*Journal section: Biomaterials and Bioengineering in Dentistry*
*Publication Types: Review*

*doi:10.4317/medoral.16.e400*
*http://dx.doi.org/doi:10.4317/medoral.16.e400*

# The influence of platform switching in dental implants. A literature review

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Received: 20/04/2010
Accepted: 14/11/2010

Serrano-Sánchez P, Calvo-Guirado JL, Manzanera-Pastor E, Lorrio-Castro C, Bretones-López P, Pérez-Llanes JA. The influence of platform switching in dental implants. A literature review. Med Oral Patol Oral Cir Bucal. 2011 May 1;16 (3):e400-5.
http://www.medicinaoral.com/medoralfree01/v16i3/medoralv16i3p400.pdf

*Article Number: 17067 http://www.medicinaoral.com/*

*eMail: medicina@medicinaoral.com*
**Indexed in:**
Science Citation Index Expanded
Journal Citation Reports
Index Medicus, MEDLINE, PubMed
Scopus, Embase and Emcare
Indice Médico Español

## Abstract
Introduction: The platform switching concept involves the reduction of the restoration abutment diameter with respect to the diameter of the dental implant.
In 1991, dental implants of 5 and 6 mm diameter platforms were introduced. However, matching-diameter prosthetic abutments were not available. These implants were restored with “standard”-diameter prosthetic components (4,1 mm).
Long-term follow up around these wide-platforms showed higher levels of bone preservation. In time, it has been called platform switching. The first case report applying this concept was indexed in MedLine in 2005.
Materials and Methods: The aim of this article is to carry out a literature review of articles which deal with the influence of this modified platform in hard and soft oral tissues. All papers involving “platform switching” that are indexed in MedLine and published in English were used. Clinical cases, experimental and non-experimental studies were included, as well as literature reviews.
Results: In our search, we found: 16 clinical series or single clinical cases, 10 test and control studies, 9 experimental studies and 3 reviews.
Conclusion: All papers written by different researchers show an improvement in perimplant bone preservation. Further long-term studies are necessary to confirm these results.
The articles consulted refer to the biomechanical behavior of the abutment-implant complex in response to occlusal loading, the maintenance of crestal bone height and the peculiar repositioning of the biological space.

***Key words:*** *Platform switching, dental implant, crestal bone preservation.*

## Introduction

Platform switching involves reducing the restoration abutment diameter in comparison with the diameter of the dental implant (1).

In aesthetic areas, the use of dental implants as replacements for lost permanent teeth remains an important challenge due to the difficulty of restoring the natural sulcus and papillary anatomical appearance around the implants. Despite the available technology, in some cases dental implants are unable to achieve optimum esthetic results (2).

Correct location of the soft tissues in dental implant restorations depends on the preservation of bone crestal height. Consequently, hard tissues are the principal determinant of aesthetic outcome (2).

The platform switching effect was accidentally established in the 1980s and early 1990s when different commercial dental implant manufacturers introduced implants of larger diameter before producing the corresponding abutments of the same measures. 14 years later, evaluation of those treatments in which abutments of lesser diameter were used revealed better preservation of the hard and soft tissues than treatment that use abutments with diameters matched to the implant (3, 4).

In platform switching it is possible to use abutments with a diameter smaller than the implant neck or body width, or alternatively an implant design can be used in which the neck diameter is increased with respect to the implant body width (fig. 1) (5).

Recently, some authors have proposed platform switching using implants with a reverse conical neck. The results obtained with this implant design do not appear to be significantly superior to those obtained with the traditional restoration designs, however (6,7).


**Fig. 1.** Implant-abutment options: in number 1, the joint between components with an equal diameter. However, in the following examples it is modified (platform switching). In number 2, the restoration diameter is reduced and in number 3, the implant platform is expanded, mathing implant and abutment diameter.

## Material and Methods

The present study offers a review of the literature dealing with the impact of reducing the diameter of the platform on the oral hard and soft tissues. To this effect, a Medline search was carried out, using the PubMed search engine with the key words “platform switching”, “expanded platform”, “dental implant”, “crestal bone preservation”, ”non-matching” and “abutment”, as well as combinations of these key words. No limit in time was used in this search.

Inclusion criteria were papers published in journals indexed in MedLine in which modified platforms in dental implants are studied (platform switching concept), using different surgical techniques and clinical situations (immediate loading, delayed loading). As exclusion criteria, papers written in other languages were not used in our work. Only articles written in english were included.

## Results

The first Medline publications on platform switching appeared in the year 2005, and since then over 30 articles have been published. All them have been included to perform this bibliographic revision.

Mostly of these studies are clinical cases or single clinical cases, 16 in total. In addition, we found 10 non-experimental tests and control studies, 9 experimental studies (2 of them are histomorphometrical models in animals and 7 finite element analyses) and only 3 articles are literature review.

