Role of Platform Switching in Success of Dental Implants- A Meta-Analysis

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Abstract

Aim: To analyze through systematic review and meta-analysis of implant failure rates, marginal bone loss (MBL) in patients who received platform-switched implants and platform-matched implants and to determine literature based evidence.

Materials and Methods :

Data: Search terms used in combination are dental implant, platform switch, platform mismatch, switched platform, implant – abutment design.

Sources : An electronic search engine without time/ language restrictions was taken from Google Scholar, Pubmed.

Clinical Significance: Platform switching for maintaining peri-implant bone levels has gained popularity over last few years. As philosophies of treatment alter over , a periodic review of different concepts are necessary to refine techniques thereby forming a basis for optimum treatment.

Keywords: *Dental implants, Meta- analysis, Marginal bone*

Introduction

Dental implants have become a standardized and predictable treatment modality for the rehabilitation of partially and completely edentulous arches, resulting in restoring the normal function, esthetics, speech, and comfort in harmony with stomatognathic system[1].

Various studies have been conducted on the effectiveness and predictability of dental implant therapy on which Dr. Branemark in 1968, first proposed the concept of osseointegration.

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Wide-diameter dental implants introduced in the late 1980s, created a situation where mismatched standard-diameter abutments were used simply because of the lack of commercial availability of components to match the wide-diameter implants. It was found that these implants exhibited less-than-expected initial crestal bone loss. This remodeling is termed as saucerization[2].

The ability to reduce this crestal bone loss may have several advantages such as improved esthetics, higher bone to implant contact and better primary stability. To minimize this crestal bone resorption, several techniques and procedures such as non-submerged technique, utilizing micro-roughness on implant neck surface and platform switching have recently been developed [3].

A better understanding of the biologic principles of bone healing around dental implants is needed and studies have demonstrated that bone resorption at the implant-abutment junction (IAJ) may be caused by an inflammatory cell infiltrate, that forms a zone around

the IAJ. Though not fully understood, the current theory of platform switching is related to the physical repositioning of the IAJ away from the outer surface of the implant and the surrounding bone, thereby avoiding the inflammatory infiltrate away from the width of the platform switched dental implant.

Considering the key importance of crestal bone loss to implant success, several preclinical and clinical studies have investigated a variety of confounding biologic and biomechanical factors contributing to CBL. The micro gap at the junction of an implant platform and the abutment has been suggested as a major contributor. Thepresent meta-analysis was conducted to investigate the impact of platform switching on marginal bone levels around platform switched and platform matched dental implants

Aim & Objectives

To analyze through systematic review and meta-analysis of implant failure rates, marginal bone loss (MBL) in patients who received platform-switched implants and platform-matched implants.

· To Collect Reliable Journal Articles Reporting The Marginal Bone Loss Among Platform Switched Dental Implants And Platform Matched Dental Implants.

· To Compare The Parameters Across The Different Articles.

· To Address The Limitations In The Collected Data.

Methodology

- A structured electronic systematic search without time or language restrictions was undertaken from March 2009-2019 in the following databases.

- PubMed library and Google scholar was searched for articles using MeSH terms.

- The following question in the PICO format (Patient, Intervention, Comparison and Outcome) was developed in patients treated with dental implants, are there any differences among platform- switched restorations compared to platform matched ones in terms of peri-implant marginal bone loss and implant survival.

- In the electronic search, 475 articles were identified , 372 articles were obtained after removal of duplicates and 36 full text articles were assessed for eligibility based on inclusion criteria. 29 articles were included in qualitative analysis and 7 articles were included in the quantitative analysis

Search Terms :

• The following combinations of keywords were used :

• Dental implant , Platform shifting, Platform switch, Platform switching, Mismatched abutment, non-platform switched implants, platform design, switched abutment, crestal bone remodeling, marginal tissue, Implant- abutment junction, Crestal bone loss, Marginal bone preservation, Marginal bone loss, Marginal bone changes, dental implants, and implant design.

