Gingival Embrasure Fill In Fixed Implant-Supported Prosthetics: A Review

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After provisional or definitive cementation of fixed implant-supported prostheses, spontaneous gingival proliferation may occur to fill the cervical embrasure areas of the prosthesis. Adequate oral hygiene, osseous spacing between the supporting implants and attached or immovable soft tissue may be the conditions that allow this phenomenon. This proliferation embrasure fill eliminates interproximal gingival voids, that is, black triangles, and makes the outcome more esthetically acceptable. Since interproximal prosthetic deign and implant positioning may be the primary factors for the fill, the gingival fill may be, in fact, an epulis.

Key Words: gingiva; proliferation, dental implant, interimplant, implant design, epithelium, mucosa, keratinized tissue

INTRODUCTION

After definitive or long-term provisional cementation some clinicians have noted that the gingiva around the prostheses becomes proliferative and fills the embrasures of prostheses.[1] This process may take several weeks or months to occur.

The esthetic zone is an important area in dental implant treatment. When there are 2 adjacent implants placed there may be an embrasure void between the definitive prosthetic crowns known as a "black triangle."[1] The black triangle is the result of an absence of a gingival papilla between crowns. Light passing through this void dissipates in the pharynx and does not reflect back to the eye of the observer. This creates the appearance of a black triangle. However, after a period of time there may be a proliferation of the gingiva that fills this void that presents a more esthetic result. This may be the same hyperplastic phenomenon as seen in orthodontic treatment or at overextended denture flanges.[2] Medications and hormonal conditions such as pregnancy are also associated with enlarged gingival.

CASE EXAMPLE 1

A 39-year-old female patient presented for dental treatment. She had an insignificant medical history and took no medications. She had not had a dental visit in 30 years. Oral and radiographic examination revealed advanced stages of dental caries and periodontitis. The majority of the remaining teeth were unsalvageable. The patient was concerned about an esthetic outcome and bone loss associated with tooth removal at her relatively young age. Options were discussed and bimaxillary implant-supported fixed complete dentures were decided upon. The maxillary and mandibular teeth were extracted and immediate removable dentures constructed. The vertical dimension of occlusion was established and after 6 months the implants were surgically installed, 12 in each arch. Because of the patient's relatively young age, an implant was placed for each missing tooth from first molar to first molar. This may minimize bone loss as she aged and provide support in the case of a failed implant later in her life. All of the maxillary implants were placed using a surgical guide and a provisional complete denture was fabricated and worn during the 4-month healing integration phase. During this time the maxillary right first molar implant failed to integrate and was removed and immediately replaced with a slightly larger press fit sintered implant (Innova). After the healing phase an implant-supported porcelain segmented complete denture was fabricated. At the time of insertion of the definitive fixed complete denture, there were gingival embrasure voids or "black triangles" noted at the cervical embrasures (Figure 1). Her lip line was low and covered these in repose and function, so there was no esthetic issue in her mind. The patient was instructed to only thoroughly brush the prostheses and not to floss or engage in any other type of oral hygiene activity. After 6 months of function at the prophylaxis appointment, a proliferation of the interproximal embrasure gingiva was noted. The gingiva had filled in the black triangles (Figure 2). The horizontal interproximal spacing was 3 mm. The vertical space measured from the crown margin to the connection of the crowns ranged from 4 to 6 mm.

CASE EXAMPLE 2

A 50-year-old female long-time complete denture wearer became interested in a fixed implant-supported maxillary complete denture to eliminate the palatal coverage. She was prepared in the usual fashion for fixed implant-supported complete denture treatment. The implants were placed using a surgical guide and allowed to heal and integrate for 4 months using her existing maxillary complete denture as a provisional. This provisional was soft lined to prevent uneven load on the soft tissue and underlying healing implants. No implants failed to

