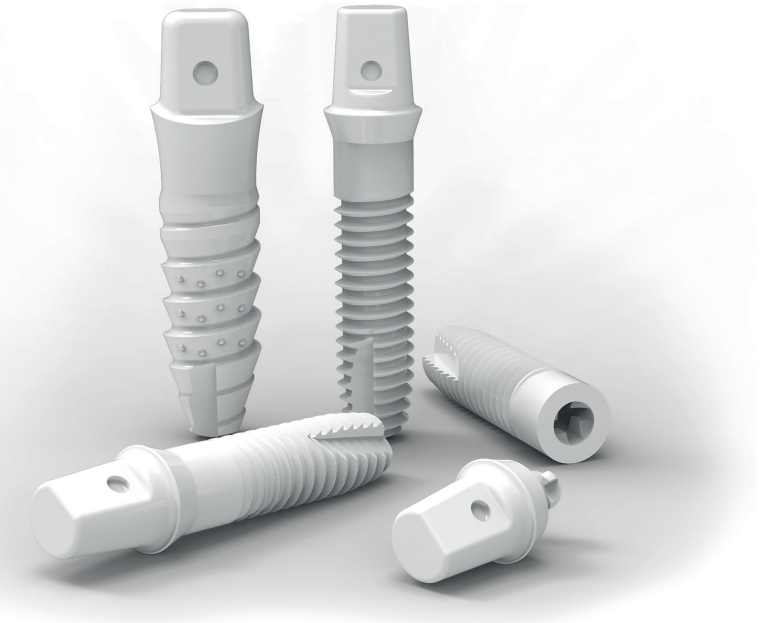

design and functionality. The unique design was developed to reduce the most common complications and to improve on the characteristics of previous implants.

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OroTox – International
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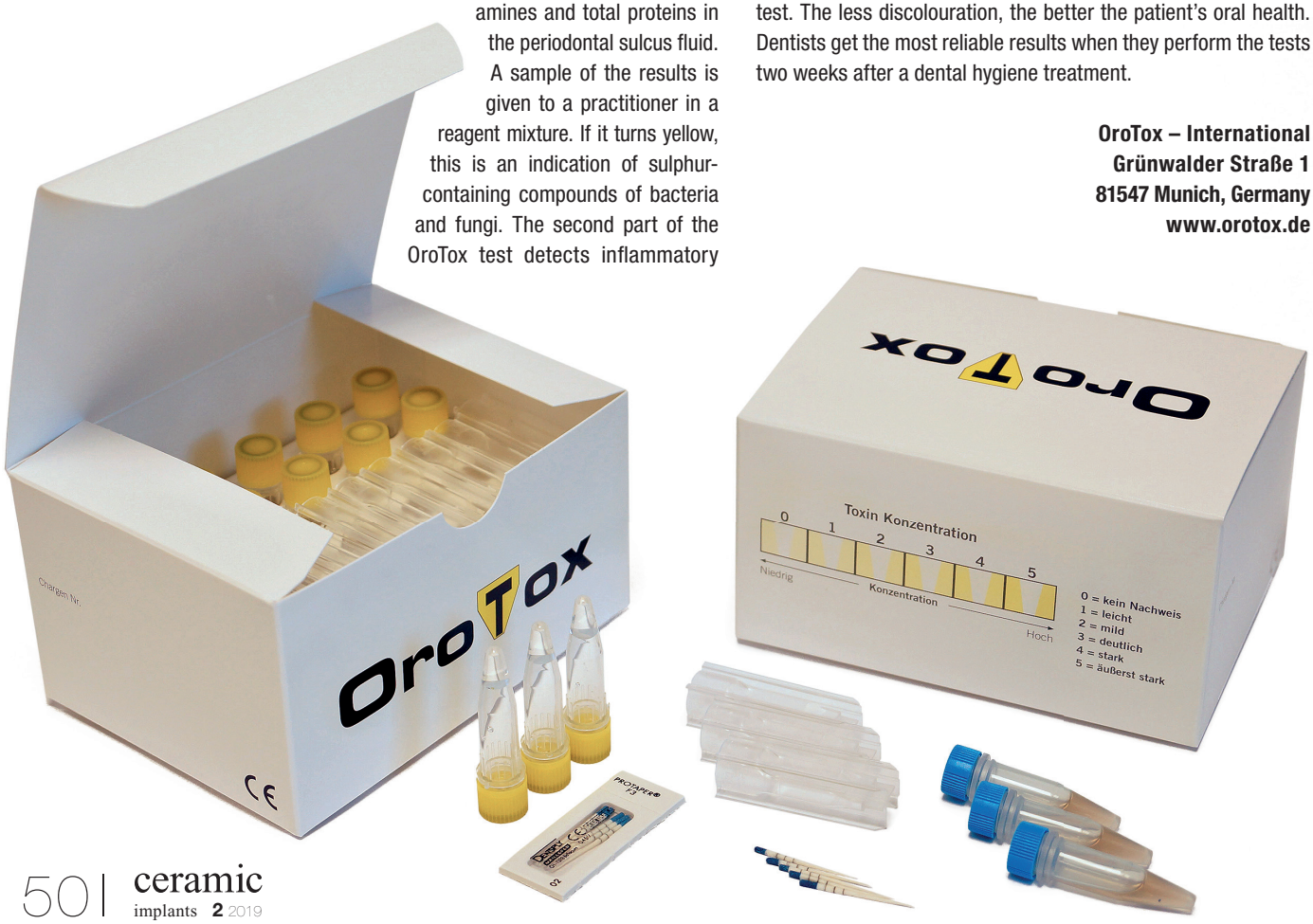

WITAR

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AWI ceramic implants from WITAR offer superior aesthetics, stability, accuracy and healthy osseointegration. A sophisticated design combined with modern materials make for an ideal solution for all bone classes and indications. Made of zirconium dioxide, AWI dental implants are metal-free and thus fully biocompatible. The cemented zirconia abutment allows an individual design. The transgingival shoulder has an ideal surface for interacting with soft tissue. The conical micro-thread allows great primary stability and axial loading. Studies have shown that the thread roughness of 1,7 µm leads to optimal osseointegration. Also, the surface is coated with a bioactive BIOVERIT I nano-coating. This surface-thread combination enables superior osseointegration for all bone classes. The self-tapping implant tip provides space for bone chips and low-compression insertion. AWI ceramic implants are now available in gingiva colour too, which leads to even better aesthetics and optimised risk areas.

