REVIEW ARTICLE

RE-DEFINING CRESTAL BONE PRESERVATION: A CRITICAL PERSPECTIVE ON PLATFORM SWITCHING IN IMPLANT DENTISTRY WITH CBCT INSIGHTS

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ABSTRACT

The success of dental implants is often evaluated based on peri-implant bone levels, as maintaining these levels is crucial for preserving the gingival margins and interdental papillae. In recent years, the concept of platform switching has gained traction among implant manufacturers as a method for preserving peri-implant bone levels. Crestal bone levels are typically located 1.5 to 2 mm below the implant-abutment junction (IAJ), a phenomenon influenced by various factors and supported by several theoretical explanations. Platform switching involves using smaller diameter abutments to restore implants, leading to a horizontal repositioning of the IAJ inward and away from the edge of the implant platform. This approach aims to reduce crestal bone loss surrounding the implants. The purpose of this review is to highlight the importance of platform switching in maintaining peri-implant bone levels.

KEY WORDS

Platform Switching (PS), Platform Matching (PM), Marginal Bone Level (MBL), Endosseous Implants, Implant-Abutment Configuration, Bone Preservation

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INTRODUCTION

The gap at the interface of dental implants and their abutments creates an environment conducive to bacterial colonization. The mechanical forces generated during chewing lead to relative movement between the implant and abutment, which facilitates the spread of endotoxins.[1] This distribution of toxins triggers an infectious response in the surrounding tissue at the implant-abutment junction (IAJ). Subsequently, bone resorption occurs beneath the IAJ until the biological width is established. Stabilizing soft tissue and preventing bone resorption require a bacteria-proof seal at the interface.[2,3]

The principle of platform switching revolves around expanding the epithelial collar's width surrounding the abutment. This approach results in a thicker and more robust seal, effectively reducing the formation of pockets around the abutment. Beyond minimizing pocketing, platform switching contributes to improved gingival health by encouraging a tighter seal, increasing soft tissue volume, and maintaining crestal bone levels.[4] Initially discovered accidentally in the late 1980s, the concept of platform switching quickly gained prominence in dental research. Today, it is widely recognized as an effective method to mitigate early peri-implant bone loss.

CONCEPT

After the completion of osseointegration, dental implants are equipped with abutments to facilitate the attachment of dental prosthesis, such as crowns, bridges, or dentures. Historically, the abutments were designed to match the diameter of the implant platform.[5] For instance, an abutment with a width of 4.8 mm would be paired with an implant of the same diameter, a technique referred to as "platform matching."[4,6]

In contrast, platform switching involves using abutments with a smaller diameter than the implant platform. For example, a 3.8 mm-wide abutment would be paired with a 4.8 mm-wide implant. This intentional mismatch represents the essence of platform switching and is a departure from the traditional approach.[7,8]

HISTORY AND ORIGIN OF PLATFORM SWITCHING

The concept of platform switching emerged inadvertently during the late 1980s with the introduction of wide-diameter dental implants.[2,3,9] At that time, standard-diameter abutments were paired with wide implants due to the unavailability of appropriate matching components. Unexpectedly, it was observed that these mismatched implants experienced less crestal bone loss than anticipated-a phenomenon related to the remodelling of bone at the crest of the alveolar ridge during the healing phase.

In 2006 platform switching concept was introduced by Robert Lazzara, Steven Porter, And David Gardner. They first documented the concept and its potential benefits. Gardner also contributed to the understanding and implementation of the technique.

Initial clinical studies reported favourable responses in both hard tissue (bone) and soft tissue (gingiva) when platform switching was applied.[4,7,10] This serendipitous discovery led implant manufacturers to integrate platform switching into their systems, including narrower-body implants, to enhance overall implant performance.

