TRANSMUCOSAL ATTACHMENT IN DENTAL IMPLANT
(LITERATURE STUDY)

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ABSTRACT

In dental implants surgery, there are two biological considerations that must be considered, namely; Relations the soft tissue-implant interface (Transmucosal Region), as well as the relationship of bone-implant interface (Jaw-Bone Region). Healing of the mucosa results in the establishment of a soft tissue attachment (transmucosal attachment) to the implant. Transmucosal attachment serves as a seal that prevents products from the oral cavity reaching the bone tissue, and thus ensures the osseointegration and the rigid fixation of the implant. The peri-implant mucosa and the gingiva have several clinical and histological characteristics in common. Some important differences, however, also exist between the gingiva and the peri-implant mucosa. The mucosal tissues around intraosseous implants form a tightly-adherent attachment known as transmucosal attachment consisting of a dense collagenous lamina propria covered by keratinized stratified squamous epithelia. The implant barrier epithelium is analogous to the junctional epithelium around natural teeth; in that, the epithelial cells attach to the titanium implant by means of hemidesmosomes and basal lamina. This evidence supports the concept that a viable biologic seal can exist between the epithelial cells and the implants. Since endosseous implants are permucosal, the soft tissue-implant interface should be considered in their placement and maintenance.

Key Word: Dental Implant, Transmucosal Attachment, Biological Seal

INTRODUCTION

The concept of replacing missing teeth for esthetics and function has been an elusive goal for more than 1500 years. This has led to the evolution of many materials and techniques including complete dentures, removable and fixed partial dentures. To overcome the limitations of these materials and techniques, dentistry has long sought a superior method of artificial tooth replacement through dental implants with a goal of restoring the normal contour, comfort, esthetics, health and the most traditional dental disciplines, which
include the bone and soft tissue reconstruction. In dental implants surgery, there are two biological considerations that must be considered, namely; Relations the soft tissue-implant interface (Transmucosal Region), as well as the relationship of bone-implant interface (Jaw-Bone Region). 

The mucosal tissues around intraosseous implants form a tightly-adherent attachment known as transmucosal attachment consisting of a dense collagenous lamina propria covered by keratinized stratified squamous epithelia. The implant barrier epithelium is analogous to the junctional epithelium around natural teeth; in that, the epithelial cells attach to the titanium implant by means of hemidesmosomes and basal lamina. 

This evidence supports the concept that a viable biologic seal can exist between the epithelial cells and the implants. Since endosseous implants are permucosal, the soft tissue-implant interface should be considered in their placement and maintenance.

LITERATURE REVIEW

Periimplant Mucosa

The soft tissue that surrounds dental implants is termed periimplant mucosa. Features of the periimplant mucosa are established during the process of wound healing that occurs subsequent to the closure of mucoperiosteal flaps following implant installation (one-stage procedure) or following abutment connection (two-stage procedure) surgery. Healing of the mucosa results in the establishment of a soft tissue attachment (transmucosal attachment) to the implant. Transmucosal attachment serves as a seal that prevents products from the oral cavity reaching the bone tissue, and thus ensures osseointegration and the rigid fixation of the implant. The peri-implant mucosa and the gingiva have several clinical and histological characteristics in common. Some important differences, however, also exist between the gingiva and the peri-implant mucosa.

Fig. 1. Schema of biological region around dental implants The surrounding tissue of dental implants is biologically divided into two regions; jaw-bone and transmucosal regions. A variety of oral pathogens (red arrows), likely bacteria and their products, are able to penetrate into the submucosal tissue around dental implants through the transmucosal region around dental implants, followed by causing the destruction of peri-implant tissue, similar to the destruction of periodontal tissue around tooth.
Dimension

The structure of the mucosa that surrounds implants made of titanium has been examined in man and several animal models (for review see Berglundh 1999). In an early study in the dog, Berglundh et al. (1991) compared some anatomic features of the gingiva (at teeth) and the mucosa at implants.

The clinically healthy gingiva and peri-implant mucosa had a pink color and a firm consistency. In radiographs obtained from the tooth sites it was observed that the alveolar bone crest was located about 1 mm apical of a line connecting the cementoenamel junction of neighboring premolars. The radiographs from the implant sites disclosed that the bone crest was close to the junction between the abutment and the fixture part of the implant. (Figure 3).

Figure 2. After 4 months of careful plaque control the gingiva (a) and the peri-implant mucosa (b) are clinically healthy

Figure 3 (Left) Radiograph obtained from the premolars in the left side of the mandible. (Right) Radiograph obtained from the implants in the right side of the mandible.

