Factors and Techniques Influencing Peri-Implant Papillae

Yiu Cheung Chow, DDS, MS,* and Hom-Lay Wang, DDS, MSD, PhD†

Aim: Loss of implant papilla is one of the more troubling dilemmas in implant dentistry. The “black triangle” around the implant-supported restoration causes not only phonetic difficulties and food impaction but also unpleasant esthetics. This is considered to be a failure in today’s implant therapy standards. As a consequence, many techniques have been developed to either preserve or regenerate the interimplant soft tissue. It is the purpose of this article to examine factors that may affect the appearance of the peri-implant papilla.

Results: Factors such as crestal bone height, interproximal distance, tooth form/shape, gingival thickness, and keratinized gingival width have all been identified to influence the appearance of the interimplant papillae. In addition, many techniques/materials have been successfully used in promoting interimplant papillae formation.

Conclusion: This article presents a comprehensive review of factors that may influence the interimplant papillae and illustrates techniques used in attempting to recreate/correct this challenging problem in implant dentistry. (Implant Dent 2010;19: 208–219)

Key Words: implant, papillae, esthetics, interproximal soft tissue

Today, in implant dentistry, patients not only want to restore the lost masticatory function but also want to demand aesthetically pleasing restorative treatments. In the maxillary anterior region, they have come to expect prostheses replacing their missing teeth to be identical to the contralateral natural healthy teeth and the gingival outline harmonious with the gingival silhouette of the adjacent teeth. Even though the dental implant is successfully osseointegrated, it is devastating to a patient if “black triangles” (i.e., missing interproximal papilla) exists when they smile and speak. Moreover, the loss of implant papilla can cause phonetic problems and food impaction. As a result, the presence/absence of interimplant papilla has become a topic of concern.

In natural dentition, the dental papilla is the gingival tissue, which occupies the embrasure space beneath the contact area of 2 adjoining teeth. The lateral borders and tips of the dental papilla are formed by marginal gingiva, and the intervening portion consists of attached gingiva. Similarly, the peri-implant papilla is the soft tissue underneath the contact between a natural tooth and an implant or 2 adjacent implants. However, there are some significant anatomical and histologic differences between dental and peri-implant papillae (Table 1).1–5

For example, the soft tissues around osseointegrated implants contain a larger proportion of collagen and a lower proportion of fibroblasts than the tissues adjacent to natural teeth. Because of the lack of cementum for collagen fiber insertion, the fibers around a dental implant run parallel to the implant’s surface rather than perpendicularly attached to the root surface as seen in natural teeth. In addition, there are fewer blood vessels in the peri-implant mucosa as compared to the gingiva around natural teeth. Another important difference is the location of biologic width. A dental implant usually has a flat platform at the coronal end. As a result, the implant is almost always positioned below the interproximal alveolar crest, which places the interproximal biologic width subcrestually instead of supracrestally as seen in natural teeth. The subcrestal formation of biologic width results in loss of interproximal bone. Consequently, all these differences make preservation or regeneration of peri-implant papilla even more challenging. Peri-implant tissues are similar to the periodontium with a junctional epithelium containing basal lamina and hemidesmosomes and connective tissue fibers.6 However, because of lack of cementum, the implant sulcus is often located at junction of implant-bone interface. This is different than the natural tooth where the sulcus is situated at cemento-enamel junction (CEJ). This translates
to about 2 mm vertical height difference to ensure for the papillae appearance in both conditions (implant: 3 mm and natural tooth: 5 mm) because normal bone level is often located at 2 mm below the CEJ.

Because the presence of papilla is one of the essential elements of anterior esthetics, the clinician may be willing to attempt to regenerate or improve deficient papillary form even though limited blood supply and access plague the procedure and significantly increase the risk of failure. Over the years, many surgical and nonsurgical techniques have been proposed to treat this soft tissue deformity and manage the interproximal space. Nonetheless, because of the limited sample size of case reports in natural studies, the predictability of these techniques remains to be determined.

Because reconstruction of peri-implant papilla remains one of the most difficult and unpredictable procedures in implant therapy, presurgical planning becomes critical for the success of the therapy. A well-thought and well sequenced treatment plan demands clinician understanding the factors influencing the appearance of peri-implant papilla. This article will review these potential clinical factors that may influence the appearance of interimplant papilla. In addition, the current techniques of peri-implant papilla enhancement are discussed.

