"In the past, ceramic implants were primarily associated with holistic dentistry, but today, they also represent an expansion of treatment options in general implantology practices. Consequently, you can find an increasing number of contributions on ceramic implants at renowned professional conferences and in specialized publications. The reasons for this have been described multiple times in the professional literature.1 It's not just the growing demand from patients that plays a role, but also the material zirconia brings specific professional advantages.2"

Dr. Jens Tartsch
"Author Information"

Literature

Next Generation – the Two-Piece Screw-Retained Ceramic Implant

Dr. Jens Tartsch

"Improved aesthetics are one of the main arguments put forth by proponents of ceramic implants. However, excellent aesthetics can also be achieved with titanium implants, provided that there is sufficient mucosal thickness of at least 2 mm. Otherwise, in cases with a thin gingival phenotype, there may be a grayish translucency of the abutment or implant.3 The solution in such cases would be the use of all-ceramic abutments, but these can lead to abrasion or even the destruction of the implant interface when used with titanium implants. The alternative thickening of the mucosa through connective tissue grafting means another procedure with corresponding morbidity for the patient. Both of these issues can be avoided through the use of ceramic implants.

However, based on clinical experience, the primary argument for ceramic implants is the excellent and almost consistently inflammation-free peri-implant soft tissue situation. Even though long-term evidence for ceramic implants is still lacking, the first"

"Five-year results are available.4 Peri-implantitis has not been clinically observed with ceramic implants so far.5 Initial findings suggest that the excellent biological properties of ceramics are the reasons for this: low bacterial adhesion to ceramic surfaces, significantly better peri-implant soft tissue blood flow, and no biocorrosion with the release of TiO2 particles and subsequent tissue reaction, as observed in recent studies with titanium implants.6–10"

Modern Ceramic Implant Systems

The mentioned advantages and the increased demand have led to a rapid development, especially in the area of materials and implant surface design. Modern manufacturing processes (HIP - Hot Isostatic Postcompaction) and the combination of zirconia with other ceramics like yttrium and aluminum oxide now allow for bending strengths ranging from 1,200 MPa (Y-TZP-A, 0.5% AlO3) to 2,000 MPa (ATZ, 20% AlO3).11,12 Modern rough implant surfaces design using techniques such as corundum blasting, thermal acid etching, laser modulation, or pre-structuring of the pressing mold now provides a Bone-Implant-Contact (BIC) nearly equivalent to titanium implants, leading to similar osseointegration.13

The described developments in ceramic implantology and their increasing relevance have also been recognized by the industry. Almost all renowned implant providers have now included ceramic implants in their product portfolios. Material-wise, the majority of the ceramic implants currently offered are one-piece systems. Both the abutment and implant are made as a single unit (monoblock), making them hermetically sealed (no separate abutment connection, no implant interface). They have the advantage of closely resembling the familiar procedures of dentists with impression-taking and cementation, similar to natural teeth.

However, the restorative treatment on one-piece implants can only be done by cementing the restoration

restoration, which is therefore not reversible or flexible. The implant shoulder defines the position of the crown margin and corresponds to the cement junction. After cement removal becomes unreliable 1.0 mm to 1.5 mm subgingivally, the implant shoulder and hence the crown margin should be placed as apically as possible.14 However, in the anterior tooth region, an apical placement of the implant shoulder is often not possible for aesthetic reasons. If the implant shoulder is located supragingivally or if the implant axis is incorrectly oriented for prosthetic restoration, this can only be corrected by grinding the implant. However, this carries the risk of damaging the material structure (phase transformation due to microcracks) of the entire implant body. These are among the reasons why even in modern titanium implantology, two-piece systems are considered the gold standard, and one-piece titanium implants are only found in very specific indications. Two-piece systems cover almost all indications, allow for unloaded healing phases and simultaneous augmentative procedures, and they are reversible and flexible.

The challenge of "two-piece design"

These arguments and principles apply equally in implantology with ceramic implants. However, the connection of hard, non-elastic zirconia abutments with hard, non-elastic zirconia implants still poses a significant challenge for the "two-piece" systems.

