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Dr Michael Gahlert

Munich/Basel
ITI Fellow
Focus on implantology and periodontology

Ceramic implants—game changer in dental implantology

Dear colleagues,

A specialist magazine exclusively concentrating on ceramic implants is a highly welcomed medium of information for all dentists working in the field of implantology. Ceramic implants have been the focus of the implantological community for a long time now and have reached full clinical approval by undergoing the same developmental stages as did titanium implants before.

From 2018 on, this brand new supplement on ceramic implants will be published twice a year presenting its subject matter as a highly complex and mani-faceted topic. By doing so, it offers practitioners a unique opportunity to exchange information based on the latest clinical and scientific findings. Against this backdrop, the fascination emanated by the "White Gold" will certainly not come up short. Being a long-term user myself I can confirm that ceramic implants do indeed polarize, and yet they also bring great pleasure to dentists and patients alike, thanks to their excellent clinical results and aesthetics.

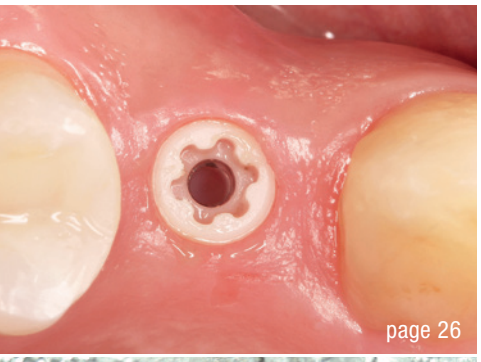
It will be very exciting to see how this topic will officially and academically be approached by the big scientific associations in the future. After an initial phase of extreme reluctance, more and more initiatives are brought forward to create scientific data around the progressive development of ceramic implants and to communicate and present those results at scientific congresses. It's merely a matter of time before the first consensus recommendation based on evidence-driven data will be formulated for practitioners. However, in addition to those affirmative developments, inconsistent quality standards of systems currently available on the market are a significant problem: The production of micro-rough zirconia surfaces as well as ceramic implants is a rather complex venture, putting high demands on the expertise and know-how of industry partners.

Ceramic implants are the last link in the chain of zirconium dioxide, a material that has so far positively influenced conservative and prosthodontic dentistry by making it largely metal-free. As a biological and metal-free alternative to titanium is now also available for the field of oral surgery, various groups of patients can henceforth be reached that previously rejected dental implants due to the ever-present titanium.

If one believes the recent IDS 2017 market analyses, ceramic implants are broadly considered as implantology's "game changer". They will most likely take centre stage in scientific discussions at future congresses, gain further global popularity as a research topic in academic circles and increase their present market penetration of currently 0.2 per cent in 2016 to 2 per cent in 2020, and even 8 per cent in 2025.

With this in mind, I wish all of those responsible for this present edition every success in implementing and establishing this topic, and I am convinced that this initiative will be successful in its contribution to further reduce communication deficits about ceramic implants.

Sincerely,
Dr Michael Gahlert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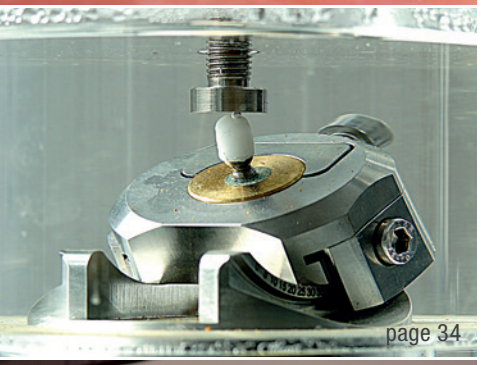
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page 50

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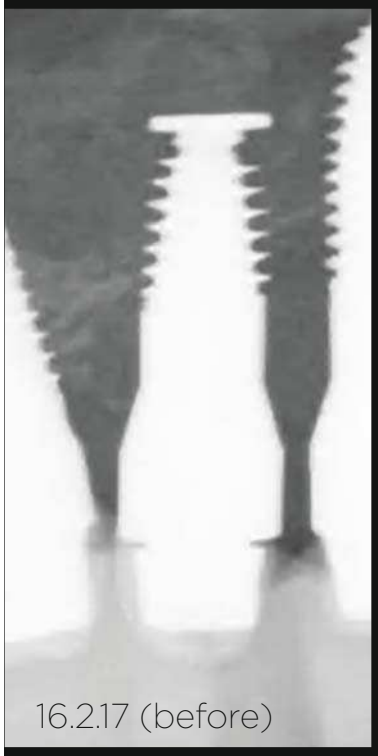
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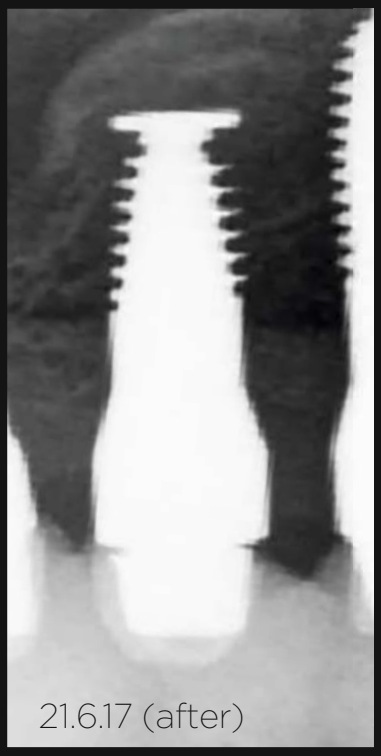
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From titanium to zirconia implants

Dr Sofia Karapataki, Greece

Zirconium is a metal with the atomic number 40. Zirconium dioxide (ZrO_2) or Zirconia is a ceramic material without any metal properties. It is electrochemically inert causing no galvanising or electro current disturbance effects at an inter- and intracellular level. It is the most bioinert and biocompatible material currently available in the market, with no detected allergies or intolerances. The material exhibits lower surface free energy that leads to hydrophilic reduced plaque (biofilm) accumulation, so, less inflammation is expected leading to superior soft tissue health.

Zirconia fulfils highly desirable aesthetic results: healthy, pink and beautiful tissue can be created around an implant, with no tissue translucency. Its high aesthetics resembles natural tooth. Unlike titanium, it may stimulate bone growth in the long-term with ultimate osseointegration for both bone and gum. In addition to the white colour, a low modulus of elasticity and thermal conductivity have made zirconia implants a very attractive alternative to titanium in implant dentistry.[1–4]

With its interesting microstructural properties, zirconia is the material of choice for the "new generation" of implants. Hashim et al. (2016) made a systematic review and evaluated the clinical success and survival rates of zirconia ceramic implants after at least one year of functioning.[5] They concluded that in spite of the unavailability of sufficient long-term evidence to justify using zirconia oral implants, zirconia ceramics could potentially be the alternative to titanium for a non-metallic implant solution. This is also shown in the review made by Cionca et al. (2017), that through *in vitro* and *in vivo* studies, zirconia has managed to earn its place as a valuable alternative to titanium.[6]

Mechanical and physical properties

Zirconia though, is a totally different material than titanium. The thorough knowledge of implantology using titanium is not so easy to be transferred to zirconia, simply due to different physical and mechanical properties of the materials. Knowledge of the potentials of the material is the key of success and the only chance to minimise failures. Zirconia (ZrO_2) is a highly biocompatible material, but it needs to osseointegrate and withstand masticatory force without fracturing. A good product needs to be fabricated that would fulfil all the necessary requirements in order to be successfully implanted.

ZrO_2 is stable at room temperature at a monoclinic phase. Doped by yttrium oxide, when it cools down from 1,173 °C, a tetragonal phase stable at room temperature (metastable) is produced. This is the material used for implants. It is of major importance for the implant to be kept in the tetragonal phase to keep its mechanical and physical properties over time. It is well established that the stability of this phase is affected by several compositional parameters, including grain-size, processing conditions and quality control.

Purity or rather contamination with impurities, density and porosity of the final product as well as pre-sintering and sintering process and time are also some of these parameters. Environment or conditions (loading-temperature-humidity) in which the product will be used (it makes a difference whether zirconia is produced for a hip prosthesis or for dental implants) are to be kept in mind. And last but not least, handling of the material is of outmost importance.[7,8] Lughi et al. (2010) suggested engineering guidelines for the use of zirconia as dental material.[9]

Producing zirconia implants

There are two ways of producing zirconia implants: through moulding and through milling of prefabricated rods. The first method produces implants with specific shape and specific low roughness on their surface. Milling of the rods on the other hand, is done either on partially or fully sintered zirconia. The fabrication of an implant through soft machining of partially sintered ZrO_2

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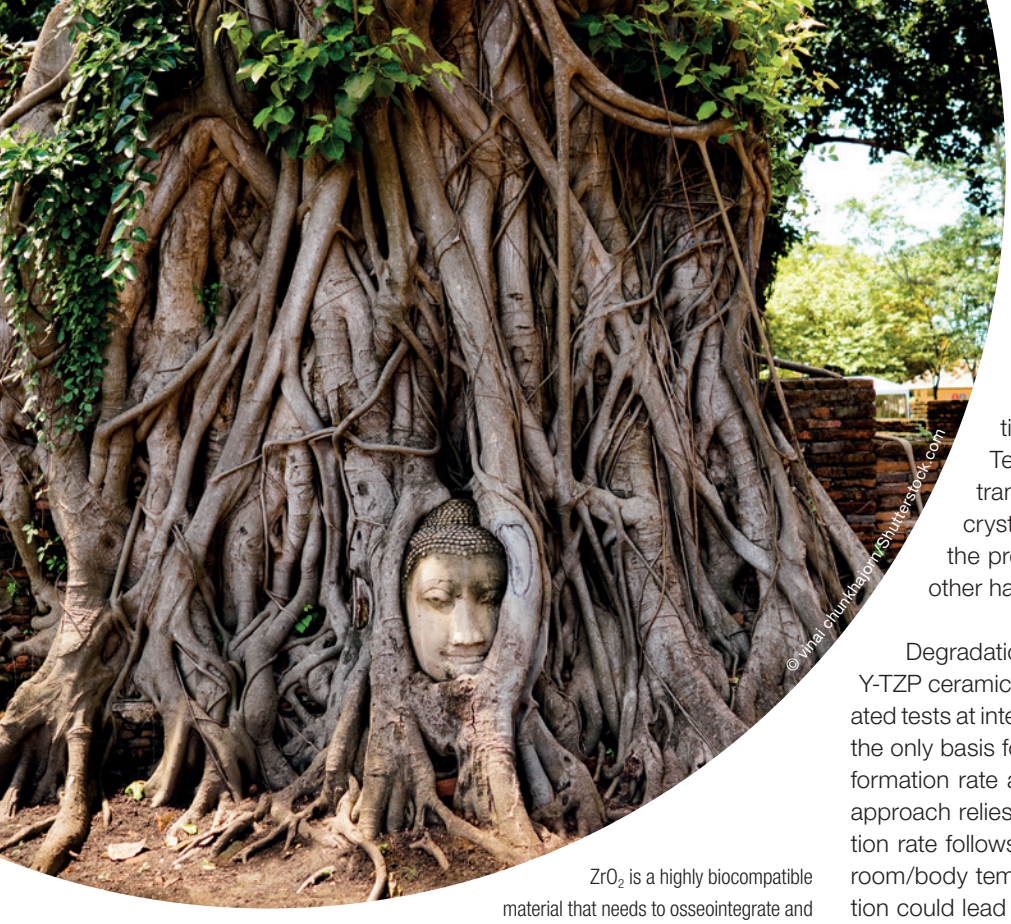

ZrO_2 is a highly biocompatible material that needs to osseointegrate and withstand masticatory force without fracturing.

provides the advantage of easier milling than the fully sintered ZrO_2. It requires less milling time and causes less wear of the cutting tools.[10, 11]

In hard machining of fully sintered ZrO_2, no sintering shrinkage is expected and there is no need for a sintering oven. However, microcracks maybe introduced.[10] Since diamond zirconia is known as the toughest material existing, only diamond tools are used for cutting sintered zirconia. The grinding of the fully sintered ZrO_2 causes a certain degree of transformation (from tetragonal to monoclinic phase) in the surface of this material.[12] When comparing the final surface of the soft machined ZrO_2 to the hard machined ZrO_2, it is expected that the former will have a more consistent final state, given that it is left intact (no sandblasting or grinding) after the final sintering.[13]

The implants that are produced need to be roughened in order to be osseointegrated. Question arises what is the optimal roughness and surface that is produced after it, in order for zirconia implants to be successfully osseointegrated in any of the aforementioned production methods. It seems that the rougher the body, the better the odds for osseointegration.[14] This though should not be the goal for the head of the implant in case that it is visible in the mouth—it could favour bacteria colonisation. The best method to achieve the optimal roughness as well as the moment that this should be realised with respect to the material's properties is also not established. Finally, depending on the procedure, the roughened surface needs to be totally clean, free of all foreign bodies.

Ageing of titanium vs zirconia

Ageing of titanium implants is a not widely known phenomenon and starts four weeks after their production which decreases dramatically the osseointegration potential.[15–18] Ageing of zirconia (Low Temperature Degradation LTD, i.e. the slow transformation of the metastable tetragonal crystals to the stable monoclinic structure in the presence of water or water vapour) on the other hand is quite well investigated.

Degradation rates at room or body temperature of Y-TZP ceramics are currently not available, and accelerated tests at intermediate temperature (100 to 300 °C) are the only basis for extrapolating an estimate of the transformation rate and, hence, of the product lifetime. This approach relies on the assumption that the transformation rate follows the same Arrhenius-like trend down to room/body temperature. Unfortunately, such extrapolation could lead to a significant error in estimating room/body temperature lifetimes.[9] Still this is the method that is used in researches. Monzavi M. et al. (2017) examined 36 zirconia implants of four different brands and found that the effect of ageing was minimal in all systems.[19] They suggested though that *in vivo* studies are needed to investigate the effect of mastication force on the extent of LTD and the influence of surface changes such as delamination of the grains on surrounding hard- and soft-tissue.

Still a certain degree of transformation from tetragonal to monoclinic phase can actually improve the mechanical properties of Y-TZP. Under stress, i.e. at the tip of a crack, the Y-TZP undergoes a phase transformation from tetragonal to monoclinic phase. This phase transformation results in a 3 to 4 per cent volumetric expansion inducing a compressive stress in the area of the crack and theoretically prevents crack propagation.[1] An implant which exhibits phase transformation in case of microcracks and high forces is desirable. Still it is not sure whether the already existing microcracks that are produced (for instance, during handling) during mastication or parafunctional activities, don't propagate, leading to a possible fracture.

One- vs two-piece zirconia implants

Zirconia appears in two varieties, one- and two-piece implants. One-piece implants offer the absence of a microgap between implant and abutment which seems to be of benefit. The surgical placement of the implant, though may not always meet the prosthodontic requirements and angled abutments in order to correct misalignment, is not common. Secondary corrections of the shape by grinding must be avoided, as this severely affects the fracture strength of zirconia.[20] Protection by use of splints is also required, though not always possible. So, two-piece implants were

designed. Designing a zirconia implant should be based on material properties and should simplify surgical and prosthetic steps for the doctor. Size limitations should be considered, in order to produce an implant that is not prone to fractures. A clinical study by Gahlert et al. (2012) showed a marked tendency of one-piece implants with a narrow diameter (3.25 mm) to fracture, with a percentage that reached 92 per cent of the fractured implants.[21] Threads and shape of implants should be designed according to the needs, always with respect to material.

Size and shape precautions should also be applied to the implant head in order to avoid the risk of creating microcracks during implantation. The implant head if positioned at the gingival level or even higher, could eliminate the need for a second surgery, as well as to bypass the bacterial growth in the gap between implant and abutment. The decision of choosing between a one- and a two-piece implant could be influenced by the design of the implant, the available space to be installed, and the prosthetic rehabilitation that follows.

Implant-abutment connection

Connection of the abutment with the implant is performed by three ways: either by screwing, cementing, or even as a combination of both. When screwing, the material of the abutment and the connecting screw is of crucial importance for the implant to be intact. As a consequence from titanium knowledge, screwing an abutment made from the same material as the implant was a "natural" step. Screwing though zirconia inside a zirconia, unlike titanium, cannot result in a tight connection, because of the stiffness of the material. This loosening could possibly result in fracture and if this happens to the implant, it could jeopardise everything. In case of abutment failure, one should estimate the convenience of removing the abutment screw.

A recent *in vitro* study by Preis et al. (2016) comes to strengthen the aforementioned performance of different implant-abutment connections, was investigated in six groups of different two-piece zirconia implant systems.[22] In group 1, the abutments were cemented to an alumina-toughened zirconia implant. In group 2, the abutments were screwed with a carbon fibre reinforced polymer screw on an alumina-toughened zirconia implant. In the remaining four groups, the abutments were screwed with titanium screws on tetragonal zirconia polycrystalline implants. A standard screw-retained titanium implant served as the control. The bonded zirconia system and the titanium reference survived without any failures. Screw-retained zirconia systems showed fractures of abutments and/or implants,

partly combined with screw fracture/loosening. Failures concerning the abutment/implant region around the screw, indicate that the connecting design is crucial for clinical success.

Additionally, a study by Neumann et al. (2014) compared the fracture resistance of abutment retention screws made of titanium, polyetheretherketone (PEEK) and 30 per cent carbon fibre-reinforced PEEK, using an external hexagonal implant/UCLA-type abutment interface assembly.[23] UCLA-type abutments were fixed to implants using titanium screws (group 1), polyetheretherketone screws (group 2), and 30 per cent carbon fibre-reinforced PEEK screws. They found that the titanium screws had higher fracture resistance, compared with PEEK and 30 per cent carbon fibre-reinforced PEEK screws.

Screwing abutments can be the trend, but cementation on the other hand could be a simpler and less time-consuming procedure as it is also shown in the study by Brüll et al. (2014).[24] It is closer to the dentist's basic education, resembles the procedure of cementing a post in natural endodontically treated teeth and requires no extra instruments. A combination of both screwing and cementing though, could make the procedure more complicated. More studies are required to determine the proper abutment material, cementation method and procedure. The restoration materials that will be used together with their limitations should be studied.

Mostly fixed prosthetics on single crowns or small bridges have been presented. The fracture resistance of two-piece zirconia and titanium implant prototypes under forces representative of a period of five years of clinical loading was tested, during an *in vitro* experiment by Kohal et al. (2009).[25] In this experiment the crown materials had no influence on the fracture strength of the zirconia implants. Still, in certain cases such as treating a patient with parafunctional chewing, a softer prosthetic material could be a wise choice. The need for further investigation on removable prosthetics on zirconia implants should be kept in mind, too.

Peri-implantitis

Peri-implantitis in titanium implants is a serious and underestimated problem involving millions of implants. The prevalence of peri-implantitis according to the review of Zitzmann and Berglund (2008) varies between 12 and 43 per cent of implant sites.[26] Many aetiological factors have been implicated, bacterial contamination among them. In peri-implantitis, the lesion extended apical to the pocket epithelium contains large proportions of plasma cells and lymphocytes but also PMN cells and macrophages in high numbers.[27,28] Peri-implantitis though has hardly been reported on zirconia implants. Zirconia demonstrates a low affinity to bacterial plaque, small amounts of inflammatory infiltrate and good soft tissue integration. These properties might lower the risk for peri-implant diseases.[1–3] This hypothesis is strengthened by the results of the study conducted by Nascimento et al. (2014), where cast and polished titanium were presented with the highest incidence and total count of bacteria, while zirconia showed the lowest.[29]

Rosenberg et al. (1991) claimed distinct differences between bacterial profiles of infected and overloaded titanium implants.[30] The latter were characterised by the absence of motile rods, spirochetes and classical periodontopathogens, along with a predominance of Gram-positive organisms, similar to what is observed in periodontal health. These observations were supported by Quirynen and Listgarten in 1990.[31] Failures of zirconia implants due to bacteria, should be differentiated against those of technical reasons and the microbiota should be investigated. It should be kept in mind that bacterial cells have a net negative charge on the cell wall, although the magnitude of this charge varies from strain to strain. Especially on the Gram-negative bacteria, LPS as a major component of their cell membrane increases even more the negative charge.[32]

Titanium is also negatively charged, thus acting repulsively to bacteria. This could be one of the reasons of success of titanium implantation in a contaminated environment. Zirconia though has no electric charge. Depending on the roughness and the hydrophilic surface of every zirconia implant system, contamination may be easier to occur and this could be a reason of early failure when zirconia is implanted in a contaminated environment. Studies are needed to clarify whether the latter could affect the osseointegration result and what is the relative danger comparing to titanium. Local disinfection could minimise the risk in immediate implantation using the help of ozone and autologous plasma. Nutrition and food supplements could also be helpful, too.

Intolerance to titanium and genetic predisposition to inflammation has been introduced as an additional and independent risk factor (Odds Ratio 12 and Odds Ratio 6 respectively) for peri-implantitis.[33] The authors propose a direct effect of the released microparticles of titanium on the immunological mechanism of the body that could possibly initiate peri-implantitis. Zirconia particles on the

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Microparticles released by titanium on the immunological mechanism of the body could possibly initiate peri-implantitis. Pictured: Titanium-infused quartz crystal cluster.

other hand have no effect on the release of TNF-α.[34] Titanium microparticles are released as a result either of friction, electrochemical corrosion, or the synergistic effect of both and can either be taken up by macrophages, remain in the intercellular space near the releasing site, or systemically migrate in organs such as liver, spleen and lung, as Olmedo et al. (2003 and 2002) found.[35,36]

Same group of authors made a long-term evaluation of the distribution, destination, and potential risk of both TiO_2 and ZrO_2 microparticles, in an animal study.[37] They evaluated:

(a) the presence of particles in blood cells and liver and lung tissue,
(b) Ti and Zr deposit quantitation,
(c) oxidant-antioxidant balance in tissues, and
(d) O_{2^-} generation in alveolar macrophages.

Ti and Zr particles were detected in blood mononuclear cells and in organ parenchyma. At equal doses and times post administration, Ti content in organs was consistently higher than Zr content. Ti elicited a significant increase in O_{2^-} generation in the lung compared to Zr. The consumption of antioxidant enzymes was greater in the Ti than in the Zr group.

Conclusion

Scientific studies are promptly needed to fulfil gaps like long-term clinical evaluations of all existing zirconia implant systems. Protocols used to design, manufacture and test titanium implants cannot simply apply to produce and evaluate the zirconia ones. Every step, from production to surgery and prosthetic reconstruction needs to be carefully planned, with respect to the properties of the new material. Accordingly, the advantages of zirconia would be fully beneficial and the risk of failure could be minimised.

Literature

contact

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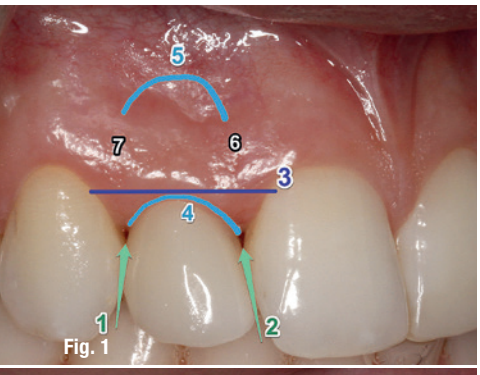
Ceramic implants: Yesterday a vision, today an everyday challenge?

