REALITIES AND LIMITATIONS IN THE MANAGEMENT OF THE INTERDENTAL PAPILLA BETWEEN IMPLANTS: THREE CASE REPORTS

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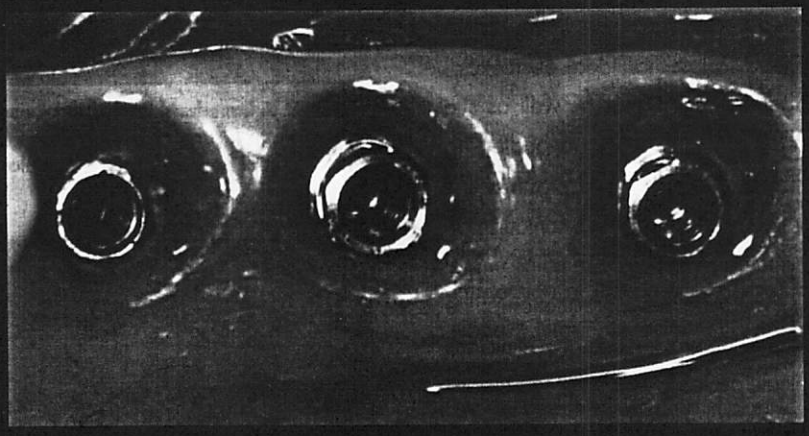

A predictable, aesthetic result is sometimes difficult to achieve when two or more adjacent implants are placed in the anterior maxilla. Maintenance of the distance from the interproximal crest of bone to the contact point influences the presence or absence of the interdental papilla. The design of the coronal portion of implants currently in the market and the contour of the implant-abutment junction may further affect the biology and reformation of the papilla between two adjacent implants. Through a series of case reports, parameters influencing implant placement are presented.

Learning Objectives:
This article describes the biological, mechanical, and clinical parameters that influence implant placement. Upon reading this article, the reader should:

- Recognize the role of interproximal tissues on aesthetics.
- Understand the role of papilla generation on treatment success.

Key Words: interproximal, papilla, soft tissue, implant

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Today, one of the most challenging aspects of implant dentistry is to obtain a predictable aesthetic result. When adjacent implants are restored, the clinical crowns are usually longer, and the interdental papillae are more apical than the interdental papillae of the preexisting or adjacent teeth. The extraction of a tooth results in the remodeling and loss of alveolar bone, which may cause ridge deformities, even in cases where prior bone loss did not exist around the extracted tooth. This bone loss has been demonstrated to average 4 mm in the buccal direction and may lead to less-than-ideal aesthetics.[1] While tissue management techniques as well as site development procedures have been advocated to improve the aesthetic outcome of implant prostheses,[2-4] the complete restoration of lost soft tissue contour, particularly that of the interdental papilla, remains unpredictable. Criteria for evaluation and classification of the interdental papilla have been proposed to help clinicians and researchers evaluate aesthetic results.[5,6] The purpose of this article is to present a series of case reports in which multiple adjacent implants were restored with a fixed prosthesis, and to discuss the biological factors and mechanical limitations impeding the formation of a natural interimplant papilla.

Literature Review

In order to understand the treatment rationale presented in the authors' attempts to generate an interimplant papilla, it is necessary to review the literature regarding the papilla between two teeth, between teeth and implants, and between adjacent implants. The presence of the interdental papilla between teeth is directly related to the distance between the contact point and the interdental crest of bone.[7] This critical distance between teeth was reported to be 5 mm or less. As the distance exceeds 5 mm, the presence of the papilla drops significantly. It has also been shown that when an implant is placed adjacent to a tooth, the distance from the crestal bone on the tooth to the contact point should be 5 mm or less in order to predictably reform a papilla.[8,9] At present, the distance required to generate a papilla between two implants has not been established. It has been reported, however, that a distance of 3 mm is necessary between

