Original Article

Bone Level Measurements Around Platform Switched and Platform Matched Implants: A Comparative Study

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ABSTRACT

Background: The overall success of dental implants depends on the crestal bone support around the implants. During the initial years, the bone loss around the implants determines the success rate of treatment. Platform switching (PLS) preserves the crestal bone loss, and this approach must be applied clinically. **Aim:** The purpose of this study was to determine the changes in vertical and horizontal marginal bone levels in platform-switched and platform-matched dental implants. **Materials and Methods:** One fifty patients received one fifty dental implants in the present study over a 1-year period. Measurement was performed between the implant shoulder and the most apical and horizontal marginal defect by periapical radiographs to examine the changes of peri-implant alveolar bone before and 12 months after prosthodontic restoration delivery. **Results:** These marginal bone measurements showed a bone gain of 1.56 ± 2.4 mm in the vertical gap and 1.49 ± 2.24 mm in the horizontal gap of the platform matching, while in the PLS, a bone gain of 2.67 ± 2.0 mm in the vertical gap ($P < 0.05$) and 2.89 ± 1.67 mm in the horizontal gap was found. Only a statistically significant difference was found comparing bone gains in the vertical gap between the two groups ($P < 0.05$). **Conclusion:** PLS helps preserve crestal bone around the implants, and this concept should be followed when clinical situations in implant placement permit.

Keywords: *Crestal bone, dental implants, platform switching*

Introduction

The overall success of dental implant depends on the presence of good amount and quality of bone around the implants, especially the crestal bone. However, early peri-implant bone loss has been commonly observed. Adell *et al*.[1] were the first to quantify the marginal bone loss during the 1st year of prosthetic loading.

Initial crestal bone loss results in increased bacterial accumulation and secondary peri-implantitis which can further result in loss of bone support, which in turn can lead to occlusal overload and crestal bone loss ultimately resulting in implant failure. Further marginal bone loss affects the gingival contours and in turn results in loss of interproximal papilla.[2]

Albrektsson *et al*.[3] found that the installation of two-piece implants healing in a submerged modality resulted in a crestal bone loss of 1.5–2.0 mm after 1 year of loading. Moreover, in experimental studies in dogs, a crestal bone remodeling with resorption of 2 mm has been verified. Clinicians, researchers, and implant companies have, thus, dedicated time to finding ways to control the crestal bone loss that occurs after abutment connection.

At the Toronto Conference,[4] the consensus with respect to bone loss around the implant was that bone loss of up to approximately 2 mm during the 1st year of implant function is acceptable, and at this level, the implant is regarded as successful. There have been many reports on studies to ascertain the causes of bone loss around implants and clinical techniques to prevent it. Some of the published reports state that

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the platform switching (PLS) technique, a technique in which an abutment that is one-size smaller than the implant platform is placed prevents bone loss around the implant.[5,6] Such a connection shifts the perimeter of the implant-abutment junction inward toward the central axis of the implant. The crestal bone loss can be reduced by repositioning the outer edge of the implant abutment interface horizontally inward and away from the outer edge of the implant platform.

Therefore, crestal bone preservation should be thought of even before the treatment planning for implant placement. Various approaches have been described in the literature to prevent the crestal bone loss. PLS is one of them. The aim of the present study was to observe the changes in both vertical and horizontal marginal bone defect measured between the implant shoulder and the most apical and horizontal marginal defect before and 12 months after prosthodontic restoration delivery between platform-switched and platform-matched dental implants.

Materials and Methods

The study was conducted on one fifty individuals within the age group of 25–60 years. Ankylos implants were early placed 3 months after tooth extraction. Full-thickness mucoperiosteal flap was elevated by giving local anesthesia and a midcrestal incision in the edentulous area. Dental implants were placed and flaps were sutured. Patients received postoperative instructions and were advised to rinse with chlorhexidine 0.12% twice a day for 10 days and sutures were removed 2 weeks after. All implants were inserted until the outer edge of the dental implant reached the marginal bone level, to allow for the apex of the cover screw to be at level with the bone crest during the healing period. After 3 months of implant insertion, a second-stage surgery was carried out and the healing abutments were placed in all the individuals.

The inclusion criteria included patients who had good oral hygiene, non smokers or with smoking history of <3 cigarettes/day, with periodontal healthy teeth adjacent to implant site and without any periapical lesion. Patients with any local or systemic disease, smoking habit >3 cigarettes/day, betel nut or tobacco chewing, alcoholism, pregnancy or breastfeeding, long-term oral medications, oral par function, nontreated periodontal disease, and with inadequate bone volume were excluded.

Implant-level impressions were taken 2 weeks postoperatively to the healing abutment surgery connection. The permanent metal ceramic crown was delivered 2 weeks after impressions. Overall, 75 patients received 75 platform-matched dental implants (diameter: 3.5-4.5 mm; length: 10–13 mm); on the other hand, 75 patients received 75 platform-switched dental implants (diameter: 3.5–4.8 mm; length: 10–12 mm). Both groups were followed up for 12 months after the final prosthetic restoration was delivered. Digital periapical radiographs of the dental implants were recorded at different time points: before loading (baseline), immediately after loading, and 1, 3, 6, and 12 months after loading. The implant shoulder was considered as the reference point for measuring vertical and horizontal dimensions (vertical bone gap and horizontal bone gap) of the mesial and distal peri-implant marginal bone defect; the same measurements were used to evaluate bone remodeling through the 12 months of follow-up.

