ECRONICON OPEN ACCESS

EC DENTAL SCIENCE
Mini Review

Platform Switching: An Overall Solution or an Overestimated Technique?

Dimokritos Papalexopoulos[1]*, Aspasia Sarafianou[2], Theodora-Kalliopi Samartzi[3] and Gerasimos Filippatos[1]

[1]*Department of Prosthodontics, National and Kapodistrian University of Athens, Greece*

[2]*Assistant Professor, Department of Prosthodontics, National and Kapodistrian University of Athens, Greece*

[3]*Private Practice, Greece*

***Corresponding Author:** Dimokritos Papalexopoulos, Department of Prosthodontics, National and Kapodistrian University of Athens, Greece.

Received: April 03, 2019; **Published:** April 29, 2019

Abstract

Since osseointegration is nowadays a given fact in implantology, research is focusing in issues related to tissue response and long-term maintenance in order to reduce biological complications. This rationale has given birth to the "Platform Switching" (PS) concept, described as the restoration of an implant by utilizing prosthetic abutments of smaller diameter than the implant prosthetic platform. This technique, originally described as promising, has been reported to initiate a more favorable peri-implant tissue response. The purpose of the present review is to investigate PS, by analysing advantages and disadvantages, underlining indications and contraindications and mentioning aspects in need of further research. The MEDLINE database of references and abstracts on life sciences and biomedical topics was selected as a search engine, where using "implants and platform switching", "effect of platform switching", "influence of platform switching in peri-implant bone" as key words, articles related to the topic were investigated and studied. Conclusively, PS has been found to offer a series of advantages regarding clinical and biological parameters, such as tissue adaptation, soft tissue and bone response and aesthetics. From a biomechanical standpoint, less strain transfer to the peri-implant bone was reported. However, potentially higher loading of the prosthetic components should be taken into consideration by the dental clinician. Further studies are needed in order to clarify certain PS aspects that remain ambiguous.

Keywords: *Implants; Platform Switching; Platform Matching; Implant Platform; Prosthetic Abutment; Marginal Bone Loss*

Abbreviations

MBL: Marginal Bone Loss; PM: Platform Matching; PS: Platform Switching; fBIC: First Bone to Implant Contact; IIP: Immediate Implant Placement

Introduction

In order to restore missing teeth, implant therapy is nowadays the treatment of choice. Its success rates exceed 90% [1,2]. While osseointegration is more or less a given fact, researchers are focusing on implant therapy features which would lead to optimal results in a biological, functional and aesthetic level.

A vulnerable aspect of the clinical performance of implants is the premature marginal bone loss (MBL), which may be regarded as normal when it ranges within the limits of 0,9 - 2 mm for the first year and 0,05 - 0,13 mm for each year during implant function [3]. The main factors associated with MBL are [3,4]: surgical trauma [5], biologic width formation [6], periodontal biotype, microgap between implant and abutment [7,8], micromovement [6,9], microbial colonisation [10], periimplantitis [11], occlusal overload [12], relation between implant platform and bone margin [13], distance between adjacent implants [14], continuous area disturbance [15].

In 1991, implants with a diameter of 5 - 6 mm were designed for patients with poor bone quality. However, no abutments with a matching diameter were available at the time. This led clinicians to use abutments narrower by 0,9 - 1,9 mm compared to the prosthetic platform. What is interesting is that 1 -5 years after implant placement, a lower MBL was observed, compared to implants restored with abutments of a matching diameter (PM) [16]. What was firstly assumed as a finding based on luck, would later comprise a promising restorative technique.

Since then, researchers have tried to explain the promising results of the "Platform Switching" (PS) concept with the following theories [4]:

- Biologic width theory
- Microgap theory
- Biomechanical theory

"Platform switching" model analysis

Biologic width theory

According to the literature, a formation corresponding to the biologic width existing around natural teeth also exists around implants. It consists of both epithelial attachment and connective tissue and is formed within the first year of implant function, following bone resorption and is supposed to provide an effective barrier against the microbial flora of the oral cavity [17].

However, histological differences exist in the biologic width around teeth and around implants. Regarding implants, the epithelium is connected to titanium with hemidesmosomes, while collagen fibers run in a direction parallel rather than perpendicular to the implant axis. There is no mechanical or chemical attachment to the titanium surface, except for a proteoglykane zone with a width of 20 μm. The connective tissue is similar to scar tissue, having less blood supply, which means poorer immune response. It also has a higher collagen fiber percentage, compared to the biologic width around teeth, which in turn has five times higher fibroblast percentage [18].

