# Platform-Switching to Preserve Peri-Implant Bone: A Meta-Analysis

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## Abstract

The objective of this meta-analysis was to determine the literature-based evidence if platform-switching has an effect in preventing marginal bone loss around prosthodontic implants following their functional loading in comparison to conventional platform-matching. A systematic literature search was performed on PubMed, Science Direct, Google Scholar for Literature from 1950 to January 2015, human randomized clinical trials (RCTs) and prospective clinical controlled cohort studies (PCCS) reporting marginal bone loss around platform-switched and matched implants. Six RCTs with a low risk of bias revealed a significantly less mean marginal bone loss (0.57 mm [CI 95% 0.30; 0.84]) around platform-switched implants in comparison to platform-matched implants [1.14 mm (CI 95% 0.69; 1.6, p < 0.001)]. The meta-analysis revealed a significantly less peri-implant marginal bone loss with platform-switched implants as compared to platform-matched implants. The qualitative analysis depicts a trend favouring the platform-switching technique over platform- matching technique to prevent marginal bone loss. However, owing to the heterogeneity of the included studies, their results necessitate cautious interpretation.


**Key Words:** *Meta-analysis. Peri-implant marginal bone level. Platform-switching. Prosthodontics.*

## INTRODUCTION

A successful treatment with implant prosthodontics must ensure the restoration and preservation of both hard and soft tissue levels around the prosthesis.[1] The extent of alveolar bone loss around an implant, following its functional loading, helps gauge the outcomes of implant therapy.[2] The resorption of marginal bone around an implant may occur as a biological host response to the placement of the prosthetic device but the extent of this physiologic bone loss is quite limited.[3] A number of systemic, anatomic, and behavioral factors also come into play, making peri-implant bone loss rather inevitable. Active diseases such as uncontrolled diabetes, osteoporosis, chronic periodontitis as well as a smoking habit, clenching or bruxism may exaggerate bone loss around dental implants.[4] Hard tissue losses of up to 1.5 mm during the first postoperative year have been reported in literature.[5]

With the advancements in dental technology and operative techniques, marginal bone loss around implants has been curtailed. More recently, following prosthetic loading of dental implants, marginal bone resorption not greater than 0.5 mm for up to 5 years has been observed and reported.[6] Such a preservation of crestal bone has been attributed, among other factors, to the concept of platform-switching.[7] The Glossary of Oral and Maxillofacial Implants defines platform-switching as "an act of changing an implant abutment to one with a smaller diameter, so as to place the implant-abutment interface medial to the edge of the implant platform".[8] This creates a step between the implant platform and the abutment, leading to more favourable hard and soft tissue responses (Figure 1).[9]

A review of the published literature suggests that even though the concept has not yet been completely understood, platform-switching has been practised for more than a decade. In 2010, Wagenberg and Forum[10] reported implant survival and crestal bone levels in 94 implants observed over a period of 11 to 14 years. Although this study lacked a control group, the findings confirmed the inhibitory effect of platform-switching on marginal bone loss around implants. However, other

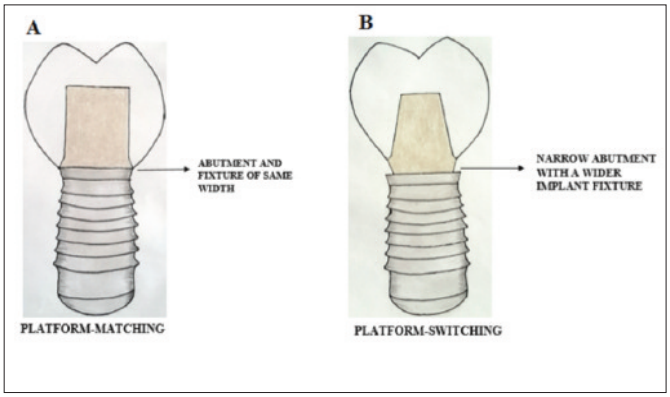


**Figure 1:** Platform-matched implant **(A)** in comparison to a platform-switched implant **(B)**.

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studies report totally contradicting results. Enkling *et al*. reported that there is no significant difference in peri-implant marginal bone loss between platform-switched and platform-matched implants.[11] Similar controversies also exist in the findings of various finite element analyses (FEA) studies comparing the stress levels and stress distribution in platform-matched and platform-switched implants.[12,13]

To date, the choice of using platform-switched or platform-matched dental implants is based more on the manufacturer's recommendations than on sound scientific data endorsing the use of either treatment modality. There exists a need to establish an evidence-based rationale endorsing the practice of platform-switching or platform-matching concept. Hence, this paper aimed at critically evaluating the available literature to statistically analyze the effects of platform-switching and platform-matching on the peri-implant bone levels.

