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Clinical Procedure And First Results of Immediately Restored Implants - a Study in Mini-Pigs

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Introduction

The immediate loading of dental implants in partially edentulous patients has not been widely investigated. Following the experience of the treatment of the anterior mandible (Ledermann 1979, Ledermann 1988), immediate loading requires pre-conditions such as immobilization of the implants with a superstructure and shortened surgical and prosthetic treatments (Brunski, 1993). The preparation of the receptor site in the mandible is accomplished with drills. In soft bone, improvement of the bone quality can be achieved by BoneCondensing (Fürst 1999). This technique can also be used to perform minor lift procedures. Adaptation of the receptor site by "under-sizing" the osteotomy relatively to the implant is another option to help achieve primary stability (Schmidinger 1999). An animal study on micro pigs was performed to evaluate the clinical success and bone reaction during the course of osseointegration for implants in the mandible and maxilla.

Material and Methods

The premolars and the first molar were removed. After three months, implant placement and prosthetic temporization was performed for 61 XiVE® implants (FRIADENT GmbH, Mannheim, Germany). 27 implants were placed in the maxilla and 34 in the mandible. The preparation in the mandible was performed with drills. The preparation in the maxilla was performed by BoneCondensing technique to increase the local bone quantity and quality with an internal sinus-lift. The special thread design with a lower thread profile in the crestal portion allows a differentiated implant site preparation with the final crestal drill. Based on the bone quality, internal condensation by the implant is used to improve the final insertion torque. 49 implants were stabilized with prefabricated caps and glass fiber ribbons. The bridges were cemented onto the abutments at the end of surgery and controlled until the animals were sacrificed. Markers for the histological staining were given according the protocol of Becker et al. (1992).

Clinical Procedure Step-by-Step

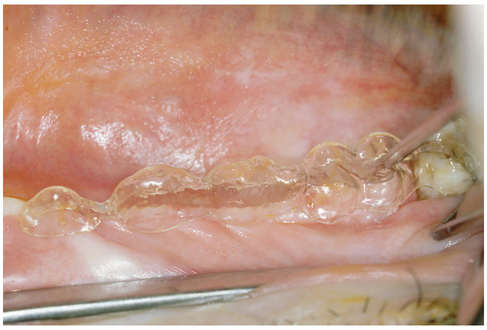

Fig. 1: Prior to the extraction of the teeth and impression was made to fabricate a surgical stent for the implant placement and for the fabrication of the provisional bridge.

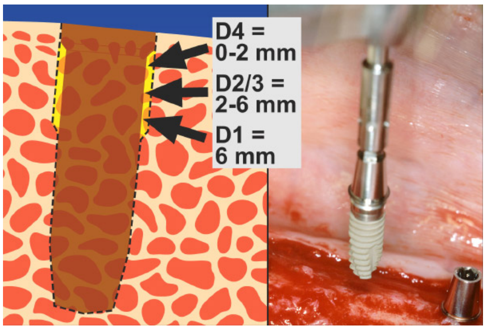

Fig. 2: The implant sites were prepared with standard drills in the mandible. The depth of the crestal preparation was reduced in soft bone to create a tighter fit of the implant (internal condensation of the bone). The implants were placed with a hand piece at 15rpm.

Fig. 3: Situation after suturing: The implant mount called a TempBase stays in place as a temporary abutment. Complete wound closure was double checked to avoid contact of the temporary resin with the fresh wound.

Fig. 4: The TempBases were reseated if the flats on the abutments were not placed in a straight line. The prefabricated TempBase caps were seated on the abutments for a stable reinforcement with fiber ribbon, a straight line is optimal.

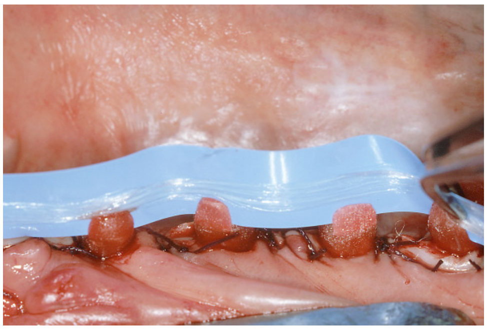

Fig. 5: Light-cured fiber material was utilized to connect the caps. Contamination for the fibers with saliva or blood during the placement of the fiber core must be prevented.

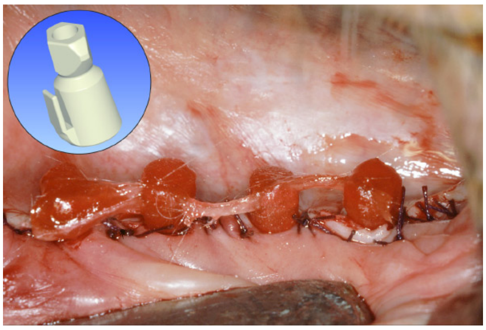

Fig. 6: Additional resin is applied to stabilize the fibers and increase the mechanical stability. The resin should be placed in thin layers to avoid tension in the superstructure during shrinkage of the material.

Fig. 7: The template is double checked before the auto-polymerizing resin is applied. During polymerization, irrigation fluid is utilized to protect the soft tissue from the high temperature of the resin as it sets.

Fig. 8: After final polymerization the superstructure is removed. Voids are filled-in with resin and the bridge is finished and polished. The bridge is cemented onto the TempBase abutments.