In implants with abutments of a matching diameter the biologic width is formed above the first implant thread, below the implant-abutment junction [13,19]. By moving the implant-abutment connection area away from the bone margin as happens in PS, the biologic width may form both vertically and horizontally. Thus, an extra horizontal dimension for the soft tissue to be attached is created [20,21].

Connective tissue creates a protective barrier and when stabilized, it does not allow further apical epithelial migration [22], determining bone absorption and offering protection against microbial and mechanical stimuli [23,24].

Overall, "platform switching":

- Provides more space for the development of soft tissues [25],
- Prevents apical epithelial migration [26],
- Places the biologic width more coronally of the implant-abutment junction, preserving connective tissue fibers above the implant platform level [16],
- Leads to thicker and more durable connective tissue [27].

Therefore, less bone has to be absorbed to reveal implant surface and establish soft tissue attachment [28]. This allows for satisfactory level of first bone to implant contact (fBIC).

Nonetheless, the basic principle of an adequate mucosa thickness is still applied, as a thickness of minimum 2 mm must be present for the PS to demonstrate its protective effect [8,29].

Microgap theory

In implant systems where the implant and the prosthetic abutment are not a single, united component (the so-called 2-piece implants), it has been found that a microgap is inevitably formed in the above junction. This is colonized by periodontopathogenic bacteria of the oral cavity flora [30] within 25 days after implant exposure and abutment placement [35], regardless of the connection type [23].

Tissues in contact with this "infected" area react by presenting a chronic inflammation infiltration [32], which is histologically positioned in the upper part of the connective tissue, right below the epithelium [4]. The use of matching abutments means that this area is in immediate contact with the bone margin, leading to gradual bone resorption.

The advantage of PS has to do with the placement of the inflammated area closer to the implant axis and further away from the critical area of the peri-implant bone margin, protecting it from the inflammation process [16,20].

Another fact, concerning ionic release must be mentioned at this point. It has been known that in the oral cavity, titanium [33], is subjected to corrosion. The byproducts of this procedure have been indicated in histological samples of peri-implant tissues, where Ti-containing foreign bodies surrounded by inflammatory areas were found [34]. In another relevant study [35], PS was found to statistically reduce ionic leakage regarding the elements Al, Co, Cr, Mo, V.

This phenomenon may be explained by:

- The smaller contact area between implant and abutment at the PS model, which may affect the amount of galvanic corrosion.
- The greater distance between the implant-abutment junction and the surrounding tissues, which may not allow for the immediate diffusion of corrosion byproducts.

Biomechanical theory

The PS technique was also studied from the biomechanical point of view, using *in vitro*, photoelastic and 3D finite element analysis [36,37]. According to these studies, reducing abutment diameter leads to force distribution closer to the implant axis, which may in turn lead to stress reduction in the cortical bone and the critical area of the implant neck.

Shear stress, which is the least tolerated type of stress for the implant-bone complex is also reduced [38]. It has been stated that PS may play a more significant role in bone preservation than abutment connection type [39]. However, a slight increase in stress regarding the cancellous bone which surrounds the apical area of the implant has been reported [40].

On the other hand, what seems as an advantage for the peri-implant bone, is a disadvantage regarding the implant-prosthetic components complex, since the abutment and the retention screw are subjected to higher stress [36,41]. Although microscopic images do not show structural distortion of the retention screws at systems with or without PS, researchers ring a bell regarding technical complications, such as screw fractures [36,37]. According to the literature, PS in overdenture cases is not indicated, especially when the type of support is mixed (both implants and mucosa) [42]. Overall the combination of PS and cemented restorations seems to exhibit the highest durability [43].

What may be accepted as a paradox regarding the unscrewing torque, is that the smaller contact area between the implant and the abutment in the PS model, as well as the higher stress concentrated on this complex, result in higher unscrewing torque value compared to PM systems, which is up to 94% of the initial screw torque [44].

Marginal bone loss (MBL)

A number of systematic reviews compared peri-implant marginal bone loss between PM and PS techniques [25,45-51]. These studies are summarized in table 1.

