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Crestal bone resorption followed a flapless insertion of tapered dental implants

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Abstract

Our aim was to examine the influence of flapless insertion of tapered implants of different designs {Biohorizon tapered internal implant (BHZ), Bioner HIKELT (HIK) and Bioner TOP DM (TOP)} on crestal bone resorption in posterior mandibular sites. Records of 44 patients with 60 flapless implants were placed in the posterior regions of the mandible. 24 implants (40%) were placed in premolar sites and 36 in molar sites (60%) and were followed for 16 months by means of clinical and radiographic examination. Repeated measures -ANOVA (a=0.05) were performed to assess the differences in marginal bone loss among the three groups of implants tested.
Results showed a mean loss of 0.32 mm around BHZ implants, 0.43 mm around HIK implants and 0.47 mm around TOP implants. The statistical analysis showed a tendency for less bone resorption around BHZ implants. Although the measured differences did not reach statistical significance at pairwise analysis (p=0.05), the Overall results showed that with the use of appropriately designed implants, a flapless insertion of tapered dental implants is an efficacious treatment approach that yields efficacious results. Although our results did not show significant differences in bone loss among the groups, the observed trends can be used as preliminary data base to design appropriately powered studies. We conclude that implants placed with the specific technique without an open flap surgery (flapless), may result in less crestal bone resorption than in implants placed under the open flap surgery.

Key words: Flapless implant surgery, Humans, Surgical Procedures, Minimally Invasive/methods, Dental Implantation

Introduction

In contemporary dental practice, the field of implantology has evolved to satisfy patient's cravings for minimally invasive procedures. Two-staged implant surgical procedures are being superseded by single-stage implant placement, while flapless placement techniques have been introduced to further minimize patient discomfort during implant placement. According to Schwartz et al. (1), when a muco-periosteal flap is reflected, consequent increase in bone loss and collapse of interproximal papillae may occur. Flap reflection can also induce gingival recession on adjacent teeth. Based on these disadvantages, flapless implant placement has been introduced in an effort to maintain soft tissue contours and minimize post-operative patient discomfort (Al-Ansari et al. 2) Flapless implant insertion has been shown to induce reduced trauma, reduce operative time, faster soft tissue healing and fewer post-operative complications leading to improved patient comfort. In vivo experimental data have shown that histological samples obtained from the buccal peri-implant mucosa adjacent to flapless implants demonstrate a significantly lower degree of inflammatory response during the period of initial implant integration compared with implants placed following flap reflection (Vlahovic Z1 et al (3). Additional animal experiments have verified that the benefit of flapless placement progresses beyond minimizing inflammation, to increased capillary distribution as well as higher vessel and collagen density in flapless implants versus implants placed with a flap surgery protocol. (Mueller CK, 4). This may be relevant in patients with compromised healing potential such as patients with diabetes and/or osteoporosis. Patients with a history of periodontal disease in whom the history of soft and hard tissue loss complicates implant treatment planning may also benefit from minimally invasive procedures. (Thöne-Mühling M et al, 5) Under these challenging conditions, flapless surgical procedures may aid by avoiding the surgical and psychological burden of flap reflection, providing better soft tissue healing, eliminating the need for a second stage surgical procedure and consequently leading to higher patient acceptance (Rajput N, 6).

Nonetheless, flapless implant placement is not a panacea. Flapless procedures have inherent disadvantages, associated the surgeon's inability to clearly visualize anatomic landmarks and vital structures. The potential for thermal damage secondary to reduced access for external irrigation during osteotomy preparation and the increased risk of mal-positioned angle or depth of implant placement should always be accounted for during pre-operative treatment planning. A matter of debate is the potential of flapless procedures to reduce crestal bone resorption around implants. Continuous marginal bone loss does not only cause implant failures but also results in poor esthetics as soft tissue recession and papilae loss proceeds the bone loss. Although it has been widely speculated that elimination of a flap procedure prevents crestal bone resorption, data in the literature regarding this topic is scarce.

As previously mentioned, the main hypothesis postulated regarding crestal bone loss after implant placement is that flap reflection compromises periosteal blood supply and thus has a deleterious on the homeostasis of the marginal bone due to trauma and lack of nourishment. However, implant type, design and surface roughness have been shown to be independent risk indicators for marginal bone loss around implants. (Job S1, Bhat V, Naidu EM. et al, 7). Therefore, the aim of the present cohort study was to assess the effect of implant design on the fate of the peri-implant bone around flapless implans.