A pioneer in two-piece zirconia implants is the Swiss company Dentalpoint. They exclusively focus on two-piece ceramic implants and introduced the first two-piece ceramic implant "ZERAMEX® Classic" to the market in 2006. Based on research findings, including studies conducted in collaboration with universities in Geneva and other institutions, Dentalpoint has continued to innovate and expand its range of two-piece ceramic implant systems.

The development continued with the "ZERAMEX® T," a conical zirconia implant with high primary stability. Even today, this type of implant with an improved abutment connection is successfully offered as the "ZERAMEX® T Lock." In all generations of this implant, however, the abutment connection was achieved through bonding the abutment to the implant. This allowed for the benefits of a two-piece system, such as an unloaded healing phase, primary wound closure with one-time augmentative procedures, and flexible abutment selection. However, a bonded two-piece implant becomes a one-piece implant after the abutment connection, subjecting it to the same principles: cementing the restoration, no longer reversible/flexible, and positioning the implant shoulder as epigingival/Tissue Level.

Metal-free screwing

A metal-free screw connection, as commonly used with titanium implants, allows for a much broader range of indications. However, ceramics are more resistant to compressive forces than tensile or bending forces that can occur with internal connections and metal screw connections. In 2013, the ZERAMEX® P6 (Fig. 1) was introduced to the market, which has proven itself to this day with its new ATZ material (Alumina Toughened Zirconia with a bending strength of 2,000 MPa). An external hex as the implant-abutment interface helps avoid internal forces and stress points in the implant body. A completely new approach is offered, especially by the metal-free VICARBO screw made of high-strength carbon fiber (60 percent) and rounded threads. According to the manufacturer's specifications, this screw allows tightening forces of up to 85 Ncm (recommended 25 Ncm). Any forces that occur are absorbed like a spring element and evenly distributed throughout the implant body. The external geometry of the implant precisely matches the external geometry.

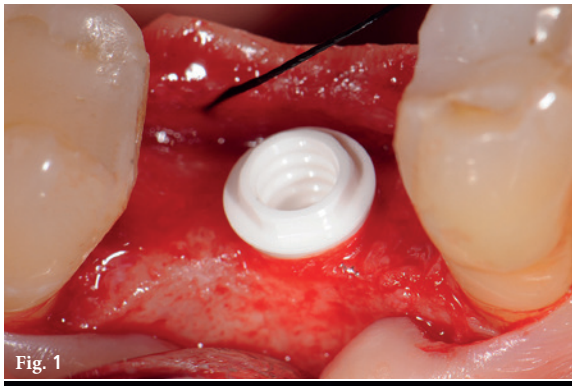
Fig. 1


Fig. 2


Fig. 3

Fig. 1: ZERAMEX® P6 implant in region 46 in the same patient as the case presentation in region 36. Fig. 2: ZERAMEX® XT with abutment. The abutment grooves are solely for rotation security and not for force transmission. Fig. 3: VICARBO screw for P6 (left) and XT (right).

The surgical protocol is the same as that of the Straumann® SP implant. Therefore, it can also be placed with the same surgical instruments. Consequently, it is subject to the same indications and contraindications as the Straumann® SP implant. The classic tulip-shaped neck area is primarily suitable as a "tissue level implant" for the "molar region" indication. Since it can be used with both screw-retained and cement-free techniques, it allows for the placement of the implant with an external hex abutment (straight or angulated) in six rotationally secured positions without introducing overloads into the implant. This allows for the creation of individual emergence profiles and prosthetic planning with abutment axis tilting. The patient case demonstrates the successful application of this system.

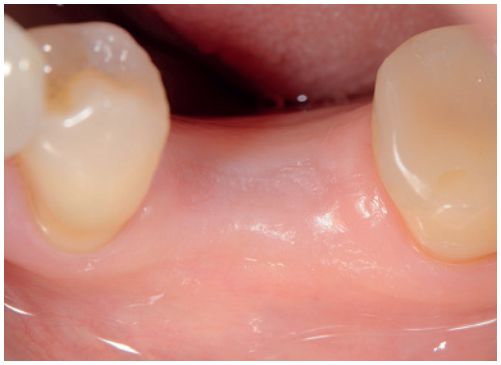

Image 4: Surgical site four months after extraction.

