Early childhood anterior tooth trauma

Implant-prosthetic restoration with a XiVE implant following piezoelectric bone splitting and bone grafting

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Due to its cancellous bone structure, the maxilla does not offer optimal conditions for the primary and long-term stability of implants. The maxillary sinus is a further factor that makes the planning and insertion of implants in the posterior region of the maxilla difficult and requires extensive pre-implantation measures to prepare the implant site.

From an aesthetic perspective, implant treatment in the maxillary anterior region is a challenge for dentists. The smallest error in the positioning of the implant or improper handling of the peri-implant hard and soft tissue can lead to an irreversible cosmetic failure. Single-tooth implants in particular require all of the dentist’s skills. In patients with a thin biotype, the visibility of the abutment through the thin gingiva presents a common problem.

Post-operative recession, resulting in parts of the implant becoming visible, is also common. Such recession generally occurs when a too large implant diameter has been selected or the implant has been positioned too close to the vestibular surface.

**Introduction**

Being able to replace missing teeth by means of implants has opened up new opportunities in patient care and revolutionised the field of prosthetic rehabilitation. Progress in implant design and in surgical technique has increased the predictability of the treatment results and the survival rates of implants and implant-supported prostheses. In the maxilla, however, owing to the anatomical conditions, implant therapy currently has its limits.

**Fig. 1** Along with the natural, healthy dentition, the initial dental orthopantomogram shows the orthodontic brackets and archwires in the maxilla and mandible.

**Fig. 2** In the transverse DVT view, a XiVE implant was virtually inserted in the optimal implant position. The buccal lamella fell short of the necessary layer thickness of 1 to 1.5 mm.

**Fig. 3** The route of the nasopalatine nerve can be estimated on the axial view of the 3-D image.
Insufficient hard and soft tissue may eventually lead to the implant restoration not integrating aesthetically with the existing dentition. Often, a reconstruction of the interdental papilla is not possible, and the contour of the marginal gingiva cannot be shaped harmoniously. A high smile line does not allow any compromises at all in soft-tissue aesthetics, since the colour and contour of the peri-implant mucosa must correspond to the soft tissue in the region of the neighbouring natural teeth. Careful planning, considering all relevant clinical and patient-related parameters, is therefore very important for achieving a predictable and aesthetically satisfactory treatment result in the implant restoration of a single tooth.

In a single-tooth replacement in the maxilla following traumatic anterior tooth loss, the practitioner faces the problem of a reduced amount of hard and soft tissue. Frequently, portions of the bony alveolar ridge near the tooth have been lost owing to trauma or natural resorption processes.

Careful selection of the grafting technique and implants with an osteoconductive surface makes treatment success predictable in terms of implant stability and aesthetics. Along with free connective-tissue grafts and guided bone regeneration using autogenous or xenogeneic bone materials, piezoelectric bone splitting or bone spreading techniques can be used for reconstruction.

Piezosurgery has been established as a successful technique in a variety of dental disciplines over the last ten years. Thanks to the adjustable ultrasound working frequency, different tissue types can be treated selectively without the risk of injury. With its narrow 60 to 200 µm width, the frictionless and vibration-free sectioning falls significantly below the incision width produced by using conventional instruments.

Today, bone splitting is considered to be a safe and simple method for the expansion of bone tissue. In a systematic review, success rates of 95 to 100 per cent were reported using this technique in combination with a single- or two-stage approach.

The final consideration in planning is the selection of the appropriate implant type: healing and osseous integration are markedly dependent on the chemical composition, loading, roughness and the morphology of the surface of the implant. Thanks to its good bone–implant interface characteristics and the associated increased primary stability, the XiVE implant system (DENTSPLY Implants) can also be placed securely and predictably into bone where the site is weak and into areas of low bone density. Long-term results demonstrate a high survival rate for XiVE implants, which can be traced back to the macro- and micro-design of the implant system.

**Case report**

**Anamnesis**

A 23-year-old, healthy patient presented at the practice requesting the replacement of tooth #21. The tooth had already been endodontically restored following an anterior tooth trauma in the patient’s childhood. Despite multiple revisions, the apical periodontitis had not healed. The tooth had been extracted and, as a result, there was severe bone resorption. The gap was initially restored with an interim prosthesis. Orthodontic treatment followed some years after the extraction, during which the gap in region #21 also had to be widened for the implant restoration.

