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A Comparative Radiographic Evaluation of Crestal Bone Loss around Dental Implants by Varying the Abutment Diameters

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Abstract:

The long-term preservation of safe peri-implant tissues, which can provide both function and aesthetics for a long time, is a major challenge in implant dentistry. Various approaches to reducing bone remodeling around implants have been suggested, with the impact of the implant–abutment interface being particularly important. The position of the abutment in relation to the implant platform, as well as its effect on marginal bone level changes, has piqued interest. As a result, the impact of platform switching on crestal bone remodeling around implants was investigated.

Material and Methods: The platform modification technique was used to test a series of 30 control cases and 30 research cases in this study. At 1, 4, and 6 months after abutment placement, digital radiography was used to measure interproximal bone resorption on the mesial and distal of each implant.

Results: At the mesial hand, the difference in mean score between platform matched and platform swapped abutments was non-significant (p value=0.92). At the distal side, the difference in mean score between platform matched and platform swapped abutments was statistically significant (p

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Value=0.03). When comparing platform matched abutments to platform switched abutments, the mean reduction in bone height was higher in platform matched abutments.

Conclusion: All patients in the study group demonstrated decreased bone loss in comparison to the control group ($p<0.001$)

Key words: Abutment, Platform Switch, Platform Match, Bone, Implant, implant – abutment interface

INTRODUCTION

Implants have changed the way people handle their teeth and produced outstanding long-term outcomes. [1] The use of dental implants to restore edentulous areas has been well established, and predictable results have been observed. [2–4] Early peri-implant bone loss has been identified in a variety of implant systems and surgical techniques. [4–6] Crestal bone loss, in particular, is the most common symptom of implant failure following osseointegration and primary stabilization. The majority of crestal bone loss occurs in the first year after implant placement, and it can reach 1.2 mm corono-apically.[7] One of the most important factors influencing the appearance and preservation of peri-implant soft tissue structure is the involvement of crestal bone.

The forces directed from the implant body to the bone, as well as the ability of the bone to withstand these forces, are the primary criteria for determining implant performance. In successfully osseointegrated endosteal implants, the initial breakdown of the implant-tissue interface occurs at the crestal site, regardless of surgical approaches, with the potential to cause implant failure. During initial loading, bone resorption up to the implant neck is common. According to Oh et al, the following factors are the most likely causes of early crestal bone loss around dental implants: (1) micro-gap, (2) implant crest module, (3) occlusal overload, and (4) biologic breadth around the dental implant. [6] Bone resorption around the implant neck does not begin until the implant is uncovered and exposed to the oral environment, according to numerous studies. [8 -11]

Progressive marginal bone loss can be caused by occlusal overload. However, it's unclear why crestal bone resorption around the implant neck is higher in the first year of use than in subsequent years. [12 – 14]

However, in the aesthetic realm, bone loss must be reduced, if not completely avoided. The implant-abutment interface is the area of concern. After loading, the crest module, i.e. the implant's transossteal zone, receives crestal stresses. [15] Oh et al hypothesized that bone loss may be related to

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the nature of the crest module rather than its length. [6]

On radiographic evaluation in 1991, it was discovered that implants restored with narrower diameter abutments showed less crestal remodeling. "Platform Switching" was coined to describe this phenomenon. [16]

The use of a smaller diameter abutment on a larger diameter implant collar is referred to as platform switching. The perimeter of the implant abutment junction (IAJ) is shifted inward toward the implant's central axis in this form of attachment. [17,18]

According to Ericsson et al., bone is still surrounded by around 1 mm of healthy connective tissue, so crestal bone remodeling occurs to create space between the bone and inflammatory cell tissue (ICT) in order to construct a biological seal. [10] Shifting the IAJ inward, according to Lazzara et al, also moves the inflammatory cell infiltrate inward and away from the crestal bone.[16]

In summary, (1) inward movement of the IAJ is thought to push the inflammatory cell infiltrate toward the central axis of the implant and away from the adjacent crestal bone; (2) connective tissue thickens laterally, increasing blood flow around that area; and (3) ICT is confined above the implant platform level. These modifications help to protect the crestal bone (the bone that surrounds the implant shoulder) from ICT. As a result, there is no bone remodeling because the biologic width does not reduce in order to cover up the ICT (i.e. to create a biological seal) (i.e. crestal bone loss).