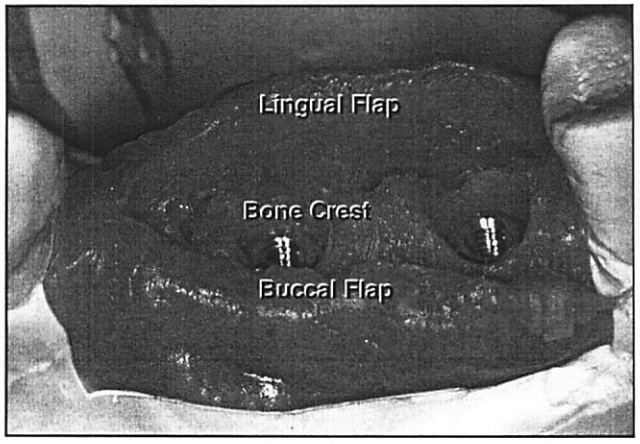

Figure 1. A bone level impression was captured at the implant level during stage II surgery with the bone crest exposed, relating the interproximal bone height to the implant platform.

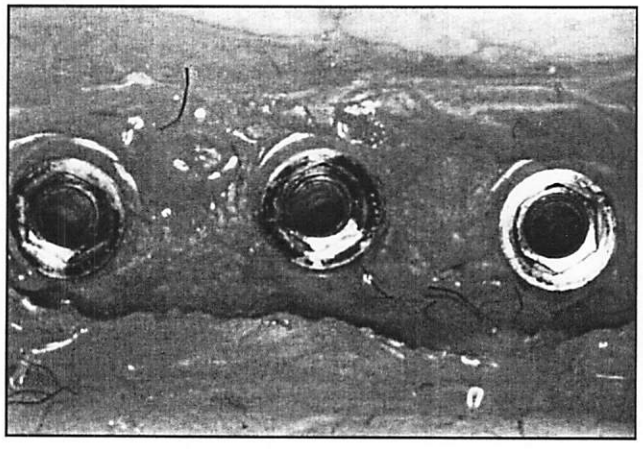

Figure 2. Case 1. Close-up of the bone-level impression of implants #28(44) through #31(47).

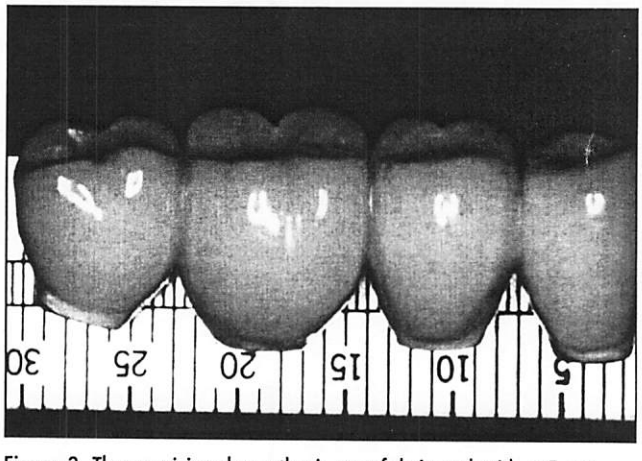

Figure 3. The provisional prosthesis was fabricated with a 5-mm distance from the contact point to the crest of bone. Note the minimum 3-mm distance between the implants.

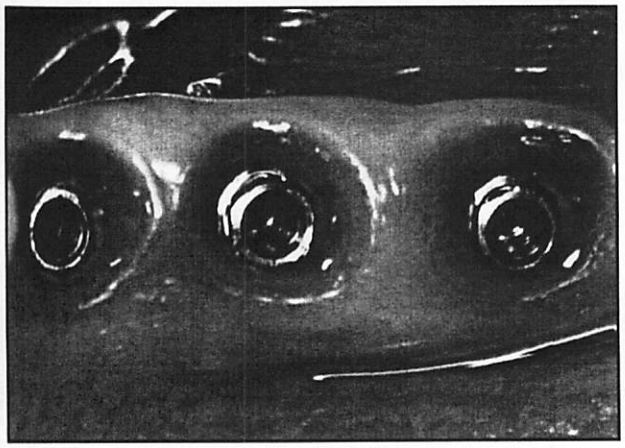

Figure 4. Soft tissue profile 3 weeks following placement of the provisional restoration.