Inclusion Criteria :

• All clinical trials,

• Randomized Control Trials

• Prospective studies,

• Case-control studies with a minimum of 10 implants/ subjects.

Exclusion Criteria :

• Animal studies,

• Biomechanical studies,

• Finite element analysis,

• Case reports,

• Studies in the absence of a comparison group.

STUDY SELECTION AND DATA COLLECTION :

• During the first step of selection, studies were retained based on the screening of the title and abstracts, later the final stage of screening involved full- text reading using a predetermined data extraction form to confirm the eligibility of each study based on inclusion and exclusion criteria.

• In addition bibliography of these selected articles were also scanned to obtain the maximum number of results possible. A total of 475 articles were obtained from Pubmed And Google Scholar , after removal of duplicates and 36 full text articles were assessed for eligibility based on inclusion criteria. 29 articles were included in qualitative analysis and 7 articles were included in the quantitative analysis.

Study Design :

· A meta-analysis on the platform switching in dental implants

PRISMA FLOW CHART

Results

Characteristics Of The Studies Included And Comparison Of Mean marginal Bone loss considering RCT'S with an observation period (Table 1)

Sl. No:	Study name	Platform switched			Platform matched		
		Mean	SD	95% CI	Mean	SD	95% CI
1.	Enkling (2011) -1 year -25 implants	0.19	0.47	-0.37,0	-0.34	0.35	-0.5,0
2.	Enkling et al(2013) -1 year -25 implants	-0.34	±0.35	0.50, 0.00	-0.19	±0.47	-0.37, 0.00
3.	Silvio et al(2014) -1 year -36 implants	0.84	±0.23	0.73,0.95	0.93	±0.26	0.81, 1.05
4.	Silvio et al (2016) -3 year -36 implants	1.06	±0.24	0.93, 1.15	1.09	±0.31	0.85, 1.13
5.	S.Rocha et al (2017) -5 years -59 implants	0.27	±0.44	0.26,0.76	0.09	±0.85	0.07, 0.64
5.	S.Rocha et al (2017) -5 years -59 implants	0.27	±0.44	0.26,0.76	0.09	±0.85	0.07, 0.64
6.	**Laura Lago et al (2018) -1 to 5 years -100 implants**	**-0.17**	**±0.67**	**0.71**	**0.34**	**±0.54**	**0.33**
7.	**Ana Messias et al (2019) - 5 years -121 implants**	**0.19**	**±0.53**	**0.33,0.43**	**0.04**	**±0.58**	**0.03, 0.43**

META- ANALYSIS :

· Mean difference of the mean bone implant contact was calculated for platform switched dental implant and platform matched dental implant and compared using student T test at confidence interval of 95%

· Graphically the data was represented as forest plot.

· Meta-analysis was done using MEDCALC software version 19.1

· In the electronic search, 475 articles were identified. Using the key words "platform switched and platform matched implants "372 articles were obtained after removal of duplicates and 36 full text articles were assessed for eligibility based on inclusion criteria. 29 articles were included in qualitative analysis and 7 articles were included in the quantitative analysis.

· Pooled estimates from the 7 studies were analysed using a continuous random effects model meta-analysis, the variable analyzed was crestal bone loss of implants placed in platform switched and platform matched dental implants.

META-ANALYSIS: CONTINUOUS MEASURE: TABLE – 2

Variable for studies	study_name
1. Intervention groups	
Variable for number of cases	N
Variable for mean	Mean
Variable for SD	Sd
2. Control groups	
Variable for number of cases	N
Variable for mean	mean_1
Variable for SD	sd1

Study	N1	N2	Total	SMD	SE	95% CI	t	P	Weight (%)	
									Fixed	Random
Enkling (2011)	25	25	50	1.259	0.306	0.645 to 1.873			5.46	12.80
Enkling et al(2013)	25	25	50	-0.356	0.281	-0.921 to 0.208			6.47	13.25
Silvio et al(2014)	36	36	72	-0.363	0.235	-0.832 to 0.106			9.22	14.05