Systematic Review	Number of papers	PM MBL	PS MBL	Difference
Atieh., *et al*. 2010 [25]	10	0,19 - 1,67 mm	0,055 - 0,99 mm	0,37 mm
Annibali., *et al*. 2012 [45]	10	0 - 0,51 mm	0 - 0,99 mm	0,55 mm (Patient level) 0,44 mm (Implant level)
Strietzel., *et al*. 2013 [46]	20	1,01 mm	0,49 mm	0,49 mm
Kinaia., *et al*. 2014 [47] (IIP)	16	0,19 - 1,67 mm	0,055 - 0,19 mm	0,77 mm
Herekar., *et al*. 2014 [48]	15	0,19 - 1,67 mm	0,055 - 0,99 mm	0,34 mm
Chrcanovic., *et al*. 2015 [49]	28	-	-	0,29 mm
Al Qutaib., *et al*. 2015 [50]	22	1,01 mm	0,49 mm	0,49 mm
Santiago., *et al*. 2016 [51]	25	0,19 - 2,23 mm	0,04 - 0,99 mm	0,41 mm

Table 1: *Comparison of marginal bone loss between implants restored with the conventional platform matching technique (PM) and those restored with the "Platform Switching" technique (PS).*

MBL: Marginal Bone Loss; IIP: Immediate Implant Placement.

According to the research, MBL was lower when PS was used.

PS (0,387 mm) also seems to be advantageous in cases where the implant was placed immediately (IIP), presenting lower resorption values, compared to PM (1,153 mm) with statistically significant difference [47].

Furthermore, as the diameter mismatch between the implant platform and the prosthetic abutment increases, the beneficial effect regarding bone preservation is more pronounced [25,47,51]. According to Canullo., *et al.* [52] when the diameter mismatch was 0,25 mm, bone resorption was 0,99 mm, with a difference of 0,50 mm, bone resorption was 0,83 mm. When the mismatch reached 0,85 mm, resorption was 0,64 mm. However, it is still not clear which is the best mismatch value.

Last but not least, as the observation period increased, the difference in bone resorption between the two models also increased, indicating a stability through time for the described model [49].

Aesthetic and technique advantages of platform switching

The favorable results of PS regarding the preservation of peri-implant bone, brings along a number of benefits for the soft tissues. Its use in aesthetically demanding areas is advantageous, since the preservation of bone leads to preservation of soft tissue level [53].

With the evolution of biomaterials, excellent results in the field of "white aesthetics" have been achieved. This leads to the need of a proportionate improvement in the field of "pink aesthetics", that is the appearance of the soft tissues surrounding restorations. Evaluation criteria of implant restorations include the level and contour of the surrounding tissues, as well as the position of the mesial and distal papilla [54]. In a list of nine criteria regarding the performance of implant restorations, Meijer., *et al.* [55] included four criteria dealing with soft tissue.

The implant biologic width is established in a subcrestal position, involving a vertical and a horizontal dimension, with values of 1,5 - 2 mm [50] and 1 - 1,5 mm [56,57] respectively. This means that two adjacent implants should be placed with a distance of at least 3 mm between them, so that the bone peak between them may not be resorbed leading to the consequent sedimentation of the papilla [58]. However, it has been reported that when PS was used, the inter-implant distance was not as critical for the final outcome, even when it was as low as 2 mm [58]. Consequently, some researchers have proposed that the rule of 3 mm can be slightly disregarded when PS is used [14,59].

Overall, it is suggested that in order to preserve the papilla, PS could be considered in cases where there is limited mesio-distal dimension for implant placement [60].

Discussion

According to the literature PS has a positive effect on MBL around implants, compared to PM [25,45-51]. This is attributed to the presence of an extra horizontal dimension where soft tissue can attach, to the ability to ward off the inflammatory infiltration from the critical implant neck area and to the beneficial stress spreading through the peri-implant bone [4].

PS has been proposed in cases where short implants are used, where further bone resorption would jeopardise implant survival. It is also indicated where the mesio-distal distance is restricted, as the 3 mm rule can be slightly disregarded without endangering the appearance of the papilla [60]. In order for the PS to deliver its beneficial effect regarding bone resorption, a 2 mm mucosa thickness is mandatory [8,29].

