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"THE EFFECT OF PLATFORM SWITCHING ON ALVEOLAR CRESTAL BONE LEVEL – A SYSTEMATIC REVIEW

Dentistry

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ABSTRACT

Background: Dental implants have become the most common restorative technique for rehabilitation of edentulism. The stability of the crestal bone is believed to be a key factor for maintaining stable soft tissue dimension with direct influence on aesthetics. The concept of "platform switching" explains the use of a smaller-diameter abutment on a larger-diameter implant collar. This may decrease the risk of bone loss around implants.

Aim: To analyze the effect of platform switching on alveolar crestal bone level.

Materials and methods: An electronic database search for randomized controlled trials, clinical trials, prospective studies and retrospective studies published in peer-reviewed Journals in English was conducted from the following databases: PubMed, EBSCOhost, EMBASE and Google Scholar.

Results: A total 248 articles were identified on electronic database. Eleven studies were included for the qualitative synthesis. Out of the 11 studies, 8 were randomized controlled clinical trials, 1 was a clinical trial, 1 was a prospective study and 1 was a retrospective study. All the included studies suggested that platform switching has significant effect on alveolar crestal bone level.

Conclusion: The platform-switched implants remained stable over the course of 10 years and had an overall survival rate of 97.1%. From the present systematic review, based on the articles that were included in this study, it can be concluded that platform switching technique has significant reduction in alveolar crestal bone level as compared to platform matched technique.

KEYWORDS

Dental Implant, Crestal alveolar bone, Platform matched abutment ,Platform switched abutment.

INTRODUCTION

Dental implants have become the most common restorative technique for the rehabilitation of edentulism, since Branemark's discovery[1]. Osseointegrated dental implants have become a predictable treatment option for single partially edentulous spans in patients. Treatment by dental Implant results in preservation of bone, improved function and quality of life. The longevity of the implants relies primarily on their stability at placement[2].

The concept of "platform switching" utilized in the mid-1980s[1], shifts the perimeter of the implant– abutment junction (IAJ) inward toward the central axis (i.e., the middle) of the implant[5]. Lazzara and Porter introduced 5mm and 6mm diameter implants with seating surfaces (i.e. restorative platforms) of the same dimensions. platform switching did not cause crestal bone resorption when observed radiographically, after period of a 5-year.

The mechanism of platform switching results in shifting of the inflammatory cell infiltrate inward and away from the adjacent crestal bone, maintenance of biological width and increased distance of IAJ from the crestal bone level in the horizontal way, the possible influence of microgap on the crestal bone is reduced and decreased stress levels in the peri-implant bone.[3] The platform system may also decrease the risk of bone loss in comparison with the conventional implants.[1]

This technique has few clinical implications where it can be used like in case of short implant, the anterior aesthetic zone & implants adjacent to natural teeth.

Rationale:

The alveolar crestal bone supports the gingival architecture. Therefore, the stability of the crestal bone is believed to be key factor for maintaining stable soft tissue dimension over time[6].The concept of platform switching results in minimal vertical bone loss radiographically around implant as compared with abutments[5]. However, there is limited literature available on the effect of platform switching on alveolar crestal bone level. Therefore, this systematic review attempted to analyze the effect of platform switching on alveolar crestal bone level.

Focused Question

Is there a possible effect of platform switching on alveolar crestal bone level?

Primary Objective

To evaluate the effect of platform switching on alveolar crestal bone level.

Protocol And Registration-

The systematic review was conducted in accordance with the Preferred Reporting Items of Systematic Reviews (PRISMA) and Meta-analysis statement.

Study Design

This is a systematic review of randomized controlled trials, clinical trials, case control studies, cohort studies and retrospective studies, that aimed to evaluate the effect of platform switching on alveolar crestal bone level.

Eligibility Criteria

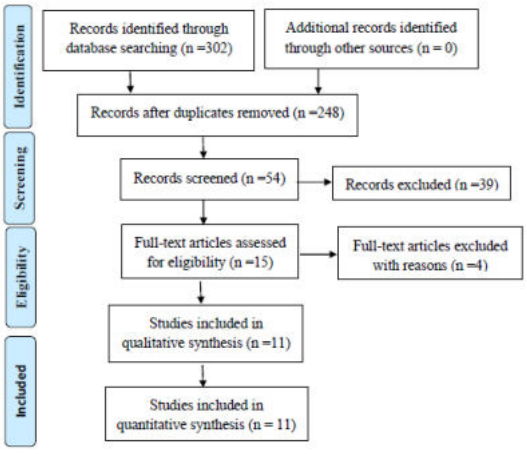
Inclusion Criteria

1. Randomized controlled trials, clinical trials, case control studies, cohort studies, retrospective studies.
2. Full text articles published in English.

