Histologic comparison of biologic width around teeth versus implants: The effect on bone preservation

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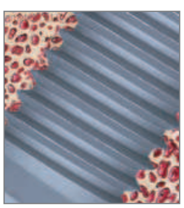


Histological analysis of the biological width surrounding primate teeth offers insights into why the blood supply is reduced after tooth extraction and implant placement. This occurs because of the reduction of ridge width and height. The reduction in blood supply tends to be exacerbated as development of a new biologic width after implant placement causes facial bone to be lost both vertically and horizontally. Evaluation of patient biotypes, combined with use of an implant designed to reduce crestal bone loss, can help to achieve optimal aesthetics.

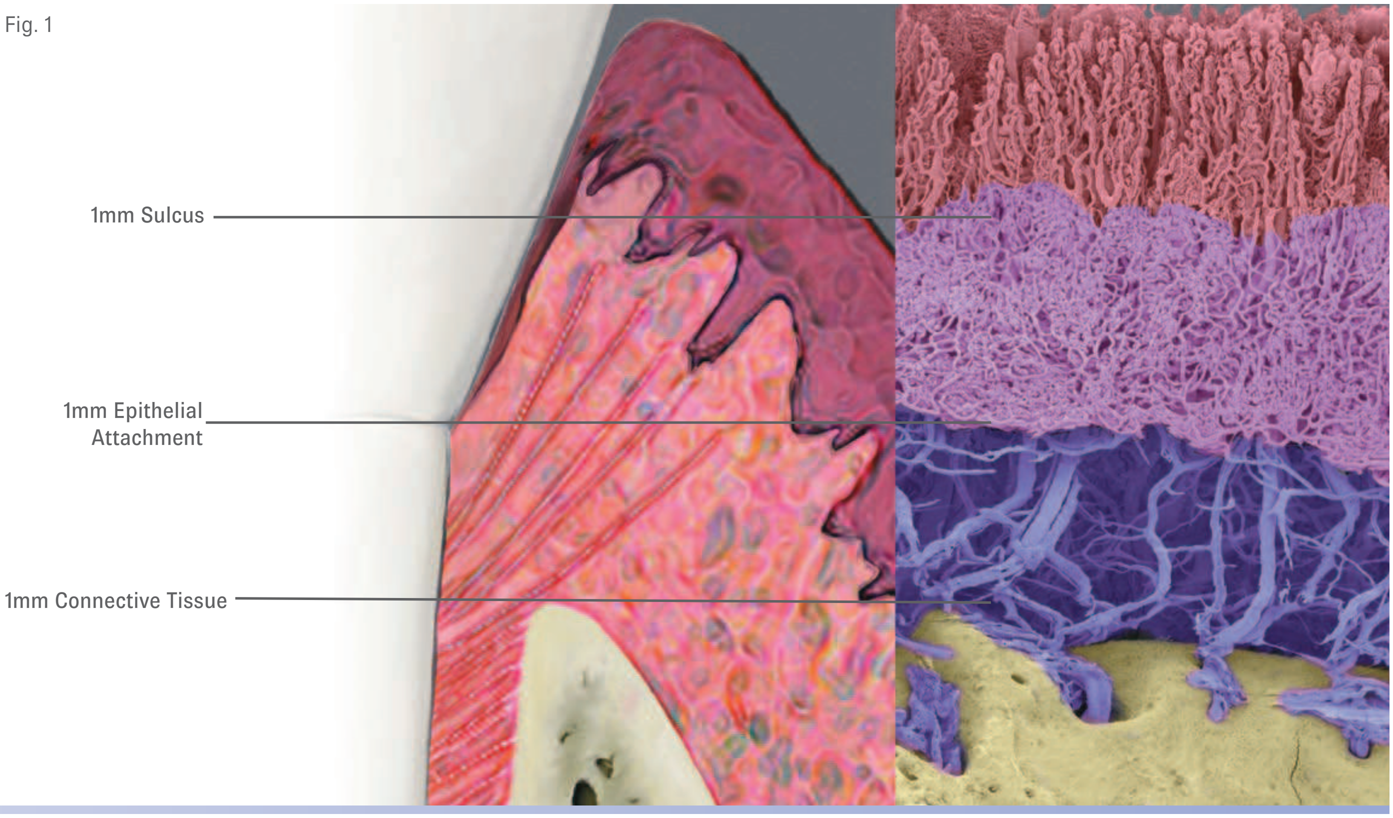
Key Words: biologic width, microvasculature, platform switching, crestal bone preservation