## Discussion

The results described by the different authors are mostly encouraging. In the last 5 years, these results have led many researchers to become interested in these studies and to perform investigations. Also dental implants with integrated platform-switching designs have been commercialized.

The principal aspects of the consulted articles refer to biomechanical behavior of the abutment-implant complex in response to occlusal loading, bone crest level preservation and biological space repositioning.

For this reason, in the study, the authors consider each aspect individually and the text is divided into three parts.

## Biomechanical Behavior

The close relationship between the bone and the implant is the essence of osteointegration. The bone changes occurring at the margins adjacent to the dental implants have been the subject of many clinical and experimental studies (8).

In turn, many hypotheses have been proposed in relation to the physiological processes that intervene in crestal bone stabilization. Although the etiological factors

underlying bone loss have not been fully established (9), the main causal factors of crestal bone loss are occlusal overload and peri-implantitis (10). Characteristics such as implant design, crestal bone geometry and the location within the oral cavity must be taken into consideration for the optimum support and distribution of occlusal loading forces to the bone components (11).
Biomechanical studies of dental implants using finite elements analysis software are increasingly common (11-14). Such analyses are used by engineers to simulate loading situations involving different materials. This type of software helps to calculate stress and pressure within solid bodies, determining force transmission between different elements and their loading relationships (14).
In 2009, Hsu et al. analyzed the behavior of reduced platform restorations in the context of a finite elements study in three dimensions. Their results showed a 10% decrease in all the prosthetic loading forces transmitted to the bone-implant interface (15).
Similar finite elements studies in two dimensions show great variability in the results obtained. In effect, while some investigators report a decrease in force to the cortical bone of less than 10% (12), other authors such as Tabata et al. have reported a decrease of 80% (13).
Rodriguez-Ciurana et al. (14), 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 favorable 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 global restoration (13).
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 platform. However, Canay and Akça (10), 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 to the need for further research on the behavior 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 (10).
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 overdentures – fundamentally compromising the connecting abutment closest to the area where loading is applied (16).

### Influence Upon Bone Crestal Level

Crestal bone loss around dental implants has been frequently documented in recent years. However, the factors implicated in the bone reabsorption and appositioning mechanisms in implant treatment are not fully clear (17).
The widely accepted factors that attempt to explain the changes in bone height that occur after functional and aesthetic implant-supported restoration include the gingival biotype, the distance of the implant-abutment junction (IAJ) from the bone crest, repositioning of the gingival inflammatory infiltrate, and the distribution of forces in the portion of the implant in contact with the cortical bone (13,18). Additional factors are loss secondary to aggression such as mucoperiosteal flap raising, second-stage surgery for exposing the screw, and colonization by bacteria belonging to the oral flora at the coronal bone and implant junction (17,19). Other authors have also studied crestal bone loss and its relationship to the facial bone thickness of the patient (20).
In numerical terms, bone loss in two-stage implant-supported restorations is estimated to be 1.5-2mm below the implant-abutment junction, exposing one or two threads after one year supporting a prosthetic restoration. In general, this exposure of the implant body is not regarded as a sign of failure (20).
However, in the studies on platform switching involving a follow-up period of 4-169 months, the reported bone loss varies between 0.05-1.4 mm (Table 1) (21).
Despite these findings in the literature, some investigators consider platform expansion to be of key importance for crestal bone stability. Experimental histomorphometric studies have shown improvement in crestal bone levels in abutments with platform reduction, though statistical significance was not reached (18,22).
In 2009, Prosper et al., in a multicenter study of 360 implants, compared expanded platforms versus cylindrical implants involving abutments of the same size, placed in 60 partially edentulous patients (9). The results showed a lesser percentage bone loss on employing the reduced platforms, with the preservation of up to 98.3% versus 66.1% after 12 months, and 97.2% versus 53.3% with the standard platform after two years.
Platform reduction with immediate functional loading

**Table 1.** Bone preservation, number of implants placed, and follow-up according to the studies found in the Medline search of dental implant platform switching in humans subjects.