However, the fact that the implant-connective screw-abutment complex absorbs higher stress, has led researchers to be cautious regarding technical failures [36,41]. As a result, its use in overdentures with mixed support is not recommended [42].

Finally, even though it has been reported that the greater the mismatch between implant platform and prosthetic abutment diameter, the less the bone resorption that occurs, it is still unclear which is the best amount of this difference, in order for the clinician to benefit from PS without increasing the risk of technical failures.

Conclusions

1. According to the literature, PS leads to less marginal bone resorption, by offering an extra horizontal dimension for the soft tissue to be attached, by warding off the inflammatory infiltration from the critical implant neck area and by creating a more favorable stress distribution closer to the implant axis.
2. Research has indicated reduced marginal bone loss for PS compared to PM models.
3. PS is indicated when the distance between adjacent implants is limited.
4. The higher amount of stress placed on the prosthetic components may potentially lead to a higher percentage of technical complications.
5. The optimal difference between implant platform and prosthetic abutment diameter needs to be further clarified by future research.

Bibliography

1. Touati B. “Improving aesthetics of implant-supported restorations”. *Practical Periodontics and Aesthetic Dentistry* 7.9 (1995): 81-92.
2. Saadoun AP., *et al*. “Current trends in implantology: Part 1--Biological response, implant stability, and implant design”. *Practical Procedures and Aesthetic Dentistry* 16.7 (2004): 529-535.
3. Singh R., *et al*. “Platform switching: a narrative review”. *Implant Dentistry* 22.5 (2013): 453-459.
4. Canullo L., *et al*. “Soft tissues around long-term platform switching implant restorations: a histological human evaluation. Preliminary results”. *Journal of Clinical Periodontology* 38.1 (2011): 86-94.
5. Becker W. “Immediate implant placement: diagnosis, treatment planning and treatment steps/or successful outcomes”. *Journal of the California Dental Association* 33.4 (2005): 303-310.
6. Hermann JS., *et al*. “Biologic Width around one- and two-piece titanium implants”. *Clinical Oral Implants Research* 12.6 (2001): 559-571.
7. Linkevicius T., *et al*. “The influence of soft tissue thickness on crestal bone changes around implants: a 1-year prospective controlled clinical trial”. *International Journal of Oral and Maxillofacial Implants* 24.4 (2009): 712-719.

8. Linkevicius T., *et al*. "Influence of thin mucosal tissues on crestal bone stability around implants with platform switching: a 1-year pilot study". *Journal of Oral and Maxillofacial Surgery* 68.9 (2010): 2272-2277.

9. King GN., *et al*. "Influence of the size of the microgap on crestal bone levels in non-submerged dental implants: a radiographic study in the canine mandible". *Journal of Periodontology* 73.10 (2002): 1111-1117.

10. Broggini N., *et al*. "Peri-implant inflammation defined by the implant-abutment interface". *Journal of Dental Research* 85.5 (2006): 473-478.

11. Fransson C., *et al*. "Severity and pattern of peri-implantitis-associated bone loss". *Journal of Clinical Periodontology* 37.5 (2010): 442-448.

12. Kim Y., *et al*. "Occlusal considerations in implant therapy: clinical guidelines with biomechanical rationale". *Clinical Oral Implants Research* 16.1 (2005): 26-35.

13. Oh TJ., *et al*. "The causes of early implant bone loss: myth or science?" *Journal of Periodontology* 73.3 (2002): 322-333.

14. Rodriguez-Ciurana X., *et al*. "The effect of interimplant distance on the height of the interimplant bone crest when using platform-switched implants". *International Journal of Periodontics and Restorative Dentistry* 29.2 (2009): 141-151.

15. Abrahamsson I., *et al*. "The mucosal barrier following abutment dis/reconnection. An experimental study in dogs". *Journal of Clinical Periodontology* 24.8 (1997): 568-572.

16. Lazzara RJ and Porter SS. "Platform switching: a new concept in implant dentistry for controlling postrestorative crestal bone levels". *International Journal of Periodontics and Restorative Dentistry* 26.1 (2006): 9-17.

17. Berglundh T and Lindhe J. "Dimension of the periimplant mucosa. Biological width revisited". *Journal of Clinical Periodontology* 23.10 (1996): 971-973.

18. Berglundh T., *et al*. "The soft tissue barrier at implants and teeth". *Clinical Oral Implants Research* 2.2 (1991): 81-90.

