Ceramic implants have shed their niche existence in implantology and are increasingly finding their way into modern dental practices. The increased health consciousness in the population and the resulting higher demand for metal-free treatment alternatives are certainly reasons for this observable trend.

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Author Information

Literature

Reversibly screw-retained ceramic implant in the aesthetic front tooth area.

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The "metal-free" trend has been recognizable in the field of crowns and bridges for quite some time, and it is now being consistently continued in implantology as well. According to a survey conducted by Straumann, 53% of the surveyed patients correctly leave the choice of implant material to their treating dentist. However, 35% of patients would opt for a ceramic implant, while only 10% would choose a titanium implant (N. N. 2%).[1]

Biocompatibility Titanium

Perhaps the increased demand is not entirely unjustified, as initial studies suggest that titanium implants may not be as biocompatible as they have always been assumed to be.

The fact that titanium implants are susceptible to biocorrosion, especially in the presence of lipopolysaccharides from bacterial cell walls, and that titanium particles have been found in peri-implant hard and soft tissues is well-established today. For a certain, as yet unknown percentage of patients, this may at least pose some concerns.

However, the often-mentioned titanium allergy does not play a role, because a titanium allergy, in the sense of a typical Type IV sensitization seen with metals, is not immunologically possible. The classical mechanisms of such Type IV sensitization to metals are based on the presence of free metal ions, which cannot occur with titanium due to its high reactivity and immediate formation of titanium dioxide.

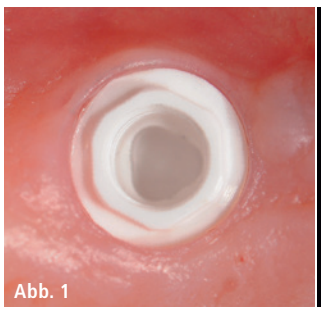
Abb. 1


Abb. 2

Abb. 1: Außen-Hex des Zeramex P6 Implantates. – **Abb. 2:** Zeramex P6 Implantat, Abutment und VICARBO-Schraube.

Reports regarding this matter are more likely attributable to sensitization to other alloy components such as aluminum and vanadium (Titanium Grade V) or to impurities like nickel or chromium (even in pure Titanium Grade IV). The titanium dioxide particles formed through corrosion and wear are phagocytized by tissue macrophages, which subsequently secrete pro-inflammatory cytokines such as TNF-α and interleukin-1β as part of a chronic non-specific inflammatory response. When there is an increased secretion rate of these cytokines, it is referred to as titanium intolerance, which can be detected prior to implantation through a blood test (titanium stimulation test). There is a growing body of evidence suggesting that these processes can contribute to the development of peri-implantitis and may even have an impact on the onset of systemic chronic diseases. Further studies are needed to confirm these findings.

Improved Properties of Zirconia Implants

In the field of dentistry, there is also a growing interest in ceramic implants as a supplement and

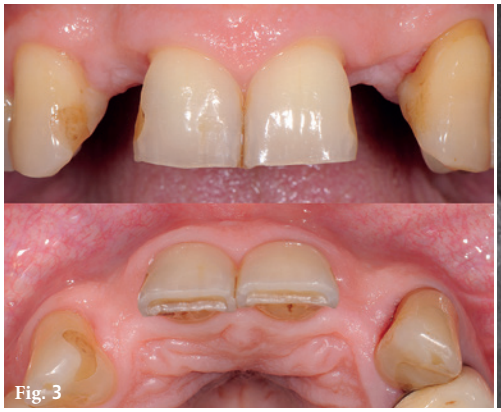
Fig. 3

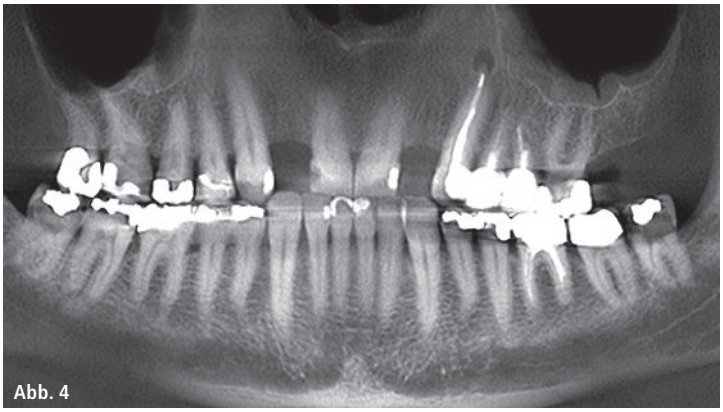
Abb. 4

Fig. 3: Initial situation. – Fig. 4: Initial OPG (Orthopantomogram) situation.