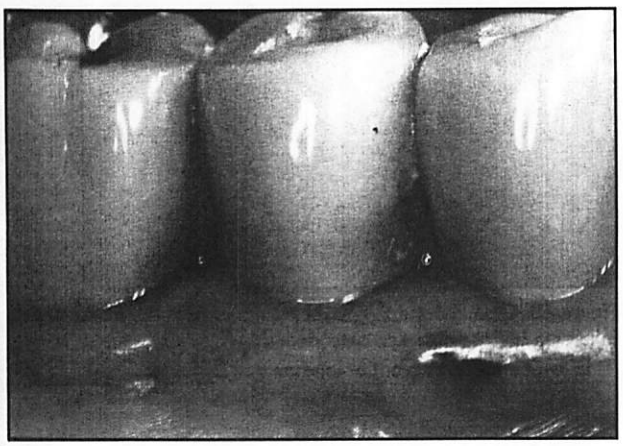

Figure 5. A 5-mm distance was observed from the contact point to the crest of bone. Only partial fill of the predetermined gingival embrasure space occurred.

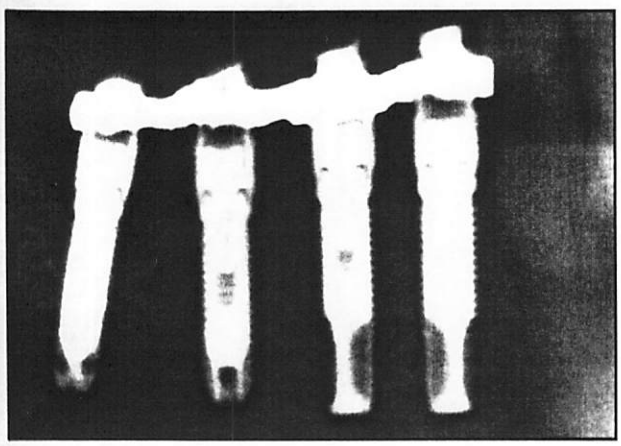

Figure 6. Postoperative radiographic appearance demonstrates bone scalloping and the preservation of the interimplant bone crest.

two implants in order to maintain the interproximal height of bone after remodeling of the biologic width.[10] This distance is measured from the implant-abutment junction (IAJ) of one implant to the other. This 3-mm interimplant distance is crucial since maintaining the level of the bone between two implants is of paramount importance in generating a papilla.

Materials and Methods

Based on these biological parameters, the necessary conditions for the formation of the interdental papilla between two implants were identified and established in the following case reports. The implants were initially placed using a two-stage approach guided by a carefully constructed surgical guide. A minimum 3-mm interimplant distance was maintained during implant placement. An impression of the bone crest was made at the time of stage II surgery in order to control the distance from the bone crest to the contact point when fabricating the provisional prosthesis. This implant level impression related the interproximal bone height to the implant platform (Figure 1). The laboratory technician fabricated the provisional prosthesis with the contact point at the desired distance (or "D") from the interimplant peak of bone. This distance "D" was altered in order to evaluate the interimplant soft tissue response. The 3-mm horizontal interimplant distance ensured that the height of the interproximal bone would be maintained following the formation of the biologic width around the implants. The following cases demonstrate the use of the aforementioned principles in establishing an interimplant papilla.

Case Presentations

Case 1: D=5 mm

Four implants were placed in teeth #28(44) through #31(47). A 5-mm distance from the contact point to the crest of bone resulted in a partial soft-tissue fill of the predetermined gingival embrasure space (Jemt Class 1: less than half of the height of the papilla is present) (Figures 2 through 6).

Case 2: D=5 mm

Two implants were placed in sites #8(11) and #9(21). With a distance "D" of 5 mm, the predetermined gingival

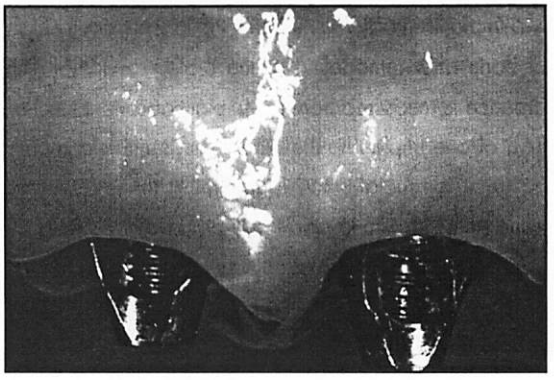

Figure 7. Case 2. Soft tissue contour around implants #8(11) and #9(21). Note the presence of interdental papilla and soft tissue scallop.

