ijcrr
Vol 04 issue 03
Category: Review
Received on:02/11/11
Revised on:20/11/11
Accepted on:15/12/11

PLATFORM SWITCHING IN IMPLANT DENTISTRY - A REVIEW

Gayathri N, Lakshmi S

Department of Prosthodontics, Meenakshi Ammal Dental College, Alappakkam Main Road, Maduravoyal, Chennai

E-mail of Corresponding Author: gayathri_nes@yahoo.co.in

ABSTRACT

The success of dental implant is dependent upon the integration between the implant and the intraoral hard/soft tissue. Crestal bone loss is one of the factors that affect the long term prognosis of a dental implant. Platform switching is a concept recently introduced in implant dentistry. It is intended to reduce the crestal bone loss that is commonly found around implants exposed to the oral environment. The purpose of this review article is to discuss the mechanism, by which it contributes to preserve crestal bone loss, literature review, benefits, limitations and consequence of platform switching; in order to assess its clinical success in implant dentistry

Keywords: Biological width, crestal bone loss, platform switching, stress.

INTRODUCTION

Dentistry is now focused mainly on the fixed replacement of lost teeth with priority given to aesthetic and function. Patient's desire for fixed restoration has increased over artificial substitutes. With new trends in dentistry, dental implants have taken the top position in fixed restoration and also have been accepted by the patient's widely.

Implants have been used for various purposes such as single, multiple or full arch restoration. It could be a single or two piece implant system. Single implant system eliminates the junction between implant platform and abutment. Also have limitations of positioning, integration and aesthetics. Traditional two-stage implants have enjoyed a long history of clinical success and have offered surgical and prosthetic versatility. They have been used in various situations with better emergence profile as well as bone integration at the implant abutment interface which gives rise to a new concept called "Platform Switching".

For two piece implant system, there exists two potential pathways for bacterial penetration resulting in crestal bone loss. One route is through the inside of the abutment, along the screw threads eventually at the implant abutment interface or micro gap. Alternatively bacteria can migrate along the outer surface of the abutment. Ericsson et al, identified two important entities in the implant crestal region i.e. Plaque associated inflammatory cell infiltrate and Implant associated inflammatory cell infiltrate and he concluded that apical border of an inflammatory cell infiltrate is the aetiological factor for crestal bone loss which was always separated from the bone crest at 1 mm of healthy connective tissue1.

However, early crestal bone loss has been commonly observed. Adell et al was the first to quantify and report marginal bone loss and indicated greater magnitude of bone loss during the first year of prosthesis loading. There are many elements that can accelerate the resorption of crestal bone, and they are discussed below2.

Factors accelerating crestal bone loss:

1) Biologic Width

The crestal bone remodelling is an important phenomenon that occurs around natural teeth and implants called the biologic width – the natural seal that develops around any object protruding from the bone and through the tissue into the oral environment. This seal isolates the bone from the oral environment.

Biological width forms within the first 2-4 weeks after the implant abutment junction has been exposed to the oral cavity. It is a barrier against bacterial invasion and food ingress implant-tissue interface. The ultimate location of epithelial attachment following phase 2 surgery in part, determines early post-surgical bone loss. Thus, implant bone loss is in part, a process of establishing the biological seal. When implants are initially placed within bone and then covered with an adequate layer of soft tissue (first-stage surgery), there is typically little or no crestal bone resorption. When the implant is uncovered (in second-stage surgery) and connected to an abutment, the body then reacts and in the process of creating the biologic width, the crestal bone may resorb3.

2) Micro gap

In two stage implant systems, after abutment is connected, a microgap exists between the implant and the abutment at or below the alveolar crest. The countersinking below the crest is done to minimize the risk of implant interface movement during bone remodelling, to prevent implant exposure during healing and also to enhance the emergence profile. Countersinking places the implant micro gap below the crestal bone. The microgap crestal bone level relationship was studied radiographically by Hermann et al, who for the first time, demonstrated that the microgap between the implant/abutment has a direct effect on crestal bone loss, independent of surgical approaches. Epithelial proliferation to establish biological width could be responsible for crestal bone loss found about 2mm below the microgap3,4.