Materials and Methods

In this retrospective cohort study, patients that underwent flapless implant placement in posterior sites were followed-up to assess peri-implant bone stability. Outpatients that presented to an Implant Clinic for implant rehabilitation we considered eligible for participation. In this clinical setting three different implant types are routinely utilized for implant treatment. These include a tapered implant with internal connection (Biohorizon tapered internal implant) and (Bioner HIKELT and Bioner TOP DM). (Figures 1-3)

As part of the pre-operative surgical assessment, data relevant to patients' demographics and general were collected. Additionally, meticulous clinical and radiographic examination was performed to assess implant site characteristics such as proper bone width, height, and soft tissue condition at the edentulous sites. Based on standard clinical protocols, following the oral evaluation patients were informed about the diagnosis and treatment alternatives.

Adult patients were included in this study if they were treatment planned for flapless implant placement in edentulous posterior sites. Exclusion criteria for this study were: medical history that contraindicates oral surgical treatment; chronic therapy with NSAIDs and/or corticosteroids; pregnancy; inadequate width of keratinized tissue; immediate placement. Included participants were divided in three groups based on the implant type (BHZ group for Biohorizon tapered internal implant, HIK for the Bioner HIKELT and TOP for the Bioner TOP DM).

Surgical Procedures

The same Oral Surgeon, utilizing the flapless approach, performed all surgical procedures. Briefly, following administration of local anesthesia (2% lidocaine with 1:100.000 epinephrine) a tissue punch was utilized via a surgical handpiece to provide access at the surgical site. Subsequently, implant site preparation was performed utilizing the implant manufacturers' guidelines. After enlargement of the osteotomies to the final dimensions, rinsing with sterile saline was performed and the implants were placed. A peri apical radiograph was obtained to verify implant angulation and proximity to adjacent roots and vital structures. Radiographs were taken with the long cone paralleling technique utilizing digital sensors and Eggen film holders. Following placement, a North Caroline type probe was utilized to measure the distance from the implant platform to the marginal mucosa. Healing abutments of appropriate height were selected based on this measurement. The abutments were torqued in place and post-op instructions were given to the patient. No suturing was necessary with the presented flapless technique. Antibiotics and non-steroid anti-inflammatory analgesics were prescribed post-surgically. The patients were also advised to follow a cold/soft diet for 48 hours and were asked to use a 0.12% chlorhexidine solution for oral rinses bid over two weeks. All implants were loaded 3 to 4 months post-placement with fixed prostheses.

Assessment of outcome

Patients were asked to return for follow-up radiographic examinations one-year post-implant loading. Peri apical radiographs of the loaded implants were obtained utilized the technique described above, by the same experienced surgeon. Marginal bone loss from baseline to follow-up was assessed as the primary outcome of this study. Measurements were taken by utilizing designated software (ImageJ, NIH, Bethesda, MD). In order to compensate for potential mis-angulation of the radiographs the length of the implant thread was utilized for internal calibration as previously described. (Kotsakis et al. JOMI, 8) In cases were the implant's apex was not visible in the radiographs, the first 6 implant threads were utilized as a fixed reference point.

Statistical Analysis:

A repeated measures ANOVA (a=0.05) was performed to assess differences in marginal bone loss among the three groups. The mean difference was reported as the pooled mean of mesial and distal sites. Post-hoc tests were performed for pairwise comparisons with p-values adjusted for multiple comparisons with the Tukey method. Analyses were performed utilizing the R statistical software (R Development Core Team (2008). R: A language and environment for statistical computing. R- foundation of Statistical Computing, Austria. ISBN 3-900051-07-0, URL http://www.R-project.org.)

Results:

A total of 44 patients with 60 flapless implants placed in the posterior regions of the mandible following a flapless surgical procedure were followed for a period of 16 months.

None of the patients had systemic health issues or any underlying medical conditions that could affect the surgical or regenerative procedure.

In total, 24 implants (40%) were placed in premolar sites and 36 in molar sites (60%). Results showed a mean loss of 0.32 mm around BHZ implants, 0.43 mm around HIKELT implants and 0.47 mm around TOP DM implants. Statistical analysis showed a trend for less bone loss around BHZ implants, although this difference did not reach statistical significance at pairwise analysis (p=0.05).