Histological Findings

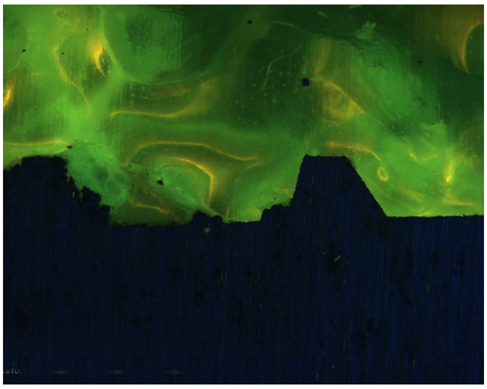

Fig. 9: Unloaded implant in flourochrome microscopy shows active remodeling around the crestal threads after internal condensation.

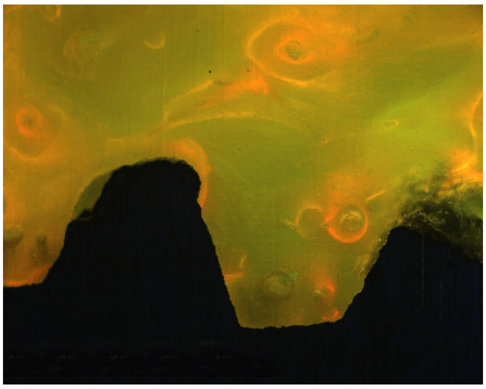

Fig. 10: Fluorochrome microscopy of the apical region of a loaded implant. Strongest cell activity is shown after eight weeks with Allzarin-marker.

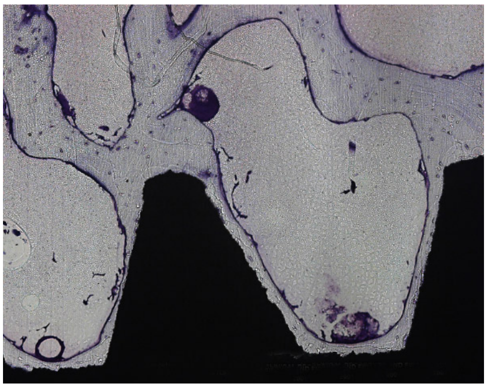

Fig. 11: Toluidin blue staining of unloaded implant illustrates close bone-to-implant contact at the apical threads. The bone between the threads shows large marrow spaces.

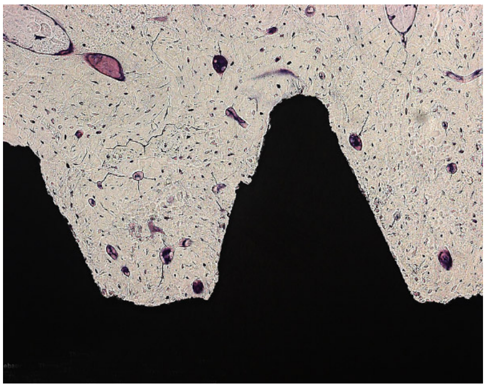

Fig. 12: Toluidin blue staining of loaded implant shows new bone formation within the threads. Active osteocytes are seen between the threads.

Results

Due to the adaptation of the receptor site preparation based on the bone quality, utilizing cortical drills in the mandible and bone condensing instruments in the maxilla, 92% of all implants were placed with an insertion torque (**IIT**) above 25 Ncm. The mean value of the insertion torque per bridge (**BIT**) was evaluated. If the BIT was less than 35 Ncm the bridges were not stable and the implants were lost after a few weeks prior to the first recall. In the mandible, of the directly loaded implants (N=27) two failures occurred (92.6% success). The control implants in the mandible had a 100% success rate (N=7).
Three out of 22 directly loaded implants in the maxilla were stable after three months (13.6% rate). Two out of 5 control implants in the maxilla were stable (40% success rate).

IIT / BIT	**Maxilla**	**Mandible**
15 - 20 Ncm	4 (4) implants	-
25 - 30 Ncm	15 (12) implants, 5 (5) bridges	4 (0) implants
35-45 Ncm	3 (3) implants, 1 (0) bridges	- , 2 (0) bridges
50 and over Ncm	3 (2) implants	23 (2) implants, 4 (0) bridges

Torque analysis loaded implants (failures)

RFA-Value	Minimum	Median	Maximum	Mean	N
Maxilla	67	76	80	75.2	5

Mandible	42	77	88	75.4	34

RFA-Analysis

There was no difference between loaded and unloaded implants regarding the RFA Resonance Frequency Analysis - values visible after three months of implant placement (Rasmusson 1998).

Discussion

Primary stability is a pre-condition for immediate implant placement. Internal condensation has been used to improve primary stability. In the maxilla additional bone condensing was used to gain additional length into the sinus. With these techniques, BIT values between 25 and 45 Ncm were reached in the maxilla. In the mandible the BIT values were between 35 Ncm and more than 50 Ncm. Bridges with a BIT below 35 Ncm failed. Bridges with BIT above 35 Ncm were successful in the animal model. The control implants were placed next to the immediate loaded implants, losing the immediate loaded implants also damaged these implant sockets. The control implants in the mandible showed complete osseo-integration. Histological observation showed no difference in bone contact for loaded and unloaded implants in successfully osseo-integrated implants. The subjective impression of a more differentiated bone reaction around the loaded implants requires further investigation. RFA-analysis showed no difference between mandible and maxilla. Also, there was no visible difference between loaded and unloaded implants.
The reduction of the occlusal contacts in the maxilla was much more difficult than in the mandible due to the anatomy of the animal model.
In general this procedure, utilizing prefabricated components, allows the fabrication of a provisional bridge in one appointment for immediate loading. The bone formation appears more differentiated in comparison to implants with standard unloaded healing if the primary stability of the bridge was suitable for initial loading.

Positive parameters

- **BIT** greater than 35 Ncm
- Implant stabilization by resin superstructure

Negative parameters

- **BIT** less than 30 Ncm
- Internal sinus lift for gaining vertical bone height
- Limited reduction of horizontal load during the first weeks of initial loading

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