This Implant, therefore, can also be placed almost epically in the frontal area, which, like the SP implant, leads to bone remodeling in the area of the implant neck, making it less suitable for the aesthetic frontal area. Due to the low primary stability with the deep and wide threads, it is especially suitable for delayed immediate and late implantation and not for immediate implantation.

As a logical consequence, this limitation led to the development of the third member of the product family: the ZERAMEX® XT implant. With this implant, the advantages of the two already proven systems were combined: the conical, highly primary stable implant body was equipped with the metal-free, reversible VICARBO screw as well as the high strength of ATZ ceramics (2,000 MPa). The "Bolt-in-Tube" internal connection has been added.

The four pins attached to the abutment serve solely to secure the rotation of the abutment on the implant (see Figure 2). They do not bear any forces and can, therefore, be designed very delicately. Vertical and horizontal forces are absorbed as compressive forces by the inwardly beveled implant shoulder. This way, stress peaks in the implant body are avoided.

The connection by the VICARBO screw follows the same principles as the ZERAMEX® P6 implant. Due to the implant's geometry, the XT screw could be made significantly narrower (diameter of the screw head 2.8 mm) while delivering the same performance (see Figure 3), allowing for a standard implant diameter of 4.2 mm.

With positive preclinical results regarding both osseointegration behavior and the implant geometry of the ZERAMEX® T, as well as the stability of the VICARBO screw of the ZERAMEX® P6, the new Bolt-in-Tube connection was additionally tested according to ISO 14801. The dynamic fatigue test resulted in 375 Ncm (according to the manufacturer's information), and the CE certification paved the way for the use of the ZERAMEX® XT in initial clinical pilot cases. Consequently, the world's first ZERAMEX® XT implant was inserted in a clinical setting.

Patient Case

Initial Situation

In April 2016, a 56-year-old patient in good general health presented with a desire to replace tooth 46. Tooth 46 had been removed approximately a year earlier due to recurrent toothaches.

Since the patient had an allergy passport issued by a dermatologist that indicated an allergy to aluminum, and she believed that titanium implants contained aluminum, she insisted on a ceramic implant. She was not entirely wrong in her suspicion: implants made of titanium grade 5 can contain up to 6 percent aluminum by volume. Although most implant manufacturers use pure titanium grade 4 for the implant body, the abutments are often made of titanium grade 5 or a titanium-aluminum-niobium alloy (TAN). Using a full ceramic abutment in the molar region would, therefore, be contraindicated.

Given sufficient bone volume, a ZERAMEX® P6 implant was placed in June 2016, and in October 2016, it was restored with a screw-retained, metal-free single crown. During the preoperative radiological diagnostics (OPG) for the implant at position 46, a periapical radiolucency of the mesiobuccal root of tooth 36 was incidentally discovered when its vitality was not clear. The patient was informed about this finding and was thoroughly briefed on the necessary endodontic measures but initially did not decide to undergo treatment for tooth 36.

It was only after the crown was placed on the implant at position 46 in October 2016 that she agreed to treatment in October 2016. However, she insisted that the recommended endodontic treatment was not an option for her. The patient requested the removal of tooth 36 and its replacement with another ceramic implant. The initial plan was to place another implant approximately four months after the extraction. Therefore, in early November 2016, tooth 36 was extracted under local anesthesia.

