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Effect of Platform switching on peri-implant tissues: A review

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Abstract:*The platform switching concept involves the reduction of the restoration abutment diameter with respect to the diameter of the dental implant.Crestal bone loss has been documented as one of the important factors that affect the long term prognosis of a dental implant. Platform switching for maintaining peri-implant bone levels has gained popularity among implant manufacturers over the last few years. However, the assumption that the inward shifting of the implant- abutment junction may preserve crestal bone was primarily based on serendipitous finding rather than scientific evidence. The platform switching configuration led notonly to a relative decrease in stress levels compared to narrow and wide standard configurations, but also to a notable stress field shift from bone towards the implant system, potentially resulting in lower crestal bone overloading.This article shows that platform switching helps to prevent crestal bone loss after implant placement and helps obtain satisfactory aesthetic results. The purpose of this article is to review the biomechanical behavior of platform switching and its influence on bone crestel levels and on peri implant soft tissues*

I. Introduction

Platform switching concept

Platform switching refers to the use of an abutment of smaller diameter connected to a implant neck of larger diameter; this connection shifts the perimeter of the implant-abutment junction inwardstowards the central axis (the middle of the implant) improving the distribution of forces It was developed to control bone loss after implant placement[1]

Platform switching involves reducing the restoration abutment diameter in comparison with the diameter of the dental implant.[2 ,3]

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 the treatment that used abutments with diameters which matched to the implant[2,4,5]

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 [6]

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[7]

considering the foregoing biological and biomechanical analysis, the concept of platform switching appears to limit crestalresorption 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[8]The purpose of this article is to review the biomechanical behavior of platform switching and its influence on bone crestel levels and on peri implant soft tissues.

II. Discussion

2.1Biomechanical behavior:

The close relationship between the bone and the implant is the essence of osseointegration. The bone changes occurring at the margins adjacent to the dental implants have been the subject of many clinical and experimental studies[9]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.[10] The stress level in the cervical bone area at the implant was greatly reduced when the narrow diameter abutment was connected compared with the regular-sized one. It was suggested that the platform switching configuration has the biomechanical advantage of shifting the stress concentration area away from the cervical bone–implant interface. It also has the disadvantage of increasing stress in the abutment or abutment screw[11]

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[12]

Vigolo P in 2009 placed 182 single 5mm diameter implants in 144 patients and all implants survived.85 implants were restored with matching wide diameter prosthetic components(group A),97 implants were restored with platform switched prosthetic components (group B).A significant difference in marginal bone levels was found between group A and group B impalnts after 1 year.He found mean marginal bone resorption was 0.9mm for group A implants and 0.6mm for group B implants.[13]

Rodriguez-Ciurana et al. , 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.[14]

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[15]

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[16], 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 [16]

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 [17]

Tabata L (2011) [36] evaluated the stress distribution in peri-implant bone tissue, implants, and prosthetic components of implant-supported single crowns with the use of the platform-switching concept using 3D finite element study.. His result showed that Platform switching leads to improved biomechanical stress distribution in peri-implant bone tissue. Oblique loads resulted in higher stress concentrations than axial loads for all models. Wide-diameter implants had a large influence in reducing stress values in the implant system

2.2 Influence upon bone crestal levels:

Crestal bone loss around dental implants has been frequently documented in recent years. However, the factors implicated in the bone resorption and depositioning mechanisms in implant treatment are not fully clear [18]

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. [19]

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 [20]

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[21,22]

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 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[23]

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[12,24-27]

Canullo L [35] performed A 3D Finite Element Analysis (FEA) on 3 different implant-abutment configurations: a 3.8 mm implant with a matching diameter abutment (Standard Control Design, SCD), a 5.5 mm implant with matching diameter abutment (Wider Control Design, WCD), and a 5.5mm implant with a 3.8 mm abutment (Experimental Design, ED). All the different experimental groups were discretized to over 60000 elements and 100000 nodes, and 130N vertical (axial) and 90N horizontal loads were applied on the coronal portion of the abutment. Von Mises stresses were evaluated and maximum and minimum values were acquired for each implant-abutment configuration. Results showed that the ED configuration minimized the stresses at the implant/abutment interface region. In addition, the observed stress reduction on the coronal part of bone tissue brought about by the ED configuration with respect to SCD and to WCD configuration amounted to 160% and 33% respectively. For the ED, due to the reduced diameter abutment, stresses are concentrated on the implant fixture rather than on the bone tissues as observed for the SCD and WCD.

Where the stress level on the micro-threaded region of the implant in cortical bone is concerned, due to the wider diameter of both the ED and the WCD, presented a 200% stress reduction in comparison to the Traditional Control fixture.

2.3 Soft tissue responses:

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[28]

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[29]

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 [26,30,31]

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[32,33]

Trammell et al.[34], 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

III. Conclusion

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. Platform switching has the biomechanical advantage of shifting the stress concentration away from the bone– implant interface. It also may have thedisadvantage of increasing stress in abutment or abutment screw. It limis the crestalresorption and seems to preserve peri-implant bone levels. Therefore we conclude that 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 aesthetics

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