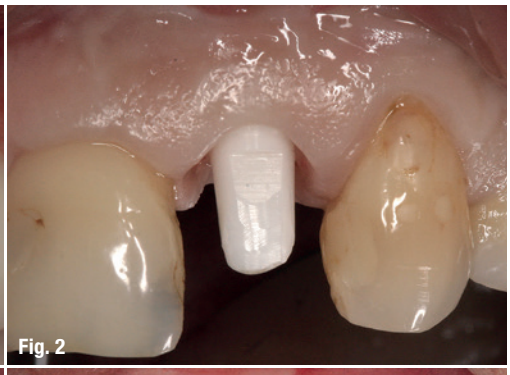
Dr Jochen Mellinghoff, Germany

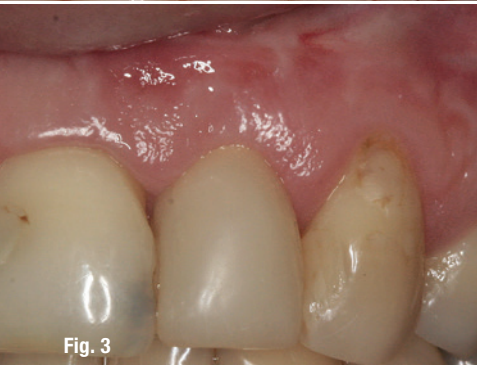
When the first ceramic implants were inserted in the 1960s and 1970s under the supervision of Prof. Willi Schulte in Tübingen in Germany, expectations were high and it appeared that an alternative to the already successful titanium implants had been found. However, in practice, it turned out differently. The implants had a high failure rate due to incomplete healing and fractures, meaning they were unacceptable for further use. This led to considerable initial scepticism around ceramic dental implants. In Germany specifically, there was a prejudice concerning the concept of ceramic implants as a whole. Fractures of ceramic components were familiar to all dentists. They saw chipping of veneer ceramics and ceramic-fused-to-metal restorations, as well as fractures of newly developed full ceramics, in everyday prosthetic practice. From these experiences, it appeared that ceramic implants would not be strong enough for use in implantation.

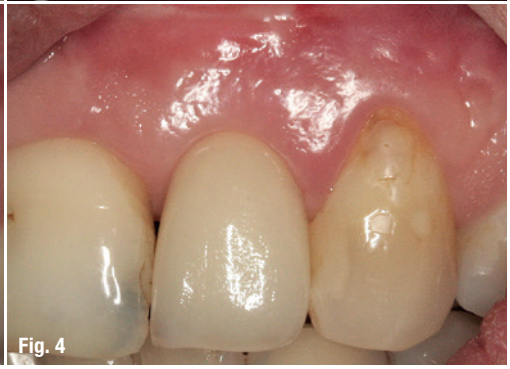
Consequently, research into titanium implants went forward quickly, while implant technology with ceramic implants was regarded as a maverick method. Despite all the positive differences in its chemical and physical properties compared with those of the previously used aluminium oxide ceramics, the advantages of zirconium dioxide only slowly gained recognition. In zirconium dioxide ceramic, we now have a material at our disposal with the properties necessary for successful and safe ceramic implants.

The safety of the material is the primary concern of zirconium dioxide ceramic implants and, once achieved, leads to additional advantages, for example good gingiva compatibility owing to their high adhesiveness and aesthetic benefits in avoiding shadow formations when a lower amount of peri-implant tissue is present.[1,2] Furthermore, overall, very good biocompatibility has been proven.[3]









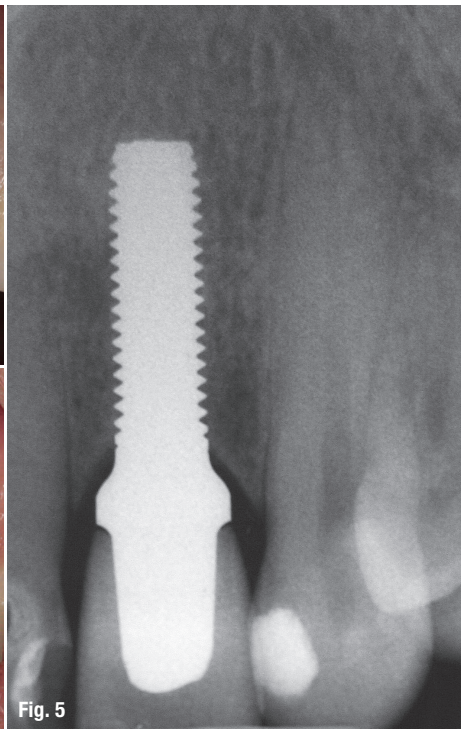


Fig. 1: Fürhauser's Pink Esthetic Score: 1 = left papilla; 2 = right papilla; 3 = soft-tissue level; 4 = soft-tissue contour; 5 = alveolar extension continuity; 6 = colour; 7 = texture. **Figs. 2–5:** Case 1: A Z5m implant was inserted in region #22. A high level of patient satisfaction was achieved.

Ceramics are hard materials with very low elasticity. Even small variations in the homogeneity of the powder mix lead to a not inconsiderable weakening of the material and possibly to complete failure. Processes such as powder compression and sintering also need a great deal of knowledge and experience on the manufacturers' behalf. Therefore, trust in the manufacturer on the part of the implantologist and very high product quality from the manufacturer are necessary.

We have been using zirconium dioxide in our practice since 2004. Functional and aesthetic results, along with material safety, are ultimately what count in any dental practice. Results must be close to, meet or exceed the expectations of patients. We use Fürhauser's Pink Esthetic Score (PES) to judge aesthetic results (Fig. 1).[4]

Case 1 (2008)

This case is presented as an example of the PES. The gingiva was prevented from growing over the implant shoulder by a well-fitting temporary crown covering the implant shoulder. This resulted in a trauma-free procedure in forming of the gingiva and cementing of the crown. The circular step represented a special challenge in the vestibular aesthetic and in cementing the crown. The insertion depth was coronal to the top of the thread.

Implantology with single-piece implants requires special conditions in prosthetic treatment, and only a portion of the required indications can be treated (Figs. 2–5). Today, we can go further by using zirconia implants for various indications made by the manufacturer Z-Systems (Fig. 6).[5]

Z-Systems has a company history of 15 years, during which time it has concentrated solely on zirconium dioxide implants. The products have been developed and manufactured together with Swiss company Metoxit (Tab. 1).[6] The initial single-piece implants were followed by various two-piece implant types. Most indications today can be covered by this range. The most common indication in Germany is single-tooth replacement. Using the treatment results presented in this article, I would now like to direct the focus to the development cycles.

Case 2 (2004)

The implant Z5m by Z-Systems, placed in region #25 is an example of long-term success. Thirteen years of post-treatment, and with very good dental care, it was difficult to tell whether there was more recession of the gingival margin at the natural teeth than at the implant site (Figs. 7–9).

Case 3 (2015)

In this case, the screw implant Z5m(t) by Z-Systems, was inserted in region #15. The tapered screw design helps to avoid penetration of the sinus floor and additionally achieves a high primary stability in weak bone (Figs. 10–12).

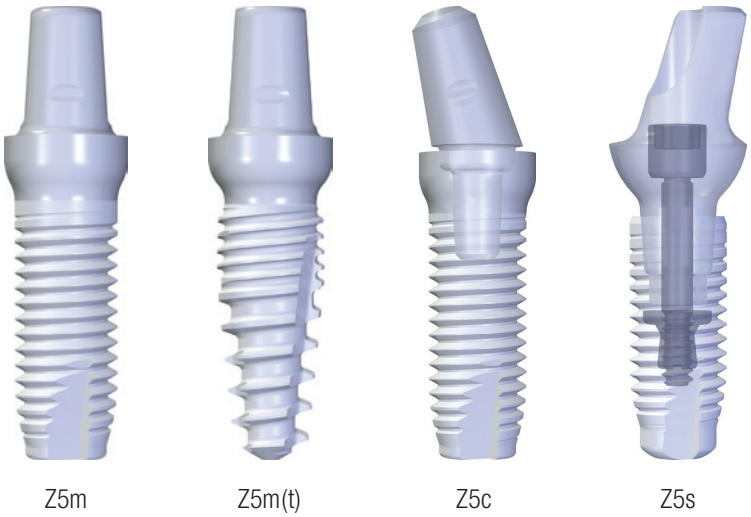


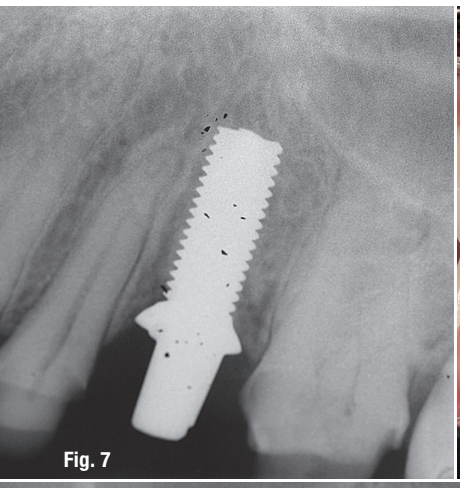
Fig. 6

Case 4 (2013)

The implant placed in region #12 in this case was a tissue level two-piece Z5c implant by Z-Systems. The condition of the periodontium of the neighbouring teeth is important for predicting the shape of the papilla be-

Description	Unit	TZP-A BIO-HIP®
Components	–	$ZrO_2/Y_2O_3/Al_2O_3$
Composition	%	95/5/0.25
Density	g/cm³	6.05
Open porosity	%	0
Grain size	µm	0.35
Vickers hardness	Hv	1,200
Mohrs hardness	–	8
Compression strength	MPa	2,000
Flexural strength	MPa	1,200
Elasticity index	GPa	210
Fracture toughness K1c	$MN/m^{3/2}$	8

Tab. 1: Table with the composition and material properties of the Z-Systems implants used in this report.[6] (Source: Metoxit)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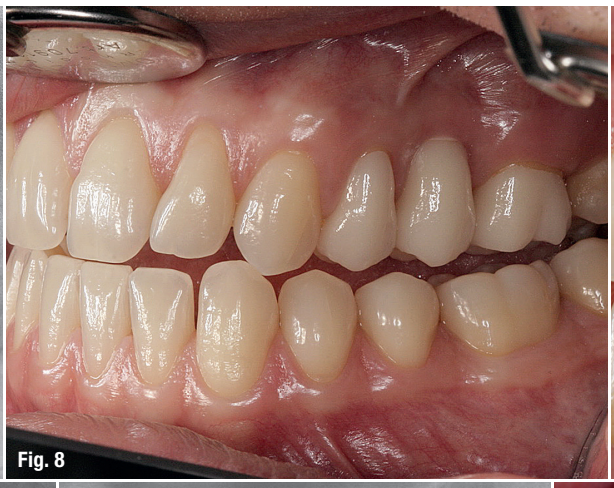
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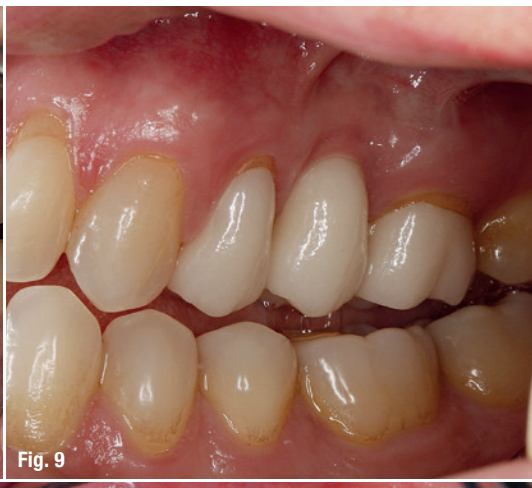
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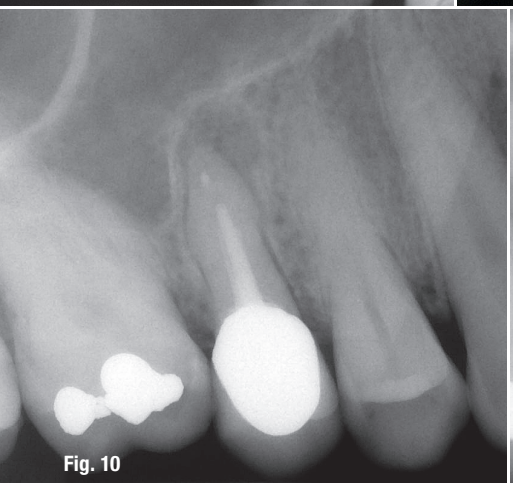
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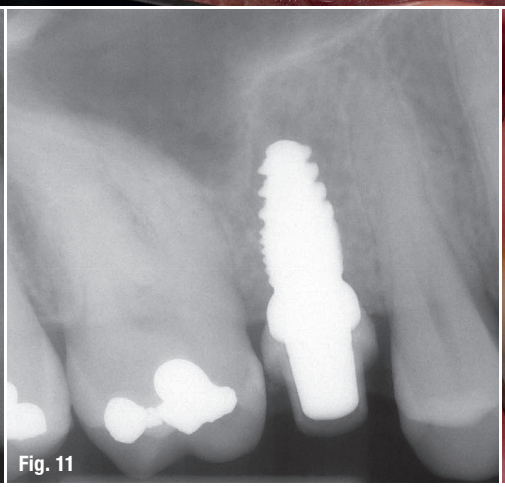
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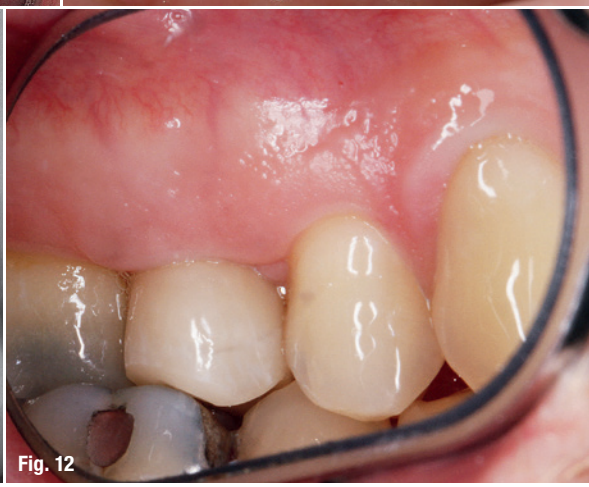


Fig. 12

Figs. 7–9: Case 2: A Z5m implant inserted in region #25 is an example for long-term success. **Figs. 10–12:** Case 3: A Z5m(t) implant was inserted in region #15.

tween the implant crown and the natural or artificial crown of the adjacent tooth. The implant in this case was placed immediately (Figs. 13–16).

Case 5 (2016)

Bone level indication extensions (Z5s implants in regions #46 and 47) were used in this case, in which, even with a two-piece tissue level implant, there were concerns about stable fixing owing to the lack of good primary stability. Furthermore, the desire of many oral surgeons to be able to collaborate clearly with the referring dentist has to be considered (Figs. 17–20).

Scientific background

We currently have at our disposal many more studies, user observations and experiences for single-piece ceramic implants than for two-piece implants. There is a great need for further studies on two-piece ceramic implants, most of all controlled long-term studies. A race can be expected between the ever-more expensive studies and the fast development of the dental industry in the future market, and experts see great growth potential here for two-piece ceramic implant systems.

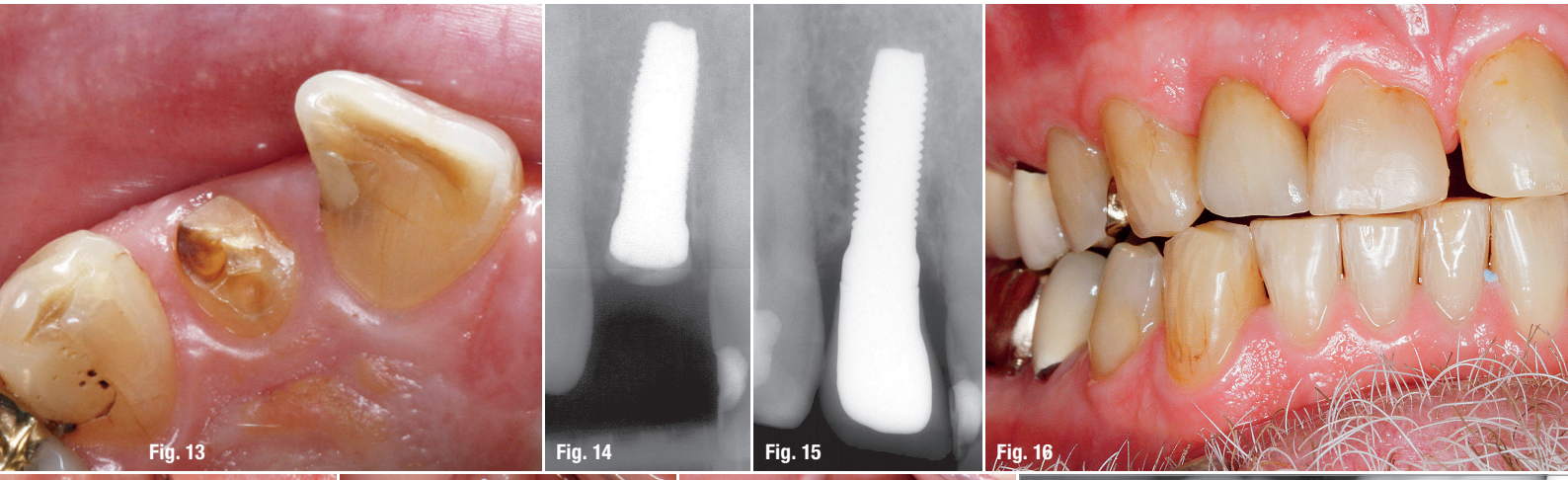
Will two-piece implants become established?

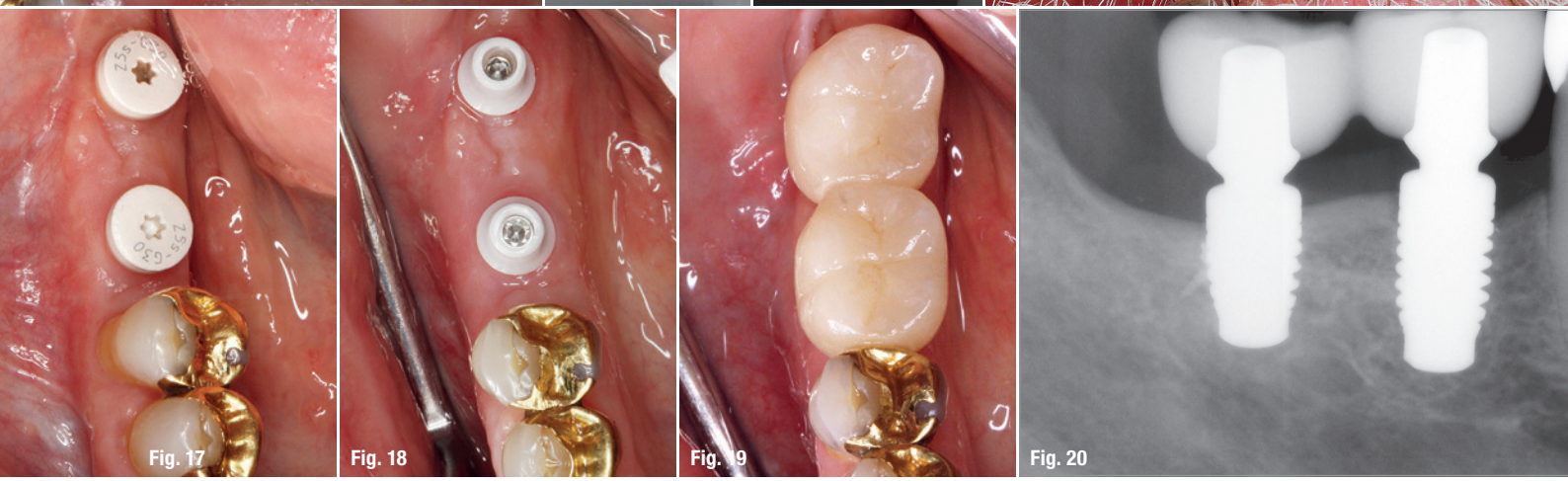
The similarity in placement procedure of the two-piece ceramic implant to that of the two-piece titanium implant is its main benefit. The risk of undesirable stresses in the healing phase do not arise. There are more possible variations in the positioning in the current operation area during surgical intervention. There is more flexibility in prosthetic treatment through the choice of abutments, with various angles and diameters available. It is thus to be expected that two-piece ceramic implants will be used more often.

Are two-piece implants safe?

There are currently no clear comparisons with a sound basis in studies between

1. one-piece and two-piece ceramic implants,
2. two-piece ceramic and titanium implants,
3. two-piece ceramic implants and two-piece implants consisting of a cemented titanium base with a zirconium dioxide superstructure.





Figs. 13–16: Case 4: A two-piece Z5c tissue level implant was inserted in region #12. **Figs. 17–20:** Case 5: Bone level indication extensions (Z5s implants in regions #46 and 47).

Such comparative studies will not be available in the near future, probably owing to the complexity in time involved in carrying them out, and a lack of a consistent study protocol reduces the possibility of easy comparability.

Summary

Implantologists can complement their implant practice today with ceramic implants and thereby gain the necessary experience in handling them. Many uncertainties can be assuaged with clinical use in practice and the literature that is already available. Ceramic implants represent a realistic alternative to titanium implants. A thorough consideration of a metal-free approach is recommended. The statements about ceramic implants and their use that have been broadly propagated in the media have led to an increased demand for advice, and this must be properly addressed. There is greater clinical experience with single-piece implants, and the risks in the healing phase are fundamentally greater owing to undesired loading. The reverse is true for two-piece implants.

In private practice, dentists can be vulnerable and must carefully observe their duty to inform patients. Critical consideration of the subject and one's own responsibility of action thus remain of great importance to implantologists.

Ceramic implants as a vision? Everyday? In our practice, patients can choose between ceramic and titanium systems.

Literature

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How to successfully place ceramic implants

Dr Dominik Nischwitz, Germany

At present, ceramic implants (Fig. 1) are routinely used by only a few dentists: This is also evident in the small number of scientific studies compared to titanium implants. Therefore, the empirical facts resulting from the practical use of ceramic implants are particularly more important at this stage. The benefits of ceramic implants with regard to its biocompatibility, soft tissue reaction and the aesthetic result are now undisputed.

Ceramic implants react differently to conventional titanium implants. This poses the requirement to learn to "think in ceramic". In this context, both the nature and biology of the body as well as the basic principles of immunology and biochemistry as well as bone and tissue regeneration are very important. Unlike titanium implants, ceramic implants only heal in absolutely healthy bone. The body recognises them as neutral and osseointegrates them during the bone regeneration phase. By comparison, titanium implants heal by means of inflammatory activation. Local inflammatory mediators remain constantly active depending on how prone the patient is to inflammation (high/low responder). To successfully insert ceramic implants, there are important basic rules to follow.

