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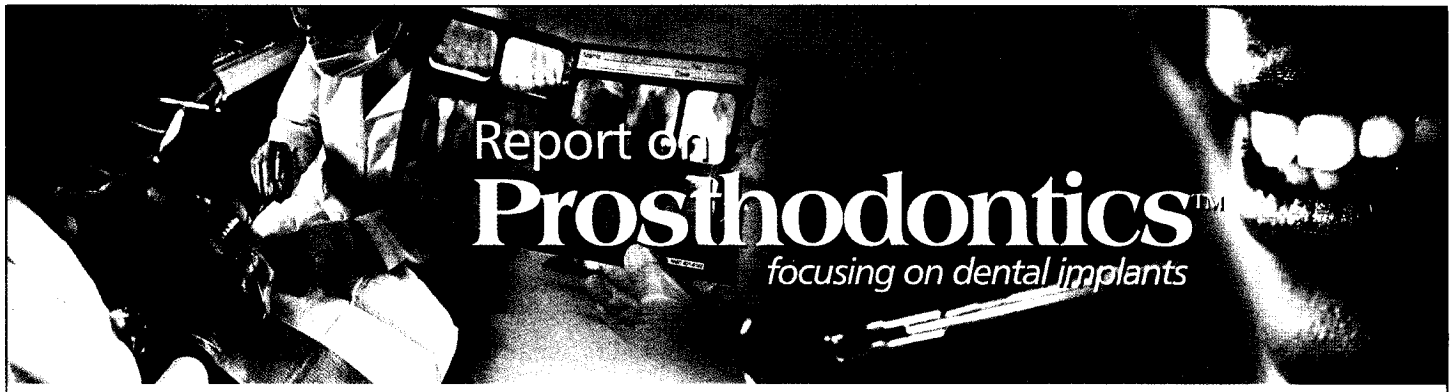

Single-tooth Dental Implants

The single-tooth implant restoration is often touted as a simple implant restoration, one with which novices to implant dentistry should get their feet wet. However, achieving optimal results of the single-tooth dental implant in the esthetic zone can be very challenging and requires the expert to obtain the desired gingival esthetic outcome. This issue of Report on Prosthodontics *reviews a series of articles related to single-tooth dental implants.*

An Evaluation of Peri-implant Mucosa Dimension

Balancing the dentogingival complex around natural teeth with the gingival architecture around dental implants to achieve the desired esthetics can be demanding. Peri-implant mucosal response around dental implants is not clearly understood, nor is the influence of biotype on mucosal changes. Kan et al from Loma Linda University, California, evaluated 45 maxillary anterior single-implant crowns in function for at least 1 year to determine the biotype and the dimension of the peri-implant mucosa. After local anesthetic administration to the examination site, the dimensions of peri-implant mucosa were measured by bone sounding, using a periodontal probe at 5 sites: the mesial (MI), midfacial (F) and distal (DI) aspects of the implants, and the proximal (MT and DT) aspects of the adjacent teeth.

Figure 1 illustrates the mean bone-sounding depth at each evaluated site of maxillary anterior single implants. The most frequently observed facial dimension of peri-implant mucosa was between 3 and 4 mm (range, 2–6 mm), while the most frequently observed mesial and distal dimensions of peri-implant mucosa were between 5 mm and 7 mm (range, 3–9 mm). The mean dentogingival complex of the teeth on the mesial and distal was 4.20 mm. The presence of the implant papilla level was dependent on the bone level of the adjacent natural tooth.

The peri-implant biotype of each studied implant was evaluated and categorized into a thick or thin group. When a periodontal probe was placed into

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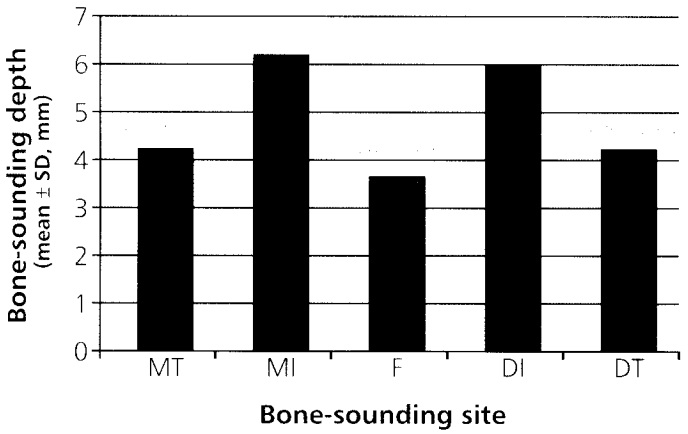

Figure 1. Mean bone-sounding depth (mm ± SD) at each evaluated site of maxillary anterior single implants.

the facial aspect of the peri-implant mucosa, the peri-implant biotype was categorized as thin if the outline of the underlying periodontal probe could be seen through the gingiva and thick if the probe could not be seen. Greater peri-implant mucosa dimensions were noted in the thick biotype as compared with the thin biotype. A total dimension >4 mm was usually observed with a thick biotype.

