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Original Article

Effect of Platform Switching on Peri-Implant Bone Levels

Danish Azeem Khan, Ashfaq Ahmed*, Ayesha Aslam**

Department of Prosthodontics, 28 MDC, CMH Lahore Institute of Dentistry, Nums Pakistan, *Department of Oral & Maxillofacial Surgery, 89 MDC Kohat Pakistan, **Department of Prosthodontics, Armed Forces Institute of Dentistry/National University of Medical Sciences (NUMS), Rawalpindi Pakistan

ABSTRACT

Objective: To radiographically assess and compare mean marginal bone loss (MBL) between platform-switched (PS) and platform-matched (PM) dental implants after functional loading

Study Design: Quasi-experimental Study

Place & Duration of Study: 89 MDC, Kohat, Pakistan; Oct 2022 to July 2023.

Methodology: Thirty subjects were selected, divided into 02 study groups (PS and PM), and provided with dental implants. In PS group, implants were platform – switched with a narrow abutment while in PM group, implants were restored with matching diameter abutments. Peri – implant MBL was evaluated radiographically on the mesial and distal aspect of each implant at the time of implant placement (T0), at the time of implant loading (T1) and at 06 months after implant loading (T2). Mean MBL was calculated and compared using independent sample's t – test.

Results: For PS group, mean MBL on the mesial and distal aspect was 0.59 ± 0.40 mm and 0.75 ± 0.61 mm respectively. For PM group, mean MBL on the mesial and distal aspect was 1.37 ± 0.72 mm and 1.65 ± 0.74 mm. Mean difference in MBL between the two groups was statistically significant for both mesial and distal aspects (p=0.001). A moderately strong negative correlation was observed between extent of implant-abutment diameter mismatch and mean MBL around implants.

Conclusion: Platform switching helped in limiting marginal bone loss around dental implants. It may serve as a preventive measure in cases where increased bone loss is anticipated.

Keywords: Alveolar bone; Dental implants; Marginal bone loss; Platform switching;

How to Cite This Article: *Khan DA, Ahmed A, Aslam A. Effect of Platform Switching on Peri-Implant Bone Levels. Pak Armed Forces Med J 2026; 76(Suppl-10): S1607-S1612. DOI: https://doi.org/10.51253/pafmj.v76i6.13089*

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INTRODUCTION

In modern dentistry, replacement of lost natural teeth with dental implants has emerged as a successful rehabilitation modality.[1] Treatment with dental implants relies on successful integration of the prosthetic device with host bone. Branemark.[2] introduced the concept of osseointegration in 1977, and today, after years of research, osseointegration of dental implants is achievable and predictable.

Osseointegration is the primary criteria to determine an implant's success. However, new parameters have been defined to measure the long-term success of dental implants. Conservation of alveolar bone around the prosthetic device is one such factor.[3] It has been observed that peri-implant marginal bone is remodeled following functional loading, leading to marginal bone loss (MBL).[4] Literature reports average MBL ranging from 1.2 - 2 mm during the first year of implant placement and loading.[5]

Correspondence: Dr Danish Azeem Khan, Department of Prosthodontics, 28 MDC, CMH Lahore Institute of Dentistry, Nums Pakistan
Received: 31 Jan 2025; revision received: 05 Dec 2025; accepted: 12 Dec 2025

Uncontrolled MBL is one of the key factors resulting in the unplanned loss of dental implants and research has always been aimed at curtailing MBL either by modifying implant designs or its surface characterizations. Another attempt to minimize MBL was reported in 2006 by Lazzara and Porter,[6] named as platform switching, that involved restoration of an implant with an abutment of a smaller diameter in comparison to the implant fixture diameter. A step is created between the abutment and the implant platform, and the implant-abutment junction (IAJ) moves inward along the long-axis of the implant.[7] It is believed that this inwards shift of the IAJ lessens the stress concentration in peri-implant bone as well as hinders bacterial adherence by moving the "microgap" away from crestal bone, thereby resulting in more favorable hard tissue responses.[8]

To date, platform-switching remains controversial in terms of its effects on MBL. While some studies have revealed a protective effect of platform-switching on MBL,[3,5,9] other studies have shown no significant disparity between regular platform and platform-switched implants in terms of preservation of crestal bone.[10] Systematic reviews of

randomized controlled trials done on this subject have concluded that although platform switching appears to have a protective effect on peri-implant marginal bone, numerous confounding factors like location of implant in reference to alveolar crest, implant surface characterizations, IAD mismatch, and quality of the study methodology e.g., use of non-standardized periapical radiographs significantly deteriorated the quality of studies and their documented results.[4,8]

There still exists a need for well-designed research studies to validate the effects of platform-switching. Moreover, to the best of our knowledge, no study has explored this concept in the local population. The purpose of this research was to radiographically assess and compare mean marginal bone loss around platform-switched and platform-matched dental implants after functional loading.

