The "Platform Switching" Effect in Implant-Supported Prosthetics as a Prevention of Alveolar Ridge Bone Loss

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Abstract

The purpose of this review is to determine the marginal bone loss minimization by using the platform switching effect technique for implant-supported crown restoration.

Publications in the electronic databases PubMed, Google Scholar and ScienceDirect were examined during a systematic literature review. Articles containing data related to the effect of platform switching on the alveolar marginal bone structure while usage of implant-supported crown restorations were included.

51 articles were reviewed during data collection. After analysis of the publications according to the exclusion criteria, the number of included studies had become 34.

Considering the studied materials, it can be said that dental prosthetics on implants with the effect of "platform switching" create favorable conditions. There is a minimum amount of bone loss due to the bone tissue remodeling after implantation, as well as after prosthetics, by distancing the foci of microorganism contamination from the marginal bone.

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Introduction

The amount of bone around the implant after surgery is one of the important criteria for a quality implantation with a favorable prognosis. However, the loss of marginal bone in the implant area is a common problem in clinical practice. The consequence of this issue is bacterial contamination of the marginal bone and implant neck, which can lead to a variety of problems ranging from unsatisfactory aesthetic results in the form of interproximal papilla loss to complete implant loss due to secondary peri-implantitis.[1]

This problem has existed since the early days of implantation and was a natural outcome of implantation. In 1986, Albrektsson formulated the criteria for bone resorption after implantation. The norm is the loss of marginal bone at a rate of up to 1.5 mm in the first year after crown placement on the implant and the subsequent loss of a 0.2 mm per year. However, these criteria were formulated based on Bronemark system implants long-term observation, so in modern realities, they have lost their relevance. At present, implants, their design, alloys, and surface treatment have been upgraded, which helps to improve osseointegration and the preservation of bone tissue level. Nowadays, there are studies showing that in the case of usage an implant with a micro thread in the neck area and a tapered connection between abutment and implant, bone remodeling in the first year can reach 0.33-0.56 mm.[2]

A comparison of modern criteria with historical ones shows that the improvement of implant and prosthetic protocols, implants design, abutments, and their connections, based on the research, provide a possible solution to bone loss minimization after implant surgery. One of the innovations is the creation of a methodology for the platform switching effect.

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The purpose is to analyze and determine the factors influencing bone loss around the implant, methods of prevention of this phenomenon at all stages of treatment.

Materials and methods

- Information Sources

Publications obtained by searching in electronic databases such as Google Scholar, PubMed, and found articles references were examined during a literature review.

- Literature search strategy

Search terms included: «Platform switching», «microgap», «biological width», «cap healing», «marginal bone loss after implantation and prosthetics», «etiology of peri-implantitis», «implant-abutment joint», «pathogenic microflora in peri-implantitis».

- Eligibility Criteria

The following criteria were used to select articles for inclusion in the analysis:

• Articles with a publication date no earlier than 1998.
• The article discusses methods of minimizing marginal bone loss after implant placement.
• The article describes a platform switching method.

The work of analyzing the studies was performed independently by two operators and involved several steps.

• Reviewing the summary of the article and determining whether the data belonged to the topic under study.
• Reading the full-text material and using the information given in them for analysis. (Figure 1).

- Risk of Bias Assessment

A two-part Cochrane Collaboration tool was used to determine the risk of systematic error. The categorization of systematic error into levels was as follows:

- low risk when all criteria were met;
- moderate risk if only one criterion was missing;
- high risk when two or more criteria were missing;
- unclear risk, with few details available to decide on a definite risk assessment.

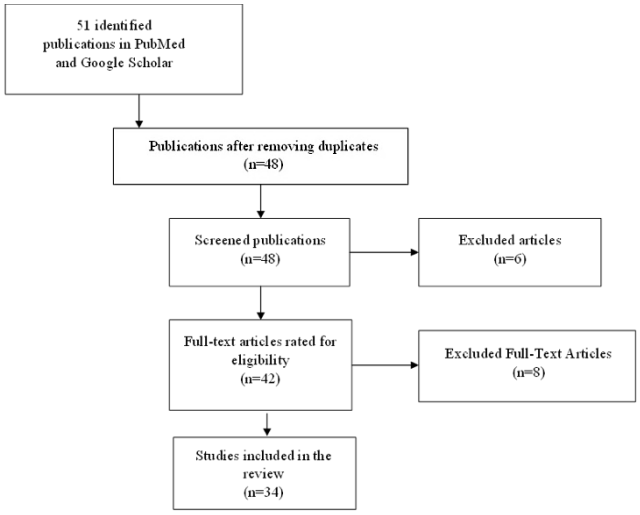

Figure 1. Article selection process.

Results

51 publications were reviewed; 15 were from the PubMed database, 36 were from the Google Scholar. The final number has become 34 after selection according to the inclusion criteria. The included studies described clinical and statistical data regarding the causes and limits of bone loss, the effectiveness of using modern systems for connecting implants and abutments.