Exclusion Criteria

1. In vitro studies, Animal studies, Case report, Case series.
2. Unpublished research.

Figure 1: Shows the Flow chart of literature search results and study selection



Search Strategy:

An electronic database search for randomized controlled trials, clinical trials, prospective studies and retrospective studies published in peer-reviewed journals in English language was conducted from the following databases: PubMed, EBSCOhost, EMBASE and Google Scholar.

Search terms used:

Dental Implant AND Crestal alveolar bone,
Peri-implantitis AND / OR Peri-implant bone loss,
Dental implant survival AND / OR Dental implant failure,
Platform matched abutment OR Platform switched abutment.

Study Selection

Study selection was carried out in two phases:
i. Assessment of titles and abstracts
ii. Assessment of full text.

Data Collection Process

Data extraction sheet was prepared based on variables associated, and the articles were analyzed. Using data extraction sheet, the following data were collected: authors, year of publication, country, aim, parameters assessed, type of study, sample size and conclusion.

Risk Of Bias In Individual Studies

Two reviewers independently assessed the risk of bias of each included study, by using the recommended approach for assessing risk of bias in studies included in Cochrane Reviews (Higgins 2011). It was based on random sequence generation, allocation concealment, blinding of participants & operators, blinding of outcome assessors, incomplete outcome data addressed, free of selective reporting, free of other bias. It involved assigning a judgement relating to the risk of bias for that entry: such that a judgement of 'Yes' indicates low risk of bias, 'No' indicates high risk of bias, and 'Unclear' indicates unclear or unknown risk of bias. Risk of bias for each included study is presented in Table 2 & 3.

A total of 302 articles were found after electronic search. 248 articles, which were of other languages and duplicates, were excluded leaving 54 articles. 39 articles were excluded as they did not fulfill the eligibility criteria leaving 11 articles. Figure 1 shows the flow chart of literature search results and study selection.

Studies included for the analysis

Eleven studies were included for the qualitative synthesis. Out of the 11 studies, 8 were randomized controlled clinical trials, 1 was a clinical trial, 1 was a prospective study and 1 was a retrospective study. All the included studies suggested that platform switching has significant effect on alveolar crestal bone level. An overview of the included studies is presented in Table 1.

Table 1- Characteristics of the included studies for the analysis

Sr no	Authors & Year of Publication	Country	Aim	Parameters assessed	Type of study	Sample size	Conclusion
1.	Bilhan H, Mumcu E [8]	University of Istanbul	To compare bone loss around platform switched (PS) and regular platform implants that support removable prostheses after a loading period of 36 months.	Plaque index (PI), Sulcus bleeding index (SBI), peri-implant probing depth & peri-implant marginal bone level (MBL).	Retrospective clinical study	51 patients with 126 mandibular overdenture implants	Platform switching appears to engender lower marginal bone loss around implants supporting removable dentures.
2.	Canullo L, Iurlaro G[9]	Rome, Italy.	To evaluate the soft tissue response to immediately placed implants using the platform switching concept.	BOP, modified plaque index, probing depth.	Randomized controlled trial	22 patients, 22 implants.	In a limited time period of 2 years, immediately placed implants with subsequent platform switching can provide peri-implant tissue stability.
3.	Canullo L, Iannello G[10]	Rome, Italy	To evaluate the impact of implant platform diameter on MBL around implants restored according to the PS concept.	Radiographic analysis.	Randomized controlled trial	12 patients, 24 implants.	The bone resorption is mostly related to biologic rather than to biomechanical factors.
4.	Enkling, N, Johren P, Klimberg V[11].	Germany	To test the hypothesis that platform switching has a positive impact on crestal bone-level changes.	PI, SBI Radiographic analysis, microbiological analysis.	Randomized clinical trial	25 patients, 50 implants.	Platform switching did not have a positive impact on crestal bone changes.
5	Enkling N, Johren P[12].	Switzerland	To test the hypothesis that platform switching has a positive impact on crestal bone-level changes after 3 years.	Radiographic investigation.	Randomized clinical trial	25 patients.	Reduced peri-implant crestal bone loss,when implants had been restored according to the concept of Platform switching
6.	Misirlioglu E K, Bolukbasi N[13].	Istanbul, Turkey	To test the hypothesis that less resorption will occur when platform-switching implants are placed 1 mm below bone level.	MPI, GI, BOP, PD, Radiographic investigation.	Randomized controlled clinical trial	56 implant	Bone resorption occurs in small amounts around implants with PS design.
7.	Rocha S, Wagner W[14]	Germany	To assess differences in bone level changes between PS and platform-matching unitary cemented restorations after 3 years of function in the posterior mandible.	PI, SBI, PPD, Radiographic investigation.	Randomized clinical trial	63 patients with a total of 135 implants	After 3 years, platform-switching restorations showed significant effect in preservation of MBL compared to platform-matching restorations.