Introduction

In the human body, ectodermal tissue serves to protect against invasion from bacteria and other foreign materials. However, both teeth and dental implants must penetrate this defensive barrier. The natural seal that develops around both, protecting the alveolar bone from infection and disease, is known as the biologic width. Around natural teeth, the biologic width has been shown to consist of approximately 1mm of connective tissue, 1mm of epithelium, and 1mm or more of sulcular depth (Fig. 1).[1] The biologic width that develops around implants at the time of abutment connection has been demonstrated to incorporate tissue zones of similar dimensions.[2] However, figures 2 and 3 demonstrate some morphologic differences in the distribution of the vascular network.

Although previous researchers have histologically examined the blood supply to the tissues of the biologic width, this work primarily has been conducted utilizing rats and dogs.[3] To assess the microvasculature of the biologic width in primates, the author worked with Japanese snow

Fig. 1



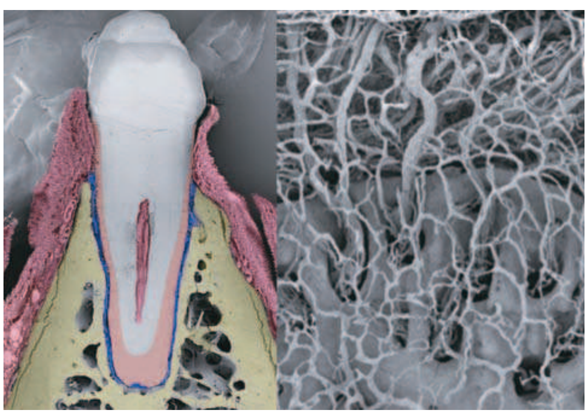


Fig. 2

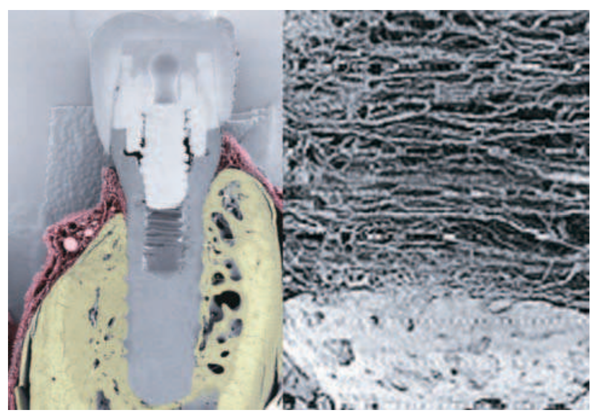


Fig. 3

monkeys *(Macaca fuscata)*, whose masticatory function and mandibular morphology closely resembles that of humans.[4] Three animals were placed on a controlled regimen of oral care, then euthanized and injected with acrylic resin. After the resin hardened, the mandible was sliced at the first premolar and bone-microvasculature cast specimens were prepared for observation under an SEM (JSM-5500, JEOL, Tokyo, Japan). Subsequently, the tooth was extracted and clear morphological differences were observed between the gingival area of the alveolus, the alveolar mucosa, and the body of the mandible. Furthermore, three different blood supply routes to the gingival connective tissue attachment site were identified.

