



10 years of xive

Site identification of the temporary immediate loading following sinus floor elevation – traditional surgical technique versus modern computer-navigated implant surgery

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INTRODUCTION

Ten years of clinical use of the Xive system convince to therapeutic safety during implant insertion as well as functioning multioptional restoration concepts with immediate or delayed loading. While, some years ago, temporary immediate restoration was still realized with conventional planning methods and manufacturing processes, the introduction of 3D diagnostics and virtual planning has led to an appreciable increase in the reliability of the treatment for the surgeon and for the prosthodontist. Aside from tissue preservation, the gains from a three-dimensionally planned and template-guided implant insertion are also in the improved predictability of the functional and esthetic result. As a consequence, reliability, speed, precision and esthetics can be identified as the most important factors that also make computer-guided treatment attractive for the patient.

A sufficient primary stability constitutes the basic requirement for uncompromised osseointegration under load. As has been shown in numerous current studies, a temporary immediate restoration can be carried out under suitable conditions, both for delayed and for immediate implant placements. At the same time, it must be borne in mind that the implant reacts extremely sensitively to manipulations at the interface in the osseointegration phase. Due to the physiological remodeling processes in the peri-implant bone, the primary stability is initially weakened and is then stabilized again secondary to the progressive osseointegration.

Essential abutment screw retentions using high torque at an earlier point in time than defined in the established standard concepts may result in the destruction of the bone bridges forming in the implant surface. The established standard healing times include a chronological safety margin which, with patient compliance, can be utilized for bone training by increasing so-called progressive loads via the temporary restoration. In combination, these evidence-based concepts, assisted by the 3D radiological analysis and virtual planning, can also

guarantee a precise and reliable predictable treatment process along with the identification of the most useful therapeutic concepts.

CONVENTIONAL PROTOCOL FOR TEMPORARY IMMEDIATE RESTORATION

A temporary immediate restoration is not only conceivable following late implant placement, but can also be performed after immediate implant placement and delayed immediate implant placement. Both for single-tooth implants and for primary splinted restorations in a line, as well as for polygonal support, the following criteria are crucial for the success of the immediate restoration:

- An insertion torque of 25 Ncm is currently stipulated as the lower limit for a sufficient primary stability.
- The bone density should not be less than D III. The density class D IV is only of limited suitability for an immediate restoration in load-capable cortical bone. Where the cortical bone is not able to bear a load, a healing period of between four and six months, in keeping with the standard healing periods, should be recommended.
- A temporary restoration with static and dynamic non-occlusion for single-tooth implants guarantees a sub-critical load.
- The final restoration can be carried out at the earliest after two months in the mandible and four months in the maxilla, that is after completed osseointegration of the implant. After this period, optimization of the red and white esthetics is reliable possible.
- The primary mechanical integration of the implant takes place secondary to the actual osseointegration, whereby the prosthetic superstructure must be fabricated such that macro-movements at the interface are precluded in this sensitive phase. The subsequent tertiary phase is characterized by the bony remodeling. Here, assimilation processes in the bone with intensified peri-implant mineralization result in an increased load capacity.

MATERIAL AND METHOD OF THE PATENTED IMPLANT SITE PREPARATION WITH XIVE

Attaining a sufficient primary stability regardless of the local bone quality requires that the implant used is provided with a special thread. By differently dimensioned crestal and apical thread surfaces, it is optimally adjusted to the bone density in these areas. In combination with the unique core design, not only a compression of the bone laterally, but also in the direction of the cortical bone is created in cancellous bone, by which the resistance of screwing, and hence the primary

stability, is increased. In addition, following this standardized drill sequence, the implant site is crestally aligned to the bone situation using the twist drill.

