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ORIGINAL ARTICLE

Platform Switching of Dental Implants: Panacea For Crestal Bone Loss?

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ABSTRACT

Crestal bone loss has been documented as one of the important factors that affect the long term prognosis of a dental implant. Various factors responsible for crestal bone loss have been reviewed. The concept of platform switching has been described on a histological basis. Its clinical benefits are discussed. A finite element analysis was performed to assess the mechanical behaviour of platform switched implants, which shows reduced crestal stress values under occlusal loads.

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Introduction

The success of dental implants is highly dependent upon the integration between the implant and the intraoral hard/soft tissue.The initial breakdown of the implant-tissue interface generally begins at the crestal region in successfully osseointegrated endosteal implants regardless of surgical approaches, with the potential to cause implant failure.

The first report quantifying early crestal bone loss was a 15 year retrospective study by Adell et al [1]. He reported 1.2 mm marginal bone loss from the first thread during healing and in the first year after loading with average 0.1 mm bone loss annually thereafter.

The criteria for implant success as given by Smith and Zarb[2] who stated that vertical bone loss (< 0.2 mm) annually following first year of implant function. A post-restorative remodeled crestal bone generally coincides with the level of the first thread on most standard diameter implants. The first thread changes the shear force of the crest module to a component of compressive force to which the bone is most resistant.

FACTORS AFFECTING CRESTAL BONE LOSS [3]

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 [4] 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 II surgery in successfully osseointegrated implants. Thus, surgical trauma is unlikely to cause early crestal bone loss.

2. Biological Width / Seal

Biological width forms within the first six weeks after the implant/abutment junction has been exposed to the oral cavity. It is a barrier against bacterial invasion and food ingress implant-tissue interface. The ultimate location of epithelial attachment following phase 2 surgery in part, determines early post-surgical bone loss.
Thus, implant bone loss is in part, a process of establishing the biological seal.

3. Microgap

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

The countersinking below the crest is done to minimize the risk of implant interface movement during bone remodeling, to prevent implant exposure during healing and also to enhance the emergence profile. Countersinking places the implant micro gap below the crestal bone. The microgap-crestal bone level relationship was studied radiographically by Hermann et al [5], 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. Epithelial proliferation to establish biological width could be responsible for crestal bone loss found about 2mm below the microgap.

4. Occlusal Overload

Excessive stress on the immature implant bone interface in the early stage of prosthesis in function is likely to cause crestal bone loss.
Cortical bone is least resistant to shear force, which is significantly increased in bending overload. However, bone loss from occlusal overload is considered to be progressive rather than limited to the first year of loading.

5. Crest Module

The transosteal region of the implant receives crestal stresses after loading.
The crest module design can transmit different types of forces onto the bone, which depends upon its surface texture and shape. A polished collar and a straight crest module design transmit shear force, whereas a rough surface with an angled collar transmits beneficial compressive force to the bone.

Research on crestal bone loss around dental implants has largely focused on implant systems with matching diameter implant seating surfaces and restorative components. In 1991, the 3i wide diameter 5.0 and 6.0 mm implants were designed with a matching diameter seating surface to be used mainly for poor quality bones to achieve improved stability. However, when introduced, there were no matching 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 0.45mm or 0.95 mm circumferential horizontal difference in dimension.
Radiographical reviews after the initial 5 year period revealed that when matching diameter implants and restorative components are used, the crestal bone contacting the implant normally remodelled to ~ 1.5-2 mm apically ~ to the first thread. In contrast, when smaller diameter components were placed on wider diameter platforms, the amount of crestal remodelling was reduced. Many platform switched restored implants exhibited no vertical loss in crestal bone height.

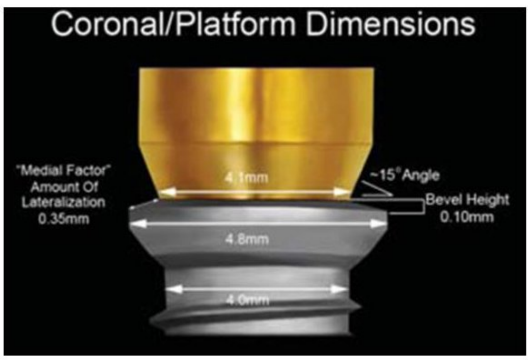
Thus, the discovery of the concept was a serendipity!

