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Evaluation of Platform Switching In Promoting Peri-Implant Tissue Health – A Short Term Study

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ABSTRACT

Background: The purpose of this study was to clinically evaluate the peri-implant soft tissue health and to radiographically evaluate the bone height mesial and distal to the Alpha-bio ®SFB platform switched implants for 1 year; post-prosthesis insertion at 3 month regular intervals.

Materials and Methods: A total of 2 Alpha-bio ®SFB platform switched implants were placed on selected patients during this study. A two-stage surgical approach was used for healed or immediate extraction sites – for implant insertion and prosthetic rehabilitation under strict aseptic conditions. The patients were subjected to clinical parameters like plaque index, gingival index, and sulcular bleeding index. Standardized radiographs were taken at different intervals and subjected to computer assisted image analysis for assessment of bone loss mesial and distal to the implant.

Results: Implant sites of both patients showed an increase in the plaque, gingival, and bleeding scores at each interval compared to the baseline, followed by a decrease in the average plaque, gingival, and bleeding scores in all patients for teeth as well as implants, indicating that neither of the sites had an increased tendency for soft tissue inflammation. No mobility was associated with any of the implants. Width of keratinized mucosa remained constant throughout the study for either of the patients. The total bone loss was lesser for immediate post-extraction implants.

Conclusion: This short-term study showed that Alpha-Bio SFB® implants could be effectively used for single tooth replacement both in conventional healed ridges or immediately post-extraction in fresh extraction sockets.

Keywords: Bone-loss, computer-assisted image analysis, dental implant, immediate extraction, platform switching, peri-implant mucosa

INTRODUCTION

Dental implants utilizing the two-stage osseointegration placement and utilization technique offer a major advance in the prosthetic replacement of lost teeth. While the major thrust with this form and type of implants has been to help secure complete dentition prostheses in totally edentulous arches,[1] an even more common application in periodontal practice may be to replace isolated missing teeth or a small segment of missing teeth.[2] Standard procedures require a mature healed edentulous alveolar ridge in which to place the implant fixture. When teeth are extracted, a healing period of 3–9 months is recommended for maturation of the socket bone before placing the implants.[3] One matter of interest has been to investigate whether it is possible to shorten the time period between tooth extraction and placement of the implant, alternatively to insert the implant at the same visit as the removal of the tooth (immediate implantation) with equally predictable success rates.[4,5]

Nowadays, there is considerable evidence supporting the view that the replacement of missing teeth by means of endosseous titanium implants has become a predictable treatment modality for both completely and partially edentulous patients. Comparable treatment outcomes have been reported for both conventional and immediate extraction implant procedures.[4] In addition to the obvious benefits for the patient in terms of fewer surgical sessions and a more expeditious delivery of the final implant restoration, the immediate implantation concepts may be advantageous from a biologic viewpoint. Previous studies have shown that early implant placement may lead to preservation of alveolar bone height and width and, furthermore, it may enhance osseointegration by taking advantage of the natural bone healing process around the implant.[4]

The distance between the implant abutment junction (IAJ) and the remodeled crestal bone following second-stage surgery has been shown to be consistent in several animal and human clinical studies, regardless of the original position of the IAJ in relation to the bone crest. This observation is consistent and has become a part of the accepted implant success criteria.[1] However, during the first year of loading, particularly, two-piece implants were frequently associated with crestal bone changes of about 1.5–2.0 mm, but were dependent upon the location of the IAJ relative to the bony crest.[6] There is evidence that the IAJ is one of the primary controllers of post-restoration crestal bone position; however, soft tissue thickness (minimum of 3 mm), the position of the abutment inflammatory cell infiltrate (ICT), the role of microgap, and the implant surface itself also seem to play roles in determining the final post-restorative crestal bone position.

Ericsson, *et al*[7] concluded that the establishment of an abutment ICT may explain the crestal bone changes during the first year of loading. However, biologic aspects such as the establishment of an adequately dimensioned biological width have also been observed to be associated with crestal bone resorption at sites with a thin mucosa.[8] Moreover, biomechanical aspects such as interfacial shear strengths as well as the influence of the implant design itself (e.g., macro and microstructure) also play a significant role.