The site can be individually prepared according to the bone density and the cortical bone thickness. Due to the internal condensation described, the insertion torque, which is viewed as a measure of the primary stability, can be increased without resulting in a non-physiological increase in the resistance of screwing in the cortical region. Mechanical insertion, as against the manual approach using a ratchet, may be preferred, not only because of the option of recording the torque achieved, but also because the insertion instrument is mounted firmly on the contra-angle handpiece. Due to the stable connection between the insertion instrument and the placement head fixed firmly in the internal implant-abutment connection, the implant can be removed in a sterile manner, placed securely and screw retained friction-locked.

PROTOCOL FOR COMPUTER-NAVIGATED IMPLANT PLANNING AND TEMPLATE-GUIDED IMPLANT SITE PREPARATION AND IMPLANT INSERTION

After the clinical examination and findings, the foundation of computer-guided implant planning is performing computer tomography (CT) or digital volume tomography (DVT) using a laboratory-fabricated scan-template, which, after a separate set-up, highlights the optimal prospective prosthetic using radiopaque teeth and a likewise radiopaque base.

With the help of these techniques, the surgical and prosthetic axes can be imaged during the planning. Drilling a one millimeter diameter hole in the prosthetic center of the radiopaque teeth is recommended for better orientation of the implant positions during the planning. The scan template thus created is inserted into the patient's mouth with lightly splinted dentition, and a digital volume tomogram of the maxilla can now be produced. The data is now saved and imported into the ExpertEase software for the implant planning. After converting the data and the calculation of the 3D volumes, the optimal implant position and angulation corresponding to the bone volume can be determined in accordance with prosthetic requirements.

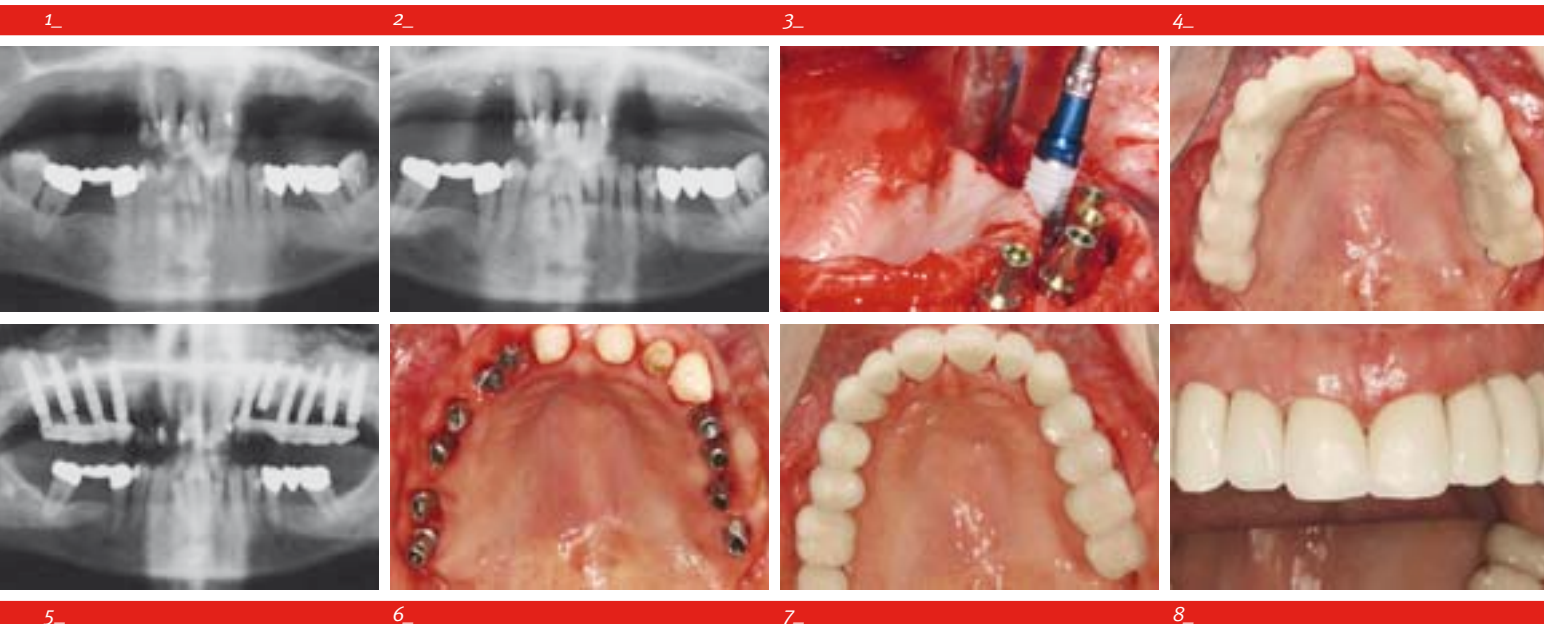
Then, the virtual planning and positioning of the fixation screws for safe intra-oral mounting of the ExpertEase template takes place. Using the unique sleeve-on-drill system, the implant site can be completely prepared intraoperatively and a template-guided implant insertion can be effected – even with a 3.0 mm implant.