3) Surgical Trauma

Heat generated during drilling, elevation of the periosteal flap and excessive pressure at the crestal region during implant placement may contribute to implant bone loss during the healing period. Signs of bone loss from surgical trauma and periosteal reflection are not commonly observed at the implant stage II surgery in successfully osseointegrated implants3. Wildermann et al, reported that bone loss due to periostium elevation was restricted to the area just adjacent to the implant, even though a larger surface area of the bone was exposed during surgery. Thus, surgical trauma is unlikely to cause early crestal bone loss5.

4) Stress

Cortical bone is least resistant to shear force, which is significantly increased in bending overload. Excessive stress on the immature implant bone interface in the early stage of prosthesis in function is likely to cause crestal bone loss. However, bone loss from occlusal overload is considered to be progressive rather than limited to the first year of loading6.

The Need for Better Crestal Bone Preservation Emerges

Crestal bone preservation should be thought during the treatment planning stage itself. There are various approaches described in the literature to prevent crestal bone loss. One of them is the Platform switching concept.

Platform switching "is the use of prosthetic components having an abutment diameter undersized when compared to the diameter of the implant platform".7

Platform switching is a restorative protocol which has been reported by Dr. Richard Lazzara as a means of limiting crestal bone loss around dental implants. In this way, the prosthetic connection is displaced horizontally inwards from the perimeter of the implant platform, creating an angle or step between the abutment and implant; improving the distribution of forces. So this article reviews about the literature how platform switching has contributed to implant dentistry especially for crestal bone preservation7.

HISTORY OF PLS

In 1991, the 3i wide diameter 5.0 and 6.0 mm implants were designed with a matching diameter seating surface to be used however, there were no matching diameter prosthetic components available, and as a result, they were restored with standard 4.1 mm diameter components, which created a 0.45mm or 0.95 mm circumferential horizontal difference in dimension. After the initial 5 year period, radiographical reviews stated that the amount of crestal remodelling was reduced and also exhibited no vertical crestal bone loss.

These results have led many researchers to become interested to perform investigations. Various studies have been conducted in human beings, animals and Finite element analysis comparing the platform switched implants with regular two piece implants.

Human Studies:

According to Lazzara and Porter, the deliberate creation of a space for the physiological barrier minimizes the space for repositioning of the fibers. By displacing the junction with the abutment to a more medial position with respect to the axis, an increased surface repositioning of the biological space occurs. This space is created in the horizontal plane 1 mm from the implant-abutment junction, supported over the external margin of the platform. Implant design also influences the morphology of the gingival margin – both the neck micro and macrostructure, and the macrostructure of the implant-abutment junction7. In turn, ensuring a minimum distance of 3 mm between implants allows sufficient margin to restore the biological space for restorations, as demonstrated by Tarnow a decade ago8. In implants involving an expanded platform integrated in their macrostructure, and ensuring the above mentioned distance between implants, bone crest preservation is seen to be 57% greater than with a traditional restoration design.

Trammell et al, in a case-control study, measured the biological space with reduced and conventional platform abutments in the same individual. They concluded that bone loss was significantly smaller with the expanded platform9.

Vela Nebot et al assessed interproximal bone resorption on the medial and distal of each implant using digital radiography at 1, 4, and 6 months after abutment attachment. Platform modification has been proposed to reduce the biologic and mechanical aggressions on the biologic width. The resulting peri-implant bone preservation leads to better aesthetics results10.

Gardner presents a case study using platform switching implants dealing with the changes that occur when an implant is placed in bone. He states that its main advantage is that it is an effective way to control circumferential bone loss around dental implants11.

Hurzeler M, showed that crestal bone height around dental implants could be influenced using a platform switch protocol and that the bone level would remain stable within 1 year after final prosthetic reconstruction. They concluded the concept of platform switching appears to limit crestal resorption and seems to preserve peri-implant bone levels12.

Canullo L, Rasperini G, suggests that immediate loading with platform switching can provide peri-implant hard tissue stability with soft tissue and papilla preservation13.

Degidi et al suggested that platform switching in combination with an absence of micro movement and micro gap may protect the peri-implant soft and mineralized tissues, explaining the observed absence of bone resorption and also said that immediate loading did not interfere with bone formation and did not have adverse effects on osseointegration14.