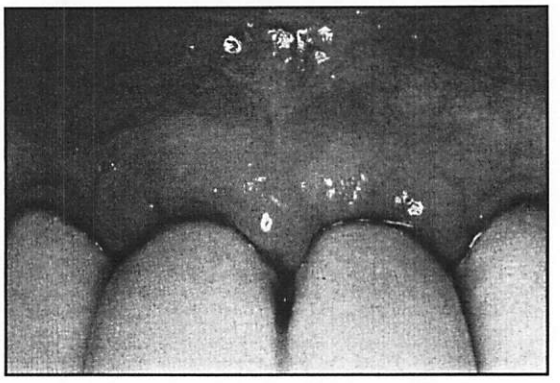

Figure 8. The predetermined gingival embrasure space was partially filled by the papilla. The provisional restoration was fabricated with a 5-mm distance from the contact point to the crest of bone.

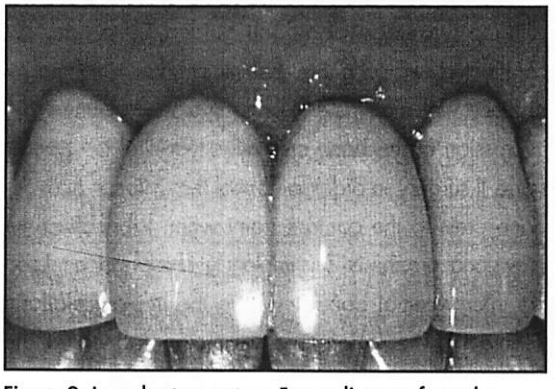

Figure 9. In order to create a 5-mm distance from the contact point to the crest of bone, the contact point was shifted apically due to prior bone loss.

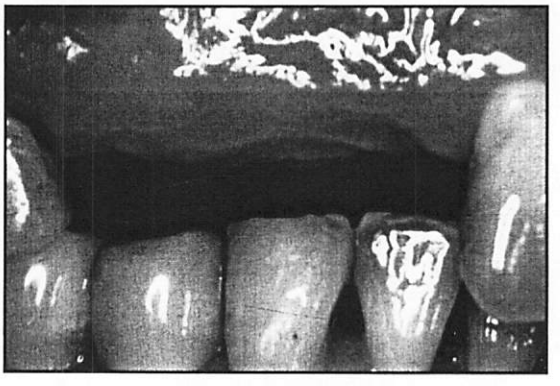

Figure 10. Case 3. Lateral view of the edentulous ridge following initial distraction osteogenesis.

embrasure space was again partially filled (Jemt Class 2: half or more of the height of the papilla is present, but does not extend all the way up to the contact point). It is important to note that the presence of the incisive papilla in the midline of the maxillary arch often provides sufficient volume of soft tissue to create an illusion of a papilla. Because of prior bone loss due to periodontal disease, however, the papilla created was in an apical position relative to the adjacent crowns. This resulted in a compromised aesthetic outcome. Scalloping of the soft tissue was present but in an apical position to its normal relationship of the original teeth (Figures 7 through 9).

Case 3: D=3 mm

In this case, an attempt was made to correct the deficiencies of the previous two cases. Since a distance "D" of 5 mm generated partial fill of the embrasure space in the previous cases, the authors decided to reduce "D" to 3 mm in this instance. In addition, the authors intended to maintain the contact point at its natural position in order to achieve natural aesthetics. To obtain a natural position of the papilla relative to the crown, site development was necessary to provide bone support to the interimplant papilla. Vertical augmentation of the alveolar bone via distraction osteogenesis positioned the interproximal alveolar crest coronally to the level of the cementoenamel junction (CEJ) of the adjacent tooth. This overcorrection compensated for potential resorption and positioned the bone crest interproximally coronal to its original position. This was necessary since the reduction of "D" to 3 mm had to be made by augmentation of the bone crest in a coronal direction rather than by apically positioning the contact point.