## METHODOLOGY

The question serving for literature search was structured according to PICOS format; where P referred human subjects with stable dental implants; I to dental implants exhibiting platform switched design i.e. wide implant fixture and a narrow implant abutment; C to control dental implants with platform matched abutments; O to radiographic crestal bone levels; and S to randomized clinical trials or prospective clinical controlled cohort studies.

A systematic literature search in the following electronic data-bases/search engines was performed: PubMed, Science Direct, and Google Scholar from 1950 to December 2014. The following search format was used incorporating the Boolean operators: "platform-switching" or "platform-switched implant" and "platform-matched implant" or "non-platform switched implant" and "dental implant" or "oral implant" and "marginal bone level" or "crestal bone level" or “alveolar bone loss”. The bibliographies of all selected articles were also skimmed for any relevant articles.

The studies were included on the basis of being clinical trials involving humans, with defined control and test groups, that documented bone levels in relation to the placement of platform-switched and platform-matched dental implants, involving delayed loading of implants, and a 12 months postloading observation period.

Articles published in English language only and studies with a low risk of bias (according to quality assesment criteria of Cochrane collaboration) were considered. Exclusion criteria were *in vitro* studies, studies carried out on animals, review articles, studies based on immediate loading of implants, any ridge augmentation procedures before implant placement and human case reports.

Criteria of the Cochrane Collaboration for systematic reviews of interventions were used to assess the quality of selected publications.[14]

Mean values for crestal bone resorption along with their standard deviations were retrieved. The bone resorption in each study had been detected on radiographs. Analyses were performed to assess mean difference between the marginal bone losses in the test group compared with marginal bone losses in the control group. Forest-plot was generated to compare the means selected studies with a 95% confidence interval, whereas publication bias was addressed using a funnel-plot. Asymmetry of the funnel-plot was assessed on the basis of linear regression. All statistical analyses were carried out using Review Manager.[15]

## RESULTS

The preliminary search generated 1186 publications on PubMed, 3257 on Science Direct and 48 results on Google Scholar. Studies were screened to assess their eligibility for the present analysis. A total of 102 publications were carefully chosen for a full-text examination, out of which 72 failed to fulfil the inclusion criteria. Thirty potentially relevant articles were further scrutinized in detail. Five studies were omitted due to lack of a control group, 5 due to duplication, 1 on the basis of short follow-up period, 2 on the type of study, and 2 because of incomplete reporting of data. Finally, 17 studies fulfilling the inclusion criteria were assessed for publication quality. Figure 2 depicts the entire process for the identification and selection of suitable studies from the preliminary search results.

Following the recommendations of Cochrane Collaboration,[14] nominated publications were subjected to a quality check. Only 6 studies showed a low risk for bias in all key domains (Figure 3).[16-21] These studies were selected for meta-analysis.

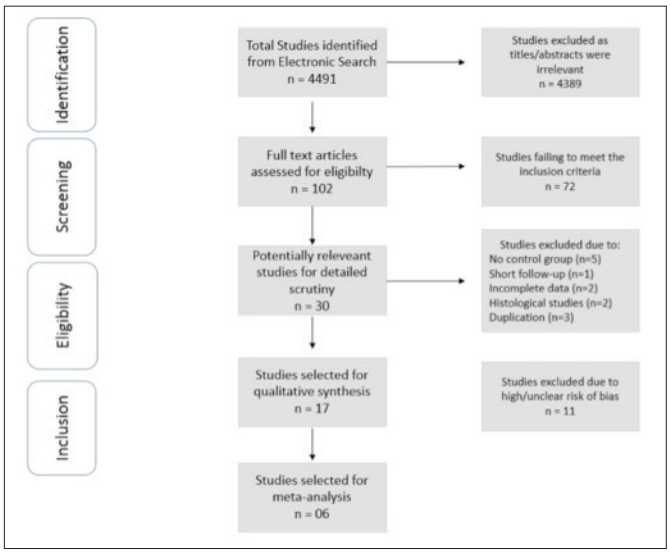


**Figure 2:** Protocol for selection, screening and inclusion of studies for meta-analysis.

For all the selected studies (n = 6),[16-21] mean values of marginal bone loss (MBL) in millimeters with their standard deviations (SD) was used. Data pertaining to each individual case was not documented and hence, could not be retrieved. The selected studies comprised a total number of 244 patients that received 454 implants. Subgroup analysis of the selected studies relating to different observational periods could not be performed since all the studies had a relatively short and varied follow-up period. 3 studies had a follow-up period of 12 months after loading, 1 reported a follow-up period of both 6 months and 12 months, another reported a follow-up of 18 months, while 1 study had a follow-up of 25 months.