Silvio et al (2016)	36	36	72	-0.107	0.233	-0.572 to 0.358			9.36	14.08
S.Rocha et al (2017)	59	59	118	0.264	0.184	-0.0997 to 0.628			15.10	14.86
Laura lago et al (2018)	100	100	200	-0.835	0.147	-1.125 to -0.545			23.61	15.37
Ana messias et al (2019)	121	121	242	0.269	0.129	0.0155 to 0.523			30.76	15.59
Total (fixed effects)	402	402	804	-0.0722	0.0714	-0.212 to 0.0679	-1.012	0.312	100.00	100.00
Total (random effects)	402	402	804	0.000827	0.234	-0.459 to 0.461	0.00353	0.997	100.00	100.00

TEST OF HETEROGENEITY :

Q	58.8846
DF	6
Significance level	P < 0.0001
I2 (inconsistency)	89.81%
95% CI for I2	81.54 to 94.37

FOREST PLOT :

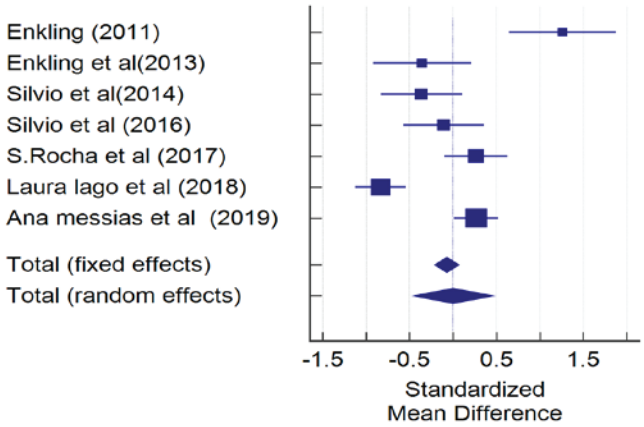

FIGURE 1, Forest Plot Depicts the Mean Differences of Marginal Bone Loss between Platform switched And Platform matched Implants.

FUNNEL PLOT:

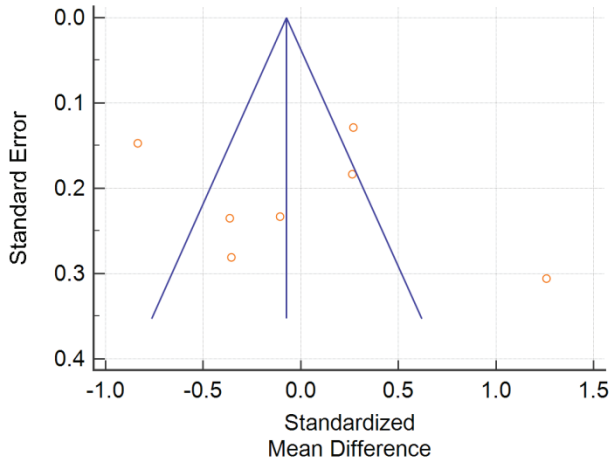

FIGURE 2, Funnel Plot For Detection Of Publication Bias

META-ANALYSIS INTERPRETATION :

FOREST PLOT :

· The main outcome of the meta-analysis is a forest plot, a graphical display as in figure 1, the X-axis (horizontal axis) forms the effect size scale (odds Ratio or Relative Risk), plotted on the bottom of the plot. Each row except bottom two, represents a study's effect size estimate in the form of a square (black box) the bigger the box, the more contribution to the study and a (95%) confidence interval and a vertical line which is known as the line of no effect / null effect.

· The diamond at the bottom of the forest plot shows the results when all the individual studies are combined and averaged. The horizontal points of the diamond are the limits of the 95% confidence interval and are subject to the same interpretation as any of the other individual studies on the plot.

· In this analysis, diamond shape 'Pooled Data ' found on the line of no effect which means there is less statistical significance or no statistical significance with the use of platform switched dental implants compared with platform matched dental implants.