Therefore, it is suggested that the factors controlling crestal bone levels around dental implants, in the order of importance, are as follows:

1. A minimum of 3 mm of soft tissue, which is necessary for the formation of biologic seal without an increased loss of crestal bone height.
2. The position of the abutment ICT and its proximity

to crestal bone.

3. The implant surface topography.

In recent years, a horizontal inward re-positioning of the implant–abutment interface, commonly termed platform switching, has been suggested in order to overcome someof the problems. Hypothetically, platform switching may increase the distance between the abutment ICT and the alveolar crest, thus decreasing its bone-resorptive effect. Moreover, with the increased surface area created by the exposed implant seating surface, there might be a reduction in the amount of crestal bone resorption necessary to expose a minimum amount of implant surface to which the soft tissue can attach.[9] Starting from the Platform Switching idea, Carcini, *et al.* elaborated the concept of bone platform switching (BPS).[10] BPS is an inward bone ring in the coronal part of the implant that is in continuity with the alveolar bone crest.

To verify if the concept of BPS really gives some advantages to reverse conical neck implants [Figure 1], a case study was performed on Alpha –Bio SFB® platform switched implants to compare the clinical and radiographic healing of Alpha-Bio SFB® implants when placed in fresh extraction sockets and healed alveolar bone sites.

MATERIALS AND METHODS

The study was conducted on a total of two volunteers who reported to the outpatient department of the Department of Periodontology and Oral Implantology (M.M. University, Mullana, Ambala) with a primary complaint of missing and/or carious tooth. The procedures to be performed were clearly explained beforehand: The relevant alternatives were also presented, a written, explained, and informed consent was obtained from the volunteers for implant procedures, to participate in the study, and to attend regular follow-up.

One of the volunteers received staged delayed implant fixture in healed/mature bone site (in place of 46), whereas the second volunteer received staged immediate implant placement in fresh extraction socket/site (in place of 15).

Figure 1: Reverse conical neck implant. The arrow focuses on the triangle of bone corresponding to the bone platform switching

Both the sites were evaluated by the following clinical parameters: Plaque index, gingival index, sulcus bleeding index by Mühlemann and on; Keratinized mucosa index by Cox, *et al*; Probing attachment level, Jemt's Papilla fill index, probing depth (TPS Probe), and implant mobility.

Radiographic parameters assessed

Peri-implant Bone–Levels (Using IOPA; Image J Version 1.24)[11] and any peri-implant bone changes viz radiolucency and bone loss were assessed [Figure 2a and b]. A pre-operative examination was performed with a careful evaluation of the soft and hard tissue and necessary diagnostic information was recorded preceding implant therapy that included detailed medical and dental history, periodontal and oral assessment, laboratory investigations, dental models (study/diagnostic cast), radiographs (IOP A, OPG, and DENTASCAN), clinical photographs, surgical template (an individualized surgical guide template was fabricated that provided sufficient information about the desired future crown contour and facilitated three-dimensional fixture placement).

Surgical procedure

A limited flap design[12] was followed for flap elevation in the conventional patient, while, in immediate extraction site, access was gained through extraction socket and atraumatic tooth/tooth root removal using a periotome and/or requisite extraction forceps. After flap reflection, the optimal implant location as decided pre-surgically by pre-surgical prosthetic guide template and the site was then marked with a surgical round bur. After marking the site, the pilot drill (D-2.0 mm) was put to use for creating an osteotomy site of the appropriate depth for implant placement. After confirmation of depth and angulation, the osteotomy site was prepared by a series of gradually larger drills (D2.8, D3.2, D3.65, D4.3, and D5.2) to the requisite width with a speed of 1400–1600 rpm at 1:16 reduction torque as per the manufacturer instructions. The implant was put into the osteotomy site. At this point, the implant was confirmed to be immobile, which re-affirmed primary implant stability. The flap margins were then repositioned and sutured tension free using 3-0 mersilk in interrupted fashion. All implants used were internal hex, sand blasted with

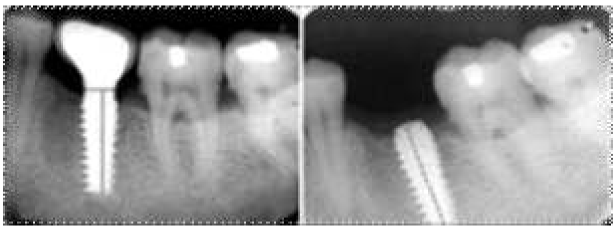

Figure 2 (a) and (b): Image J analysis software

large grid particles and acid etched surfaces, and of self tapping type with in-built platform switching capability. Implant length ranged from 10 to 16 mm and the diameter from 3.3 to 5.2 mm. A radiograph was taken post operatively to evaluate the implant angulation and position in relation to adjacent structures such as nasal floor, sinus, inferior alveolar canal, and adjacent teeth.