| Author | Crestal bone loss (mm) | Nº implants | Follow-up(months) | Study Caracteristics | Surgical Caracteristics |
|---|---|---|---|---|---|
| Wagenberg & Froum 2010 (18) | 0,33 – 0,31 | 94 | 132 – 169 | Clinical cases | Two stage surgical protocol |
| Prosper et al. 2010 (25) | 0,51 - 1,16 | 116 (total 120) | 60 | Clinical cases | Immediate and delayed loading |
| Cocchetto et al. 2010 (29) | 0,05 – 1,63 | 15 | 18 | Clinical cases | One step surgical protocol (one post-extraction implant) |
| Bilhan et al. 2010 (26) | 0,91 – 0,89 | 126 | 36 | Clinical cases | Two steps surgical protocol |
| Canullo et al. 2010 (32) | 0,83 | 44 (total 60) | 33 | Test and control group multicenter | Two steps surgical protocol |
| Trammel et al. 2009 (40) | 0,99±0,53 | 25 | 24 | Test and control group | One step surgical protocol |
| Canullo et al. 2009 (28) | 0,47-0,36 | 22 | 25 | Clinical cases multicenter | Inmediate post-extraction restoration |
| Rodriguez-Ciurana et al. 2009 (14) | 0,59-0,6 | 82 | 15 | Clinical cases, multicenter | Two stage surgical protocol |
| Prosper et al. 2009 (9) | 0,05-0,23 | 180( total 360) | 24 | Test and control group | One-step and two step surgical protocol |
| Calvo-Guirado et al. 2009 (5) | 0,08-0,09 | 59 | 12 | Clinical cases | Inmediate funcional loading |
| Cappiello et al. 2008 (21) | 0,95±0,32 | 75 ( total 131) | 12 | Test and control group | One step surgical protocol |
| Calvo-Guirado et al. 2008 (30) | 0,6 | 104 (Total 105) | 16 | Clinical cases | Immediate loading and immediate restauration |
| Hurzeler et al. 2007 (37) | 0,12±,40 | 148 (Total 22) | 12 | Test and control group | Two stage surgical protocol |
| Canullo & Rasperini 2007 (39) | 0,78±0,36 | 10 | 22 | Clinical cases | Inmediate post-extraction restoration |
| Calvo-Guirado et al. 2007 (1) | 0,05-0,07 | 10 | 6 | Test and control group | Inmediate post-extraction restoration |
| Vela-Nebot et al. 2006 (31) | 0,76-0,77 | 30 (Total de 60) | 6 | Test and control group | One-step and two step surgical protocol |
| Garner 2005 (3) | 1,3-1,4 | 1 | 4 | Clinical case | Inmediate post-extraction restoration |

in the rehabilitation of edentulous arches has also been documented in the literature. The authors consider this design of the abutment-implant complex to be decisive for crestal bone stability in both non-smokers and smokers of more than two packs of cigarettes a day (23-26).
There have also been reports of immediate post-extraction rehabilitation with very satisfactory results in terms of soft and hard tissue preservation. Platform expansion in post-extraction situations makes it possible to minimize the gap between the recently extracted tooth bed and the implant, acting as a physical barrier against the penetration of bacteria in the zone of contact between the bone and implant. This increase in diameter favors improved primary stability (15,28-31).

## Soft Tissue Response

Of the different theories proposed to explain maxillary bone remodeling after dental implant placement, the most widely studied has been the formation of a new biological space. The creation of this mechanical barrier serves as a defense mechanism, preventing the penetration of bacteria from the oral environment (32).
Such physiological sealing shows morphological differences according to whether it is formed in relation to a tooth or a dental implant. The biological space adjacent to an implant is greater than the space adjacent to a natural tooth, with histological differences in terms of the organization and distribution of the fibers. In addition to differences attributable to location, the biological space of an epicrestal implant forms at subcrestal level, while in the case of a natural tooth the space is formed at supracrestal level (33).
These differences in formation and morphology could be related to the corresponding vascular supply. In effect, while the soft tissues surrounding an implant are only vascularized by vessels from the periosteum, the tissues adjacent to natural teeth are also vascularized through the periodontal ligament (34).
Implant design also influences the morphology of the gingival margin – both the neck micro- and macrostructure, and the macrostructure of the implant-abutment junction. In turn, ensuring a minimum distance of 3 mm between implants allows sufficient margin to restore the biological space of both restorations, as demonstrated by Tarnow et al. a decade ago. 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 (30, 35, 36).
According to Lazzara and Porter, the deliberate creation of a space for the mentioned 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 area of the implant is freed – thus favoring controlled repositioning of the biological space (37,38).
The space is created in the horizontal plane one millimeter from the implant-abutment junction, supported over the external margin of the platform. In addition, this procedure keeps the inflammatory infiltrate away from the crestal bone margin, with a 50% reduction in occupation surface (38,39).
Trammell et al. (40), in a case-control study, measured the biological space with reduced and conventional platform abutments in the same individual. Although the mean biological width was similar in both groups (1.57 ± 0.72 mm with the expanded platform and 1.53 ± 0.78 mm with conventional abutments), bone loss was significantly smaller with the expanded platform.

## Conclusions

All authors agree that the use of implants with platform switching improves bone crest preservation and leads to controlled biological space reposition. According to the different papers, this expanded platform obtains excellent aesthetic outcomes.
Due to the limited sample of human beings, and the small number of implants and follow ups, further clinical investigations are necessary to show long term results.

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***Acknowledgement***
Authors wants to show their gratitude to Damian Serrano Sánchez for the implant platforms design didactic image. Contributing in an unselfish way.