Understanding the factors that affect and ultimately determine the gingival contour around dental implants is key to an esthetically successful outcome. Evaluation of the mucosal dimension around implants is a first step in comprehending the complex nature of the development of interproximal papilla and a stable mucosal architecture.

Following tooth removal, the interproximal papilla usually collapses due to the loss of tooth support, and the degree depends on the thickness of the mucosa. Under such circumstances, the papilla may be restored with an implant-tooth replacement to varying degrees, depending on the peri-implant biotype. While the implant papilla may be retained at or reestablished to the normal level (4.5 mm from the underlying bone) with the thick biotype, it can seldom be re-created beyond 4 mm with the thin biotype.

The authors concluded that 2 very important influencing factors related to achieving an appropriate interproximal papilla in the single-tooth dental implant. The implant papilla level is dependent on the bone level of the adjacent natural tooth. Achievement of "normal" levels of implant papilla is directly related to the thickness of the peri-implant biotype. The prosthodontist's knowledge of these details helps in making critical decisions when planning treatment for a single-tooth implant.

Kan JYK, Rungcharassaeng K, Umezu K, Kois JC. Dimensions of peri-implant mucosa: an evaluation of maxillary anterior single implants in humans. J Periodontol *2003;74:557-562.*

Evaluation of the Papilla Level Adjacent to Single-tooth Dental Implants

In an attempt to better understand the relationship of hard- and soft-tissue anatomy around single-tooth dental implants, Choquet et al from University of Brussels, Belgium, evaluated the bone level and papilla height in relation to the proximal contact point of single-tooth implant restorations. Twenty-seven implant restorations were examined. The evaluation of 52 papillae was made through clinical and photographic examination, using a 4-point scale to characterize the absence or presence of papillae. Radiographic analysis measured the vertical relationship between

- bone,
- papilla,
- implant and
- adjacent teeth contact points.

The papilla was present almost 100% of the time when a measurement of ≤5 mm from the contact point to the crest of the bone was observed. As the contact point distance to bone increased to ≥6 mm, the presence of the papilla decreased to 50% of the time. The mean interproximal papilla height was 3.85 mm.

The authors clearly demonstrated the association between level of bone, soft-tissue height and the position of the proximal contact. The absence or presence of papilla around a single-tooth dental implant is related to the distance between the contact point and interproximal bone crest. This investigation clearly defined a threshold point of 5–6 mm distance, greater than which a dramatic decrease of papilla occurrence is observed. The information gained by this study should be used by the prosthodontist in treat-

ment planning. Based on the level of the bone and the position of the contact point of the proposed restoration as determined by the prosthodontist, decisions will need to be made regarding the necessity of additional surgical procedures, such as bone augmentation, to achieve the desired esthetic result.

Choquet V, Hermans M, Adriaenssens P, et al. Clinical and radiographic evaluation of the papilla level adjacent to single-tooth dental implants: a retrospective study in the maxillary anterior region. J Periodontol *2001;72: 1364-1371.*

Effect of Bone Height on Presence of Papilla Between Implants

With increasing demands for more natural-looking restorations in the esthetic zone, clinicians must maintain a high level of skill and knowledge to maintain or reform the interdental papilla between teeth, between implants and teeth, and between adjacent implants. Two studies by Tarnow et al from New York University examined the influences of inter-implant distance on inter-implant bone crest and the vertical distance from the crest of the bone to the height of the interproximal papilla between adjacent teeth. These studies are presented together due to the interrelated nature of the research.

To further understand the relationship between bone and papilla height in the esthetic zone, these investigators continued work done in previous studies on single-tooth implants by investigating the bone-papilla relationship in 2 adjacent implants (Figure 2). In the first study, radiographic measurements were made to determine if there was a relationship between the 2 implants, distance and the height of crest bone. The authors' findings suggested an increase in crestal bone loss when there is a distance of <3 mm between dental implants.

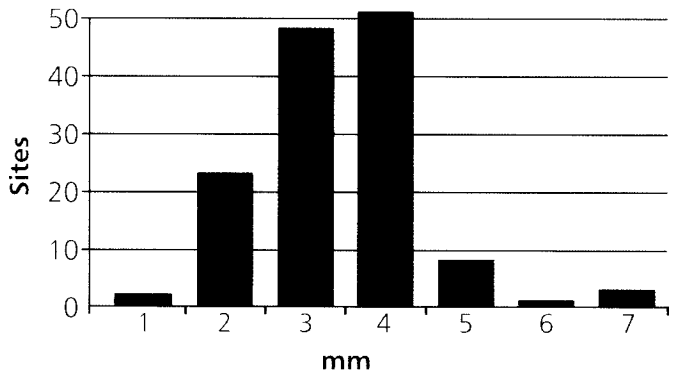

Figure 2. The mean height of tissue of the papillae between 2 adjacent implants was 3.4 mm, with a range of 1–7 mm.