Systemic preparation for the operation (obligatory)

The Bone Healing Protocol (BHP® according to Dr Dominik Nischwitz) has proven effective for the perioperative support of bone regeneration and is used ahead of all surgical procedures to support the body's own regeneration. At least 14 days prior the planned operation, it is crucial that the nutrients are consumed precisely according to this protocol. Poor nutrition with too much sugar, wheat and cow's milk products as well as a lack of sunlight depletes the body of important vitamins and minerals: mainly vitamin D3 (lack of sun), zinc, magnesium and omega-3 fatty acids. This deficiency frequently causes the body to become overwhelmed with healing processes—it is almost in a state of "hibernation" and is not able to build new tissue as the nutrients to do so are simply not there.

Therefore, the patient's diet, at least at this stage, should be as hypoallergenic and nutritious as possible. Common nutritional allergies and all compromising food additives are to be strictly avoided so that the immune system can concentrate on its most important task of constructing bone- and soft-tissue. A gluten and cow's milk-free diet is recommended. Alcohol, tobacco and caffeine should be kept to a minimum and sugar, sweeteners, flavor enhancers, trans fats and other compromising food ingredients and additives should be completely avoided. Proteins, healthy fats and vegetables should be consumed. It is also important for the patient to drink plenty of fluids (daily consumption of 2 to 3 litres of still water).

Bone quality

According to university doctrine, there are four bone density categories that classify the ratio of mineralised bone substance to bone volume. As our experience has


Fig. 1

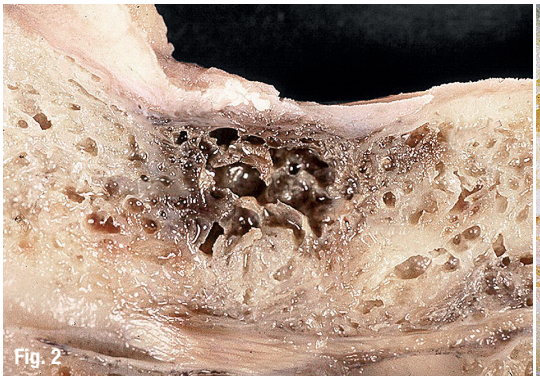
Fig. 2


Fig. 3

Fig. 1: Ceramic implants. **Fig. 2:** Diseased bone. **Fig. 3:** Healthy bone.

shown, bones classified as category 3 and especially 4 are defective or even diseased (Fig. 2).

Every implantologist knows the phenomenon of "falling" into cavities while drilling. Chronic inflammations in the jaw bone frequently occur as result of wounds caused by tooth extractions in the past, which have not healed properly, tooth development or foreign particles. These inflammations are often not visible on conventional X-ray images. Similar to root-treated teeth, inflammatory mediators (TNF-α, IL-1, RANTES) can also cause symptoms in other parts of the body. Neurological (NICO) or joint problems frequently occur. NICO stands for "neuralgia-inducing cavitational osteonecrosis", which refers to chronically inflamed areas in the jaw bone. This osteolysis is also referred to as ischemic necrosis, a typical interference field in the jaw, which is also included in the category of neuromodulative triggers. Ceramic implants do not heal in bones of category 3 or 4. For this reason, osteolysis needs to be treated before implantation can occur. The bone must be absolutely healthy to ensure a successful implant healing (Fig. 3). The development of osteolysis is caused by a lack of nutrients as stated above.

Disinfection and plasma membrane

These osteolytic areas of bone contain fat cysts, degenerated trabeculae and allow chronic infections, particularly anaerobes, to feel at home in this area, triggered by the ischemic change in the bone. According to studies conducted by Lechner, increased heavy metals and other environmental toxins become deposited here. This bone area must therefore be cleaned and disinfected during implantation with the utmost precision.

Conditions for ideal bone healing:

- The bone must be hard. There must be no "yellow bone". The blood must be clear (no drops of grease or "foamy" blood).
- In addition to implant drilling, piezosurgery has proven to be successful in order to remove diseased bone. Osteolysis frequently affects the N. alveolaris inferior or the upper jaw up to the sinuses—the piezoelectric technique allows the dentist to carry out procedures even in critical areas, since due to the use of rotating instruments soft tissue injuries are unlikely to occur.
- For disinfection we recommend ozone (Fig. 4). Ozone is a proven bactericide, virucide and fungicide. It therefore kills all microorganisms present. This facilitates healing as the immune system does not need to deal with additional infections. The use of ozone is indicated particularly after root-treated teeth have been extracted and ceramic implants have been immediately inserted (SCC® Short Cut Concept according to Dr Karl Ulrich Volz). In addition to the ozone production, the voltage formed in the glass vial (OzoneDTA; Fig. 5) stimulates bleeding.
- Plasma (A-PRF™, PRGF®, etc.): In the author's practice, inserting a plasma membrane (PRGF® or Choukroun A-PRF™; Fig. 6) gained from the patient's own blood has proven to be effective. The blood is freshly extracted from the patient's vein, centrifuged for around eight minutes and then activated (PRGF®). After 15 to 30 minutes, the membrane is ready for insertion. The plasma membrane technology is 100 per cent autologous and therefore completely biocompatible.

Combined with ozone therapy, plasma membrane insertion is a key part of all surgical procedures in our practice and is used after tooth extraction, in implants, for bone formation and as an insert following NICO removal. When using endogenic membranes, the regeneration of bone- and soft-tissue is phenomenal.

The whole protocol should be followed before and after every tooth extraction and must be followed for every surgical procedure on the bone. Thanks to this procedure, dry alveoli belong to the past.

Neural therapy and infusions

To further support the body's own regeneration, the alveolus is rinsed with procaine after disinfection and then infiltrated with Traumeel in the vestibulum. Procaine is an anti-inflammatory local anaesthetic that stimulates blood circulation at the site. This ensures clean bleeding following the vasoconstringent of the anaesthetic. Fur-

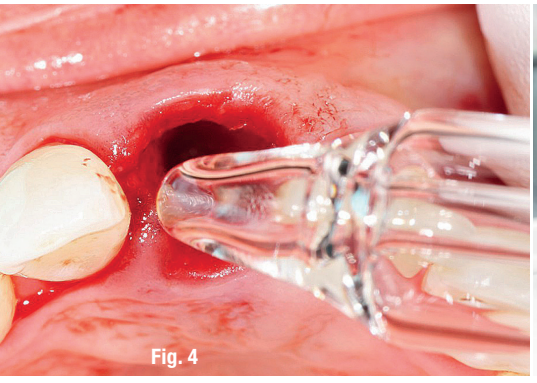
Fig. 4


Fig. 5


Fig. 6

Fig. 4: Ozone application. **Fig. 5:** Ozone generator OzoneDTA. **Fig. 6:** A-PRF™ plasma membrane.

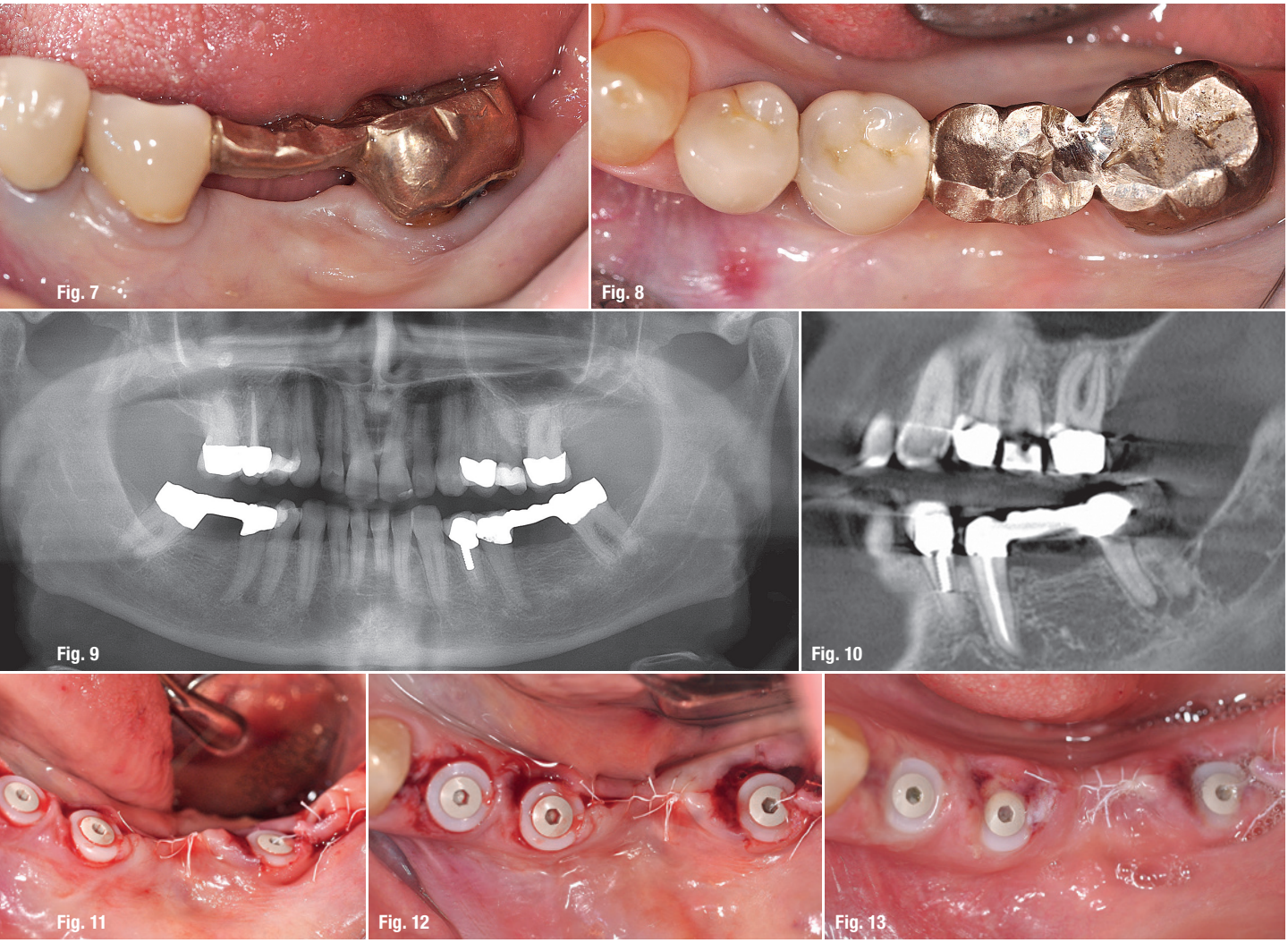

Fig. 7: Lateral situs, pre-operatively. **Fig. 8:** Occlusal situs, pre-operatively. **Fig. 9:** OPG before surgery. **Fig. 10:** Radicular cysts 35 and 37. **Fig. 11:** Lateral situs, postoperatively. **Fig. 12:** Occlusal situs, postoperatively. **Fig. 13:** One day after surgery.

thermore, additional medication can be used: Notakehl (homeopathic antibiotic), Selenium (orthomolecular antibiotic) and Arthrokehlan "A" ("antitoxin").During larger operations, such as a sinus lift, infusions are used on a routine basis: The combination of "single shot" antibiotics and cortisone (dexamethasone) has proven effective even at the operation day. The positive properties of antibiotics are used—which are basically prevention of infection—without the side effects caused by the oral intake (e.g. increased stress on liver and intestine).

Furthermore, the immune system is supported by a high dose of vitamin infusions administered intravenously as part of the surgical and ozone treatments.

Properties of ceramic implants

In addition to the numerous benefits of ceramic implants compared to titanium implants, there are also certain special features and even disadvantages. For example, ceramic implants do not dissipate heat. During the operation, it is thus extremely important for the surgeon to use the bone properties at the site for orientation. Unlike titanium implants, ceramic implants should be inserted with regard to the bone categories. Ceramic implant surgery therefore requires good intuitions. While category 1 bone (extremly hard with little blood circulation) must be prepared oversized in order to create cavities for subsequent callus formation, soft bone can be prepared undersized. Once ceramic implants are osseointegrated, the rules for the prosthetic build-up are more sensitive than those for titanium implants. Due to material properties, titan implants show a lower ductility and can therefore better compensate occlusion and articulation particularly in case of slight deflections. In contrast, ceramic implants are securely fixed in the bone and cannot be moved. Solitary ceramic implants should therefore be milled in minimal infraocclusion and without any articulatory contacts.However, this lack of mobility is also a major advantage of ceramic implants. Against university

doctrine, one millimeter bone around the implant is no longer necessary for ceramic implants. As long as the ceramic implant is primarily stable, it will heal. This poses the requirement to learn to "think in ceramic": This simply means that those areas of the implant that are completely surrounded by bone form the actual implant and those areas where periosteum or gingiva is fixed around the implant form the abutment. Since the periosteum and gingiva creepingly attach to the ceramic, completely new methods of ceramic implantology are possible. There is no attached gingiva to titanium or other metal abutments. Therefore, a ceramic abutment is the absolute standard even in usual, titanium-based implantology.

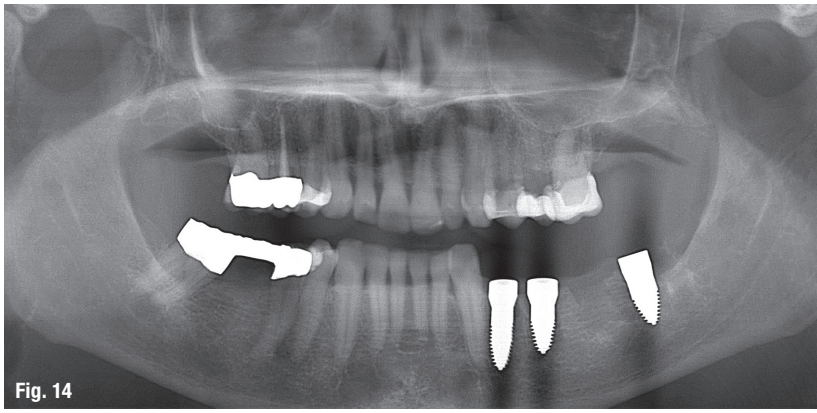

Fig. 14: OPG after surgery.

Patient case

In early October 2016, a patient presented with prosthetically and conservatively insufficiently restored adult dentures. A bridge region 34 to 37 (Figs. 7–9) was in especially high need of renewal and the devitalised tooth 37 exhibited apical alterations in the form of radicular cysts (Fig. 10). These teeth were not viable for another prosthetic restoration due to their deficiencies. The apical findings in region 35 and 37 were confirmed by the CBCT, verifying the clinically noticeable pressure pain in region 35 and occlusal pain in region 37. Patient and dentist agreed on immediate implantation with two-piece ceramic implants as an ideal form of socket preservation. Immediate implantation can thus be achieved in spite of chronically apical inflammation.

In cases such as this, the perioperative preparation of the patient is decisive. Two weeks ahead of implantation, the patient's physiological constitution and metabolism are primed for bone- and soft-tissue regeneration by a selection of nutrients (BHP® according to Dr Nischwitz). The patient's immune system is optimally prepared. During surgery, the alveolus must be thoroughly cleaned and disinfected, as ceramic implants only become incorporated in healthy bone. For disinfection, ozone is used. Periodontal fibres and any granulation or cystic tissues must be removed completely. The implant can be viewed as the "bonus on top", supporting the whole alveolus when inserted primarily stable. In this case, the author opted for two-piece ceramic implants in order to prevent any tongue pressure and to allow for absolute rest during healing. This surgical procedure can be standardised, has a high success rate and is both painless and minimally invasive—the results speak for themselves (Figs. 11–14).

Conclusion

Ceramic implants, particularly immediately inserted ones (SCC®—Short Cut Concept according to Dr Karl Ulrich Volz), offer huge advantages over titanium implants. While immediate titanium implants, particularly in the posterior region, are only possible in a few cases, immediate implantation with ceramic implants is possible in almost all cases of tooth extraction. Therefore, immediate implantation with ceramic implants is the gold standard, provided a strictly followed protocol. If both the systemic support of the bone and tissue regeneration are well-functioning, the dentist is working carefully and the alveolus is disinfected properly and precisely examined for isolated osteolysis, ceramic implants are ideal for socket preservation. It then works almost like a plug. Since the alveolus is smaller than the implant, the wounded area, which has to heal, is also smaller. At this stage, endogenic regenerations processes in bone and tissue are working at full power. Particularly with regard to aesthetics, immediately inserting ceramic implants is the ideal time to operate according to the author. With a success rate of over 90 per cent, complicated immediate implants can also be carried out as routine in the posterior region in most cases.

Following this procedure means that the patient does not require an additional implantation appointment, the bone- and soft-tissue are immediately supported and—in addition to the significantly more efficient process for patient and dentist—the immediate implantation is generally completely painless.

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Implant insertion through the DWOS Synergy™ workflow

Dr Richard Zimmermann & Dr Stefanie Seitz, USA

Initial situation

A 30-year-old female with non-contributory medical history presented to the clinic for evaluation of a maxillary edentulous site. Review of her dental history revealed that tooth 12 (ADA) was lost due to failed endodontic therapy approximately a year ago during her pregnancy and she was now ready to have it replaced. She presented with a high smile line, medium-scalloped gingiva with medium thickness and a desire not to have any metal in her oral cavity. When discussing the various options regarding implant therapy, the patient was very interested in being evaluated for an all ceramic implant. On January 11, the FDA cleared the Straumann® PURE Ceramic Implant for use within the US. Though new to the US, European case documentation has shown excellent osseointegration and soft tissue response. The Straumann® PURE Ceramic Implant is a monotype style implant, meaning the abutment and implant body are one-piece.

Treatment planning

The patient was sent to get a computerised cone beam tomography (J. Morita, USA) of the area and digital diagnostic impressions were taken using an intraoral scanner (TRIOS 3, 3Shape). Once obtained, the DICOMs were imported into the implant planning software (coDiagnostiX™) while the scan files were imported into the laboratory software (Straumann® CARES® Visual; Figs. 1 & 2). Since the Straumann® PURE Ceramic Implant are monobody in design and it is not recommended to modify the abutment, the DWOS Synergy™ workflow was utilised to virtually plan this case. DWOS Synergy™ provides real-time communication between the implant planning software (coDiagnostiX™) and the lab software (Straumann® CARES® Visual). This feature improves implant planning by allowing the visualisation of the relationship between the proposed implant position and the proposed restoration.

Modifications made to the implant position or restoration design are immediately transferred to the other software, providing instantaneous feedback on how the modification of one affects the other. Of special interest in regard to the Straumann® PURE Ceramic Implant is that one can design the restoration and ensure that the planned position will not require modification for restorative materials. Once the planning was complete, both the surgical guide and the provisional designs were sent off for fabrication. The guide was sent to a lab to be printed by an Objet30 OrthoDesk (Stratasys) while the provisional file was sent to Straumann Milling Center in Arlington to be fabricated out of polycon ae (PMMA; Figs. 3 & 4). During the surgical planning utilising the DWOS Synergy™ workflow, a Straumann® PURE Ceramic Implant (Ø 4.1 x 12 mm) was selected with an abutment height of 5.5 mm.

Surgical procedure

The Straumann® PURE Ceramic Implant design is a combination of the tissue level and bone level implant—the neck of the implant mirrors the Straumann® Tissue Level implant while the implant body mimics the Straumann® Bone Level design (Fig. 5). As such, the surgical protocol for preparing the osteotomy for the PURE is the same as the corresponding Bone Level implant. For this case a guide was used to prepare the osteotomy following the protocol set forth for Bone Level implants given by coDiagnostiX™. Though this case was performed with Straumann Guided Surgery (SGS), a small flap was made to ensure the desired position of the Straumann® PURE Ceramic Implant shoulder. SGS utilises different combinations of sleeve positions, drill lengths and drill handles to prepare the osteotomy to the correct depth. Sleeves can be placed at three different heights from the implant level (2, 4 or 6 mm) based on the case and surgeon's preference. The combination of drill length (short, long or extra-long) and drill handle (1 or 3 mm) are determined by the implant planning software which provides the surgical protocol to use at time of surgery.

The Straumann® PURE Ceramic Implant system uses a series of "position indicators" that aid in ensuring the correct position of the implant during surgery. Both abutment diameters and heights have corresponding position indicators that are placed into the osteotomy for evaluation (Fig. 6). Once the osteotomy has been prepared, typically a surgeon will use a "guided implant",

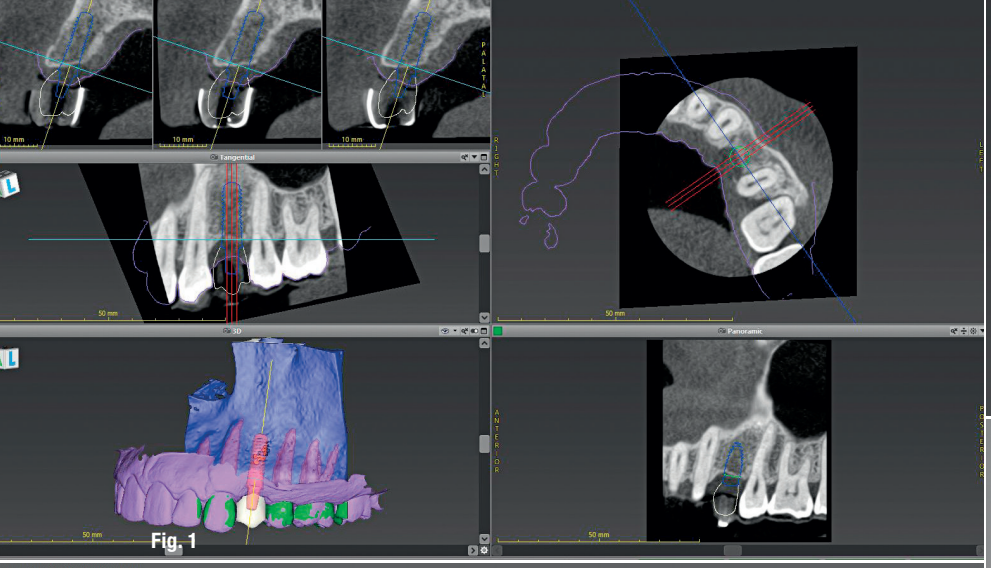
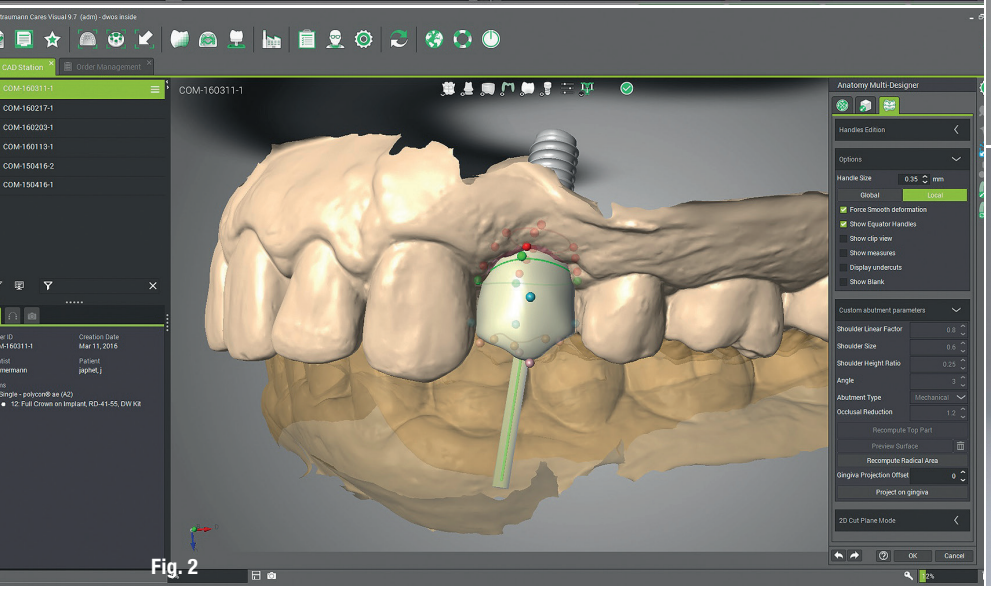


Fig. 1



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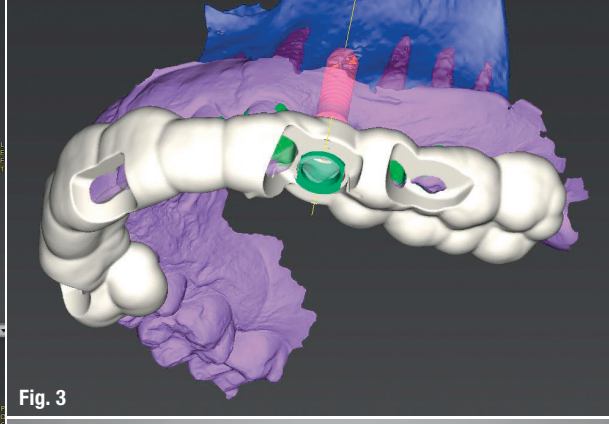


Fig. 3

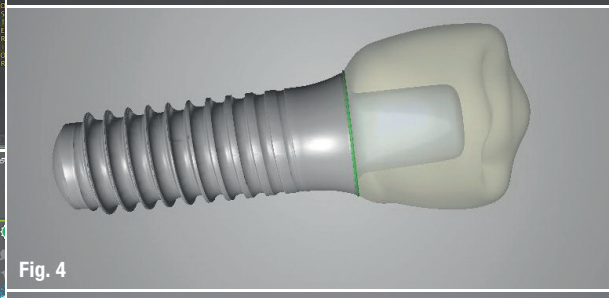


Fig. 4


Fig. 5

Fig. 1: DICOMs were imported into the implant planning software (coDiagnostiX™). **Fig. 2:** Scan files were imported into the laboratory software (Straumann® CARES® Visual). **Fig. 3:** The surgical guide was sent to a lab to be printed by an Objet30 OrthoDesk (Stratasys). **Fig. 4:** The provisional file was sent to Straumann Milling Center in Arlington to be fabricated out of polycon ae (PMMA). **Fig. 5:** Straumann® PURE Ceramic Implant design is a combination of the tissue level and bone level implant.

which has a unique driver, to ensure proper placement of the implant. However, the Straumann® PURE Ceramic Implant currently does not have such a driver, therefore, the surgical guide was only used to prepare the osteotomy while implant placement was performed freehand. Bone quality was determined to be Type II. The Straumann® PURE Ceramic Implant comes with a separate transfer piece for placement which snaps into place much like the Tissue Level impression cap. Three dots on the driver line up with a flat surface of the abutment portion of the implant and also indicate distance to the shoulder (1, 2 and 3 mm). The implant was placed without any incidence to the desired depth and position of the dots (Figs. 7–9).

