The Influence of Initial Hard and Soft Tissue Dimensions on Initial Crestal Bone Loss of Immediately Loaded Dental Implants

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The aim of this case-control study was to evaluate the influence of soft tissue thickness at implant placement (thin [< 3 mm] vs thick [≥ 3 mm]) and bone volume (abundant vs limited) on initial crestal bone remodeling of immediate postextraction and delayed (healed site) implants in immediate loading situations. A total of 67 patients with 133 implants could be evaluated, of which 77 were placed immediately after extraction and 56 in healed ridges. If sufficient bone volume is present and primary stability is achieved, immediate loading of the implant yields good clinical and radiographic outcomes, yet implants placed in healed ridges with thin soft tissues are more prone to initial crestal bone loss. Int J Periodontics Restorative Dent 2018;38:873–878. doi: 10.11607/prd.3458

Traditionally, dental implants have been placed in healed ridges and loaded after 3 to 6 months. However, as implant treatment has become more predictable, faster treatment strategies have developed. Immediate placement after extraction and immediate loading have been shown to be viable treatment options if some prerequisites are fulfilled.¹,² One of the major requirements for immediate loading is primary stability, which is linked to the insertion torque at implant placement. The latter can be measured from the drill torque during implant insertion or the ISQ values, which reflect on the micromobility of the implant.³ In a comparative study by Ottoni et al,⁴ 23 patients each received two single implants, of which one was loaded after a healing period and one was immediately loaded. Of the 23 immediately loaded implants, 10 failed. However, 9 of those were placed with a seating torque of < 20 Ncm, indicating a poor primary implant stability. If primary stability is achieved, however, survival rates of immediately loaded implants are comparable with conventionally loaded ones.⁵

Crestal bone preservation remains an important concern in implant dentistry. Initial crestal bone remodeling happens during the first year after implant placement, reaching a steady state and leading to stable crestal bone levels over the
Galindo-Moreno et al. conducted a retrospective study evaluating 508 implants in 208 patients and concluded that implants with increased crestal bone loss at early stages have a greater chance of progressive crestal bone loss over the longer term. This indicates that limiting the initial crestal bone loss is paramount for a successful implant treatment. One of the causes of this initial crestal bone loss is the establishment of the biologic width. This is determined by an ideal vertical position, ensuring a 3- to 4-mm soft tissue seal. But not only the vertical position is important to limit crestal bone loss. As stated by Grunder et al., a 2-mm buccal bone thickness and a distance of 1.5 mm between teeth and implant has to be respected to limit initial crestal bone loss. The ideal implant position could be jeopardized if limited bone volume is present, suggesting that a limited bone volume and thin soft tissues could influence initial crestal bone loss.

The aim of the present study was to evaluate the influence of soft tissue thickness at implant placement (thin [< 3 mm] vs thick ≥ 3 mm) and bone volume (abundant vs limited) on initial crestal bone of immediate and delayed implants in immediate loading situations.

Materials and Methods

Study Implants

The T3 implant (Zimmer Biomet) is a tapered implant with an internal connection and an integrated platform shift. The implant has a hybrid surface with a dual acid-etched surface (DAE) on the coronal 1.5 mm up to the first thread and a combined DAE and blasted surface on the remaining mid and apical part. The respective surfaces are minimal-ly rough coronally (Sa: 0.48 μm) and moderately rough (Sa: 1.39 μm) below the upper 1.5 mm. A nanoscale topography also was applied to the entire length of the DAE implant via discreet crystalline deposition of nanometer-scale crystals of calcium phosphate.

Patient Selection

Partially and fully edentulous patients in need of implant-supported restorations were consecutively selected. Presurgical clinical diagnostic included clinical inspection and periapical radiographic examinations. Inclusion criteria were loss of single or multiple teeth (control) or presence of teeth that needed extraction (test), and sufficient residual bone to ensure stability of an implant of at least 4 mm in diameter and 8.5 mm in length. Patients younger than 18 years or patients with general contraindications for oral surgery were excluded. If a periapical infection was present, the patient was not excluded from immediate placement provided the infection could be removed during osteotomy preparation and proper bone curettage was possible without damaging the crest. Patients with major bone augmentations were excluded from the study. Patients who smoked < 10 cigarettes per day and patients with Type 2 diabetes but controlled glycemic level were not excluded. Good oral hygiene (plaque level < 30%) had to be present at the time of implant placement. Each patient received specific oral hygiene instructions and, if necessary, professional plaque and calculus removal prior to implant treatment. Patients were thoroughly informed and gave signed informed consent. The study was conducted in full accordance with relevant ethical principles, including the World Medical Association Declaration of Helsinki of 1995 as revised in 2000.

