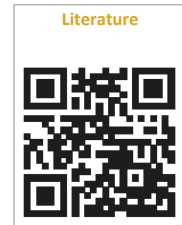


Ceramic implants have long since left behind their former rather marginal status as the exotics of implantology and are now increasingly being adopted in modern dental practice. Increased health awareness of the general public and hence the increased demand for metal-free treatment options are also certainly factors in this perceptible trend.



Reversible screwed ceramic implants in the aesthetic front tooth area

Dr. Jens Tartsch

The “metal-free” trend has long been apparent especially with crowns and bridge prostheses and by extension is also now evident in implantology. According to a survey by the firm Straumann, 53% of patients who were questioned would correctly leave the choice of implant material to the treating dentist, but a significant 35% of patients would opt for a ceramic implant and only 10% for a titanium implant (N. N. 2%).¹

Biocompatibility of titanium

The increased demand for metal-free implants is perhaps not entirely unjustified, as initial studies give reason to believe that titanium implants are not quite as biocompatible as was previously supposed. There is now no question that titanium implants are subject biocorrosion, especially in the presence of lipopolysaccharides from bacterial walls and that titanium particles have been found in the peri-implantational hard and soft tissues.²⁻⁵ For a certain proportion of patients, which cannot at present be quantified in terms of percentage, this is likely to be not entirely unproblematic.

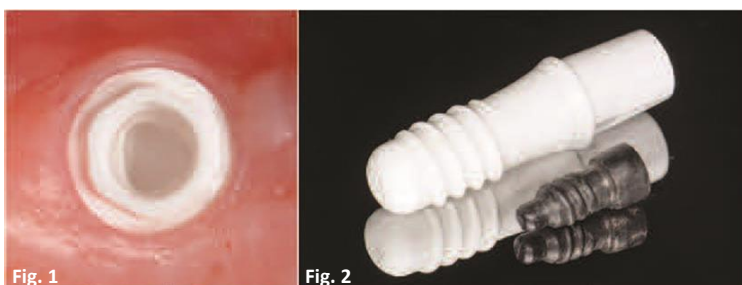


Fig. 1: External hex of the Zeramex P6 implant. – **Fig. 2:** Zeramex P6 implant, abutment and VICARBO screw.

The frequently cited titanium allergy does not however play a role, as a titanium allergy in the sense of a type IV sensitization typical for metals is not considered to be possible from an immunological point of view. The classic mechanism of such type IV sensitization to metals is based on the presence of free metal ions, which cannot occur with titanium due to its high reactivity and immediate formation of titanium oxide. Such reports are probably due to sensitization to other alloy components such as aluminum and vanadium (titanium grade V) or due to impurities due to nickel or chromium (also with pure titanium IV).⁶ The titanium dioxide particles

created by corrosion and wear are phagocytized by tissue macrophages, which consequently by way of a chronic, non-specific inflammation reaction secrete proinflammatory cytokines such as TNF- α and interleukin-1 β . If an increased secretion rate of these cytokines occurs, this is described as a titanium incompatibility, which can be identified by means of a blood sample even before the implantation is performed (titanium stimulation test). There is a lot of evidence to suggest that these processes may contribute, among other things, to the occurrence of peri-implantitis and even appear to influence the emergence of systemic chronic disorders.⁷ Further studies are required in this area in the future.

Improved characteristics of zirconium implants

The increasing interest in ceramic implants as an extension and supplement to the treatment options is also discernible among practicing dentists. This is because modern ceramic implants are practically equivalent to titanium implants, with comparable success rates and exhibit significant differences to earlier ceramic implants.⁸