Clinically and radiologically, a caries- and filling-free dentition was evident, with orthodontic brackets and archwires in the maxilla and mandible. There was evidence of severe buccal resorption of the alveolar process in region #21 (Fig. 1).

**3-D radiological analysis**

A 3-D analysis of the bony structures and the position of the nerve and the vascular bundles was performed for the treatment planning. Three-dimensional assessment plays a central role in the...
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planning of the treatment steps and the predictability of the post-operative result.

The surgical procedure was determined on the basis of the digital volume tomogram (DVT). The central issue was the optimal method of reconstructing the resorbed bone. Since the horizontal bone volume was adequate, spreading the alveolar ridge by means of bone splitting in combination with implant placement and guided bone regeneration was the treatment of choice. The anatomy of the patient’s alveolar ridge and his bone quality confirmed the decision to use the XiVE implant, as its unique surface promotes the stable attachment of osteogenic cells and its apically increasing thread depth contributes to a high degree of primary stability. In the DVT transverse view, a XiVE implant with a diameter of 3.8 mm and a length of 13 mm was virtually placed using the software in the optimal implant position. It was established that the buccal lamella would have fallen short of the layer thickness of 1 to 1.5 mm necessary for the long-term retention of the implant (Fig. 2). Since this is indispensable for uneventful healing and an aesthetic result, the bone splitting was to be performed to a depth of 7 to 10 mm. The 3-D image demonstrated that the bone volume was adequate for this procedure. In addition to the bone splitting, a final lateral onlay graft had to be performed. The surgical procedure was determined on the basis of the digital volume tomogram (DVT). The position of the nerve is a limiting factor for the implant position in the palatal direction. The risk of a fracture of the buccal lamella or of damage to the nerve, however, is small when the correct procedure is used.

Surgical procedure

The mucoperiosteal flap was prepared and raised for the purposes of a full thickness flap. The periosteum was carefully detached from the bone (Fig. 4). Following the completion of the implant placement, the sutures should be located approximately over the split bone with the inserted implant. The alveolar crest at the planned implant site was initially marked using a round drill and then enlarged with a pilot drill. In the next step, two small vestibular incisions and a horizontal incision to a depth of 10 mm and at an angle of 90 degrees were done using the Piezotome (Acteon; Fig. 5). The two relatively deep (5 to 7 mm) vertical incisions prevent a fracture of the buccal lamella, improve its mobility and protect the marginal periodontium of the adjacent teeth. The alveolar bone was then gradually expanded horizontally using the appropriate instruments (Fig. 6). In the process, the bone was also condensing horizontally at the same time by compression to improve the primary stability of the implant. Using a twist drill, the bone for the implant site was prepared gradually (Fig. 7).

The bone chips were removed simultaneously via the grooves in the twist drill to where they could be collected extra- orally. The implant site was prepared at low speed in order to avoid overheating the tissue. The vestibular lamella was stabilised by the apically pedicled flap on the periosteum and fixed. After the final drilling, the actual preparation of the implant site was complete. The bone-specific crestal preparation of the cavity was then carried out using the crestal twist drill to adapt the preparation to the clinical situation (Fig. 8).

In the next step, a XiVE S plus implant with a diameter of 3.8 mm and a length of 13 mm was
mechanically inserted at a slow rotational speed (Fig. 9). In the process, the XiVE implant thread grips the bone palatally, while the labial lamella is not traumatised. The implant was sealed against saliva and bacteria using a colour-coded cover screw in preparation for the submerged healing phase.

The gaps in the implant site were then filled using the autogenous bone chips collected during the drilling process. In order to compensate for the resorption of the autogenous bone, a stable-volume alloplastic bone-grafting material was placed over the bone chips as a second layer. The raspatory was placed in front of the nasopalatine nerve to protect it, as there is only a thin bone lamella between the nerve and the mucosa. A resorbable collagen membrane was then placed over the augmented area and fixed to the bone with two titanium nails (FRiOS membrane tacks, DENTSPLY Implants). In this way, the mucoperiosteal flap prevented shifting of the membrane.