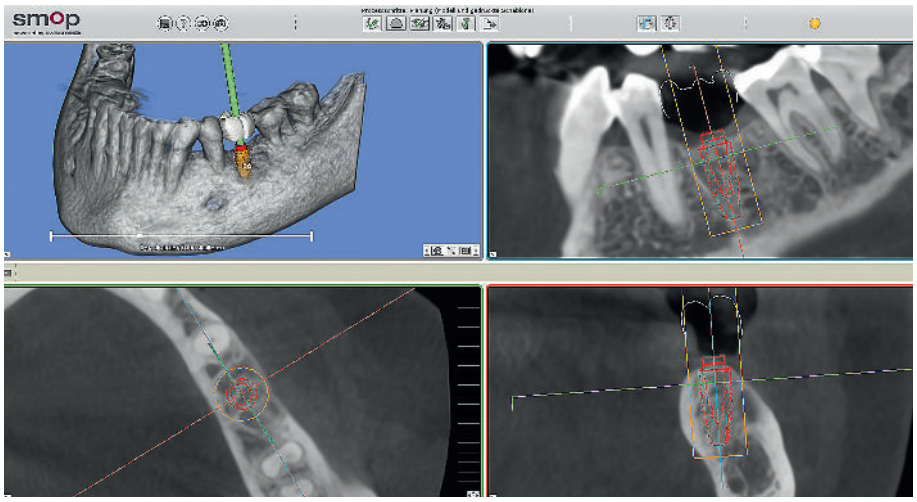

Figure 5: Planning of implant dimensions and position using SMOP


Fig. 6

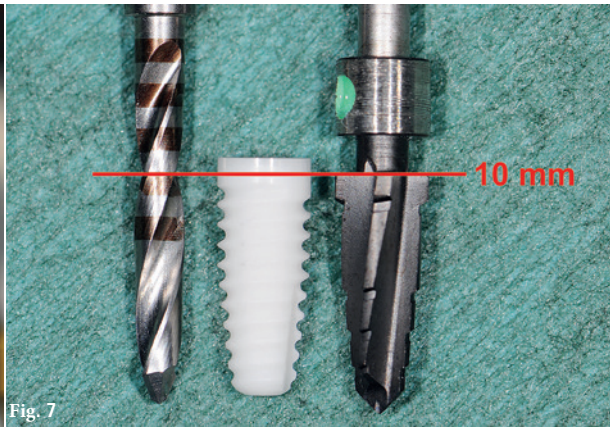

Fig. 7

Figure 6: XT profile drills color-coded with carbon coating. Figure 7: Pilot and profile drills: intrabony length of 10 mm plus 0.6 mm in the neck area.

She had it removed gently, separating the mesial and distal roots, and the socket was curetted before closing it with a stabilizing cross suture. The wound healing proceeded without complications.

When the patient returned for further treatment four months after the extraction, ideal soft and hard tissue conditions were observed (Figure 4). This presented a standard situation for the first clinical use of the ZERAMEX® XT ceramic implant. The patient was thoroughly informed about the situation as a "pilot patient," the associated risks, and the still lacking evidence for this type of implant. Likely influenced by her positive experience with implant 46, she agreed to the insertion.

Preoperative Planning

The implant selection was done using 3D planning software (SMOP, Swissmeda AG; Figure 5). Even though, in this case, no template-guided surgery was planned, this software allows for a secure preoperative plan. While the implant geometry of the Straumann Bone Level Tapered implant does not exactly match that of the ZERAMEX® XT, you can closely approximate length, diameter, and position by using the Bone Level Tapered template.

In this case, an implant with a diameter of 4.2 mm and a length of 10 mm was planned. The specified length corresponds to the osseous part of the implant should be considered for selection. It's important to note that there is an extending etched neck region with a height of 1.6 mm to account for the biological width. Consequently, a 10 mm implant effectively has a total length of 11.6 mm. If the mucosal thickness is minimal, the implant can be placed 1 mm deeper, leaving only a 0.6 mm supracrestal neck region, resulting in an osseous portion of 11 mm. This aspect can be reliably planned by adjusting the abutment height along with an additional 1 mm for gingival height of the abutment. For the pilot phase, implants with only a 0.6 mm neck region were initially available.