The origins of these blood supply routes are as follows: from the periodontal ligament to the connective tissue, from the alveolar process to the periodontal ligament and then to the connective tissue, and from the alveolar process directly to the connective tissue (Fig. 4).

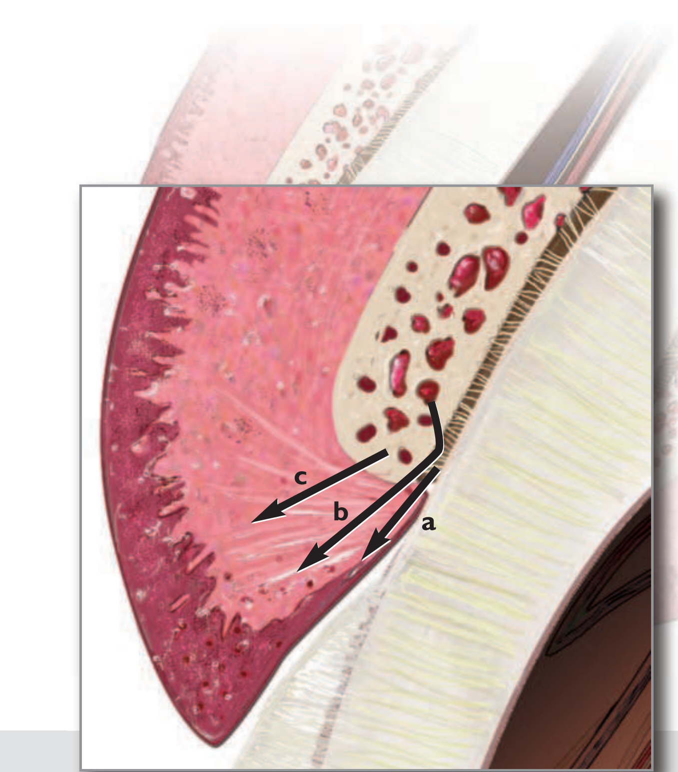


Fig. 4

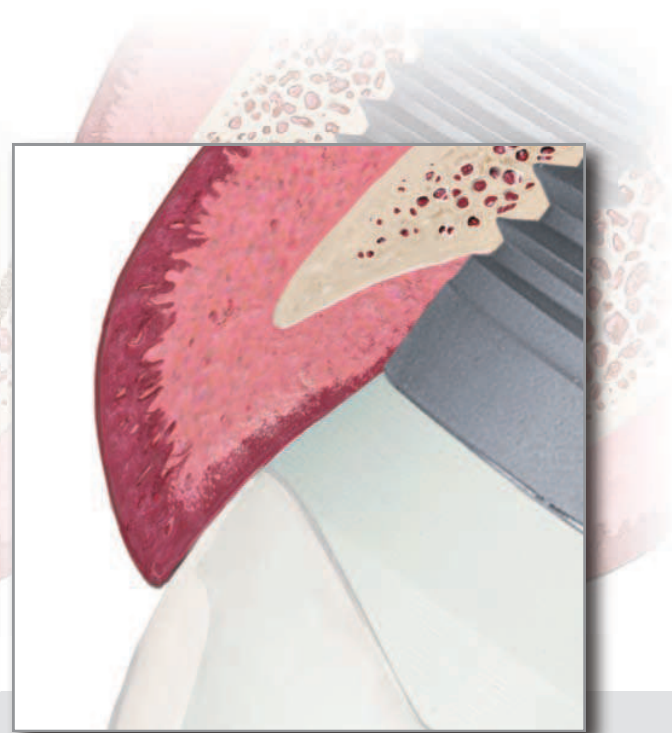


Fig. 5

Fig. 4 Around teeth, blood supply support originates from the periodontal ligament (PDL) to the connective tissue (CT) (arrow a); from the alveolar process to the PDL and then to the CT (arrow b); and from the alveolar process to the CT (arrow c).