8.	Telleman G, Raghoebar GM[15].	Netherlands	To assess the medium-term results of 8.5 mm implants supplied with a conventional platform matched implant-abutment connection or a platform-switched design.	Marginal bone-level changes, PPD, IPI, IBI, IDC, GI.	Randomized clinical trial	80 patients	The 5-years results showed that, interproximal bone resorption was minor and comparable around platform-matched , platform-switched implants. ,peri implant health and patient satisfaction was favorable.
9.	Zarandi A, Novin M[1]	Tabriz, Iran	To investigate the marginal bone loss around two different types of implant□abutment junctions, called PS and non platform switched after 2years of loading.	Marginal bone loss from radiographic investigation.	Clinical trial	49 patients, 64 implants.	The platform-switching technique seems to reduce the peri-implant crestal bone resorption, which supports the long-term predictability of implant therapy.
10	Jose Luis Calvo-Guirado[16]	Spain	To evaluate the survival rates at 10 years of expanded platform implants in maxilla anterior & immediately restored with single crowns.	RFA, Radiographic investigation.	Prospective Study	86 implants were placed in 32 men & 32 women	The platform-switched implants remained stable over the course of 10 years and had an overall survival rate of 97.1%.
11	Lago L, Silva L M[17].	Spain	To assess the difference in radiographic level of peri-implant bone crest between tissue-level implant restored with platform matching (control group) and bone level implants restored with platform switching (test group) in posterior region with a 5year follow-up	Radiographic investigation.	Randomized controlled trial	100 implant in control group 102 implant in test group.	Radiographic level of peri implant bone crest in tissue-level implant restored by platform matching were stastically significant in the three interval time.

Assessment of risk of bias in randomized controlled trials studies

This assessment was conducted using the recommended approach for assessing the risk of bias in studies included in Cochrane Reviews using the tool RevMan 5.4.1. We used the two-part tool to address the six specific domains (namely random sequence generation, allocation concealment, blinding, incomplete outcome data, selective reporting and other bias). Each domain included one or more specific entries in a risk of bias table. Within each entry, the first part of the tool involves describing what was reported to have happened in the study. The second part of the tool involves assigning a judgment relating to the risk of bias for that entry: either low risk, unclear risk or high risk.

The domains of random sequence generation, allocation concealment, blinding, incomplete outcome data and selective reporting are addressed in the tool by a single entry for each study. We completed a "risk of bias' table for each included study. The risk of bias of the included studies is presented in Table 2 and Graphs 1 & 2

Table 2: Risk of Bias of the randomized controlled trials studies included in the systematic review

Sr no	Author	Year	Random sequence generation	Allocation concealment	Blinding of participant	Blinding of outcome	Incomplete outcome data	Selective reporting
1	Canullo L, Iurlaro G[9].	2009	Low	Low	Low	Low	Not clear	Low
2	Canullo L, Iannello G[10].	2011	Low	Low	Low	Low	Low	Not clear
3	Enkling, N, Johren P, Klimberg V[11].	2011	Low	Low	Low	Low	Low	Not clear
4	Enkling N, Johren P[12].	2013	Low	Low	Low	Low	Low	Not clear
5	Misirlioglu E K, Bolukbasi N[13].	2014	Low	Low	Low	Low	Low	Not clear
6	Rocha S, Wagner W[14]	2016	Low	Low	Low	Low	Low	Not clear
7	Telleman G, Raghoebar GM[15].	2016	Low	Low	Low	Low	Low	Not clear
8	Lago L, Silva L M[17].	2018	Low	Low	Low	Low	Low	Not clear

Assessment of risk of bias in non-randomized controlled trials studies

This assessment was conducted by using the recommended approach for assessing risk of bias using ROBINS-I[7]. The tool is particularly useful to those undertaking systematic reviews that include non-randomized studies using the tool RevMan 5.4.1

The Newcastle-Ottawa and Downs-Black tools have been two of the most popular: both were on a shortlist of methodologically sound tools, but each includes items relating to external as well as internal validity and a lack of comprehensive manuals means that instructions may be interpreted differently by different users.