Surgical Procedure

Under local anesthesia and following a crestal incision, the flap was raised, and the implant site was prepared according to the surgical protocol. Due to the analogous implant geometry, this corresponds to the ZERAMEX® T protocol. After pilot hole preparation using the pilot drill with a 2.3 mm diameter to the planned length of 10 mm, considering the correct implant axis, the subsequent steps involve using congruent profile drills for different lengths. Thus, for further preparation, the "small" profile drill with a length of 10 mm and a diameter of 3.3 mm (color-coded pink) is used, followed by

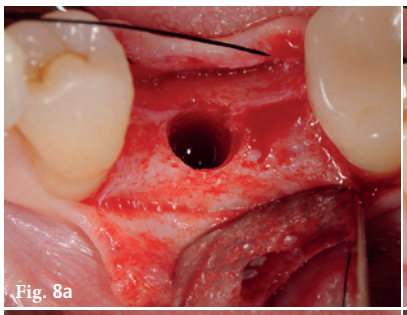
Fig. 8a

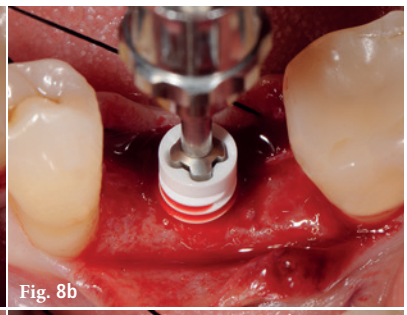
Fig. 8b

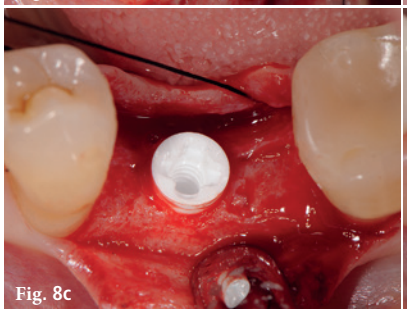
Fig. 8c

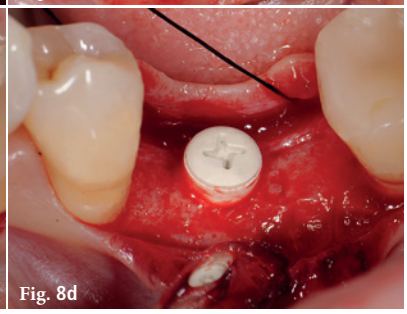
Fig. 8d

Fig. 8a: Prepared implant bed after thread cutting. – Fig. 8b: Insertion with Bolt-in-Tube insertion instrument at 30 Ncm. – Fig. 8c: Implant in situ, neck area 0.6 mm supracrestal. – Fig. 8d: The flat healing cap allows for primary wound closure.

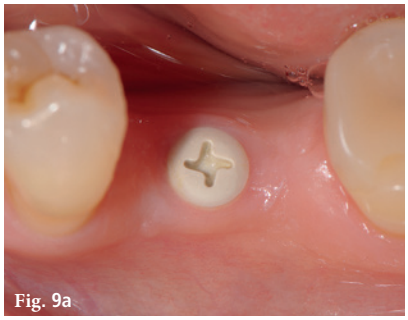
Fig. 9a

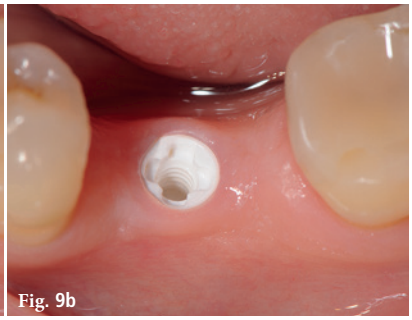
Fig. 9b

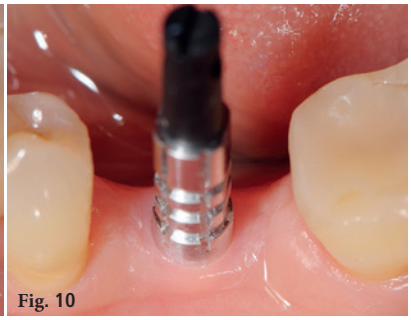
Fig. 10

Fig. 9a: Transition phase with Gingivaformer XT. – Abb. 9b: ZERAMEX® XT implant before impression. – Fig. 10: Precise impression taking through open impression.

The "regular" profile drill with a length of 10 mm and a diameter of 4.2 mm (color-coded green) was selected (Fig. 6). The lower shoulder of the profile drill corresponds to the intrabony length of the implant without the neck area (Fig. 7). Since the implant is not self-tapping, and during the insertion of the implant, the ceramic material does not dissipate heat like a titanium implant, the threading instrument had to be used as the last instrument, covering the entire length of the implant (Fig. 8a). The implant was then placed 0.6 mm supracrestally with a torque of 30 Ncm. A new instrument designed for the Bolt-in-Tube internal connection was used for implant placement.

