# Influence of Platform Switching Concept on Marginal Bone Alteration around Dental Implant

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**Abstract:** The aim of the current study is to investigate the role of the type of abutment/implant connection on the marginal bone loss around dental implant. The present study was conducted on fourteen patients, eight males and 6 females with age range from 26 to 40 years. Thirty consecutive dental implants were inserted for implant – supported restoration in the posterior maxilla. The dental implants of all subjects were assigned to one of the 3 platform diameters which were 3.8 mm (control group), 4.5 mm (test group A) and 5.5 mm (test group B). At the time of prosthetic rehabilitation, 3.8 mm abutments were connected to the all inserted dental implants. Radiographic assessment of marginal bone was performed immediately at the time of abutment connection (baseline) and every six months for 24 months after final restoration. Statistical analysis revealed that there was a significant difference between the control group and both test groups as regard the total mean of marginal bone loss. In conclusion, platform-switching concept seems to have a role in minimizing the marginal bone loss around dental implant.
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***Key words***: dental implant, bone levels

## 1.Introduction:

Since Brånemark found that osseointegration occurred between titanium and bone in the mid-1960s, several studies have investigated titanium dental implants and their clinical applications, Yun et al.,(2011). The healing following implant installation of various systems has been documented in a variety of clinical studies. Albrektsson et al. ,(1986) found that the installation of two-piece implants healing in a submerged modality resulted in a crestal bone loss of 1.5–2.0mm after 1 year of loading . Moreover, in experimental studies in dogs, a crestal bone remodeling with a resorption of 2 mm has been verified, Hermann et al.,(1997); Farronato et al.,(2012). Although different techniques and procedures have been developed, postrestorative reductions in peri-implant bone height have long been acknowledged to be a normal consequence of implant therapy involving 2-piece implants, Smith and Zarb(1989); Morris and Ochi(1992);. Hürzeler et al.,(2007).

The resulting crestal bone levels around implants following restoration have been a topic of discussion and used as a reference for evaluating implant success and survival for many years, Berglundh et al.,(2002). Achieving esthetically pleasing implant therapy is crucially affected by the height of the supracrestal soft-tissue portion, since this is highly relevant to the level of bony support around the fixture, Chang et al.,(1999).

There are many suggested causes for early implant bone loss. Changes in crestal bone height have been attributed to implant loading and concentration of forces, the countersinking procedure during implant placement procedures, and localized soft-tissue inflammation, among others. Implant design can affect occlusal overload and the crestal module, which is the implant body that receives the stress from the implant after loading, Yun et al.,(2011).

These crestal bone levels are typically located approximately 1.5 to 2 mm below the implant-abutment junction (IAJ) at 1 year following implant restoration, but are dependent on the location of the IAJ in relation to the bone crest, Albrektsson et al. ,(1986);Hermann et al.,(1997; 2001). Therefore, the inevitable micro-gap of the IAJ and its microbial colonization seems to play a major role in this remodeling process. This is also confirmed by the finding that crestal resorption is not evident as long as the implant remains completely submerged, but develops once an implant has been exposed to the oral environment, Lazzara RJ, Porter (2006);Hürzeler et al.,(2007).

Cardaropoli et al.,(2006) demonstrated that following implant surgery, bone remodeling occurs and is characterized by a reduction in bone dimension, both horizontally and vertically. The radiographic marginal bone level showed a mean loss of 0.9mm at the time of abutment connection and crown placement and a further mean loss of 0.7mm at 1 year. Similar results were reported in a retrospective study, which showed a range of resorption of 2–3mm after 1 year depending on arch, jaw region, smoking status, case type, bone quality, surface type and implant design.

It has been suggested that this biologic process resulting in loss of crestal bone height may be altered when the outer edge of the implant–abutment interface is horizontally repositioned inwardly and away from the outer edge of the implant platform. This prosthetic concept has been introduced as 'platform switching' and radiographic follow-up has demonstrated a smaller than expected vertical change in the crestal bone height around implants, Canullo et al.,(2010).

Using three-dimensional finite-element models, Maeda et al., (2007) examined the possible biomechanical advantage of platform switching in an in vitro study and suggested that by this configuration, the stress concentration would be shifted away from the cervical bone–implant interface.

The ability to reduce or eliminate crestal bone loss would be a major achievement in implant dentistry. Clinical benefits such as superior esthetics (particularly for adjacent implant sites), better bone to implant contact and improved primary stability, could be obtained, Hürzeler et al.,(2007). The purpose of this clinical trial was to show that the crestal bone height around dental implants could be influenced by using a platform switch protocol.