In the field of dentistry, there is also a growing interest in ceramic implants as an expansion of the treatment spectrum. Modern ceramic implants now compete with titanium implants on nearly equal footing, with comparable success rates and significant differences from earlier ceramic implants.8

Especially in terms of material and surface design, rapid advancements have occurred. Materials like Y-TZP-A with a bending strength of up to 1,200 MPa or ATZ with a bending strength of up to 2,000 MPa reduce the risk of fractures to a minimum.9,10 The aging process due to hydrothermal degradation has little clinical relevance.11 In addition to alumina blasting (macro-structuring) Acid etching of the implant surface (micro-structuring) results in increased and comparable Bone-Implant-Contact (BIC) to titanium. Thus, ceramic implants are now on par with titanium implants in terms of osseointegration.12–14 In the right indications and when following manufacturer guidelines, ceramic implants represent a safe and reliable treatment option today, especially since they even offer advantages over titanium implants.

Soft Tissues and Ceramic

First and foremost, aesthetics are emphasized by manufacturers of ceramic implants. However, it is naturally understood that "Outstanding aesthetics can also be achieved with titanium implants. The prerequisite is the presence of a peri-implant mucosa that is at least 2 mm thick, preventing the grayish appearance of the implants from showing through.15

If this is not the case, thickening of the mucosa with connective tissue grafts should be considered, which entails additional morbidity for the patient. In most cases, this can be avoided with ceramic implants. The alternative use of all-ceramic abutments as a solution should also be avoided. The micro-movement of hard zirconia on the softer titanium leads to titanium abrasion and can result in the destruction of the implant interface. [16,17]