Qian Li et al evaluated the clinical results of dental implant treatment with platform switching technique in esthetic zone and to investigate its technical characteristics. He concluded that platform switching is a simple and reliable technique for dental implant treatment, helping to control marginal bone loss and ensure esthetic results in the esthetic zone15.

Baumgarten et al describes that platform switching technique and its usefulness in situations where shorter implants must be used, where implants placed in aesthetic zones and where a larger implant is desirable but prosthetic space is limited. They concluded that sufficient tissue depth of approximately 3mm or more is necessary to accommodate an adequate biologic width and also, platform switching helps to prevent the anticipated bone loss and also preserves crestal bone16.

Cappiello M observed vertical bone loss between 0.6mm and 1.2 mm in platform switched implants comparatively lesser than regular two piece implants17.

Hermann et al reviewed platform switching, implant design in cervical region, nano roughness, biological width, fine threads, abutment designs and avoidance of micro lesions in the peri implant soft tissue as factors that determine the preservation of crestal bone levels. He concluded that these factors determine the aesthetic outcomes of implant restorations18.

Vela Nebot et al concludes that platform switching improves aesthetic results and that when invasion of biologic width is reduced, bone loss is reduced10.

Mangano et al evaluated 1920 Morse tapered connection implants clinically and radiographically at 12, 24, 36 and 48 months after implant insertion. They noted an overall cumulative implant survival rate of 97.56% (96.12% in maxilla and 98.91% in the mandible). The absence of an implant–abutment interface (micro-gap) is associated with minimal crestal bone loss19.

Animal Studies:

Becker et al in his histomorphometric study in dogs, concluded that twenty eight days after implant placement, both CAM (sand blasted and acid etched screw type implants with either matching) and CPS (smaller diameter healing abutments) revealed crestal bone level changes but they found no significant differences between them20.

Sarment et al is found some changes in the width and height of bone when using platform switching implants21.

Weiner et al connects the development of biologic width with the implant surface. They did not mention platform switching but focuses the study on the use of shift tissue engineered collars with micro grooving22.

Histological Studies:

Luongo et al, examined biopsy specimens to helps explain the biologic processes occurring around a platform-switched implant. An inflammatory connective tissue infiltrate was localized over the entire surface of the implant platform and approximately 0.35 mm coronal to the implant-abutment junction, along the healing abutment. A possible reason for bone preservation around a platform switched implant may lie in the inward shift of the inflammatory connective tissue zone at the implant-abutment junction, which reduces its injurious effect on the alveolar bone23.

Degidi M et al evaluated the histology and histomorphology of three morse cone connection implants in a real case report and he explains that when there is zero microgaps and no micro movement, platform switching shows no resorption. He also observes that this method provides better aesthetic results24.

FEA Studies:

Hsu et al analyzed the behaviour of reduced platform restorations in a 3 D FEA. Their results showed a 10% decrease in all the prosthetic loading forces transmitted to the bone-implant interface. Similar finite elements studies in two dimensions show great variability in the results obtained25. In effect, while some investigators report a decrease in force to the cortical bone of less than 10%, other authors such as Tabata et al have reported a decrease of 80%26.

Rodriguez-Ciurana et al in a two-dimensional biomechanical study involving platform switching integrated into the implant design, failed to obtain peri-implant bone force attenuation values as high as those reported in earlier studies, when comparing platform expansion with a traditional restoration model. In addition, the authors concluded that force dissipation in the platform switching restoration is slightly more favourable in an internal than in an external junction, since it improves distribution of the loads applied to the occlusal surface of the prosthesis along the axis of the implant. On the other hand, this concentration of forces along the axis of the implant, transmitted through the retention screw, increases the possibility of abutment fracture, and thus may lead to failure of the restoration. All studies contrasting platform switching versus continuity of the platform with the body of the implant agree that force to bone diffusion is improved by expanding the platform27.

However, Canay and Akça, in a three dimensional finite elements analysis involving different implant-free expanded platform dimensions and a range of abutment designs, claimed that the effect of platform expansion is not attributable to the distribution of loads to the peri-implant bone but rather simply to redistribution of the new biological space. Nevertheless, the authors pointed the need for further research on the behaviour of the marginal bone around the implants. The most appropriate reduced platform abutment design for securing lesser implant abutment material fatigue is represented by conical emergence abutments with a variable height of 1.5-2mm, freeing extension of the implant platform between 0.5-0.75mm. Such platform switching is not advisable in mandibular implant mucosal support prostheses, since reduction of the diameter of the junction lessens the abutment resistance in response to occlusal loading applied in the posterior area of the over dentures – fundamentally compromising the connecting abutment closest to the area where loading is applied28.