Discussion

Improved implant designs and connections between implants and abutments give better results with regard to marginal bone health. The platform switching effect is one of the techniques to overcome the phenomenon of marginal bone loss during implantation. It is necessary to understand such concepts as: biological width of the tooth and implant (supracrestal attachment to tissues), microgap, microbial contamination as a result of microleakage causing bone loss, before determining the positive effects of this technique and due to what these effects give the necessary result.

• Biological width around the tooth.

The periodontal tissues surrounding the teeth consist of 4 anatomical structures: gingiva, gingival sulcus, connective epithelium and alveolar bone. The part of the periodontium formed by the gingival sulcus, connective epithelium and supraalveolar connective tissue

(circular ligament) forms the dento-gingival junction. This area defines the biological width, a functional unit described by Gargiulo et al. in 1961.[3,4,5]

The dimensions of the dento-gingival junction, the distance between the crest of the alveolar process and the gingival margin define the biological width. This distance is approximately 3.0 mm: 1.5-2.0 mm of gingival sulcus and connective epithelium plus 1.0-1.5 mm of connective tissue (circular ligament). Biological width is a bio-defined dimensional constant whose function is to protect and maintain the dentoalveolar junction, as an area subject to aggression by oral microflora.[3,6,7,8,9]

- Biological width of implants.

As in natural teeth, a soft tissue complex is formed around the implants protecting the bone tissue and the implant itself from microbial contamination[10,11,12], previously this formation was called biological tooth width. However, in 2017, a relatively new term - supracrestal tissue attachment (STA) - was introduced after the World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions, organized jointly by the American Academy of Periodontology (AAP) and the European Federation of Periodontology. The composition of this structure is similar to that of the biological tooth width, i.e., STA includes sulcus, epithelial attachment, and connective tissue attachment. Glauser et al.[13] in their study, conducted on one-piece mini-implants, calculated the average dimensions as 4-4.5 mm. Kahn et al.[14] calculated the average size as 6.17 mm at the mesial, 3.63 mm at the midline and 5.93 mm at the distal implant sites in their study of anterior implants after probing the bone at specific sites. The epithelium around the double-commanding implants was always located apical to the microgap.[15,16] The function of the STA is also similar to that of the biological tooth width - to protect the bone from microbial contamination and, in this case, the implant.[17,18]

- Microflora responsible to cause bone loss.

The microflora which is migrating from the oral cavity to the implant-abutment interface is mainly represented by the following bacteria: Actinobacillus actinomycetemcomitans, Tannerella forsythensis, Campylobacter rectus, Eikenella corrodens, Fusobacterium nucleatum, Porphyromonas gingivalis, Prevotella intermedia and Treponema denticola.[3,19,20,21]

Ericsson et al.[22] identified two important sites in the area of the implant crest in a study of peri-implant tissue histology. They identified a plaque-associated inflammatory cell infiltrate (PaICT) and an implant-associated inflammatory cell infiltrate (IaICT). They observed that the bony ridge around the implant was consistently located 1.0-1.5 mm apical to the implant-abutment junction (IAJ). The apical border of the IAJ was always separated from the bone crest by approximately 1.0 mm of healthy connective tissue. Thus, they concluded that IaICT is an etiologic factor in sacral bone loss.[23,24]

- Microgap.

The microgap is the gap between the implant and abutment in a two-piece implant. This point is very important clinically because it directly affects the loss of marginal bone in the implant area. According to Kano et al.[25], the horizontal impairment has values of 75-103 μm, depending on the implant system used, while the vetric impairment is 0-11 μm.[26] Dibart et al. in the study[27] found a gap as small as 5 μm, in the area of the tapered connection between the implant and abutment. Above mentioned information allows us to call these conditions "sterile" because the size of the bacteria exceeds the size of the microgap. The connective epithelium extends to the implant-abutment contact surface (or even slightly below this level), and the connective tissue borders the implant collar. This gap allows microleakage of fluids containing small molecules of disaccharides and short peptides that contain bacterial byproducts or nutrients necessary for bacterial growth (better known as an infiltrate of adjacent inflammatory cells).[28] This results in horizontal and vertical bone resorption ranging from 1.5-2 mm.[16]

- The concept of "platform switching".

In 1991, Implant Innovations, Inc. (3i, Palm-Beach-Gardens, Florida, USA) introduced 5 and 6mm diameter implants with abutments of the same size. Clinicians used 4.1 mm diameter abutments due to the unavailability of appropriately sized abutments. After a 5-year period, typical alveolar ridge resorption was not observed radiologically after using this design of abutments.