Post-surgical phase

The patients were instructed to function on a soft diet and to avoid mastication in the treated area for at least 8 weeks. After 1 week, the sutures were removed. Oral hygiene was limited to soft brushing in the surgical site for the first 2 weeks, after which conventional brushing and flossing were permitted with a rinse of 0.12% chlorhexidinegluconate. Oral hygiene was monitored regularly at monthly visits thereafter.

Prosthetic phase

The second stage surgery was performed as early as 3–6 weeks. Impressions were made with the impression post attached to the implant using the closed tray impression technique. Healing abutment/gingiva former was replaced till the time taken for laboratory manufacture of prosthesis. After approximately 4–7 days, the healing abutments were removed and replaced with final abutment.

Radiographic interpretation

Computer assisted image analysis

All IOPA radiographs were analyzed using computer assisted image analysis. All radiographs were digitized by scanning, following which the images produced were converted from pixels to a gray scale of 8 bits, thereby auto-adjusting a standard brightness and contrast for all radiographs. The distance/area of interest was then converted and standardized from pixels to millimeters (mm), thereby setting a standard scale for all the linear radiographic measurements. After complete standardization of all intra oral periapical radiographs, the linear radiographic distances were calculated by drawing a line from the reference point (IAJ) to the level of bone on both the mesial as well as distal aspects of the implant. This helped in assessing the amount of bone loss over the recall period.

Statistical analysis

Data was represented using means and standard deviation values. Paired *t*-test and Chi-square test was used to compare crestal bone height around the implants and to study the changes with time at both the implant sites. This significance level was set at $P \leq 0.05$. Chi-square test was also used to compare soft tissue parameters at both the implant sites. All analyses were conducted using commercially available software (SPSS package version 13).

RESULTS

In this preliminary study, a total of two sites were selected from two volunteers in need of single tooth replacement. First site received staged delayed implant fixtures in healed/mature bone site (in place of 46) and the second

site received staged immediate implant placement in the fresh extraction socket/site (in place of 15). A total of two implants were inserted that comprised of 5 × 11.5 mm implant at the healed site and 5 × 13 mm implant at the extraction site. Radiographic bone levels [Figures 3 and 4] and soft and hard tissue responses to inward horizontal repositioning of the IAJ were assessed at an interval of 3 months till 9 months post-prosthetic restoration in both the implant sites [Tables 1 and 2].