## 2.Materials and Methods:

### *2.1. Materials:*

#### *2.1.1.Samples:*

The current study was conducted on fourteen patients, eight males and 6 females, with age range from 26 to 40 years. All patients had posterior partially edentulous area in premolar –molar region. Thirty consecutive dental implants in the fourteen patients were inserted for implant-supported restorations in the posterior maxilla. All patients were in general good health. They were followed for a period of 24 months after prosthetic rehabilitation.

*The exclusion criteria were:*

- Sites with acute infection.
- Patients with aggressive periodontal disease
- Sites with narrow width of bone crest that mandate augmentation.
- Sites with interproximal or buccal bone defects.
- Smokers with >10 cigarettes/day.
- Patients with uncontrolled diabetes mellitus.
- Pregnant or lactating women.
- Patients with a history of bisphosphonate therapy.

#### 2.1.2.Implants:

The root shaped dental implant (Xive, Friadent, Dentsply) were used in this study presented with micro-threads in the coronal portion and a sand-blasted and acid-etched surface in the entire length of the body.

Every patient received two adjacent dental implants except two subjects who received three adjacent dental implants in maxillary premolar molar area. The dental implants of all subjects included in the study were assigned to one of the three platform diameters which were 3.8, 4.5 and 5.5 mm. At the time of prosthetic rehabilitation, 3.8 mm abutments were connected to the all inserted dental implants. The inserted implants of 3.8 mm platform diameter were considered as control group whereas the inserted implants of 4.5 (group A) and 5.5 mm (group B) platform diameter were considered as test groups

### 2.2.Methods:

***Surgical protocol:***

Pre-operative orthopantogram was performed to assess bone condition and available bone height. Study models were prepared and mounted for evaluation of the interocclusal distance, achievement of ridge mapping and construction of surgical stent. Before the surgical procedure, full-mouth professional prophylaxis appointments were scheduled and performed. All patients received 1 g amoxicillin/clavulanate (Glaxo SmithKline, England) 1 hour before surgery and continued with 2 g/day for 5 days.

All dental implants were inserted according to the submerged surgical protocol. Pericrestal incision was performed after local anesthesia. Standard mucoperiosteal flap was reflected with careful handling of the soft tissues.

Sequential drilling to the desirable depth of the recipient bone under copious irrigation was done at the pre-planned sites. The osteotomy sites were enlarged to receive appropriate dental implant of suitable platform diameter according to the preplanned preoperative workup. A distance of 2.5 mm between implants and between implant and teeth should be achieved (fig.1).

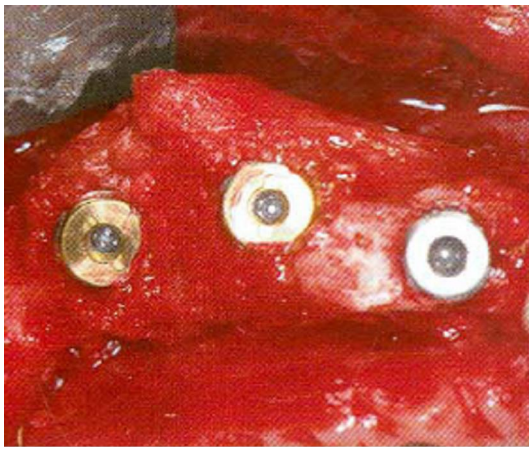

**Figure (1): The inserted three consecutive dental implants with platform at the bone level.**

All implants were inserted with platform at the bone level. A 3.8 mm cover screw was used for each implant. Tension-free suture was performed using a 000 monofilament vicryl.

Patients were instructed to have a soft diet and to avoid chewing in the treated area until the suture removal. Oral hygiene at the surgical site was limited to soft brushing for the first 2 weeks. Regular brushing in the rest of the mouth and rinse with 0.12% chlorohexidine were prescribed for 2 weeks.

After 2 weeks, sutures were removed. Implants were allowed for a submerged healing. Three months later, the uncovering procedure was carried out. Only uneventfully healed implants were accepted in this study.

Three months after the first stage surgery, by performing a crestal incision just over the area corresponding to the implant, the cover screws were exposed and removed.

Attached keratinized mucosa was present both on the palatal and buccal aspect around all implants. Subsequently, a 3.8-healing abutment was inserted. After 1 week, a 3.8mm coping transfer was used and an impression was taken.

For restoration, in test and control groups, always a 3.8 abutment was used. All restorations were splinted single-unit crowns in order to protect implants from inhomogeneous loading. Two weeks after the re-opening procedure, crowns were cemented using provisional cement (Temp Bond, Kerr, WA, USA).