Fig. 5 Illustration depicting the inherent thinning of the ridge following the development of the biologic width around standard two-stage implants. Note the increase in cortical bone and the reduction in cancellous bone.

In contrast, when implants replace teeth that have been lost, and a new biologic width develops after connection of conventional two-stage implants to abutments, the overall blood supply to the gingival connective tissue is reduced, due to the absence of a periodontal ligament. This has important implications for clinicians considering placement of implants, particularly in the aesthetic zone, where recession of buccal gingival tissue is a common occurrence.[5,6] The reduction in blood supply that occurs first after extraction and then after implant placement may predispose this loss of soft-tissue volume and increase the risk of implant and/or abutment exposure. Evaluation of the patient's tissue biotype and bone thickness should thus be conducted at the time of treatment planning, with expectations for the clinical outcome adjusted accordingly. The thicker the native hard and soft tissue, the more abundant the blood supply that can be expected after implant placement, with correspondingly heightened expectations for aesthetic success.

Besides the absence of the periodontal ligament, blood supply around dental implants is less than that around natural dentition as the result of a dynamic process of bone remodeling. After implant placement, the biological width must be reestablished. As this occurs, circumferential bone loss typically occurs around the implant's coronal aspect up to the first implant thread (Fig 5). Also, resorption in a palatal direction following tooth loss results in ridge thinning. The thin bone remaining on the facial aspect of the implant tends to be