There was a good reliability between the two reviewers with a high kappa coefficient (k>0.89). We completed a 'Risk of bias' table & summary for each included study. The risk of bias of the included studies is presented in Table 3 and Graphs 3 & 4

Table 3: Risk of Bias of the Non-randomized controlled trials studies included in the systematic review

Sr no	Author (Year)	Type of study	Bias due to confounding	Bias in selection of participants into the study	Bias in classification of interventions	Bias due to deviations from intended interventions	Bias due to missing data	Bias in measurement of outcomes	Bias in selection of the reported result
1	Bilhan H, Mumcu E [8]	Retrospective clinical study	NO	YES	YES	NO	YES	YES	NO
2	Zarandi A, Novin M[1]	Clinical trial	NOT CLEAR	NO	YES	YES	NOT CLEAR	NO	YES
3	Jose Luis Calvo-Guirado[16]	Prospective study	NO	YES	NO	YES	NO	NOT CLEAR	YES

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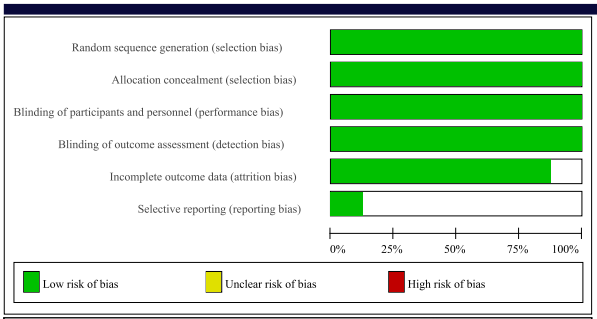
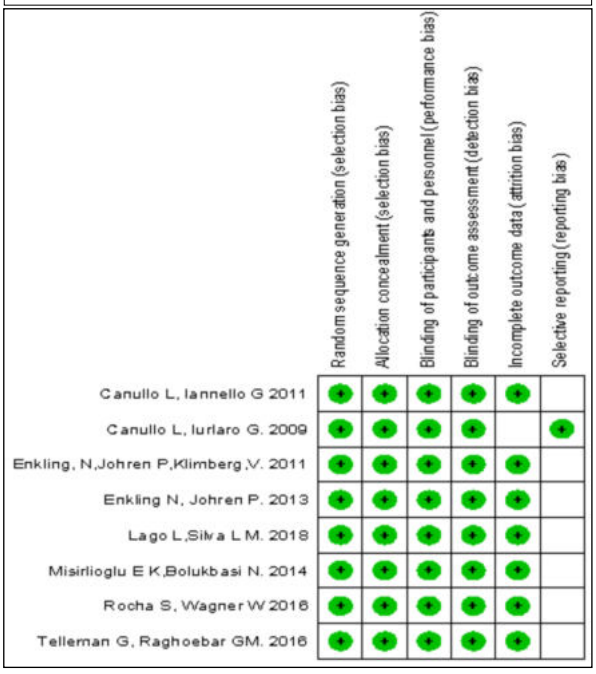
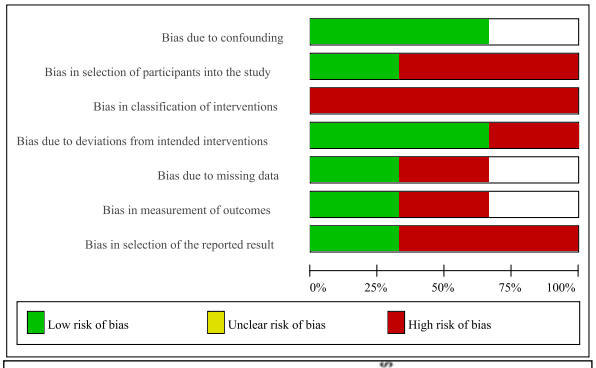
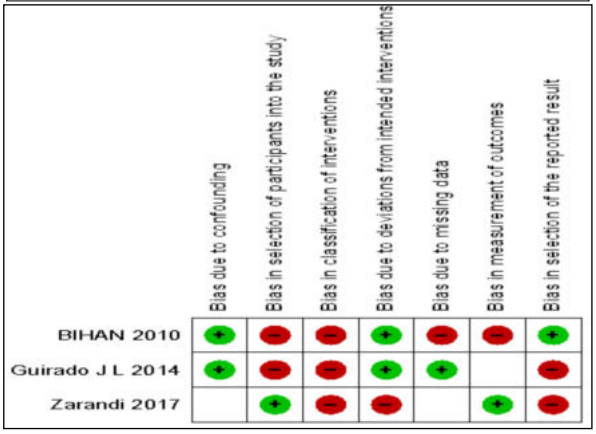