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www.witar.de

Champions-Implants

Ceramic implant now available

In releasing its new ceramic implants BioWin!, available as both one-piece and two-piece versions, Champions-Implants is breaking new ground. Without having a screw connecting the implant body and the abutment, the two-piece option is entirely metal-free. Since the glass fibre abutment is being glued, there is no space that is vulnerable to paropathogenic germs or bacteria, as it might happen in two-piece implant systems. The roughness of the surface is created using a one-of-a-kind patented process resulting in a faster osseointegration. Scientific studies (Prof. Becker, University Düsseldorf, among others) find osseointegration to be at 95.8 per cent. The implants are available in five different lengths (6, 8, 9, 11, 13 mm) and diameters (4.1, 4.5, 5 mm). Moreover, there is a free and user-friendly software available, with which individual implants having individual emergence profiles can be developed. BioWin! implants can be inserted using either a minimally invasive approach or a classic full-flap one.

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www.championsimplants.com

CAMLOG

Natural aesthetics with the CERALOG® Implant System

The demand for highly aesthetic, natural-looking restorations is continually increasing. This trend favours ceramic implant solutions with high levels of biocompatibility, particularly zirconia, known for its excellent soft-tissue compatibility. The CERALOG® Implant System is established and has been in clinical use for more than seven years. It offers a high level of predictability and provides aesthetically pleasing results. The two-piece design of the system that allows for screw-retained prosthetics offers great benefits. CERALOG® is easy to use, owing to the simplified prostheses, lean instrumentation, and clearly structured surgical procedure. Options for the treatment workflow include flexible trans- or submucosal healing of the two-piece CERALOG® Hexalobe implant and transmucosal healing of the CERALOG® Monobloc implant. The implants are made of yttria-stabilised tetragonal zirconia, which is a ceramic widely used in the dental industry and other highly demanding medical fields. The ivory colour of the material, which is very close to that of a natural tooth, and the properties of zirconia lead to natural-looking results. Zirconia is chemically inert, making it especially suitable as an implant material. Due to its manufacturing process called ceramic injection molding (including sintering and hot isostatic pressing), it offers an outstanding combination of excellent mechanical properties and high strength.

AESTHETICS
The ivory colour, which is close to the natural tooth colour and the properties of zirconia supports high aesthetic results.

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Similar to the way that a GPS system guides you while driving, Navident by ClaroNav guides clinicians by using the CBCT image as a map. It offers surgeons an easy to use, accurate, highly portable and affordable way to plan restorations and implant placements. With Navident 2, clinicians will no longer need to do a special extra scan. They can use the diagnostic scan already available for the patient. The stress of stent making is also gone because a stent is no longer required. Trace and Place (TaP) is a game-changing development for dynamic navigation. With TaP, the Navident workflow is streamlined, efficient, user-friendly and seamlessly integrated into the daily practice. “Trace and Place is a real tipping point for dynamic navigation guidance,” said user Dr George Mandelaris, a periodontist from Chicago, USA. “It has streamlined and simplified the workflow in both the diagnostic and surgical phases to allow state-of-the-art technology to be an everyday component of my surgical implant practice. I can’t imagine going back.” Clinicians are invited to learn from masters and interact with peers at ClaroNav’s booth #3M27 at this year’s ADF Meeting, to be held from 26 to 30 November in Paris, France.

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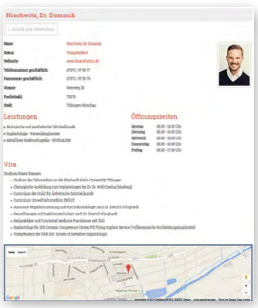

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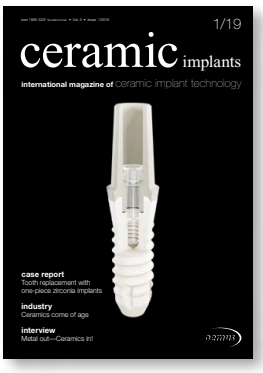

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An implant suitable for all surgical indications

In this interview Dr Ralf Lüttmann, a pioneer in ceramic implantology, talks about the current state of ceramic implants and his experiences with the new SNOW implant system, the latest addition to Straumann's ceramic implant portfolio, which was developed in cooperation with Z-Systems.

Ceramic implants have been an alternative to titanium implants in your practice for two decades. Where did your early interest in this material come from?
At the beginning of the 1990s, I got to know and love the excellent tissue-friendliness and aesthetic advantages of this material through the ceramics then already available for prosthetic applications. Therefore, it was only logical to look for ceramic solutions in implantology as well. However, there were sacrifices that one had to make. On the one hand, the ceramic surfaces of the time were significantly smoother than those of titanium implants, which could make fast and reliable osseointegration more difficult due to a reduced bone-to-implant contact (BIC). On the other hand, for reasons of mechanical stability, the implants were predominantly one-piece. A rather smooth surface in combination with the one-piece design could make the early osseointegration phase challenging, and simultaneous augmentation and sinus lift procedures were not an option. In addition, the one-piece design often forced compromises in implant positioning due to prosthetic limitations.

