Platform Switching: A New Era in Implant Dentistry

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Abstract
Platform switching is the use of smaller diameter abutments on wider diameter implants. It is used as a method of reducing crestal bone loss and maintaining the gingival papillae. Platform switching appears to limit crestal resorption and seems to preserve peri-implant bone levels. A certain amount of bone remodeling one year after final restoration occurs, but significant differences concerning the peri-implant bone height compared with the nonplatform switched abutments are still evident one year after final restoration.

Review method: The basic search process included a systematic review of article in PubMed/Medline database dating between January 2000 and September 2009. Studies both of human beings and animals were reviewed in order to assess the influence of platform switching both on marginal bone loss around the cervical region of the implant and on soft tissue esthetics.

Keywords: Platform switching, Implants, crestal bone loss.

INTRODUCTION
The development of osseointegrated implants represents one of the most important breakthroughs in contemporary dental practice in the oral rehabilitation of partially or fully edentulous patients. Based on the pioneering work of Brånemark (University of Gothenburg, Sweden) and Schroeder (University of Berne, Switzerland), who first proposed the concept of osseointegration or functional ankylosis, respectively, implant dentistry has subsequently seen some major advances, particularly in the past two decades.1

One aspect of implant therapy that can be extremely challenging is the placement and subsequent restoration of implants in the esthetic zone. In order to predictably realize patients’ esthetic expectations, the crestal bone changes that commonly occur around endosseous implants and the subsequent soft tissue reaction to the osseous changes must be understood. The soft tissue must then be managed to ensure its long-term stability.2

Crestal bone loss has been documented as one of the important factors that affect the long-term prognosis of a dental implant. The initial breakdown of the implant-tissue interface generally begins at the crestal region in successfully osseointegrated endosteal implants.3

After second stage surgery, bone resorption of 1.5 to 2 mm may occur at the implant-abutment junction. One criterion of successful implant osseointegration is that vertical bone loss should not exceed 2 mm in the first year of function and should remain less than 0.2 mm annually thereafter.4

Understanding how crestal bone responds to implant placement and subsequent abutment connection is critical in achieving an acceptable esthetic outcome. The position of crestal bone will influence the position of the soft tissue, which in turn dictates, along with other factors, the total esthetic outcome.5

BIOLOGIC WIDTH—A KEY DETERMINANT OF ESTHETICS
Garguilio, Wentz and Orban in a study of the periodontium, demonstrated an average histological dimension of the epithelial attachment (0.97 mm) and connective tissue attachment (1.07 mm).5,6 Known as biologic width, this dimension is a key determinant of esthetics. It acts as a barrier and seals against bacterial invasion and food debris ingress into the tooth-tissue interface.3
The biologic width found around teeth is also characteristic of the peri-implant complex. The dimensions of peri-implant biologic width are similar to that of teeth and is stable even after loading. The position of the gingival architecture in relation to the osseous crest. This position in fact follows the principles of biologic width.5,7-9

Early implant bone loss, in part, is from the processes of establishing the biologic width. The amount of bone loss and location of the biologic width may be associated with the thickness of the soft tissue around the implants.3,11 This situation has important consequences for the esthetics of the interdental papilla which can suffer mesial and distal bone loss of around 0.07 mm after a 6 month follow-up period.2 Use of an implant design that aids in the preservation of crestal bone, in theory, will support soft tissue that may impact the esthetic outcome. Greater bone volume can also increase blood supply for the health and maintenance of soft tissues.9

Factors affecting crestal bone loss:3,12
1. Surgical trauma
2. Microgap
3. Biologic width
4. Crest module

1. Surgical Trauma

Surgical trauma due to 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. Wildermann et al reported that bone loss due to periosteal elevation was restricted to the area just adjacent to the implant, even though a larger surface area of the bone was exposed during surgery. Early implant bone loss is in the form of horizontal saucerization. However, bone loss after osseous surgery in natural teeth is more vertical. Signs of bone loss from surgical trauma and periosteal reflection are not commonly observed at the implant stage two surgery in successfully osseointegrated implants. Thus, surgical trauma is unlikely to cause early crestal bone loss.11

2. Microgap

In most of the two-stage implant systems (submerged implants), after abutment is connected, a microgap exists between the implant and the abutment at or below the alveolar crest. For all two-stage implants, the crestal bone levels are dependent upon the location of the microgap and are approximately 2 mm below it.13

