The Vertical Soft Tissue Thickness and Subcrestal Implant Placement as Factors for Peri-implant Crestal Bone Stability

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Introduction

The stable peri-implant crestal bone is one of the most desired outcomes in implant dentistry [1]. Peri-implant crestal bone loss <1.5 mm was defined as a reference point for successful implant treatment after 1 year of loading [2]. However, this concept needs redefining with the use of new implant designs, surface technologies, and new research on factors affecting bone remodelling [3]. 1.5 mm of bone loss is no longer acceptable during the 1st year in function. According to one clinical trial, 96% of implants with bone loss >2 mm during the first 18 months presented with mean 0.44 mm bone loss 6 months post loading [4]. Many factors contribute to bone loss: Inadequate occlusion, the presence of a microgap, use of an implant with a smooth collar, infection, and more importantly, soft tissue thickness and its influence during re-establishment of the biologic width [5], [6], [7], [8], [9].

Crestal bone level changes around dental implants may be presented as bone remodelling (controlled bone loss that stops at the level at the prosthetic implants platform) and progressive bone loss – bone remodeling that continues past the implant neck, which becomes exposed to soft tissue. Progressive bone loss around the implant neck leads to peri-implantitis development. Therefore, minimizing or preventing this initial bone remodeling is of paramount importance, starting at the time of implant placement. Different methods have been proposed to minimize bone loss: Platform switching, different apicocoronal positions of the implant with regard to the alveolar crest, and laser-modified implant surfaces [10], [11], [12].

The aim of this prospective study was to determine the influence of vertical soft tissue thickness on bone level changes in platform-switched implants placed equicrestally or subcrestally and restored with screw-retained or cement-retained restorations.

Methods

Fifty-two bone-level implants with platform-switched design (Implantswiss, Novodent SA,
Yverdon-les-Bains, Swiss) were placed in a single stage manner (with simultaneously connected healing abutment) in 38 patients. The patients included in the study were at least 18 years old with no medical contraindication for implant surgery. Additional inclusion criteria were missing teeth in the posterior lower jaw; at least 6 mm bone width and 8 mm bone height; periodontal health: Bleeding on probing (BOP) < 20%, periodontal index (PI) < 25%; a minimum of 4 mm keratinized gingiva buccolingually; no bone augmentation procedures before or during implant placement, and primary implant stability of 35 Ncm to allow single-stage surgery. After administration of local anesthesia, (1.8 ml 2% Mepivacaine, Scandonest Special, Septodont, Saint-Maur-des-Fossés, France), a midcrestal incision was done to preserve the attached mucosa. A full-thickness buccal flap was raised, and the vertical soft tissue thickness was measured with a 1.0 mm marked periodontal probe (UNC, Hu-Friedy, Chicago, IL, USA), vertically positioned before lingual flap was raised (Figure 1).

Figure 1: (a and b) Vertical soft tissue thickness: Thin versus thick

Implant sites were divided into two groups: Implant sites with gingival thickness of 3 mm or more (control group) and implant sites with gingival thickness of <3 mm (test group). After the measurement, the lingual full-thickness flap was elevated, and the site for implant placement was prepared. The osteotomy site was at least 1.5 mm from the adjacent tooth/teeth, and there was at least 1 mm of space between the buccal and lingual crests of the alveolar ridge and implant. The implants in the control group were placed equally to the bone crest level (equicrestally), whereas the sites from the control group were randomly allocated to receive equicrestally or subcrestally (below bone crest level) placed implants. The subcrestal implant placement was done using a final osteotomy drill longer by 2 mm than the prescribed implant length. The primary and the secondary implant stability were determined using an implant stability quotient (ISQ) instrument (Penquin ISQ, Gothenborg, Sweden). After implant insertion, healing abutments were placed and flaps were closed with 5/0 interrupted absorbable sutures (Assucryl, Assut Medical, Pullly/Lausanne, Swiss) (Figures 2 and 3). The patients were given postoperative oral hygiene instructions.