**Potential Clinical Factors**

**Crestal Bone Height**

The underlying osseous morphology has long been recognized as the foundation for the support of gingival tissue. In a classic study, Tarnow et al investigated the effects of crestal bone height on the presence or absence of dental papilla. The authors examined 288 interproximal sites and demonstrated that the papilla was present almost 100% of the time when the distance from the contact point to the crest of the bone was 5 mm or less. Salama et al assumed a similar relationship in implant-supported restoration. Grunder confirmed this speculation. The author presented a case report of 10 single dental implants in the maxillary central/lateral incisor area and evaluated changes in papilla height 1 year after function. All the peri-implant papillae reformed after the final crowns were placed on the implants when the crestal bone level on the adjacent tooth was 5 mm or less from the contact point. Similarly, Choquet et al studied the papilla level around sin-

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**Table 1. Tooth vs Dental Implant**

<table>
<thead>
<tr>
<th></th>
<th>Tooth</th>
<th>Implant</th>
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<tbody>
<tr>
<td><strong>Hard tissue interface</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone-to-tooth/implant</td>
<td>Resilient connection: bone-periodontal ligament (PDL)-cementum</td>
<td>Rigid connection: functional ankylosis/osseointegration; lack of PDL</td>
</tr>
<tr>
<td><strong>Soft tissue interfaces</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junctional epithelium (JE) [Origin]</td>
<td>Hemidesmosomes and basal lamina [Reduced enamel epithelium]</td>
<td>Hemidesmosomes and basal lamina [Adjacent oral epithelium]</td>
</tr>
<tr>
<td>Connective tissue (CT)</td>
<td>Perpendicular collagen fibers inserted into cementum</td>
<td>Parallel collagen fiber bundles</td>
</tr>
<tr>
<td><strong>Tissue quality</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT composition</td>
<td>Lower proportion of collagen</td>
<td>Higher proportion of collagen</td>
</tr>
<tr>
<td><strong>Clinical characteristics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biologic width</td>
<td>JE—1 mm</td>
<td>JE—2 mm</td>
</tr>
<tr>
<td>Probing depth</td>
<td>CT—1 mm</td>
<td>CT—1 mm</td>
</tr>
<tr>
<td>Probing penetration</td>
<td>≤3 mm</td>
<td>2.5–4.0 mm</td>
</tr>
<tr>
<td></td>
<td>Healthy: apical 1/3 JE</td>
<td>Healthy: supracrestal CT</td>
</tr>
<tr>
<td></td>
<td>Gingivitis: coronal 1/3 CT</td>
<td>Disease: bone</td>
</tr>
<tr>
<td></td>
<td>Periodontitis: apical 1/3 CT</td>
<td></td>
</tr>
<tr>
<td><strong>Bleeding on probing</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other characteristics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prionprocieption</td>
<td>Highly sensitive receptors present within PDL (e.g., Ruffini-like mechanoreceptor, coiled Meissner’s corpuscles)</td>
<td>No receptors</td>
</tr>
<tr>
<td>Adaptablecy</td>
<td>Width of PDL can alter to allow tooth movement</td>
<td>No adaptive capacity and orthodontic movement impossible</td>
</tr>
<tr>
<td><strong>Fulcrum</strong></td>
<td>Apical 1/3 root</td>
<td>Crestal bone</td>
</tr>
<tr>
<td>Axial mobility</td>
<td>25–100 µm</td>
<td>3–5 µm</td>
</tr>
<tr>
<td>Movement phases</td>
<td>I. Nonlinear and complex</td>
<td>I. Linear and elastic</td>
</tr>
<tr>
<td>Movement patterns</td>
<td>Primary: immediate movement</td>
<td>Gradual movement</td>
</tr>
<tr>
<td></td>
<td>Secondary: gradual movement</td>
<td></td>
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</table>
Single dental implants in 26 patients and reported papilla was present almost 100% of the time when the distance from the contact point to the crest of the bone was 5 mm or less. Interestingly, the occurrence of papilla regeneration was at least 50% of the time when the distance was ≥6 mm. Therefore, other factors, such as horizontal distance between the 2 adjacent teeth at the level of CEJ, probably contributed to the presence of the papilla.

Compared with a single dental implant, regenerating a papilla between 2 adjacent implants is even more challenging. In a series of case reports, Elian et al. found a 5 mm height of tissue between 2 implants was not routinely possible. Tarnow et al. agreed with the previous finding. The authors examined a total of 136 interimplant papillary heights in 33 patients and found the mean papillary height was only 3.4 mm. Although there was a range of 1 mm to 7 mm, the soft tissue heights were 2, 3, or 4 mm in 90% of the cases. On the basis of these data, the ideal distance from the base of the contact point to the bone crest between adjacent implants is 3 mm and, between a tooth and an implant, ≥5 mm (Table 2).