Why should every dentist today deal with the subject of ceramic implants?
Ceramic implants are high-tech products, but for a long time they had to lead a shadowy existence in the niche of holistic dentistry. But when we see the excellent mucosal behaviour around ceramics and, at the same time, given the importance of the mucosal cuff for the long-term preservation of implants, this material simply cannot be ignored. When, in medicine, we are forced to replace body parts, we should consider the use of materials that most closely match the body's own substances. Ultimately, our bone is nothing more than a calcium-based bioceramic—so what could be more natural than replacing hard substances in the body with high-performance ceramics such as zirconium dioxide? No study has investigated the risks posed by ceramics to the human body, and any dentist who wants to provide their patients with materials that are as biocompatible as possible should look into this issue.

Why are ceramic implants only available in the high-price segment?
Well-developed ceramic implants are high-tech products whose manufacturing process involves a large number of complex steps. This starts with the production of the high-purity ceramic powder and continues through the whole subsequent processing phase. More than 20 time-consuming and costly production steps are necessary from the original zirconium dioxide powder to the final product. A high-quality ceramic implant cannot be produced at low cost today. Implants are generally not a low-budget solution. Patients who are concerned with implants know that this type of tooth replacement is more expensive and are willing to invest in the best possible quality of life. Implant patients for whom quality of life means not only good function but also a highly aesthetic solution, and one that is as compatible as possible with their body, often explicitly demand ceramics. It is less a question of price than of the patient's attitude.

Are all ceramic implant systems on the market equally well-engineered?
All ceramic implant systems today are based on zirconium dioxide (ZrO_2). However, the systems differ significantly in terms of macro design, secure osseointegration and long-term stability. Many systems are one-piece designs and mostly tissue-level concepts. Among the

two-piece ceramic implants available on the market, there are also serious differences in the abutment-to-implant connection. Studies by Holger Zipprich and others show that conical connections are very stable and greatly reduce the risk of abutment loosening or pumping effects known from hex connections. This promotes the long-term success of the prosthetics and the preservation of the crestal bone. However, the production of a conical connection in ceramic requires extremely high manufacturing precision, which is why most ceramic implant brands do not currently offer this type of two-piece connection.

In addition, there are also huge differences in the manufacturing process, from the original powder form to the finished implant, which have a significant effect on the mechanical stability and ageing resistance of the implants. The base material is almost identical, and all implants are called zirconia ceramic implants. However, the manufacturing process—whether injection-moulded, milled from the sintered material, or milled from a sintered and additionally compressed material—means that the strength values differ considerably. Especially with ceramics, it is not the external design that is decisive for long-term success. The difference lies in the processing of the powder into a highly stable finished product, the surface treatment for secure osseointegration, and the precise connection between implant and abutment. As banal as it may sound: experience in the very specialised manufacturing process is what distinguishes long-standing ceramic implant manufacturers from their competitors who have only recently embraced this technology.

What are the specific advantages of the new Straumann SNOW implant?
SNOW is the first truly reversibly screw-retained all-ceramic implant system at bone level: ceramic implant, ceramic abutment and ceramic connecting screw. The special feature is the true bone level design with platform switch and excellent mucosal adaptation in the important transition area of the implant abutment. Thus, this implant is suitable for all surgical applications in implantology in all bone qualities, including immediate implant placement after extraction, simultaneous internal or external sinus lift, or extensive accompanying augmentation. The drilling instruments are available with integrated drill stops, which simplifies surgery for less experienced users and provides additional safety for experienced ones in critical situations. Speaking of prosthetics: for SNOW, a large number of ceramic standard abutments are available for prosthetic restorations, enabling simple solutions for all cases. Analog impressions are possible both indirectly and directly, and the abutments are optimised for intraoral scans to allow direct scanning at abutment level as an alternative to scan bodies. As for full-arch treatments: So far, it was possible to place six or more one-piece implants with good bone quality and to splint them by means of a fixed temporary, because other there was an increased residual risk of biomechanical overload. This risk is greatly reduced with SNOW. The prosthetic restoration is performed using fixed bridges, removable telescopic constructions or SNOW-Loc, a locator-based solution.

What advice would you give colleagues interested in starting to work with ceramic implants?
Dentistry, and implantology in particular, is an empirical discipline. If our titanium pioneers had waited for studies, we would not be where we are today. Today, ceramic implantology works just as well in clinical practice as titanium implantology. In the long term, ceramics might be even better because of the more stable perio-integration. My advice to interested colleagues is clear: start as soon as possible, deal with the material and its handling, and attend specific training courses. As a dentist, ceramic implants allow you to make a relatively strong name for yourself within the oversupplied field of implantology that exists today from the patient's point of view.

contact

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Peter Merian-Weg 12
4052 Basel, Switzerland
www.straumann.com

Carbon fibre—established in implant dentistry

Digitalisation in combination with ceramic implantology is one of the fastest-growing and most innovative areas in dentistry. With its Zeramex brand, Dentalpoint is considered a pioneer of "white implants". The screw connection of its metal-free two-piece ceramic implant system Zeramex P6 is unique worldwide. Carbon–ceramic technology provides the connection strength required for such a system. The centrepiece is the VICARBO screw, made of carbon fibre-reinforced high-performance PEEK. In this interview, Pascal Wettstein, Head of Research and Development at Dentalpoint, shares some insight on implant–abutment connections and what the future holds in this field.

Mr Wettstein, it is predicted that ceramic implant systems will have a market share of up to 25 per cent by 2022. Which innovations from Zeramex have contributed to this development?
Traditionally, there was a choice between a one-piece or two-piece cemented implant system and this is where Zeramex first began. But we quickly realised that, for reasons of prosthetic flexibility, a two-piece reversible solution was required. One-piece systems are not easy to use in prosthetic treatments and are practically no longer used in titanium implantology. So it was clear to us that, even in metal-free implantology, a system with reversible screw connections was required. And we were the first to bring a metal-free two-piece ceramic implant system with a reversible screw connection on to the market. This has been the major innovation from Zeramex.