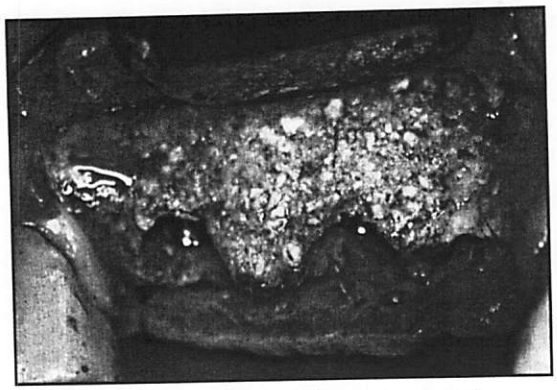

Figure 11. Lateral appearance following implant placement. Note that the implant platform was placed at less than 3 mm apical to the buccal CEJ of tooth #4(15).

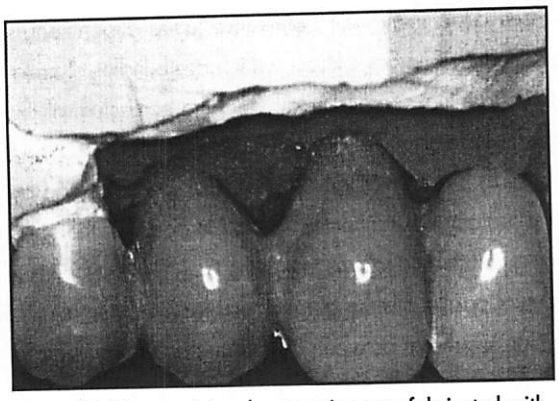

Figure 12. The provisional restoration was fabricated with a 3-mm distance between the contact point and the crest of bone.

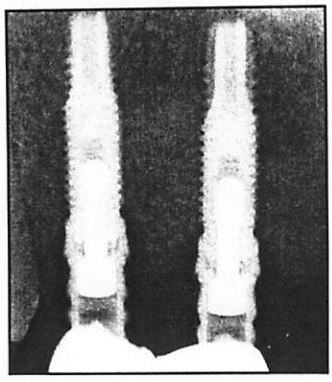

Figure 13. Postoperative radiographic evaluation demonstrates bone scalloping and the interimplant bone crest approximately 2 mm coronal to the mesial bone level of tooth #4.

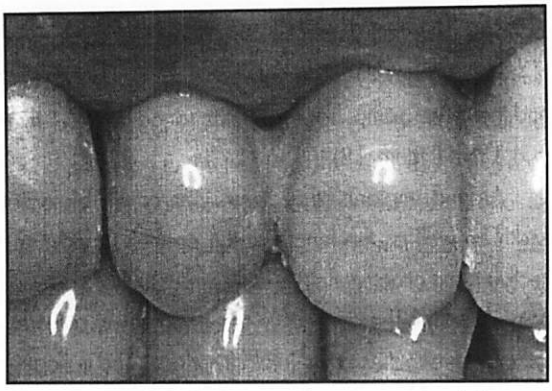

Figure 14. Clinical appearance during insertion of the provisional restoration.

Following distraction osteogenesis, implants were placed in the #5(14) and #6(13) areas. Site preparation rendered the bony architecture scalloped, resulting in the interproximal crest of bone being coronal to its original position between the lost natural teeth. With "D" equaling 3 mm, the predetermined gingival embrasure space was completely filled (Jemt Class 3: the papilla fills up the entire proximal space and is in good harmony with the adjacent papilla). Bone remodeling and bone loss did, however, result in a postoperative loss of volume of the interproximal papilla, which required adjustment of the contact point to maintain complete soft tissue fill of the embrasure space (Figures 10 through 16).