### Table 2. Conditions Favoring Peri-Implant Papilla Appearance

<table>
<thead>
<tr>
<th>Interproximal dimensions</th>
<th>Single implant: ≤5 mm</th>
<th>Two adjacent implants: ≤3 mm</th>
<th>Single implant: ≥1.5 mm</th>
<th>Two adjacent implants: ≥3 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bone crest-contact point</td>
<td>Single implant: ≤5 mm</td>
<td>Two adjacent implants: ≤3 mm</td>
<td>Single implant: ≥1.5 mm</td>
<td>Two adjacent implants: ≥3 mm</td>
</tr>
<tr>
<td>Interproximal distance</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tooth factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crown form/shape</td>
<td>Squared shape</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contact length</td>
<td>Long</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tooth position</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Soft tissue factors</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gingival thickness</td>
<td>Thick</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gingival scallop</td>
<td>Flat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Keratinized gingival width</td>
<td>≥2 mm</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Interproximal Distance

The interproximal distance has been thought to affect the appearance of the hard and soft tissue in the embrasure space. Heins and Wider demonstrated very thin lamina dura existed when the inter-root distance was <0.5 mm. When the inter-root distance became <0.3 mm, the crestal bone disappeared. Instead, the adjacent root surfaces were connected by the 2 adjacent periodontal ligament spaces. On the basis of these findings, teeth with root proximity are more susceptible to crestal bone loss, which can subsequently cause the papillary disappearance. In addition, Tal found that a vertical defect occurs only when there is at least 1.5 mm interdental distance. Otherwise, horizontal crestal bone loss occurs with the recession of dental papilla. In a recent study of 206 dental papillae in 80 patients, Cho et al. supported this notion. The authors found the ideal vertical dimension for papilla formation should be ≤5 mm from the contact point to the alveolar crest while the ideal horizontal dimension was 1.5–2.5 mm between adjacent roots. Besides, the authors suggested there were independent and combined effects of both dimensions on the existence of papillae.

These findings in natural teeth make the researchers question if there is a similar correlation in implant-supported restoration. Tarnow et al. investigated the effect of the interimplant distance on the height of inter-implant bone crest. The authors found that there was a lateral component of bone loss around implants, and 3 mm was a critical interimplant distance. If the distance was <3 mm, 0.56 mm more pronounced bone loss was observed. The authors then speculated that this interimplant distance might play a significant role for presence of the papilla. A recent study performed by a Brazilian group confirmed this speculation. In a group of 48 patients with 96 interproximal sites, Gastaldo et al. examined the effects of the vertical and horizontal distances between adjacent implants and between a tooth and an implant on the incidence of the papilla. When the distance between adjacent implants and between a tooth and an implant were <3 mm, papilla was absent 100% of time, regardless of the vertical distance. Furthermore, they found that there was an interaction between horizontal and vertical distances when the interproximal spacing was >3 mm. In contrast, Novaes et al. failed to show any significant effects of interimplant distance on papilla formation in a dog model. In one of their 2 studies, 2 implants were inserted in the mandible separated by 2 mm (group 1). Other 2 implants were separated by 3 mm (group 2). In all cases, final metallic crowns were fabricated to maintain a distance of ~5 mm between the interproximal contact and crestal bone. The mean papilla heights in groups 1 and 2 were similar with 3.07 mm and 3.55 mm, respectively. The probable reasons for these contrary results could be due to the different study models (e.g., human vs dog) and different implant designs (e.g., machined titanium implant vs rough surfaced implant). Further studies are necessary to resolve this controversy.

### Tooth Form/Shape

Tooth shape can be classified into triangular, ovoid and square while tooth form can be defined as long narrow or short wide. In natural dentition, gingival morphology is partly related to the tooth shape and form. In a study of 192 subjects, Olsson and Lindhe demonstrated patients with long-narrow/triangular-shaped upper central incisors experienced more recession of the gingival margin at buccal surfaces than those with a short-wide form/square shape. In their next study, Olsson et al. reported that individuals with the long-narrow tooth form displayed a thin free gingiva, a narrow zone of keratinized gingiva, shallow probing depth, and a pronounced “scalloped” contour of the gingival margin. Likely, the tooth shape and form can influence the peri-implant soft tissue architecture as well. Indeed, Kois described tooth shape as 1 of the 5 essential diagnostic keys for the peri-implant esthetics,
which should be considered in the pre-surgical phase of implant therapy. In his opinion, it impacts the tissue both coronal and apical to the free gingival margin (FGM). Coronal to the FGM, individuals with square-shaped teeth have a more favorable esthetic outcome because of the long proximal contact and less amount of papilla tissue to fill the interproximal space. On the contrary, the contact of triangular tooth is short and more incisally positioned. The interproximal area requires more tissue height to fill. Therefore, in the case of triangular tooth shape, there is higher risk of black hole, and peri-implant papilla regeneration can be very challenging. Kois suggested, in this situation, modification of the adjacent tooth shape with either direct composite or porcelain veneer may be necessary after an implant-supported restoration. Apical to the FGM, the triangular tooth shape is more favorable than the square one. The triangular teeth allow for roots positioned farther apart than the squared ones. As a result, there is potentially thicker interproximal bone, which may minimize crestal bone loss and subsequent papilla loss after extraction and implant placement.