The micro-gapcrestal 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 (submerged or nonsubmerged). This study also demonstrated that epithelial proliferation to establish biological width could be responsible for crestal bone loss found about 2 mm below the microgap.13

Microgap may not be considered as the only cause of early implant bone loss, it might cause implant crestal bone loss during the healing phase, if it is placed at or below the bony crest.3

3. Biologic Width

As discussed earlier, the biologic width term essentially pertains to the physiologic attachment apparatus made up of the connective tissue and epithelium, and is approximately 2.04 mm. Early implant bone loss, in part, is from the processes of establishing the biologic width.2,3,5,9,11

4. Crest Module

The crest module of an implant body is defined as the transosteal region of the implant and serves as the region which receives the crestal stresses to the implant after loading.

A smooth crest module may actually contribute to the crestal bone loss. Cortical bone is strongest to compressive loads, 30% weaker to tensile forces, and 65% weaker to shear forces compared to compressive forces. A smooth, parallel-sided crest module may result in shear stresses in this region, and an angled crest module of more than 20 degrees with a surface texture that increases bone contact might impose a slight beneficial compressive and tensile component to the contiguous bone and decreases the risk of bone loss.3,14

It can be hypothesized that the bone loss may slow down at the first thread because the first thread changes the shear force of the crest module to a component of compressive force to which bone is the most resistant.3

IMPLANT-ABUTMENT CONNECTION AND “MICRO-PUMPING EFFECT”15

Implant abutment connections are based on the design model allowing for a clearance fit, which permits the two parts
(abutment and implant) to fit together. The very nature of this “clearance fit” creates a microgap, both microscopically and macroscopically (Fig. 4). This microgap not only allows for movement of bacteria and their toxins to and from the abutment-implant external interface, but also allows for micromovement of the abutment within the implant.15

Micromovement can create movements and stresses on the abutment screw which causes loosening and a “micropumping effect” that expels additional bacterial by-products and toxins at implant-soft tissue interface and eventually at the osseous crest. With a concentration of toxins, the body’s defenses come into play, including increased inflammatory cells at the osseous crest, causing soft tissue detachment and crestal bone loss. The implant design that displays the smallest microgap consists of dental abutment connections called the “press fit”, “conus”, or conical connections.13

<table>
<thead>
<tr>
<th>Table 1: Implant abutment connection15</th>
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<tbody>
<tr>
<td><strong>Clearance Fit</strong></td>
</tr>
<tr>
<td>Index/parallel sides</td>
</tr>
<tr>
<td>Micromovement</td>
</tr>
<tr>
<td>Micropumping effect due to microgap increase inflammatory cells</td>
</tr>
<tr>
<td>Replace Select™, Certain™, Ankylos™, Biocon™</td>
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In a recent article in *Implantologic*, Zipprich and coworkers observed micromovements at the implant abutment interface when average occlusal forces were placed on them. All but a few conical designs showed broad evidence of a developing microgap on loading, micromovement and creation of the “micropumping effect” mentioned previously. The implant design that displayed the smallest microgap function fell into a second group of dental abutment connections called the “press fit,” “conus,” or conical connections.13 Press fit designs employ the “Morse taper” connection. This conical connection is used in several implant designs of various lengths and angles. This allows for a bacterial seal unlike the “clearance fit” connection and nearly eliminates micro-movement. Retention of the abutment, elimination of the microgap and micromovement are all achieved by the “press fit” conical connection. This allows this unique two-piece implant design with a “conus” connection to behave like a one-piece implant. A tight microgap and lack of micro-movement will insure bone stability at or above the shoulder of the implant, thereby producing a lasting papilla and soft tissue contours around the implant crown.15,16

**CONTROLLING CRESTAL BONE LOSS**

Crestal bone loss around implants has both horizontal and vertical components. Following abutment connection, crestal bone will move away from the microgap 1.3 mm to 1.4 mm in a horizontal direction.

This can influence the interproximal height of bone if implants are not placed correctly adjacent to teeth (1.5 mm) or other implants (3 mm).14 The loss of interproximal bone will increase the distance to the contact point, influencing esthetics.5,17

Clinicians, researchers and implant companies have dedicated time to finding ways to control crestal bone loss after abutment connection. Use of nonsubmerged implants to control or eliminate bone loss is a proven way to accomplish this.18 A scalloped implant platform has been developed to follow osseous architecture and eliminate crestal bone loss.5

Another method is altering the horizontal position of the microgap. As stated previously, crestal bone loss following abutment connection has both horizontal and vertical components. The horizontal component consists of the 1.3 mm to 1.4 mm of bone loss from the microgap to the crest of bone. If the horizontal component can be controlled or decreased, then crestal bone loss can also be decreased.5 This can be done by means of what is now called as the platform switching concept.