Maeda Y et al, showed that the stress level in the cervical bone area at the implant was greatly reduced when the narrow diameter abutment was connected compared with the regular-sized one. They suggested that the platform switching configuration has the biomechanical advantage of shifting the stress concentration area away from the cervical bone-implant interface. It also has the disadvantage of increasing stress in the abutment or abutment screw29.

Schrotenboer et al investigated the effects of implant microthreads on crestal bone stress compared to a standard smooth implant collar and to analyze how different abutment diameters influenced the crestal bone stress level. They concluded that microthreads increased crestal stress upon loading. Reduced abutment diameter resulted in less stress translated to the crestal bone in the microthread and smooth-neck groups30.

DISCUSSION

According to review literature, the technique of platform switching seems to have greatest potential to limit the crestal resorption. The inflammatory connective tissue infiltrate is located at the level of the collar, and doesn’t migrate apically. Thereby resorption is avoided and the crestal bone is stabilized at the level of the implant collar. At the same time, the micro-gap is shifted away from the crestal bone, decreasing the probability of resorption by an increased distance of the peripheral bone and the base of the abutment.

To maintain the long term implant stability, it is important to minimize crestal bone loss around implant. Stress is concentrated around the crestal region where 2 materials such as bone and implant with different modulus of elasticity interact. Peak bone stresses that appear in marginal bone are believed to cause bone micro fracture. So, decreased stresses may not be the only reason for the positive results shown by platform switching. Moreover, by decreasing the abutment diameter, more stresses are concentrated near the abutment, increasing the likelihood of abutment fracture. The other possible reason for the efficacy of the platform switching configuration is that the microorganisms are likely to move toward the high-energy area or by the mechanism such as interface micro movements that allow the microorganisms to move into that area, it is advantageous to have a large distance between the stress concentration area and bone surface. Hence implant abutment interface is a very important criterion for implant success.

However, further studies utilizing modified 3D finite element models and animal experiments as well as longitudinal clinical observations are still necessary.

A critical analysis of how platform switching reduces crestal bone loss:

The mechanism by which platform switching can contribute to maintain the crestal bone height could be due to four reasons:

- Shifting the inflammatory cell infiltrate inward and away from the adjacent crestal bone.
- Maintenance of biological width and increased distance of implant abutment junction from the crestal bone level.
- The possible influence of micro-gap on the crestal bone is diminished.
- Decreased stress levels in the peri-implant bone (According to FEA studies).

Consequences of Horizontal Repositioning:

- Reduction in the amount of crestal bone resorption is necessary to expose a minimum amount of implant surface to which the soft tissue can attach.
- Horizontal Repositioning of abutment inflammatory cell infiltrate within less than 900 confined area of exposure decreases the resorptive effect on the crestal bone. Reduced diameter components beginning with healing abutment must be used from the moment the implant is exposed to the oral environment, since the process of biological width formation begins immediately.

Limitations of platform switching

- If normal size abutments are to be used, larger size implants need to be placed. This is not possible every time clinically, especially if bone width is less.
- If normal sized implants are placed, smaller-diameter abutments are necessary, which may compromise the emergence profile, especially in anterior cases.

Benefits of platform switching

- Improved aesthetics as crestal bone preservation helps to preserve papilla.
- Increased implant longevity.
- The effect of inter-implant distance is minimized.

A minimum of 3 mm inter implant distance is needed to preserve marginal bone. Arthur et al, found that distances of 1, 2 and 3 mm between implants do not result in statistically significant differences in crestal bone loss around submerged or non-submerged implants with a Morse cone connection and platform switching31. The only requirement of platform-switched implant is that the implant should be placed crestally if sufficient soft tissue height and inter occlusal space are present, or sub crestally if insufficient soft tissue height and inter-occlusal space are present. So, soft tissue depth of approximately 3 mm should be present to place platform switched implants or else bone resorption is likely to occur, irrespective of implant geometry. Also, sufficient bone width should be present to accommodate the larger-diameter implant.