Gingival Thickness

Gingival tissue biotype is another important diagnostic key for peri-implant esthetics. It was proposed, 2 basic types of gingival architecture exist—“scalloped thin” and “flat-thick.” Thin gingival tissue has been described to have less underlying osseous support and less vascularization. As a result, the thin tissue is more susceptible to trauma and increases the risks of facial recession and loss of interproximal tissue after any surgical procedure. In contrast, thick gingival tissue implies thicker underlying bone structure, more fibrotic tissue, and more blood supply. Therefore, the thick tissue is more resistant to physical damage and bacterial ingress. Indeed, abundant empirical evidence suggests thick gingival tissue not only resists physical trauma and subsequent tissue recession but also allows better tissue manipulation, encourages creeping attachment, improves papilla fill, reduces clinical inflammation, and renders predictable surgical outcomes. In a clinical trial on 24 patients, Oh et al. studied the effects of flapless implant surgery on the soft tissue profile. The authors found better papillary index (PI) with the thick soft tissue (ie ≥3 mm) than the thin tissue (ie, <3 mm); however, the difference was not significant. In a case series of 45 patients, Kan et al. evaluated the dimensions of the peri-implant mucosa around 2-stage maxillary anterior single implants after 1 year of function. The authors categorized the peri-implant biotype into a thick or thin group by placing a periodontal probe into the facial aspect of the peri-implant mucosa. If the outline of the underlying probe could be seen through the gingiva, the peri-implant biotype was defined as thin. If the probe could not be seen, the biotype was thick. The interproximal dentogingival dimension in the subjects with the thick biotype was significantly greater than those with the thin biotype (ie 4.3 mm vs 3.8 mm). Therefore, peri-implant papilla may be maintained or re-established with the thick biotype.

Other Potential Factors

The relative tooth position, type of gingival scallop and amount of keratinized/attached gingiva are other possible factors that may determine the level of papilla around dental implant. Before removal of the hopeless tooth, it is critical to evaluate its position relative to the remaining dentition because the existing tooth position will influence the presenting configuration of the gingival architecture. For example, tooth with root proximity has a very thin interproximal bone. This thin bone is highly susceptible to resorption after extraction, which will subsequently cause the interproximal soft tissue loss. In contrast, tooth with diastemas possess thicker interproximal bone, which is at less risk for resorption after wound healing. As a result, peri-implant papilla preservation or regeneration will be more predictable.

Based on a survey of 100 patients, the gingival scallop can be categorized into high, normal or flat. Compared with the normal or high gingival scallop, flat gingival architecture has less tissue coronal to the bone interproximally than facially. It tends to follow the osseous scallop creating less discrepancy and less risk of interproximal tissue loss after tooth extraction. Consequently, the maintenance of interproximal papilla becomes more predictable.

The role of keratinized/attached gingiva around natural teeth is a controversial issue. It has been suggested 2 mm of keratinized tissue with at least 1 mm attached tissue was required to maintain gingival health. However, others have found that the amount of keratinized or attached gingiva was not critical for tissue health but patient’s oral hygiene. Similarly, there is a debate over the need for keratinized and attached tissue for the maintenance of dental implants. Currently, the general consent is, with a proper plaque control, lack of adequate keratinized/attached tissue will not increase the incidence of attachment loss or soft tissue recession. However, under the condition of inflammation, the site with inadequate keratinized tissue is highly susceptible to progressive attachment loss and recession. In addition, new evidence suggested, regardless of the surface configurations, the absence of adequate keratinized and attached tissue in dental implants is associated with higher plaque accumulation and gingival inflammation. On the basis of these data, one can speculate that keratinized/attached tissue may influence the appearance peri-implant papilla, particularly in the situation of inflammation.

Dental Papilla Enhancement Technique

Over the last 2 decades, various techniques have been proposed to preserve the papillary area or restore the missing papilla. In general, these techniques can be classified as surgical and non-surgical (Table 3). The surgical technique focuses on soft and hard tissue management, such as flap de-
In a study on 24 patients, Iasella et al. compared extraction alone with ridge preservation using freeze-dried bone allograft and a collagen membrane. The ridge preservation group gained an average of 1.3 mm bone height. In contrast, the extraction alone group lost an average of 0.9 mm. Although both groups lost ridge width, the ridge preservation group only showed minimal resorption (~1 mm) while the extraction alone group shrunk ~3 mm. The authors concluded the ridge preservation is a predictable procedure for the maintenance of ridge height, width, and position.