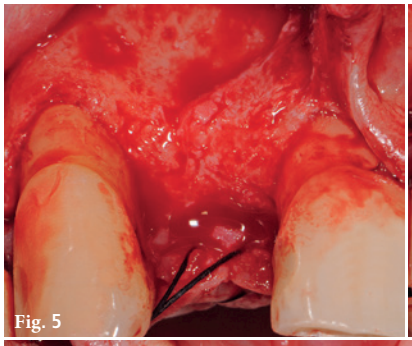
Fig. 5

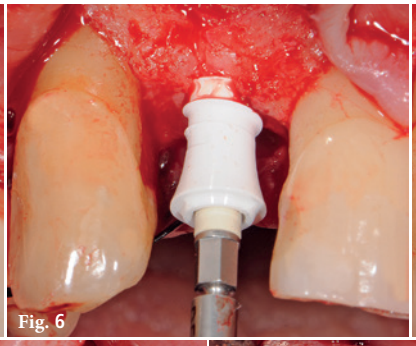
Fig. 6

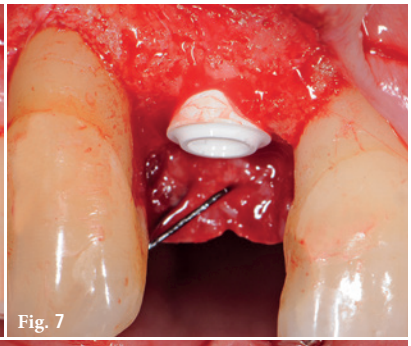
Fig. 7

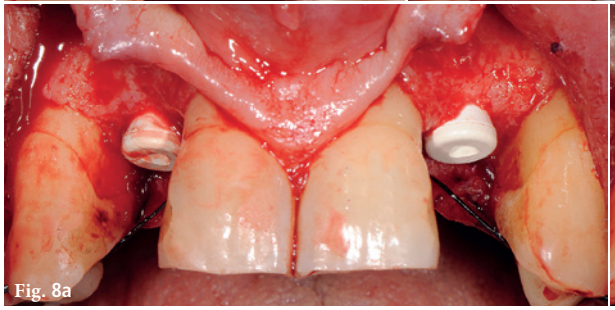
Fig. 8a

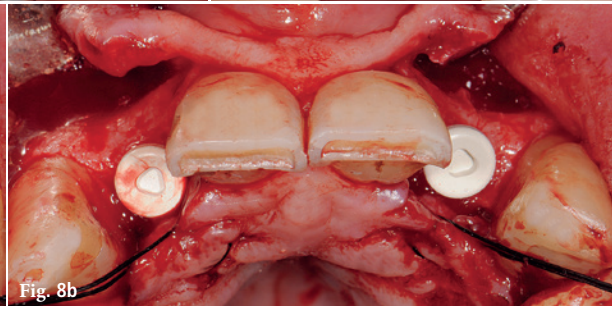
Fig. 8b

Fig. 5: Insertion site with incisive fossa. – Fig. 6: Slow insertion of the implant. – Fig. 7: Implant in situ, implant shoulder slightly below the enamel-cement border. – Abb. 8a: Implants with closure screws frontal. – Fig. 8b: Implants with closure screws occlusal, slightly palatal position of the implants.

The primary argument for the use of ceramic implants lies in the positive impact of the material on peri-implant soft tissues. This fact is well-known to any dentist who compares the soft tissues around metal-ceramic veneer crowns and all-ceramic crowns. The same applies to implant materials. Ceramic material exhibits significantly lower plaque accumulation and reduced bacterial adhesion.18,19 Furthermore, the circular blood circulation with ceramics closely resembles that of natural teeth, whereas with titanium, it is significantly reduced.20

On the other hand, most ceramic implants today are still one-piece systems. While this initially aligns with the procedures for prosthodontists, as the protocols for impression-taking and cementing the restoration match those for treating a natural tooth, there's a limitation—only cementation is possible, and removing the cement is not reliably feasible when the crown margin is located more than 1 to 1.5 mm subgingivally.21 Therefore, one-piece systems should be correctly positioned at the tissue level.

Additionally, this type of implant requires high primary stability, especially for the provisional phase during the healing period, and precise vertical and horizontal alignment of the implant axis to meet prosthetic requirements. In the aesthetic zone of the front teeth, this often necessitates more extensive augmentative procedures due to anatomical constraints, with the aim of achieving a covered wound closure.22 Complete wound closure is not possible with one-piece implants.

Here lies the advantage of two-piece systems, which initially allow for an unloaded healing process and a covered wound healing after the surgery. After the completion of the healing phase, in these systems, the abutment connection is typically achieved by cementing the abutment onto the implant. The restoration is also cemented. Similar to one-piece implants, the implant shoulder must be positioned epigingivally as it defines the location of the crown margin. The two-piece implant, in the prosthetic phase, essentially becomes a one-piece implant and is no longer flexible or reversible.

New Concepts: Two-Piece Screw-Retained

Flexibility and reversibility are only possible with the screw-retained connection of the abutment and the restoration, which is today's gold standard in the restorative treatment of titanium implants. The advantages are clear: no risk of excess cement, easy soft tissue management, shaping of the emergence profile, and straightforward repair and re-entry options. Since ceramics are much more resistant to compression than tension, the screw-retained connection of zirconia abutments with zirconia implants and metal screws presents new challenges.23 Metal screws introduce tensile forces and stress points that are unfavorable for ceramic materials. Friction and fretting can lead to wear and abrasion on the screw.24 A completely new solution is presented by the company Dentalpoint with the ZERAMEX P6 implant. This implant is made of high-strength ATZ ceramic with a bending strength of 2,000 MPa. The implant surface is sandblasted, and acid etching is additionally microstructured. The implant design is analogous and congruent

