Factors Influencing the Preservation of the Periimplant Marginal Bone

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Numerous techniques within surgical hard-tissue and soft-tissue management are available today to assist in achieving an ideal aesthetic treatment result. The current view is that the long-term preservation of healthy periimplant tissues is of primary importance for ensuring function and esthetics over an extended period. The following parameters play a significant role: (a) considerations of biologic width; (b) the concept of platform switching; (c) implant design in the cervical region: (d) nanoroughness; (e) fine threads; (f) insertion depth; (g) abutment design; and (h) the avoidance of microlesions in the periimplant soft tissue created by the exchange of various secondary prosthetic components.

A stable bone level around the implant neck is a prerequisite for achieving support and, hence, long-term optimal and stable gingival contours. This is especially so with regard to the interdental papillae in the anterior region. It is important to consider all the possible factors that may exert an influence within this sensitive region when designing an implant treatment plan to achieve an optimized functional/esthetic treatment outcome.

Biologic Width

The clinical term biologic width denotes the dimensions of periodontal and periimplant soft-tissue structures such as the gingival sulcus, the junctional epithelium, and the supracrestal connective tissues. According to Tarnow et al., the bone facing the oral cavity is invariably covered by periodontal tissue, connective tissue, and epithelial tissue, all of which may vary in thickness. The original studies of the “dentogingival complex” can be traced back to Gottlieb, whom Orban and Kohler returned many years later. Gargiulo et al. examined the dimensions of these tissues in dead human bodies. One year later, in 1962, Cohen defined the clinical concept of biologic width to include the dimensions of the epithelial and connective tissue attachments. The definition of the dentogingival complex additionally includes the vertical dimension of the gingival sulcus.

According to measurements conducted by Gargiulo et al., the average biologic width (from the base of the sulcus to the alveolar bone margin) is 2.04 mm, of which 0.97 mm is epithelial attachment and 1.07 mm is connective tissue attachment. These dimensions, however, are in no way static but subject to interindividual variation (from tooth to tooth and from patient to patient) and will also vary according to gingival types and implant concepts.

Numerous studies have shown that bone resorption around the implant neck does not start until the implant is uncovered and exposed to the oral cavity. This invariably leads to...

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first defined by Tarnow et al1 in 1992 and modified in 2003,12 and the distance between the bony base of the papilla and the contact point of the superstructure. Only if all these points are observed can we expect the interdental space to be filled in completely, leading to an optimal esthetic outcome.

The Platform-Switching Concept

The platform switching effect was first observed in the mid-1980s. At the time, larger-diameter implants were often restored with narrower abutments (Ankylos Densply, Friadent, Germany; Astra-Zeneca, Sweden; Bi- con, Boston), as congruent abutments were often still unavailable. As it later turned out, this was a remarkable coincidence.

The abutments used with conventional implant types are generally flush with the implant shoulder in the contact zone. With many implant systems, this results in the formation of microcracks between the implant and the abutment. Numerous studies13–15 have shown that bacterial contamination of the gap between the implant and the abutment adversely affects the stability of the perimplant tissue. If above-average axial forces are exerted on the implant, a pumping effect may ensue (depending on the positive internal/external connection at the interface) that may then result in a flow of bacteria from the gap, provoking the formation of inflammatory connective tissue in the region of the implant neck. Ericsson et al16 coined the term distance-sleeve-associated infiltrated connective tissue to describe this phenomenon. They interpreted this to be a biological protective mechanism against the bacteria residing in the microcrack, explaining the plaque-independent bone loss of approximately 1 mm during the first year. This bone loss may result in a reduction of the marginal bone level in both the vertical and the horizontal dimensions. The entire process must be seen as a bacterial infection occurring naturally on transgingival implants and on submucosally placed implants as they are exposed, in both cases as a result of the communication with the oral cavity.7–10 If the microcrack is located close to the bone, the creation of the biologic width will occur at the expense of the bone.5,16–18

The platform-switching concept requires that this microcrack be placed away from the implant shoulder and closer toward the axis in order to increase the distance of this microcrack from the bone.19–21 This generally implies the use of a reduced-diameter abutment (Figs. 1 and 4). The implant used has a standard abutment diameter of 3.05 mm. With implant diameters of 3.8, 4.3, and 5.0 mm, the abutment margin runs between 0.375 and 0.975 farther axially than the circumference of the implant. According to the microbiological considerations outlined above, this delivers a measure of protection for the marginal bone.

The preservation of the perimplant bone is particularly important in the esthetic zone and in areas with a limited bone supply. Here the objective is to avoid provoking an additional postprosthetic bone loss and to preserve the long-term stability of the bone and soft tissue alike.

Implant Design in the Cervical Region: Nanoroughness, Fine Threads, and Insertion Depth

Conventional implant types generally feature a smoothly polished cervical region that may vary in width. As a result of the radiologic and histologic studies conducted by Hermann et al13,22 there is awareness of the implications of the position of the implant shoulder on crestal bone resorption. The relative positions of the interface between the implant shoulder and the abutment and the transition zone from the smooth to the rough implant surface, respectively, to the alveolar ridge are of eminent importance. The literature mentions a distance of 3.6 mm in the mandible and 4.1 mm in the maxilla between the point of first bone-to-implant contact and the implant shoulder for ITI (Straumann, Switzerland) standard implants (2.8 mm) with this neck configuration.23 Current trends in implant design favor a reduction or elimination of the smoothly polished segment. In newer implants, the rough segment was extended 1 mm coronally. Here the biologic width created was reduced to an average of 2.19 mm after 32 months.24 Therefore, it is to be ex-
expected that the biologic width will be reduced by limiting the width of the smoothly polished cervical region. However, if the smooth segment is inserted below the bone level, the bone will resorb all the way down to the rough-to-smooth transition line. Moreover, it was shown that the amount of bone loss also depends on the nature of the adjacent structures (cantilever situation, implant, natural dentition). The biologic width in 2-piece implant systems invariably starts at the implant-abutment interface. Depending on the positive fit of the internal or external connective interface, this microcrack might provoke bone loss to an extent that will vary, depending on the insertion depth of the implant.