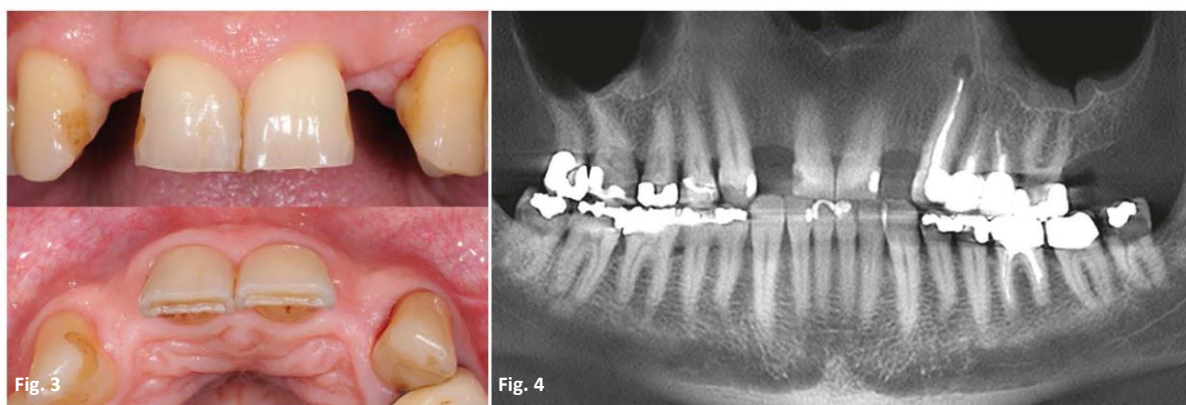


Fig. 3: Initial situation. - **Fig. 4:** OPG (orthopantomogram) initial situation.

There have been rapid developments, especially with regard to the material and surface design. With materials such as Y-TZP-A with a flexural strength of up to 1,200 MPa or ATZ with a flexural strength of up to 2,000 MPa, the risk of fracture is reduced to a minimum.^{9,10} Aging processes due to hydrothermal degradation have hardly any clinical relevance.¹¹ Aluminum oxide blasting (macrostructuring) and acid etching of the implant surface (microstructuring) create an enhanced bone-implant contact (BIC) comparable with that which is achieved with titanium. Accordingly, ceramic implants are now in no way inferior to titanium implants with regard to osseointegration.¹²⁻¹⁴ With the right indication and with observance of the manufacturer's guidelines, ceramic implants are now a safe and reliable treatment option, which even offers advantages in comparison with titanium implants.

Soft tissues and ceramics

Manufacturers primarily emphasize the benefits of ceramic implants with regard to aesthetics. However, it goes without saying that excellent aesthetic results can also be achieved with titanium implants. The prerequisite for this is the presence of an at least 2 mm thick peri-implantational mucous tissue, which prevents gray translucence of the implants.¹⁵ If this is not the case, the mucous tissue should be thickened with connective tissue transplants, which means an additional morbidity risk for the patient. In most cases this can be avoided with ceramic implants. The alternative use of full ceramic abutments as a solution for problems should be avoided. Micro-movement of the hard zirconium on the softer titanium leads to wear of the titanium and even destruction of the implant interface.^{16,17}