There are currently only a few publications on PLS, and as a result, the scientific data on this subject is both scarce and of poor quality. However, since there are few studies on the mechanism of action or the degree of bone loss prevention, it's difficult to claim that PLS's impact has been thoroughly investigated. [19]

MATERIALS AND METHODS

The aim of this analysis was to see how changing the diameter of the implant abutment affected crestal bone loss between implants restored with matching diameters and those restored using the platform switching principle. The principle of platform switching entails the use of a narrow-diameterabutment.

SOURCE OF DATA:

Individuals seeking prosthetic tooth replacement with implants at the Department of Prosthodontics and Implantology.

Sample size:

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The sample size comprised of 60 implants placed in patients.

Method of collection of data (including sampling procedure, if any):

The inclusion and exclusion criteria were set. Based on these criteria subjects were selected for the study. The inclusion criteria were as follows:

-Age 18 years and above-healthy individuals-good oral hygiene-maxillary/mandibular partially edentulous regions-two months post extraction-availability for follow-up visits

The exclusion criteria were as follows:

-uncontrolled diabetes or systemic disease-individuals with blood dyscrasias - radiation to head and neck-patients undergoing steroid therapy-individuals with osteoporosis-heavy smokers

-periodontally compromised patients-patients with poor oral hygiene-patients undergoing bisphosphonate treatment

The patients who were chosen underwent a pre-surgical assessment. Clinical and radiographic examinations were performed as part of this method (IOPA, OPG, CBCT scans as per the individual case treatment.

The procedure was fully explained to all patients and written consent was obtained. The research received ethical approval from the Institutional Review Board.

Two groups were formed for the study: a research group and a control group. The research group had platform swapped implants (implants with a smaller diameter abutment than the implant) and the control group had platform matched implants (implants restored with abutment diameter same as that of implant).

Both of the osteotomies were done using a two-stage surgical procedure. The research used implants from the OSSTEM implant system

All of the implants were mounted so that the implant platform's surface was at the same level as the alveolar crest. The procedure was carried out in two stages. Stage one surgery was used to insert the implants, and stage two surgery was used to attach the abutments after the implants had osseointegrated (3 months in mandible and 4 months in maxilla).

Radiographs were taken at the following intervals to assess the amount of bone remodeling that occurred around each implant:

1) On the day of abutment placement.
2) One month post abutment placement
3) Four months post abutment placement

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4) Six months post abutment placement

The participants in this study were divided into two classes, each with a sample size of 30. Platform matched abutments were used in the control group, while platform switched abutments were used in the test group. With the aid of Kodak Software, measurements were taken on radiographs on the mesial and distal sides of the implants in each of these groups. This radiographic examination was performed four times after the second stage of surgery.

RESULTS:

Comparison of bone loss between platform matching and platform switching:

Comparison of mean score in platform matched and platform switched abutment at mesial side showed non-significant results (p value=0.8)

Comparison of mean score in platform matched and platform switched abutment at distal side showed statistical significant results (p value=0.01)

The mean reduction in bone height was observed to be higher in platform matched abutment as compared to platform switched abutment implant. (Table 1)

Table1: Comparison of means core in platform matched and platform switched abutment at mesial and distal side

	V1	N	Mean	SD	Mean diff	P value
Mesial side	1	30	1.1	.14	.56	0.8
	2	30	.9	.22		
Distal side	1	30	1.21	.21	.44	**0.01***
	2	30	1	.35		

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Comparison of Platform Switching and Platform Matching

Comparison of mean score one month after placement of abutment in platform matched and platform switched abutment at mesial side showed no statistically significant results (p value=0.1)

Comparison of mean score one month after placement in platform matched and platform switched abutment at distal side showed a statistical significance (p value=0.02). The mean reduction in bone height was noted to be higher in platform-matched abutment as compared to platform switched abutment on the distal side.