Surgical Procedure

At 1 hour prior to surgery, antibiotics (2 g amoxicillin [Amimox, Meda]) and diazepam (0.3 mg/kg body weight Stesolid, Alpharma) were given to each patient. If the implant was placed in a healed ridge, a midcrestal incision was performed and a mucosal flap was reflected under local anesthesia (lidocaine-epinephrine [Xylocaine-Adrenaline 2%, Dentsply]). If the implant was placed in an extraction socket, a flapless procedure was used so that the mucoperiosteal flap was not detached from the crest to minimize postsurgical bone resorption due to surgical trauma. The soft tissue
thickness was measured before implant placement (Figs 1 and 2), and the implant was placed crestal or subcrestal, ensuring a soft tissue seal of at least 3 mm to prevent bone loss due to placement of the biologic width. Bone volume was assessed, using Lekholm and Zarb criteria, which is a subjective measurement. The same clinician performed the surgeries and bone assessments (P.O.O.), allowing a useful comparison among various bone quantities. The drilling protocol used in this study conformed to the guidelines of the manufacturer, but countersinking was not performed. When placed immediately after tooth extraction, implants were positioned more palatal and Endobon Xenograft (Zimmer Biomet 3i) was used to fill the gap between the implant and the buccal wall of the socket if the void was > 2 mm.

After final implant seating, insertion-torque values were registered on the drill unit (Elcomed, W&H Dentalwerk) and resonance frequency analysis was recorded (Integration Diagnostics, Ostell). Based on these measurements, the loading protocol was determined. A minimum insertion torque of 25 Ncm and an ISQ > 60 had to be achieved for immediate loading (insertion torque < 25 Ncm and/or ISQ < 60) were excluded from the study. Immediately after surgery, baseline radiographs were taken. After implant placement, the patients were advised to use 0.1% chlorhexidine mouthrinse (Hexident, Ipex Medical) for 1 minute three times per day for 10 days. A diet consisting of soft food was advised for the first 10 days after surgery.

Follow-up Evaluations

Posttreatment follow-up examinations were scheduled at 3, 6, 12, 18, and 24 months. Patients’ oral hygiene was reinforced whenever necessary, and professional maintenance was individualized. Crestal bone level served as the main variable and was assessed on periapical radiographs after calibration with the Kodak program by comparing the distance from the implant-abutment junction to bone-to-implant contact. Crestal bone level at follow-up was compared with the level at baseline to calculate initial crestal bone loss.

Statistical Method

The data were processed using SPSS Statistics version 20 (IBM). Data analysis was performed using the implant as the experimental unit. The data were tabulated, and from these measurements, mean, SD, minimum, and maximum were calculated. Mean crestal bone loss was compared for immediate and delayed placed implants using Mann-Whitney test. To identify the effect of bone volume (abundant [A–B] or limited [C–D], as proposed by Lekholm and Zarb) and initial soft tissue thickness (thin soft tissues [< 3 mm] vs thick soft tissues [≥ 3 mm]) on initial crestal bone loss of immediate and delayed implants, the data file was split and Mann-Whitney test was applied on both groups separately. Additionally, chi-square test was used to determine if bone volume and initial soft tissue thickness are related. The level of significance was set at .05.
The total number of implants was 161, placed in 87 patients (54 women and 33 men) with a mean age of 68.6 years (range: 25 to 91). Of these, 28 in 20 patients did not meet the criteria for immediate loading and were excluded. Of the remaining 133 implants, 77 were placed immediately after extraction and 56 in healed ridges. One implant, placed in a healed site, failed after 4 weeks, for a survival rate of 99.25% after a mean follow-up period of 22.5 months (SD 5.2; range: 14.2 to 34.3). Seventy-two percent of the implants were placed in the maxilla and 28% in the mandible; 32.6% of the implants were restored with single crowns and 40.2% and 27.2% with fixed partial and fixed full dentures, respectively. The surviving 132 implants had a mean ISQ of 74.16 (SD 7.64) and a mean insertion torque of 50.57 Ncm (SD 12.30). After > 1 year in function, an overall mean crestal bone loss of 0.12 mm (SD 0.24; range: –0.3 to 1.05) was measured around 132 implants. Statistically significantly less initial crestal bone loss could be identified when implants were placed immediately after extraction (0.07 mm; SD 0.18; range: –0.15 to 0.95) compared to implant placement in healed ridges (0.19 mm; SD 0.18; range: –0.30 to 1.05) (P = .011). Table 1 gives an overview of the effect of bone volume and soft tissue thickness on initial crestal bone loss of immediate and delayed implants. Implants placed in healed ridges with thin soft tissues showed statistically significantly more initial crestal bone loss compared to delayed implants with thick soft tissues (P = .029) (Figs 3 and 4). A correlation between soft tissue thickness and bone volume could be identified in healed ridges (P < .001) but this could not be shown when implants were placed immediately postextraction (P = .89).