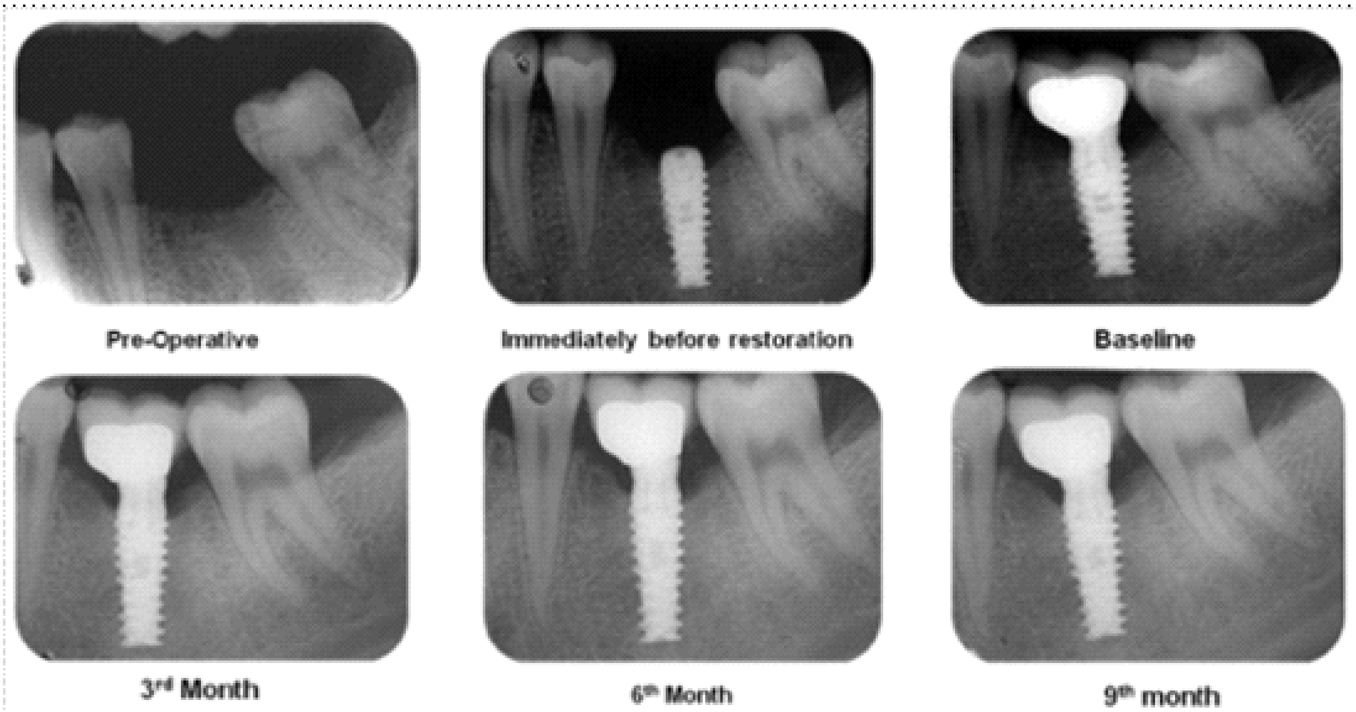

Figure 3: Radiographs at baseline, 3 months, 6 months and 9 months for implants placed in healed extraction site

