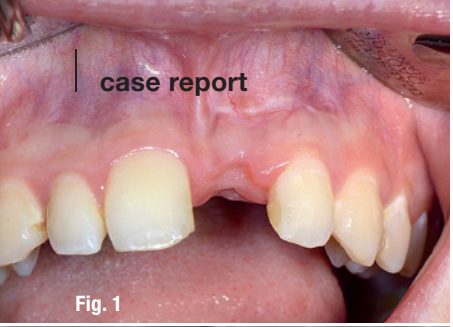

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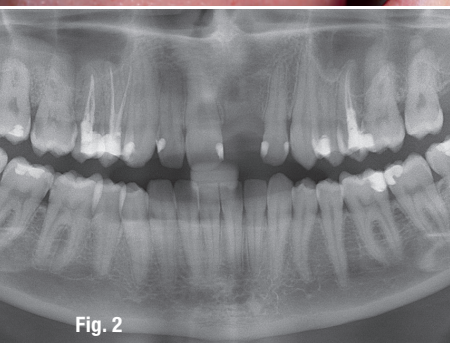

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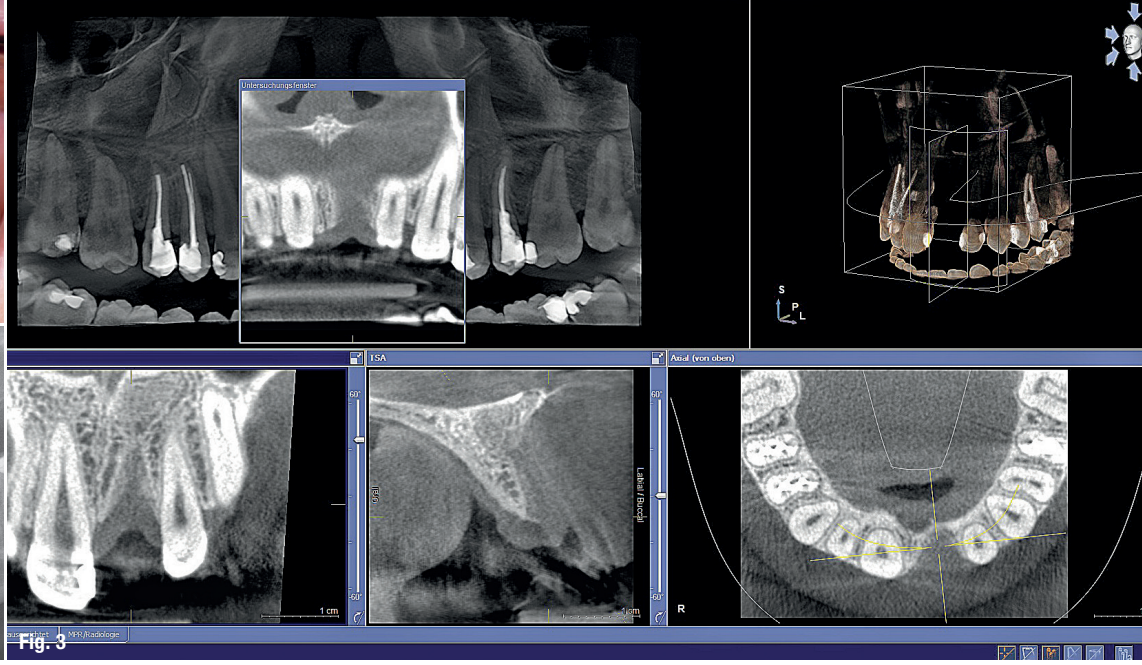