Radiographs were taken in high resolution mode with Vario DG X-ray and Xios AE sensor (Densply Sirona, New York, USA) using a Rinn-like film holder and utilizing the paralleling intraoral radiographic technique. Bone remodeling/loss was measured as a distance (in millimeters) between the implant edge and the first radiological contact between implant and bone at two reference points at mesial and distal implant side. The measurements were done using the digital software Sidexis 4 (Densply Sirona, New York, USA) at baseline, 3 months postoperatively and 6 months after delivery of final prosthetic restoration (Figure 4). Implants were restored with metal ceramic screw-retained or cemented restorations using long-term temporary cement (Dentotemp, Itena Clinical, Vilepinte, France). All patients underwent 2-month follow-up examinations for periodontal health control.

Data were analyzed using statistical software Prism 9.0 with the implant as a statistical unit. Descriptive statistics, including means, SEs, medians, and ranges of measurements, were calculated. Multiple testing correction analysis was performed using two-way ANOVA. According to the acquired measurement values of bone loss extent, data were distributed into four groups: Bone loss >1.5 mm, 1.01–1.5 mm, 0.51–1 mm, 0–0.5 mm. The mean differences were considered statistically significant at p < 0.05.

Results

After 3 months of healing, clinical stability of implants was evaluated. Implants were considered successfully osseointegrated if they presented ISQ

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values above 60, were clinically immobile, showed no evident radiolucencies, and the patients reported no pain. The sample size included 38 patients (14 males and 24 females) with a mean age 52 (range 25–81). Equal number of implants (26) were placed equicrestally and subcrestally. 27 implants were restored with screw retained and 25 with cement-retained restorations (Table 1). The mean, the median values of vertical soft tissue thickness, as well as the distribution of the vertical soft tissue thickness were calculated (Figure 5).

Crestal bone losses at 3 months postoperatively and 6 months post prosthetic restoration in implant sites with vertically thin and thick tissues are given (Table 2). Tukey’s multiple comparison test showed statistical difference between crestal bone loss values in sites with thin and thick gingiva at two measurement time points (p < 0.001) (Table 3). Table 4 shows crestal bone losses only in implant sites with thin vertical soft tissue thickness in equicrestally and subcrestally placed implants. Tukey’s multiple comparison test again shows high statistical significance between the two groups (p < 0.001) (Table 5).

Table 5: Statistical analysis of mean bone loss values (mm) in vertically thin gingiva depending on implant placement type

Table 6 shows crestal bone losses in implants restored with screw retained and cement-retained restorations. No statistically significant difference for

| Table 4: Bone loss (mm) in vertically thin gingiva depending on implant placement type |
|---------------------------------|-------|-------|-------|-------|-------|
|                                  | mean  | max   | min   | MD    | SD    |
| subcrestal                      |       |       |       |       |       |
| after 3 months                  | 0.62  | 1.77  | 1.77  | 0.49  |       |
| 6 months after prosthetic rest. | 0.98  | 3.9   | 0.30  | 1.80  | 0.51  |
| subcrestal                      |       |       |       |       |       |
| after 3 months                  | 1.25  | 2.90  | 0.09  | 2.80  | 0.88  |
| 6 months after prosthetic rest. | 1.44  | 3.09  | 0.09  | 3.00  | 0.96  |

Table 6: Bone loss (mm) in vertically thin gingiva depending on implant - prosthetic restoration connection type

Table 7 shows crestal bone losses in implants restored with screw retained and cement-retained restorations. No statistically significant difference for
The implant abutment connection is an important factor in the etiology of bone loss because of the presence of the microgap between the implant and the abutment as well as the micromovement that pumps bacterial load in the surrounding tissue. To distance the microgap away from the alveolar bone, several methods have been proposed, such as displacing this implant abutment connection horizontally and vertically [10], [11]. In platform-switched implants, the implant abutment connection is displaced inward, so that the microgap is farther away horizontally from the alveolar bone. The rationale resides in this microgap acting as a reservoir for bacterial colonization, accumulating an inflammatory cell infiltrate that, because of its proximity to the bone, may trigger bone resorption with the negative effect of bacteria and mechanical micromovement [13], [14], [15], [16]. Multiple randomized controlled trials as well as systematic reviews have confirmed its efficacy in maintaining crestal bone [17], [20], [21].