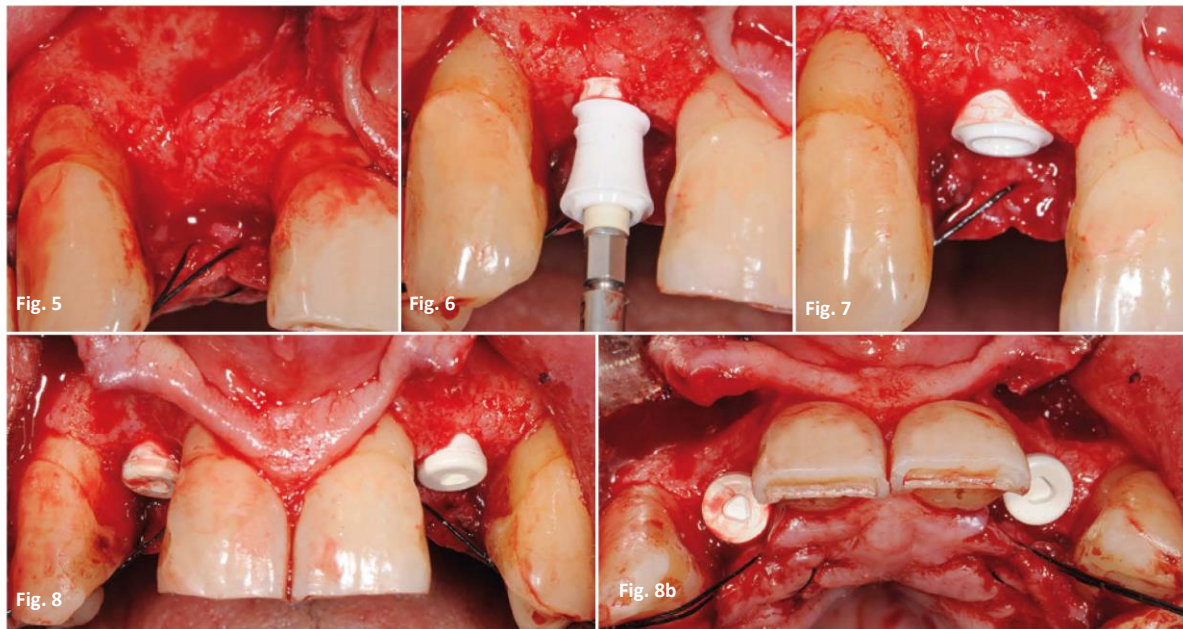


Fig. 5: Insertion site with incisive fossa. - **Fig. 6:** Gradual installation of implant. - **Fig. 7:** Implant in situ, implant shoulder just below the enamel-cement boundary. - **Fig. 8a:** Implants with sealing screws, frontal. - **Fig. 8b:** Implants with occlusal sealing screws, slight palatal offset of implants.

The main argument for the use of ceramic implants is the positive effect of the material on the peri-implant soft tissue. Any dentist who compares the tissue around metal-ceramic veneer crowns and full ceramic crowns is aware of this. This equally applies to the implant material. Ceramics as a material exhibits significantly less plaque accumulation and lower bacterial adhesion.^{18,19} With ceramics, circular blood perfusion also corresponds to that in the natural tooth, whereas with titanium it is significantly reduced.²⁰

One-piece vs. two-piece

On the other hand, at present most ceramic implants are still one-piece systems. Although this is initially advantageous to the prosthetic dentist, for example in for taking impressions and cementation, with protocols corresponding to those for the treatment of a natural tooth, however, only cementation is possible and removal of the cement is no longer reliably achievable when the crown edge is more than 1 to 1.5 mm subgingival.²¹ One-piece systems should therefore correctly be positioned at tissue level. This implant type also requires a high level of primary stability, above all in the temporary phase during the healing period and also requires exact vertical and horizontal alignment of the implant axis in accordance with the prosthetic requirements. In the aesthetic frontal tooth area, due to the anatomical conditions this requires in many cases more extensive augmentative measures, whereby covered wound closure is desired.²² Complete wound closure is not possible with one-piece implants.

This is the advantage of two-piece systems, which enables unstressed healing and covered wound healing immediately after surgery. When the healing phase is completed, the abutment connection is normally created in these systems by cementation of the abutment to the implant. The restoration is also cemented. Similarly to one-piece implants, the implant shoulder must be epigingivally positioned as this defines the position of the crown edge. The two-piece implant once again becomes a one-piece implant in the prosthetic phase and is hence no longer flexible or reversible.

New systems: two-piece screwed

Only the screw fixing of the abutment and restoration is flexible and reversible, which now represents the gold standard of restorative care of titanium implants. The advantages are obvious: No risk of excess cement, simple soft tissue management, molding of the emergence profile as well as simple repair and reentry options. As ceramics are significantly stronger under compression than under tension, the attachment of the zirconium abutment to the zirconium implant with metal screws presents new challenges.²³ Metal screws generate tensional forces and tensional peaks in the implant which are disadvantageous for the ceramic material. Wear and abrasion can be caused in the screw by rubbing and fretting.²⁴

The Dentalpoint ZERAMEX P6 implant provides a completely new solution. This implant consists of high strength ATZ ceramics with a flexural strength of 2,000 MPa. The implant surface is sand blasted and is additionally microstructured with acid etching. The implant design is analogous to and congruent with the Straumann SP implant, which came out top in an implant study (Swedish Implant Register).²⁵ The surgical protocol for the Zeramex P6 is also analogous to the Straumann SP implant is ; thus the original Straumann instruments can be used in the surgical phase. The difference lies in the implant interface, which in the P6 consists of an external hexagon. The abutment (straight or angulated) can be placed in six positions with rotational locking on this “external hex” (Fig. 1), without the implant being mechanically overloaded.