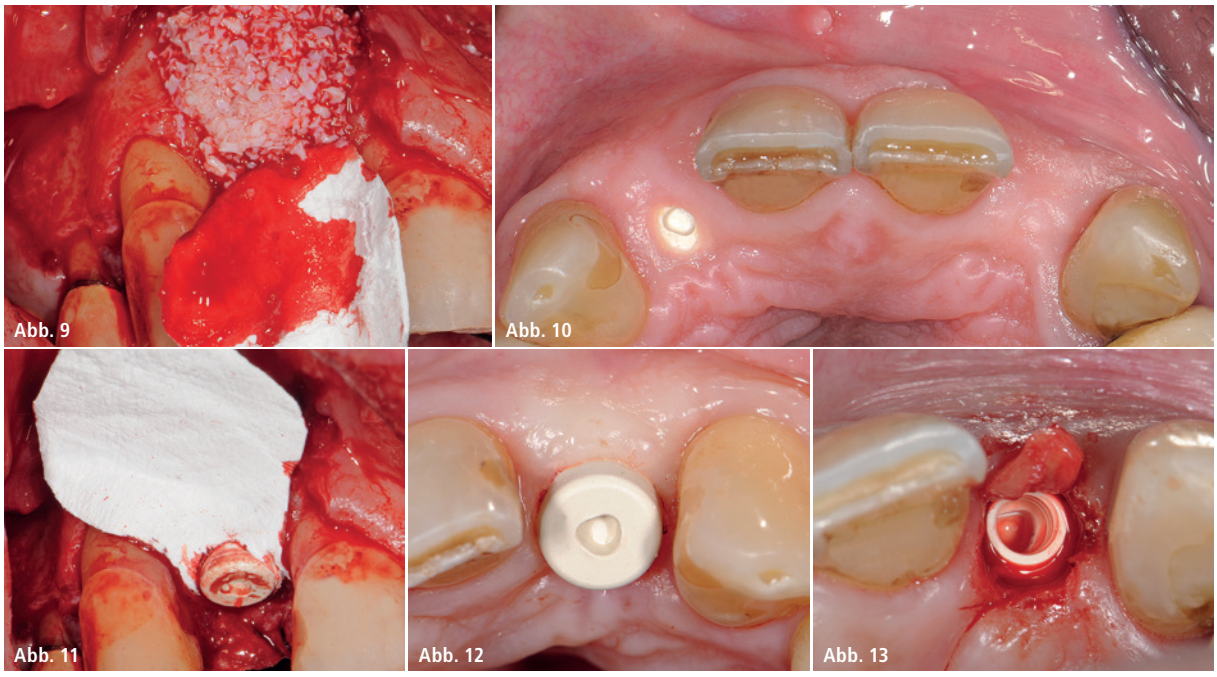

Abb. 9: Laterale Konturaugmentation mit Bio-Oss und Bio-Gide. – **Abb. 10:** Gelochte Membrane. – **Abb. 11:** Reizlose Verhältnisse prä Reentry. – **Abb. 12:** Gingivaformer in situ. – **Abb. 13:** Reentry mit Roll-Flap.

Abb. 14: Erstabformung geschlossen. – **Abb. 15:** Abdruck mit reponiertem Laboranalog. – **Abb. 16:** Auswahl der Abutments. – **Abb. 17:** Provisorische Kronen auf PEEK-Abutments. – **Abb. 18:** Anämische Zone nach weiterer Ausformung mit erweiterter provisorischer Krone. – **Abb. 19:** Neues Emergenzprofil okklusal. – **Abb. 20:** Neues Emergenzprofil frontal. – **Abb. 21:** Schrittweise Erweiterung des Provisoriums und der definitiven Restauration.

to the Straumann SP implant, which performed the best in an implant study (Swedish Implant Register).25 Therefore, the surgical protocol for the Zeramex P6 is also analogous to the Straumann SP implant, and even the original Straumann instruments can be used for the surgical phase. The difference lies in the implant interface, which, in the case of the P6, is an external hexagon. On this 'external hex' (Fig. 1), the abutment (straight or angulated) can be securely placed in six rotational positions without introducing overloads into the implant.