However, many studies failed to demonstrate any significant difference if thin mucosa (<2 mm) is present [22], [31]. Vandeweghe and DeBruyn concluded that platform switching is effective only when mucosal thickness is sufficient for establishment of biologic width [32]. Galindo-Moreno et al. reported that vertical mismatching in relation with prosthetic abutment height, conditioned clinically by the keratinized mucosa width, is better than platform switching in the preservation of crestal bone loss values was found between the two groups at two measurement time points (Table 7). Figure 6 shows the distribution of bone loss in implants sites with vertically thin and thick tissues.

### Discussion

This study aimed to evaluate the effect of vertical soft tissue thickness on crestal bone loss in platform-switched implants and the subcrestal placement of implants with platform-switched design.
To distance the implant-abutment connection and its negative effect from the crestal bone, bone-level implants can be placed supracrestally and subcortically. Supracrestal implant placement requires polished implant neck, while subcrestal placement requires stable conical implant abutment connection. Dibart et al. reported that an implant placed at the crestal bone level approximated the microgap to the bone, and bone loss would occur due to possible bacterial leakage [35]. Piattelli et al. suggested that a more apical position of the implant abutment connection implied a higher crestal bone loss than a more coronal position due to closer proximity to the bone of the inflammation zone associated with the implant abutment interface [11]. Subcrestal placement of bone-level implants is recommended with simultaneous use of healing abutments to avoid the unnecessary bone growth over the implant platform. Hermann et al. in a series of animal studies [15] reported extensive bone loss in subcrestally placed implants with polished neck and with matching implants abutment connection. Therefore, only implants without polished neck but with stable conical platform-switched connection that distances bacteria from the bone and precludes movement of the abutment platform can be placed subcrestally.

Most studies aiming at minimizing the crestal bone loss lack proper analysis of the mucosal thickness at the time of implant placement [17], [18], [19], [20]. In 1996, it was demonstrated that if a minimal requirement for biologic width formation is not satisfied, providing enough surface for both junctional epithelium and connective tissue attachments, bone resorption will occur [9]. Galindo-Moreno et al. and Verhake et al. concluded that implants with longer abutments had less crestal bone loss. Although both studies lacked measurements of tissue thickness at the time of implant placement, it could be hypothesized that longer abutments correspond with thicker tissues which is why less bone loss is expected [29], [30]. Several clinical trials investigated the influence of soft tissue thickness on initial bone remodeling after implant placement, concluding that if a minimum 2 mm is not present during stage 1 surgery, bone resorption will occur regardless of the use of laser-microtextured collars and platform-switching connections [22]. Linkevičius, Puisys et al. [23], [24] demonstrated statistically significantly less crestal bone loss when thick tissue or augmented thin tissues were present compared with non-augmented thin tissues. Results from studies from this group showed that tissues with >2 mm thickness, as measured perpendicularly from the crest at the time of implant placement, had less bone loss [25], [26], [27], [28].

Although the threshold between thin and thick tissues in most clinical trials is 2 mm, in our study it was 3 mm. This was done because in the clinical trials, highly prevalent issues with medium thickness of 2.5 mm showed similar values for bone loss with thin tissues (<2 mm). Several studies have already implemented the use of 3 mm as a minimal tissue thickness to avoid the gingival height in etiology of crestal bone loss [36].

The present study has several limitations. Firstly, the validity of the results might be limited to the posterior mandibular area, and additional studies may be required to evaluate the effect of soft tissue thickness on crestal bone stability in the maxilla. Secondly, the extent of bone loss is measured at mesial and distal reference points, lacking data about vestibular, and lingual implant sides. On the other hand, this study shows that thin soft tissue may predispose bone to significant remodeling around implants with platform switching and that subcrestal implant placement in thin tissue sites may minimize or eliminate crestal bone loss.

Conclusion

Within the previously mentioned limitations of the study, it can be concluded that vertical soft tissue thickness plays an important role in the etiology of crestal bone loss. The platform switched implants are prone to more bone loss when they are placed in sites with thin soft tissue, regardless of the type of final restoration (screw-retained or cement-retained). Subcrestal placement of platform-switched implants can prevent crestal bone loss in sites with vertical soft tissue thickness < 3 mm.

References


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