### Discussion

This clinical study aimed to identify the influence on initial crestal bone loss of soft tissue thickness and bone volume of immediately and delayed implants in immediate loading situations. In general, a high
survival rate (99.25%) and limited crestal bone loss were found. In a retrospective clinical study conducted by Cosyn et al., survival rates of 1,180 implants placed for a variety of indications in a dental implant training center were evaluated. After at least 1 year in function 3.5% of the implants had been lost. No additional risk for implant failure of immediately placed implants could be identified, which is comparable with this study. A systematic review and meta-analysis conducted by Kinaia et al. compared outcomes of implants placed with a different surgical protocol. A total of seven studies discussed crestal bone loss of immediately placed implants \( n = 268 \) and crestal bone loss around implants placed in healed bone \( n = 384 \) after a minimum follow-up of 1 year. These were included in a meta-analysis. The immediately placed implants had statistically significantly less crestal bone loss (0.24 mm) than those placed in healed sites. This may be explained by the use of xenograft material at the time of implant placement, which could also be the case in the present study.

As biologic principles become clearer, the ideal vertical position may well be determined. If an implant is placed and the suprastructure penetrates the soft tissue, a soft tissue seal of 3 to 4 mm is set. When the soft tissues are thin (< 3 mm) and the implant is placed crestally, the biologic width is not respected and crestal bone loss occurs. Linkevicius et al. conducted a clinical study in which 40 implants were placed in healed ridges with thin soft tissues and 40 implants were placed in healed ridges with thin soft tissues. After 1 year of follow-up, there was statistically significantly more crestal bone loss when there were thin soft tissues at the time of implant placement (1.17 mm) compared to when thick soft tissues were present (0.21 mm). The latter could be confirmed in the present study, yet the difference in initial crestal bone loss was less obvious. Linkevicius et al. placed the implant at a crestal level even when thin soft tissues were present. In the present study, biologic width was accounted for and the soft tissues were measured prior to implant placement, adapting the vertical position to the soft tissue thickness and counteracting the effect of soft tissue thickness on initial crestal bone loss. Yet the latter could not fully prevent initial crestal bone loss in sites with thin soft tissues. As soft tissue thickness and bone volume are related, implant sites with thin soft tissues are more likely to also have a limited bone volume, making these high-risk cases that may be more prone to initial crestal bone remodeling.

A possible confounding factor is that only 18 and 12 immediately placed implants, respectively, had thin soft tissues and limited bone volume prior to implant placement. As those implants were placed immediately after extraction, bone resorption and soft tissue healing had not yet initiated and few of those high-risk cases could be evaluated. Another bias could be the use of a xenograft in immediate implant placement. This material is radiopaque and could conceal crestal bone loss, leading to overestimation of implant outcome. Caution is advised when evaluating the results; nonetheless, periapical radiographs remain the most practical method to assess crestal bone loss.

Conclusions

Regardless of the type of surgery (immediate postextraction placement or placement in a healed site), immediate loading yields good clinical and radiographic outcomes provided that primary stability and ideal three-dimensional positioning are feasible.

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References