***2.2.2.Radiographic and clinical assessment:***

For each patient, an individual customized digital film holder was fabricated to ensure a reproducible radiographic analysis. Furthermore, digital periapical standardized radiographs were taken at the time of abutment connection to control the perfect adaptation of the abutment on the implant and to provide baseline for marginal bone measurement. Every 6 months for 24 months after the final restoration, periapical standardized digital radiographs were taken in order to evaluate marginal bone level alterations after loading.

A computerized measuring technique was applied to digital periapical radiographs. Evaluation of the marginal bone level around implants was performed using image analysis software (Owandy Quickvision™ , Digital Imaging Systems and Software, France). The image analysis software calculated bone remodeling at the mesial and distal aspects of the implants. Because each implant was inserted at the bone-level crest, the distance was measured from the mesial and distal margin of the implant neck to the most coronal point where the bone appeared to be in contact with the implant.

For each implant, mean values of mesial and distal records were used. All measurements were made and collected by the same two calibrated examiners, different from the implant surgeon. For each pair of measurements, mean values were used.

***2.2.3.Statistical analysis:***

The collected data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (SPSS 15.0 for windows; SPSS Inc, Chicago, IL, 2001). Data was presented and suitable analysis was done according to the type of data obtained for each parameter.

**3.Results:**

***3.1.Clinical findings:***

Thirty implants were utilized in the current study with platform diameters 3.8mm (9 implants), 4.5mm (13 implants) and 5.5mm (8 implants). All patients showed uneventful healing after the first stage surgery. At the second stage surgery, all implants were clinically osseointegrated and showed no signs of peri-implant infection or soft tissues inflammation. All implants were loaded at three months after insertion.

***3.2.Radiographic results:***

Radiographic findings showed successful osseointegration with no peri-implant radiolucency. Radiographic measurements revealed marginal bone loss for all inserted implants (fig.2,3). The mean of bone loss in control and both test groups along the whole study period were tabulated in table (1).

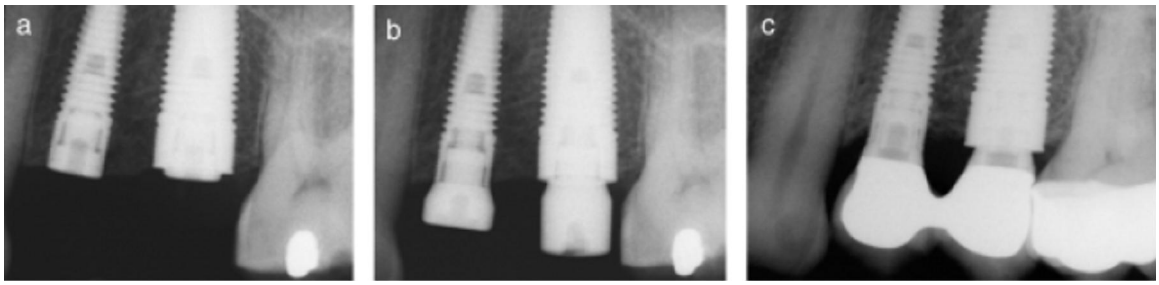


**Figure (2): Periapical radiographs of a patient treated with 3.8 and 5.5mm implants (a) at the time of implant insertion, (b) abutment connection and (c) 24 months after abutment connection. Regardless of implant diameter, the diameters of the cover screw, the healing abutment and the prosthetic abutment were always 3.8mm.**

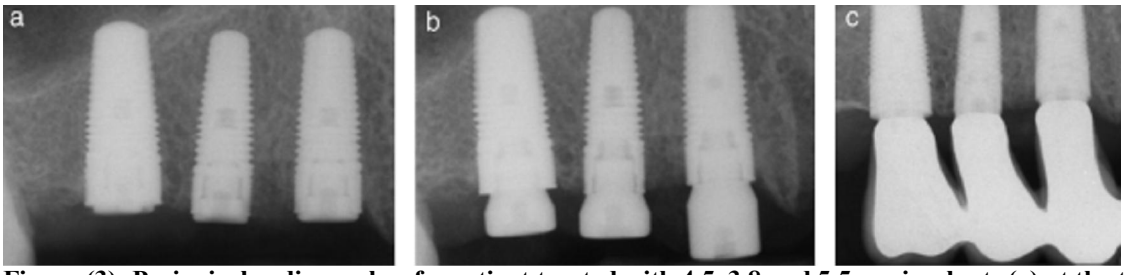


**Figure (3): Periapical radiographs of a patient treated with 4.5, 3.8 and 5.5mm implants (a) at the time of implant insertion, (b) abutment connection and (c) 24 months after abutment connection. Regardless of implant diameter, the diameters of the cover screw, the healing abutment and the prosthetic abutment were always 3.8mm.**