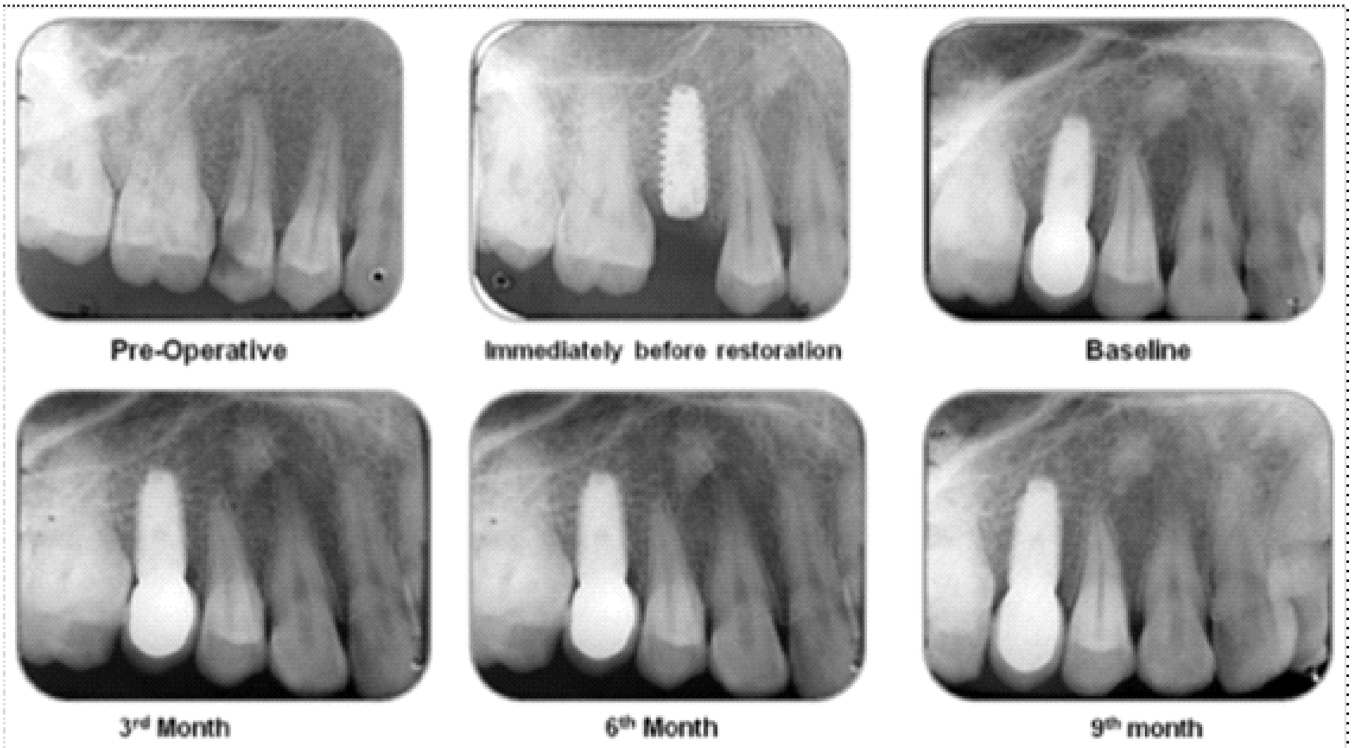

Figure 4: Radiographs at baseline, 3 months, 6 months and 9 months for implants placed in immediate extraction site.

Plaque index scores of two implant sites

On comparison, the mean differences of plaque score at baseline, 3rd, and 6th months were 0.00 ± 0.00, 0.01 ± 0.31, and 0.07 ± 0.18, respectively. The respective "z" values were 0.00, 0.00, and 0.98 and the "*P*" values were 1.00, 1.00, and 0.32 that were statistically not significant. The mean difference of plaque scores at 9th month was 0.16 ± 0.17. The respective "z" value was 0.21 and the "*P*" value was 0.03 that was statistically significant.

Gingival index scores of two implant sites

On comparison, the mean differences of gingival index score at baseline, 3rd, and at 6th months were 0.00 ± 0.00, 0.01 ± 0.47, and 0.17 ± 0.30, respectively. The respective "z" values were 0.00, 0.07, and 1.25 and the "*P*" values were 1.00, 0.94, and 0.20, which were statistically not significant. The mean difference of gingival index scores at 9th month was 0.14 ± 0.14. The respective "z" value was 2.13 and the "*P*" value was 0.03, which was statistically significant.

Sulcular bleeding index scores of two implant sites

On comparison the mean differences of sulcular bleeding index score at baseline, 3rd, 6th, and at 9th months were 0.00 ± 0.00, 0.23 ± 0.46, 0.17 ± 0.30, and 0.14 ± 0.23, respectively. The respective "z" values were 0.00, 1.06, 1.25, and 1.49 and the "*P*" values were 1.00, 0.28, 0.21, and 0.13, which were statistically not significant.

Difference in probing depth at two implant sites

On comparison, the mean differences of probing depth score at baseline, 3rd, 6th, and at 9th months were 0.04 ± 0.10, 0.23 ± 0.34, 0.18 ± 0.46, and 0.15 ± 0.40, respectively. The respective "z" values were 0.92, 1.65, 1.34, and 1.28. The "*P*" values were 0.35, 0.09, 0.18, and 0.19, which were statistically not significant ($P < 0.05$).

Difference in probing attachment level at two implant sites On comparison, the mean differences of probing attachment level scores at pre-operative, baseline, 6th, and at 9th months were 0.00 ± 0.00, 0.00 ± 0.54, 0.15 ± 0.53, and 0.17 ± 0.49, respectively. The respective "z" values were 0.00, 0.00, 0.62, and 0.85. The "*P*" values were 1.00, 1.00, 0.53, and 0.39, which were statistically not significant ($P < 0.05$).

Mean difference in the width of connective tissue

On comparison, the mean differences of keratinised mucosa index scores at pre-operative, baseline, 6th, and at 9th months were 0.02 ± 0.53, 0.02 ± 0.53, 0.02 ± 0.53, and 0.02 ± 0.53, respectively. The respective "z" values were 0.76 each. The "*P*" values were 0.94 each, which were statistically not significant ($P < 0.05$).