The data are presented as means ± standard error and were analyzed by Statistical Package for Scientific Studies for Windows (SPSS 20, IBM, Armonk, NY, USA) at a significance level of $P \leq 0.05$. Independent and paired sample *t*-tests were conducted and comparisons were computed by means with repeated measures within and between groups, respectively. Statistical significance was set at $P < 0.05$. The statistical evaluation of the difference in mesial and distal marginal bone gap loss was accomplished with independent *t*-test.

Results

No significant differences in demographic data were found between the groups. In total, 150 patients (75 men and 75 women) received 150 dental implants in the present study.

Overall, 75 platform-matched implants were implanted in a total of 75 patients (mean age: 43.8 ± 20.7 years and 44.1 ± 24 years). On the other hand, 75 platform-switched implants were placed in 75 patients (mean age: 43.1 ± 28 years and 42.3 ± 16.7 years).

In Table 1, the vertical bone gap variations from platform-switched implants are presented. The mean vertical bone gap in platform-switched implants was 3.0 ± 1.11 mm mean before loading; 3.10 ± 1.01 mm mean immediately after loading; 2.97 ± 1.23 mm mean 1 month after loading; 3.66 ± 1.79 mm mean 3 months after loading; 3.90 ± 2.44 mm mean 6 months after loading; and 3.55 ± 1.73 mm mean 12 months after loading. Statistical analysis showed a statistically significant difference ($P < 0.05$) between the baseline and 6 months and between the baseline and 12 months in all the vertical measurements [Table 1].

Horizontal bone gap variations in platform-switched implants are shown in Table 1. The mean horizontal bone gap in platform-switched implants was 4.66 ± 2.41 mm

Table 1: Platform switching (mean±standard deviation, mm)

	Mesial (vertical)	Distal (vertical)	Mean (mm)	Mesial (horizontal)	Distal (horizontal)	Mean (mm)
Baseline	2.89±1.3	3.11±1.39	3.0±1.11	4.81±2.61	4.50±2.20	4.66±2.41
Immediately after loading	2.99±1.0	3.12±1.21	3.10±1.01	5.01±3.60	4.51±3.21	4.76±3.41
1 month after loading	3.01±0.91	2.92±1.55	2.97±1.23	5.11±2.51	4.21±3.11	2.89±1.57
3 months after loading	2.77±1.56	4.55±2.01	3.66±1.79	4.81±3.50	3.10±3.01	3.96±3.26
6 months after loading	3.31±0.88	3.08±2.12	3.19±1.5	5.0±2.3	3.84±2.91	4.42±2.61
12 months after loading	3.20±1.01	3.90±2.44	3.55±1.73	4.92±3.20	3.03±2.20	3.98±2.70

Table 2: Platform matching (mean±standard deviation, mm)

	Mesial (vertical)	Distal (vertical)	Mean (mm)	Mesial (horizontal)	Distal (horizontal)	Mean (mm)
Baseline	3.2±1.1	2.43±1.05	2.82±0.99	1.88±0.92	2.30±1.01	2.09±0.65
Immediately after loading	2.12±1.0	1.99±0.99	2.10±0.92	3.22±2.1	3.21±2.11	3.22±2.1
1 month after loading	4.33±2.1	3.55±2.11	3.94±2.11	3.67±2.13	2.1±1.0	2.33±1.0
3 months after loading	3.14±2.4	3.41±1.61	3.28±2.01	3.01±1.11	2.2±1.1	2.61±1.2
6 months after loading	3.44±2.6	3.55±2.11	3.50±2.36	2.5±1.05	2.67±2.5	2.56±1.78
12 months after loading	3.16±2.0	2.01±2.0	2.59±2.0	3.44±2.16	1.95±0.83	2.70±1.50

mean before loading, 4.76 ± 3.41 mm mean immediately after loading, 2.33 ± 2.81 mm mean 1 month after loading, 3.96 ± 3.26 mm mean 3 months after loading, 4.42 ± 2.61 mm mean 6 months after loading, and 3.98 ± 2.70 mm mean 12 months after loading. Statistical analysis showed a statistically significant difference ($P < 0.05$) between the baseline and 6 months and between the baseline and 12 months in all the horizontal measurements [Table 1].

Table 2 shows the vertical marginal bone gap variations in platform-matched implants during the 12-month study period. The mean vertical bone gap in platform-matched implants was 2.82 ± 0.99 mm mean before loading, 2.10 ± 0.92 mm mean immediately after loading, 3.94 ± 2.11 mm mean 1 month after loading, 3.41 ± 1.61 mm mean 3 months after loading, 3.55 ± 2.11 mm mean 6 months after loading, and 2.01 ± 2.0 mm mean 12 months after loading. Statistical analysis showed a significant difference (P <0.05) between the baseline and 12 months in distal measurements [Table 2].