A precise and form-fitting implant insertion instrument is available, ensuring optimal force transmission (Abb. 8b and c). The healing caps are significantly flatter than those used with the ZERAMEX® P6 implant, allowing for an easy primary wound closure (Fig. 8d).

Prothetische Phase

Clinical experience has shown that a healing period of three months is suitable for both ceramic and titanium implants. However, due to the pilot nature of the case, in this instance, the reentry with a crestal incision and the placement of the gingiva former was performed after four months.

After the soft tissues had healed (Fig. 9a and b), an open impression was taken two weeks later (Fig. 10), and the master model was created. Since it's a two-part implant system, and the abutments are also made of high-strength ATZ ceramic, these abutments can be individualized either in the dental practice or the dental laboratory through grinding if necessary. In this case, the abutment shoulder was moderately adjusted to the gingival contour, and the abutment height was reduced (Fig. 11). In the CAD/CAM process, a monolithic zirconia crown made of Zolid FX (Amann Girrbach) with occlusal access to the screw channel was fabricated (Fig. 12).


Fig. 11

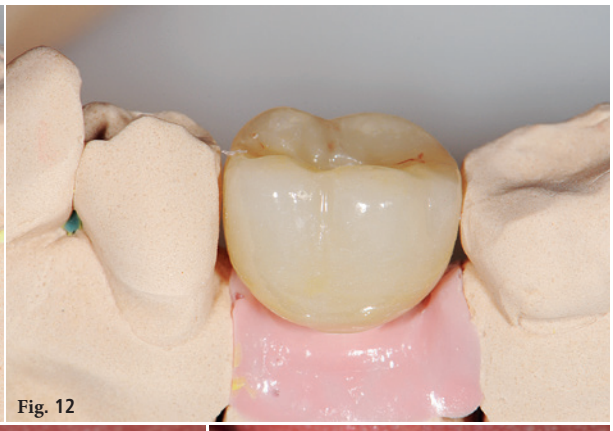
Fig. 12

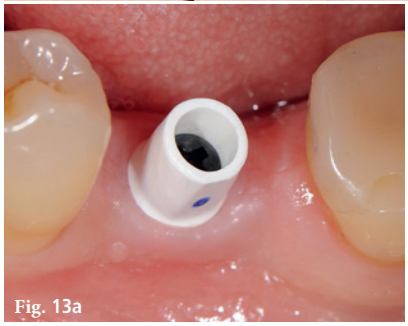
Fig. 13a

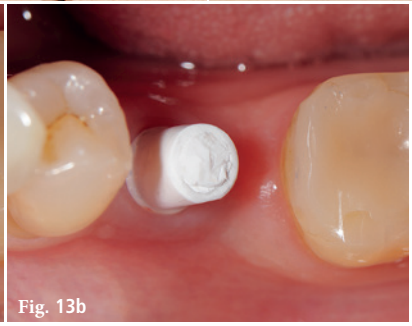
Fig. 13b

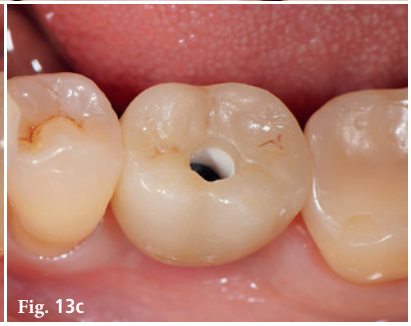
Fig. 13c

Fig. 11: Individualized abutment on master model. – Fig. 12: Monolithic zirconia crown with occlusal screw access. – Fig. 13a: Verification of the abutment in situ. – Fig. 13b: Closure of the screw channel with Teflon tape in preparation for bonding. – Fig. 13c: Restoration bonded in situ, Teflon tape already removed through the screw channel.