Figure 4 shows the funnel-plot calculation for the selected studies, which revealed no asymmetry (p = 0.4383)

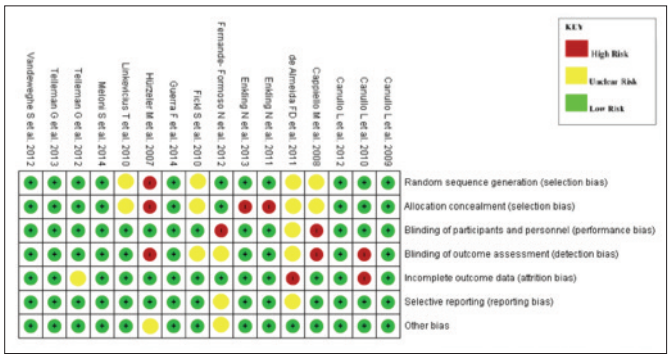


**Figure 3:** Summary of risk of bias in selected studies[11,16-21] following the Cochrane recommendations.[14]

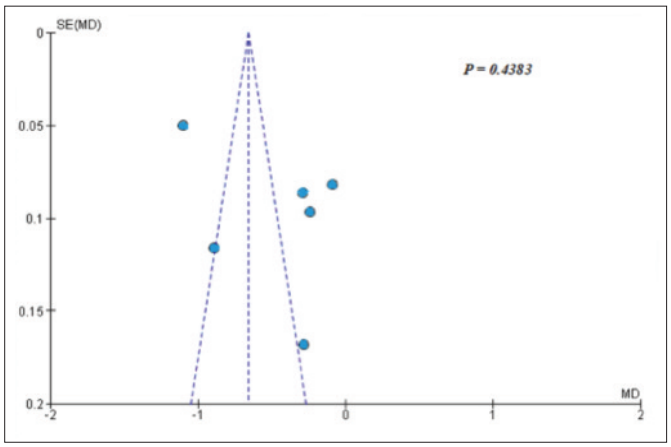


**Figure 4:** Funnel-plot of mean difference of mean marginal bone loss between platform-switched and platform-matched implants.

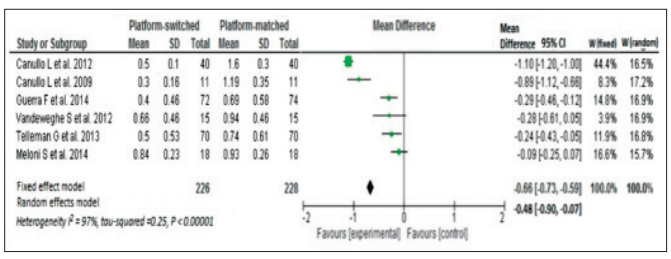


**Figure 5:** Forest-plot showing mean difference of treatment effects of platform-switched and platform-matched implants.

suggesting no evidence supporting the bias of selected studies.

The degree of heterogeneity of studies was assessed by using the "DerSimonian-Laird estimate for inter-study variance", whereby $Tau^2 = 0.25(I^2 = 97\%)$. The value obtained varied significantly from 0 ((p < 0.00001) signifying considerable heterogeneity. Therefore, it was assumed that treatment effects are not homogeneous among the selected studies, favouring the selection of a random effects model to combine the effects of all studies. On the other hand, the range of marginal bone loss in test groups was 0.3 - 0.84 mm and in control groups was 0.69 - 1.6 mm. Five of the selected studies,[16,17,19-21] showed significant reduction in peri-implant marginal bone loss around platform switched implants while one study[18] did not yield any significant difference in degree of bone resorption between the test and control groups. Mean difference of marginal bone loss was found to be 0.66 mm (CI 95%; 0.07; 0.90) between platform-matched and platform-switched implants (value suggestively varies from 0 (p < 0.00001), suggesting a mixed-effect model). Figure 5 shows the forest-plot of mean difference in marginal bone loss between platform-switched and platform-matched groups.