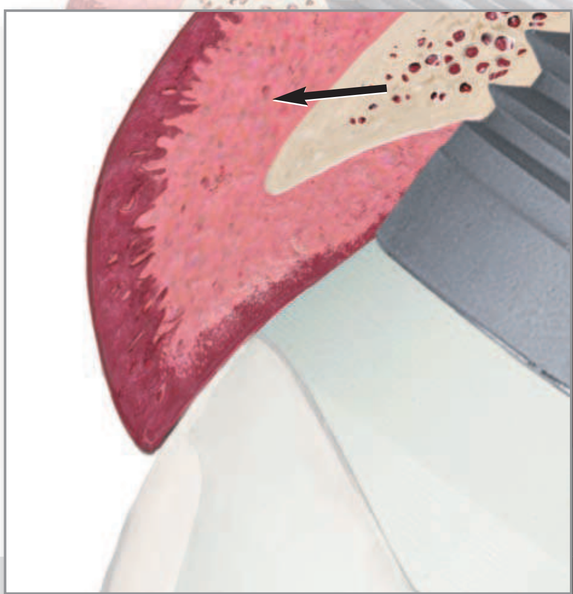


Fig. 6

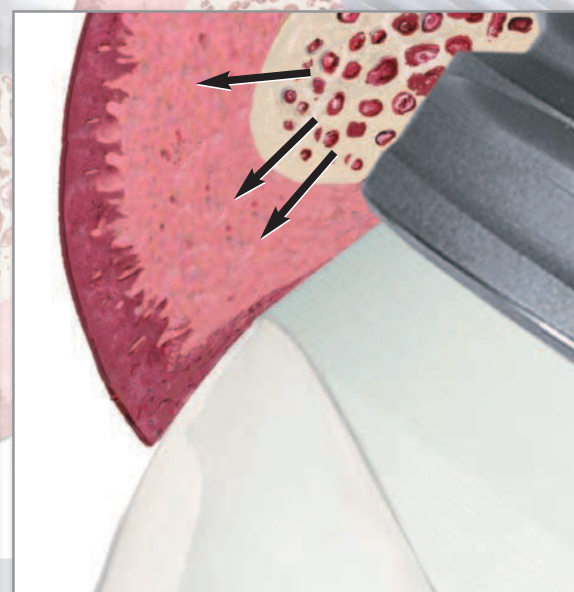


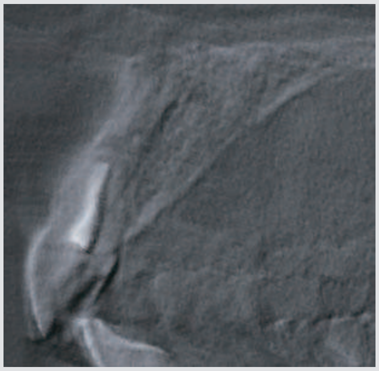
Fig. 7

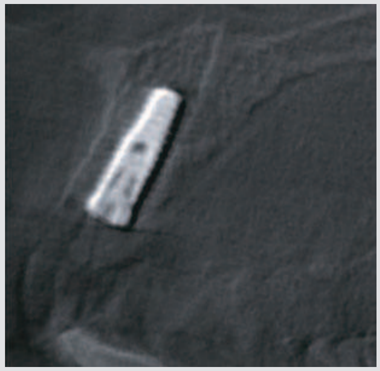
Fig. 6 Illustration depicting increased presence of cortical bone and the subsequent reduction in the available blood supply following development of the biologic width around standard two-stage implants.

Fig. 7 Illustration depicting an implant design with built-in platform switching, which is designed to aid in crestal bone preservation.

cortical, with significantly less vascularity. Furthermore, in a thin ridge, there is rapid drop off (sloping) of the buccal aspect of the crest, resulting in more of the blood supply being positioned apically, where the bone crest is wider and more cancellous (Fig. 6).

The microgap that occurs at the junction of the implant and abutment in traditional two-stage implant systems has been implicated as a cause of the vertical and horizontal bone loss occurring after abutment connection.[7] Bacterial contamination of this microgap has been associated with formation of an inflammatory cell infiltrate[8,9] that, in turn, may trigger circumferential bone resorption. The concept of platform-switching[10] suggests that shifting the implant-abutment junction inward and away from the peri-implant bone can help to shield the bone from inflammatory cell infiltrate and reduce crestal bone resorption. Use of an implant design that incorporates the platform-switching concept, e.g., a PREVAIL® Implant (BIOMET ***3i***), may aid in the preservation of crestal bone. In theory, if bone is preserved, it will support soft tissue that may impact the aesthetic outcome. Greater bone volume can also increase blood supply for the health and maintenance of soft tissues (Fig. 7). Cross sectional axial slices (Figs. 8-10) demonstrate a clinical situation where a failed maxillary central incisor was extracted and replaced immediately with a straight collar PREVAIL Implant. This implant design was chosen due to its built-in platform switching.





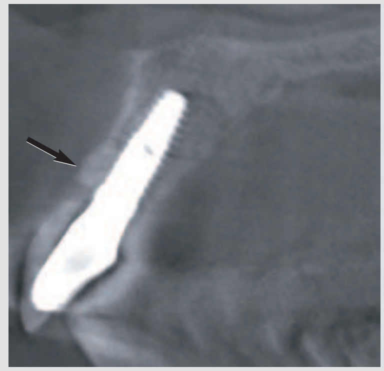


Fig. 8 Cross sectional axial slice showing the adjacent central incisor as a reference.

Fig. 9 Cross sectional axial slice of a straight collar NanoTite™ PREVAIL® Implant on the day of placement in tooth position 8 [11].

Fig. 10 Cross sectional axial slice taken at 14 months post-implant placement and six months post-restoration in tooth position 8 [11]. Note the preservation of the facial bone (see arrow).

Clinical Relevance

The lack of a periodontal ligament and consequently reduced microvasculature surrounding dental implants may jeopardize the maintenance of optimal aesthetics over time. For this reason, candidates with thick biotypes are better candidates for implants in the aesthetic zone. The PREVAIL Implant was used, which is an implant designed to aid in crestal bone preservation. Such bone preservation may include crestal bone on the facial aspect of the implant. During development of the biologic width following implant exposure, attempts to preserve the facial bone may improve outcomes in aesthetic areas or areas of thin biotypes.

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