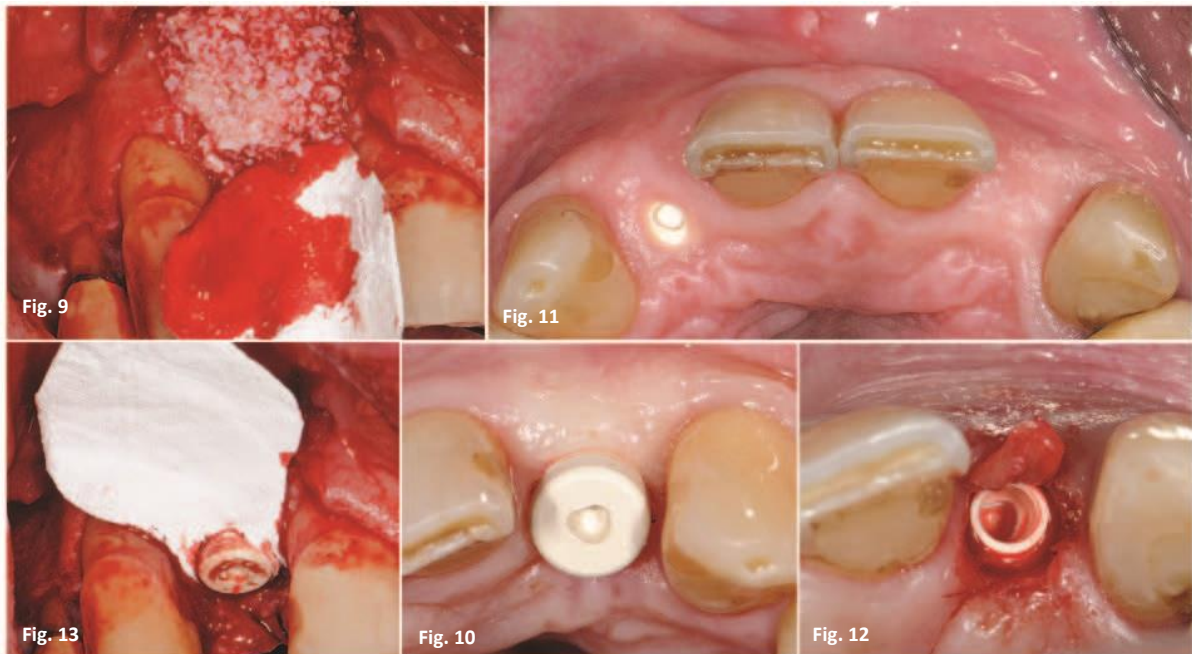


Fig. 9: Lateral augmentation with Bio-Oss and Bio-Gide. - **Fig. 10:** Perforated membrane. - **Fig. 11:** Inflammation-free status pre-reentry. - **Fig. 12:** Gingiva former in situ. - **Fig. 13:** Reentry with roll flap.