In relation to Zeramex systems, a carbon–ceramic technology called VICARBO is used. Why did Dentalpoint choose carbon fibre for this, and what are its special characteristics?
To briefly sketch the background, fibre composites—and carbon fibre composites in particular—have special material properties. They have a very high tensile strength, about twice as high as that of Grade V titanium; they have a high rigidity; they are chemically resistant; and because of the fibres, they are anisotropic. This means that the properties along the fibre axis differ from those across it. This can be utilised by controlling the fibre direction or ensuring that it is parallel to the main loading direction or directions. A classic example is a bicycle fork made of a carbon fibre composite: this is designed to react elastically to longitudinal loads so that it can optimally absorb bumps etc. In relation to transverse or torsional loads, it is very rigid, which greatly improves the handling of the bicycle. With an aluminium fork, it is not possible to control the properties to the same extent, since aluminium is an isotropic material (the properties are generally the same in all directions). These excellent mechanical properties, in combination with the low weight, have led to carbon fibre becoming established in various high-tech industries, such as aviation (Airbus A380 and Boeing 787), space travel and racing. We also exploit the mentioned properties. As a result, we design the process so that the main fibre flow in the screw is such that it can withstand high levels of mechanical stress in the form of torsion and tension. The combination of a relatively soft screw and the very hard ceramic also allows us to produce the screw so that it is slightly over-dimensioned. The screw then fits snugly into the ceramic inner thread. This provides the sealing effect. The matrix material in our case is PEEK, which has a long tradition in medical technology.

Is carbon fibre already used in other medical fields?
Yes, it is. The advantages of carbon fibre composites are obvious. The material is lightweight, very rigid, radiolucent and corrosion-resistant, which makes it ideal for medical technology applications. It is already being used for bone screws or in spinal cages and cervical plates for the surgical treatment of degenerative disc disease. Carbon fibre composites have a higher rigidity than titanium does. They also have a better fatigue strength. This is a decisive advantage when you are dealing with high cyclical alternating

loads, which occur continuously in the spinal column, for instance. Naturally, the same applies to an abutment screw, which is constantly exposed to alternating loads due to chewing.

We often hear of stability problems with screws in two-piece implant systems. What about the VICARBO screw's long-term stability?
Although no clinical studies are yet available on the VICARBO screw, our five-year data gives a very clear message. Of course, even with a composite material such as VICARBO, material failures such as fibre pull-outs or matrix delamination can occur. These are not fractures in the conventional sense, but each one starts with failure at the interface of the PEEK matrix and the carbon fibres, which ultimately leads to failure of the composite. As with any screw, care should be taken to ensure that the torque is maintained. In addition, the prosthetic wrench must be squarely seated in the screw drive to ensure optimum force transmission. This is generally true for all screws, not just the VICARBO screw. However, based on our market feedback, we can say that, since the introduction of our VICARBO technology, the screw has been extremely reliable.

Studies are always a much-discussed topic in medicine and can also provide information on whether a product is ready for the market. Are studies available on the VICARBO screw?
As I said, there are no long-term studies available, but we have well-documented five-year data from our market feedback and it looks very good. We have had very few problems with the VICARBO screw and that makes us feel very positive about the future. We will have to wait for another five to 15 years for the ten- to 20-year data. But this is generally true for any new development, regardless of the system. However, enough data has been generated to allow us to conclude that the materials used or the system as a whole is stable in the long-term. The data was obtained from, among others, artificial ageing tests, alternating tests in various media and maximum stress tests. All these tests have shown that the VICARBO material is highly suitable for this application because of its unique properties. The values in cyclical loading tests in particular are comparatively very high. Also, all Zeramex systems currently available on the market have been approved by the U.S. Food and Drug Administration.

Are there any special points to consider in comparison with titanium screws?
Basically no. Our VICARBO screw is also a simple screw that is inserted using a prosthetic wrench. Because a relatively soft screw is screwed into a very hard ceramic thread, the haptic feedback is somewhat different to when two ductile materials, such as titanium on titanium, are used. Owing to the specific properties of the two materials, our screw connection is also in the form of a round thread, which is not the case with titanium implants.

Zeramex XT implant system with abutment and VICARBO screw connection.

Other manufacturers have also now introduced reversible two-piece ceramic implants. Which system do you think will become the market standard?
Quite simply, the system that is easiest to use and gives the best results will ultimately prevail. Time will tell which system that will be. What I can say is that we have been working with VICARBO for five years. We are very satisfied with the market feedback and are therefore on the right track to playing a decisive role in the industry. Well-known companies are including our products in their portfolio, underlining the confidence in our developments—something which we can be proud of. We as a company have been dealing with ceramics for more than 12 years, with a corresponding pool of experience, setbacks and successes. We have invested heavily in experiments, tests and groundwork, testing various compounds and materials to establish a rigorous and experimentally validated basis. In our industry, anything else would be negligent. The decision to use VICARBO was finally made because, based on the data, we came to the conclusion that this is the best solution that optimally complements the very specific properties of ceramics. But let's not forget that there are always new products coming on to the market and that many very talented people are working on new solutions. It is impossible to say which developments, improvements or (r)evolutions are in the pipeline and whether these will displace existing products. In any event, it is always interesting for us to observe the dynamic developments in this field.

