

## REVIEW ARTICLE

# The Platform Switching Concept—A Myth or Fact: A Literature Review

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## ABSTRACT

The peri-implant bone level has been used as one of the criteria to assess the success of dental implants. It is an important prerequisite for preserving the integrity of gingival margins and interdental papillae. Platform switching for maintaining peri-implant bone levels has gained popularity among implant manufacturers over the last few years. Typically, crestal bone levels are situated 1.5 to 2 mm below the implant-abutment junction, dependent on various factors and there are several theories stating the reason for this phenomenon. Platform switching is a concept which aims at reduction of the crestal bone loss around the implants and involves the restoration of implants with smaller diameter abutments such that the implant abutment junction (IAJ) is horizontally repositioned inwardly and away from the outer edge of the implant platform. This review aims at summarizing the significance of platform switching.

**Keywords:** Platform switching, Dental, Implants.

**How to cite this article:** Mittal S, Goyal S, Sekhri S. The Platform Switching Concept—A Myth or Fact: A Literature Review. *Int J Oral Implantol Clin Res* 2014;5(2):55-59.

**Source of support:** Nil

**Conflict of interest:** None

## INTRODUCTION

Gap between implant and abutment leads to bacterial colonization. Chewing loads cause a relative movement between the components. This distributes endotoxins, causing an infectious reaction in the tissue at the implant-abutment interface level. Bone is resorbed below the implant-abutment connection (IAJ) until the biological width is established. Only a bacteria-proof connection prevents bone resorption and stabilizes the soft tissue.

Concept of platform switching is about increasing the width of the epithelial collar around the abutment, hence, resulting in thicker and tighter seal around the abutment minimizing the pocketing around the abutment. It empha-

sizes the promotion of gingival health, increases the volume of soft tissue, preserving the crestal bone levels. Discovered by accident in the late 1980s, the benefits of platform switching soon became a heavy focus of implant-related research and are now considered to be a means of preventing initial peri-implant bone loss.

## CONCEPT

After undergoing osseointegration, dental implants are fitted with abutments in order to allow dental restorations (e.g. crowns, dentures, etc.) to be attached. Historically, the diameter of the abutment matched the diameter of the implant platform, for example, a 4.8 mm wide abutment was placed on a 4.8 mm wide implant—this can be termed platform-matching.<sup>1</sup>

When platform switching, a narrower abutment diameter for a given implant platform diameter is used, for example, placing a 3.8 mm wide abutment on a 4.8 mm wide implant.<sup>1</sup>

## HISTORY AND ORIGIN OF THE CONCEPT OF PLATFORM SWITCHING

The introduction of wide-diameter dental implants in the late 1980s created a situation in which mismatched standard-diameter abutments were used simply because of the lack of commercial availability of components to match the wide-diameter implants. Serendipitously, it was found that these implants exhibited less than expected initial crestal bone loss—the effect of bone remodeling at the crest of the alveolar bone into which dental implants are placed, during healing. Several early clinical reports demonstrated enhanced soft (gingiva) and hard (bone) tissue responses to these platform switched implants, leading many implant companies to incorporate platform switching into their implant systems even for narrower-body implants.<sup>2,3</sup>

## RATIONALE

It has been demonstrated that bone resorption at the IAJ may be caused by an inflammatory cell infiltrate that forms a zone around the IAJ.<sup>4</sup> Although not yet fully understood, the current theory of the benefit of platform switching is related to the physical repositioning of the IAJ away from the outer edge of the implant and the surrounding bone, thereby containing the inflammatory infiltrate within the width of the platform switch.<sup>3</sup>

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In line with the supposed mechanism of action, it is not merely the introduction of a platform switch, but the magnitude of the implant-abutment diameter mismatch, that makes a difference. Difference in bone levels became statistically significant when the implant-abutment diameter mismatch was greater than 0.8 mm, providing a 0.4 mm circumferential width of platform switch when the center of the abutment is aligned with and fixed to the center of the implant.<sup>5</sup>

### MECHANISM BY WHICH PLATFORM SWITCHING REDUCES CRESTAL BONE LOSS

The mechanism by which platform switching can contribute to reduce the crestal bone loss could be due to following reasons.

1. Shifting of the inflammatory cell infiltrate inwards and away from the adjacent crestal bone.
2. Maintenance of biological width and increased distance of IAJ from the crestal bone level in the horizontal way.
3. The influence of microgap on the crestal bone is reduced.
4. The stress levels in the peri-implant bone are decreased.