During the healing phase, a protective cap is placed over the abutment to protect it. Since the patient was concerned with aesthetics and has a high smile line, it was decided to place a provisional to provide more aesthetic appearance. The recommendation by Straumann not to immediately load a PURE implant was taken into account during the DWOS Synergy™ design session by eliminating occlusal and lateral contacts. This provisional was then further modified at time of surgery by further reducing the anatomy and creating more of a custom healing abutment than immediate provisional. The provisional was cemented using temporary cement (TempBond, Kerr) and only two interrupted sutures were required to secure the flap. At the one-week follow up, the tissue was healing beautifully around the implant and the patient was scheduled for the final impression seven weeks out (Fig. 10).

Final result

The patient was in slight discomfort following the surgery, but stated that this surgery was less painful than the previous extraction. She was pleased to have the modified provisional versus a dark space in her smile.

Conclusion

Since the Straumann® PURE Ceramic Implant endosteal portion is based on the Straumann® Bone Level

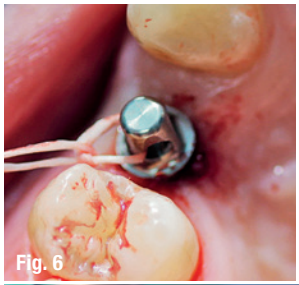


Fig. 6

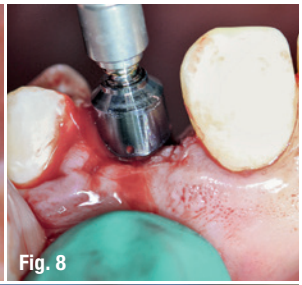


Fig. 8

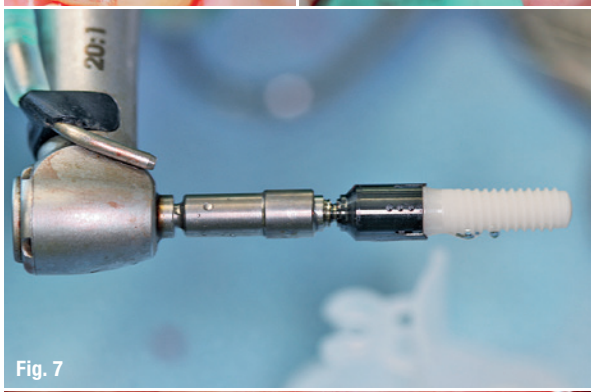
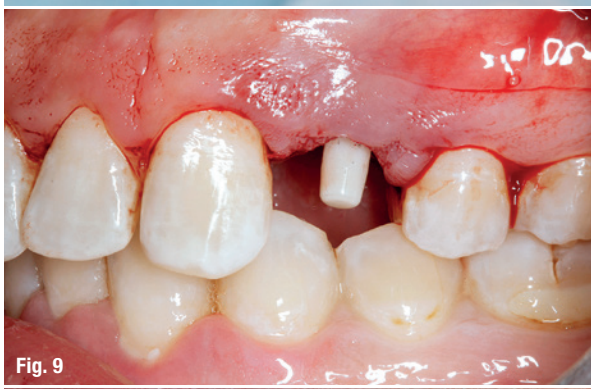


Fig. 7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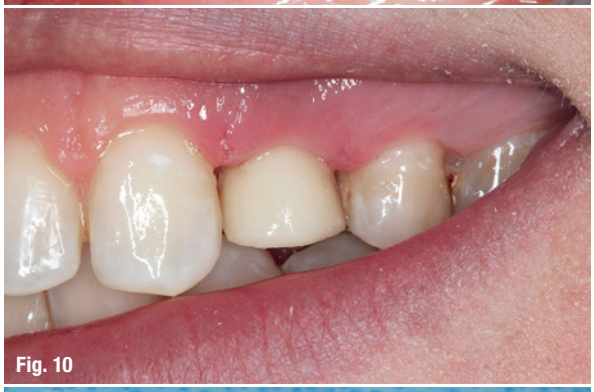
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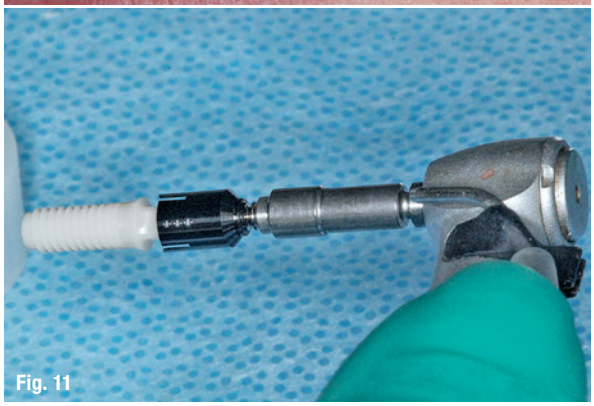
Fig. 11

Fig. 6: Abutment diameters and heights have position indicators that are placed into the osteotomy for evaluation. **Figs. 7–9:** The implant was placed without any incidence. **Fig. 10:** At the one-week follow up, the tissue was healing beautifully around the implant. **Fig. 11:** When placing the driver onto the Straumann® PURE Ceramic Implant abutment care must be taken to align the indicator dots up with the facets.

design, it does not require additional surgical instruments or drilling protocols for placement while the specialised transfer piece comes with the implant. When placing the driver onto the Straumann® PURE Ceramic Implant abutment care must be taken to align the indicator dots up with the facets, otherwise incomplete seating of the driver may occur (Fig. 11). As implant therapy has evolved, patient expectations have risen. The desire to have a natural looking, metal-free restoration is increasing as can be seen by the decrease of metal substructures for crowns and frameworks and the increase in ceramic restorations. While titanium can cause a greying of the tissues, the ivory colouring of the Straumann® PURE Ceramic Implant can provide a more aesthetic outcome. Another patient was ecstatic to have the option for a Straumann® PURE Ceramic Implant since her husband has a titanium implant in the anterior region and she can see the grey. All ceramic implants have the potential to provide greater aesthetic outcomes but do require more precise planning and placement. Initially, one might consider the Straumann® PURE Ceramic Implant to be limited by design, to a degree it is, however the DWOS Synergy™ workflow can help to reduce the challenge of placing a monotype implant.

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Ceramic implants—naturally beautiful and clinically proven

Dr Frederic Hermann, M.Sc., Switzerland

Patients are increasingly requesting ceramic implants. Reasons behind their decisions are often related to their emotions, as "white" implants mean smiles appear even more radiant and soft tissue looks even healthier. As such, this kind of implants contribute to a better quality of life and higher levels of self-confidence. However, there are also medical reasons for using metal-free implants, especially for sensitive patients. This specialist article will outline the rehabilitation of a premolar in the upper jaw area with a two-part zirconium dioxide implant produced in a ceramic injection moulding procedure with a rough dual surface texture.

Modern-day ceramic implants are made from yttrium-stabilised zirconium dioxide. Previous studies have produced predominantly positive results in terms of cell attachment, osseointegration and durability.[1–6] The development of ceramic implants that has taken place during recent years shows that they are increasingly becoming a part of the dental indication spectrum. However, two-part implants are still subject of controversial discussions. Can they really be used as an alternative to titanium implants?[7]

Patients feel that treatment has been successful if they are satisfied with their subsequent appearance, as well as with the care they received. Ivory-coloured, translucent ceramic implants have a clear advantage here, as they are the most similar to the natural tooth root.[8] Due to their colour and compatibility with soft tissue, these implants act as an aesthetic buffer, especially in clinically compromising situations, such as if patients have a thin gingiva biotype, or high smile line.

Zirconium dioxide implants osseointegrate like a titanium implant and encourage soft tissue to adapt well. This means that it is possible to achieve natural gingiva and dental aesthetics.[2,9–11] Product quality and safety is substantiated by the manufacturer's statement that each individual implant is subjected to extensive load tests and dimensional inspections before being packaged.

Medical history and planning

At the end of 2015, a 38-year-old patient was experiencing discomfort during biting and had recurrent fistulas in the left part of the upper jaw. She was a non-smoker with adequate oral hygiene and good compliance. An X-ray image evidenced that her teeth were in need of restoration and findings were endodontical and conservative.

She was diagnosed with apical periodontitis stemming from root-treated tooth 24, which also evidences a vertical fracture (Figs. 1 & 2). Due to the existing diagnosis, endodontic revision did not seem promising. There were not any particular findings from the functional check-up. According to the criteria specified in the SAC classifica-

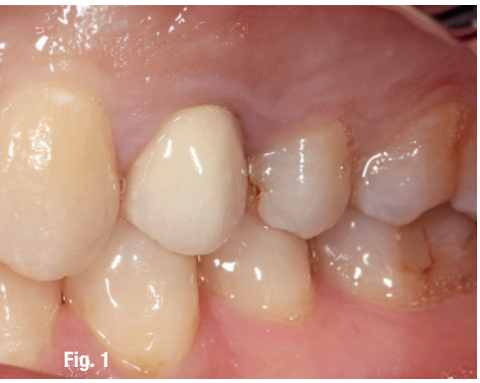
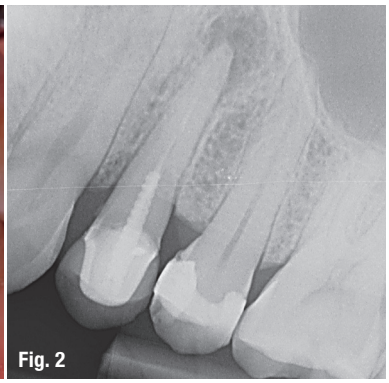


Fig. 1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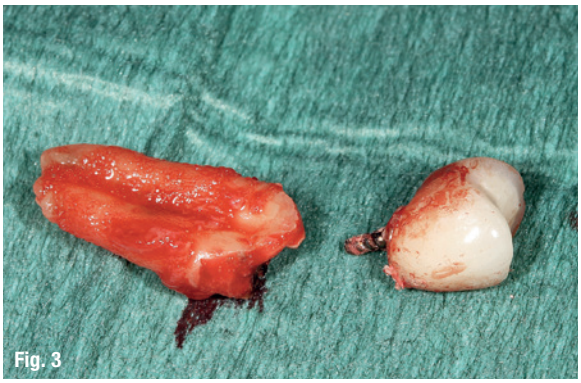
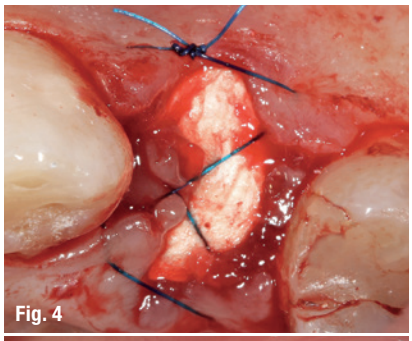


Fig. 3

Figs. 1 & 2: Apical periodontitis stemming from root-treated tooth 24, which also evidences a vertical fracture. **Fig. 3:** Minimally invasive procedure for removing tooth 24 whilst preserving buccal bone lamella.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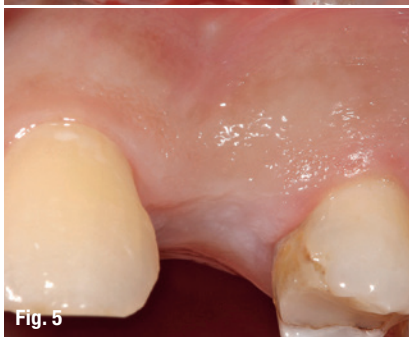
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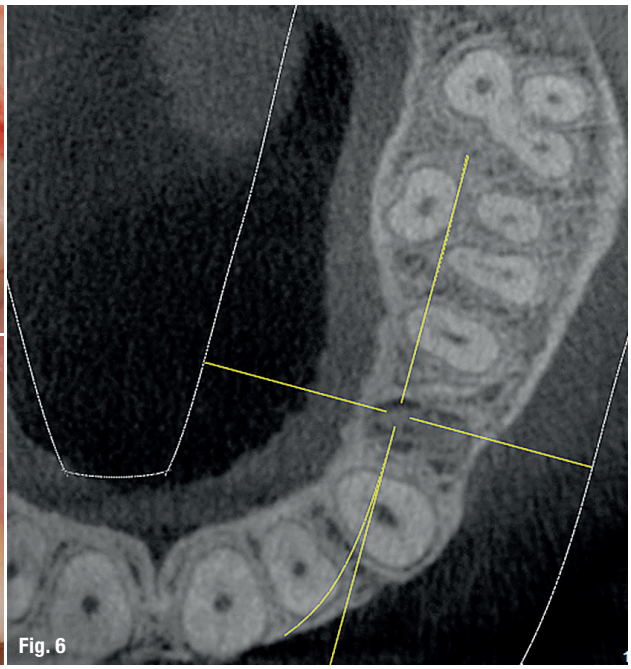
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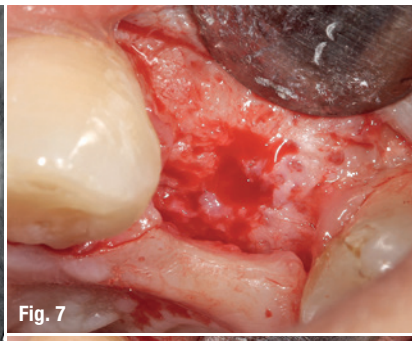
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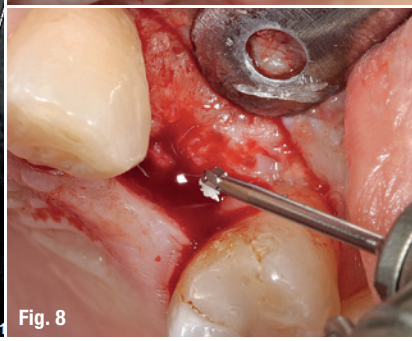


Fig. 8

Fig. 4: The alveolus was cleaned and filled in with an alveolar cone made from collagen. **Fig. 5:** After four months of integration. **Fig. 6:** DVT image for planning purposes. **Fig. 7:** Minimally invasive flap formation. **Fig. 8:** Marking the position of the implant.

tion, a method which was first outlined by Sailer and Pajarola in 1996 as a means to categorise the complexity involved in implant surgery, the risk profile was low in terms of surgical, aesthetic and restorative evaluations.[11]

The patient was made aware of a gentle tooth extraction procedure. She was extremely opposed to having a conventional bridge restoration and expressed that she would like a metal-free, fixed implant. She was made aware of the small amount of evidence-based documentation concerning ceramic implants, in comparison to the documentation available concerning titanium implants, and she was also informed about the advantages and disadvantages of two-part ceramic implants. The patient opted for the two-part implant as she did not want to wear the protective shield necessary to ensure that a one-part ceramic implant becomes integrated due to aesthetic reasons.

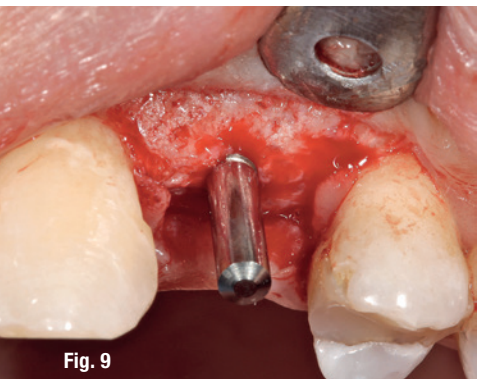
Pre-implant procedures

The first step was to extract tooth 24 with a minimally invasive and particularly gentle procedure (Fig. 3). It is imperative that the alveolar bone structure is preserved so that there is minimal resorption of hard- and soft-tissue postsurgery. By using periotomes, it means that desmodontal fibres rupture during this method of extraction and teeth, or more specifically the remains of the root, can be carefully removed whilst keeping the expansion of the alveolar bone to a minimum. Due to apical inflammation, and from an economical perspective, in order to save costs, the aim was to let the patient heal autologously, without any bone replacement material. The alveolus was cleaned and filled in with an alveolar cone made from collagen (PARASORB HD Cone, RESORBA Medical; Fig. 4). After approximately two weeks had passed, the extraction alveolus was closed with provisional connective tissue and the primary cancellous bone started to develop.

Inserting the implant

During the four-month recovery phase, the filling in tooth 25 was renewed, parodontal pretreatment was completed and the patient was taught about oral hygiene procedures. Before the implant was inserted, a DVT was produced in order to depict the anatomic structure of the surrounding area and to determine the exact position for the implant (Figs. 5 & 6). The bone bed is prepared for the implant (CERALOG Hexalobe, CAMLOG) to be inserted as per the surgical protocol specified.

After a minimally invasive flap formation procedure, the alveolar ridge was prepared (Fig. 7). In order to achieve a functional and aesthetic end result, the three-dimensional placement of the implant is of high importance. The implant shoulder should be two to three millimetres below the cementum-enamel junction of an adjacent tooth and displaced palatinal to a slight extent. In this way, the coronal emergence profile can be shaped in the best way to meet aesthetic criteria. According to these guidelines, the position of the implant was marked on the jawbone with a round bur (Fig. 8). The pilot hole was then drilled and the new three-dimensional position checked with paralleling pins.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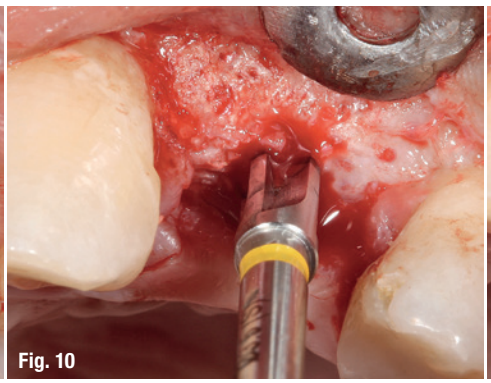


Fig. 10

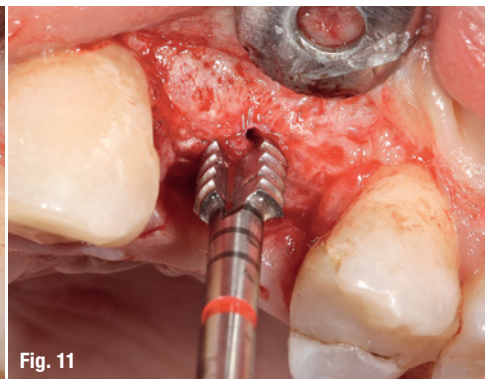


Fig. 11

Figs. 9–11: Pilot drill, paralleling pins, enlargement drilling and threading.

The pilot hole was drilled subsequent to the implant site being enlarged with a form drill (S 2.9 mm, M 3.4 mm). In order to avoid the potential increase in pressure that may arise when the implant is being inserted into the bone, we also used a thread cutter (Figs. 9–11). In order to avoid necrosis, the implant has to be inserted into the hole at a slower pace than a titanium implant, as zirconium dioxide is a poor conductor of heat. The implant used here was fixed in place in the implant site by hand, by making a few turns using an insertion device that had been taken out of sterile packaging and connected to a rachet adapter.

Subsequently, it was manually inserted deep into the hole (Figs. 12–15). By using the hexalobe joint modified specially for use with the ceramic implant, the insertion tool was guided into the implant in an optimal fashion. The protocol specified a maximum of 15 revolutions per second and a torque of 35 Ncm. The shoulder was placed at 1.5 mm in a supracrestal position so that the prosthetic platform would be located around 0.5 mm under the soft tissue. This position corresponds to where the smooth ZrO_2 surface changes to have a coarse texture at the level of the bone. To enable open integration, the implant is sealed used a healing cap and the soft tissue is adaptively sewn using a 6-0 suture (Figs. 16–18).

Prosthetic restoration

Prosthetic restoration takes place after the four-month integration phase. The healing cap is removed with a screw driver and an impression is made with the pins for the open tray technique (Figs. 19–21). Dental technicians created a master model in a laboratory. The lab analogue (PEEK) was attached to the impression post using a screw, then the model was emptied and mounted on the articulator. The technician marked the anatomical coronal emergence profile on the plaster model and, using a bur, milled the profile up to the lab analogue (Fig. 22). Subsequently, the PEKK abutment was scanned and an occlusal screw-retained hybrid crown was designed from zirconium dioxide, which was then veneered buccally. After checking the aesthetics, the crown was cemented to the PEKK abutment with a Multilink Hybrid Abutment (Ivoclar Vivadent; Figs. 23 & 24).