CASE REPORT 1**CONVENTIONAL PROCEDURE FOR SINUS FLOOR ELEVATION WITH XIVE AND FRIOS ALGIPORE**

The 46-year-old female patient, unremarkable in terms of general history, was provided with an interim tooth replacement following the extraction of the non-conservable maxillary teeth. There was a free-end situation on both sides of the maxilla; the remaining dentition in the front was to be retained (Fig. 1). The goal of the treatment was to be a fixed tooth replacement in the maxilla following preoperative surgical and periodontal treatment. Due to the only meager residual bone height in the right and left maxilla, we chose a two-stage approach. First, we performed a subantral augmentation (sinus floor elevation) using Frios Algipore and autogenous bone chips. Both of the access windows placed facially in both quadrants were sealed using Frios BoneShield membranes, which were fixed onto the bone with Frios membrane tacks (Fig. 2). The implant placement was planned for approximately six months following the augmentation.

Following the local anesthesia, the incision direction was made paracrestally and palatally including a relief incision into the vestibulum. A muco-periosteal flap was created to expose the alveolar ridge. The conventional drill guide, manufactured on the basis of a diagnostic wax-up, was used to

determine the implant position, which was transferred onto the bone using a round drill. Then, we used the twist drills to prepare the implant site to the calculated drilling depth, in increasing diameters each time. Following this, the 3.4 mm, 3.8 mm and 4.5 mm diameter Xive S plus implants were inserted into the prosthetically precise position with a controlled torque (Fig. 3). The torques finally achieved in all of the implants were higher than 20 Ncm. The Friadent TempBase abutments, which were initially used as placement heads, were left on the implants, in order to serve as the base for the temporary restoration. The muco-periosteal flap was repositioned for the wound closure and sutured using resorbable suture material. The tooth-supported section for the long-term temporary denture produced chairside was fabricated and positioned separately from the implant-supported part (Fig. 4 and 5). The final restoration was fabricated with single crowns in the maxilla four months later. After impression making in the maxilla using a customized tray, the single crowns were fabricated in the laboratory using the Friadent EstheticBase abutments as a base. The abutments were positioned intra-orally on the completely osseointegrated implants (Fig. 6) and tightened with the torque-wrench as specified by the manufacturer. The veneered ceramic crowns were then able to be finally cemented (Fig. 7 to 9).



1_ Preoperative OPG: Condition post extraction treatment in the maxilla with remaining anterior dentition
 2_ OPG after subantral augmentation with Frios Algipore in both sides of the maxilla
 3_ Torque-controlled insertion of the Xive S plus implants
 4_ Insertion of the immediate, chairside fabricated restoration into the maxilla

5_ OPG post temporary immediate restoration
 6_ Customized Friadent EstheticBase abutments inserted and fixed in the maxilla
 7_ Inserted ceramic crowns in the maxilla – occlusal view
 8_ Final tooth replacement after soft tissue management in the anterior maxilla

CASE REPORT 2

XIVE AND DIGITAL DENTISTRY

The clinical examination of the 56-year-old patient with residual dentition in the maxilla showed an insufficient denture retention with simultaneous severe loosening of the telescope-crowned teeth 23 and 24. Following bilateral augmentation of the lateral maxilla and the appropriate implant surgery and prosthetic planning, the aim of the treatment here was also to have a fixed restoration in the maxilla (Fig. 10 and 11). Due to the pronounced atrophy of the alveolar process with a limited residual bone height of less than three millimeters, a two-stage approach was also planned.