Discussion

From a clinical standpoint, the goal of treatment with dental implants is to create a functional and aesthetic outcome that is similar to that of the natural dentition. From an anatomical and histological standpoint, however, the relationship of the interproximal bone and soft tissue between two teeth differs from that between two implants.

Biologic Width

Histologic and Vasculature Considerations

In the past 10 years, it has been demonstrated that bone loss that occurs around implants during the first year is related in large part to the formation of a biologic width.[11-14] Nevertheless, the biologic width around an implant differs from that around a natural tooth. Around teeth, the distance between the base of the sulcus and the crest of the bone has been termed biologic width.[15] The average distance of the biologic width around a tooth is approximately 2 mm. These 2 mm consist of approximately 1 mm of epithelial adherence and 1 mm of connective

tissue attachment. The connective tissue attachment is formed by Sharpey's fibers, which are bundles of collagen inserting perpendicularly into the cementum of the tooth. In healthy teeth, the bone crest is separated from the CEJ by an average distance of 1 mm occupied by the supracrestal connective tissue.[15] In addition, the bone crest architecture follows that of the CEJ.[16] When the interdental papilla fills the gingival embrasure, 5 mm of soft tissue is present between the bone crest interproximally and the tip of the interdental papilla. These 5 mm consist of: 1 mm of supracrestal connective tissue, 1 mm of junctional epithelium, and 3 mm of sulcular depth (Figure 17). The type of periodontium (ie, thin scalloped or thick flat) determines the degree of scalloping of the bone. The difference between the facial bone crest and the interproximal bone crest can range from 2.1 mm to 4.1 mm (Figure 18).[17]

Around implants, the dimensions of the biologic width as well as the length of the epithelial and connective tissue attachments are fairly similar to those around natural teeth.[18] The connective tissue, however, *adheres* rather than *attaches* to the implant surface. The collagen fibers are aligned in a parallel direction to the surface.[14]

In addition to the aforementioned histological differences, the composition of the connective tissue components differs dramatically between teeth and implants. Around a tooth, the connective tissue is cellular, rich with fibroblasts and blood vessels. The connective tissue neck around an implant has a paucity of cells and is composed primarily of dense collagen fibers, similar to scar tissue.[14,19] Furthermore, the connective tissue is well vascularized around natural teeth and poorly vascularized around implants.[20-22]

Location of the Biologic Width: Anatomical Considerations

An Implant Adjacent to a Healthy Tooth

When an implant is placed adjacent to a tooth, the bone level interproximally is maintained at its original level because the biologic width at the tooth side remains undisturbed. This is particularly true if the implant is not placed in close proximity to the root surface (Figure 19).[23] The IAJ is placed 3 mm to 4 mm apical to the height of tissue of the tooth being replaced.[24] The formation of the biologic width around an implant occurs apical to the IAJ. The subcrestal mesial and distal placement of the IAJ in the aesthetic zone occurs with all implant systems when they are properly positioned for aesthetics based

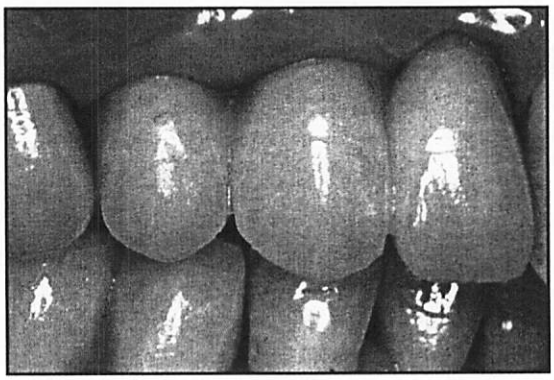

Figure 15. Postoperative clinical appearance following loss of papilla and insertion of the definitive prosthesis with the contact point moved apically as compared to the provisional positioning.