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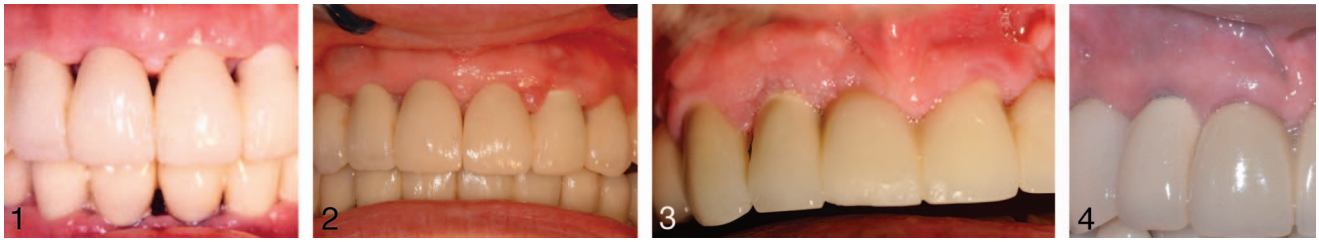

Figures 1–4. Figure 1. Case 1 black triangles just after prosthetic delivery. **Figure 2.** Case 1 embrasure fill by gingival proliferation 6 months postdelivery. **Figure 3.** Case 2 embrasure fill by gingival proliferation 4 months postdelivery. **Figure 4.** Case 3 embrasure fill by gingival proliferation 6 months postdelivery.

integrate. A segmented fixed implant-supported porcelain fused to noble alloy definite prosthesis was fabricated. After insertion with provisional cement she complained of an "ess" sound during speech. This was due to a lack of tongue accommodation to the now not-covered anterior hard palate and open gingival embrasures. The patient was instructed in tongue positioning and reassured that tongue accommodation would occur and that the gingiva would fill the embrasures to close any escaping air flow through the embrasures. After 2 months the embrasures did fill with gingival peaks and her tongue did accommodate (Figure 3). There were no issues with "ess" pronunciation. The vertical embrasure space ranged from 4 to 6 mm.

Case Example 3

A 45-year-old male presented for maxillary fixed implant-supported prosthetics for edentulism. He was worked up in the usual fashion and he approved the treatment plan. A surgical guide was used to place the implants and a provisional complete removable denture that was periodically soft relined. After 4 months of healing prosthetic fabrication began and a segmented fixed implant supported prosthesis was delivered. After 6 months spontaneous embrasure fill was noted (Figure 4).

Discussion

There have been many implant dentists noting a gingival embrasure proliferation phenomenon.[1,3] After several months of function, the interproximal gingiva of fixed implant-supported dentures proliferate and fill an embrasure space void without surgical intervention.

When there are gingival embrasure voids in the definitive prosthesis, patients may object to the appearance of black triangles even if there is a low lip line.[4] A minority of patients will esthetically tolerate a poor gingival architecture outcome.[5] However, some patients are "lip lifters" and want to see scalloped gingival marginal architecture. Gingiva, under appropriate conditions, appears to proliferate and fill embrasures at the cervical areas of a definitive fixed prosthesis presenting an appropriate architecture.

This appears to occur in natural teeth prostheses and around orthodontic bands as well.[2] The shape of the adjacent teeth may be important in papilla formation.[6] The vertical and horizontal dimensions of interproximal areas have substantial, independent, and combined effect on the existence of interproximal papillae.[7] Most work on this topic has been done on natural teeth and these results may not be applicable to interimplant embrasures. The periodontal ligament (PDL) may influence the papillary fill by providing fibroblasts.[7] A 1-mm interdental distance was found to have 100% embrasure papilla fill.[7] This may not be appropriate for interimplant distance. Implants do not have a PDL and the displacement of the implant may physically block angiogenesis that may encourage immediate papilla formation. The PDL and fibroblasts may be important cells in gingival proliferation.[8] Gingival and PDL fibroblasts differ in their ability for gingival proliferation.[8] Additionally there are differences in chemotactic response, propensity for apoptosis, protein and collagen synthesis and glycosaminoglycan content.[7,8] Since dental implants do not have a PDL, gingival fibroblasts may be the only cells responsible for proliferation and this may be a response to the prosthetic embrasure design.[7]

In natural teeth the papillae may recede with an increase in the dimension of contact point-to-bone crest, contact point-to-cementoenamel junction (CEJ), and CEJ-to-bone crest distance, an increase in the inter-radicular distance, decrease in the interproximal contact area length, or increase in the embrasure space size.[9,10] A triangular tooth shape is associated with loss of embrasure gingival fill.[9,10] This occurs when there is a large embrasure base with a straight slope to the contact area.