**Table (1): Mean bone loss every 6 months of follow up during 24 months**

| Mean bone loss (*mm*) | | Mean ± SD |
|---|---|---|
| 6 (*months*) | Control (3.8*mm*) | 0.7 ± 0.1 (0.6---0.9) |
| | Group (4.5*mm*) | 0.5 ± 0.1 (0.3---0.6) |
| | Group (5.5*mm*) | 0.4 ± 0.1 (0.3---0.5) |
| 12 (*months*) | Control (3.8*mm*) | 1.1 ± 0.2 (0.9---1.4) |
| | Group (4.5*mm*) | 0.6 ± 0.1 (0.4---0.8) |
| | Group (5.5*mm*) | 0.5 ± 0.1 (0.4---0.7) |
| 18 (*months*) | Control (3.8*mm*) | 1.4 ± 0.2 (1.2---1.8) |
| | Group (4.5*mm*) | 0.8 ± 0.2 (0.4---1.2) |
| | Group (5.5*mm*) | 0.5 ± 0.1 (0.4---0.8) |
| 24 (*months*) | Control (3.8*mm*) | 1.5 ± 0.2 (1.2---1.9) |
| | Group (4.5*mm*) | 0.9 ± 0.1 (0.6---1.2) |
| | Group (5.5*mm*) | 0.6 ± 0.1 (0.4---0.8) |

***3.3.Statistical analysis results:***

The data of the current study revealed that the total mean of bone loss during the whole follow up intervals was 1.2mm (± 0.2 SD) on the control group, 0.7 mm (± 0.1 SD) on the test group A and 0.5 mm (± 0.1 SD) on test group B (fig.4).

Both one way ANOVA and one way ANOVA Post Hoc tests were performed on the total mean bone loss during the whole study period. The one way ANOVA test revealed that there was a statistical significant difference between the control and both the test groups.

Furthermore, the one way ANOVA Post Hoc test revealed that there was a statistical significant difference between the control and test group A, as well as, between the control and test group B. Meanwhile, there was a statistical significant difference between the test group A and B (table 2,3).

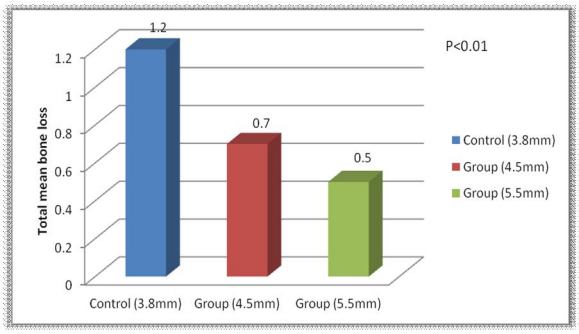


**Fig.(4): Comparison between control and test groups regards total mean bone loss during 24 months of follow up**

**Table (2): Comparison between control and test groups regards total mean bone loss during 24 months**

| Bone loss | Mean ± SD | F | P value | Significance |
|---|---|---|---|---|
| Control (3.8*mm*) | 1.2 ± 0.2 | 56.27 | 0.000 | Significant |
| Group (4.5*mm*) | 0.7 ± 0.1 | | | |
| Group (5.5*mm*) | 0.5 ± 0.1 | | | |

*One-Way ANOVA*

**Table (3): Comparison between control and test groups regards total mean bone loss during 24 months**

| Group (I) | Group (J) | Mean difference (I-J) | P Value | Significance |
|---|---|---|---|---|
| Control (3.8 *mm*) | Group (4.5 *mm*) | 0.5 | 0.000 | Significant |
| | Group (5.5 *mm*) | 0.7 | 0.000 | Significant |
| Group (5.5 *mm*) | Group (4.5 *mm*) | -0.2 | 0.006 | Significant |

*One-Way ANOVA Post Hoc Tests*

**4. Discussion:**

In the current study, over a period of almost two years, it could be demonstrated that implants restored according to the platform-switching concept experienced significantly less marginal bone loss than implants with matching implant–abutment diameters. In addition, it was observed that marginal bone levels were even better maintained with increasing implant/abutment mismatching.

The limitation of this study was that standardized radiographic evaluation only provided information about mesial and distal bone levels. Buccal and palatal bone levels were not evaluative. However, it has to be realized that this limitation was applied to several studies of Abrahamsson et al.,(2009) and lang et al.,(2009).