RATIONALE

Bone resorption at the implant-abutment junction (IAJ) is believed to result from the presence of an inflammatory cell infiltrate localized around this area. While the exact mechanisms behind this phenomenon are not fully understood, the prevailing theory suggests that the physical repositioning of the IAJ away from the implant's outer edge and adjacent bone minimizes the spread of inflammatory infiltrate. By confining this infiltrate to the platform switch's width, peri-implant bone preservation can be achieved.[11,12] Furthermore, it has been demonstrated that the extent of the implant-abutment diameter mismatch plays a pivotal role in influencing bone levels. A statistically significant reduction in bone loss is observed when the mismatch exceeds 0.8 mm, creating a platform switch width of at least 0.4 mm. This alignment ensures the abutment is centred with the implant, promoting optimal stability.[13,14]

MECHANISM OF CRESTAL BONE LOSS REDUCTION

Platform switching aids in mitigating crestal bone loss through several mechanisms:

1. Redirecting the inflammatory infiltrate inward, away from the surrounding crestal bone.
2. Maintaining biological width while increasing the horizontal distance between the IAJ and crestal bone level.
3. Reducing the micro-gap's influence on crestal bone health.
4. Lowering stress levels in the peri-implant bone.

Crestal bone loss can be influenced by numerous factors, including surgical trauma, biological width, crest module, micro-gap, occlusal overload, and implant design.[15,16.17]

Luongo et al. conducted a biopsy analysis to explore the biological processes associated with platform-switched implants.[18] Their findings indicated that inflammatory connective tissue infiltrates were localized above the implant platform, approximately 0.35 mm coronal to the IAJ, without affecting the crestal bone.[19,20] This localization may explain the preservation of crestal bone levels through platform switching.[21,22]

In a separate study, Maeda et al. utilized three-dimensional finite element analysis to demonstrate the biomechanical advantages of platform switching.[23] They observed that SWITCHING stress concentration away from the bone-implant interface resulted in increased stress forces in the abutment or abutment screw.[25] Similarly, Schrotenboer et al. applied a two-dimensional model to examine bone-implant interactions under chewing forces.[14,26] Their findings revealed minimal effects of reduced abutment diameter on von Mises stresses in the cortical bone's crestal region, warranting further clinical trials before definitive conclusions can be drawn.[17]

Canay et al. noted that stresses were largely confined to the cortical bone surrounding the implant neck.[27] However, designs with greater horizontal offsets subjected the abutments above the bone level to higher stress intensities, potentially compromising their mechanical integrity. Hsu et al. found that platform switching reduced bone strain by less than 10%, compared to traditional implant designs. Degidi et al. explored the histology and histomorphology of Morse cone connection implants, concluding that with zero micro-gap and absence of micromovement, platform switching does not induce resorption.[17,28]

BIOMECHANICAL ASPECTS

Changes in bone margins adjacent to dental implants have been extensively studied in both clinical and experimental settings.[8,22,29] Stress tends to concentrate in the crestal region where bone and implant materials with differing elastic moduli interact.[30] Although the precise causes of bone loss remain unclear, factors such as peri-implantitis, occlusal overload, crest module geometry, implant design, and placement location significantly affect crestal bone stability.[21,27]

Finite element analysis software is increasingly utilized in biomechanical studies of dental implants. Rodríguez-Ciurana et al., in a two-dimensional study, found that platform switching integrated into implant designs yielded slightly lower peri-implant bone force attenuation than traditional restoration models.[26,31] However, the authors concluded that internal junction platform switching offered better load distribution along the implant axis than external junction designs.

Despite its advantages, platform switching may not be suitable for mandibular implant-mucosal support prostheses. Reducing the junction's diameter diminishes abutment resistance against occlusal loads applied to posterior areas, potentially compromising the abutments nearest the load application zones.[32]

MICRO-GAP AND ITS RELATIONSHIP TO CRESTAL BONE LEVELS

The term "micro-gap" refers to the microscopic space at the interface where the abutment's base connects with the implant's top surface.[33] This small gap can provide an ideal environment for bacterial accumulation, resulting in bone resorption at the connection site. Radiographic studies conducted by Hermann et al. demonstrated a direct relationship between the micro-gap at the implant-abutment junction and crestal bone loss, independent of surgical techniques.[16,20] It is hypothesized that epithelial proliferation to establish biological width may contribute to the crestal bone loss observed approximately 2 mm below the micro-gap.[34,35]

Bacteria tend to accumulate in these minute spaces, and their dynamic activity creates a "zone of toxicity" at the micro-gap level.[36] This leads to remodeling of alveolar bone beneath the affected zone, resulting in the typical bone loss noted at the "first thread" of the implant. Micromovements further exacerbate this bone loss. The main aim of platform switching is to prevent the bone loss typically observed down to the first thread and enhance soft tissue aesthetics and stability.