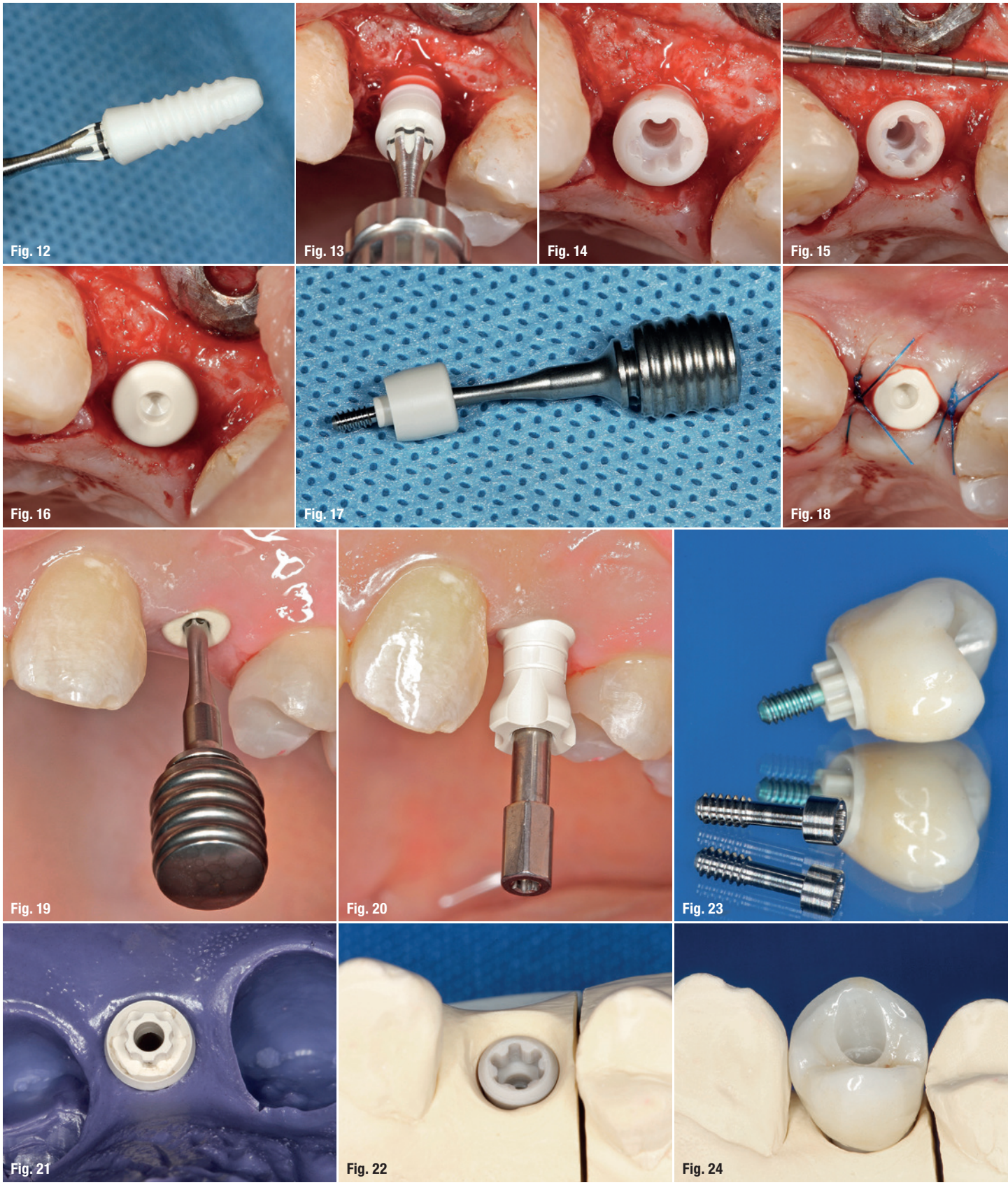
Before the crown was integrated into the mouth, implant stability was checked using Osstell ISQ and an X-ray image was produced.[10, 12, 13] When the PEEK gingiva former was removed, a peri-implant gingiva free from irritation could be seen (Figs. 25–27). The hybrid abutment crown was inserted and screwed in place using a titanium screw with 25 Ncm (Figs. 28–30). As the high-performance polymer is not X-ray opaque, an uninterrupted gap of around 1 mm can be seen at the point of the implant-abutment crossover in the X-ray image (Fig. 31).

The channel where the screw entered was sealed with Teflon tape and a light-curing composite after the functional check-up. Figure 32 shows the clinical situation one year after the prosthetic restoration took place. The crown blends in with the row of teeth perfectly. The papillae are solid and pointed, closing the interdental spaces. The patient was happy about the successful and “invisible” treatment she received with implant prosthetics.

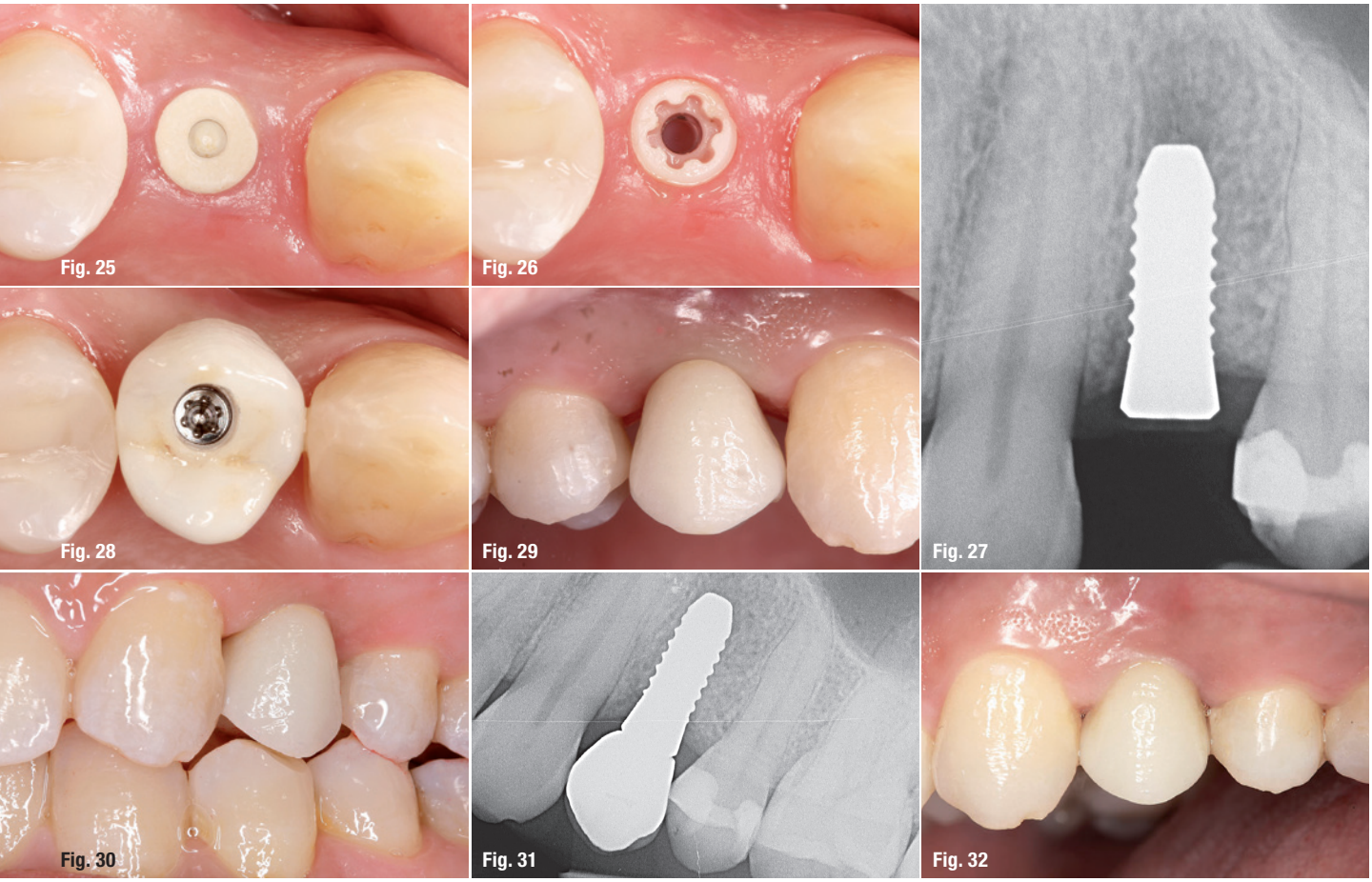
Discussion

The two-part ceramic implant used in the case outlined above (CERALOG Hexalobe, CAMLOG) is an alternative to a titanium implant. It osseointegrates and is used for patients who want a metal-free, aesthetic solution. The implant can be used both supracrestally and epicrestally. In general, the primary indications for CERALOG implants are fixed single tooth crowns and three-part bridge restorations without extensions. In terms of the latest developments, there are limitations in the domain of removable treatment concepts.

CERALOG implants are produced in a ceramic injection moulding process, whereby after having been injection moulded, the implants are then subjected to a sintering



Figs. 12–15: Manual implant insertion with torque regulation. **Figs. 16–18:** For an open healing process, the implant was closed with a healing cap and the soft tissue adaptively sewn with monofilament 6-0 suture. **Figs. 19–21:** The healing cap is removed with a screw driver and an impression is made with a transfer post for the open tray technique. **Fig. 22:** Dental technicians created a master model in a laboratory. The lab analogue was attached to the impression post using a screw. **Figs. 23 & 24:** The crown was cemented to the PEKK abutment with a Multilink Hybrid Abutment.



Figs. 25–27: When the PEEK gingiva former was removed, a peri-implant gingiva free from irritation could be seen. **Figs. 28–30:** The hybrid abutment crown was inserted and screwed in place using a titanium screw with 25 Ncm. **Fig. 31:** As the high-performance polymer is not X-ray opaque, an uninterrupted gap of around 1 mm can be seen at the point of the implant-abutment crossover in the X-ray image. **Fig. 32:** The clinical situation one year after the prosthetic restoration took place.

process in a mould. This high-tech manufacturing process makes a dual surface texture possible without the surface requiring any subsequent processing. In the enossal region, it is just as coarse (1.6 µm) as the approved surface (Promote, CAMLOG). In the neck region, the coarseness has a value of 0.5 µm, optimal for soft tissue adaptation.

The implant system is easy to use as the abutment can be fixed with screws and the surgical procedure is easy to follow, among other aspects. The current version of the implant has been used in clinical practice with a PEKK abutment since 2013. PEKK is a high-performance polymer from the polyaryletherketone (PAEK) group. PEKK combines excellent mechanical strength with first-rate thermal properties and chemical stability.[14]

PEKK is mainly used as an implant material in CMF applications, such as reconstructive cranial surgery, and in the spine, such as for spinal fusion and rods for posterior lumbar interbody fusion. The ductility of the material used for the abutment simulates dental properties, as well as having excellent sealing properties. Since the early summer, individually manufactured CAD/CAM abutments made from zirconium dioxide have been on offer for this implant system via a manufacturing service (DEDICAM). The translucent ivory-coloured zirconium dioxide implants are a similar colour to the tooth roots and as such, provide an aesthetically pleasing solution.

Literature

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Metal-free restauration from A to Z

Dr Michael Leistner, Germany

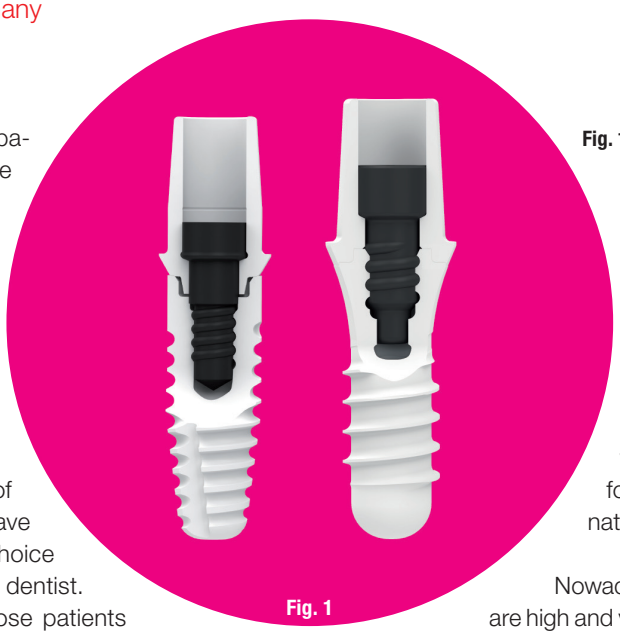


Fig. 1: The XT and P6 implant system.

Today, more and more patients both desire and require metal-free dental provisions. Experts are therefore talking of a major, if not mega trend comparable to the organic food sector and the constantly growing range of organic products. According to a survey conducted by Straumann, 53 per cent of the respondents would leave —quite rightly so—the choice of implant material to their dentist. However, 35 per cent of those patients surveyed would choose ceramic implants and only 10 per cent would settle for titanium implants as a substitute for their natural teeth (N.N. 2 per cent).[1]

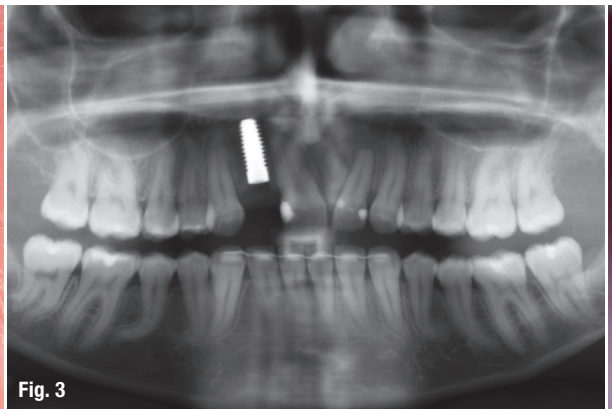
After ten years of development and experience gained from more than 30,000 placed implants, ZERAMEX® offers an alternative to titanium implants which is 100 per cent metal-free. This alternative could help to reduce local and systemic inflammations in patients suffering from titanium intolerance, which is caused by the interference of titanium dioxide particles with the human body. Those particles result from corrosion and abrasion processes and are phagocytised by tissue macrophages. Subsequently, this may lead to chronic and unspecific inflammatory reactions, and, ultimately, to a lack of bone integration and other health problems.[2–6]

Meeting the patients' needs

The informed patient is subject to the consistency of his needs. He meets his dentist at eye level and wants to be objectively informed and advised on alternative treatment possibilities.

Nowadays, patients' expectations are high and varied: they want a safe treatment, normally concerning a missing tooth. They want a treatment that is free from health side effects offering them a natural dentition without any unwanted interactions with the human body or other dental materials. And, above all, patients request a natural aesthetic. However, the main argument for using ceramic implants is the material's positive impact on peri-implant soft tissue.[7] Blood circulation at ceramics corresponds to the natural tooth, whereas, in titanium, it is significantly reduced.[8] Furthermore, ceramic material has shown a lower deposition of plaque and a lower bacteria adhesion.[9, 10]

Modern patients consider their teeth as part of their whole body system, and not just as tools for the comminution of food. Patients know about the impact of ill teeth on the surrounding tissue, and the possible effects on or-



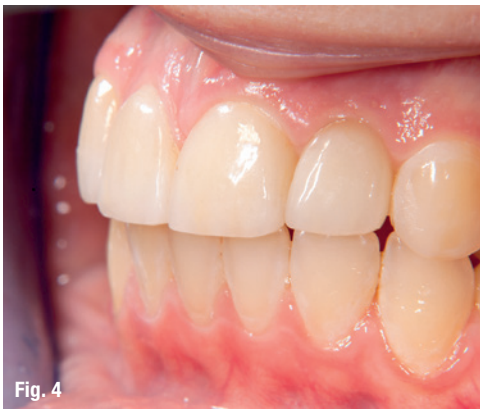


Fig. 2: The implant body is inserted by hand. – **Fig. 3:** Postoperative X-ray, placed implant. – **Fig. 4:** Final situation after prosthetic loading.

gan and body functions. Furthermore, they are well aware of the treatment efforts with regards to psychological and physical exposures, and the time spent. With the ZERAMEX® P6 and ZERAMEX® XT implants, dentists meet the needs of their modern and informed patients. Although, ZERAMEX® implants have unique characteristics, they rank among the same price category as premium dental implants.

Increasing interest among dentists

Ceramic implants have also gained a growing interest among dentists who wish to complement and widen their treatment spectrum. Further developments concerning material properties and implant surface have become increasingly faster.[11–13] With regard to osseointegration, ZERAMEX® implants are no longer inferior to titanium dental implants.[14–16] The clinical handling is comparable

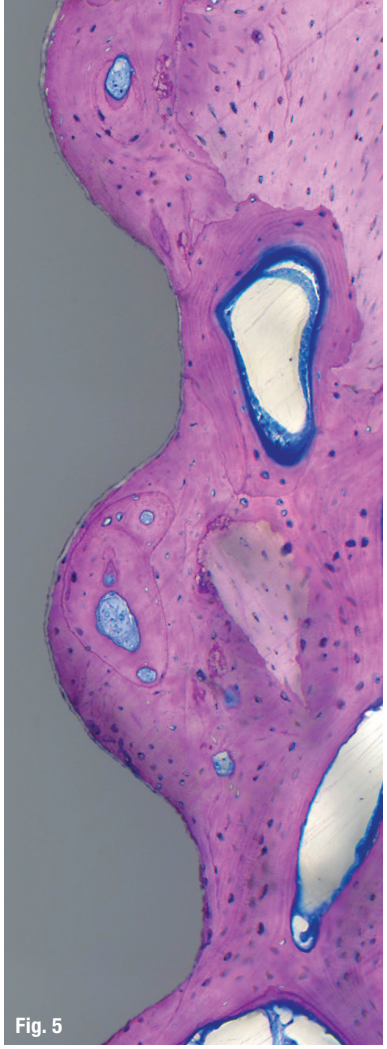


Fig. 5

Fig. 5: Osseointegrated ZERAMEX® T.

with those of modern implant systems and the safety of the treatment is proven in practice and science.

Today, medical dental services encounter tough competition. Thus, the modern practitioner must meet the need for metal-free provision by conviction. Furthermore, he advices his patients thoroughly, and positions himself at the market with services that will quickly become known, hence, strengthening his economic situation.

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Shifting of dental implants through ISO standards

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The introduction of cylindrical endosseous implants to dentistry have had a significant effect on restorative treatment planning.[1] These advances can also affect treatment planning for teeth requiring endodontic treatment.[2] The long-term success of titanium osseointegrated implants in periodontally healthy patients has been documented in various studies.[3] However, additional data are still needed to confirm the long-term predictability of dental implants in general.

Titanium as dental implant material

Titanium and titanium alloys are commonly used as dental implant materials. The process of integration of titanium with bone has been firstly termed by Brånemark[4] as "osseointegration". Currently, most of the commercially available implant systems are made of pure titanium or titanium alloy. Titanium and its alloys provide strength, rigidity, and ductility similar to those of other dental alloys. Whereas, pure titanium castings have mechanical properties similar to type III and type IV gold alloys. Titanium and its alloys give greater resistance to corrosion in saline and acidic environments. However, even though titanium alloys were exceptionally corrosion-resistant because of the stability of the TiO_2 oxide layer, they are not passive to corrosive attack.[5] Moreover, one of the most renowned problems regarding titanium is hypersensitivity.[6,7]

Some reports have considered titanium hypersensitivity as a risk factor in dental implant failure.[8,9] Even though titanium has been used as a biomaterial for more than 50 years, several reports have identified its potential toxicity. Sakellariou and colleagues reported postoperative spinal infection due to titanium spinal implants.[10] Similarly, Hettige and Norris documented a case of mortality after a suspected fatal local allergic response of the brain to a titanium cranioplasty.[11] Patients sensitive to metals such as nickel, aluminium, or cobalt appear to be more susceptible to titanium-hypersensitivity reactions, and special care should be taken in the selection of implant biomaterial for such patients.[12]

Another relevant problem related to titanium dental implants is the potential fracture. Although fracture of dental implants is not a frequent phenomenon, it can cause unfavourable clinical results. Green et al. reported a fracture of a dental implant four years after loading.[13] The failure analysis of this implant revealed that the fracture was caused by metal fatigue and that the crown-metal, a NiCrMo alloy, exhibited corrosion. In another study, Yokoyama et al. concluded that titanium in a biological environment absorbs hydrogen and this may be the reason for delayed fracture of a titanium implant.[14]

Dental ceramics

Porcelain has been used in dentistry for 100 years. Aesthetics is the major advantage of porcelain, and brittleness is its weakest point for load-bearing restorations. Therefore, porcelain-fused-to-metal restorations to make "metal-ceramic restorations" have been the first choice of prostheses to satisfy requirements for aesthetics, durability, and fit to the abutments.[15,16]

Two main types of all-ceramic fixed dental prosthesis systems are proposed. The first system involves using a single material for full-contour crowns. Reinforced glassy materials were successfully used to make single crowns for anterior and premolar regions. Innovatively, polycrystalline zirconia with improved translucency has been used for full-contour crowns in the molar region.[17] The second system is to fuse aesthetic ceramics, such as porcelain and other glassy materials, to frameworks made of high-strength ceramics instead of alloys. Dense sintered polycrystalline zirconia-based material is promising for frameworks of fixed dental prostheses.[18]

Industrial dense polycrystalline ceramics such as alumina, zirconia, and alumina-zirconia composites are currently available for use with CAD/CAM technology via a networked machining system. In particular, Yttrium partially-stabilised Tetragonal Zirconia Polycrystalline (Y-TZP) shows better mechanical properties and superior resistance to fracture. Y-TZP has a high fracture toughness, from 5 to 10 MPa $m^{1/2}$, and a flexural strength of 900 to 1,400 MPa.[19,20] The positive clinical performance of Y-TZP has been recently confirmed through several reports.[21,22]

Figs. 1 & 2: DORA 14801 provides in-house testing of dental implants according to ISO 14801.