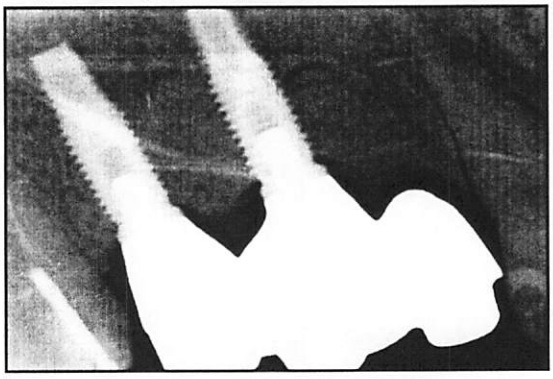

Figure 16. Postoperative radiograph demonstrates loss of the bone crest interproximally to the level of the implant-abutment junction.

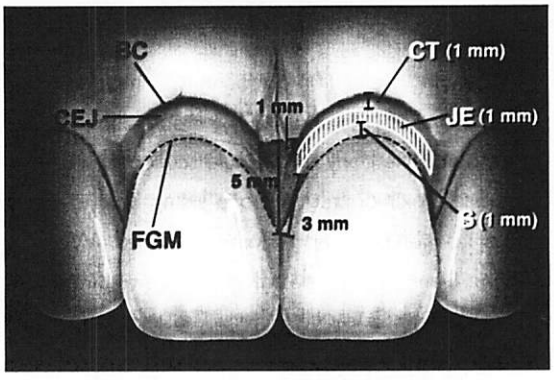

Figure 17. Illustration demonstrates the relationships between the soft tissue contour, bone scalloping, and the CEJ in healthy dentition. A 5-mm distance is present from the interproximal bone crest to the contact point.

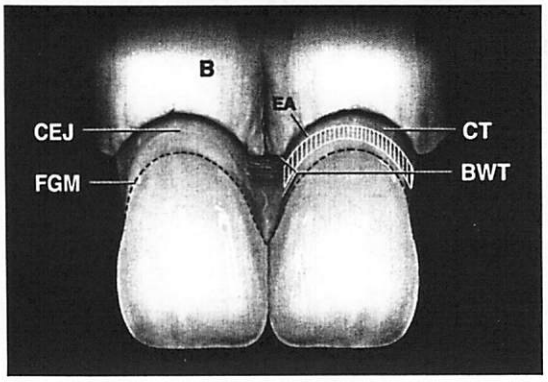

Figure 18. Illustration demonstrates the supracrestal position of the biologic width (BWT) and epithelium (EA) on healthy teeth.

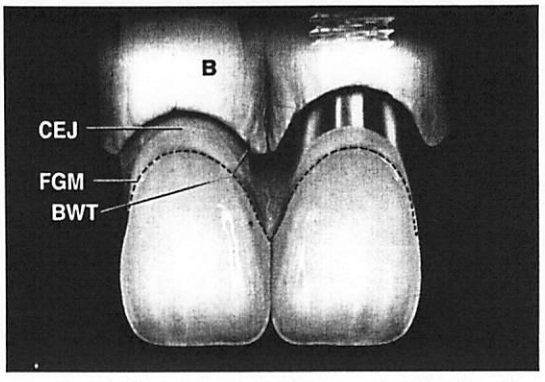

Figure 19. Implant placement adjacent to healthy dentition does not affect the interdental papilla due to the supracrestal position of the biologic width (BWT).

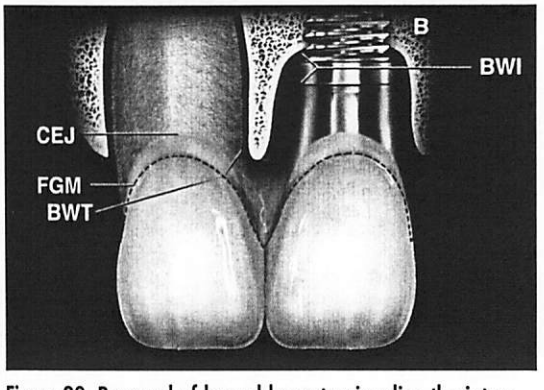

Figure 20. Removal of buccal bone to visualize the interproximal bone level midway between buccal and palatal corticals. Note position of biologic width around implant (BWI) in comparison to the tooth (BWT).