Comparison of mean score four month after placement of abutment in platform matched and platform switched abutment at mesial side showed no statistical significant results (p value=0.1) .

Comparison of mean score four month after placement in platform matched and platform switched abutment at distal side showed a statistical significance (p value=0.01). The mean reduction in bone height is higher in platform-matched abutment as compared to platform switched abutment.

Comparison of mean score six month after placement of abutment in platform matched and platform switched abutment at mesial side showed no statistically significant results (p value=0.43).

Comparison of mean score six month after placement in platform matched and platform switched abutment at distal side showed a statistical significance (p value<0.001) the mean reduction in bone height is higher in platform matched abutment was higher compared to platform switched abutment Table 2.

Table 2: Comparison of mean score in platform matched and platform switched abutment at mesial and distal side

	Group	N	Mean	SD	Mean diff	P value
1 month post abutment Placement mesial	**Platform matched**	30	.30	.07	.13	.1
	Platform switched	30	.16	.08		
Distal	**Platform matched**	30	.32	.07	.09	**.02***

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	Platform switched	30	.22	.12		
4 months post abutment placement mesial	**Platform matched**	30	.42	.05	.19	.15
	Platform switched	30	.22	.07		
Distal	**Platform matched**	30	.51	.05	.23	**.01***
	Platform switched	30	.28	.11		
6 months post abutment placement mesial	**Platform matched**	30	.57	.05	.29	.51
	Platform switched	30	.28	.07		
Distal	**Platform matched**	30	.62	.04	.29	**<.00***
	Platform switched	30	.33	.12		

DISCUSSION

One of the factors for determining the effectiveness of dental implants is the peri-implant bone level. It's a must if you want to keep your gingival margins and interdental papillae in good shape. The aesthetics of soft tissue around implants is determined by biologic width. [20] There has been a lot of research into whether or not there is a biologic width around osseointegrated implants. [21.] When bone is exposed to the oral world, it covers itself with periosteum and connective tissue, resulting in the formation of a biologic width. Connective tissue also has epithelium that protects it. [22]

The loss of peri-implant bone may have a detrimental impact on soft tissue topography, resulting in papillae recession or absence. As a result, the peri-implant crestal bone remodeling that occurs after implant exposure to the oral environment is receiving more attention.[20]

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Adell et al, who recorded an average of 1.2 mm of bone loss around submerged two-piece implants in the first year following restoration, accepted bone resorption as a physiologic bone response to second-stage implant uncovering. By the end of the first year of occlusal loading, other authors have confirmed peri-implant bone resorption ranging from 0.5 to 2 mm. [23]

The micro-gap, the implant crest module, occlusal overload, and the biologic width around the dental implant are the factors that are most likely to cause early crestal bone loss around implants, according to Oh et al. [6]

Marginal bone resorption occurs during the remodeling phase, which is influenced by one or more of the following factors: Surgical procedure, loading conditions, the location, shape, and size of the implant-abutment microgap and its microbial contamination, biologic width, and soft tissue considerations are all important factors to consider. Peri-implant inflammatory infiltrate, implant and prosthetic part micromovements, repetitive screwing and unscrewing, implant neck geometry, and infectious process are all factors to consider.

Although there are multiple factors the nature of the implant –abutment interface has generated interest. Currently, a concept to prevent bone loss around dental implants has been proposed as the Platform Switching concept (PLS). This technique suggests the use of prosthetic abutments with reduced diameter in relation to the implant platform diameter. This has the greatest potential to limit the crestal bone resorption.[19]

Comparison of platform matched and platform switched abutment:

In the present study, Comparison of mean score one month after placement of abutment in platform matched and platform switched abutments was done in order to check the influence of varying abutment diameters on the marginal bone level.

It was observed that no difference in bone level was noted on the mesial side when comparison was done between the two groups however, on the distal side the reduction in bone height was seen to be higher in platform-matched abutments as compared to platform switched abutments

The observation of bone level changes done on the mesial and distal side of implants in both the groups' show that at 4 months there is no significant difference in bone level on the mesial side but onthe distal side more bone loss is observed in the PM group.