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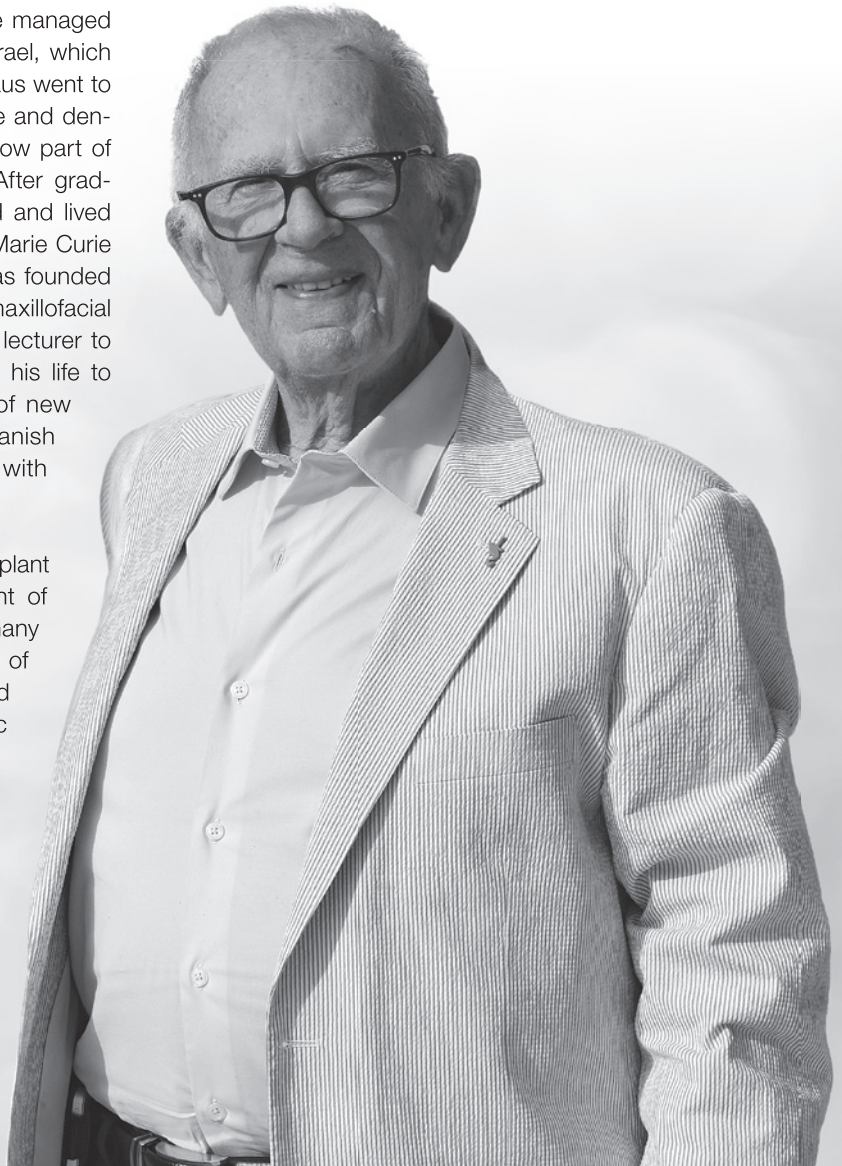
Pioneer of ceramic implantology Prof. Sami Sandhaus dies at 92

On the first weekend of October, a true pioneer in the field of implantology passed away at age 92 after a life of great success and achievement. In dentistry, Prof. Sami Sandhaus was best known for the development of ceramic dental implants. With the crystalline bone screw (CBS) implant made of white polycrystalline aluminium oxide, he succeeded in 1960 in creating a true innovation: a metal-free biocompatible implant. Under the name SIGMA dental implant, the CBS system was available on the dental market for quite some time, albeit in a slightly modified form.

Prof. Sandhaus was born in 1927 in the western Ukrainian town of Chernovtsi, which at the time was a flourishing centre of Jewish life and culture. Because of his Jewish ancestry, he was subjected to the horrors of the Nazi regime first-hand. At the age of 14, after Hitler's invasion of the Soviet Union in 1941, he was sent to a concentration camp. Unlike most of the deportees, he managed to escape, which led him via Romania to Israel, which was only formed in 1948. Later, Prof. Sandhaus went to Germany, where he studied human medicine and dentistry at the Düsseldorf Medical Academy (now part of the Heinrich Heine University Düsseldorf). After graduating in 1959, he emigrated to Switzerland and lived there until his death. At Université Pierre et Marie Curie (now part of Sorbonne University), which was founded in 1968, he specialised in dentistry and maxillofacial surgery and passed on his knowledge as a lecturer to future generations. Prof. Sandhaus devoted his life to research, teaching and the development of new dental implant technologies. He set out to banish metal from living tissue by replacing metal with biocompatible materials.

The development of Prof. Sandhaus' CBS implant marked a turning point in the advancement of dental implant systems. However, as with many new ideas, the realisation of the advantages of metal-free dental prostheses gained ground slowly. It is only in recent years that ceramic has been considered a material superior to titanium in terms of biocompatibility, healing time, wear resistance and aesthetics in dental implantology. Throughout his entire career, Prof. Sandhaus persistently sought to convey these benefits to dentists and patients all over the world. To this end, he founded the Forum Odontologicum in Lausanne, an educational institute for dentists and dental technicians that offers postgraduate courses in restorative dentistry and implantology, and the International Society for Oral Rehabilitation. During the sixth International Academy of Ceramic Implants World Congress in Miami in 2017, Prof. Sandhaus was honoured for his lifetime achievements in ceramic implantology by IAOCI President Dr Sammy Noumbissi.

Prof. Sami Sandhaus was invited as a guest of honour by European Society for Ceramic Implantology President Dr Jens Tartsch to the first congress of the society, which was held from 10 to 12 October in Zurich. He was unfortunately unable to take up the invitation owing to his poor physical condition.