Fig. 3

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

# Restoration after augmentation in the maxillary anterior region

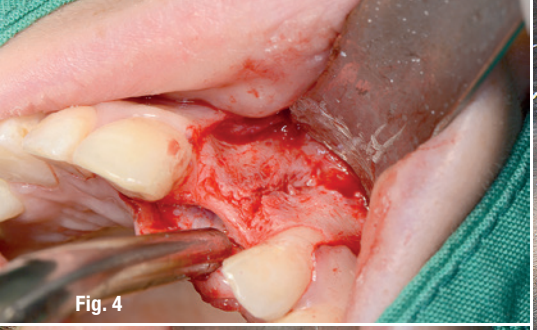
Dr Falk Nagel, Germany

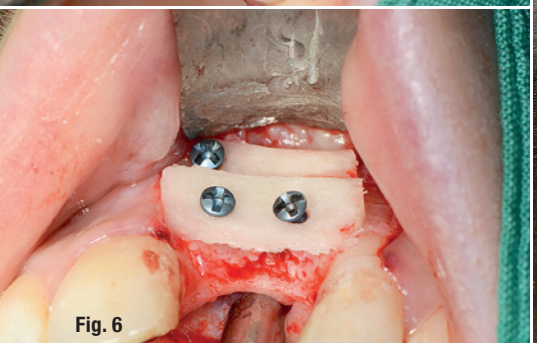
**The implant treatment** of a tooth gap in the anterior region of the upper jaw with a high bone deficit represents a special challenge in surgical practice. It requires comprehensive knowledge of the handling and modes of action of different products for hard-tissue regeneration, as well as of adequate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

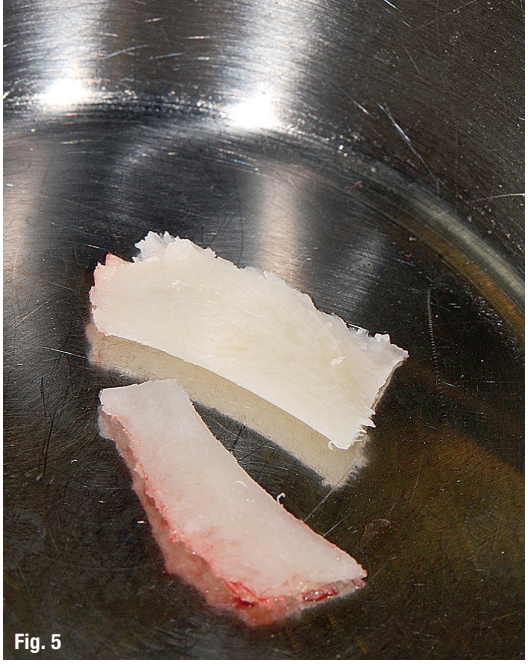
## Case presentation

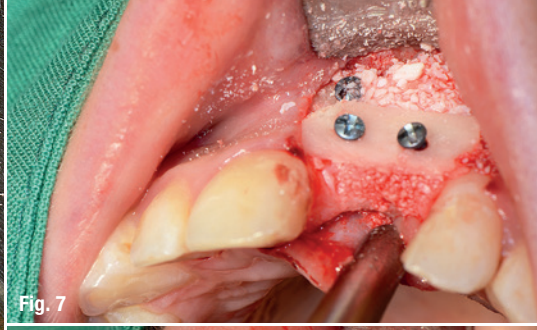
In May 2017, a 24-year-old female patient with an anterior gap was referred to our practice. After a trauma in the form of root canal therapy and a root tip resection about ten years before, tooth #21 was repeatedly treated, having suffered multiple occurrences of apical inflammation. After recurring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

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



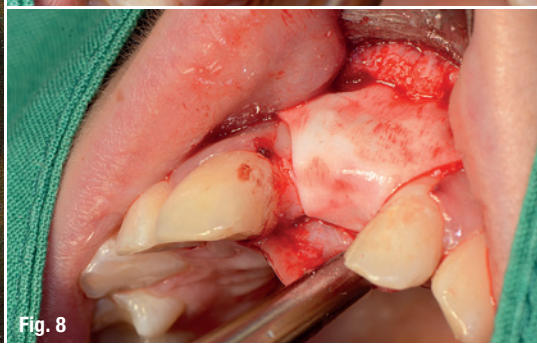




**Fig. 4:** Intra-op view of the alveolar ridge. **Fig. 5:** Two bone blocks were taken intra-orally. **Fig. 6:** View of the bone regeneration procedure. **Fig. 7:** Bone augmentation material was inserted. **Fig. 8:** The site was covered with a double-layered resorbable membrane.