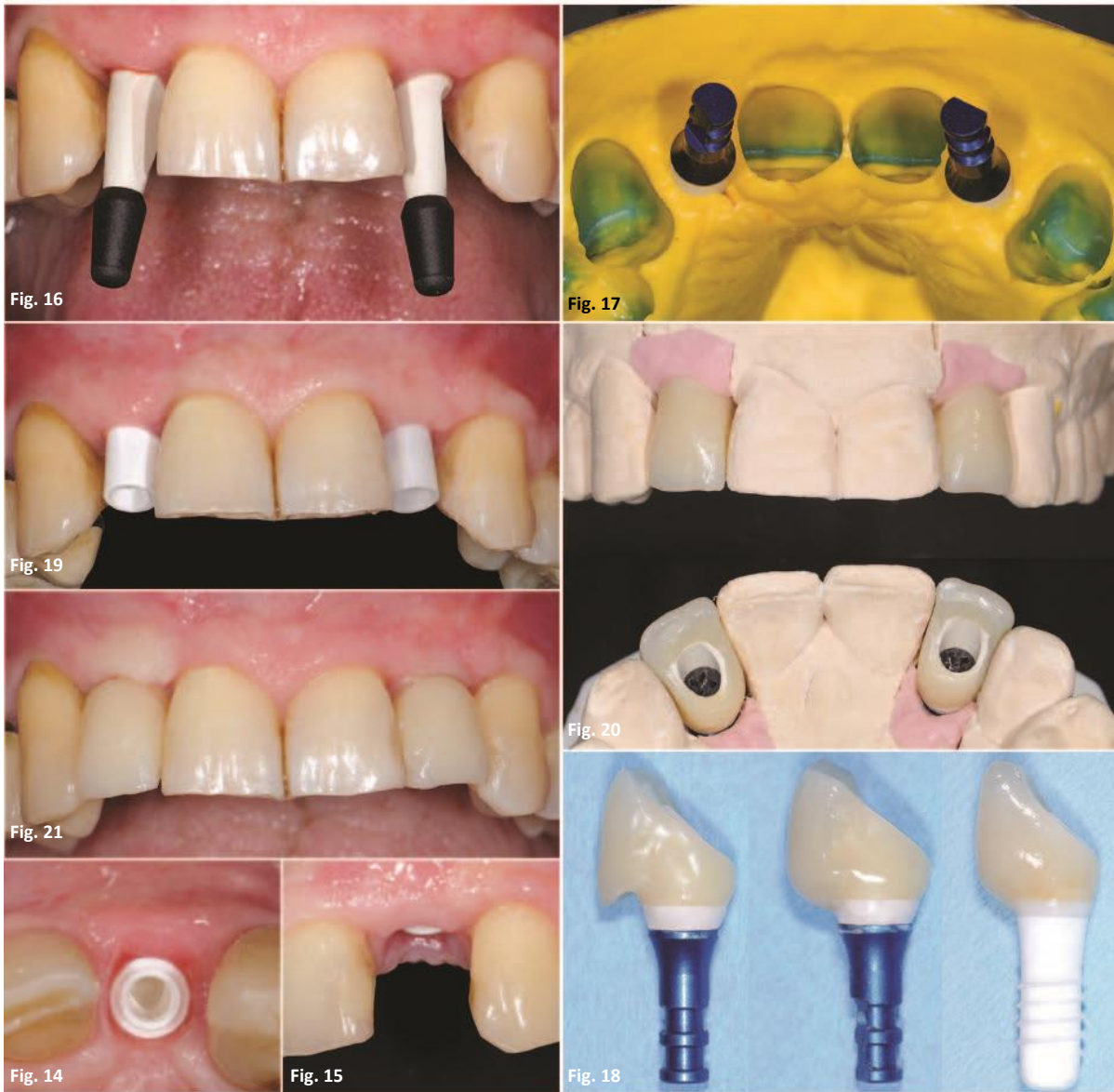


Fig. 14: Initial impression taking completed. - **Fig. 15:** Imprint with reduced laboratory analog. - **Fig. 16:** Selection of abutments. - **Fig. 17:** Provisional crowns on PEEK abutments. - **Fig. 18:** Anemic zone after further molding with extended provisional crown. - **Fig. 19:** New occlusal emergence profile. - **Fig. 20:** New frontal emergence profile. - **Fig. 21:** Gradual extension of the temporary restoration and the final restoration.