FUNNEL PLOT :

Funnel plot has the following characteristics,

· The plot ideally resembles a pyramid or inverted funnel, with scatter due to sampling variation. The shape is expected because the studies have a wide range of

standard errors. If the same size, the studies would fall on the horizontal line.

In this analysis, Few studies (3 out of 7) were scattered out of the funnel plot it shows that there was a possible error in the studies, which may due to poor methodological design, inadequate analysis, heterogeneity (size of the effect differs according to study size) and sampling variation.

Discussion

Platform switching for maintaining of peri-implant bone levels has gained popularity over last few years. As philosophies of treatment alter over time, a periodic review of different concepts is necessary to refine techniques thereby forming a basis for optimum treatment. Crestal bone loss is considered an important criteria for the evaluation of the implant outcome and evidence for the presence or absence of peri-implant tissue health. Therefore, efforts were made to preserve the peri-implant marginal bone levels stable throughout and following the prosthetic loading phase.

Platform switching technique is one among the various approaches to achieve marginal or crestal bone stability. With the platform switching technique, there is a close adaptation of soft tissues, increased bone-implant contact area, good per mucosal seal, and hence better emergence profile is obtained thereby improving the esthetics.

Recently, published systematic reviews and meta-analyses supported this assumption by confirming the effectiveness of the platform switching technique[4] significantly limiting marginal bone resorption around dental implants, while the cumulative estimated implant success rate was statistically less significant between both intervention groups of platform switched and platform matched dental implants.

All the studies included in the meta-analysis were RCT's, the analysis of the methodological quality of some of them revealed some potential criticisms i.e bias for reporting incomplete outcome data, due to dropouts or exclusion after randomization, some authors did not report the periodontal health status of the patients included in the study.

The platform switching technique and effects of platform switching were found via electronic database, of which 475 records were found. 36 articles were fully assessed for eligibility , 29 met the inclusion criteria for the qualitative analysis, and 7 were found eligible for the quantitative, to be included in meta-analysis. Considering the results of RCT's included in this meta-analysis, three studies stated that the difference of marginal bone levels were remarkably in favor of the platform switched group. However a statistical analysis has to be done to calculate the level of significance, and four studies indicated the difference of marginal bone levels was less significant in the platform switched group compared to those utilizing platform matched implant-abutment connections.

The possibility cannot be ignored, but it is not known whether the loss of marginal bone is a long term process. Only drawback is, only few studies are available with long term follow up. Moreover, it is debatable whether such mean difference may have clinical significance. Several hypotheses trying to explain this phenomenon have been raised in the literature. Some studies have shown that bone resorption around the implant neck does not begin until the implant is uncovered and exposed to the oral cavity, which invariably leads to bacterial contamination of the gap between implant and abutment. The bacterial reservoir in the microgap may continuously invade the bone through micro-spaces. Toxins produced by the bacteria create a zone of toxicity at the level of microcap, resulting in peri-implant inflammation and typical bone loss upto 1st thread.

Especially periodontally compromised smoking patients with treated periodontitis revealed significantly more peri-implant marginal bone loss compared to periodontally healthy smokers , therefore smoking and the history of periodontitis should be considered risk factors for marginal bone loss around dental implants.

However, studies done by Enkling[5] et al in 2011, Enkling[6] et al in 2013, Silvio[7] et al 2014, Silvio[8] et al 2016, S.Rocha[9] et al in 2017, Laura lago et al in 2018, Ana messias[10] et al in 2019 cautiously summarized their findings, especially on emphasizing the bone-preserving effects on platform switched implant and platform matched implant. Nevertheless, within the limitations of the recently published RCTs included for meta-analysis presented here, the results of former systematic

reviews confirmed, a less significant difference between the mean MBL change at dental implants with a PS implant – abutment compared to a PM implant-abutment configuration.

Atieh[11] et al, in their systematic review and meta-analysis involving a total of 10 RCTs, reported significantly lower bone loss in implants restored with platform switching vs platform matching.