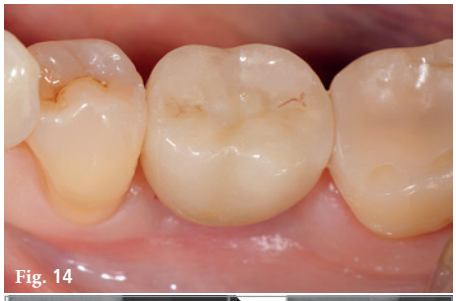
Fig. 14

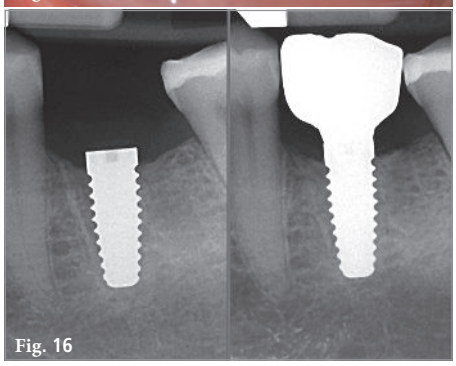
Fig. 16

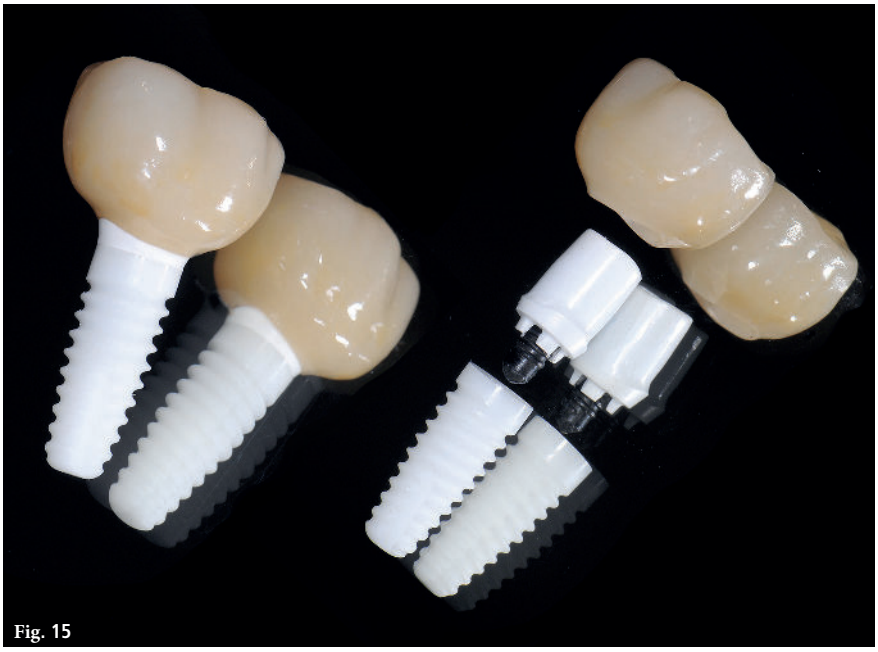
Fig. 15

Fig. 14: Crown with composite closure of the screw access channel. – Fig. 15: ZERAMEX® XT – the next Generation. – Fig. 16: Postoperative X-ray control four months after restoration.

Similar to a titanium adhesive base, the restoration was bonded to the abutment (RelyX™ Unicem, 3M ESPE). To avoid any potential internal stresses in the ceramic implant-abutment connection, this was done intraorally in the patient's mouth (Fig. 13a–c). The restoration bonded with the abutment could then be removed, excess cement safely removed, and the transition polished. For the definitive insertion, the specified tightening torque for the abutment screw of 25 Ncm must be observed. After filling the screw channel with Teflon tape, the access cavity was sealed with composite in the usual manner (Fig. 14). The result is a metal- and cement-free, screw-retained, and reversible single-tooth restoration (Fig. 15).

Radiographic control images were taken postoperatively and four months later at the time of restoration placement. Stable peri-implant bone conditions were observed in comparison (Fig. 16). Another comparison will be made at the first-year follow-up.