METHODOLOGY

The quasi-experimental study was conducted at 89 MDC, Kohat, Pakistan from Oct 2022 – July 2023. Prior approval from MDC's Ethics Committee was sought (Letter no. 310/Adm/Coy dated 20 Aug 2022). Based on previously published data, sample size was calculated using WHO calculator. Keeping the confidence interval (1-α) at 95%, power of study (1-β) at 90%, mean ± SD for Group 1- Platform-switched (PS) Group at 0.04 ± 0.08 and mean ± SD for Group 2 – Platform-matched (PM) Group at 0.19 ± 0.16,[7] a sample size of 15 was calculated for each group, making the total sample size 30. Non – probability consecutive sampling was done. Patients reporting to the dental OPD for replacement of missing teeth were assessed using the following criteria:

Inclusion Criteria: Subjects with age 25 years or more, one or more missing teeth, sufficient bone volume to allow placement of an implant of minimum diameter and length (3.5 x 9 mm), a mucosal thickness greater than 2 mm at the prospective implant site and good oral hygiene were selected.

Exclusion Criteria: included patients with any active systemic disease including diabetes mellitus, infectious diseases and bone pathologies, ongoing chemotherapy or radiotherapy or history of such a treatment in the last 12 months, drugs that affect bone metabolism e.g., bisphosphonates, active periodontal disease and pregnant or lactating females.

An informed consent was taken from the study participants and details of research were explained to them. Subjects were divided into two groups: PS group and PM group. Single blinding was done - the study participants did not know whether they were part of PS or PM group. All selected subjects were provided with dental implants (TLR Laser-lok, Biohorizons IPH, Inc. AL, USA) using the flap technique by the principal investigator. Implant size was selected based on quantity of available bone in each patient. After placement, implants were allowed to osseointegrate with the host bone for 03 months. Once the healing was complete, implants were exposed using a second – stage surgical protocol and healing abutments were placed. After optimal gingival healing, implants were restored with prosthetic abutments. Subjects in the PS group were provided with abutments narrower than implants, creating an implant-abutment diameter (IAD) mismatch while PM group implants were restored with matching abutments. The implants were then restored with metal – ceramic crowns.

Marginal bone levels were measured from the top of implant to the first observed point of contact between the marginal bone and implant (Figure-1) using periapical radiograph DIGORA™ Optime DXR-60 digital intraoral imaging plate system (Soredex, NC, USA) with associated imaging software and measuring tool SCANORA™. All observations were carried out by the principal investigator. To minimize intra-operator errors, each measurement was performed thrice and a mean value of variables was then noted in proforma. Moreover, 20% of the measurements were repeated after two weeks and intra-class coefficient (ICC) test was used to assess intra-rater reliability. A strong correlation value of 0.91 was achieved, showing high reliability.Radiographic evaluation of peri-implant bone levels was made at the time of implant placement, at the time of implant loading and at 6 months post-loading. Null hypothesis for the study stated that no difference exists in mean MBL between PS and PM dental implants. Data was analyzed using Statistical Package for Social Sciences (SPSS) version 24. Descriptive statistics were calculated. Mean and standard deviation (SD) was calculated for age and implant-abutment diameter (IAD) mismatch whereas frequency and percentages were reported for gender, implant location (maxilla vs. mandible) and type of implant placement (crestal vs sub-crestal). Mean difference in MBL between the two study groups was compared using Independent Samples t – test while Pearson's correlation was used to find any correlation between MBL and IAD mismatch. $p \leq 0.05$ was considered significant for all

statistical tests. Figure-2 highlights the entire step-by-step process from patient selection to follow-up and analysis.



Figure-1: Measuring Peri-Implant Marginal Bone Levels On Peri-Apical Radiographs

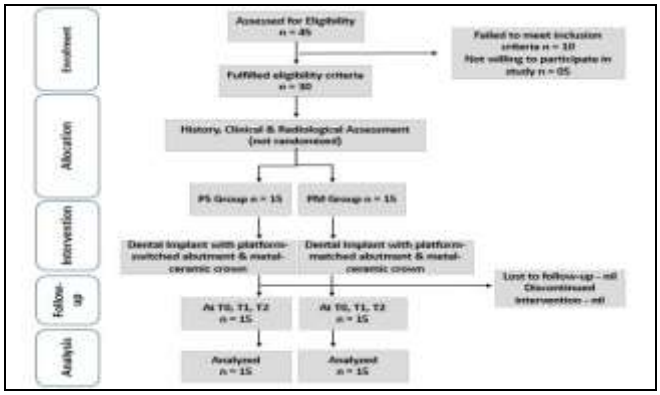


Figure-2: Flow Chart Showing The Step-By-Step Process From Patient Selection and Enrollment To Follow-Up And Analysis

RESULTS

Of the thirty subjects, 43.3% (n=13) were male and 56.7% (n=17) were females. Mean age of the subjects was 50.67±13.16 years (range: 28-72 years). Majority i.e., 70% (n=21) implants were placed in the mandible and only 30% (n=09) were placed in maxilla. The extent of IAD mismatch for the PS group ranged from 0.5 mm to 2mm, with a mean of 0.84±0.39 mm.