It can be speculated that the findings of the reduced amount of bone loss at platform-switched implants in the present study may be related to their increased implant diameter rather than to the platform switching. However, comparative studies of Friberg et al.,(2002)with implants different diameters in relation to marginal bone loss did not show different outcomes. Further studies could be helpful to clarify the relevance of wide-diameter implants rather than platform switching in preserving marginal bone.

In the present study, implants with micro-threads in the marginal portion were used. The possible influence of such design on the marginal bone loss was addressed in an experimental study of Abrahamsson et al.,(2006) in dogs. The authors reported that the marginal bone level was located at a more coronal position of implants when compared with implants without micro-threads in the marginal portion, and suggested that the possible positive effects may be related to the osseous healing events after implant placement rather than bone preservation during function.

Several authors, Albrektsson et al. ,(1986); Smith DE, Zarb (1989); Jung et al.,(1996) reported crestal bone loss of about 1.5-2 mm which associated with two pieces dental implant. The results of the present study, where the control group exhibited total mean marginal bone level alteration of 1.2mm at the end point of the study are well in line with these previous findings. These observed changes can be attributed to the potential role of the microgap at the abutment/implant interface for the bacterial colonization of implant sulcus, as it has been shown, the implant/abutment junction (IAJ) is always encircled by an inflammatory cell infiltrate tes and microbiologic invasion, Ericsson et al.,(1995);Hermann et al.,(2001); King et al.,(2002).

The platform switching concept was developed to control bone loss after implant placement. This refers to the use of an abutment of smaller diameter connected to an implant neck of a larger diameter. This connection shifts the perimeter the IAJ inward toward the central axis of the dental implant.

The results of the present study revealed a statistical significant difference between the control and both test groups as the total mean of bone level alteration. These observations can be speculated upon the horizontal inward re-positioning of the implant-abutment interface which has been suggested to overcome some of the problems associated with two pieces implants. Platform switching abutment connection may increase the distance between IAJ associated inflammatory cell infiltrate and marginal bone level, and thereby decrease its resorptive effect. Also, there might be a reduction in the amount of marginal bone loss that can lead to exposure of a minimum amount of implant surface to which soft tissue can attach, Lazzara and Porter (2006). These assumptions are supported by several animal studies, Jung et al.,(2008); Weng et al.,(2008); Cochran et al.,(2009) and human histological observations, Luongo et al.,(2008); Degidi et al.,(2008).

Ericsson et al.,(1995)and Wearhange(1977) reported that the inward shifting of IAJ can provide about 1mm of healthy connective tissue which establish a biologic seal comparable to the natural teeth and hence, protect the underlying bone from inflammatory cell infiltrate. These reports support the findings of the present study.

Clinical case series of immediate implants, Canullo L, Rasperini (2007); Calvo-Guirado (2009) and prospective controlled studies have evaluated bone responses as well soft tissue responses, Prosper et al.,(2009) to platform switched implants. These studies could collectively demonstrate statistically significantly less marginal bone loss as assessed on radiographs at implants restored according to the platform-switching concept. Our findings not only confirmed these data but could also establish a relationship between the extent of platform switching and the amount of marginal bone loss as there was a statistical significant difference between the both test groups. These observations could possibly be attributed to a wider space for horizontal repositioning for biological width and / or a better distribution of loading stress at the bone / implant interface.

In experimental studies, Becker et al.,(2009), implants were installed 0.4 mm supracrestally in alveolar bone crest in dog mandibles, both with matched and mismatched implant abutments. No difference was found in crestal bone level between matched and mismatched abutment up to 24 weeks following implant insertion. The lack of any difference in alveolar crestal bone levels and in soft

tissue dimensions may be attributed to the fact that implants were placed coronal to crestal bone level, thus eliminating any influence of mismatched implant abutments.

Farronato et al.,(2012) demonstrated that mismatched abutments of implants inserted flush with the bony crest allowed the establishment of a smaller biological width and less bone level alteration when compared with matched abutments of implants with the same positioning. So, it can be concluded, from the previous findings, the implant insertion flushed with bony crest is the pre-requisite to minimize marginal bone loss with platform-switching concept. These observations and conclusions support our study design as all implants implemented in the present study were inserted flushed with alveolar bone crest. Also, the implant design modifications involved in platform switching offer multiple advantages and potential applications, including situations in which a larger implant is desirable but the prosthetic space is limited.

In conclusion, the concept of platform-switching seems to be capable of limiting crestal resorption and preserve peri-implant bone levels. Bone remodeling after final restoration can be encountered, but significant differences regarding the peri-implant bone height compared with the non platform switched abutments are still evident within 24 months after final restoration. Further studies should confirm the presented results with a larger sample patient's size.

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