Summary

Have ceramic implants, due to rapid advancements in success rates, materials, and surface design, become comparable to titanium implants. Ceramic implants have already come significantly closer to titanium implants in terms of success rates, materials, and surface design due to rapid advancements. As described in the presented case, they can now adopt the well-established surgical and prosthetic protocols used for titanium implants. This is certainly an important factor for the continued acceptance of ceramic implants in implantology practice.

The new ceramic implant (ZERAMEX® XT) offers high primary stability due to its conical implant body and tight threads, and it can be placed at either bone level or tissue level with the option of cement-free screw retention. This fills a gap: alongside the already proven ZERAMEX® P6 for posterior teeth, it seems that the ZERAMEX® XT now provides a metal-free and flexible alternative for the aesthetic anterior region (Abb. 17). Further clinical studies will be necessary.

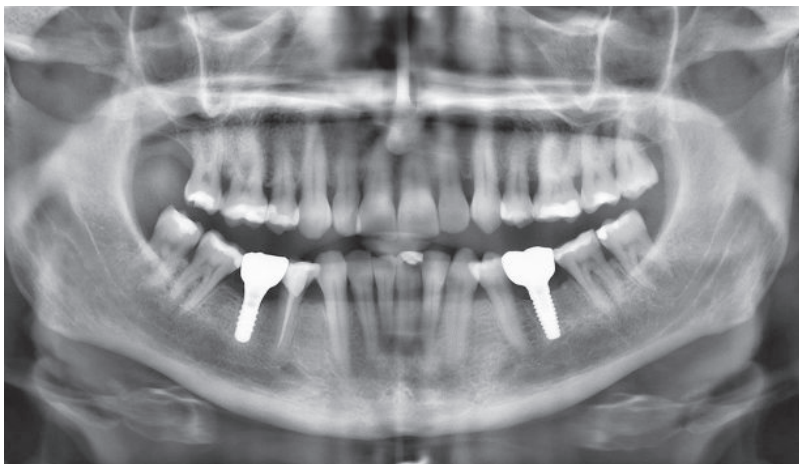
Fig. 17: A special feature - both ZERAMEX® systems in the same jaw: P6 (46) and XT (36).

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Practical Part

The practical exercises were distributed on the tables as follows: Sinus procedures were demonstrated using standard table techniques, and simultaneous implantations as well as indirect sinus lifts were practiced by a "table team." Following this, the same procedures could be tested using Piezotechnology. With the professional assistance of an employee from the mectron company, who kindly provided the Piezosurgery® devices, this was achieved perfectly (Figure 8). Another practice table focused on topics such as bone splitting, condensing, nerve exposure, and preparation in the upper jaw to avoid a sinus lift or mandibular nerve interference, as well as the All-on-4-or-More principle. Dr. Valentin, a recognized expert in autologous bone transplantation, explained during a Separate table for the transfer and fixation of the bone block.

This year as well, the two supervisors, Dr. Navid Salehi and Dr. Marcus Quitzke, impressed with their expertise and perfect collegiality.

Suturing techniques could be practiced towards the end of the course at an additional table under the guidance of oral surgeons Dr. Uta Voigt and Dr. Martina Vollmer. Dr. Ute Nimtschke and Prof. Dr. Werner Götz were available during the practical part at a complete cadaveric specimen to demonstrate structures of interest to the dentist, such as the pelvic crest, the skullcap, the sural nerve, the larynx, a cricothyrotomy, and vascular puncture. This allowed all remaining questions of the participants to be clarified. Participants were particularly pleased with the script "Topographic and Clinical Anatomy of the Maxillofacial Region" by Ute Nimtschke, Marie Böhnisch, Werner Götz and Wolfgang Schwab, which has been newly released in collaboration with the DGZI (German Society of Dental Implantology). The script is available through the DGZI office for a contribution towards the costs.

The next anatomy course will take place on October 26th and 27th, 2018, once again in Dresden. Registrations from non-curriculum participants are now being accepted. It is important to highlight that all participants of the DGZI Curriculum Implantology will receive a comprehensive script for all three mandatory weekends (Prosthodontics, Hard and Soft Tissue Management, Anatomy) free of charge, based on the lectures of the speakers.

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