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

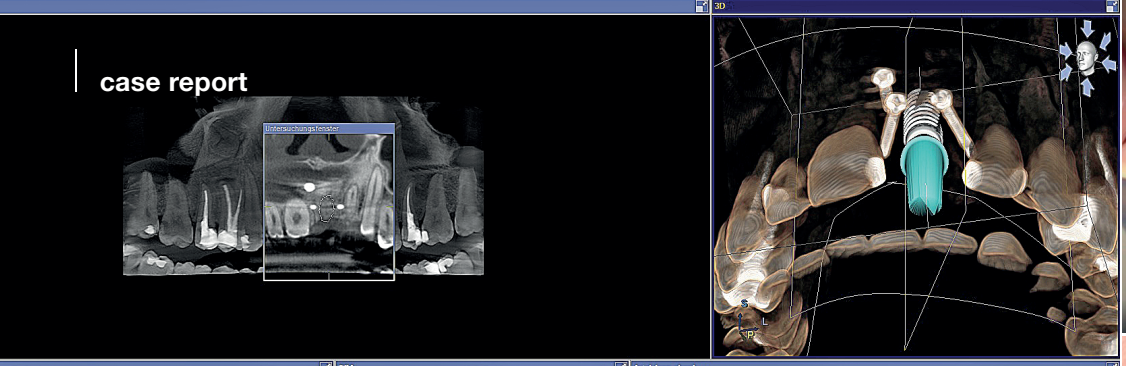
## Complex bone augmentation

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

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

## Surgical procedure

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



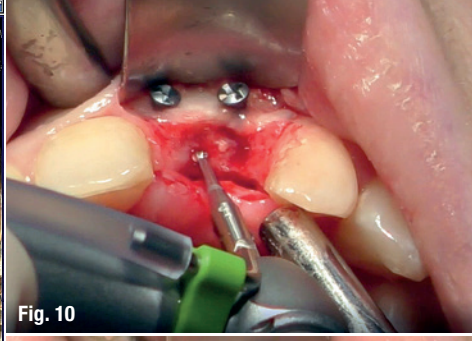
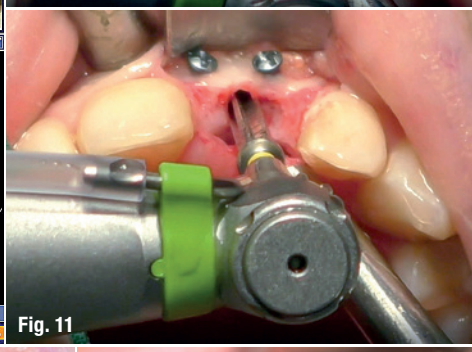



Fig. 10

Fig. 9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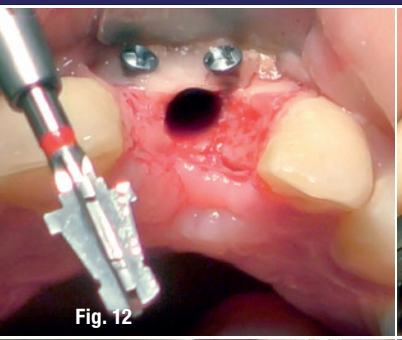
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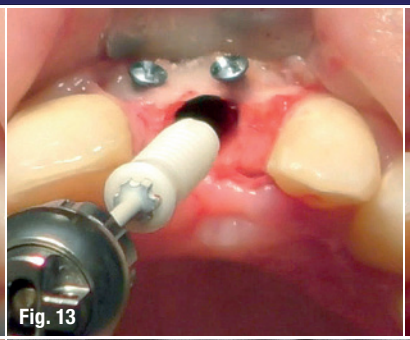
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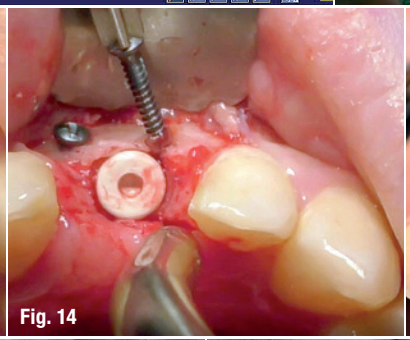
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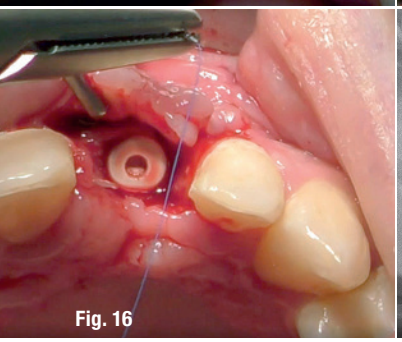
Fig. 15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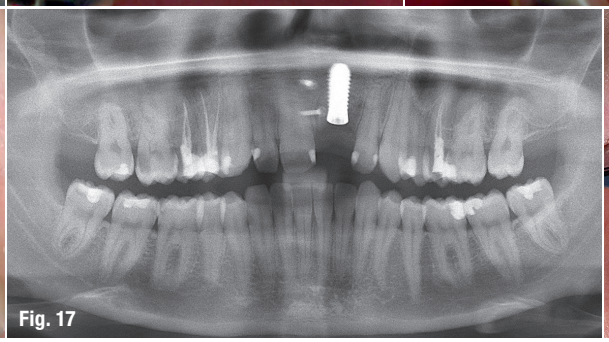
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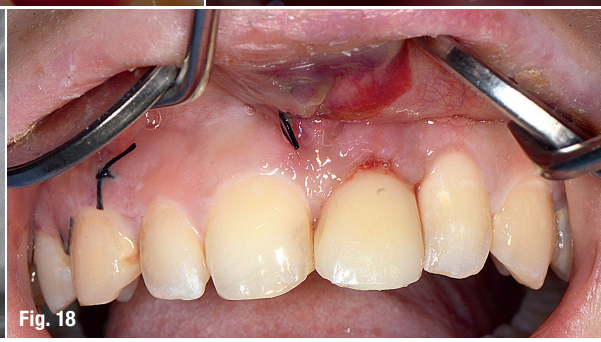
Fig. 18