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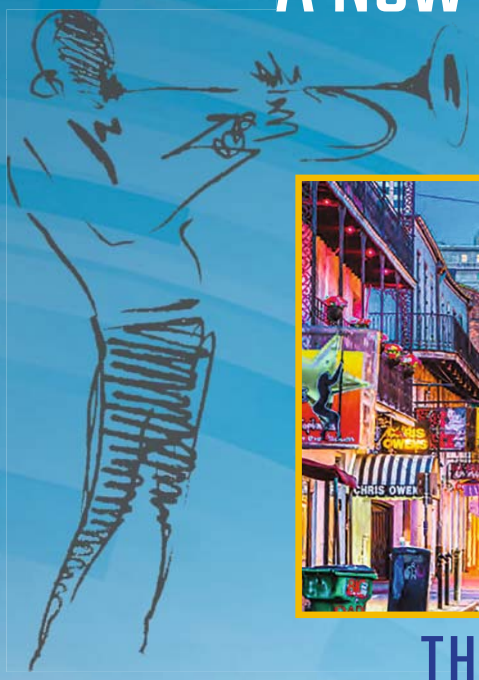

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SPEAKERS


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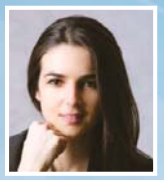
Dr. Karl Ulrich Volz


Dr. Dominik Nischwitz


Dr. Fabrizia Luongo


Dr. Henriette Lerner


Dr. Giuseppe Luongo


Prof. Jerome Chevalier


Dr. Sam Bakuri


Dr. Pascal EPPE


Dr. Yung-tsung Hsu


Dr. Kenneth Van Stralen


Dr. Gerry Curatola

Dr. Sammy S. Noumbissi
Lecture Title: Zirconia Ceramic Implants: A Decade of Experience and the Future Perspectives

Dr. Karl Ulrich Volz
Lecture Topic: Immediate Placement of Zirconia Ceramic Implants to Replace Infected Teeth with a History of Root Canal Therapy: Suggested Protocols for Success

Dr. Dominik Nischwitz
Lecture Topic: How to Use Macro and Micronutrients Intelligently to Boost the Osseointegration of Ceramic Implants and Help with Tissue Growth

Dr. Fabrizia Luongo
Lecture Topic: The Management of the Aesthetic Area with Digital Approach

Dr. Henriette Lerner
Lecture Topic: Esthetics in Dentistry; Implant Esthetics, Grafting Procedures, Biomaterials Science and Digital Technologies.

Dr. Francesco Mangano
Lecture Topic: Digital Implantology: The Modern Approach to the Implant Therapy

Dr. Jerome Chevalier
Lecture Topic: Reliability of Commercially Available Zirconia Implants: Mechanical Performances and Long Term Stability

Dr. Sam Bakuri
Lecture Topic: Ceramic Implant Placement A To Z

Dr. Pascal EPPE
Lecture Topic: The Interplay Between Electromagnetic Fields Pollution and Dental Implants. Fact or Fiction?

Dr. Yung-tsung Hsu
Lecture Topic: Temporary Prostheses For One-Piece Zirconia Implants

Dr. Van Stralen
Lecture Topic: Dental Aesthetics and the Placement and Restoration of Titanium and Ceramic Dental Implants Using Static and In Dynamic Guided Systems

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IAOCI

ASCI American Society of Ceramic Implantology

www.ioaci.com

The City of Light provides backdrop for the first EACim Congress

On 28 June 2019, the first congress of the European Academy of Ceramic Implantology (EACim) was successfully held in Paris, France, where specialists from nine nations gathered to discuss the theme of ceramic implantology. Held under the theme "Ceramic implants, an alternative to titanium", the congress was packed with scientific lectures and friendly exchange between participants, speakers and the many industry partners supporting the project. At the event, one could easily sense the growing interest in ceramic implantology and a promising open-mindedness toward things to come for this still rather young discipline in implantology.

Perfectly embodying today's growing excitement about zirconia-based implantology, former EAO President Dr Pascal Valentini had the honour of chairing the congress. Dr Pascal Eppe delivered a lecture, in which he brilliantly explained the notion of "immuno-integration", a decisive factor in eventually establishing zirconia as material of choice in implantology. Thereafter, Dr Fabrice Baudot discussed preventive aspects of zirconia: he argued that a long-term stable interaction between the interface and soft tissue is vital for countering the growing scourge of peri-implantitis. Dr Giancarlo Bianca then highlighted the superior biological and mechanical behaviour of ceramic implants by sharing insight into his 13 years of clinical experience. Afterwards, Dr Philippe Duchatelard touched on fundamental material-specific aspects, emphasising the mechanical strength of the latest generations of zirconia implants. Also, he outlined scientific concepts that might help clinicians in deciding which prosthetic components to choose for which implant system.

A further contribution to winning over the audience in favour of this promising evolution in implant dentistry was made by Dr Simon Tordjman, who presented the advantages of monobloc implants with great conviction. He argued that with monobloc implants the clinical practice becomes simpler, more intuitive, and more accessible to clinicians. The approach to dental structures using monobloc implants is completely in line with the philosophy of biomimetic dentistry. Moreover, Dr Stéphanie Gouiran showed how easy taking optical impressions and digitising prosthetic cases has become, propelling ceramic implantology into the world of the digital workflow. Finally, Dr Franz-Jochen Mellinghoff summed up the concepts discussed during the congress in one magnificent presentation, in which it was shown that, with ceramic implants, even the most complex reconstructions can be treated.

contact

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Fig. 1: From left: Dr Fabrice Baudot (France), Dr Giancarlo Bianca (France), Dr Stéphanie Gouiran (France), Dr Pascal Valentini (France), Dr Franz-Jochen Mellinghoff (Germany), Dr Pascal Eppe (Belgium), Dr Philippe Duchatelard (France) and Dr Simon Tordjman (France).

Fig. 1

Fig. 1: At the Zeramex Roadshow 2019, Cologne-based Dr Thomas Mehnert delivered a presentation on prosthetic handling.