The special innovation lies in the screw connection, which for the first time is a genuinely metal-free screw made of the high performance material VICARBO (Fig. 2). This material has been used for several years to create cages in spinal column surgery, where it has demonstrated its stability and biocompatibility. VICARBO is a PEEK matrix with a 60% proportion of continuous, uninterrupted carbon fibers, which are responsible for the extremely high tensional strength. Theoretically a tightening torque of up to 85 Ncm possible; however, in the clinical context only a torque of 35 Ncm is required, as in the case of titanium screws. The forces are not transmitted, as in the case of metal screws, by sharp threads pitches but rather by rounded threads, which enable an even force transmission into the implant body without load peaks. Loading tests in accordance with ISO 14801 demonstrated good fatigue resistances with values comparable to those of titanium fixings. These innovative screw connections mean that the advantages of screwed titanium implants can now also be realized in ceramic implants as is shown in the following case.

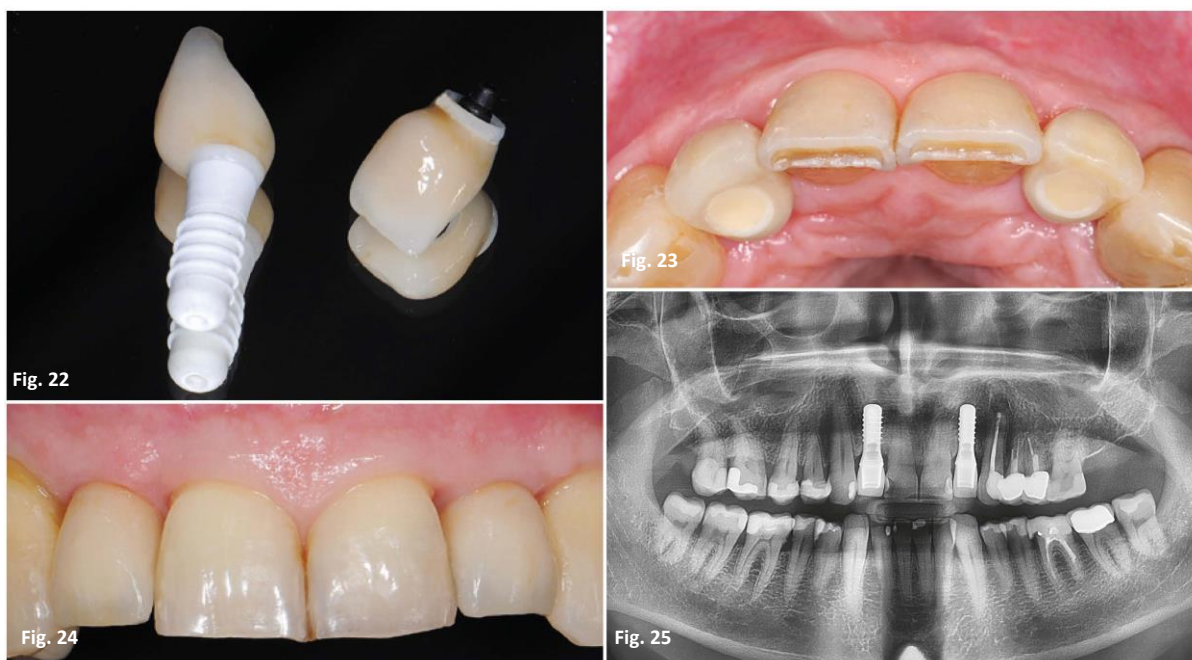


Fig. 22: Directly pressed over, metal-free screwed crowns. - **Fig. 23:** Palatal closure of screw canal. - **Fig. 24:** 1.5 years after surgery. - **Fig. 25:** OPG 1.5 years after surgery.

Case study

A 63 year old male patient (non-smoker) came to the practice with a request for metal-free treatment with ceramic implants. The two lateral incisors had been removed eleven years previously at another practice in a foreign country, allegedly due to insufficient, irreversible root fillings (Fig. 3 and Fig. 4). This could not be verified as no documentation of the initial situation was available. At 23 there was an apical osteitis; treatment (root tip resection) was performed with the implant. A bridge was not considered due to the healthy state of the adjacent teeth. The general medical history was unremarkable. Oral hygiene, which was initially suboptimal, was significantly improved by patient instruction and motivation.