Mean difference of MBL between PS and PM groups was found to be statistically significant for both mesial and distal sites, where by PS implants showed a significantly lower MBL (Table I). However, no statistically significant difference in mean MBL could be observed for gender groups, implant location, or type of placement (Table II).

A moderately strong negative correlation (r = -0.545, -0.508; p = 0.002, 0.004) was observed between extent of IAD mismatch and mean MBL around implants, suggesting that MBL decreases with an increase in IAD mismatch (Table III). On the contrary, a weak correlation of MBL with implant length (r = 0.261, 0.206; p = 0.163, 0.175) and diameter (r = -0.118, 0.215; p = 0.536, 0.253) was seen.

Table-I: Comparison Of Peri – Implant Marginal Bone Loss Between Platform – Switched And Matched Implants (n=30)

Bone Loss Location	Study Group	Number of Subjects (n=30)	Marginal Bone Loss Mean ± SD (mm)	Difference (PS – PM) Mean ± SD (mm)	*p*-value
Mesial	Platform - Switched	15	0.59 ± 0.40	- 0.94± 0.92	0.001
	Platform - Matched	15	1.37 ± 0.72		
Distal	Platform - Switched	15	0.75 ± 0.61	- 0.90 ± 0.13	0.001
	Platform - Matched	15	1.65 ± 0.74		

Table-II: Comparison Of Peri – Implant Marginal Bone Loss Between Groups Based On Gender, Implant Location (Maxilla vs. Mandible) And Type of Implant Placement (crestal vs sub-crestal)

Location	Parameters		Number of Subjects (n=30)	Bone Loss Mean ± SD (mm)	*p*-value
Mesial	Gender	Male	13	0.97 ± 0.62	0.92
		Female	17	0.99 ± 0.77	
	Jaw	Maxilla	09	1.08 ± 0.43	0.50
		Mandible	21	0.93 ± 0.78	
	Location in bone	Crestal	05	1.1 ± .41	0.68
		Sub-crestal	25	0.96 ± 0.74	
Distal	Gender	Male	13	1.34 ± 0.93	0.36
		Female	17	1.06 ± 0.63	
	Jaw	Maxilla	09	1.53 ± 0.75	0.11
		Mandible	21	1.03 ± 0.75	
	Location in bone	Crestal	05	1.28 ± 0.64	0.75
		Sub-crestal	25	1.16 ± 0.80	

Table-III: Correlation between mean marginal bone loss (MBL) and extent of implant abutment diameter (IAD) mismatch, implant length and implant diameter (n=30)

Parameter	Pearson Correlation	Mesial MBL	Distal MBL
Extent of IAD Mismatch	r value	- 0.545	- 0.508
	p-value	0.002	0.004
Implant Length	r value	0.261	0.206
	p-value	0.163	0.275
Implant Diameter	r value	-0.118	0.215
	p-value	0.536	0.253

DISCUSSION

Results of this study reveal that mean difference in MBL between the two study groups after 06 months of functional loading was statistically significant for both mesial and distal aspects (p=.001). These findings are comparable to those reported by Gago-Garcia *et al*.[3] who reported almost 50% decreased rate of MBL for PS implants in comparison to PM implants. Our findings are also endorsed by Farronato *et al*.[9] and Lin *et al*.[5] who not only reported more bone loss in PM implants but also a vertical and horizontal bone gain around PS implants. Messias *et al*.[11] also documented results favoring the platform-switching concept with

observations over a period of 5 years. Similar results have also been concluded in a meta-analysis by Mishra *et al*.[12] who reported a lower mean MBL around PS implants (0.33 ± 0.41 mm) compared to PM implants (0.66 ± 0.42 mm). However, contrary results have been reported by Meloni *et al*.[10], Bilhan *et al*.[13] and Uraz *et al*.[14] who found comparable results of MBL for both PS and PM dental implants. This difference may be attributed to differences in ethnicity, patient selection and surgical protocol followed.