The concept of "platform switching" refers to the use of a smaller diameter abutment on a larger diameter implant neck. This connection shifts the perimeter of the implant-abutment junction (IAJ) inward toward the central axis of

the implant, thus there is a control or reduction of bone loss horizontal component and also a protection of the marginal bone from stress concentration. Also, inward displacement of the IAJ moves inflammatory cell infiltration toward the central axis of the implant and away from the adjacent alveolar ridge, which is thought to limit alveolar ridge resorption. Moreover, bone ridge loss and soft tissue stability are influenced by the abutment neck length, which determines the final placement of the crown margin and the subsequent aesthetic outcome.[1,2,29,30] An important step before direct implant prosthetics is also the use of gingival shapers for gingival healing with direct formation of the gingival margin (soft tissue bed for the base of the crown). For example, if the Astra tech system is used for implantation, the formation of a crown space is carried out by gradually size increase of the gum former, starting from d=3.0 mm (which also depends on the group of the tooth where the defect was located), forming a sufficient amount of space for soft tissues. While the data on the diameter of the gum former are translated when transferring the prosthetic protocol, which is also an integral part of prosthetics on implants. Due to these manipulations and formation, and soft tissue remodeling, a barrier against the penetration of pathogens is formed (sufficient thickness of the vertical volume of the gingiva is formed), which in turn can be a prevention of bone resorption phenomenon, as well as a serious complication as overimplantitis.

Markus Hurzeler[31] studied by comparison the bone loss of the alveolar ridge around implants with and without platform switching. The results showed that the average sacral bone loss was 0.22 mm for implants with platform switching and 2.02 mm for implants without platform switching respectively. On this basis, they also concluded that a reduction in abutment size of 0.45 mm on each side is sufficient to avoid bone loss around the implant. Cappiello et al. conducted a study[32] and analyzed the results. They concluded that vertical bone loss for cases with platform change ranged from 0.6 to 1.2 mm (mean: 0.95 ± 0.32 mm), while for cases without platform change, bone mass loss ranged from 1.3 and 2.1 mm (mean: 1.67 ± 0.37 mm).[33]

In another study, Canullo et al. divided 80 implants based on platform diameter into four groups: 3.8 mm (control), 4.3 mm (test group 1), 4.8 mm (test group 2), and 5.5 mm (test group 3). Placement was performed in the posterior maxilla in 31 patients. After 3 months, the implants were connected to a 3.8 mm abutment and final restorations were made. Radiographically, bone height was measured by two independent examiners at the time of implant placement (baseline) and after 9, 15, 21, and 33 months.

After 21 months, all 80 implants were clinically osseointegrated in 31 treated patients. A total of 69 implants were available for analysis, as 11 implants had to be excluded from the study due to early inadvertent plug exposure. Radiographic evaluation showed a mean bone mass loss of 0.99 mm (SD=0.42 mm) for test group 1, 0.82 mm (SD=0.36 mm) for test group 2 and 0.56 mm (SD=0.31 mm) for test group 3. These values were statistically significant lower (P<0.005) in comparison with controls (1.49 mm, SD=0.54 mm). After 33 months, five patients dropped out of follow-up. Evaluation of the remaining 60 implants showed no differences compared to the data after 21 months, except for test group 2 (0.87 mm) and test group 3 (0.64 mm).[34]

Vella-Nebot et al., in the study3 presented a series of 30 control cases and 30 study cases using the platform switching technique. Interproximal bone resorption medially and distally of each implant was evaluated with digital radiography at 1,4 and 6 months after abutment placement.

The results of the study showed that the mean value of bone resorption observed in the mesial measurement for the control group was 2.53 mm, whereas it was 0.76 mm for the patients included in the main group. The mean value of bone resorption observed in the distal measurement for the patients in the control group was 2.56 mm, whereas it was 0.77 mm for the patients included in the main group.

These studies indicate the effectiveness of this design of abutments with respect to bone preservation, which gives high esthetic results and absence of complications associated with bone loss.

- "Dual platform switching".

It is necessary to have a sufficient vertical volume of gingival soft tissues for minimal bone remodeling. As it was mentioned above, gingival formers and abutments of smaller diameter than the implant diameter are used for this purpose in the Platform switching concept, but in order to achieve the maximum result it is necessary to

minimize the width parameters of the previously mentioned structures, in this case there are problems in creating an aesthetically acceptable design.

This problem is solved by the use of the s-shaped contour of the abutment neck, e.g. with the AnyRidge prosthetic system. The lower part of the abutment, which is 1.5-2 mm long, is maximally narrowed and then sharply widened to match the abutment diameter. Thus, it allows to create maximum space for soft tissues around the implant of any diameter (provided that there is a single prosthetic platform).

Conclusions

The "platform switching" concept accordingly contributes to the reduction of marginal bone loss of the alveolar ridge due to:

-Displacement of the inflammatory cell infiltrate inward and away from the adjacent alveolar ridge.

-Preservation of the biological width and increased distance of the IAJ from the level of the alveolar ridge.

-The possible influence of the microgap on the alveolar ridge is reduced.

In this way, the clinician can provide a more predictable and precise treatment result in the long term, increase the longevity of the implant and create the desired gingival profile in the aesthetically important area.

Declaration of Interest

The authors report no conflict of interest.

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