The initial situation showed adequate bone volume with resorption-related buccal bone deficits at the extraction sites and retractions of the right and left incisive fossa (Fig. 5). To prevent further resorptive processes and for aesthetic support of the soft tissues, a lateral contour augmentation was provided; a two-piece implant system was required to ensure saliva resistant closure with simultaneous implantation.²⁶ After local anesthesia, a crestal, slightly palatally offset incision was made with only one buccal, distalrelief incision.

As the design of the implant used in this case (ZERAMEX P6) was congruent with the Straumann SP titanium implant, two implants each with a diameter of 4.1 mm and length of 12 mm were inserted in accordance with the surgical protocol (Straumann SP implant) within the comfort zone:²⁷ Implant shoulder 2 mm below the enamel-cement boundary of the adjacent teeth, slightly palatally offset with a axial inclination appropriate for a palatal screw connection. This low positioning of the implant shoulder was only possible because the implant can be screwed in place without cementation (. - Fig. 6-Fig. 8b).

Lateral contour augmentation (BioGide, Bio-Oss) was also performed at both implant positions. Among other things, this served to prevent recessions, which could result from the funnel-shaped, but constantly stable bone remodeling as previously described for SP implants.²⁸ In order to ensure that the wound

closure was as strain-free as possible, the collagen membrane was perforated and drawn over the implant (Fig. 9 and . - Fig. 10). After periosteal slitting, the surgical zone was sutured to seal it against bacteria. The healing process was free of complications.

When the implant was opened, twelve weeks after surgery, a slight, completely inflammation-free perforation could be seen above the implant 12 (. - Fig. 11). It was thus possible to introduce the gingiva former without further measures (. - Fig. 12). The implant 22 was completely covered and was opened with a buccally pediculated roll flap (. - Fig. 13).

14 days after reentry, the initial impression with impression post was performed as with titanium implants (Fig. 14 and Fig. 15). It was therefore possible to dispense with manipulation of the new hemidesmosomal attachment to the implant neck by electrotomy or retraction threads, which would otherwise be necessary with one-piece or previously cemented implants for exposure of the implant shoulder and thus the crown edge. The emergence profile did not yet correspond to the desired form, but rather to the round cylindrical gingiva former. Although the abutments could already be individually adjusted (Fig. 16), the screw connection offers the possibility of further gradual shaping of the emergence profile. In the laboratory, the provisional restoration with overhang was created on the PEEK secondary section and palatally screwed into place (Fig. 17). The overhang represented the desired contour of the later mucosal garland.

Over 14 days, this overhang was gradually supplemented with flowable composite to form the emergence profile (Fig. 18-Fig. 21), which in this case was complete after six weeks. The second individual imprint for the production of the final restoration could now be performed, which also integrated the newly modeled emergence profile. Due to their screw connections, the abutments allow a variety of prosthetic options; these include, for example, cementation onto screw abutments or extra- or intraoral cementation similar to a titanium cementation base.

In this case, it was decided to dispense with the use of any cement or glued joints. The abutment was therefore directly pressed over with e.max Press and the emergence profile formed according to the imprint (Fig. 22). The palatal screw canal was adjusted in the passage to the width of the screw, which enabled simple substitution of the screw and the restoration.

For the integration of the restoration it is recommended, to simply trust the screw and to tighten it with the specified torque of 35 Ncm. This is the only way to ensure that the VICARBO, which is more ductile than zirconium, evenly fits to the internal geometry of the implant so that the closure is as seamless as possible. The screw access canal was sealed with a Teflon tape and composite (Fig. 23). Even 1.5 years after implantation, the implant is stable and inflammation-free. Bone remodeling is completed and unchanged (Fig. 24 and Fig. 25).

Abstract

The novel screw connection of the ceramic implant used in this case enables all variants of restorative treatment which are standard with titanium. Even the digital workflow is supported by the screw connection. For this purpose, a scanbody and the abutment (ZERABASE) are available as a special zirconium cementation base. The implant (ZERAMEX P6) thus enables the implementation of almost all standard treatment protocols based on titanium implants even in implantology with ceramic implants.

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