In the present study, the extent of implant – abutment diameter mismatch in the PS group varied from 0.5 mm to 2 mm. A moderately strong negative correlation was found between the extent of IAD mismatch and the ensuing peri – implant MBL suggesting that as the IAD mismatch increases, MBL around PS implants decreases. Increasing the implant – abutment diameter mismatch increases the distance between the microgap and the marginal bone. As a result, inflammatory infiltrate is confined more medially, away from the bony crest which is protected against resorption.[8] Hence, greater the mismatch, greater will be this protective phenomenon. These findings are corroborated by Mishra *et al*.[12] who reported that MBL around PS implants decreased as the IAD mismatch increased. Atieh *et al*.[15] in their systematic review and meta – analysis on PS implants inferred that favorable effects of PS are evident when the mismatch is greater than 0.4 mm. This is largely dependent on the implant system used. The system used in the present study did not allow switching with a mismatch <0.5 mm.

The present study also did not find any statistically significant correlation between MBL and implant length or diameter. Amato *et al*.[16] and El-Adl *et al*.[17] also reported no significant effect of implant length on marginal bone loss around dental implants. Cruz *et al*.[18], Park *et al*.[19] and Pesce *et al*.,[20] in their respective systematic reviews and meta-analyses, did not report any significant difference in MBL between narrow diameter and regular diameter implants. The length and diameter of a dental implant is selected depending upon the volume of bone available. If all other factors which may affect MBL are kept constant, the risk of bone loss is equal for long/short and narrow/wide implants. Exaggerated MBL with short, narrow (<3.75 mm) or too wide (≥6mm) may be seen in cases of poor treatment planning, that may result in poor osseointegration due to reduced bone-implant contact, occlusal overloading or a stress-shielding effect.[21,22]

Strengths of this study include an attempt to eliminate or minimize confounding factors that seem to influence peri – implant MBL and affected the quality of previously conducted studies. All participants were either non – diabetic or had a strict glycemic control with HbA1c levels <6.5. All subjects were strictly non – smokers, non – alcoholics, had no parafunctional habits, maintained a good oral hygiene and did not have a history of any periodontal disease. All patients had sufficient bone height and width to allow implant placement as well as a mucosal thickness >2 mm at the prospective implant site.

To minimize chances of heterogeneity, all subjects were provided with dental implants of the same design with identical macro and micro topography and surface treatments. Implant size i.e., length and diameter were selected individually for each patient as governed by the apico – occlusal height, mesio – distal length and bucco – lingual width at the site of implant placement. Majority of the implants were placed subcrestally using a two – stage surgical technique. Although it is thought that sub – crestal implant placement may exaggerate vertical bone resorption, studies have reported otherwise.[23] Therefore, sub - crestal implant placement was favored. The patients neither required nor were provided with any bone grafts. Implants were restored following a delayed – loading protocol and fixed dental prostheses were provided. Standardized digital radiographs were used to assess vertical bone loss.

The study also presents certain limitations. Double – blinding was not possible since it involved radiographical analysis of bone levels. This, however, has been a limitation of all such radiograph – based studies and does not seem to affect the study results. Random allocation was also not applied since patients required individualized treatment planning. Intervention was decided after careful clinical and radiological evaluation of patients. Those deemed at an increased risk of bone loss were favored for PS concept. Moreover, only mesial and distal bone levels were assessed while buccal and lingual bone levels were not catered for. This is an inherent limitation of 2 – dimensional periapical radiographs and can only be overcome if conventional or cone beam CT images are used which come with additional expenses and exposure to radiation. Also, bone levels were measured in only one dimension i.e., vertical.

Horizontal bone loss was not assessed which again required CT images. It has been suggested that PS can affect both vertical and horizontal bone levels by increasing the distance between inflammatory cell infiltrate and alveolar crest.[12,15] Future studies addressing these limitations are suggested.

The results of this study favor platform – switching for reducing peri – implant MBL. It, however, needs to be emphasized that reduced MBL around implants cannot be ascribed wholly to platform – switching concept. Peri – implant MBL is a complex phenomenon and the responsibility to confine this loss lies equally with the dentist and the patient. Negligence on part of either responsible parties will severely undermine the efforts made by the other. Hence, a close cooperation between the dentist and the patient is mandatory.

CONCLUSION

Dental implants with platform – switched abutments showed significantly less mean marginal bone loss on mesial and distal aspects as compared to dental implants with platform – matched abutments. No statistically significant difference was observed in mean MBL between males and females. A moderate negative linear correlation existed between marginal bone loss around dental implants and the extent of implant – abutment diameter mismatch.

Conflict of Interest: None.

Funding Source: None.

Authors' Contribution

Following authors have made substantial contributions to the manuscript as under:

DAK & AA: Data acquisition, data analysis, critical review, approval of the final version to be published.

AA: Study design, data interpretation, drafting the manuscript, critical review, approval of the final version to be published.

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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