At 6 months it was observed that the mesial side did not show much difference in bone level between the 2 groups, however a significant change is noted on the distal side when matching abutments are used.

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A study by Vela Xavier Nebot, indicate that a statistically significant reduction in bone loss occurred in all those cases in which the platform geometry was modified, as compared with the control group for which matching-diameter implant platforms and abutments were used. The radiologic protocol used indicated that the bone loss occurred between the time when the first and second radiographs were taken (i.e., within the first month after the oral exposure).[24]

Michele Cappiello in a clinical and radiographic prospective study evaluated bone loss around two piece implants that were restored according to the platform- switching protocol. Clinical and radiographic examinations were performed prior to surgery, at the end of surgery, 8 weeks after implant placement, at the time of provisional prosthesis insertion, at the time of definitive prosthesis insertion, and 12 months after loading. The data collected showed that vertical bone loss for the test cases was (mean: 0.95 ± 0.32 mm), while for the control cases, bone loss was (mean: 1.67 ± 0.37mm). These data confirm the important role of the microgap between the implant and abutment in theremodeling of the peri-implant crestal bone.[22]

Cappiello et al reported vertical bone loss between 0.6 and 1.2 mm with platform-switched implants 1 year after prosthetic reconstruction. They concluded that bone loss around platform-switched implants was significantly smaller than compared to the control group.[22]

The study of Novaes et al confirmed that crestal bone remodeling was still present despite the use of the platform switching technique. Those implants were placed 1.5 mm subcrestally, and the bone stopped near the top of the implants.[25]

Crespi et al in a study found no statistically significant differences in crestal bone loss between the platform switched implants and platform matched implants in a study on 64 implants. All the implants were placed in fresh extraction sockets and immediately loaded as well. At 24 months after implant placement, the platform- switched implants showed a mean bone loss of 0.78 ± 0.49 mm and the conventional implants showed a mean bone loss of 0.73 ± 0.52 mm. Although a slight difference in favour of the platform switching group was reported, statistical evaluation showed that thisdifference was not significant.[26] These findings are in accordance with those reported by Canullo and Rasperini, who placed 10 consecutive immediately loaded implants in extraction sockets in maxillae without compromised bone tissue.[27] The very minimal changes in marginal bone level between platform-switched and non–platform switched implants placed in fresh extraction sockets may be explained by the use of a minimally invasive surgical procedure.[25]

Platform modification has been proposed to reduce the biologic and mechanical aggressions on the

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biologic width. The resulting peri-implant bone preservation leads to better aesthetics.

From a biologic standpoint, it may be efficacious to shift the inevitable microgap of the IAJ away from the outer edge of the implant and neighboring bone.

The IAJ is always encircled by an inflammatory cell infiltrate (ICT) which is 0.75 mm above and below the IAJ.

To protect the underlying bone from this inflammatory infiltrate and microbiologic invasion, 1mm of healthy connective tissue is needed to establish a biologic seal comparable to that around natural teeth.

Thus, a close proximity of the IAJ to the bone, which is always established when implants are placed epicrestally, is eliminated by bone resorption and establishment of the biologic seal. From a mechanical viewpoint, it might be advantageous to shift the stress concentration area away from the cervical bone–implant surface to ensure less micromovements in the adjacent bone structure.

It may be speculated that reduced stress in the coronal portion of platform- switched implants helps prevent crestal bone remodeling

CONCLUSION

In platform switching there was significant bone loss on both mesial and distal aspect over a period of 6 months of abutment connection. Comparison of bone loss observed on the mesial side in platform matched and platform switched abutment showed non-significant difference between the 2 groups. Comparison of bone loss observed on the distal side in platform matched and platformswitched abutment showed significant difference. The amount of Bone reduction seen in platform switching is lesser than that observed in platform matching. Hence, the study concludes that platform switching limits the crestal bone resorption as compared to the bone resorption observed in platform matched implants.

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