on the midfacial tissue height.[24] All implants have a circular and flat IAJ in the same plane. Since the top of the implant is flat, the buccal position of the IAJ determines its interproximal position. While the subcrestal formation of the biologic width around the implant undermines the interproximal bone, a normal attachment level at the tooth side (ie, supracrestal biologic width) maintains the bone level and the presence of a natural papilla (Figure 20).[25]

Two Adjacent Implants

When two adjacent implants are placed, the biologic width around a flat implant does not support the papilla interproximally. In fact, the subcrestal formation of the biologic width around implants violates the interimplant bone due to the lateral component of the bone loss. The lateral distance from the crest of the bone to the implant was found to be approximately 1.3 mm on average.[10] In this scenario, the interproximal bone generally resorbs to the level of the IAJ (Figures 21 and 22).

The aforementioned differences between the soft tissues surrounding teeth and implants indicate reduced blood perfusion to the peri-implant tissue. The volume of soft tissue that can be predictably generated coronal to the bone crest interproximally between implants is less than that between natural teeth. While a distance of 5 mm from the contact point to the crest of bone would predictably generate a papilla between teeth, it will only provide a partial fill between implants. Based on the case presentation discussed herein, a distance "D" of 3 mm was necessary to generate a papilla between implants. Research to validate this theory is presently being conducted.

Conclusion

To obtain ideal implant aesthetics, the contact point between two implants should be restored to its original level between two teeth. Although moving the contact point apically to compensate for the lack of the interdental papilla compromises the aesthetic result, this modification may be necessary due to insufficient interproximal tissue. A thorough understanding of the biology of wound healing of bone and soft tissue around implants is necessary to apply these principles to implant-supported restorations in the aesthetic zone. In the cases presented, a variety of procedures were employed in order to create favorable aesthetics. This included site development and overcorrection of the existing defect using distraction osteogenesis, soft tissue management techniques,

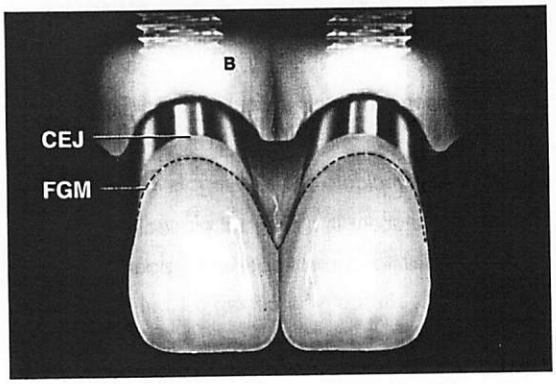

Figure 21. The placement of two adjacent implants results in the loss of the supracrestal biologic width. This means the soft tissue papilla will be higher.

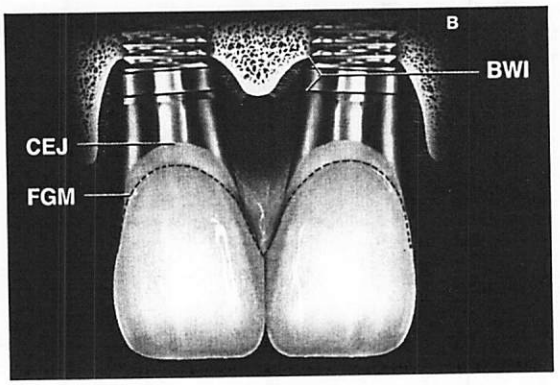

Figure 22. Buccal cortical plate removal to visualize the interproximal bone level midway between the buccal and palatal corticals. Note the position of the biologic width around the implant in relation to the contact point.

ideal implant placement according to the parameters suggested in the literature, and prosthetic management. Despite these efforts, the aesthetic results were less than ideal. It appears that the primary variable for success involved the subcrestal formation of the implant biologic width, which is related to the subcrestal location of the IAJ. The flat design of the coronal portion of current implants and the flat contour of the IAJ may have been the most influential mechanical factor that negatively affected aesthetic papilla formation.

Additional research is presently under way to determine the height of tissue that can predictably be counted on to fill the interimplant papilla area. In addition, the concept of a scalloped IAJ combined with a new biologically driven implant design may further influence treatment success in subsequent applications.

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