Chu and coworkers published a study where they demonstrated that 3-mm interimplant spacing between external hex design implants may be optimal.[11] The peak of bone that persists in this space may support gingival papillae and may allow proliferation of the gingival epithelium.[12,13] Since bone supports gingiva and it generally follows osseous contour interimplant spacing may be crucial to gingival proliferation.

Gingival proliferation may be related to epulis fissuratum, where an overextended denture flange may cause the formation of mucosal collagenous scar tissue.[14] Tissue proliferation from flange pressure and collagenous scarring acts to protect the mucosa from being ulcerated by the flange overextension.[14] Nevertheless, interproximal proliferation is probably most related to the interproximal dimensional contours of these surfaces where there may be a gentle contact pressure on the gingival papilla. The dimensions may be paramount for papillary formation.[15–18] The most appropriate interproximal dimensions have not been well studied. This may be due to the many different implant types and designs as well as the expense of randomized controlled trials. Physical

contact of the papilla may be an important parameter in combination with good oral hygiene and adequate facial attached tissue.

In orthodontic patients gingival proliferation may occur that encourages interdental plaque accumulation.[19,20] The question arises as to which causes which. Does plaque cause gingival proliferation or does gingival proliferation cause plaque accumulation?[19,20]

Inflammation as a result from emergence profile pressure from the porcelain-fused-to-metal (PFM) prosthetic marginal shape may occur just as denture flange pressure causes submucosal collagenous scarring known as an epulis.[14] Subsequently plaque accumulation may induce additional gingival thickening.

Dental plaque is considered the primary causative agent of periodontal disease but disease progression is related to host inflammatory factors.[21] The specific mechanism of disease progression is not fully understood.[21] The patient inflammatory process may result in a reduction of collagen fibers but the remaining fibers are thicker and more densely packed.[21] Types I, III, and VI collagen are involved with this collagen degradation and fiber thickening.[21] This thickening may be responsible for clinical gingival thickening. Nevertheless, epulis formation may involve the same or similar physiochemical inflammatory process. A skin decubitus ulcer on the buttocks or ischium forms under surface pressure from a patient remaining in one position such as in a bed or wheelchair.[22] There are internal strains in the skin, muscle, and fat tissue from the surface pressure against underlying bone.[23] Fat and muscle stiffness affects strain variations between the tissues.[23] Skin is less influential.[23] Tissue thickness also influences the development of decubitus ulcers.[23] Skin and mucosa are both epithelium and oral epuli may be related to decubitus ulcers. Epuli may not ulcer because of the lubricating action of saliva and the activity of intraoral muscles that prevent static pressure on mucosa. There is always underlying bone, generally the facial aspect of the mandible, associated with epuli. Areas of the mouth that have less salivary accumulation such as the medial aspect of the edentulous mandible may develop ulcers rather than epuli. Interproximal embrasures are well bathed in saliva and thus may develop gingival proliferation and not an ulcer. The salivary lubrication and residual interimplant bone may provide a scenario for a gingival proliferation or epulus.

The dimensions for a successful papillary growth or gingival proliferation may be 2 to 3 mm between crown margins and 1 to 7 mm from crown margin or gingival attachment level to the proximal contact area.[11,12,15–18] Choquet and coworkers in 2001 found that when there was 5 mm or less from the osseous crest to the implant interproximal contact point there was 100% papillary presence.[18] The optimal mesial distal dimensional range was found to be 2 to 3 mm in a study by Elian and coworkers.[16]

An adequate zone of attached gingiva enhances the probability of papilla generation.[6] An apical repositioning of crestal attached gingival augments the attached zone and may provide a stable base for papilla formation.[6] Implant sites with thick mucosa will more readily have papillae formation.[19] A thin biotype and osseous support may not cause greater incidence of interproximal papilla fill but a vertical interproximal vertical opening of 5 mm or less and horizontal of 4 mm did have a higher incidence of papillary fill.[19] These dimensions do not appear to agree with outcome in the patient reported herein (Figure 2). Augmentation with subepithelial connective tissue grafting may induce papilla fill between implants and teeth.[24,25] This may be a result of increased facial collagenous attached tissue in these sites.