Recently, immediate dental implant placement has become a feasible and popular treatment option in the anterior maxilla in select situations. Numerous case reports and some clinical trials have shown that immediate implantation may allow preservation of the alveoli and surrounding structures with favorable esthetic outcomes. Kan et al. evaluated the implant success and esthetic outcomes of immediately placed and provisionalized maxillary anterior single implants on 35 patients. After 12 months, all implants were successfully osseointegrated. The average marginal bone loss was <0.3 mm. The midfacial gingival level and mesial and distal papilla levels lost an average of 0.55 mm, 0.53 mm, and 0.39 mm, respectively. None of the patients had noticed any changes at the gingival level. The authors concluded that immediately placed and provisionalized maxillary anterior single implants provided favorable implant success rate and excellent esthetic outcomes.

Juodzbalys and Wang also reported 100% success rate of immediate implant placement after a 1-year follow-up. According to the recent dental literature, peri-implant papillae showed a height of 0.54 mm, while the remaining 57.7% showed a score of 3. The authors suggested that, with careful evaluation of potential extraction sites, immediate implant placement promotes optimal implant esthetics.

In the event of multiple failing anterior teeth, simultaneous extraction of the adjacent teeth often leads to flattening of the interproximal bony scallop and results in implant restorations with missing interimplant papillae. To manage this esthetic setback, Kan et al. proposed an interimplant papilla preservation technique involving alternate removal of teeth atraumatically with immediate implant placement and provisionalization. The authors claimed that 1 side of the proximal bone and the associated papilla can always be maintained while the other side is healing. In addition, the adjacent tooth form can serve as a guide for implant placement and provisionalization. In 6 patients, the authors showed all interimplant papillae with a mean PI score of 3 after a mean functioning time of 22.6 months. All patients were satisfied with the final esthetic outcome.

Implant placement with flapless approach provides some distinct advantages over the conventional open-flap approach, such as a lessened surgical time, bleeding and postoperative discomfort, minimal changes in crestal bone level, soft tissue inflammation, and probing depth adjacent to implants. Therefore, flapless implant surgery is one possible treatment option for enhancement of implant esthetics. Becker et al. placed 79 implants in 59 patients using a one-stage flapless technique. At 2 years, the cumulative success rate was ~99%. The changes in crestal bone level were insignificant (i.e., 0.1 mm). The authors concluded flapless implant surgery is a predictable procedure. Oh et al. replaced a missing single tooth in the premaxillary region with an endosseous implant using a flapless technique. The implants were either immediately loaded or delayed loaded. At 6 months, no signifi-
significant differences were detected between the 2 treatment groups in any clinical parameters. The mean PI in the immediate loading group increased from 1.50 at baseline to 2.09 at 2 months and then remained stable up to 6 months (i.e., 2.30). In the delayed group, the mean PI stayed the same (i.e., 2.06 at both baseline and 6 months). These were minimal changes of the marginal soft tissue level in both treatment groups over 6-month period. Both studies demonstrated flapless implant surgery provides esthetic soft tissue profile around single-tooth implant restorations, regardless of the loading protocol.

Soft Tissue Management

Two soft tissue management approaches are generally found in the dental literature. The first approach focuses on the flap designs or surgical techniques to maintain full papillary form after the surgical procedure.\(^\text{81–89}\) The second approach uses grafting techniques to fill the open interproximal spaces.\(^\text{90–104}\) However, because of the minimal blood supply and difficult access to the papillary tissue, only limited success has been achieved with these approaches.\(^\text{12}\)

Takei et al\(^\text{98}\) developed the “papilla preservation technique” with the aim to improve the deficient interproximal papillae between multiple teeth. Later, various modifications of Takei’s technique (e.g., modified papilla preservation technique, simplified papilla preservation technique and papillary amplification flap) have been proposed to optimize interproximal soft tissue preservation.\(^\text{81–83,85,89}\) Similarly, the concepts of preserving blood supply to the peri-implant papillae and minimizing soft tissue recession in the esthetic zone, such as paramarginal pedicle flap, flap without disturbing the periosteum, are advocated.\(^\text{84–86}\)

Gomez-Roman\(^\text{85}\) compared 2 different flap designs: a widely mobilized flap that included papillae and a limited flap that protected papillae, and determined their effects on the peri-implant interproximal crestal bone loss. One year after crown placement, the mean interproximal bone loss was significantly lower after the use of a limited flap design than the widely mobilized flap procedure (ie 0.29 mm vs 1.12 mm). As a result, the limited flap design minimized the risk of papilla loss. In addition, Flanagan\(^\text{84}\) proposed an incision design, which allows lifting of the gingiva without disrupting the periosteum and its blood supply, to promote the gingival base for the creation of interdental implant papilla.

A number of techniques have been published to describe surgical reconstruction of deficient dental/peri-implant papillae.\(^\text{90–104}\) All these techniques are based on the traditional plastic surgical approaches (e.g., subepithelial connective tissue graft).