CONCLUSION

The ultimate objective of implant dentistry is to create optimal prosthetic restorations that are surrounded by stable bone and a natural gingival architecture that exists in harmony with the other teeth. All authors agree that the use of implants with platform switching improves bone crest preservation, excellent aesthetic outcomes and controlled biological space reposition. Requirement of platform-switched implant is that soft tissue depth of approximately 3 mm should be present to place platform-switched implants or else bone resorption is likely to occur, irrespective of implant geometry. Platform switching appears to be simple, functional, and predictable technique for preserving peri-implant crestal bone and can be clinically applied when clinical situation permits. Definitive clinical trials are currently underway and further clinical investigations are necessary to show long term results.

ACKNOWLEDGEMENT

Authors acknowledge the immense help received from the scholars whose articles are cited and included in references of this manuscript. The authors are also grateful to authors / editors / publishers of all those articles, journals and books from where the literature for this article has been reviewed and discussed.

REFERENCES

1. Ericsson I, Persson LG, Berglundh T, Marinello CP, Lindhe J. Different types of inflammatory reactions in peri implant soft tissues. J clin Periodontol 1995;22:255-261.
2. Adell R, Lekholm U, Rockler B, Branemark PI. A 5 year study of osseointegrated implants in the treatment of edentulous jaw. Int J Oral Surg 1981;10:387-416.
3. Misch CE. Stress treatment theorem for implant dentistry. Contemporary Implant Dentistry. Elsevier Mosby; 3rd edition. Page -75.
4. Hermann, J.S., Cochran, D.L., Nummikoski, P.V, Buser, D. Crestal bone changes around titanium implants. A radiographic evaluation of unloaded nonsubmerged and submerged implants in the canine mandible. Journal of Periodontology 1997; 68:1117–1130.
5. Cappiello M, Luongo R, Di Iorio D, Bugea C, Cocchetto R, Celletti R. Evaluation of periimplant bone loss around platform-switched implants. Int J Periodontics Restorative Dent. 2008 Aug; 28(4):347-55.
6. Misch CE. Bone density: A key determinant for clinical success. Contemporary Implant Dentistry. Elsevier Mosby; 3rd edition. Page -134.
7. Lazzara RJ, Porter SS. Platform switching: A new concept in implant dentistry for controlling post restorative crestal bone levels. Int J Periodontics Restorative Dent 2006 Feb;26(1):9-17.
8. Tarnow DP, Cho SC, Wallace SS. The effect of inter-implant distance on the height of inter-implant bone crest. J Periodontol. 2000;71:546-9.
9. Trammell K, Geurs NC, O’Neal SJ, Liu PR, Haigh SJ, McNeal S, et al. A prospective, randomized, controlled comparison of platform-switched and matched-abutment implants in short-span partial denture situations. Int J Periodontics Restorative Dent. 2009;29:599-605.
10. Vela-Nebot X, Rodríguez-Ciurana X, Rodado-Alonso C, Segalà-Torres M. Benefits of an implant platform modification technique to reduce crestal bone resorption. Implant Dent. 2006;15:313-20.
11. Gardner DM. Platform switching as a means to achieving implant esthetics. N Y State Dent J 2005;71:34-7.
12. Hürzeler M, Fickl S, Zuhr O, Wachtel HC. Peri-implant bone level around implants with platform switched abutments: preliminary data from a prospective study. J Oral Maxillofac Surg. 2007:Jul;65(7 Suppl1):33-9.
13. Canullo L, Rasperini G. Preservation of peri-implant soft and hard tissues using platform switching of implants placed in immediate extraction sockets: a proof-of-concept study with 12- to 36-month follow-up. Int J Oral Maxillofac Implants. 2007;22:995-1000.
14. Degidi M, Iezzi G, Scarano A, Piattelli A. Immediately loaded titanium implant with a tissue-stabilizing/maintaining design ('beyond platform switch') retrieved from man after 4 weeks: a histological and histomorphometrical evaluation. A case report. Clin Oral Impl Res 2008 Mar;19(3):276-82. Epub 2007 Dec 13.