Figure 4 (Left). Microphotograph of a cross section of the buccal and coronal part of the periodontium of a mandibular premolar. Note the position of the soft tissue margin (top arrow), the apical cells of the junctional epithelium (center arrow) and the crest of the alveolar bone (bottom arrow). The junctional epithelium is about 2 mm long and the supracrestal connective tissue portion about 1 mm high. Figure 4 (right). The direction of the principal fibers (arrows).
Histological examination of the sections revealed that the two soft tissue units, the gingiva and the peri-implant mucosa, had several features in common. The oral epithelium of the gingiva was well keratinized and continuous with the thin junctional epithelium that faced the enamel and that ended at the cemento-enamel junction (Fig. 4). The supraalveolar connective tissue was about 1 mm high and the periodontal ligament about 0.2–0.3 mm wide. The principal fibers were observed to extend from the root cementum in a fan-shaped pattern into the soft and hard tissues of the marginal periodontium.³

The outer surface of the peri-implant mucosa was also covered by a keratinized oral epithelium, which in the marginal border connected with a thin barrier epithelium (similar to the junctional epithelium at the teeth) that faced the abutment part of the implant. It was observed that the barrier epithelium was only a few cell layers thick and that the epithelial structure terminated about 2 mm apical of the soft tissue margin and 1–1.5 mm from the bone crest. The connective tissue in the compartment above the bone appeared to be in direct contact with the surface (TiO2) of the implant. The collagen fibers in this connective tissue apparently originated from the periosteum of the bone crest and extend towards the margin of the soft tissue in directions parallel to the surface of the abutment.³

In another study (Abrahamsson et al. 1998), it was demonstrated that the material used in the abutment part of the implant was of decisive importance for the location of the connective tissue portion of the transmucosal attachment. Abutments made of aluminum based sintered ceramic (Al2O3) allowed for the establishment of a mucosal attachment similar to that which occurred at titanium abutments. Abutments made of a gold alloy or dental porcelain, however, provided conditions for inferior mucosal healing. When such materials were used, the connective tissue attachment failed to develop at the abutment level. Instead, the connective tissue attachment occurred in a more apical location. Thus, during healing following the abutment connection surgery, some resorption of the marginal peri-implant bone took place to expose the titanium portion of the fixture to which the connective tissue attachment was eventually formed.³

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Figure 5. (Left) Microphotograph of a buccal–lingual section of the peri-implant mucosa. Note the position of the soft tissue margin (top arrow), the apical cells of the junctional epithelium (center arrow), and the crest of the marginal bone (bottom arrow). The junctional epithelium is about 2 mm long and the implant–connective tissue interface about 1.5 mm high.³ Figure 5 (Right). Higher magnification of the apical portion of the barrier epithelium (arrow).³
Figure 6 (Left). Schematic drawing illustrating that the mucosa at the test site was reduced to about 2 mm. From Berglundh & Lindhe (1996) (Right) Schematic drawing illustrating that the peri-implant mucosa at both control and test sites contained a 2 mm long barrier epithelium and a zone of connective tissue that was about 1.3–1.8 mm high. Bone resorption occurred in order to accommodate the soft tissue attachment at sites with a thin mucosa. From Berglundh & Lindhe (1996).

Gambar 7 (Left). Note on the tooth side the presence of an acellular root cementum with inserting collagen fibers. The fibers are orientated more or less perpendicular to the root surface. Microphotograph of the peri-implant mucosa and the bone at the tissue/titanium interface. Note that the orientation of the collagen fibers is more or less parallel (not perpendicular) to the titanium surface.

The location and dimensions of the transmucosal attachment were examined in a dog experiment by Berglundh and Lindhe (1996). Implants (fixtures) of the Brånemark System® were installed in edentulous premolar sites and submerged. After 3 months of healing, abutment connection was performed. In the left side of the mandible the volume of the ridge mucosa was maintained while in the right side the vertical dimension of the mucosa was reduced to ≤2 mm (Fig. 3.19) before the flaps were replaced and sutured. In biopsy specimens obtained after another 6 months, it was observed that the transmucosal attachment at all implants included one barrier epithelium that was about 2 mm long and one zone of connective tissue attachment that was about 1.3–1.8 mm high. A further examination disclosed that at sites with a thin mucosa, wound healing consistently had included marginal bone resorption to establish space for a mucosa that eventually could harbor both the epithelial and the connective tissue components of the transmucosal attachment.
Figure 8 (Left). Microphotograph of the implant/connective tissue interface of the peri-implant mucosa. A large number of fibroblasts reside in the tissue next to the implant. Figure 8 (Right). Schematic zone A and B.

Figure 9. A buccal–lingual section of a beagle dog gingiva. Cleared section. The vessels have been filled with carbon. Note the presence of a suprapериosteal vessel on the outside of the alveolar bone, the presence of a plexus of vessels within the periodontal ligament, as well as vascular structures in the very marginal portion of the gingiva.