Immediate placement of nonfunctionally loaded implant-supported provisional crowns have a high incidence of papilla preservation when the provisional crown conforms to the morphology of the natural tooth it replaces.[24,25] An extension of this concept may advise immediate implant placement in multiple sites with a morphologically consistent provisional prosthesis to preserve the gingival architecture. This procedure may be practically difficult.

External hex and platform switched designs may have different osseous and gingival responses that may also differ with interproximal dimensions.[26] In one study platform switched implants were placed 1.5 mm or greater away from adjacent natural teeth. After 2 years, there was complete fill of all interproximal embrasures areas treated. With respect to bone loss around platform switched and nonplatform switched implants there may be no difference.[27] Thus the osseous support would be the same for both designs. This may indicate that the prosthetic embrasure design may be more important than osseous support for embrasure fill.

A papilla augmentation may be accomplished after 3 to 6 months with platelet-rich fibrin gingival treatment.[28] Nevertheless this treatment may be superfluous with appropriate embrasure design.

Lab technicians may not be able to design and fabricate implant crown prosthetic interproximal dimensions based on soft tissue or osseous measurements.[13,29,30] Nevertheless careful attention should be paid to prosthetic tooth shape. Coronae that are triangular shaped with occlusally-positioned contact areas may not be amenable to papillary fill.[9,10] Computer-assisted design and manufacturing may offer more control of the interproximal embrasure design for the clinician. This may ensure appropriate gingival proliferation and papilla formation.[29]

The implant surgeon may use papilla-sparing incisions to preclude poor papillary healing to ensure appropriate papilla formation.[31] Papilla-sparing incisions prevent scar formation in the papillae, which may allow easier papilla formation.

Accurate measurement of the papillary dimensions and landmarks can be done noninvasively with a periodontal probe and radiographs.[32] This technique is usually used in research measurements.

There is a higher quantity of elastin in keratinized mucosa as compared to nonkeratinized mucosa.[33] It is not known if elastin modulates the keratin expression of oral epithelial cells. As conjecture, the increased presence of elastin may allow the proliferation expression.

It is well known that gingival hyperplasia occurs in patients with certain diseases and those taking calcium channel blockers and other drugs. A genetic-related causation has not yet been found.[34] Gingival hyperplasia may occur in patients being treated with cyclosporine. Transformer growth factor beta and

Sonic hedgehog pathways (known as Shh) may mediate cyclosporine induced gingival fibroblast proliferation.[35]

Nevertheless the proliferation that occurs at implant-supported prosthetics appears to be a mechanical imposition of the interproximal design against the interproximal gingiva rather than medicinal or hormonal effects. Interproximal morphologic related proliferation may cause the gingival hyperplasia associated with orthodontic treatment.[2]

Conclusions

There may be a phenomenon of gingival proliferation that occurs to fill in gingival implant interproximal embrasure voids or "black triangles" of fixed implant-supported prostheses without augmentation procedures. With adequate oral hygiene, the vertical contact dimension of less than 6 mm occlusal to the osseous crest, adequate bone between implants, adequate soft tissue marginal protection, and appropriate interproximal cervical design, the gingiva may proliferate and fill an interproximal prosthetic void after provisional or definitive cementation with no augmentation intervention. The physical imposition contact created by the interproximal embrasure design may be the only or at least primary inducer of the gingival proliferation in prosthetic embrasures. Thus the embrasure fill may be, in fact, an epulis.

Abbreviation

PDL: periodontal ligament

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