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

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

## Temporary and final restorations

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

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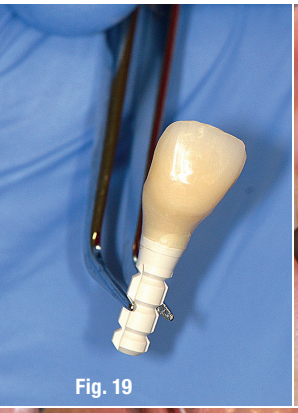
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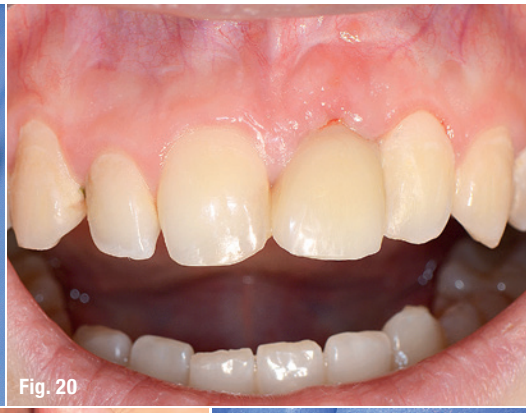
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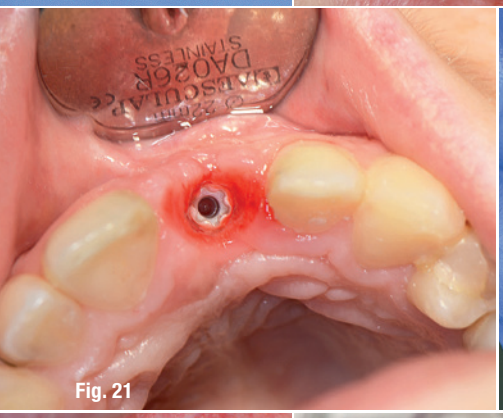
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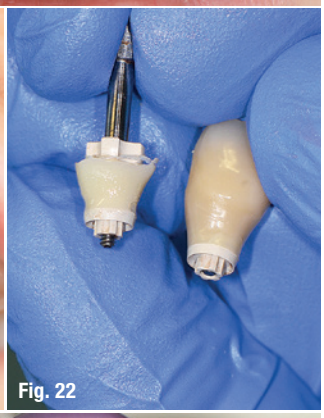
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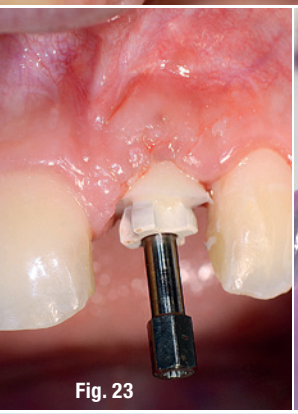
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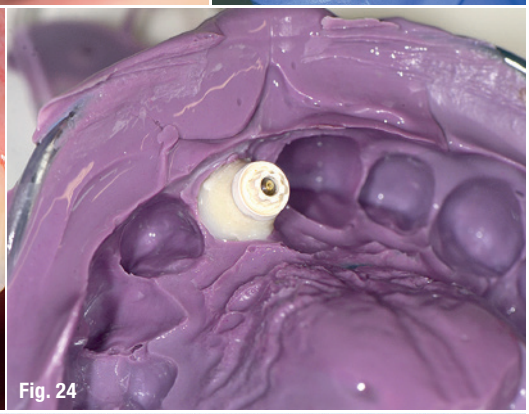
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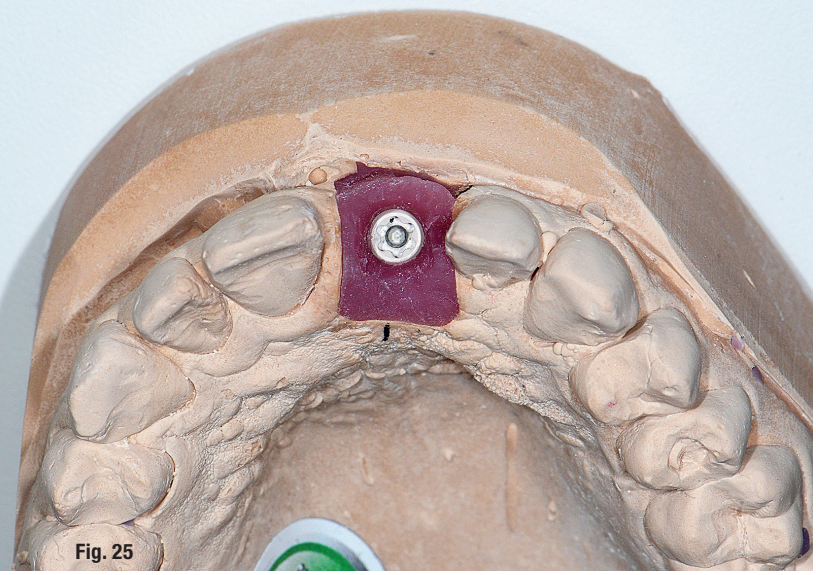
Fig. 25