Factors affecting crestal bone loss include surgical trauma, crest module, biological width, microgap, occlusal overload, crest module.<sup>6</sup>

Luongo et al<sup>7</sup> studied biopsy specimen to find out the biologic process occurring around the platform-switched implant. They found that an inflammatory connective tissue infiltrate was localized over the entire surface of the implant platform and approximately 0.35 mm coronal to the IAJ but did not reach the crestal bone, which may be the reason for crestal bone preservation by platform-switching. Maeda et al,<sup>8</sup> in a 3D finite element analysis, found the biomechanical advantages of platform switching. They noted that this procedure shifts the stress concentration away from the bone-implant interface, but these forces are then increased in the abutment or the abutment screw. Schrottenboer et al<sup>9</sup> fabricated a two-dimensional model to analyze the bone-implant interactions under masticatory forces. Results showed that reduction of abutment diameter resulted in measurable but minimal effect on von Mises stresses in the crestal region of cortical bone. However, it was concluded that further clinical trials are warranted before any firm conclusion is drawn.

Canay et al<sup>10</sup> concluded in their study that stresses are confined to the cortical bone region around the implant neck. For the designs with greater horizontal offset, intensity of stresses are higher at the abutment part resting above the bone level. Thus, platform switching may risk the mechanical properties of abutments if horizontal set-off is increased. Though decrease in abutment diameter decreases the stresses generated around the implant, the differences are

very slight. Hsu et al<sup>11</sup> concluded in their study that bone strains were reduced by <10% when platform switching was used compared to no platform switching. Degidi et al<sup>12</sup> evaluated the histology and histomorphology of three morse cone connection implants in a real case report and they explained that when there is zero microgap and no micromovement, platform switching shows no resorption.

### Biomechanical Aspect

The bone changes occurring at the margins adjacent to the dental implants have been the subject of many clinical and experimental studies.<sup>13</sup> Stress is concentrated around the crestal region where 2 materials with different moduli of elasticity (bone and implant) interact. Although the etiological factors underlying bone loss have not been fully established,<sup>14</sup> the main causal factors of crestal bone loss are occlusal overload and peri-implantitis 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.<sup>15,16</sup>

Biomechanical studies of dental implants using finite elements analysis software are increasingly common.<sup>16-18</sup>

Rodríguez-Ciurana et al,<sup>18</sup> 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.

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.<sup>19</sup>

### MICROGAP AND THE CRESTAL BONE LEVELS

Microgap is the term used for the microscopic space where the bottom of the abutment meets the top of the implant. This tiny area would be a great place for bacteria to grow and cause bone resorption at the connection. The microgap-crestal bone level relationship was studied radiographically by Hermann et al who 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 2 mm below the microgap.

Bacteria gather around these micro spaces. This dynamic movement pumps the toxins that form in the gaps and creates a 'zone of toxicity' at the level of the microgap. Alveolar bone is then remodeled below the zone, resulting in the typical bone loss down to 'first thread'. This is one of the reasons for the bone remodeling noted at the crestal area. Any micromovement compounds the effect of bone loss. The goal of platform switching is to prevent the normal bone loss down to the first thread that occurs around most implants, thus enhancing soft tissue esthetics and stability.

### Platform Switching to preserve the Crestal Bone

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.<sup>20</sup>

The widely accepted factors that attempt to explain the changes in bone height that occur after functional and esthetic implant-supported restoration include the gingival biotype, the distance of the 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.<sup>17,21</sup> 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.<sup>20,22</sup> Bone loss in two-stage implant-supported restorations is estimated to be 1.5 to 2 mm below the IAJ, exposing one or two threads after 1 year supporting a prosthetic restoration.<sup>23</sup>

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.<sup>21-25</sup>

Platform reduction with immediate functional loading 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 nonsmokers and smokers of more than two packs of cigarettes a day.<sup>26-29</sup>

There have also been reports of immediate postextraction rehabilitation with very satisfactory results in terms of soft and hard tissue preservation. Platform expansion in postextraction 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.<sup>11,30-34</sup>

### The Response of Soft-tissue to Platform Switching

The most widely studied theory proposed to explain maxillary bone remodeling after dental implant placement 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.<sup>1</sup>

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.<sup>12</sup>

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.<sup>35</sup>

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.<sup>33,36,37</sup>

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.<sup>38</sup>

The space is created in the horizontal plane one millimeter from the IAJ, 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.<sup>3,39</sup> Trammell et al,<sup>40</sup> 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 ( $1.57 \pm 0.72$  mm with the expanded platform and  $1.53 \pm 0.78$  mm with conventional abutments), bone

loss was significantly smaller with the expanded platform. The use of Morse taper connection implants represents a successful procedure for the rehabilitation of partially and completely edentulous arches. Mangano et al<sup>41</sup> 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 (microgap) is associated with minimal crestal bone loss.

## CONCLUSION

Having reviewed the available literature, we have reached the conclusion that platform switching is capable of reducing or eliminating crestal bone loss to a mean of  $1.56 \pm 0.7$  mm. It also contributes to maintaining the width and height of crestal bone and the crestal peak between adjacent implants and it also limits the circumferential bone loss. We conclude that the implant design modifications involved in platform switching offer multiple advantages and potential applications, which include situations where a larger implant is desirable but the prosthetic space is limited and in the anterior zone where preservation of the crestal bone can lead to improved esthetics.

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