Design details of a platform switched implant restoration (Table/Fig 1)

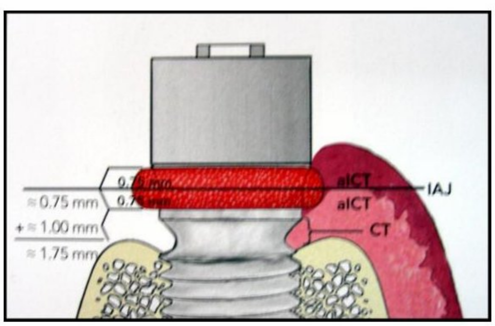
- The collar bevels medially into a smaller-diameter prosthetic platform.
- Restoring the 4.8mm diameter collar (implant restorative platform) with the

4.1mm prosthetic component medializes the implant/abutment junction.

The histology of peri-implant tissues was studied by Ericsson et al 1995 [6] [Table/Fig 2]. He identified two important entities in the implant crestal region viz., Plaque associated inflammatory cell infiltrate (P/ICT) and Implant associated inflammatory cell infiltrate (ICT). He observed that the Peri-implant bone crest was consistently located 1.0-1.5 mm apical to IAJ. The apical border of an ICT was always separated from the bone crest at ~ 1.0 mm of healthy connective tissue. Thus, he concluded that aICT is the aetiological factor for crestal bone loss.



(Table/Fig 1)

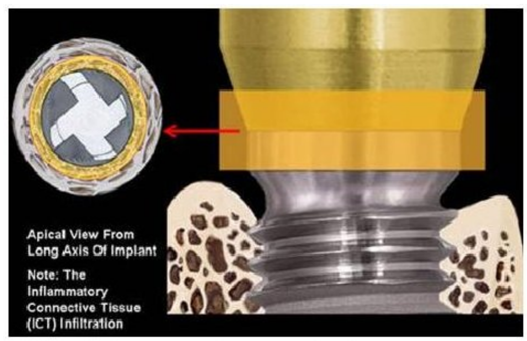


(Table/Fig 2) Histological Picture of Peri-Implant Tissue

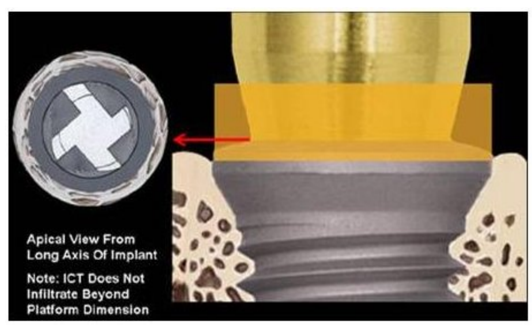
Consequences of Horizontal Repositioning: [Table/Fig 3], [Table/Fig 4].

1. Reduction in the amount of crestal bone resorption is necessary to expose a minimum amount of implant surface to which the soft tissue can attach.

2. Horizontal Repositioning of aICT within < 90-degree confined area of exposure decreases the resorptive effect of aICT on the crestal bone. Reduced diameter components beginning with healing abutment must be used from the moment the implant is exposed to the oral environment, since the process of biological width formation begins immediately.



(Table/Fig 3)



(Table/Fig 4)

Other Clinical Benefits of Platform Switching

1. Optimal Management of the Prosthetic Space

The amount of restorative volume available for an optimally contoured, physiological implant restoration is a critical factor. With the crestal bone preserved both horizontally and vertically, support is thus retained for the interdental papillae. Maintenance of midfacial bone height helps to maintain facial gingival tissues.

2. Improved Bone Support for Short Implants

Bone remodeling around a platform switched implant is minimized; therefore, there is potentially a greater bone/implant contact for short implants, thus opening the possibility of treating more patients with less extensive therapy.

Although the biological basis for platform switching has been proposed, the biomechanical aspect still needs to be investigated.

To evaluate the effect of horizontal repositioning on the stress transfer under occlusal load, an FEA was carried out.

Materials & Methods [7]

A 3D FE model of a mandibular section of bone with a missing premolar and an implant to receive a crown structure was used in this study. Two implant models were created.