**ACCIDENTAL DISCOVERY OF PLATFORM SWITCHING19,20**

Platform switching (the concept was introduced in the literature by Lazzara and Porter and Gardner), limits the circumferential bone loss around dental implants by using prosthetic components having a platform diameter undersized when compared to the diameter of the implant platform. In this way, the implant abutment junction is displaced horizontally inwards from the perimeter of the implant platform, and further away from the bone. This creates an angle, or step, between the abutment and the implant. Because it essentially is resting on the outer circumference of the implant platform, the inflamed connective tissue does not extend laterally to the same extent as it does with a traditional matched implant-abutment junction.
In 1991, the 3i Implant Innovations Inc. (Palm Beach Gardens, FL) introduced wide diameter 5.0 and 6.0 mm implants that had identically dimensioned platforms. These were designed to be used mainly for poor quality bones to achieve improved primary stability. However, when introduced, there were no matching wide-diameter prosthetic components available, and as a result, most of the initially placed implants were restored with standard 4.1 mm diameter components, which created a 0.45 mm or 0.95 mm circumferential horizontal difference in dimension. Many platform switched restored implants exhibited no vertical loss in crestal bone height.

Thus, the discovery of the concept was a coincidence. The crestal bone clinically and radiographically appears to maintain its position, while the soft tissue appears not to recede as much as it does with traditional “matched” configurations. In a sense, this implant configuration appears to limit biologic width reformation because the ledge of the implant platform, to a significant extent, may isolate the underlying bone.

It is important to note that for platform switching to be effective, the under sizing of the components must be carried out during all phases of the implant treatment, i.e. from placement of the implant through to final restoration.

CLINICAL RELEVANCE OF PLATFORM SWITCHING

1. **Increased biomechanical support:** Where anatomic structures such as the sinus cavity or the alveolar nerve limit the residual bone height, the platform switching approach minimizes the bone resorption and increases the biomechanical support available to the implant.11

2. **Effect on soft tissue esthetics around dental implants:** Tarnow et al. showed how the presence of the dental papilla is influenced by the distance between the implants. When two implants are placed close to one another (inter-implant distance 3 mm or less21) the inter-implant bone height can resorb below the implant-abutment connection, reducing the presence of an inter-implant papilla. This may affect the clinical result in the esthetic zone. Platform switching reduces this physiologic resorption, moving the microgap away from the inter-implant bone that supports the papilla. Maintenance of midfacial bone height helps to maintain facial gingival tissues. This helps to avoid cosmetic deformities, phonetic problems, and lateral food impaction.11

3. **Effect on crestal bone stress levels in implants with microthreads:** A finite element analysis was done to study the effect of microthreads and platform switching on crestal bone stress levels. It was reported that microthreads increase crestal stress upon loading. When the concept of platform switching was applied by decreasing the abutment diameter, less stress was translated to the crestal bone in the microthread and smooth-neck groups. The study concluded that platform switching reduced stress to a greater degree in the microthread model compared to the smooth-neck model.24

CONCLUSIONS

“Platform switching” is a simple and effective way to control circumferential bone loss around dental implants. By altering the horizontal position of the microgap, the horizontal component of bone loss after abutment connection can be reduced. This technique, however, has its faults. Switching can only be used with components that have similar designs, that is, the screw access hole must be uniform. In addition, sufficient space is needed to develop a proper emergence profile.

Although the biological basis for platform switching has been proposed, the biomechanical aspect still needs to be investigated. In a study done to analyze the biomechanical rationale for platform switching, Maeda et al. suggested that platform switching has the biomechanical advantage of shifting the stress concentration away from the cervical bone–implant interface. It also may have the disadvantage of increasing stress in abutment or abutment screw.

Despite the rapid growth of body of evidence with regard to platform switching, further substantiation with experimental and clinical outcomes with larger sample size and longer follow-up periods is still needed to determine the viability of this technique. More accurate long-term studies with a more relevant number of patients are required to allow proper conclusions related to soft and hard tissue reaction to this alternative restorative protocol.

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