Ceramics in implant dentistry

Due to the possible negative effects of titanium, as well as the positive features of ceramics, the clinical application of implants made from different novel ceramic biomaterials has become more active. Such ceramic materials include single- and poly-crystal alumina[23], bioactive glasses[24], hydroxyapatite[25], and zirconia[26]. Furthermore, zirconium oxide coatings (approximately 100 nm) of Ti6Al4V, or titanium orthopaedic implants, usually after the application of macro-texturing methods, may promote bone growth and thus provide evidence of enhanced implant osseointegration.[27,28] Y-TZP is currently considered an attractive and advantageous endosseous dental implant material due to its high biocompatibility, improved mechanical features, high radiopacity, and easy handling during abutment preparation.[29,30]

Zirconia ceramic is well-tolerated by bone- and soft-tissues and possesses mechanical stability.[31] Since the difference in bone-to-implant attachment strength between bio-inert ceramics and stainless steel was not significant, it was indicated that the affinity of bone to bio-inert ceramics has almost the same capacity as metal alloys.[32] *In vitro* culture tests were performed to verify biocompatibility, genetic effects, and osteoblast interactions of potential zirconia implant substrates. A series of well-reviewed studies showed no adverse response, surface-specific and non-surface-specific proliferation, attachment and spreading of osteoblasts, and no genetic effect of zirconia on bone formation.[33–36]

Animal studies that focused on zirconia implants without loading demonstrated comparable qualitative and quantitative characteristics to that of the titanium implants in biocompatibility and osteoinductivity.[37,38] *In vivo* studies proved that micro-modification of Y-TZP implants, resulting in a roughened surface, was beneficial for initial bone healing, bone apposition, and interfacial shear strength.[39] Different studies were performed to define the feasibility of zirconia implant systems. A finite element assessment of the loading resistance revealed non-distractive and well-distributed stress patterns, similar to those of titanium implants.[40]

Regarding the impact of the design (one or two pieces) on the biomechanical behaviour of Y-TZP implants using chewing simulation testing conditions, a prototype two-piece zirconia implant revealed low fracture resistance at the level of the implant head and therefore questionable clinical performance,[41] while one-piece zirconia implants seem to be clinically applicable. More recently, Schepke et al. (2017) conducted a study to describe the histologic and histomorphometric features of a functional endosseous Y-TZP implant in a human subject.[42] It was shown that the histologic data provided further evidence of the potential of such implants to osseointegrate to a similar degree as titanium in humans.

To date, there are several commercially available zirconia implant systems on the market.[43] Some provide both one- and two-piece designs and the others provide only one-piece designs. Despite some promising preliminary clinical results, no clinical long-term data are available concerning zirconia implants. Survival rates after one year were reported at 93 per cent (189 one-piece implants, Z-Systems)[44], 98 per cent (66 one-piece implants, Z-Systems)[26], and 100 per cent (one-piece implants,

CeraRoot)[45]. A notable review proposed that in an ongoing clinical study, TZP-α ($ZrO_2/Y_2O_3/Al_2O_3$) experimental implants (n = 119) with an especially roughened surface presented a survival rate of 96.6 per cent after a one-year observation period.[41] However, clinical and laboratory research data were scarce on safe recommendations for a widespread clinical application of Y-TZP implants.[7]

Mechanical tests

In order to bring dental implants into markets, they should firstly pass several mechanical tests like fatigue and dynamical loading tests. These tests are mainly related to the ability of an implant to withstand the loading strength as a simulation to what is comparable to the oral cavity. Fatigue is defined as the weakening of a material caused by repeatedly applied (mechanical) loads (repeated loading and unloading), normally below the ultimate stress limit. Not only clinical loading scenarios are simulated including pressure or bending, but also torsion, shearing, or tensile forces are occurring. Fatigue stages are crack initiation, crack growth, and final failure. Cracks may, for example, initiate from structural or superficial defects (wear or processing traces). Stress level, rate, form, and frequency of the load situation are essential on the performance of the material as is the form of the specimen or its surface condition.

It seems important to select the loading parameters (force, frequency, etc.) in dependence on the material properties (e.g. viscoelastic behaviour) and application conditions (e.g. wet environment). Fatigue tests are often performed by measuring the crack growth in a fracture mechanics approach or by determining the residual stability or strength after fatigue/aging tests. Therefore, short-term tests are required for each individual material or restoration, which lead to degradation or final failure.[46,47] A number of publications underline the influence of the fatigue environment and synergetic corrosion fatigue on the performance of the materials, especially in case of ceramic materials. Some studies indicated strong variations for the manuscripts available in literature, providing no information, 20 °C or room temperature (dry), 37 °C (dry, in water or saliva), or thermal cycling (usually 5 °C/55 °C) as testing condition.[48,49]

Loading tests for dental implants can be denoted according to predefined standards or norms (i.e. ISO, DIN, or EN). For instance, DIN 50100 describes a load-controlled fatigue testing design at constant load amplitudes on metallic specimens and components. The endurance limit can be displayed, for example, in a Wöhler curve or in fatigue strength diagrams.[50] However, this standard is not usually applicable for testing dental implants. ISO 13356:2015 specifies the requirements and corresponding test methods for a biocompatible and biostable ceramic bone-substitute material based on yttria-stabilised tetragonal for use as a material for surgical implants. This norm imposes that a maximum of 25 weight per cent of monoclinic phase is present in test specimens after an accelerated aging test (134 °C in a humid atmosphere with an air pressure of 0.2 MPa).[51]

ISO 14801:2016 (previously known as ISO 14801:2007) specifies a method of dynamic testing of single post endosseous dental implants of the transmucosal type in combination with their pre-manufactured prosthetic components,[52,53] and is used in 162 member countries around the world. It is most useful for comparing endosseous dental implants of different designs or sizes.[54] This international standard is not a test of the fundamental fatigue properties of the materials from which the endosseous implants and prosthetic components are made, and, moreover, is not applicable to dental implants with endosseous lengths shorter than 8 mm nor to magnetic attachments. While ISO 14801:2016 simulates the functional loading of an endosseous dental implant under "worst case" conditions, it is not applicable for predicting the *in vivo* performance of an endosseous dental implant or dental prosthesis, particularly if multiple endosseous dental implants are used for a dental prosthesis.

Critics and possible modifications

Although ISO standards are equipped to encounter all possible loading situations that could take place in the mouth, they still lack more real conditions that should be taken into consideration. ISO 13356 prescribes the evaluation of test specimens with a simplified geometry (bending bars) and a polished surface. However, complex geometries as well as postprocessing steps like micro-roughening to enhance osseointegration are known to significantly compromise the mechanical properties

Fig. 3

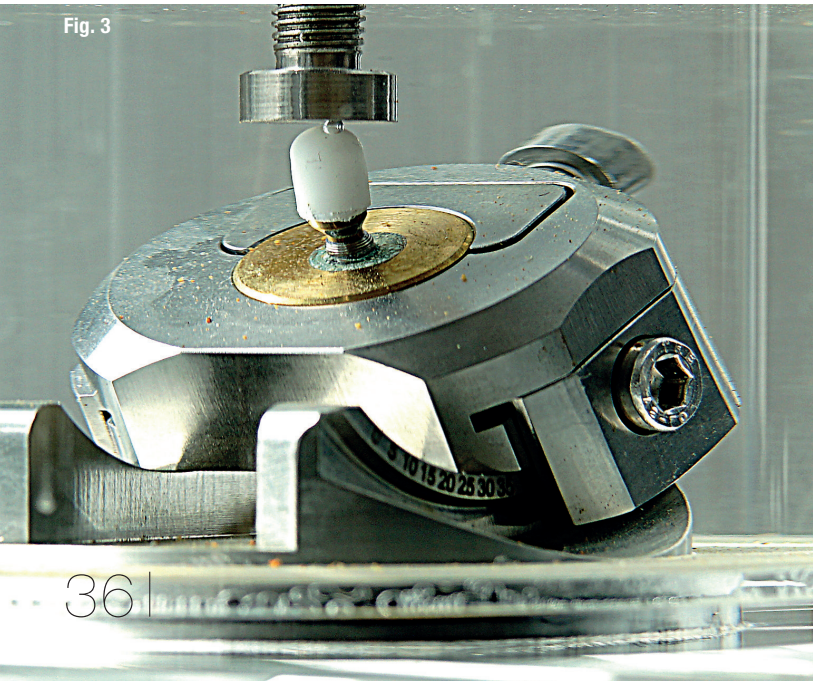

Fig. 3: The testing facility allows for efficient testing of abutment and materials.

NOUVAG

We talk implantology

MD 11
for Implantology

MD 30
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and Oral Surgery

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Fig. 4: Eight electronic components can be integrated into the control unit DORA CONTROL.

and, even more important, accelerate the aging kinetics.[55] Therefore, ISO 13356 does not account for the real transformation rate of samples with roughened surface and a non-porous bulk, whereas ISO 14801 requires a dynamic loading procedure subjecting the implants to different loads, to finally obtain a fatigue resistance curve.[56] Regrettably, only the latter standard evaluates the "market-ready" product but it misses to provide any environmental condition that induces aging.

Since complex geometries, manufacturing procedures and surface modifications of zirconia oral implants are known to compromise the original mechanical material properties and aging kinetics measured by the use of bending bars or discs,[57] long-term thermomechanical loading in a hot aqueous environment of the finally designed implant should be mandatory before its market release. This method validates the functionality and safety of the product prior to the clinical application. Otherwise, the patient might be the one who suffers from potentially predictable early fatigue. Y-TZP is prone to low temperature degradation (LTD; "aging") in presence of water vapour.[58] Aging can result in intergranular micro-cracking, surface-roughening and, up from a certain level, in reduced strength.[59]

To simulate intraoral aging to the extent possible and, in particular, address the degradation susceptibility of metastable zirconia ceramics, an experimental setup by Spies et al. (2016) tried to add some modifications that differed from ISO 14801.[54] The mentioned norm does not include horizontal loading components or degradation accelerating environmental factors. By placing the samples of the mentioned study in a warm fluid of 60 °C during the dynamic loading procedure, the applied testing protocol was designed to account for the specific nature of zirconia ceramics and its behaviour in aqueous environments. Furthermore, ISO 14801 dictates the simulation of a 3 mm bone recession. According to a clinical observation,[60] the implants of the investigation by Spies et al. were embedded simulating 0.5 to 1 mm of bone recession. Moreover, the authors wanted the area assumed to be the most fragile (i.e. the transition zone from abutment to implant) near the point of entry to the embedding material, since maximum loads occur in this zone.[40] Therefore, the calculated pure fracture load values of the final static loading test were not comparable to other investigations adapting ISO 14801.

More recently, Spies et al. (2017) conducted a study aiming at investigating a new testing protocol considering environmental conditions adequately inducing aging during dynamic fatigue when using zirconia dental implants.[61] It was shown that phase transformation was only detectable after hydrothermally induced aging. Strength of the investigated zirconia prototype implant was not reduced by aging, fatigue or simultaneous treatment. However, increased fracture load of solely dynamically loaded implants indicated localised stress-induced transformation. The authors argued that the presented protocol might serve as a reference for the discussion on how to specify the current testing standards.

In another important trial to enhance the testing conditions of ISO 14801, Castolo et al. (2017) tried to use finite element analysis to assess the influence of design pa-

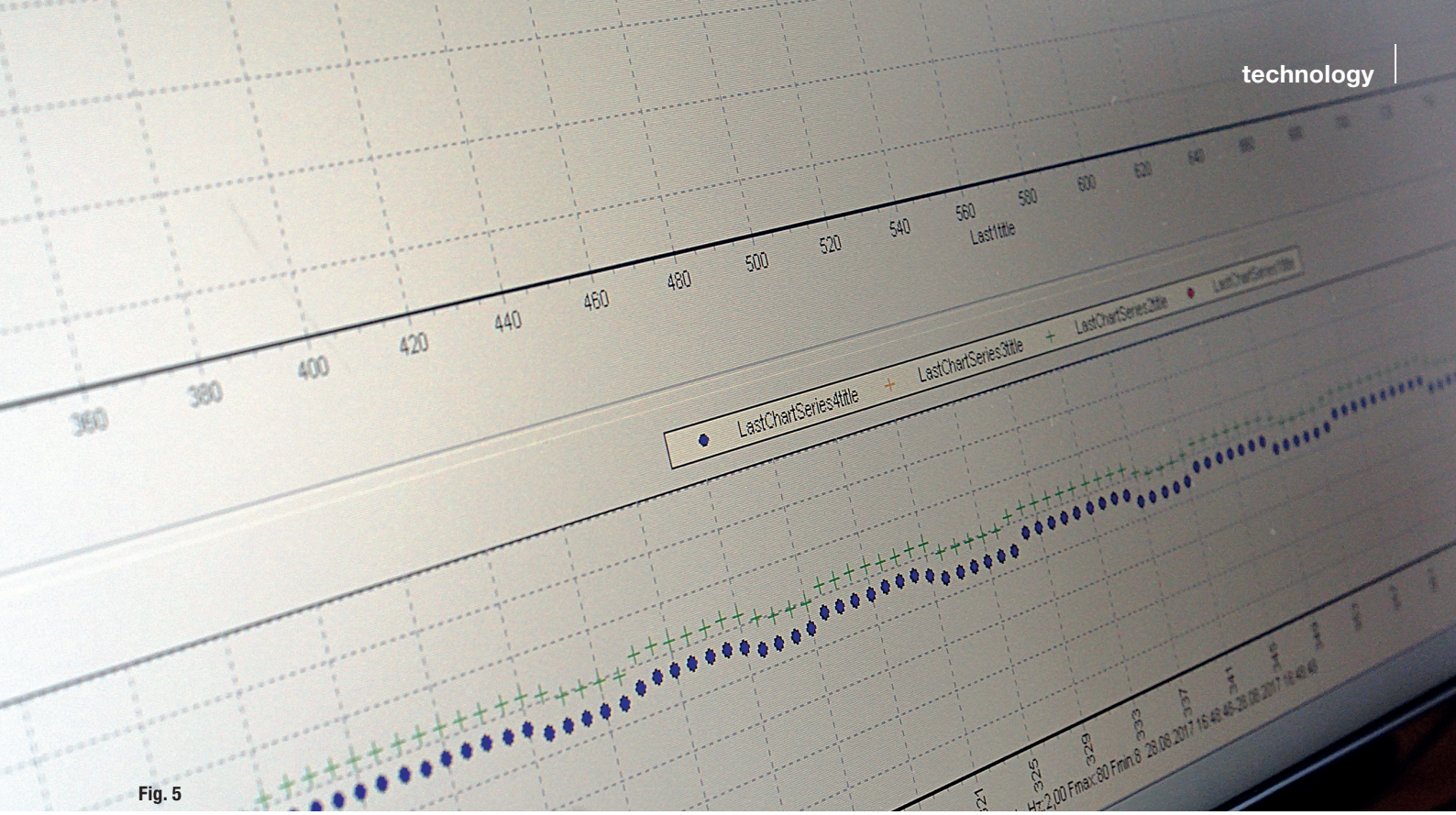

Fig. 5

Fig. 5: During the testing process, all relevant data of ISO 14801 are recorded in a measurement diagramme with DORA SOFT.

rameters on the mechanical performance of an implant in regard to testing conditions of ISO 14801 standard.[62] In their study, an endosseous dental implant was loaded under ISO standard 14801 testing conditions by numerical simulation, with four parameters evaluated under the following conditions: conditions of the contact surface area between the implant and the loading tool, length of the fixation screw, implant embedding depth, and material used for implant stiffness. Finite element analysis was used to compare the force that needed to reach the implant's yield and fracture strength. It was shown that finite element analysis made it possible to evaluate four performance parameters of a dental implant under ISO standard 14801 conditions. Under these conditions, the contact surface area was found to be the major parameter influencing implant performance.

Numerical methods should be considered in the process of implants design, as they can improve the performance of dental implants and their prosthetic parts under the conditions of ISO standard 14801.

Conclusion

Titanium is regarded as the "gold standard" for dental implant materials due to its biocompatibility. Numerous studies have affirmed the high success and survival rates of titanium dental implants in many different applications. One disadvantage is that it can result in poor aesthetics, especially in the anterior region, because of its greyish colour and exposure of the implant body due to soft tissue recession or if the individual has thin gingival biotype. Moreover, some reports have considered titanium hypersensitivity as a risk factor for dental implant failure. Zirconium implants appear to offer the similar success rates as titanium implants. Zirconium implants have an obvious aesthetic advantage over titanium implants being "pure white", making them indistinguishable from natural teeth.

Fracture, corrosion, fatigue, the possible abrasion actions that take place within the connected parts of implant, and other relevant terms are all important mechanical factors that should be taken into consideration before introducing ceramic dental implants in the market. Such mechanical features should be tested through previously defined standards or norms. To date, two separate international ISO standards are available for testing dental implants; namely ISO 13356 and ISO 14801. However, there is still a recent debate regarding these currently applicable ISO standards due to the fact that they are not addressing the *in vivo* aging behaviour of zirconia dental implants to verify their real pre-clinical safety.

Literature

contact

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55411 Bingen am Rhein, Germany
Tel.: +49 6721 309321-0
info@14801.de
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CAMLOG

Prosthetic solutions on ceramic implants

The demand for aesthetic and particularly tissue-friendly implant restorations is showing steady growth. Sophisticated ceramic implant systems are one solution. The company CAMLOG meets these requirements and entered the market for ceramic implants with CERALOG®. CAMLOG has been working on ceramic implants for several years, and in summer 2016 acquired a majority stake in AXIS biodental SA, a Swiss pioneer in the production of zirconium dioxide implants. The CERALOG® implant system includes two proven ceramic implants: the one-piece CERALOG® Monobloc implant and the CERALOG® Hexalobe implant, the first two-piece ceramic implant with reversibly screw-retained PEKK abutments. The Hexalobe connection design, which is suitable for ceramics, allows modern prosthetic solutions on a ceramic implant. The Hexalobe implant in its current configuration has been used successfully in clinical practice since 2013. CERALOG® is initially only available in Germany, Austria and Switzerland, and is gradually being introduced in other countries.

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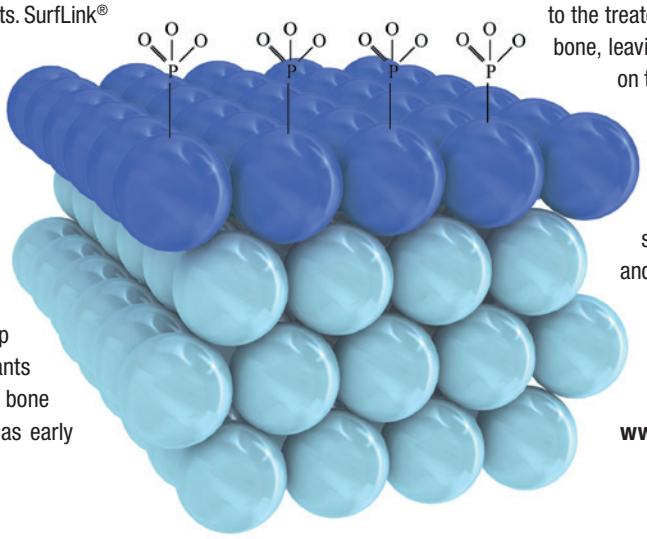
Treating ceramic-based implants with SurfLink® results in a nanometer thin layer of phosphorous-rich molecules, which is seen as bone-like by the body. It is the first product to permanently create bone fixation on dental implants. SurfLink® is compatible with any surface roughness or porosity and permanently hydrophilic by design. Preclinical studies have shown bone growing directly on titanium implants, neo-vascularisation and reduced bacterial adhesion around ceramic implants. In a sheep study with titanium implants the product increased new bone formation by +44 per cent as early as two weeks after implantation. After only two weeks, SurfLink® showed a 32 per cent increased implant fixation compared to the control. Torque testing after 52 weeks showed that bone fixation to the treated implant surface is stronger than bone, leaving a thin layer of mineralised bone on the implant surface.



For most manufacturer nearly no extra equipment is necessary for implementing the product in their production line. Furthermore, no specially trained personnel is needed and all standard logistics can be used.

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1196 Gland, Switzerland
www.nbmolecules.com

TAV Dental

Ceramic Injection Molding technology

TAV Dental, a division of TAV Medical, is a family-owned company with four decades of experience in the medical devices market. The company focuses on the development, manufacturing and marketing of zirconia dental implants and prosthetic parts, and is seeking to improve dental implant treatments by making zirconia dental implants common worldwide.

TAV Zirconia implants are the result of years of profound research and development process with exceptional focus on the safety and performance of the implants. The implants are manufactured using the advanced Ceramic Injection Molding (CIM) technology. This technology offers great advantages in terms of part design, mechanical properties and manufacturing capabilities. TAV Dental offers both one-piece and two-piece zirconia implants. Thereby, the two-piece implant-abutment connection is done by screwing.

Ceramic implants are taking the dental industry a major step into the future. Thanks to this metal-free option, implant treatment with reliable osseointegration, superior mechanical properties, biocompatibility and high aesthetic results can now be offered to the patients.

TAV Dental
Shlomi, Israel
www.tavdental.com

ZiBone

Reduced healing time

ZiBone is a one-piece zirconia implant (fixture and abutment in one piece) made of extremely strong high-purity zirconia ZrO_2-TZP, which has been used for years as orthopaedic implant material. By use of this material, the implant perfectly conforms to ISO 13356.

Zirconia is an ideal material for the manufacturing of dental implants. Compared to implants made from aluminium oxide and titanium, zirconia possesses superior mechanical properties that are making the implant stronger, less brittle, resist to fracture and deformation. The one-piece ceramic ZiBone implant is extremely biocompatible, and thus suitable for most patients. Through thorough preliminary assessment, patients will experience an enhanced osseointegration and reduced time for healing.

ZiBone is born out of the Taiwan company COHO Biomedical Technology, which has long-term experience in manufacturing biotech machinery and products specifically for the use in dentistry. Having the foundation and studied intensively with precision on the exact delicate detail of CIM (Ceramic Injection Molding) and PIM (Powder Injection Molding), the company successfully obtained several patents.

ZiBone
COHO Biomedical Technology Co., Ltd.
No. 21 Dafeng Street, Luzhu District
Taoyuan City 33860, Taiwan
www.zibone.com

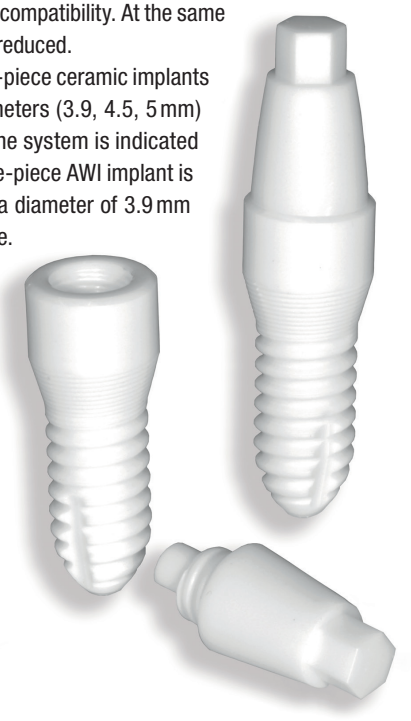
WITAR

Biocompatible ceramic implant

Metal-free, biocompatible and aesthetic: Ceramic implants have gained popularity among dentists and patients. Building upon this trend, WITAR offers a new AWI implant system for transgingival healing. With this, the company promises an implant treatment that is safe, cost-efficient and simple. The two-piece system that has been developed and patented recently is made from Y-TZP ceramic and offers a reliable and easy handling. Treatment steps had been optimised for an increased safety and biocompatibility. At the same time, treatment costs and time could be reduced.

The implant system consists of nine two-piece ceramic implants that are available in three different diameters (3.9, 4.5, 5 mm) and lengths (8, 10, 12 mm). With this, the system is indicated for all bone classes. Additionally, the one-piece AWI implant is available in two sizes (10, 12 mm) with a diameter of 3.9 mm and can be used in the anterior mandible.

Four full-ceramic abutments of which two are straight and two are angled by 15 degrees, belong to the system as well. Furthermore, the system includes a sterilisation box, surgical tray with milling machines made from ATZ high-performance ceramics, and turning tools.