1. Standard implant abutment combination without horizontal mismatch
2. Implant With Platform Switching

Bone block – 24.2 mm in height, 16.3 mm in width and length

Co- Cr was used as a crown framework material of thickness 0.8 mm. Feldspathic porcelain on occlusal surface of thickness 2mm.

All materials were presumed to be linear elastic, homogenous and isotropic [Table/Fig 5].

(Table/Fig 5) Details of parameters used in FEA.

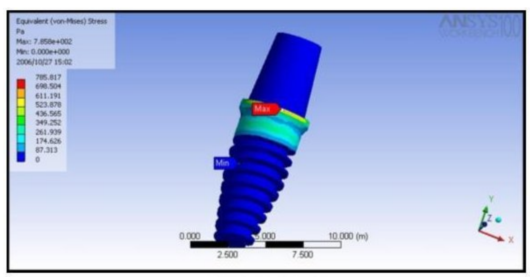
Material	Young's Modulus	Poisson's Ratio
Ti Implant & Abutment	110	0.35
Dense trabecular bone	1.37	0.3
Cortical bone	13.7	0.3
Co-Cr Alloy	218	0.33
Feldspathic porcelain	82.8	0.35

The finite element on the X-axis of each design was assumed to be fixed, which defined the boundary condition.

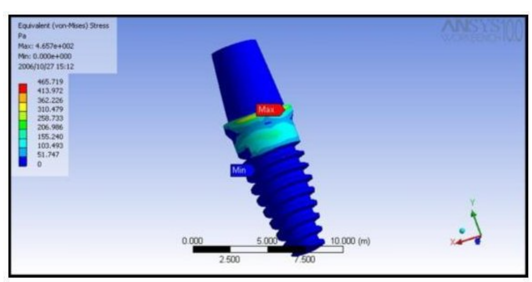
A static occlusal force of 300 N was from the buccal cusp and the distal fossa in the centric occlusion. Sevimay et al 2005.

The implant, superstructure and supporting bone were simulated using FE software (Pro/ Engineer 2000i; Parametric Tech. Corp, Needham, Mass)

The analysis was performed using software ANSYS 10.0. Stress levels were calculated using von Misses stress values. Maximum stress values were noted at the cortical bone for both implants. However, for a standard implant without a platform switch, the value was 785 Mpa and for an implant with platform switching, it was 465.71 Mpa [Table/Fig 6],[Table/Fig 7].



(Table/Fig 6)



(Table/Fig 7)

Within the limitations of this study, it can be concluded that: Von Mises stresses reached the highest values at the neck of the implant. Platform switched models exhibited lower values of Von Mises stresses than the standard implant without platform switching. These results are in accordance with previous studies on the same concept. Schrotenboer et al [8] investigated the effect of microthreads and platform switching on crestal bone stress levels, with finite element analysis. They showed that when the abutment diameter decreased from 5.0 to 4.5 mm and then to 4.0 mm, the microthread model showed a reduction of stress at the crestal bone level from 6.3% to 5.4% after vertical loading. Cappiello et al [4], in their clinical and radiographic prospective study, evaluated the bone loss around two-piece implants that were restored according to the platform-switching protocol. The data collected, showed that vertical bone loss for the test cases varied between 0.6 mm and 1.2 mm (mean: 0.95 +/- 0.32 mm), while for the control cases, bone loss was between 1.3 mm and 2.1 mm (mean: 1.67 +/- 0.37 mm). Hürzeler et al [9] reported preliminary data from a prospective clinical study about the peri-implant bone level around implants with platform-switched abutments, stating that mean bone level change from the baseline to 1-year follow-up was -0.12 mm +/- 0.40 mm for the platform switched group and -0.29 mm +/- 0.34 mm for the control group.

Conclusion

Long term clinical studies are still awaited. However, considering the foregoing biological and biomechanical analysis, the concept of 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 reconstruction occurs, but significant differences concerning the peri-implant bone height when compared with the non-platform-switched abutments, are still evident one year after final restoration. The reduction of the abutment of 0.45 mm on each side (5 mm implant/4.1 mm abutment) seems to be sufficient to avoid peri-implant bone loss.

It is certain that this concept of platform switching holds promise as a simple method to reduce crestal bone loss, physiological prosthetic contours and optimum aesthetics.

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