Annibali[12] et al in their systematic review with a follow-up of 36 months reported that there is no significant difference in implant success rate between platform matching and platform switching. Implants restored by platform switching showed a lower degree of marginal bone loss over time of 0 to 0.99 mm and - 0 to 2.02 mm for platform matching dental implants. In fact, there seems to be a relationship between a higher degree of discrepancy and a smaller amount of bone loss.

Herekar[13] et al, in their systematic review of 10 RCTs and 5 controlled clinical trials, showed that marginal bone loss around implants restored by platform switching was statistically less significant than that of implants restored by platform matching −0.34 mm. Strietzel et al, in their systematic review and meta-analysis, reported that most studies showed a favorable trend toward platform switching.

Santiago[14] et al analyzed a total of 17 RCTs and 8 prospective studies. This meta-analysis revealed a significant reduction in marginal bone loss for implants restored with platform switching compared with implants restored with platform matching. Another highlight, regardless of the P value, is the clinical relevance these findings may offer, since the difference between the two techniques is seldom greater than 0.5 mm. If possible error in the measuring method is taken into account, the comparative advantage of bone-level implants restored by platform switching over the tissue-level implants restored by platform matching may be limited by this value.

The last, as reported by Hsu, Lin, and Wang [15] (2017), seems to be a crucial factor for the preservation of marginal bone levels, contributing to the success of the rehabilitations. Notwithstanding that and taking into consideration the validity of these results, we believe that any patient receiving implants in any healed bounded or free end edentulous areas would benefit from the use of PS prosthetic components from the early stages of the rehabilitation (i.e. from surgery onwards), as long as strict hygiene and motivation is practised with follow-up programme is done to ensure patient compliance.

Summarizing the findings of the included publications, especially among the RCTs remarkably more studies indicated results favoring less significance for the use of PS technique to prevent MBL changes. Therefore, heterogeneity among the study conditions is supposed to have a crucial influence on study outcomes.

The results of the study in the forest plot suggested that the study done by Enkling et al in 2013, Silvio et al in 2014, had a significant impact on the platform switching technique. Whereas study done by Enkling in 2011 , S Rocha et al in 2017, Ana messias et al in 2019 had a less significant impact in this technique. The pooled estimate of the study (diamond shape) lied in the center of line of no effect stating that ,there is less significant difference with use of platform switched when compared with platform matched dental implants.

Meta-analysis of 7 RCTs revealed a significantly less mean MBL change at PS implants compared with PM implants, thus confirming the supposed bone level stabilizing effect of PS implant-abutment configurations at least when considering short-term observations. The longest follow-up period within the RCTs was reported up to 60 months i.e.5 years by S.Rocha et al. (2017) and Laura lago et al (2018).

Limitations

· First, few clinical studies with less numbers of patients were available for data extraction. Second, there was not enough evidence from RCT in the selected literature.

The impact of positioning the micro-gap on soft tissue margin changes around PS implants lacks documentation and may not allow for any conclusions.

Platform Switching may have a positive effect on bone preservation in the first year, but after five years, the marginal bone change is insignificant, as compared to that at one year, around both PS and PM implants.

More homogeneous studies with a longer follow-up

are needed to confirm platform switching phenomenon to reduce crestal bone resorption, and health of peri-implant soft tissue and hard tissue .

Summary and Conclusion

· The meta-analysis of 7 RCT'S revealed a significantly less mean MBL change at implants with a PS – implant –abutment configuration compared with PM-implant-abutment design. However, within the limitations of the recently available publications of the RCT'S and PCCS, the tendency revealing from the studies results favors less significance of the PS technique to prevent or minimize peri-implant marginal bone loss, compared to implants with PM abutments.

· The results of the present study suggest that there is a significantly less MBL at implants with platform-switching than on implants with platform matching. Moreover, precisely designed and appropriate clinical trials with larger samples and longer follow-up periods are required for literature based evidence.

Ethical Clearance – Institutional Ethics Committee, Sree Balaji Dental College and Hospital, Committee registered with DCGI. (Registration no: SBDCH/IEC/04/2019/22)

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Conflict of Interest – Nil

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