Six months waiting time was scheduled for the osseous regeneration (Fig. 12) post sinus floor elevation using Frios Algipore and autogenous bone chips. Following the wax-up (Fig. 13) and manufacture of a scan template (Fig. 14), a DVT was produced, the data imported into the planning software (ExpertEase) and computer-guided implant planning was carried out (Fig. 15a to 16b). Based on this virtual planning, the ExpertEase drill guide was able to be manufactured using the stereolithography. This was used to fabricate a model on which a long-term temporary restoration with individualized TempBase abutments for immediate function was fabricated (Fig. 17a and 17b). After anesthesia, teeth 23 and 24 were

removed and the drill guide was fixed into its final position on the maxillary mucosa with an even, moderate pressure (Fig. 18). The fixing screws were then screwed into the bone through the corresponding sleeves, the crestal mucosa was removed through the template with the help of the punch and the bone was center punched using the round drill to mark the implant position (Fig. 19a and 19b). After drilling the template-guided pilot hole, all of the preparation was made through the template in the planned implant diameter. Following this, we inserted with torque control ten 3.4 and 3.8 mm diameter Xive S plus implants with 13 mm in length in the prosthetically correct position (Fig. 20). The integrated depth stop ensured adherence to the exact depth. After removing the drill guide, the premounted Friadent TempBase abutments used as placement heads were replaced by the TempBase abutments modified in the laboratory (Fig. 21a and 21b). The temporary restoration was now able to be inserted tension-free with temporary cement (Fig. 22 and 23).

Four months after the implant placement, the model and the individualized all-ceramic abutments (Xive TitaniumBase), as well as the superstructure were fabricated in porcelain after impression making. After inserting the abutments in the osseointegrated implants at a torque of 24 Ncm, the tooth replacement was able to be finally cemented (Fig. 24 to 26).



9_ OPG after insertion of the single crowns

10_ OPG of the initial situation in the maxilla with residual dentition 23 and 24

11_ Model analysis by mounting the situation model in the articulator

12_ Radiological image post sinus floor elevation with Frios Algipore bilaterally in the maxilla

13_ Set-up of the prospective restoration in the maxilla

14_ Scan template prepared for the radiological scan

15a, 15b_ Virtual implant planning with the ExpertEase planning software

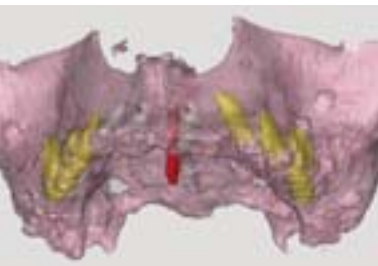
DISCUSSION

While taking an adequate occlusion and articulation concept into account, a load-limited temporary restoration potentially gives the bone a chance to adapt by way of remodeling in a progressive loading mode. This option should particularly be used with a reduced number of implants, a reduced bone density, and in combination with or following augmentation. To identify the appropriate healing or loading concept, concrete conditions, such as an adequate primary stability, must be fulfilled. Additionally, the appropriate patient behavior is vital for immediate functional rehabilitation.