Quality

The quality of the connective tissue in the supraalveolar compartments at teeth and implants was examined by Berglundh et al. (1991). The authors observed that the main difference between the mesenchymal tissue present at a tooth and at an implant site was the occurrence of a cementum on the root surface. From this cementum (Fig. 3-22), coarse dento-gingival and dento-alveolar collagen fiber bundles projected in lateral, coronal, and apical direction. At the implant site, the collagen fiber bundles were orientated in an entirely different manner. Thus, the fibers invested in the peristeum at the bone crest and projected in directions parallel with the implant surface (Fig. 3-23). (Buser et al. 1992).  

The connective tissue in the supra-crestal area at implants was found to contain more collagen fibers, but fewer fibroblasts and vascular structures, than the tissue in the corresponding location at teeth. Moon et al. (1999), in a dog experiment, reported that the attachment tissue close to the implant (Zone A) contained only few blood vessels but a large number of fibroblasts (Collagen 67%, Fibroblast 32% dan Blood vessel 0,3%)
that were orientated with their long axes parallel with the implant surface. In more lateral compartments (Zone B), there were fewer fibroblasts but more collagen fibers and more vascular structures (Collagen 85%, Fibroblast 11%, Vascular 3%). From these and other similar findings it may be concluded that the connective tissue attachment between the titanium surface and the connective tissue is established and maintained by fibroblasts.

**Blood Supply**

The vascular supply to the gingiva comes from two different sources (Fig. 3-26). The first source is represented by the large supraperiosteal blood vessels, that put forth branches to form (1) the capillaries of the connective tissue papillae under the oral epithelium and (2) the vascular plexus lateral to the junctional epithelium. The second source is the vascular plexus of the periodontal ligament, from which branches run in a coronal direction and terminate in the supraalveolar portion of the free gingiva. Thus, the blood supply to the zone of supra-alveolar connective tissue attachment in the periodontium is derived from two apparently independent sources.

Berglundh et al. (1994) observed that the vascular system of the peri-implant mucosa of dogs (Fig. 3-27) originated solely from the large supraperiosteal blood vessel on the outside of the alveolar ridge. This vessel that gave off branches to the supra-alveolar mucosa and formed (1) the capillaries beneath the oral epithelium and (2) the vascular plexus located immediately lateral to the barrier epithelium. The connective tissue part of the transmucosal attachment to titanium implants contained only few vessels, all of which could be identified as terminal branches of the supraperiosteal blood vessels.

*Figure 10. A buccal-lingual cleared section of a beagle dog mucosa facing an implant (the implant was positioned to the right). Note the presence of a supraperiosteal vessel on the outside of the alveolar bone, but also that there is no vasculature that corresponds to the periodontal ligament plexus. (b) Higher magnification Note the presence of a vascular plexus lateral to the junctional epithelium, but the absence of vessels in the more apical portions of the soft tissue facing the implant and the bone.*
DISCUSSION

In dental implants surgery, there are two biological considerations that must be considered, namely: Relations the soft tissue-implant interface (Transmucosal Region), as well as the relationship of bone-implant interface (Jaw-Bone Region).1,4

The mucosal tissues around intraosseous implants form a tightly-adherent attachment known as transmucosal attachment consisting of a dense collagenous lamina propria covered by keratinized stratified squamous epithelia. The implant barrier epithelium is analogous to the junctional epithelium around natural teeth; in that, the epithelial cells attach to the titanium implant by means of hemidesmosomes and basal lamina.1

This evidence supports the concept that a viable biologic seal can exist between the epithelial cells and the implants. Since endosseous implants are permucosal, the soft tissue-implant interface should be considered in their placement and maintenance.1

Transmucosal Attachment can be said to have a resemblance with a slight difference to the relationship with the soft tissue and the teeth, so that the relationship must be considered during installation and maintenance of the implants. This attachment aims to prevent foreign bodies from the oral cavity reaches the bone tissue, and with thus it can be ascertained occurrence of osseointegration and strong fixation of the implant.3

In another study (Abrahamsson et al. 1998), it was demonstrated that the material used in the abutment part of the implant was of decisive importance for the location of the connective tissue portion of the transmucosal attachment. Abutments made of aluminum based sintered ceramic (Al2O3) allowed for the establishment of a mucosal attachment similar to that which occurred at titanium abutments.3

CONCLUSION

Transmucosal attachment is composed of two parts, the barrier epithelium that is similar to the junctional epithelium with a length of 2 mm. Then proceed with the connective tissue zones with a thickness of 1 - 1.5 mm which is composed of collagen fibers running in parallel with the surface of the implant, the fibers originating from the periosteum of the alveolar bone crest.

The connective tissue in the area supracrestal implants was found to contain more collagen fibers, but fewer fibroblasts and vascular structures.

The vascular system of the mucous periimplant come only from large supra-periosteal blood vessels, which provide blood supply to the connective tissue under the oral epithelium and the connective tissue in the lateral barrier epithelium. This happens due to lack of vascular source derived from the periodontal ligament around Implant.

The implant barrier epithelium is analogous to the junctional epithelium around natural teeth; this evidence supports the concept that a viable biologic seal can exist between the epithelial cells and the implants.
REFERENCES