Palacci\(^\text{102}\) developed an unique papilla regeneration technique at stage 2 uncover for multiple implants, in which a semilunar beveled incision is performed in the elevated flap in relation to each implant to create a pedicle. The pedicle is then rotated 90 degree toward the mesial aspect of the abutment and stabilized with interrupted mattress sutures to form a new interimplant papilla. Subsequently, numerous modifications of Palacci’s technique have been reported in case studies or clinical trials.\(^\text{97,99,101}\) In a recent pilot study, Misch et al\(^\text{98}\) used a “split-finger” incision design to promote papilla formation. The authors reported 16 single-tooth implant restorations with a mean PI score of 3 while 5 multiple implant-supported prostheses had a mean PI score of ≥2. In addition, soft tissue grafting was also suggested to enhance papillary appearance.\(^\text{93,103}\) In a single case report, Price and Price\(^\text{93}\) described the use of subepithelial connective tissue graft to restore papillae adjacent to a single dental implant. The authors showed a 3-year clinical follow-up with complete gingival papillae. Similarly, Azzi et al\(^\text{93}\) reported 3 successful cases, in which a subepithelial connective tissue graft was inserted in a pouch to move the entire peri-implant gingivopapillary unit incisally.

Despite these extensive efforts to preserve or regenerate papillary tissue, none of these procedures provide evidence of predictability, and few demonstrate long-term stability.

Nonsurgical Techniques

Restorative/Prosthetic Treatment

In certain circumstances, restorative/prosthetic techniques may be helpful for treating papillary insufficiency, for example, when all hard and soft tissue augmentation procedures fail to achieve esthetic outcomes or when patients refuse any surgical interventions. By means of restorative/prosthetic reshaping, the contact of the crowns can be lengthened and located more apically.\(^\text{98,105–107}\) As a result, the open embrasure space is reduced with an illusion of papilla regeneration.

After a single anterior tooth removal, Spear\(^\text{108}\) advocated the use of ovate pontic to help in molding the papillary height and gingival embrasure form. In a single case report, Al-Harbi\(^\text{109}\) adapted Spear’s concept and successfully enhanced the interimplant papillary tissue by a cantilevered fixed partial denture with an ovate pontic. Similarly, Jent\(^\text{110}\) attempted to promote interimplant papillary formation by the means of placing a provisional resin crown at the time of second-stage surgery. The author showed that the use of provisional crowns were able to guide the soft tissue into the interimplant space faster than healing abutments alone; however, the volumes of the papillae adjacent to single-implant restorations were similar after 2 years of function.

Orthodontic Therapy

Orthodontic therapy offers the best esthetic outcomes in several distinct clinical situations.\(^\text{107}\) In the presence of diastema, the interdental papilla is apparently missing. This situation can be remedied by combining orthodontic tooth approximation with apical positioning of the contact point through stripping.\(^\text{111}\) Root divergence is another situation that can lead to the open interproximal space when the contact point between the 2 clinical crowns is situated too incisally. Again, orthodontic treatment can create a new papilla by aligning the roots and squeezing the interproximal tissue.\(^\text{86}\) In addition, when teeth or roots are indicated for extraction, forced orthodontic extrusion should be considered to enhance both hard and soft tissue profiles.\(^\text{112}\) This
eruption technique can be valuable for the improvement of the peri-implant papilla height.13

**Novel Approach**

McGuire and Scheyer12 introduced an innovative papilla priming procedure in an attempt to enhance papillary form. Twenty-one subjects with interdental papillary deficiency were enrolled. The deficient sites were randomized to receive autologous fibroblast injections or placebo injections. At 2 months, the test sites showed more papillary height gain than the placebo sites. However, the treatment effect disappeared at 4 months. Future research in this area is certainly needed.

**Conclusion**

At this point, the crestal bone level seems to be the primary factor for the presence of peri-implant papilla. Similarly, the interproximal distance may affect the existence of the papilla. In addition, there are also other potential factors, such as tissue thickness, keratinized/attached tissue width, tooth form/shape and position. Unfortunately, these factors have never been fully investigated due to lack of funding and long-term follow-up. Future studies are necessary to clarify the importance of each of these factors. Although numerous techniques showed successful papillary preservation or regeneration, most were documented in case reports, and none has been proved to be predictable in the long term. Therefore, more controlled clinical trials are needed to evaluate the efficiency of these papillary enhancement techniques.