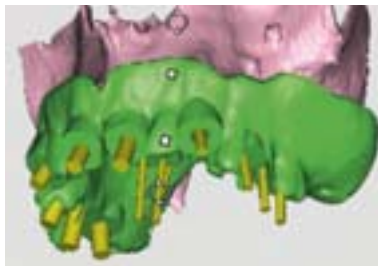
A practical implant system should therefore include options for immediate loading, transgingival healing and for a submerged approach. Micromovements, that is, minimal distension and compression of the bone during osseointegration, are, at the same time, viewed as physiologically useful for the bone healing. A limited load represents beneficial bone training. For an immediate implant placement with temporary immediate restoration, the balancing act between the minimal physiological movements and damaging macromovements must also be successful. The primary sufficient stability necessary for an immediate restoration can be most reliably achieved by a screw design with compression screw fixation of the implant. Where the macroretention of the implants, high bone density and polygonal load distribution are adequate, conditions can

be created that also facilitate reliable osseointegration for an immediate loading of the implants. Biomechanically, the osseointegration of polygonally supported and splinted implants is comparable to fracture healing after a restoration with osteosynthesis plates under functional load. Where single-tooth implants are initially loaded, this polygonal load distribution is absent. These are highly susceptible to loss, since overloading due to macromovements may lead to tearing of the connective tissue. Both the primary stability achieved and the level of the loading are therefore responsible for the osseointegration. Studies and clinical experience have shown that transgingival implants osseointegrate successfully in spite of a limited load. Since a broad deposition surface on the implant reduces the effect of the force and hence the likelihood of a mechanical deformation of the bone, an implant geometry with ideal enhancement of the surface by the micro design is important for osseointegration under load. The aim of the temporary immediate restoration, then, is to reduce treatment times by means of an esthetically correct, stable, fixed long-term temporary denture on the day of the implant insertion. Under ideal conditions, in combination with the immediate and late implant placement, this results in retention of the structure of hard and soft tissues. Current technologies should be integrated into the established concepts usefully and beneficially for the patient.

16a_



16b_



17a_



17b_



18_

16a, 16b_Virtual implant planning with the ExpertEase planning software

17a, 17b_Individualized Xive TempBase abutments and completed long-term temporary denture

19a_

18_Positioning the drill guide intraoperatively

19a, 19b_Template-guided implant site preparation

20_Insertion of the Xive S plus implants interforaminally with 3D drill guide (Safe Guide, ExpertEase)

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The 3D diagnostics and virtual implant planning provide safety and patient comfort. ExpertEase can guarantee an exact illustration of the implants and the abutments and hence a predictable therapeutic process.

By using patient-specific templates produced by the stereolithography, a precise seating on the jaw can be achieved for all indications, such as tooth-supported, bone-supported and mucosa-supported restorations. The integration of pre-mounted, precisely fitting and relocatable drilling sleeves with depth stop (Sleeve-on-Drill) ensures the exact guidance of the internally cooled implant drill. Template-guided, the implant can be positioned absolutely accurately. Hence, the surgery time is considerably reduced and, simultaneously, the optimal precision is achieved. Surgical trauma is reduced to a minimum. The patient, however, must be counseled concerning the significantly decreased loading capacity of the implants in the osseointegration phase. ■

Literature on request from the authors

Please allow us just one final, personal word: More than anyone else, we have Dieter Haessler to thank for Xive's success today. His input has substantially shaped Xive and continues to influence our work today. We miss him each day.



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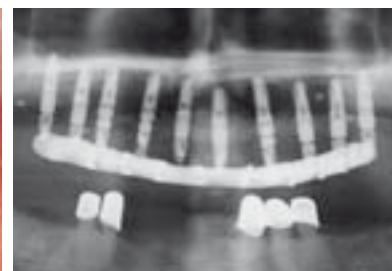
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26_



21a_ Condition post implant placement after removal of the drill guide
21b_ Positioning of the temporary abutments modified in the laboratory
22_ Incorporation of the temporary tooth replacement for approximately four to six months
23_ Control image post implant insertion and temporary immediate restoration in the maxilla

24_ Individual all-ceramic abutments positioned and fixed with a retaining screw
25_ Single crowns finally inserted into the maxilla
26_ The radiological control image of completely osseointegrated implants and the precisely positioned ceramic abutment positioned using the key and fixed with torque.