The special innovation lies in the screw, which is truly metal-free for the first time and is made of the high-performance material VICARBO (Fig. 2). This material has been used for several years as cages in spinal surgery, where it has demonstrated its stability and biocompatibility. VICARBO is a PEEK matrix with a 60% continuous, uninterrupted carbon fiber content, which results in an extremely high tensile strength. Theoretically, a torque moment of up to 85 Ncm is possible, but clinically, only a tightening force of 35 Ncm, as required with titanium screws.

The transmission of forces does not occur as with metal screws, which have sharp threads, but rather with rounded threads, allowing for even force distribution without stress peaks in the implant body. Load tests according to ISO 14801 demonstrated good fatigue strength values comparable to those of connections made with titanium. With this innovative screw, the advantages of screw-retained titanium implants can now also be realized with ceramic implants, as illustrated in the following case.

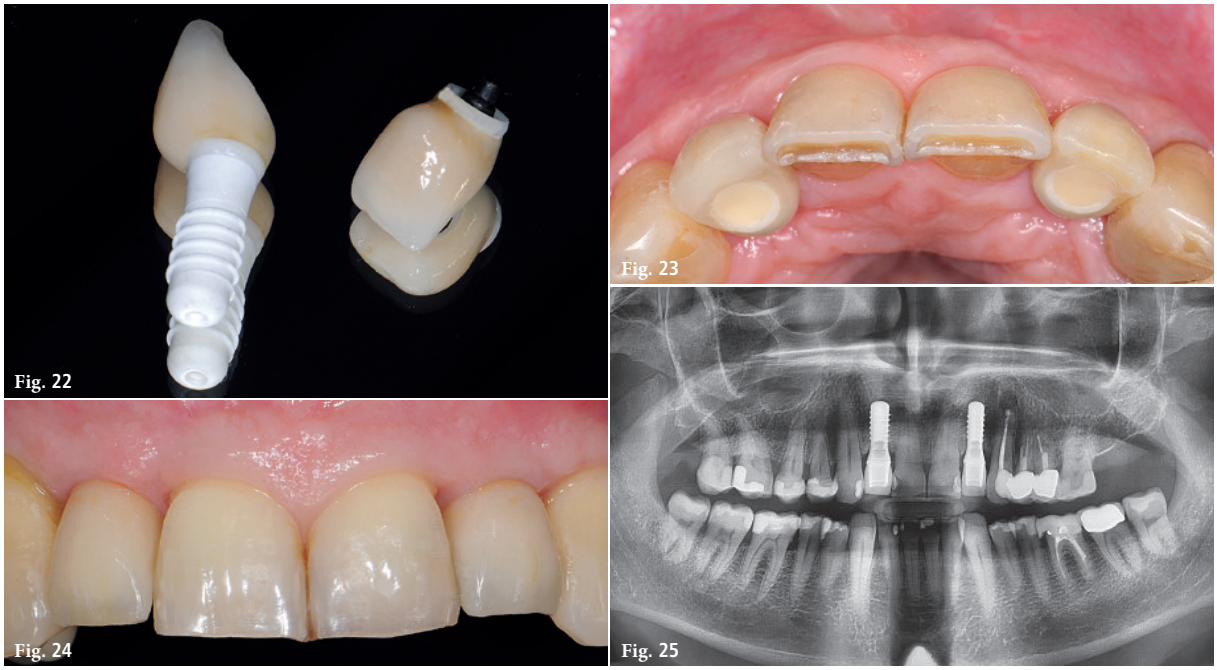

Fig. 22: Directly overpressed, metal-free screw-retained crowns. – Fig. 23: Palatal closure of the screw channel. – Fig. 24: 1.5 years post-operation. – Fig. 25: Orthopantomogram (OPG) 1.5 years post-operation.

Patient Case

A 63-year-old patient (non-smoker) presented to the practice with the desire for a metal-free solution using ceramic implants. The two lateral incisors had been removed abroad allegedly due to inadequate, irreparable root fillings eleven weeks earlier (Fig. 3 and 4). This could not be verified since there was no documentation of the initial situation. Apical osteitis was found at 23, and therapy (apicoectomy) was performed along with implant placement. A bridge restoration was not considered due to healthy neighboring teeth. The patient's general medical history was unremarkable. Initially suboptimal oral hygiene was significantly improved through instruction and motivation.