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

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

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

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

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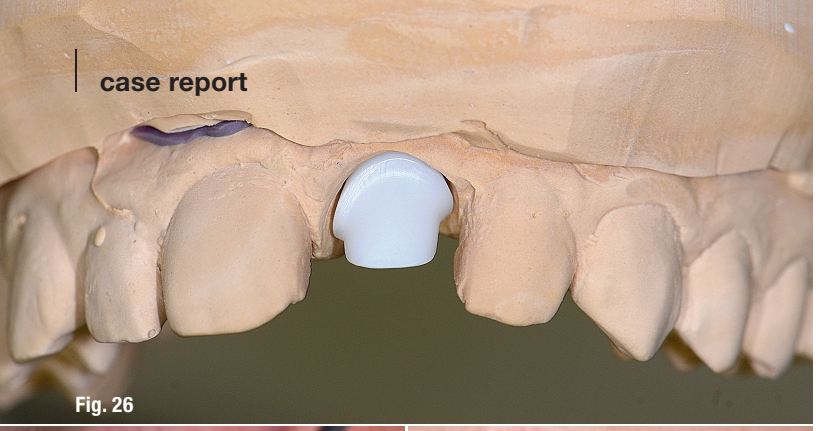
Fig. 26


Fig. 27


Fig. 28


Fig. 29

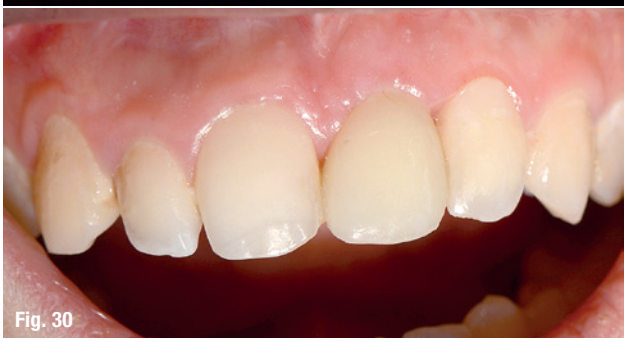
Fig. 30

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

## Conclusion

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

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

*Acknowledgements: The author would like to express his gratitude to ZTM Holm Preußler (Dentallabor Lexmann in Dresden), who was instrumental in the success of the restoration with his comprehensive knowledge and outstanding technical design of the restoration.*

## about the author

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

## contact

**Dr Falk Nagel**
Fetscherstraße 27
01307 Dresden, Germany
Phone: +49 351 82121110
praxis@doktornagel.de
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