**Disclosure**

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ABSTRACTO: Propósito: La pérdida de la papila del implante es uno de los dilemas más preocupantes en la odontología de implante. El “triángulo negro” alrededor de la restauración apoyada en implantes no solamente causa dificultades fonéticas y la acumulación de comida sino también un resultado estético poco agradable. Esto se considera una falla en las normas actuales de terapia con implantes. Como consecuencia, se han creado muchas técnicas para proteger o regenerar el tejido blando interimplante. El propósito de este trabajo es examinar los factores que pueden afectar la papila perimplante. Materiales y Métodos: Se usó una búsqueda en MEDLINE para identificar artículos publicados hasta septiembre del 2007 relacionado con la estética del implante como papila interimplante. Resultados: Factores tales como la altura del hueso crestral, distancia interproximal, forma y contorno del diente, espesor gingival y ancho gingival que-ratínizado fueron identificados como que influenciaban el aspecto de la papila interimplante. Además, se han usado muchas técnicas y materiales exitosamente en la promoción de la formación de la papila interimplante. Conclusión: Este artículo presenta una evaluación general de los factores que pueden influenciar las papilas interimplante e ilustra técnicas usadas para tratar de recrear o corregir este problema en la odontología de implantes.

PALABRAS CLAVES: Implante, papilas, estética, tejido blando interproximal

PORTUGUESE / PORTUGUÉS

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Fatores e Técnicas que Influenciam Papilas Peri-implantes

RESUMO: Objetivo: A perda de papilas de implante é um dos dilemas mais perturbadores na odontologia de implante. O “triângulo negro” em torno da restauração suportada por implantes não só causa dificuldades fonéticas e impactação alimentar, mas também estética desagradável. Isso é considerado uma falha nos padrões atuais de terapia de implante. Como consequência, muitas técnicas foram desenvolvidas para preservar ou regenerar o tecido mole interimplante. É objetivo deste artigo examinar fatores que podem afetar o aparecimento de papilas peri-implantes. Materiais e Métodos: A busca no MEDLINE foi usada para identificar artigos publicados ao longo de setembro de 2007 relacionados a estética de implante como papilas interimplante. Resultados: Fatores como altura da crista óssea, distância interproximal, forma/formato do dente, espessura gengival e largura da gengiva ceratinizada foram todos identificados como influenciadores do aparecimento de papilas interimplante. Além disso, muitas técnicas/materiais foram usados com sucesso na promoção da formação de papilas interimplante. Conclusões:
Este artigo apresenta uma revisão abrangente de fatores que podem influenciar as papilas interimplantes e ilustra técnicas usadas na tentativa de recrivar/corriger esse problema desafia-
dor na odontologia de implante.

PALAVRAS-CHAVE: Implante, papilas, estética, tecido mole interproximal

RUSSIAN / РУССКИЙ

АВТОРЫ: Yiu Cheung Chow, доктор хирургической стоматологии, магистр естественных наук, Hom-Lay Wang, доктор хирургической стоматологии, доктор философии

Факторы и методы, влияющие на формирование десневых сосочков вокруг имплантатов

РЕЗЮМЕ. Цель. Утрата десневых сосочков вокруг имплантата – это одна из наиболее серьезных проблем дентальной имплантологии. «Черный треугольник», образующийся вокруг реставрации с опорой на имплант, не только ухудшает дикцию и задерживает остатки пищи, но также представляет собой эстетический дефект. Современные стандарты имплантологии позволяют считать такой результат неблагоприятным исходом. Как следствие, было разработано множество методик, позволяющих либо сохранить, либо восстановить мягкые ткани между имплантатами. Целью данной работы является изучение факторов, способных повлиять на внешний вид межзубных десневых сосочков вокруг импланта-
tов. Материалы и методы. Для поиска статей, опуб-
ликованных до сентября 2007 г. включительно, по
эстетическим аспектам имплантологии, связанным
dесневыми сосочками, использовалась электронная база MEDLINE. Результаты. Было установлено, что на внешний вид межзубных десневых сосочков в области имплантатов влияют такие факторы, как высота альвеолярного гребня, размер межзубных промежутков, форма конфигурация зубов, толщина десны и ширина зоны кератинизированной десны. Кроме того, множество существующих методик и материалов с успехом используются для формиро-
вания десневых сосочков между имплантатами.

Вывод. В данной работе представлен истерпывающий обзор факторов, влияющих на состояния десневых сосочков между имплантатами, и приведены методики, применимые для их вос-
создания и решения этой насущной проблемы дентальной имплантологии.

КЛЮЧЕВЫЕ СЛОВА: имплантат, десневые сосочки, эстетика, межзубные мягкие ткани

TURKISH / TÜRKÇE

YAZARLAR: Yiu Cheung Chow, DDS, MS, Hom-Lay Wang, DDS, MSD, PhD

Peri-implant Papillar Etkileyen Faktör ve Teknikler

ÖZET: Amaç: Implant papillasının kaybı, implant dışçiliği
nin en rahatsız edici sorularından biridir. Implant ile deşte-
klenen restorasyonun etrafındaki “siyah üçgen” sadece fonetik
güçlülük ve yiyecik maddelerinin gömülmesine neden ol-
makla kalmaz, ayrıca tılsız bir estetik görünüm de yaratır.
Gününüzün implant terapi standartlarına göre bu bir başarı-
sızlık kabul edilir. Bu nedenle, inter-implant yumuşak
dokuyu ya korumak ya da yeniden u