Our experience with an implant design of the most recent generation that has continuous microrough and nanorough surface extending to the implant neck and a fine thread in the cervical region (Fig. 5) has shown that the crestal bone level was stabilized in numerous clinical cases. Integrating the platform-switching concept in the presence of a completely rough implant surface played a central role in moving the microcrack on the implant platform more closely to the implant axis, counteracting bone resorption tendencies.

Implants with a continuous micro-rough and nanorough titanium surface extending to the implant neck facilitate osseointegration along the entire length of the implant, involving the entire implant surface. A fine thread in the cervical region results in functional loads being transmitted to the adjacent bony structures, supporting the formation of trabecular bony structures and stabilizing the region in question. Complete bony coverage of the entire implant surface can be attained upon successful osseointegration if the platform-switching concept is implemented.

When inserting implants in a reduced-bone environment, an additional advantage of the fine thread around the implant neck becomes manifest: the thread stabilizes the implant in the presence of an under-prepared osteotomy (implant bed preparation), contributing to the achievement of primary stability. This

Fig. 2. Checking the 3-dimensional position, using parallelizing posts.
Fig. 3. Macrodesign of an implant and the integrated platform-switching concept.
Fig. 4. Revois implant with a rough titanium surface extending to the implant shoulder, integrated platform switching, and a fine thread around the implant neck.
Fig. 5. Radiological situation at the 1-year follow-up. The marginal bone level is preserved.
Fig. 6. Radiological control prior to impression-taking showing the multifunctional precision post.
in turn may help reduce the length of time for the healing phase.

### Abutment Design and the Avoidance of Microlesions: Radiologic Follow-Up

The radiologic follow-up images in Figs. 5 and 6 impressively demonstrate the effect of platform switching. Following immediate placement of an implant (Revois 3.8/13 mm; Curasan AG) in the region of tooth 45, a transgingival healing mode using a narrower healing cap was selected. Following a healing phase of 4 months, an impression was taken using a multifunctional precision post of 3.05 mm (compared to the implant diameter of 3.8 mm), which relocates the biologic microcrack inward toward the implant axis and reduces the amount of distance-sleeve-associated infiltrated connective tissue formed. Additional nonsurgical thickening of the soft tissue is caused by the tapered shape of the post and its tulip profile as the prepared ledge 1.9 mm above the implant shoulder is approached (Figs. 1, 4, 5, and 6). Fig. 6 shows the situation directly before the impression was taken, whereas Fig. 5 shows the situation 1 year after insertion of the prosthetic reconstruction. The standardized radiologic follow-ups clearly show the preservation of the interdental bone, which is located at the level of the prosthetic platform. It should be noted that this effect is not created by platform switching alone but is the result of the combination of all the factors previously described.

The influence of additional parameters on the functional and esthetic long-term results of implant therapy will be discussed in the next installment of this series of articles titled “Parameters of Esthetics.” This is intended be able to integrate many criteria and documented results into im-
Implant therapy in the esthetically sensitive anterior region to achieve optimal long-term treatment outcomes. These criteria include:

1. Anatomy: bone volume/bone quality
2. Mucosal quality: type/thickness
3. Condition of the adjacent teeth: classification of Palacci
4. Distances to the adjacent teeth: Tarnow relations
5. Biologic width and the platform-switching concept
6. Implant design: macro-/micro-/nanostructure and implant dimensions
7. Abutment design: macro-/micro-/nanostructure
8. Augmentation procedures: type/materials/membranes
9. Surgical procedure: soft-tissue management/ton of insertion; implant insertion depth; time of loading/time of restoration
10. Prosthetic procedure: frequency of secondary-component replacement
11. Suturing techniques: materials
12. Provisional restorations: abutment materials/abutment shapes; crown materials/crown shapes
13. Definitive restorations: abutment materials/abutment shapes; crown materials/crown shapes
14. Patient compliance: oral hygiene/smoking/nutrition/recall intervals

**CONCLUSION**

For long-term esthetic results with implant restorations, the following parameters are important:

- Implant position following the literature concerning distance between implants or implants and natural teeth.
- Implant design and macro-, micro-, and nanostructures play an important role in maintaining the bone and soft tissue in the initial positions.
- Platform switching in combination with a final abutment inserted the day of implant placement (nonocclusal restoration) can be useful to obtain and maintain the long-term result concerning the biological width.

**Clinical Case**

Figs. 7 through 15 exemplify our procedure by showing a clinical case.

**Disclosure**

Each of the authors claims to have a financial interest in Curasan Company, whose product Revois Implant is mentioned in this article, inasmuch as each author lectures for Curasan.

**REFERENCES**


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Maßgebliche Parameter für ein ästhetisches Ergebnis: Teil I
Die die Erhaltung des randständigen Knochengewebes im des Implantat umlagernden Bereich beeinflussenden Faktoren.