In the second study, inter-implant papillary heights were measured using bone sounding. It should be noted that this retrospective study contained many variables—type and shape of implant, regenerated and natural bone, implant placement in partially or completely edentulous maxillas or mandibles, vertical location of the implant crest and exact mesial-distal distance of the adjacent implants—that may have affected the average vertical height of the interproximal papillae between adjacent implants.

It is thought to be more difficult to maintain a papilla between 2 adjacent implants as compared with an implant and a natural tooth. These 2 studies are very helpful to understand the complexity of developing papilla height between 2 implants. The clinical significance of placing 2 implants ≤3 mm apart will result in greater crestal bone loss, which in turn produces a greater distance between the crest of bone and the contact point of the adjacent crowns. If this distance is >3–4 mm in height, it is unlikely that the papilla will be absent. As the prosthodontist evaluates an edentulous area for implants, these factors need to be taken into account in the treatment-planning phase. Decisions with regard to number and diameter of implants need to address this lateral space issue, particularly regarding esthetic outcomes.

The authors concluded from the research that the clinician should proceed with great caution when placing 2 adjacent implants in the esthetic zone. Modifications in treatment planning may be necessary when the clinician is presented with this esthetically challenging situation.

Tarnow D, Elian N, Fletcher P, et al. Vertical distance from the crest of bone to the height of the interproximal papilla between adjacent implants. J Periodontol *2003;74:1785-1788.*

Tarnow DP, Cho SC, Wallace SS. The effect of inter-implant distance on the height of inter-implant bone crest. J Periodontol *2000;71:546-549.*

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focusing on dental implants

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3-D Bone-to-implant Relationship on Esthetics

Because there are biologic limits to the soft-tissue dimension around implants, the limiting factor for the esthetic result of implant therapy is the bone level at the implant site. Clinicians must focus on the 3-dimensional (3-D) bone-to-implant relationship to establish the basis for an ideal and harmonic soft-tissue situation that is stable over a long period. In some situations, missing bone is a limiting factor for esthetics; in others, it is possible to regenerate new bone around implants. A certain amount of bone resorption around implants occurs as soon as the implant comes in contact with the oral environment. The distance between an implant and adjacent tooth, and between 2 implants, is as important as the bone volume on the implant head buccal side and in the papillary area, especially for the long-term result.

Grunder, a private practitioner from Zollikon-Zürich, Switzerland, et al, summarized the current knowledge of the relationship between hard and soft tissue, with regard to development of papilla between an implant and adjacent tooth and between 2 adjacent implants. The authors described the ideal 3-D implant-to-bone relationship.

Treatment recommendations were made based on clinical appearance. A certain amount of bone resorption occurs around implants as soon as the implant comes in contact with the oral environment. This bone resorption occurs not only in a vertical, but also in a horizontal, direction; a minimum distance of 1.5 mm between the implant and the tooth is recommended to prevent bone resorption around the tooth that would lead to loss or reduction of the interproximal papilla. The more apical the implant placement, the bigger the distance between the implant and tooth needs to be, due to the shape of the bone loss. The bone thickness buccal to the dental implant, whether adjacent to a tooth or another implant, should be a minimum of 2 mm, preferably 4 mm, to avoid a loss of bone height and a high risk of soft-tissue recession.

The authors recommended creating this thickness with bone augmentation procedures in esthetically demanding situations. When 2 adjacent implants are used, the implant-to-implant distance should be >3 mm in order to create and maintain the interproximal bone peak between the implant shoulders. More apically placed implants require a greater distance between implants. To compensate for lack of inter-implant distance, the bone volume on the buccal side of the papillary area should be augmented.

Determining the implant position in relation to a natural tooth or another implant to create the optimal bone support for soft-tissue architecture and ideal esthetics is of paramount importance to the clinician. Using the information provided as a guideline in dental implant treatment may be a helpful aid in treatment planning. Bone volume is clearly an essential determining factor to achieve ideal esthetic results. The presence of papilla around an implant adjacent to a natural tooth is dictated by the level of bone attachment on the tooth side, while that between 2 adjacent implants is determined by the volume of bone interproximal to the 2 implants. Understanding these facts can help develop solutions to address any deficits the patient might have with regard to these issues in order to provide the best esthetic result possible.

Grunder U, Gracis S, Capelli M. Influence of the 3-D bone-to-implant relationship on esthetics. Int J Periodontics Restorative Dent *2005; 25:113-119.*

In the Next Issue:

- Comparative Study Between Delayed and Immediate Loading of Implant-retained Mandibular Overdentures
- Early Loading of Unsplinted Implants Supporting Mandibular Overdentures
- Progressive Loading of Unsplinted Mandibular Implants
- Immediate Loading of Implant Overdentures

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