Discussion:

Although flapless insertion of dental implants will not all together entirely eliminate the phenomenon of crestal bone resorption, our analysis showed a very small amount of bone loss measured for implants placed with the flapless technique compared to open flap placement technique.

A possible explanation for lacking a significant difference among the groups, might be lying with the fact that only 60 implants were incorporated in the study, which might have underpowered the study.

Marginal bone loss was first reported by Adell (9) et al and stated that it is an important aspect of implant survival and prognosis. Progressive and continuous marginal bone loss can lead to failure of implants. However there are many causes attributed to marginal bone loss such as Periosteal reflection hypothesis, Implant osteotomy hypothesis, Autoimmune response of the host hypothesis, Biological Width Hypothesis, implant design, implant surface type, occlusal load and the type and classification of the bone where implant has been placed.

It has been stated before that implant body and design may affect the amount of strain at the implant-bone interface. The design of an implant refers to a three-dimensional structure of an implant system, characterized by shape, type of implant-abutment mating, presence or absence of threads, thread design, surface topography and chemical composition. To overcome implant failures and provide an implant-abutment junction that can reduce the peak bone-implant interface, shear stress and strain, various implant designs with different types of surfaces are available.

Surface roughness has been identified as an important parameter for implants and its capacity for being anchored in bone tissue. There are available a variety of different manufacturing methods to increase the surface roughness of the implant, where the most commonly used are: Machining, Sandblasting, Acid etching, Anodic oxidation, Laser modification or a combination of these methods are commercially available. Dental implants surface are usually Sandblasted and acid etched (SLA). Meaning, first blasted by particles and then subsequent etched by acids. This is performed to obtain a dual surface roughness as well as removal of embedded blasting particles. The etching reduces the highest peaks while smaller pits will be created resulting in a reduced average surface roughness. The chemical process of the acid etching creates a titanium hydride layer on the surface with a thickness of 1-2 µm intermediating the surface oxide and the bulk metal (Conforto et al., 2004, 10). Furthermore, SLA implant is rinsed in a nitrogen atmosphere and stored in saline solution until installation, which reduces the amount of carbon contamination and improves the hydrophilicity of the implant surface (Rupp et al., 2006, 11). The result of this procedure is creating a new hydrophilic surface (SLActive). This procedure allows the SLActive to maintain a chemically active surface that is conditioned to the human body. According to Ellingsen et al. (12) higher removal torque and higher bone-implant contact has been observed for blasted and fluoride modified implants compared solely blasted implants in a rabbit model after 1 and 3 months of healing (Ellingsen et al., 2004, 12). Studies have shown that SLActive implants achieve a higher bone contact and stability at earlier time points (6 weeks) and dramatically reduced healing times from 12 to 6 weeks (Buser et al., 2004, 13); Schwarz et al., 2007, 1).

Implant shape also effects bone remodeling, according to Sakoh et al. (14), conical tapered implants have a higher primary stability than cylindrical implants. Using Toyoshima et al (15) showed that tapered implants show better primary stability rates than cylindrical implants. When it comes to implant neck, rough implant necks have been considered to present less marginal bone loss. However, if exposed it will attract plaque enhancing a rapid bone loss. In cases where there is no presence of bone loss exposing crest module, rough surface design should be considered. According to Wolff's law the presence of retentive elements at the implant neck will dissipate some forces leading to the maintenance of the crestal bone height. Palmer et al demonstrated maintenance of marginal bone levels with an implant that had retentive elements at the neck. In a dog model, Abrahamsson & Berglundh (16) found increased BIC at 10 months in implants with micro threads in the coronal portion (81.8%) when compared with control non-micro threaded implants (72.8%). Lee et al in a study conducted on humans comparing implants with and without micro threads at the crestal portion, indicated that addition of retentive elements might have an effect in preventing marginal bone loss against loading which may lead to a decrease in the probability of implant failure due to marginal bone loss.

Mueller CK et al (4) reported that flapless implant placement results in a diminished inflammatory response as compared to flap surgery. The same authors hypothesized that less inflammation yields reduced capillary damage and higher vessel and collagen density that may ultimately lead to less crestal bone resorption. When flapless implant placement is combined with tapered implants and with appropriate surgical techniques there may be an additional benefit to marginal bone stability and to the longevity and survival rate of the dental implant.