Yazımcının amacı, peri-implant papillanın

goingil

Sonuç: Bu makale, inter-implant papillayı etkileyebilen faktörleri incelemek için kullanlan teknikleri

ANAHTAR KELİMELER: İmplant, papilla, estetik, inter-
proksimal yumuşak doku

インプラント周辺歯間乳頭に影響する要因と技術

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研究概要: 目的: インプラント周辺歯間乳頭喪失はインプラント歯科においても比較的深刻なジレンマのひとつといえる。インプラ
ト支台補綴周辺の「ブラッシュオンタイプ」は音韻不全や食物歯牙埋没を起因すると同時に、審美障害もある。こし
た不具合は今日のインプラント治療基準では失敗と見なされており、結果としてインプラント間の軟組織維持もしくは再生
を目指した多くの技術開発が進められている。当文献ではインプラント周辺歯間乳頭の形状に影響する要因調査を目的とした。

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方法と素材: MEDLINE検索でインプラント周辺歯間乳頭関連インプラント審美課題を扱った2007年9月までに発表された記事を確認した。

結果: 歯槽骨欠損をはじめとして歯間距離や歯の外形/形態、さらに歯茎の厚みや角質化した歯茎幅などの諸要因がすべてインプラント歯間乳頭の外観に影響することが指摘された。それだけでなく、既に多くの技術/材質がインプラント歯間乳頭形成促進に成功をおさめている。

結論: 本文献はインプラント歯間乳頭に潜在的影響をおよぼす要因を徹底調査し、インプラント歯科において困難ながらも意欲をそそるこの課題について、再生/修正を試みる諸技術を説明する。

キーワード: インプラント, 歯間乳頭, 審美, 歯間軟組織

**CHINESE / 中国語**

影響植体周辺乳突的因素和技術

作者: Yiu Cheung Chow, DDS, MS, Hom-Lay Wang, DDS, MSD, PhD

摘要:
目的: 植体乳突流失是比較棘手，今牙科植体學進退兩難的問題。植體支援義歯週圍的「黑色三角形」不僅造成發音困難和食物嵌塞，外觀也不討喜。從當今的植體治療標準來看，這被視為失敗結果。因此，已經有許多技術發展用來保留植體間軟組織或促進植體間軟組織再生。本報告的目的是檢查可能影響植體週圍乳突外觀的因素。

資料與方法: 使用MEDLINE检索確認截至2007年9月已發表的植體間乳突之植體美學相關文章。

結果: 牙結骨高度、齲洞距離、齲质/齒形，牙齦厚度以及角質化牙齦寬度等因素，皆已確認會影響植體間乳突的外觀。此外，許多技術/材料已成功應用於促進植體間乳突形成。

結論: 本文完整探討可能影響植體間乳突的因素，並闡述植體牙醫學用於嘗試重建/修正這個棘手問題的技術。

**KOREAN / 한국어**

임플란트 주위 유두에 영향을 미치는 인자 및 기법

저자: 유수초우 (Yiu Cheung Chow), DDS, MS, 을레이 왕 (Hom-Lay Wang), DDS, MSD, PhD

요약:
목적: 임플란트 유두 소르의 치과 임플란트 분야에서 매우 글치 아픈 달래마 중 하나이다. 임플란트-지지 수복부위 주변의 ‘블랙 트라이앵글(black triangle)’은 발증하는데 불편함을 주거나 음식물이 깔 뿐 아니라 심미적으로도 좋지 않은 결과를 초래한다. 이것은 오늘날 임플란트 치료 기준에서 실패로 간주된다. 따라서, 임플란트간(inter-implant) 연조직을 보존 또는 재생하기 위해 많은 기법들을 개발하고 있다. 본 연구의 목적은 임플란트 주변 유두 외관에 영향을 미칠 수 있는 인자들을 평가하는데 있다.

제료 및 방법: 임플란트간 유두의 임플란트 심미성과 관련되어 2007년 9월 발표된 논문들을 확인하기 위해MEDLINE 검색을 이용하였다.

결과: 치조골 높이, 치간 거리, 치아 형태/모양, 임플 삽입 및 각화된 임플 넓이와 같은 인자들이 임플란트간 유두의 외관에 영향을 미치는 것으로 확인되었다. 또한, 임플란트간 유두 형상을 측정하는데 많은 기법/재료들이 사용되고 있다.

결론: 본 논문은 임플란트간 유두에 영향을 미칠 수 있는 인자들을 포괄적으로 검토하고, 치과 임플란트계에서의 이러한 단체를 해결/보정하기 위해 사용되는 기법들을 기술하였다.

키워드: 임플란트, 치유두, 심미학, 치간연조직