The Zeramex Roadshow 2019—ceramic implants on tour

On 10 October 2019, the Zeramex Roadshow 2019 took place in Zurich in Switzerland. Under the theme "Fit for the future? Zirconium Implants & Digital Workflow—Simply Explained", a pioneer in two-piece ceramic implants taught participants how simple surgeries with ceramic implants can be: in his lecture on prosthetic handling, Dr Thomas Mehnert, specialist for oral and maxillofacial surgery from Cologne, Germany, gave a detailed account of his practical experiences with the aid of clinical case studies. Thereafter, he was joined by Philip Bolleter (CTO of Zeramex) and Adrian Hunn (Head of Marketing & Sales at Zeramex), who answered the participants' questions in detail. They then invited them to an interesting tour around the in-house production facilities, where the entire Zeramex portfolio was presented, including novelties. With their new competence centre Zeramex Digital Solutions, for instance, Zeramex brings individually customised digital prosthetic solutions directly into the dental practice. All participants received 2.5 training points for participating at the Zurich event.

The Zeramex Roadshow 2019 was held as pre-event to the first European Congress of the European Society for Ceramic Implantology (ESCI), which also took place in Zurich, on 11 and 12 October. It was the first instalment of a three-part series of further training events. The third and last part will conclude on 27 November 2019 in Munich, to which dental technician Wolfgang Weisser from Essingen in Germany and Klaus Pettinger (Area Manager at Zeramex) are invited as scientific experts. The event is free and all participants receive a certificate of participation, as well as 3 training points. Participants can register by e-mail at event@zeramex.com, or by phone under +41 44 3883634. Further information can be found on the company's website.

Fig. 2

Fig. 2: From left: Adrian Hunn (Head of Marketing & Sales at Zeramex), Jürg Bolleter (founder and CEO of Zeramex) and Philip Bolleter (CTO of Zeramex).

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Fig. 1

Fig. 1: The Bocken estate near Zurich served as the venue for the 1st European Congress for Ceramic Implant Dentistry. **Fig. 2:** The event was sold out and the conference room was filled up to the last seat.

"Facts of Ceramic Implants" presented in Zurich

On 11 and 12 October 2019, the European Society for Ceramic Implantology (ESCI) invited ceramic enthusiasts from all over the world to Horgen/Zurich in Switzerland, where the 1st European Congress for Ceramic Implant Dentistry was held. Dr Jens Tartsch was delighted about the successful outcome: the event was sold out with an audience of more than 170 attending. Coming from as far as India or China, participants gathered in Zurich to gain valuable new insights into the scientific foundation and the numerous application possibilites of ceramic implants as a reliable treatment modality and an alternative to the well-established titanium implants. The Bocken estate, a congress centre situated just ten minutes outside of Zurich in the lush green countryside, served as perfect and inspiring backdrop for this high-profile congress topic.

Fig. 2

Fig. 3

Fig. 3: Internationally renowned speakers were invited by the scientific directors Dr Jens Tartsch, Dr Stefan Röhling and Prof. Ralf Kohal. **Fig. 4:** From left: Dr Stefan Röhling (Vice President of the ESCI), Georg Isbaner (Editorial Manager of *ceramic implants*) and Dr Jens Tartsch (President of the ESCI).

ESCI
Europäische Gesellschaft für Keramik Implantologie
Société européenne pour l`implantologie en céramique
Società europea per l`implantologia ceramica
European Society for Ceramic Implantology

Ceramic implantology is currently the fastest growing and most research-intensive field in dentistry. All the more important is a practice-oriented, but at the same time scientific and evidence-based discussion revolving around this topic. In other words, only the facts count. "Facts of Ceramic Implants" was therefore the motto of the event which was considered a definitive highlight by many, not only from a technical stance. 14 renowned speakers from seven countries were invited to the Congress, which was helmed by scientific directors' Dr Jens Tartsch (President of the ESCI), Dr Stefan Röhling (Vice President of the ESCI) and Prof. Ralf Kohal (Member of the Scientific Advisory Board of the ESCI). Through numerous first-rate lectures, newcomers to ceramics, experienced clinicians and industry partners were provided with an in-depth knowledge about the successful handling of the "white implants". All relevant facts and associated aspects of ceramic implantology were discussed, ranging from the possibilities and limitations of zirconium dioxide as an implant material to its clinical application with regard to the unique prosthetic options.

Fig. 4

The ESCI is a hub for scientific research and clinical and practical experience with ceramic implants. The first ESCI Congress was also an opportunity for young researchers in particular to present their findings and clinical case outcomes in the "short lecture sessions". The best presentation in its category was awarded with the "ESCI Award", which is endowed with 500 Euro each. Germany-based Dr Rouven Wagner won the award in the category "Best Clinical Case Presentation" for his lecture titled "Using individual designed abutments on ceramic implants for rebuilding the aesthetic zone—a posttraumatic case" (supported by CAMLOG). The winners in the category "Best Scientific Abstract Presentation" were Dr Mona Monzavi (USA) and Dr Yuguang Wang (China) for their presentations titled "Microstructural analyses of Artificial Ageing in 5 Commercially and Non-Commercially Available Zirconia Dental Implants" and "Enhanced osseointegration and biofilm eradication of bone zirconia implant using non-invasive phototherapy device", respectively.

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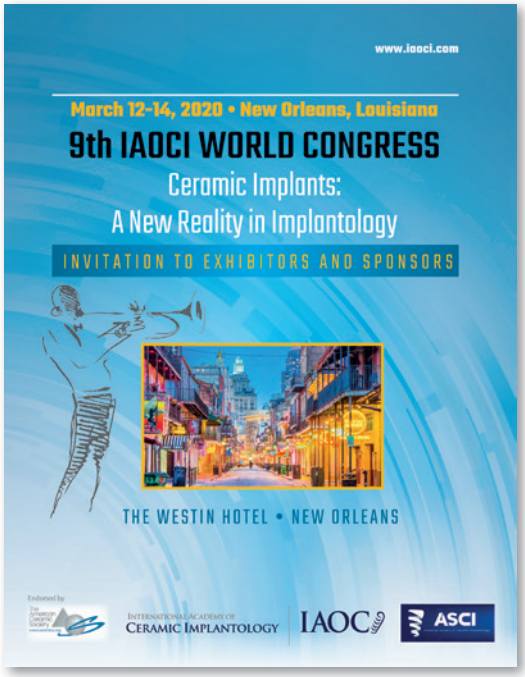
Berlin chosen as venue for