19. De Bruyn H., *et al*. "Radiographic evaluation of modern oral implants with emphasis on crestal bone level and relevance to peri-implant health". *Periodontology 2000* 62.1 (2013): 256-270.

20. Enkling N., *et al*. "Effect of platform switching on peri-implant bone levels: a randomized clinical trial". *Clinical Oral Implants Research* 22.10 (2011): 1185-1192.

21. Pessoa RS., *et al*. "Biomechanical evaluation of platform switching: different mismatch sizes, connection types, and implant protocols". *Journal of Periodontology* 85.9 (2014): 1161-1171.

22. Farronato D., *et al*. "Establishment of the epithelial attachment and connective tissue adaptation to implants installed under the concept of "platform switching": a histologic study in minipigs". *Clinical Oral Implants Research* 23.1 (2012): 90-94.

23. Rompen E., *et al*. "The effect of material characteristics, of surface topography and of implant components and connections on soft tissue integration: a literature review". *Clinical Oral Implants Research* 17.2 (2006): 55-67.

24. Schwarz F., *et al*. "Histological evaluation of different abutments in the posterior maxilla and mandible: an experimental study in humans". *Journal of Clinical Periodontology* 40.8 (2013): 807-815.

25. Atieh MA., *et al*. "Platform switching for marginal bone preservation around dental implants: a systematic review and meta-analysis". *Journal of Periodontology* 81.10 (2010): 1350-1366.

26. Becker J., *et al*. "Stability of crestal bone level at platform-switched non-submerged titanium implants: a histomorphometrical study in dogs". *Journal of Clinical Periodontology* 36.6 (2009): 532-539.

27. Hermann F., *et al*. "Factors influencing the preservation of the periimplant marginal bone". *Implant Dentistry* 16.2 (2007): 165-175.

28. Gardner DM. "Platform switching as a means to achieving implant esthetics". *New York State Dental Journal* 71.3 (2005): 34-37.

29. Linkevicius T., *et al*. "Influence of Vertical Soft Tissue Thickness on Crestal Bone Changes Around Implants with Platform Switching: A Comparative Clinical Study". *Clinical Implant Dentistry and Related Research* 17.6 (2015): 1228-1236.

30. Romanos GE and Javed F. "Platform switching minimises crestal bone loss around dental implants: truth or myth?" *Journal of Oral Rehabilitation* 41.9 (2014): 700-708.

31. Callan DP., *et al*. "DNA probe identification of bacteria colonizing internal surfaces of the implant-abutment interface: a preliminary study". *Journal of Periodontology* 76.1 (2005): 115-120.

32. Ericsson I., *et al*. "Different types of inflammatory reactions in peri-implant soft tissues". *Journal of Clinical Periodontology* 22.3 (1995): 255-261.

33. Grosgogeat B., *et al*. "Measurement and evaluation of galvanic corrosion between titanium/Ti6A14V implants and dental alloys by electrochemical techniques and auger spectrometry". *Biomaterials* 20.10 (1999): 933-941.

34. Wilson TG Jr., *et al*. "Foreign bodies associated with peri-implantitis human biopsies". *Journal of Periodontology* 86.1 (2015): 9-15.

35. Alrabeah GO., *et al*. "The effect of platform switching on the levels of metal ion release from different implant-abutment couples". *International Journal of Oral Science* 8.2 (2016): 117-125.

36. Maeda Y., *et al*. "Biomechanical analysis on platform switching: is there any biomechanical rationale?" *Clinical Oral Implants Research* 18.5 (2007): 581-584.

37. Cimen H and Yengin E. "Analyzing the effects of the platform-switching procedure on stresses in the bone and implant-abutment complex by 3-dimensional fem analysis". *Journal of Oral Implantology* 38.1 (2012): 21-26.

38. Sugiura T., *et al*. "Evaluation of threshold stress for bone resorption around screws based on in vivo strain measurement of miniplate". *Journal of Musculoskeletal and Neuronal Interactions* 1.2 (2000): 165-170.

39. De Medeiros RA., *et al*. "Evaluation of marginal bone loss of dental implants with internal or external connections and its association with other variables: A systematic review". *Journal of Prosthetic Dentistry* 116.4 (2016): 501-506.e5.