Table 1: Different clinical parameters at baseline, 3 months, 6 months, and 9 months in implant placed at healed extraction site

Case I	Plaque index	Gingival index	Bleeding index	Probing depth (in mm)	Probing attachment level	Implant mobility	Papilla fill index	Bone loss (Mesial) (in mm)	Bone loss (Distal) (in mm)
Baseline	0	0	0	1	0	0	3	0	0
3 months	0.75	0.25	0.25	1	0.5	0	3	0.12	0.12
6 months	0.75	0.25	0.25	1.25	0.5	0	2	0.15	0.17
9 months	0.75	0.25	0.25	1.5	0.5	0	2	0.17	0.19

Table 2: Different clinical parameters at baseline, 3 months, 6 months, and 9 months in implant placed at fresh extraction site

Case 2	Plaque index	Gingival index	Bleeding index	Probing depth (in mm)	Probing attachment level	Implant mobility	Papilla fill index	Bone loss (Mesial) (in mm)	Bone loss (Distal) (in mm)
Baseline	0	0	0	1	0	0	3	0	0
3 months	0.75	0.25	0.25	1.5	1	0	2	0.12	0.12
6 months	0.75	0.25	0.25	1.5	1	0	2	0.16	0.14
9 months	0.75	0.25	0.25	1.75	1	0	2	0.17	0.19

DISCUSSION

The goal of modern dentistry is to return patients to oral health in a predictable fashion. The partial and complete edentulous patient may be unable to recover normal function, aesthetic, speech, or comfort with a traditional removable prosthesis.[13] The loss of a single premolar or molar is regarded as a common cause of non-physiological occlusion resulting from tipping of neighbouring teeth and extrusion of opposing teeth. In visible sites, aesthetics concerns may also raise psychological implication necessitating replacement treatment. Therefore, there is need for replacing even single tooth.[14]

The implants that have been used in the present study utilized the concept of bone platform switching (BPS) as proposed by Carcini, *et al*[10] as a modification of the findings of Lazzara and Porter,[9] whose research was directed at prosthetic platform switching. The BPS is obtained by using dental fixture with a reverse conical neck [Figure 2]. This type of implant gives an increased residual crestal bone volume around the implant neck and carries several advantages: A reduced mechanical stress in the crestal alveolar bone area, the repositioning of gingival papillae on the bone ring (that is the physiological condition), and a proper vascular supply to hard and bone tissue also in case of reduced inter-implant space.

The ensuing crestal bone levels post-restoration are a reference for evaluating implant success. During the first year of loading, however, particularly two-piece implants were frequently associated with crestal bone changes of about 1.5–2.0 mm.[1,15] The present study showed bone loss in all groups at 12th week and 24th week time interval, while mean bone loss was 0.5 mm with a range of 0.5–1.5 mm, while as reported by some other authors, the vertical bone loss was <0.2 mm annually after the 1 year of service. According to some other study reports, mean marginal bone loss around dental implants in the first year ranged from 0.4 to 1.6 mm.[16]

Historically, the resulting 1-year post-restorative repositioned crestal bone level (approximately 1.5 mm apical to the IAJ or at the first thread) has been used as one of the criteria for success of a dental implant.[1,17] The ensuing crestal bone levels post-restoration are a reference for evaluating implant success. Crestal bone levels have been reported to be usually located at about 1.5–2 mm below the implant–abutment junction (IAJ) after 1 year following implant restoration.[9] Other studies also demonstrated that crestal bone remodels to a level about 2.0 mm apical to the IAJ.[18,19]

Recent studies suggest[9,10,13] that platform switching technique can preserve soft and hard tissues and, therefore, may provide better aesthetic outcomes because they are consequential to reduced bone resorption, a harmonious relationship between the implant-supported restoration, and the remaining natural teeth can be established alongside reconstructing a natural gingival architecture around the implant.

CONCLUSION

Periodic assessment of these clinical and radiographic parameters confirmed soft and hard tissue health at the end of recall assessments, i.e., 9 months post-definitive restoration. On comparison of immediate extraction and conventional sites, both were associated with a minimal loss of the crestal alveolar bone, observed slightly lesser for immediate extraction sites.

This short-term study showed that Alpha-Bio SFB® implants could be effectively used for single tooth replacement both in conventional healed ridges or immediately post-extraction in fresh extraction sockets. It might be hypothesized that the inward horizontal re-positioning of the implant abutment interface away from the crestal bone into a more confined area has positively influenced bone resorption at Alpha-Bio SFB Implants. Therefore, further investigations are needed in order to clarify this issue.

Limitations and future directions

The present study was of a short duration with no histological appraisal of the osseointegration process. Further long-term clinical and histological longitudinal studies with large samples are needed to establish any claims of reduced crestal bone resorption and peri-implant soft tissue and hard tissue health with the bone platform switching phenomenon.

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