WITAR Consulting GmbH
Rodenkirchener Straße 148
50997 Cologne, Germany
www.witar.de

Straumann® PURE Ceramic Implant System

Straumann

Swiss quality and precision

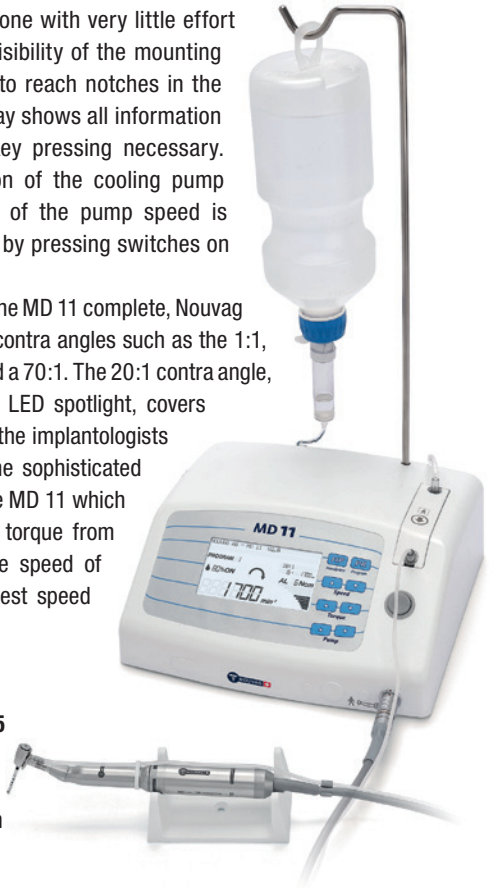
Nowadays, patients are more aesthetic and health conscious than ever before. Healthy-looking oral soft tissues and bright teeth are considered a prerequisite for a beautiful smile and self-esteem, adding directly to health-related quality of life.
With the Straumann® PURE Ceramic Implant System dentist can grant the best aesthetic, natural and strong treatment to their patients. Patients will benefit from all the highly aesthetic advantages of a natural ceramic implant. Yet dentists can rely on a high-performance zirconia ceramic material, being even stronger as the gold standard, grade-4 titanium implants.
Every single ceramic implant has to undergo a proof test before it leaves the Straumann production facility. This exceptional standard is the result of more than 12 years of relentless research and development until the ceramic implants complied with the company's premium quality standards. They combine Swiss quality and precision, strength, clinical success and flexible treatment protocols in an innovative solution that helps dentists to meet the needs of their patients.

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

Nouvag

Sophisticated motor management

Nouvag's latest development in the field of implantology is the motor system MD 11. Drilling, thread cutting, screwing in the implants and placing the cover screw are now organised in separate programmes. The insertion of the tubing set is done with very little effort due to the great visibility of the mounting bracket and easy to reach notches in the bracket. The display shows all information at a glance, no key pressing necessary. Even the activation of the cooling pump and the changing of the pump speed is conveniently done by pressing switches on the pedal.
To make the set of the MD 11 complete, Nouvag offers all required contra angles such as the 1:1, 16:1, 20:1, 32:1 and a 70:1. The 20:1 contra angle, also available with LED spotlight, covers the largest field of the implantologists tasks, thanks to the sophisticated motor control of the MD 11 which provides sufficient torque from the lowest possible speed of 15 rpm to the highest speed of 1,700 rpm.



Nouvag AG
St. Gallerstr. 23–25
9403 Goldach,
Switzerland
www.nouvag.com

SDS Swiss Dental Solutions

Ceramic implant forms with osteogenic functionality

While SDS ceramic implants were being applied routinely at the Swiss Biohealth Clinic of Dr Volz, the experience and knowledge that were gained there led to the development of a new kind of implant. The improved biocompatibility of zirconium dioxide implants, together with the bone- and soft-tissue growth associated with it have provided new options for implantation wherever pronounced oval alveoli need to be treated, or multiple rooted teeth must be replaced. To this end, the implant ranges "oval" and "balcony" were developed, available in different diameters and lengths, both as single pieces and in two parts, and which were able to optimally close the alveoli, especially with emergency implantations.
The new SDS "sinus implants" (Fig.) were developed specifically for sinus lifting. Due to the increased biocompatibility of ZrO_2, bone growth is also optimally exploited for this indication. In the apical area of the sinus implants, a plate is introduced, which on the one hand spares damage to the Schneiderian membrane upon sinus lifting, and on the other forms a large cavity under the plate due to an umbrella effect. The actual implant serves as a tent pole in this cavity, which creates optimal conditions for inward bleeding and the bone regeneration which results from this. Bone graft material is not necessary in almost all cases. The sinus implants are also available in various diameters and lengths.

SDS Swiss Dental Solutions AG
Zollstr. 8
8280 Kreuzlingen, Switzerland
www.swissdentalsolutions.com

High-quality alternative to metal-based implants

Oded Ben Shabat, CEO of TAV Medical.

TAV Dental is a professional, dynamic and innovative unit founded as a division of TAV Medical Ltd, a company with more than 40 years of experience in the medical field. TAV Dental manufactures a wide range of dental products including implants, abutments and tools, manufactured from variety of raw materials such as zirconia, titanium and plastics. The company is founded on advanced technology, which serves as a significant basis for all developments and production processes. In the area of dental implantology, the company especially focuses on developing and manufacturing zirconia dental products with a vision to redefine the quality of zirconia dental products and its performances. Oded Ben Shabat, CEO of TAV Medical, spoke about the company and its aims.

TAVDental
PRECISION. PASSION. PARTNERSHIP

Mr. Ben Shabat, what makes your company a leading force in the area of metal-free implantology?

TAV Medical has over 40 years of experience in manufacturing dental and medical products. Unlike most zirconia implants available in the market, we are manufacturing the implants in-house using ceramic injection technology and as such are able to maintain a standard of excellence in the quality of the implants.

What are the challenges that dentists who practice implantology are faced with today?

As nowadays patients are more aesthetic and health conscious than ever, dentists should be ready to provide those patient's needs. Titanium implants have been successfully used for decades, however, the world is rapidly developing and changing, so is the dental implant market. Dentists have to leave their comfort zone, learn about new technologies and techniques in order to bring patients the best and up-to-date solution available at the market.

What do you think, are ceramic implants a good alternative to titanium implants?

The search for metal-free implants began more than 40 years ago, however, recent improvements in ceramic materials and manufacturing technologies have made zirconia implants viable alternative. Zirconia implants today have the same success rate as titanium implants. Various treatments are applicable with ceramic implants such as immediate placement, immediate temporisation, full-arch and full-mouth rehabilitation can be performed with excellent and predictable outcomes.

How does zirconia change the dental market and what are your future plans?

Recently, we can feel the changes in market demand, as more and more dentists are looking for zirconia implant solutions as well as implant companies, normally selling titanium implants, that want to be able to offer a zirconia implant option as well. We are here to supply those needs. Furthermore, we see our role as making zirconia implants known to dentists by providing extensive education on the uses and benefits of zirconia implants so that they can be comfortable knowing that they are offering a high-quality alternative to metal-based implants.

contact

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“Ceramic will replace titanium in the long run”

swiss made

ISO 13485 Zertifiziert SWISS MADE

CE FDA

In 2004, Z-Systems obtained the first CE certification for one-piece ceramic implants; three years later they obtained FDA certification as the first ceramic implant manufacturer. From that point on, the company developed to one of the leading companies in the global market of ceramic implants. Tens of thousands of successfully placed implants and more than 15 years of experience have brought the company significant advances in manufacturing, quality and know-how. In the interview, Z-Systems provides an insight into the company’s success story and gives an ambitious outlook into the future of ceramic implants.

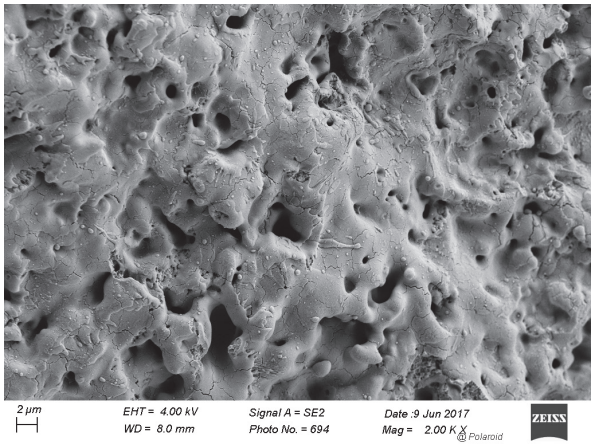
Z-SYSTEMS
ceramic implants

Z-Systems is one of the leading companies in the field of ceramic implants. What is your success story?

We are not only one of the leading companies in the field of ceramic implants, but we are also innovation and world market leader for many years now. In the last 16 years, about 50,000 Z-Systems implants had been inserted. This is a number which is not even roughly achieved by any other company. Thereby, uppermost maxim and one main reason of success is our uncompromising safety awareness. We know from experience that in the development and production of ceramic implants there are far more factors needed to be kept in mind than for titanium implants. Material, surface and implant-abutment geometry are key factors for favourable outcomes, guaranteeing long-term traceable success rates of over 98 per cent.

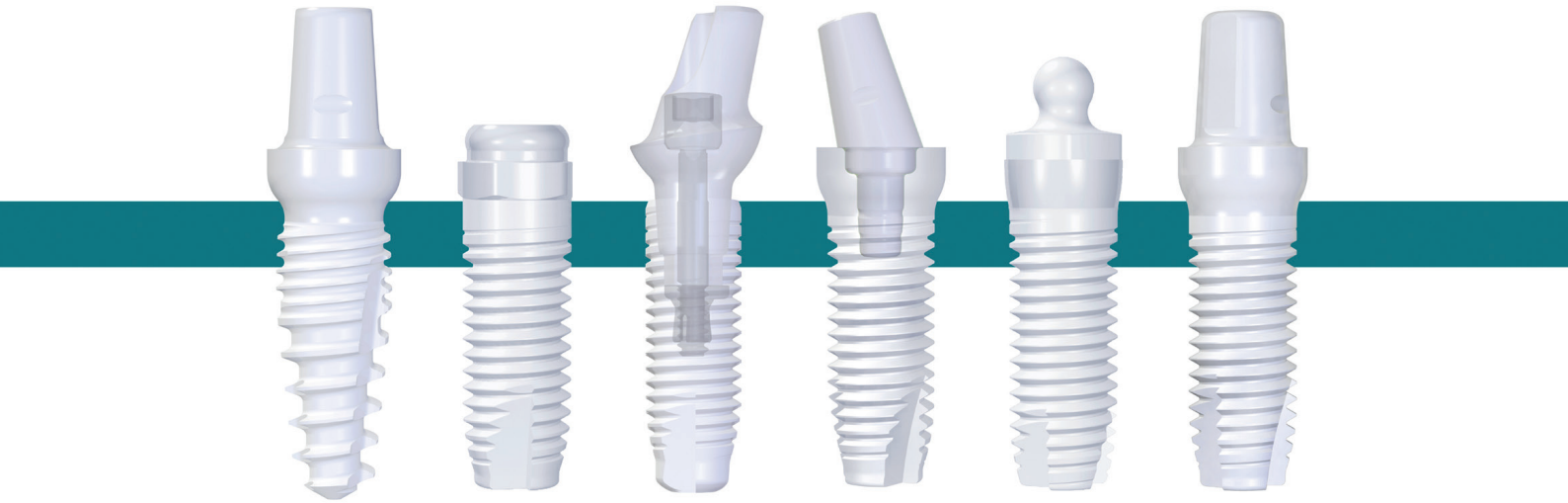
In your portfolio, you are offering both two-piece and one-piece ceramic implants. How is your ceramic produced? What are the characteristics of your ceramic implants' surface structure? And which technology do you use for your implant-abutment connection?

Our ceramic is produced under strict obedience of ISO Norm 13356 which defines the composition of ceramic implants' material. Surprisingly, there are some systems available at the market which do not comply with this norm. However, our implants and superstructures are produced in a unique and patented Zirkolith® manufacturing process. The implant's surface is also manufactured with a patented SLM® method where the flanks of the thread are roughened by using a laser device. With this method, an optimal degree of micro-/macro-roughness is achieved. Furthermore, the surface is made hydrophilic with an elaborate plasma sterilisation.



Surface is manufactured with a patented SLM® method.

Our product portfolio comprises both one-piece and two-piece implants. Thereby, one main advantage is the grindability of abutments and implants, which has been released by Z-Systems in 2004 already. The one-piece implants are available in different geometries, while the two-piece implants contain a cementable gingiva level and a screw-retained bone level implant. This again illustrates the pioneering role of Z-Systems: A working and secure bone level implant, as presented with the Z5s which at the same time fulfils the accustomed process in surgery and prosthodontics, is a novelty in zirconia-based implantology.



Will the material ceramic completely replace titanium in dental implantology over the long term?

We are convinced that ceramic will replace titanium in the long run. Currently, this may sound a bit overbearing and little farsighted, but: In only a few months, Z-Systems will be able to offer a complete implant system which will be just as good in the field of implant and prosthodontics as a titanium implant system. Since ceramic implants are more aesthetic, sustainable and healthier, there will actually be no reason to use titanium implants in the future any more.

At which events can dentists gather information on the products of Z-Systems?

Z-Systems is present at the most important global congresses. Beyond that, dentists can feel free to directly contact us via one of our branch offices worldwide mentioned at our company website.

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Zirconium dioxide implants— a holistic approach

Prof. Prof. h.c. Dr Werner Becker, Dr Witalij Kolbe and DT Artur Wolf, for dentists and patients alike, ceramic implants pose an alternative to titanium implants. You are advocates of a holistic approach in dentistry. Where do you stand on this topic?

Dr Kolbe: You may be amazed that I, as a previous implant opponent, have become an advocate of a certain realm of implantology. In my opinion, metal implants, especially those made of titanium, are obsolete due to their negative effect on the regulatory system. My colleague Prof. Werner Becker and I suggest that titanium implants can only be retained in the bone for a certain amount of time by an interactive, chronic "inflammatory process". From a medical point of view, this period can be quite long.

Prof. Becker: It is important to me that there is knowledge available on titanium as material used in implantology. Because, in this context, we are talking of material made of titanium alloys and not pure titanium. For processing requirements, there is no other option possible. The processing of pure titanium as a material wouldn't be easily accepted, as its metallic "toxicity" is undisputed among toxicologists, but it is ignored by dentistry. But this is unimportant for dental implants, as all of them are alloys with over 90 per cent titanium content. The rest is made of metal admixtures which facilitate later process ability. One of the most serious admixtures is aluminium, the toxicity of which is generally known in the medical field and which has been listed as one of the problem materials in the occurrence of Alzheimer's and Parkinson's diseases. This is demonstrated by research in this field.

The medical mechanism of action is the following: the titanium implant reacts with the protein of the bone where it is screwed or wedged. This creates protein titanium compounds known under the chemical denomination metal chelates. These generate an inflammatory process in the bone (peri-implantitis). Initially, this stabilises the implant in the bone, but from now on also is a constant chronic focus which requires extensive defence activities from the human immune system. If this process remains in its chronic phase through the body's "defence compensation", this kind of implant can remain in situ for a long time, but, as mentioned previously, under considerable strain on the body's general regulation system.

What is the consequence emerging from these inflammatory processes?

Prof. Becker: If this process becomes acute, it is usually bacterially superimposed and the implant "festers". The bone substance remains loaded in the peri-implant area, and continues to be a focus. In this case, the bone previously enclosing the implant must be milled out until healthy, in order to exclude any effects of this focus on the body. The circumstance just described occurred for the implant lost in the lower jaw. Titanium and its compounds are mainly neurotoxins. They destroy the protective membranes surrounding the nerve, the so-called myelin sheaths. An initial effect is mainly muscle pain, since the nerves supplying these areas are damaged, as well as damage to hard tissues of the body, such as hair, nails and bones.

To this date, dental prosthetics are mainly based on metallic materials. Examples include titanium suprastructures, gold crowns or amalgam fillings. How do you assess this situation from a biological as well as medical point of view?

Prof. Becker: It is important to note that in any case an electroplating of metal elements takes place in the oral cavity. These micro currents are responsible for destroying the nervous system also, as they suppress the transmission of stimuli through the synapses e.g. to the muscle tissue, and regulation therefore becomes impossible. Effects could be damage to the muscles, sensation changes, paralyses, atony and therefore muscle loss. These electric micro disruptions could also mix up the otherwise balanced microbe system in the gastrointestinal tract, and disorders e.g. of the bowel such as Crohn's disease or leaky gut syndrome can arise. The range of disease possibilities up to cardiovascular diseases and other internal problems must then almost be expected. However, each individual responds differently to these disturbances. That makes the diagnostic investigations particularly challenging.

What does this mean for the field of implantology?

Prof. Becker: What was said about metal implants also equally applies to ceramic or zircon implants. Everything depends on the source materials and their chemistry, and on the toxicological factors. As far as I am aware,

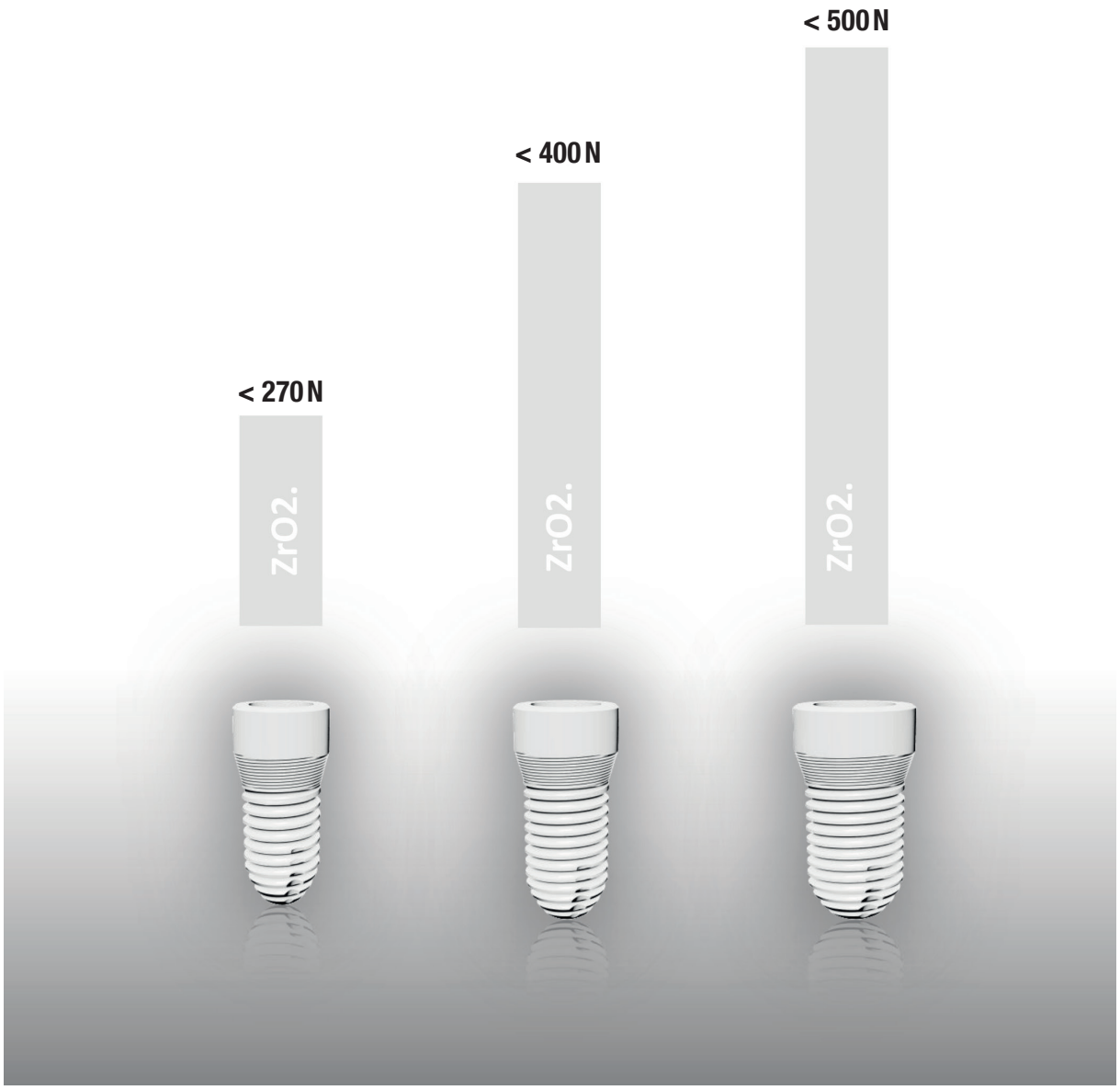

Fig. 1: Investigation report: dynamic and static examination according to ISO 14801.

there is only one zircon worldwide that does not contain aluminium. I do not know whether Canadian zircon meets these standards, as all the deposits known in Canada have natural admixtures of aluminium in zircon. I do not know of any deposit in the whole American region which is free from chemically questionable admixtures. Only Japan and Australia have deposits from which dental zircon products can be made. I have conducted in-depth research on zircon for about 15 years.

Dr Kolbe: I am, by now, convinced by zircon implants. They clearly guarantee inflammation-free integration. However, it must be said that that these implants either integrate or are lost very soon after implantation—as has been pointed out by a scientific group working with Andrea Mombelli at the University of Geneva. The loss of an implant usually happens without much "collateral damage", hence, without any further inflammation.

What could be the cause of those early losses that occur without any signs of inflammation?

Dr Kolbe: According to our experience, one reason or cause for such "spontaneous" implant failures could be the fact that past focal infections and interferences had not healed properly in the preliminary stages in the area designated for implantation. This applies to the bone as well as to the soft tissue. By the way, this assessment is in line with the approach of our colleague Nischwitz. In well over 90 per cent of these cases, I found out that there had previously been a serious incident of this kind in the bone, and that it still showed, despite its alleged healing, a defence reaction. In this kind of implantation area, metabolic processes occur which the tissue matrix cannot regulate in a "draining" manner. The so-called sol-gel transformation, as described in 2001 by Thomas Gyöngyösi, is the ability of cells and

tissue structures to self-regulate and, where necessary, to heal. If these self-regulatory forces are impaired, no decomposition product (as part of an inflammation) can be eliminated, and rejection occurs. This is my explanation for the sudden loss if zircon implants. It is therefore vital to record in advance a detailed assessment concerning the inaugurated implantation area. If that has been done, the implant can be placed in a holistically acceptable way.

Prof. Becker: My further point with regard to the focus or interference issue is that large-scale extraction wounds usually don't heal in such a way that they can then be considered focus-free. In the vast majority of cases, residual osteitides (persistent osteitides) remain on these "long stretches". These then form cavities in the bone that are filled out with connective tissue structures and are therefore "soft". These then produce substances that are not poisonous, but significantly disturb the metabolism of the surrounding bone and do not allow an optimal supply of this area. If these regions are later treated with implants, those implants find no stability and are soon "rejected". However, this applies to both, titanium as well as ceramic implants.

There is a variety of implant systems available, all based on different technologies, designs and prosthetic strategies. What is your implant system of choice?