40. Pellizzer EP., *et al*. "Stress analysis in platform-switching implants: a 3-dimensional finite element study". *Journal of Oral Implantology* 38.5 (2012): 587-594.

41. Chang CL., *et al*. "Biomechanical effect of platform switching in implant dentistry: a three-dimensional finite element analysis". *International Journal of Oral and Maxillofacial Implants* 25.2 (2010): 295-304.

42. Sabet ME., *et al*. "Effect of platform switching on strain developed around implants supporting mandibular overdenture". *Implant Dentistry* 18.4 (2009): 362-370.

43. Anchieta RB., *et al*. "Platform-Switching for Cemented Versus Screwed Fixed Dental Prostheses: Reliability and Failure Modes: An In Vitro Study". *Clinical Implant Dentistry and Related Research* 18.4 (2016): 830-839.

44. De Carvalho BAC., *et al*. "Effect of Mechanical Cycling on Screw Torque in External Hexagon Implants with and without Platform Switching". *Brazilian Dental Journal* 26.3 (2015): 284-287.

45. Annibali S., *et al*. "Peri-implant marginal bone level: a systematic review and meta-analysis of studies comparing platform switching versus conventionally restored implants". *Journal of Clinical Periodontology* 39.11 (2012): 1097-1113.

46. Strietzel FP., *et al*. "Impact of platform switching on marginal peri-implant bone-level changes. A systematic review and meta-analysis". *Clinical Oral Implants Research* 26.3 (2015): 342-358.

47. Kinaia BM., *et al*. "Crestal bone level changes around immediately placed implants: a systematic review and meta-analyses with at least 12 months' follow-up after functional loading". *Journal of Periodontology* 85.11 (2014): 1537-1548.

48. Herekar M., *et al*. "Influence of platform switching on periimplant bone loss: a systematic review and meta-analysis". *Implant Dentistry* 23.4 (2014): 439-450.

49. Chrcanovic BR., *et al*. "Platform switch and dental implants: A meta-analysis". *Journal of Dentistry* 43.6 (2015): 629-646.

50. Al-Qutaib AY. "There is No Clear Evidence of Superiority Concerning the Platform-switching in the Preservation of the Marginal Bone Level". *Journal of Evidence-Based Dental Practice* 15.3 (2015): 118-120.

51. Santiago JF Jr., *et al*. "Platform-switching implants and bone preservation: a systematic review and meta-analysis". *International Journal of Oral and Maxillofacial Surgery* 45.3 (2016): 332-345.

52. Canullo L., *et al*. "Platform switching and marginal bone-level alterations: the results of a randomized-controlled trial". *Clinical Oral Implants Research* 21.1 (2010): 115-121.

53. Lopez-Mari L., *et al*. "Implant platform switching concept: an updated review". *Medicina Oral Patologia Oral y Cirugia Bucal* 14.9 (2009): e450-e454.

54. Furhauser R., *et al*. "Evaluation of soft tissue around single-tooth implant crowns: the pink esthetic score". *Clinical Oral Implants Research* 16.6 (2005): 639-644.

55. Meijer HJ., *et al*. "A new index for rating aesthetics of implant-supported single crowns and adjacent soft tissues--the Implant Crown Aesthetic Index". *Clinical Oral Implants Research* 16.6 (2005): 645-649.

56. Tarnow DP., *et al*. "The effect of inter-implant distance on the height of inter-implant bone crest". *Journal of Periodontology* 71.4 (2000): 546-549.

57. Jaffin RA., *et al*. "Immediate loading of dental implants in the completely edentulous maxilla: a clinical report". *International Journal of Oral and Maxillofacial Implants* 19.5 (2004): 721-730.

58. Elian N., *et al*. "Effect of interimplant distance (2 and 3 mm) on the height of interimplant bone crest: a histomorphometric evaluation". *Journal of Periodontology* 82.12 (2011): 1749-1756.

59. Vela-Nebot X., *et al*. "Implant positioning when replacing the four maxillary incisors: a platform-switched treatment option". *International Journal of Periodontics and Restorative Dentistry* 31.4 (2011): 375-381.

60. Pita MS., *et al*. "Prosthetic platforms in implant dentistry". *Journal of Craniofacial Surgery* 22.6 (2011): 2327-2331.

Volume 18 Issue 5 May 2019