The horizontal bone gap results in platform-matched implants are shown in Table 2. The mean horizontal bone gap in platform-matched implants was 2.09 ± 0.65 mm mean before loading, 3.22 ± 2.1 mm mean immediately after loading, 2.89 ± 1.57 mm mean 1 month after loading, 2.61 ± 1.2 mm mean 3 months after loading, 2.56 ± 1.78 mm mean 6 months after loading, and 2.70 ± 1.50 mm mean 12 months after loading. Statistical analysis showed no statistically significant differences between the baseline and the rest of the time points in any of the horizontal measurements [Table 2].

These marginal bone measurements showed a bone gain of 1.56 ± 2.4 mm in the vertical gap and 1.49 ± 2.24 mm in the horizontal gap of the platform matching, while in the PLS, a bone gain of 2.67 ± 2.0 mm in the vertical gap ($P < 0.05$) and 2.89 ± 1.67 mm in the horizontal gap was found. Only a statistically significant difference was found comparing bone gains in the vertical gap between the two groups ($P < 0.05$).

Discussion

In the current study, over a period of almost a year, it could be demonstrated that implants restored according to the PLS concept experienced significantly less marginal bone loss than implants with matching implant abutment diameters.

Having reviewed the available literature, it has been confirmed that PLS is a major contributing factor in limiting crestal bone resorption. Certain biological width is necessary to maintain the soft tissues and hard tissue. The connection between implant fixture and the abutment is termed the implant abutment interface (IAI) or "microgap". This area is subjected to the micromovements during clinical function and also permits micro-leakage of fluids. This infiltration results in the permanent presence of an area of abutment inflammatory cell infiltrate. The inflammatory cell infiltrate around the area promotes osteoclast formation and activation, which contributes to bone loss. Platform switching shifts the implant abutment junction inwards and the microgap is shifted away from crestal bone thus limiting the bone resorption in that area.[7]

The etiology of bone remodeling was believed to be dependent on the localized inflammation of the peri-implant soft tissue.[8]

This view was supported, especially in view of the microgap at the IAJ inflammatory cell infiltrate of the abutment, where it is always possible to detect bacterial infiltration, as reported by Jensen *et al*.[9]

In the present study, both platform-switched and platform-matched implant groups exhibited reduced vertical and horizontal gaps at the end of the 12 months. There was greater reduction in the mean marginal bone gaps in the platform-switched dental implants, with only statistically significant differences between the two groups at the end of the 12 months in the vertical measurements, where platform-switched implants presented more mean reduction in the vertical marginal bone gap than the platform matched implants did. Similar results have been reported in previous studies, where marginal bone levels were better maintained in platform-switched implants.[10,11] In addition, the platform-switching concept helps obtain satisfactory long-term esthetic results by the mean marginal bone reduction obtained in vertical and horizontal gaps.[12,13]

A recent meta-analysis conducted by by Laurell and Lundgren showed the mean marginal bone-level changes of 0.24 mm (Astra Tech Dental Implant System), 0.75 mm (Branemark System), and 0.48 mm (Straumann Dental Implant System) after 5 years of implant loading. A possible reason for these differences in bone loss between implant systems is the design of the implant shoulder.[14]

Platform switching refers to the use of smaller diameter abutment on a larger diameter implant platform. Such a connection shifts, the perimeter of the implant-abutment junction inward toward the central axis of the implant to preserve marginal bone from stress concentration. It is also believed that inward movement of IAJ shifts the inflammatory cell infiltration to the central axis of the implant and away from the adjacent crestal bone which is thought to restrict crestal bone resorption. Moreover, crestal bone loss and soft-tissue stability are influenced by the abutment collar length which controls the final crown margin location and the subsequent esthetic outcome.[6,15]

All studies comparing the platform-switched and nonplatform-switched implants suggested that platform-switched implants result in lesser marginal bone resorption. Hürzeler *et al*.[16] compared crestal bone loss around platform-switched and nonplatform-switched implants. They found the mean crestal bone loss was 0.22 mm in platform-switched implants and 2.02 mm in nonplatform-switched implants. They also concluded that reduction of the abutment of 0.45 mm on each side is sufficient to avoid peri-implant bone loss. Another study by Cappiello *et al*.[17] found that vertical bone loss for the platform-switched cases varied between 0.6 and 1.2 mm (mean: 0.95 ± 0.32 mm), while for the cases without PLS, the bone loss was between 1.3 and 2.1 mm (mean: 1.67 ± 0.37 mm). An average of 1–2 mm of bone loss occurs in nonplatform-switched implants, while minimal bone loss occurs in platform-switched implants.

Implant–abutment interface is a very important criterion for implant success.

Conclusion

In the present study platform switching showed positive impact on the marginal bone level around the dental implants. Thus this concept must be taken into consideration in clinical practice.

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Conflicts of interest

There are no conflicts of interest.

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