2020 Annual Meeting of ISMI

ISMI | INT. SOCIETY OF METAL FREE IMPLANTOLOGY

Under the guiding theme "Ceramic Implants – State of the Art", the International Society of Metal Free Implantology (ISMI) invites ceramic implant enthusiasts to its 6th International Annual Meeting, to be held on 8 and 9 May 2020 at the Steigenberger Hotel am Kanzleramt in Berlin in Germany. On both congress days, renowned experts and practitioners from Germany and abroad will discuss practical experiences and current trends in the use of ceramic implants, as well as biological aspects of metal-free implantology with the participants. The two-day event begins on Friday with two Pre-Congress Symposia including the online broadcast of a live operation via multi-channel streaming. The highlight of the first conference day will be the ISMI White Night, at which participants and speakers alike will be able to wind down after a highly scientific and practice-oriented day in a relaxed atmosphere with wine and music. Saturday will then be dedicated to scientific lectures, which will be simultaneously translated into German and English. More information on the event can be found online at www.ismi-meeting.com.

Source: ISMI



The 9th IAOCI World Congress

To be held in March 2020

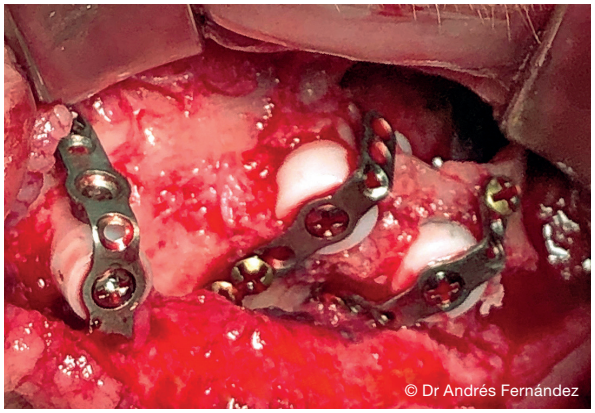
From 12 to 14 March 2020, the 9th World Congress of the International Academy of Ceramic Implantology (IAOCI) will be held in New Orleans, USA. This event will have a cultural and international character with a first-rate scientific and clinical programme delivered by experienced international and national speakers. We promote and deliver innovative and forward-thinking ideas through workshops, lectures and symposia that enhance the understanding of and the rationale for ceramic implants. For the first time ever we are introducing a clinical and scientific poster presentation competition and the winner will be given 30 minutes on the main podium to present their work. In keeping with the changes and innovations in implantology, we are offering a pre-congress Digital Dentistry Symposium and a dental hygiene event focused on ceramic implant care. Clinicians, students and manufacturers will have access to, learn from and exchange with the largest community of experts in dental bioceramics science and technology. For more information, visit www.iaoci.com/iaoci2020.

Source: IAOCI

A new bone growth inducing solution

From Swiss Dental Solutions

With pronounced bone resorption, immediate implantation with high primary stability is not always possible. The new Bilateral Implant Stabilization System (BISS) from Swiss Dental Solutions will offer new opportunities in this area. Dr Rebekka Hueber, oral surgeon at the Swiss Biohealth Academy in Kreuzlingen supervises the world's first clinical trial with BISS, in cooperation with Dr Andrés Fernández, oral and maxillofacial surgeon at Dental Cosmetics Costa Rica. BISS acts as a parasol that keeps the periosteum at a distance and stabilises the implant, thus inducing bone growth and allowing immediate osseointegration with lamellar bone. The osteosynthesis plate, made of grade 5 titanium, adapts to any situation and is fixed to the alveolar crest with the BISS osteosynthesis screw, available in lengths of 3, 5 and 7 mm. The connecting screw fixes SDS implants to the plate, stabilising them. In initial clinical trials, successful osseointegration with minimal



bone supply was achieved. The results show that BISS will significantly expand the surgical spectrum and enable immediate implantation even in difficult situations.

Source: Swiss Dental Solutions

Second EACim Congress

To take place in Brussels

Those who were not able to attend this year's congress of the European Academy for Ceramic Implantology (EACim) in Paris can already look forward to next spring: on Saturday, 25 April 2020, the second congress of the EACim will take place at the Hotel Le Plaza in Brussels in Belgium. The congress, chaired by Prof. Carlo Maiorana from the University of Milan in Italy, will be held under the guiding theme "Large Reconstruction with Ceramic Implants" and comprise various lectures from internationally recognised speakers. In addition, one day ahead of the main congress, on Friday, 24 April, there will be an optional workshop titled "Digital Workflow with Ceramic Implants" which interested participants can attend. The manufacturing companies bredent medical, CAMLOG, Nobel Biocare, Zeramex, ZiBone and Z-Systems will be supporting the congress as industry partners. More information on next year's event and the registration possibilities can be found online at www.eacim-ceramic-implantology.com.

Source: EACim

Congresses, courses and symposia

IAOCI

9th IAOCI World Congress

12–14 March 2020
New Orleans, LA, USA
www.iaoci.com/iaoci2020

AO Annual Meeting

18–20 March 2020
Seattle, WA, USA
www.osseo.org/2020-annual-meeting

2nd EACim Congress

25 April 2020
Brussels, Belgium
www.eacim-ceramic-implantology.com

6th Annual Meeting of ISMI

8–9 May 2020
Berlin, Germany
www.ismi-meeting.com

EAO
EUROPEAN ASSOCIATION FOR OSSEOINTEGRATION
CONGRESS

EAO Congress 2020

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

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international magazine of ceramic implant technology

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