15. Qian Li, Ye Lin, Li-xin Qiu, Xiu-lian Hu, Jian-hui Li, Ping DI. Clinical study of application of platform switching to dental implant treatment in esthetic zone. Chinese journal of stomatology 2008; 43(9):537-41.
16. Baumgarten H, Cocchetto R, Testori T, Meltzer A, Porter S. A new implant design for crestal bone preservation: initial observations and case report. Pract Proced Aesthet Dent. 2005;17:735-40.
17. Cappiello M, Luongo R, Di Iorio D, Bugea C, Cocchetto R, Celletti R. Evaluation of periimplant bone loss around platform-switched implants. Int J Periodontics Restorative Dent. 2008 Aug; 28(4):347-55.
18. Hermann J, Buser D, Schenk RK, Schoolfield JD, Cochrane DL. Influence of the size of the microgap on crestal bone changes around titanium implants. A histometric evaluation of unloaded non-submerged implants in canine mandible. J Periodontol 2001; 72:1372-83.
19. Mangano C, Mangano F, Piattelli A, Iezzi G, Mangano A, La Colla L. Prospective clinical evaluation of 1920 Morse taper connection implants: Results after 4 years of functional loading. Clin Oral Impl Res 2009; 20:254-61.
20. Becker J, Ferrari D, Herten M, Kirsch A, Schaer A, Schwarz F. Influence of platform switching on crestal bone changes at non-submerged titanium implants: a histomorphometrical study in dogs. J Clin Periodontol 2007;34:1089-96.
21. Sarment DP, Meraw SJ. Biological space adaptation to implant dimensions. Int J Oral Maxillofac Implants 2008; 23:99-104.
22. Weiner S, Simon J, Ehrenberg DS, Zweig B, Ricci JL. The effects of laser micro textured collars upon crestal bone levels of dental implants. Implant Dent 2008; 17:217-28.
23. Luongo R, Traini T, Guidone PC, Bianco G, Cocchetto R, Celletti R. Hard and soft tissue responses to the platform switching technique. Int J Periodontics Restorative Dent 2008 Dec; 28(6):551-557.
24. Degidi M, Iezzi G, Scarano A, Piattelli A. Immediately loaded titanium implant with a tissue-stabilizing/maintaining design (‘beyond platform switch’) retrieved from man after 4 weeks: a histological and histomorphometrical evaluation. A case report. Clin Oral Implants Res 2008; 19:276-82.
25. Hsu JT, Fuh LJ, Lin DJ, Shen YW, Huang HL. Bone strain and interfacial sliding analyses of platform switching and implant diameter on an immediately loaded implant: Experimental and three-dimensional finite element analyses. J Periodontol 2009 Jul; 80(7):1125-32.
26. Tabata LF, Assunção WG, Adelino Ricardo Barão V, De Sousa EA, Gomes EA, Delben JA. Implant platform switching: biomechanical approach using two-dimensional finite element analysis. J Craniofac Surg 2010; 21(1):182-187.
27. Rodríguez-Ciurana X, Vela-Nebot X, Segalà-Torres M, Calvo-Guirado JL, Cambra J, Méndez-Blanco V, Tarnow DP. The effect of interimplant distance on the height of the interimplant bone crests when using platform-switched implants. Int J Periodontics Restorative Dent 2009; 29:141-51.
28. Canay S, Akca K. Biomechanical aspects of bone level diameter shifting at implant-abutment interface. Implant Dent 2009; 18:239-248.
29. Maeda Y, Miura J, Taki I, Sogo M. Biomechanical analysis on platform switching: Is there any biomechanical rationale. Clin Oral Implants Res. 2007 Oct; 18(5):581-4. Epub 2007 Jun 30.
30. Schrotenboer J, Tsao YP, Kinariwala V, Wang HL. Effect of microthreads and platform switching on crestal bone stress levels: A Finite element analysis. J Periodontol. 2008; 79(11):2166-72.
31. Novaes, Arthur B Jr de Oliveira, Rafael R Muglia, Valdir A Papalexiou, Vula Taba, Mário. The effects of interimplant distances on papilla formation and crestal resorption in implants with a morse cone connection and a platform switch: a histomorphometric study in dogs. Journal of periodontology 2006;77:1839-1849