Dr Kolbe: I use the new two-component ceramic system AWI by WITAR GmbH, a company based in Cologne. AWI is a simple and secure system with three main advantages: it is metal-free, biocompatible and aesthetic. The newly developed and patented two-component system made of biocompatible Y-TZP-ceramic is not only reliable and stable, but also easy to handle which has, subsequently, a positive effect on keeping costs and treatment time down. The new AWI implant system combines all advantages and proven characteristics of modern ceramic implants with a newly developed, extremely stable and tissue-compatible construction for transgingival healing.

In your opinion, what are the main surgical and prosthetic characteristics that distinguish this new system from others?

DT Artur Wolf: Whether in terms of aesthetics, stability, biocompatibility or osseointegration: AWI is not a replica of an existing system, but a real new development in all areas with its innovative design. The implant thus has a gap-reduced connecting system with a rotatable and cementable all-ceramic abutment, a tangential micro thread in the cortical bone area and a transgingival shoulder region which provides an ideal surface for the soft tissue and for the aesthetic transition to the prosthetic treatment. For successful osseointegration, it also has an ideal thread roughness of 1.7 µm—this was revealed by a study by the University of Jena on cell colonisation. The surface roughness can therefore be compared to that of leading titanium implants. Another benefit: The universally usable implant was condensed to its essential elements. The treatment process is therefore extremely simple, safe and about twice as fast as with other systems. The implants are sealed directly after insertion with a gingiva former as a healing cap. The screwed and cemented ceramic abutment can later be ground and moulded like a natural tooth inside the mouth—for less appointments, costs and treatment time, and more stability and safety.

New systems usually lack scientific data, a circumstance which makes them easily attackable by sceptics. What can you tell us about the system you use in term of its clinical and scientific evidence?

Dr Kolbe: The system is, of course, clinically tested, certified and scientifically evaluated. The AWI implant system has proven its reliability in various clinical studies (including at Krasnoyarsk State University in Russia); dynamic and static load tests have shown that, with values of up to 500 N, it withstands more than most other systems made of ceramic or titanium; and its breaking forces are demonstrably beyond the values of what bones can endure. The AWI system, which is completely manufactured in Germany, therefore provides a clinically protected, compact and cost-effective implant concept which has already been applied successfully more than a thousand times.

There is also a one-piece AWI implant for the lower anterior region with a diameter of 3.9 mm and two sizes (10 and 12 mm). The system also contains two straight all-ceramic abutments and two all-ceramic abutments at a 15° angle, a steribox and a surgical tray with fibres made of ATZ high-performance ceramic and turning tools.

Thank you very much for this conversation.

contact

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Long-term experiences in the production of zirconia

ZiBone has inherited the rich experience of the Taiwan company COHO Biomedical Technology in manufacturing biotech machinery and products. Having the foundation and studied the exact delicate details of CIM (Ceramic Injection Molding) and PIM (Powder Injection Molding), the company successfully obtained several patents in the area of medical devices. In the interview, ZiBone spoke about their products and aims in the field of ceramic implantology.

How came that ZiBone entered the dental market?

Since 2001, COHO Biomedical produces medical devices made from zirconia, such as abdominal surgery knifes, orthopaedic scalpels and other surgical tools. High-quality materials and innovative designs led by our research team ensure the continuous improvement of our products. COHO provides not only the cutting edge products but also the reliable customer support.

ZiBone's success was based on many years experience in the production of medical devices made from zirconia. To meet the increasing demand of clinical applications of zirconia, ZiBone expands the product lines to dental implants, surgical tools, CAD/CAM milling blocks, and paediatric crowns in the recent years.

What is your core product in the area of zirconia?

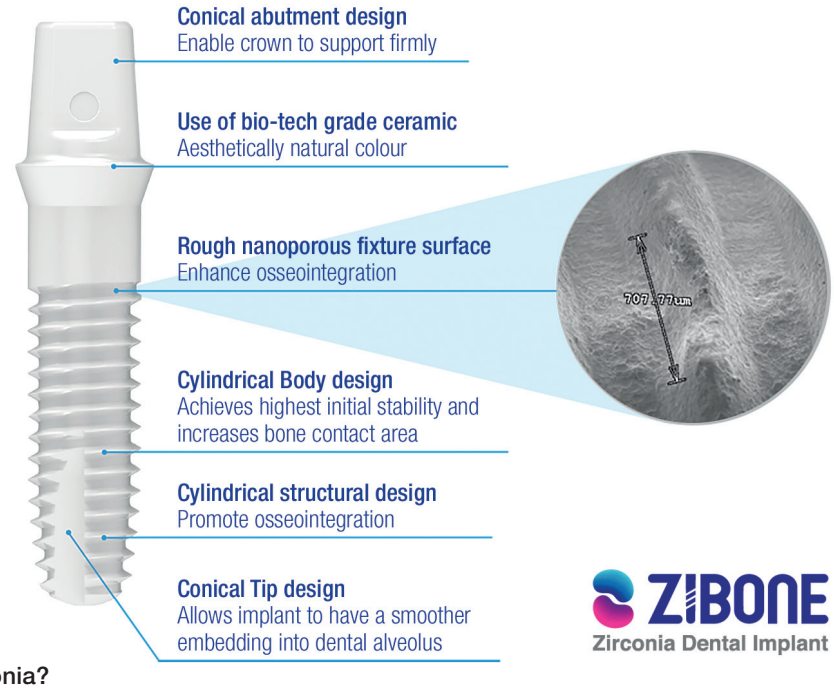
Our core product is our one-piece ceramic implant made of extremely biocompatible zirconia that is suitable for most patients. With laboratory, animal, and clinical studies, ZiBone implants demonstrate reliable osseointegration and initial stability with unique surface treatment and thread design. The abutment design also provides maximum surface available for the retention of a crown.

Is zirconia the "better" choice over titanium?

Studies show that both titanium and zirconia will provide satisfactory outcomes in clinical applications. There are several limitations of zirconia implants; however, they also provide unique advantages, such as biocompatibility of hard/soft tissue and improved aesthetics in thin biotype gingiva. Zirconia implants are new in dental treatments and long-term researches are needed for zirconia implants.

What makes your company successful?

COHO Biomedical has long-term and mass production experience in zirconia medical devices. We continue investigating the improvement of the materials and technology, developing more user-friendly products, and providing global customer services. Our ultimate goals are patient safety and reliable products. ZiBone will be the leader of ceramic implants.



What are your future plans?

ZiBone continues developing different surface treatment techniques to improve osseointegration and ensures long-term success. In addition, our research team also works on the integration of digital diagnostic tools and prosthodontic applications in different situations.

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ISMI congress 2018 will take place in Hamburg

Jürgen Isbaner, Germany

Founded in 2014, the International Society of Metal Free Implantology (ISMI) held its 3rd annual meeting under the topic "Metal free implantology—Defining its position". With more than 150 participants and speakers from eight countries and a broad programme, the society's 3rd annual meeting, held on 5 and 6 May 2017 in Constance, Germany, was a total success. Participants were presented with a programme of seminars, various live surgeries as well as in-depth scientific lectures. On both congress days, international speakers and participants discussed their practical experiences and current trends regarding the use of ceramic implants. Following the recent IDS in March, the society's 3rd annual meeting highlights once again, a particularly innovative area within the field of implantology.

SAVE THE DATE

The 4th annual meeting of the International Society of Metal Free Implantology (ISMI) will be held on 22 and 23 June 2018 in Hamburg, Germany.

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Fig. 1

Fig. 2

Fig. 3

Fig. 1: More than 150 participants and speakers from eight countries participated at the ISMI congress 2017. **Fig. 2:** During the conference, a live surgery using ceramic implants and performed by Dr Karl Ulrich Volz was streamed online and in the conference hall via multi-channel streaming technology. This innovative technology is provided by OEMUS MEDIA AG. **Fig. 3:** President of the ISMI, Dr Karl Ulrich Volz during his lecture.

The meeting started on Friday morning with pre-congress symposia and various live operations as well as seminars focusing among others on implant surgery and biological dentistry. The highlight of the first congress day was the ISMI White Night at Villa Barleben, where participants could end the day enjoying culinary specialities in a relaxed atmosphere. Saturday was entirely dedicated to scientific lectures. The range of topics being dealt with covered all areas of metal-free implantology, although the main focus was placed on practical experiences regarding the use of ceramic implants. In addition to such topics as implant design and questions concerning the materials' characteristics, the lectures addressed in particular, the specific nature of bone and tissue regeneration as well as biological aspects. The discussions concluded that ceramic implants have become indispensable in modern implantology, and, based on aesthetic and biological considerations, they are the better alternative.

ISMI was founded with the aim of promoting and enhancing metal-free implantology's innovative direction and pioneering approach within the field of implantology. In this context, ISMI supports its members by providing advanced training offers as well as regular specialist and market information. By reaching out to expert circles and patients alike, ISMI actively promotes the comprehensive establishment of metal-free treatment concepts. A particular highlight of this year's meeting was the simultaneous broadcasting of live surgeries to the audience in Constance as well as to the German dental news platform zwp-online.info.

ISMI | INT. SOCIETY OF METAL FREE IMPLANTOLOGY

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Clear mission for ceramic implants

IAOCI World Congress 2017 in Miami

Georg Isbaner, Germany

From 16 to 18 February, the International Academy of Ceramic Implants (IAOCI) invited participants to its 6th International Annual Congress in Miami, Florida. Providing a range of expert speakers, the three-day symposium enabled nearly 100 participants from all parts of the world to deepen their knowledge regarding the basics as well as further possibilities of ceramic implantology.

In his opening words to the 6th IAOCI World Congress on 17 February and speaking in front of a large audience, founder and President of IAOCI, Dr Sammy Noumbissi, referred to the fact that "in 2011, when the International Academy of Ceramic Implants held its first annual congress, 25 people, including members of the exhibiting companies, participated in the event". Dr Noumbissi was clearly proud to present the international auditorium with a similarly international as well as renowned team of excellent expert speakers. The focus of this year's congress were implants made of zirconium dioxide which aim to reach the capability of titanium implants.However, before this can be achieved numerous long-term studies and case numbers must show reliable results and convincing outcomes to firmly establish and underpin this claim. With this in mind, the IAOCI has set itself the task, to compile and assemble the required data in regular panels, such as the one in Miami, Florida. Hence, participants of the 6th IAOCI World Congress discussed in great detail material specific data, surface texture, prosthetic possibilities as well as the biological characteristics of ceramic implants which must be measured against those of their implant siblings made of titanium.

Ceramic implants have a seemingly clear mission: They are set out to make peri-implant inflammation less likely and reach better aesthetic results in, for example, the an-

terior region than their titanium counterparts. In fact, implants made of titanium are more and more suspected to accelerate inflammatory processes in certain cases, or to even initiate inflammation. A few years ago and in a rather dramatic way, such cases were referred to as titanium allergy. Nowadays it is simply described as a hypersensitivity or intolerance to titanium. However, today's knowledge also include that fact that, due to abrasion and corrosion, small titanium particles can become detached from the implant surface and cause intolerances. Aspects of this phenomenon were extensively outlined by such speakers as Volker von Baer, Dr Daniel Olmedo and Dr Elisabeth Jacobi-Gresser in their respective lectures. Furthermore, Dr Jacobi-Gresser and colleagues strongly recommend a patient risk assessment prior to an implant therapy in order to filter out those patients who might develop an intolerance due to titanium debris. "There is an individual and/or genetic predisposition of certain patients to inflammatory reactions caused by titanium particles which could jeopardise an implant therapy's long-term success," said Dr. Jacobi-Gresser. For those identified as risk patients, treatment options with implants made of zirconium dioxide are, according to expert opinions, particularly suitable.

In addition to their immunological compatibility, osseointegrative properties are a decisive aspect of the application of ceramic implants, highlighted Dr Richard J Miron in his speech. Thus, he pointed out that the osseous integration of titanium implants was improved and accelerated by specific modifications in their surface (mainly by sandblasting and etching). Recently, similar procedures have become available for the manufacturers of ceramic implants, adding an improved osseointegration to their advantageous effect on soft tissue regeneration. Moreover, Dr Jens Fischer described in his speech how the diameter of ceramic implants plays an important role in their application. According to Dr Fischer, a recently published study implies that implants made of zirconium dioxide should not feature a diameter smaller than 4.0 mm as this would disproportionately increase the risk of fracture.

In his speech on the phenomenon of low-temperature degradation (LTD) in the humid milieu, Dr Jerome Chevalier illustrated that we still need to do some homework on ceramic implants. In certain zirconium dioxide implants, this milieu may lead to a loss of stiffness and stability due to the transition of the chemical phase from tetragonal to monocline. Dr Chevalier added that further efforts in materials research will be necessary in order to further evaluate this phenomenon.

Dr Jaafar Mouhyi added another aspect in his speech on Saturday: Not only do the material features of the implant surface, the physical properties of the implant body and its design affect possible peri-implant complications, but implant positioning is another important factor. If a functional prosthetic restoration cannot be achieved due to a


Fig. 1


Fig. 2

Fig. 1: From left: Dr Jens Tartsch, Prof. Dr Sami Sandhaus, Dr Sammy Noumbissi (IAOCI founder and President). **Fig. 2:** More than 100 participants attended the IAOCI congress in Miami.

Photos: Henrik Schröder, OEMUS MEDIA AG

disadvantageous implant position, this could be the starting point of peri-implant inflammations, states Dr Mouhyi. However, ceramic-implant manufacturers have recently found a way to prosthetically adjust incorrect implant positioning to some extend: Dr Jens Tartsch and Dr Jochen Mellinghoff, M.Sc., discussed the prosthetic flexibility and advanced prosthetic applications of screwed two-piece zirconium dioxide implants.

In conclusion, the congress makers behind the 6th IAOCI World Congress must be complemented for giving the topic "ceramic implants" a rare but broad basis for discussion. However, further investigations and symposia of this calibre will be necessary in order to establish zirconium dioxide as a fully adequate alternative to titanium implants. As predicted, there were even more ceramic implant manufacturers after the last International Dental Show in Cologne, Germany,—good prospects for patients who wish to be provided with a metal-free implant-based restoration.

The 7th IAOCI World Congress will be held in California, USA, from 15 to 17 February 2018. For more information please visit: www.iaoci.com.

Fifth International Z-Systems Congress

Source: Z-Systems

About 70 specialists from ten countries met in the middle of June in sunny Nice for an update about ceramic implants. The high-quality presentations both amazed and convinced the participants.

It's all about ceramics

The first day was devoted to well-known concepts from dental practice. Dr Gabor Roza (Switzerland) started the presentations, and focused on treating patients without teeth, with special consideration to decreasing manual skills in later years. Thus, he uses a two-piece ceramic implant with straight and angled Locator® abutments. Dr Christoph Blum (Germany) then compared various ceramic systems and proved the clear clinical benefits of Z-Systems. In particular, he assessed the ability to grind abutments and the implants in collaboration with the laboratory as an important benefit.

Subsequently, Dr Georg Bayer and ZTM Norbert Wichnalek (Germany) gave an impressive presentation. Both have many years of experience in implantology and are personally convinced of the benefits of ceramic implants. Dr Bayer showed many successful immediate insertions of one-piece Z-Systems implants and immediate provision with temporary crowns. They also focused on the material and its handling. All ceramic implants are treated with plasma in their practice before implantation, which stimulates cell growth and leads to faster osseointegration. Dr Bayer and ZTM Wichnalek also showed that implant integration with plasma-treated ceramic functions better than titanium surfaces. They strongly advise against the use of PEEK and PEKK, because these two materials are a true plaque magnet. Further, the speakers pointed out that, for patients with a suspicion of periodontitis, one must conduct a titanium tolerance test, in order to meet their obligation of patient clarification.

Dr Jean-Louis Roche closed the programme in his practice which was only 50 metres away, with a smooth, live surgery with the new, two-piece bone-level implant. Afterwards, all participants enjoyed a social gathering in a nearby beach restaurant to the early morning hours.


Fig. 1


Fig. 2


Fig. 3

Fig. 1: About 70 specialists from ten countries met in the middle of June for the Fifth International Z-Systems Congress in Nice, France. **Fig. 2:** Dr Lüttmann, Dr Bianca, Dr Eppe and Dr Piconi (from left). **Fig. 3:** Dr Bayer (left) and Dr Mellinghoff.

High-calibre ceramic specialists

The second day started with Dr Ted Fields from Texas, who showed impressive results in terms of case numbers and clinical quality. He has placed over 500 two-piece Z-Systems implants in addition to a large number of one-piece ceramic implants, and impressively showed their aesthetic superiority as compared to conventional solutions. Dr Fields' very interesting presentation showed the benefit of grinding the implant shoulder, which provides functional and aesthetic optimisation of the soft tissue.

Dr Jochen Mellinghoff was then presented as another high-calibre ceramic specialist. His many years of experience, now with the two-piece Z-Systems implant, convinced the participants. His conclusion: the screw-type, two-piece Z5s bone-level implant has the potential to exceed the usual standard of titanium implants in the near future, and to revolutionise the market. Dr Giancarlo Bianca from Marseille then presented convincing aesthetic photos. As a scientific referent for the French Association for Periodontology, as well as Continuing Education in Implantology at Corte University (France), he values serious documentation and predictable treatment protocols. His conclusion was quite practical: Soft tissue loves ceramic, and accumulates very well there.

Two substantive scientific lectures about zirconium oxide by Prof. Corrado Piconi and Dr Pascal Eppe again filled the auditorium to its maximum. Prof. Piconi, as a materials scientist (University of Rome, Italy) specialising in ceramics technology, demonstrated the strengths and, of course, the special characteristics of zirconium dioxide in a very systematic manner. Dr Eppe (Belgium) on the other hand, pointed out various critical health aspects through a number of publications which have not yet received the attention they deserve on the use of metals in general, and in particular about titanium. Dr Ralf Lüttmann concluded the congress with an entertaining outlook on BoneWelding® in dental implantology, and showed new opportunities for the future which will be very exciting.

At its fifth international congress, Z-Systems proved with a good mixture and selection of speakers and topics why the company has achieved a technological leap over other ceramic systems. This concentrated skill in Nice was both clearly visible and tangible. The next congress will take place on 29 and 30 June 2018 in Valencia, Spain.

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Nobel Biocare and Dentalpoint announced

Partnership in the production of metal-free implants

Prof. Dr Stefan Holst, Vice President Nobel Biocare, Hans Geiselhöringer, President Nobel Biocare, Sandro Matter, Vice President of the Nobel Biocare multi-brand strategy.

At the 2017 European Association of Osseointegration (EAO) Congress in Madrid, Spain, Nobel Biocare announced it has entered into a partnership agreement with Dentalpoint AG, a leader in ceramic dental implants, to add a zirconia implant solution to its portfolio.

The partnership with Dentalpoint will add a new implant option to Nobel Biocare's leading range of titanium dental implants with the clinically proven TiUnite surface. The innovations from Dentalpoint, known for its ZERAMEX® implant brand, are intended to help clinicians meet patient demand for metal-free solutions and high-end aesthetics.

Utilising breakthrough manufacturing technology, Dentalpoint is the developer of the first completely metal-free two-piece bone level implant system with internal connection that is not dependent on cement. Screw-retained with an innovative metal-free screw based on carbon fibre, the two-piece nature of the system means that clinicians can treat patients with a zirconia implant using protocols similar to those they are familiar with for traditional implants. It also offers greater restorative flexibility compared with existing one-piece or cement-retained ceramic implant options.

A solution featuring this first-of-a-kind technology will be available from Nobel Biocare in early 2018. The introduction of a ceramic implant further extends Nobel Biocare's comprehensive range of innovative solutions for immediate function and excellent aesthetics.

Hans Geiselhöringer, President Nobel Biocare, said: "Nobel Biocare has been actively researching ceramic dental implant technology for many years. In Dentalpoint AG we have now found a partner and solution that meet the high standards we and our customers demand. As a result of this partnership, Nobel Biocare customers will very soon be able to offer their patients the very first completely metal-free screw-retained two-piece implant solution with an internal connection. It is the ideal addition to our already extensive range of solutions that maintain tissue-health and deliver long-lasting aesthetics."

Jürg Bolleter, President Dentalpoint AG, said: "As interest in ceramic implants among patients grows, so too does demand around the world. We are excited by the potential of this partnership with a company of the reputation and heritage of Nobel Biocare and, most importantly, the role it will play in helping more clinicians and patients across the globe to benefit from our standard-setting ceramic implant innovations."

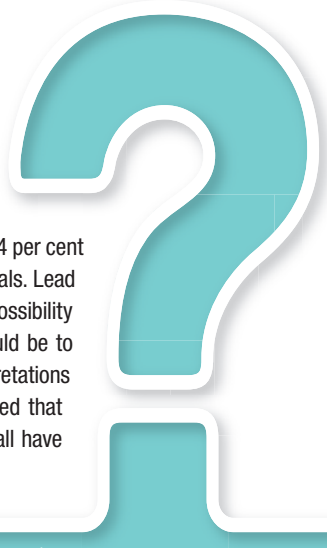
Researchers uncover the

Spin in scientific papers

In a new study, researchers from Australia have found more than a quarter of biomedical scientific papers may utilise practices that distort the interpretation of results or mislead readers so that the results are viewed more favourably—a practice known as "spin".

The researchers from the University of Sydney's Charles Perkins Centre and Faculty of Pharmacy, used meta-analysis to examine the association of spin with industry sponsorship of research. They reviewed 35 reports that investigated spin in clinical trials, observational studies, diagnostic accuracy studies, systematic reviews and meta-analyses, with the nature of spin varying depending on the study design.

In the researchers' findings, more than 26 per cent of papers identified as systematic reviews or meta-analyses contained spin. This figure rose to up to 84 per cent in papers reporting on non-randomised trials. Lead author Kellia Chiu pointed out that one possibility for combating the publishing of spin would be to publish results alongside other interpretations from multiple researchers. Chiu also noted that researchers, peer reviewers and editors all have a responsibility to remain vigilant for spin.



INTRODUCING THE

IAOCI | INTERNATIONAL ACADEMY OF CERAMIC IMPLANTOLOGY

7th IAOCI World Congress

INTERNATIONAL ACADEMY OF CERAMIC IMPLANTOLOGY

FEBRUARY 15th–17th, 2018

Hilton Resort & Spa, San Diego, CA

PLAN TO ATTEND

SPEAKERS

- Ulrich Volz *Keynote Speaker*
- Dianne Daubert
- Dan Hagi
- Sook Hong
- Johann Lechner
- Dominik Nischwitz
- Sammy Noumbissi *Program Chair*
- Mutlu Özcan
- Paul Petungaro
- Corrado Piconi
- Joan Pins-Anfruns
- Andre Saadoun
- Antonio Scarano
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www.iaoci.com

4th Annual Meeting of ISMI

22–23 June 2018
Venue: Hamburg, Germany
www.ismi.me

6th International Z-Systems Congress

29–30 June 2018
Venue: Valencia, Spain
www.zsystems.com

1st Future Congress of Dental Implantology 48th Annual Meeting of the DGZI

28–29 September 2018
Venue: Düsseldorf, Germany
www.dgzi.de

EAO Congress 2018

11–13 October 2018
Venue: Vienna, Austria
www.eao.org

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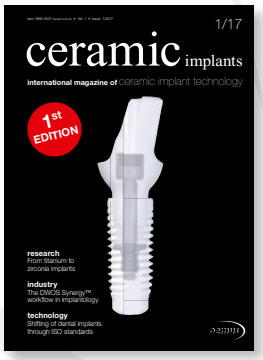

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