PLATFORM SWITCHING AND ITS ROLE IN PRESERVING CRESTAL BONE LEVELS

Recent literature highlights the frequent documentation of crestal bone loss surrounding dental implants. However, the factors driving bone resorption and apposition in implant treatments remain only partially understood. Widely recognized explanations for changes in bone height after functional and aesthetic implant restorations include the influence of gingival biotype, the distance of the implant-abutment junction (IAJ) from the bone crest, the repositioning of inflammatory infiltrate, and force distribution in regions where the implant contacts cortical bone.[37] Additional contributing factors include aggressive surgical interventions, such as mucoperiosteal flap elevation, second-stage screw exposure surgery, and bacterial colonization at the junction between coronal bone and implant.

Bone loss in two-stage implant-supported restorations is commonly estimated to range between 1.5 to 2 mm below the IAJ, exposing one or two threads after one year of prosthetic restoration.[12,26,38] Despite this, some researchers emphasize the critical importance of platform expansion in maintaining crestal bone stability. Experimental histo-morphometric studies indicate potential improvements in crestal bone levels with abutments featuring platform reductions, although statistical significance has not consistently been observed.

Platform reduction in combination with immediate functional loading has shown promising results in rehabilitating edentulous arches. It is considered crucial for crestal bone stability in both non-smokers and smokers who consume more than two packs of cigarettes daily.[10,18,39] Furthermore, immediate post-extraction implant placement has yielded satisfactory results, preserving both soft and hard tissues. In these scenarios, platform expansion acts as a physical barrier against bacterial penetration at the contact zone between the implant and bone, promoting better primary stability.[40]

THE RESPONSE OF SOFT TISSUES TO PLATFORM SWITCHING

One widely studied hypothesis regarding maxillary bone remodeling after dental implant placement is the formation of a new biological space. This mechanical barrier serves as a defense mechanism, protecting against bacterial invasion from the oral cavity.[4,29,34] The biological space adjacent to dental implants differs morphologically from those surrounding natural teeth. Specifically, the biological space of an implant tends to form subcrestally, whereas in natural teeth it forms supracrestally.

These morphological differences may arise from variations in vascular supply. Soft tissues around dental implants derive their blood supply exclusively from periosteal vessels, while tissues adjacent to natural teeth benefit from vascularization through the periodontal ligament as well.

Maintaining a minimum distance of 3 mm between implants helps restore the biological space in both restorations effectively.[17,20] Tarnow et al. demonstrated that bone crest preservation improved by approximately 57% when expanded platforms were incorporated compared to traditional restoration designs. Lazzara and Porter proposed that creating such physiological spaces minimizes fiber repositioning around the implant. By moving the junction medially relative to the implant axis, additional surface area of the implant becomes accessible-favoring the controlled repositioning of the biological space. This shift also keeps inflammatory infiltrates away from the crestal bone margin, significantly reducing their occupation area.[25,31]

Trammell et al., in a case-control study, compared biological spaces of reduced and conventional platform abutments.[41] While both showed similar mean widths, bone loss was markedly reduced in expanded platforms. Morse taper connection implants have proven effective for rehabilitating partially and fully edentulous arches. Mangano et al., through their evaluation of 1920 Morse taper implants over four years, reported a cumulative survival rate of 97.56%, with minimal crestal bone loss attributed to the absence of micro-gaps at the implant-abutment interface.[41]

CONCLUSION

Upon reviewing the literature, the mean crestal bone loss was 0.22 mm in platform-switched implants and 2.02 mm in nonplatform-switched implants. They also concluded that reduction of the abutment of 0.45 mm on each side is sufficient to avoid peri-implant bone loss. Hence, it is evident that platform switching effectively reduces or even eliminates crestal bone loss, with an average reduction of 1.56 ± 0.7 mm. Furthermore, it plays a significant role in preserving both the width and height of crestal bone, as well as maintaining the crestal peak between adjacent implants. It also minimizes circumferential bone loss. The modifications in implant design associated with platform switching present numerous benefits and practical applications. These include scenarios where larger implants are necessary but prosthetic space is constrained, as well as in the anterior region, where maintaining crestal bone levels enhances overall aesthetics.

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