A double-layered wound closure was performed in order to prevent dehiscence. First, a resorbable suture (4.0) was used to attach the periosteum to the periosteum (Fig. 11). Then the mucosa was passively fixed with two over-and-over sutures. The radiological control shows that the XiVE implant in region #21 was positioned nearer to tooth #22 than to tooth #11 (Fig. 12). This distal position is typically due to the location of the nasopalatine nerve and is unavoidable.

Uncovering and soft-tissue management

Three months post-implant placement, the vestibular gingiva showed no signs of inflammation (Fig. 13). Measures to improve the soft-tissue volume by extension in the aesthetic zone were planned. The XiVE implant was uncovered (Fig. 14) and the cover screw was replaced by a Friadent gingiva former for this purpose (Fig. 15).

After a brief healing phase of ten days, the patient was recalled for the actual temporary restoration. A suitable impression coping with a transfer technique with a TransferCap was inserted into the implant for impression taking using a polyether material (Fig. 16).

The cast model of the maxilla subsequently fabricated in plaster was then scanned in. An individual abutment was virtually created with the aid of the ScanBase, which displays the scanable counterpart to the TitaniumBase (DENTSPLY Implants; Fig. 17). The resulting construction data was transmitted to the milling machine, where the abutment was milled from a lithium disilicate block (Fig. 18). The finished abutment was then cemented to the TitaniumBase. After completion, the precise position for the intra-oral insertion was reproduced on the master cast using a transfer key made from Pattern Resin.

Fabrication of the temporary restoration using CAD/CAM technology in the dental laboratory

Three months post-implant placement, the gingiva showed no signs of inflammation.

The XiVE implant was uncovered.

To improve the soft-tissue volume in the aesthetic zone, the cover screw was replaced by a Friadent gingiva former.

Friadent transfer post with a suitable TransferCap in situ prior to impression taking.
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In the next step, the fully anatomical provisional crown was designed using the software and milled from a lithium disilicate block (Fig. 20). After completion, it was polished to a high gloss (Fig. 21).

Placement of the temporary crown

Subsequently, the mucosa healed around the gingiva former and exhibited a homogeneous, inflammation-free structure (Fig. 22). Prior to the screwing of the TitaniumBase abutment into the XiVE implant, the screw channel was cleaned with chlorhexidine then dried and the peri-implant mucosa was cleansed.

The precise intra-oral position of the abutment was checked using the resin transfer key. Following this, the optimal position for the temporary crown was also determined by means of the key and the crown was temporarily attached using cement (Fig. 23).

The facial view of the opened mouth and the length of the incisal edge conformed to the functional, aesthetic and phonetic requirements (Fig. 24). A well-osseointegrated implant was evident, along with the radiopaque TitaniumBase and superstructure in the final radiologic control (Fig. 25). As the patient was very pleased and as a stable material, lithium disilicate, had been used for the temporary restoration, the patient initially did not want a final restoration.

The method of implant placement and a grafting procedure with bone splitting in a single session described here presents a realistic alternative to conventional grafting of hard and soft tissue in the aesthetic region. The prerequisite is an adequate horizontal and vertical bone volume, in order to make the deep incisions necessary to mobilise the buccal lamella. The removal of bone blocks from additional surgical sites can be dispensed with for the patient.

The XiVE implant, which also guarantees primary stability in weak bone, with its unique, osseointegration-promoting surface and its compressive apical section, made the implant placement in this complicated case predictable, safe and successful.

Editorial note: A complete list of references is available from the author.

Fig. 19 The precise position of the TitaniumBase, which was cemented to the customised abutment, was reproduced by means of a transfer key.

Fig. 20 The temporary crown was virtually designed using the software and milled from a lithium disilicate block.

Fig. 21 The finished, highly polished crown.

Fig. 22 The healed peri-implant soft tissue.

Fig. 23 The crown, inserted with the aid of the transfer key and temporarily attached using cement.

Fig. 24 When the mouth was open, the length of the incisal edge conformed to the functional, aesthetic and phonetic requirements.

Fig. 25 The final radiological control shows a well-osseointegrated implant, along with the radiopaque TitaniumBase and superstructure.