## DISCUSSION

The present meta-analysis was carried out using the guidelines of PRISMA[32] and Cochrane Collaboration.[14] The focused question addressed was if platform-switching has an effect in preventing marginal bone loss around implants following their functional loading. Preservation of marginal bone levels is one of the key parameters symbolizing the success of dental implants.[33] Efforts have, therefore, been aimed at stabilizing peri-implant marginal bone levels after the functional loading of implants. Platform-switching is one such technique advocated for its inhibitory effect on marginal bone resorption.

The effectiveness of platform-switching in preserving peri-implant marginal bone levels has been endorsed by published literature, including systematic reviews and meta-analysis. Atieh *et al*. confirmed the positive role of platform-switching in preserving crestal bone levels emphasizing that improved preservation may be achieved by increasing the extent of implant-abutment mismatch.[7] Similar findings were reported by Al-Qutub, who found that increasing the diameter of the implant fixture resulted in decreased stress and strain on the peri-implant alveolar bone and that implant diameter had a more significant effect on decreasing peri-implant stress as compared to implant length.[34] Annibali *et al*. also validated platform-switching as an effective treatment modality, with greater bone-preserving effects associated with implants having a wider diameter.[35]

Strietzel *et al*. in their review and meta-analysis concluded that although current literature favours platform-switching, further studies with comparable study designs must be carried out to further validate this concept.[6]

In the present study, meta-analysis of the selected randomized controlled trials revealed a significantly less mean marginal bone loss around platform-switched implants compared with platform-matched implants. This finding favours the limiting effect of platform-switching on the marginal bone resorption following implant placement. The results seem true, especially for studies with a short-term follow-up period (average 12 months). The longest follow-up period among the selected studies was reported by Canullo *et al*., whereby the patients were observed at 27 months after prosthetic loading of implants.[21]

An attempt was made to optimize the quality of studies included in the meta-analysis. The Cochrane Collaboration's tool for assessing risk of bias[14] was used to assess the risk for individual studies. Only studies with low risk in all key domains were deemed eligible for the analysis. Studies with a high or unclear risk in any key domain were excluded. This was done in an attempt to minimize the risk of bias among selected studies so as to make the meta-analysis interpretation less controversial.

The present meta-analysis has a number of strengths. First and foremost, it was carried out systematically following PRISMA guidelines and using a focused and well-structured PICO statement. Second, only human clinical trials with a control group and a test group were selected. Third, the selected literature was analyzed quantitatively to evaluate the effectiveness of platform-switched dental implants in maintaining crestal bone levels compared to the conventional platform-matched implants. Fourth, only studies with a low risk of bias in all key domains were included to minimize the risk of publication bias.

A number of limitations can also be attributed to this analysis. One, all the selected studies measured only vertical bone loss around implants, whereas ideally bone loss should be evaluated in both vertical and horizontal dimensions. Also, the level of implant placement in bone was not standardized. Studies suggest that supra-crestal placement of implants may be associated with less bone loss as compared to crestal or sub-crestal implant placement.[7,36] Although only English language articles were included in this analysis suggesting a publication bias, it has been proposed that such an exclusion does not significantly affect the overall evaluation of treatment outcomes.[37]

A number of potential confounders that affect the health of peri-implant tissues and marginal bone levels were overlooked in most of the studies. These include the systemic health of the subjects, the periodontal status, and a history of smoking – all of which are risk factors for marginal bone loss around implants.[3,38,39] Moreover, parameters such as implant diameter, surface characteristics, placement level, and extent of implant-abutment mismatch were also not compared. Therefore, the results of this meta-analysis need to be carefully construed.

Further investigations on the effects of platform-switching need to be carried out with greater emphasis on homogenizing the study designs of the randomized clinical trials. Studies should not only compare implant related parameters, but patient-related risk factors should also be addressed. Such uniformity of design among studies will allow the selection of a larger number of studies for analysis and the results could, therefore, be more easily generalized. Moreover, the randomization protocols in randomized clinical trials need to be strictly followed to minimize the risk of bias.

## CONCLUSION

Within the limitations of the available data, the meta-analysis of selected randomized clinical trials with low risk of bias reveals that platform-switching by means of using narrower abutments favours the preservation of peri-implant marginal bone levels. However, well-designed randomized clinical trials with longer periods of follow-up are required to establish the long-term efficacy of platform-switching in preventing the resorption of marginal bone around dental implants.

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