Graph 1 & 2: Risk of bias graph: review authors judgments about each risk of bias item presented as percentages across all randomized controlled trials studies





Graph 3 & 4: Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across non-randomized controlled trials studies.

Table 4: Characteristics of Excluded Studies

Sr no	Authors (Year)	Reason for Exclusion
1.	Alves CC, Munoz F (2014)[18].	Animal study
2.	Schrotenboer J, Tsao YP (2008)[19].	In-vitro study
3.	Arora V, Rao J (2015)[20].	In-vivo study
4.	Linkevicius T, Apse P (2010)[21].	Pilot study

Studies excluded from the analysis

Four studies were excluded, in which 1 was an animal study, 2 were in-vitro studies and 1was a pilot study. An overview of the excluded studies is presented in Table 4.

DISCUSSION

Vijayalakshmi R (2016) stated that, crestal bone loss can result in increased bacterial accumulation resulting in secondary peri-implantitis and loss of bone support, which leads to occlusal overload resulting in implant failure.[22]

First, the inward positioning of the implant abutment interface creates an additional horizontal surface area. This allows the biologic width to be formed horizontally, reducing the amount of crestal bone resorption necessary to expose a minimum amount of implant surface to which the soft tissues can attach.[5]

Second, the effect of the abutment inflammatory cell infiltrate on the peri -implant tissue may be reduced, by repositioning the IAJ inward and away from the peri implant tissue and adjacent bone. It is also suggested that platform switching locates the inflammatory infiltrate within an approximate 90 degree confine area of exposure to the surrounding hard and soft tissue. As a result of this, platform-switched abutment shows reduce inflammatory cell infiltrate.[5]

The present systematic review summarizes the result of various studies investigating the effect of platform switching on alveolar crestal bone level. All the studies showed a positive correlation between platform switching and alveolar crestal bone level.

Table 1 highlights the general characteristics of study population including the author, year of publication, country, aim, parameter assessed, type of study, sample size, conclusion. All the studies evaluated bone loss around platform switched implants. Radiographic investigation was assessed in all the included studies. Periodontal parameter like plaque index and sulcular bleeding index was evaluated in three of the included studies (Bilhan H et al8, Enkling N et al11, Rocha S et al14, Telleman G et al15). Probing depth was evaluated in four of the included studies (Bilhan H et al8, Misirlioglu 0EK et al13, Rocha S et al14, Telleman G et al15). Marginal bone loss was evaluated in three of the included studies (Bilhan H et al8, Telleman G et al15, Zarandi A et al1). Only one study performed microbiological analysis (Enkling N et al11).

Table 2 highlights the risk of bias of the randomized controlled trials studies included in the systematic review. All the randomized controlled trials showed low risk of bias. The randomized controlled trials checklist does not include items relating to external as well as internal validity and a lack of comprehensive manuals means that instructions may be interpreted differently by different users. Therefore there was a need for different checklist. Table 3 highlights the risk of bias of the non randomized controlled trials studies included in the systematic review. Bilhan H et al8 showed high risk of bias (selection of participant into the study, bias in the classification of intervention, bias into missing data, bias in measurement of outcome).

Limitations

a) The present systematic review included only published articles written in English
b) Included articles whose full text was available
c) Meta-analysis could not be performed with this systematic review, due to heterogeneity among data.
d) Several authors could not be contacted, thus detailed information about some of the interventions remains ambiguous.

CONCLUSION

The platform-switching technique seems to reduce the peri-implant crestal bone resorption, which supports the long-term predictability of implant therapy. The platform-switched implants remained stable over the course of 10 years and had an overall survival rate of 97.1%. From

the present systematic review, based on the articles that were included in this study, it can be concluded that platform switching technique has significant reduction in alveolar crestal bone level as compared to platform matched technique.

Implications for research

- Further, more randomized controlled trial studies with low risk of bias need to be conducted, so as to limit heterogeneity of data.

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