Conclusion:

Out of all the three implants BioHorizons and Bioner HIKELT implants showed least bone remodeling at the crestal level at the end of 16 month follow up period. This can be attributed towards its surface roughness, shape and design. However more studies with larger sample size are required to confirm the results of this study. We conclude that implants placed with the specific technique without flap surgery may result in less crestal bone resorption than in implants placed under the open flap surgery.

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Figures

Figure 1. BioHorizons implant

Figure 2. Bioner HIKELT implant

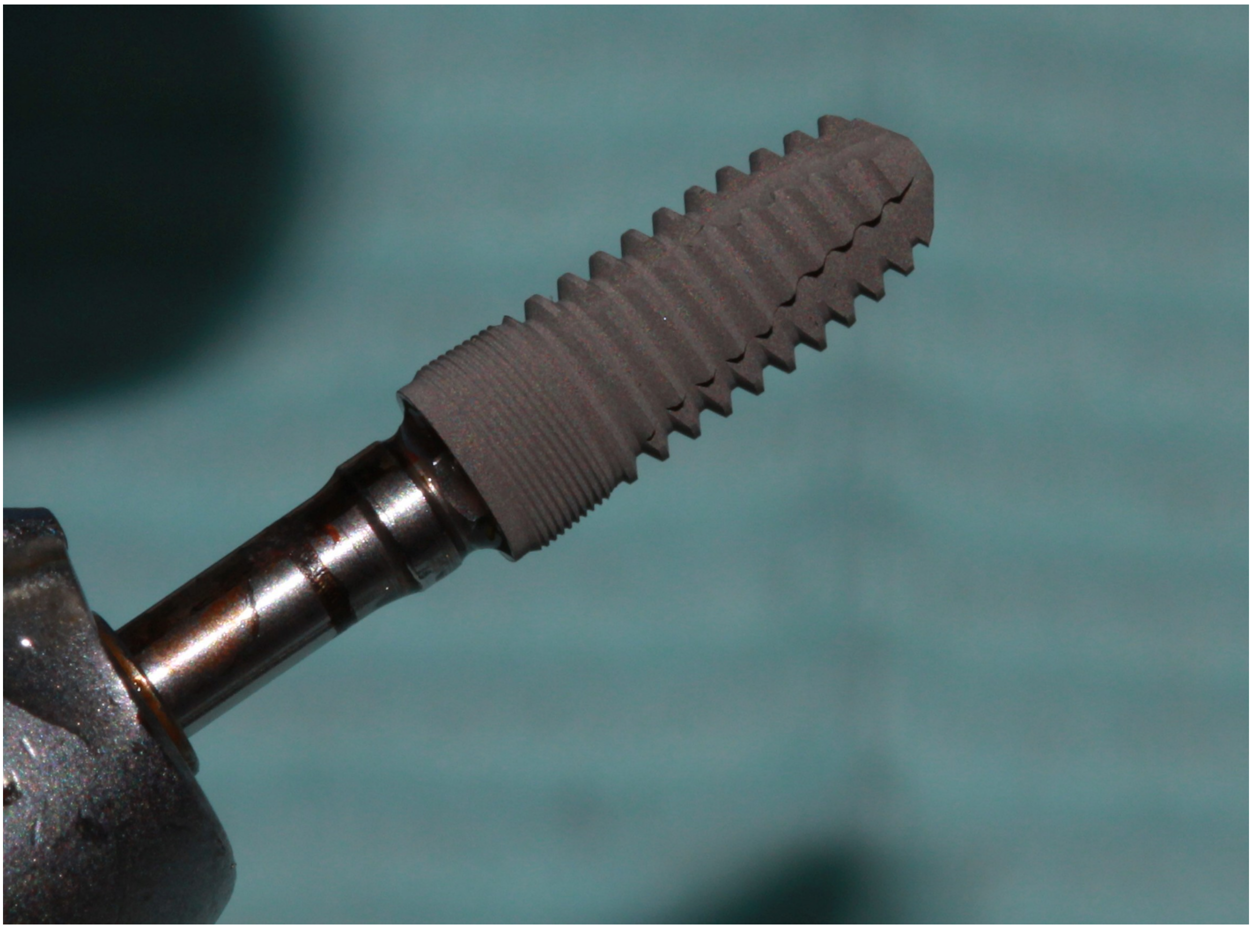

Figure 3. Bioner TOP DM implant