The initial situation revealed sufficient bone volume with buccal bone deficiencies due to resorption at the extraction sites and indentations in the incisive fossa on the right and left (Fig. 5). To prevent further resorption and for aesthetic support of the soft tissues, a lateral contour augmentation was planned, with a saliva-tight closure using.

the need for a two-piece implant system for simultaneous implantation.26

Following local anesthesia, a crestal, slightly palatal offset incision was made, each with only one buccal relief incision placed distally. Since the implant used here (ZERAMEX P6 implant) has a design congruent with the Straumann SP titanium implant, the insertion of two implants with a diameter of 4.1 mm and a length of 12 mm each was carried out according to the surgical protocol (Straumann SP implant) within the comfort zone:27 Implant shoulder positioned 2 mm below the enamel-cement border of the adjacent teeth, slightly palatally offset with an axis inclination suitable for palatal screwing. This deep positioning of the implant shoulder is only possible because the implant can be screw-retained without cement (Fig. 6–8b).

A lateral contour augmentation (Bio-Gide, Bio-Oss) was performed at both implant positions. Among other things, this serves to prevent recessions that could arise due to the funnel-shaped but always stable bone remodeling described for SP implants.28 To achieve as tension-free a wound closure as possible.

to achieve as tension-free a wound closure as possible, the collagen membrane was perforated and pulled over the implant (Fig. 9 and 10). After periosteal slitting, the surgical area could be sutured in a bacteria-tight manner. The healing process was uneventful. At the implant opening twelve weeks post-operation, a slight, completely benign perforation was observed above implant 12 (Fig. 11). Therefore, the gingival former could be placed without further measures (Fig. 12). Implant 22 was completely covered and opened with a buccally based roll flap (Fig. 13).

14 days after re-entry, the initial impression was taken using impression posts, analogous to titanium implants (Fig. 14 and 15). This allows avoiding manipulation of the new hemidesmosomal attachment at the implant neck using an electrotome or retraction thread, as is necessary with one-piece or already cemented two-piece implants to demonstrate the implant shoulder and thus the crown margin. The emergence profile does not yet match the desired shape but resembles the round cylindrical gingival former. Although the abutments can already be individually adapted (Fig. 16)

however, the screw-retained approach allows for the gradual shaping of the emergence profile. In the laboratory, the provisional restoration with an overhang is fabricated on the provisional PEEK secondary part and palatally screwed in (Fig. 17). The overhang marks the desired course of the future marginal mucosa garland.

Every 14 days, this overhang is gradually supplemented with flowable composite, thus shaping the emergence profile (Fig. 18–21), which was completed in this case after six weeks. Now, the second individual impression can be taken for the production of the definitive restoration, which also captures the newly designed emergence profile. The abutments allow for various prosthetic treatment options through screw retention, such as cementing on screw-retained abutments or extra- and intraoral bonding, similar to a titanium

In this case, any cement or adhesive joint was avoided. Therefore, the abutment was directly overpressed with e.max Press, and the emergence profile was shaped accordingly (Fig. 22). The palatal screw channel was adapted to the width of the screw passage, allowing for easy replacement of the screw and restoration.

For the restoration placement, it is recommended to trust the screw and tighten it with the specified torque of 35 Ncm. Only in this way can it be ensured that the VICARBO, which is more ductile than zirconia, evenly conforms to the implant's inner geometry and provides the most seamless closure possible. The screw access channel is sealed with Teflon tape and composite (Fig. 23). Even 1.5 years after placement, stable and inflammation-free conditions were observed. Bone remodeling is complete and unchanged (Fig. 24

Conclusion

The innovative screw-retained design of the ceramic implant used here allows for all variants of restorative treatment, similar to those standard with titanium. Even the digital workflow is enabled through screw retention. For this purpose, a scanbody and the abutment (ZERABASE), as a special zirconia bonding base, are available. The implant (ZERAMEX P6) thus makes it possible to implement almost all treatment protocols commonly associated with titanium implants in the field of implantology using ceramic implants.

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