

## Review Article

# Black triangle dilemma and its management in esthetic dentistry

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## ABSTRACT

In recent years, clinician and dentist's esthetic demand in dentistry have increased rapidly, driven by an enhanced awareness of beauty and esthetics. The ultimate goal in modern restorative dentistry is to achieve "white" and "pink" esthetics in esthetically important zones. "White esthetics" is the natural dentition or the restoration of dental hard tissues with suitable materials. "Pink esthetics" refers to the surrounding soft-tissues, which includes the interdental papilla and gingiva that can enhance or diminish the esthetic result. Reconstruction of the lost interdental papilla is one of the most challenging and least predictable problems. Restoration and maintenance of these tissues with adequate surgical and prosthetic techniques are a real challenge in modern esthetic dentistry. Treatment of marginal tissue recession, excessive gingival display, deficient ridges, ridge collapse, and esthetic defects around teeth and implants are some of the esthetic problems associated with the interdental papilla that have to be corrected in today's scenario which has been discussed in this review.

**Key Words:** Black triangle disease, interdental papilla, pink esthetics, white esthetics

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## INTRODUCTION

The presence or absence of the interproximal papilla is of great concern to periodontists, restorative dentists, and to the patients. The loss of papilla can lead to cosmetic deformities (so-called "black triangle disease"), phonetic problems (space allows passage for the air or saliva), and lateral food impaction. Often the loss of papilla is a consequence of periodontal disease because of gingival inflammation, attachment loss and interproximal bone height resorption. Missing papillae can also result from periodontal surgical therapy, as the soft-tissues usually contract during the healing period. The interdental papilla as a structure with minor blood supply was left more or less untouched by clinicians. Reconstruction of the lost interdental

papilla is one of the most challenging and least predictable problem and hence, it is very important to respect papillary integrity during all dental procedures and to minimize as its disappearance as far as possible. In the past several cases, presentations have been published comprising of various surgical and prosthetic techniques to rebuild lost papillae, but no long-term results are available to recommend any particular technique over another for correcting lost interdental tissues completely and predictably.

The purpose of present review, to discuss all the currently available non-surgical and surgical treatment modalities recommended for the papilla preservation and re-construction, around natural teeth, in past and present.

Interdental papilla: The interdental papilla<sup>[1]</sup> is formed by a dense connective tissue covered by oral epithelium and occupies the physiological space between the teeth. The shape is determined by the contact relationships between the teeth, the width of the approximal tooth surfaces, and the course of the cemento-enamel junction. Cohen<sup>[2]</sup> was the first who described the morphology of the interdental papilla.

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Inter-dentally, the gingiva that occupies the space coronal to the alveolar crest is known as interdental gingiva. In the incisor area, it has a pyramidal shape with the tip located immediately beneath the contact point, and it is narrower and referred as a dental papilla. In the posterior region, it is broader and was formerly described as having a concave col or bridge shape.<sup>[2]</sup> However, when a contact point is absent or when interdental papilla migrate apically as a result of inflammation, the col disappears and interdental papilla takes on a pyramidal shape, which is unesthetic and dysfunctional.<sup>[3]</sup>

Kohl and Zander:<sup>[4]</sup> Stripped the interproximal tissue on monkeys to determine if the papilla and col would reform. They found that the papilla reformed by the end of the eight post-surgical weeks. On the contrary, Holmes<sup>[5]</sup> showed in a clinical study that an excised interdental papilla does not regenerate completely to its original outline and height.

## FACTORS INFLUENCING THE PRESENCE OF PAPILLA

There are number of factors<sup>[6]</sup> affecting the presence or absence of the papilla. They are as follows.

1. Availability of underlying osseous support: Ochsenein<sup>[7]</sup> described the term “positive architecture” which refers to the osseous crest follows the shape of the cemento-enamel junctions, and the position of the interproximal bone is more coronal than the radicular bone. The authors<sup>[8,9]</sup> emphasized the concept that a more pronounced gingival scallop had a higher level of the interdental bone when compared with a flatter gingival scallop (4.1 mm vs. 2.1 mm). According to Tarnow<sup>[8]</sup> when the distance from the contact point to the alveolar bone was less or equal to 5 mm, the papilla was present in 98% of the times, while at 6 mm it dropped to 56% and at 7 mm it was only present 27% of the times. Tall<sup>[10]</sup> studied the interproximal distance of roots and the prevalence of infrabony defects. The author reported that only when the distance between roots was  $\geq 3.1$  mm, two separate infrabony defects were noted. This implies that a minimal of 3 mm interdental distance may be needed in maintaining papillae.<sup>[10]</sup> The number of papillae that filled the interproximal space decreased with the increasing distance from the contact point to the alveolar crest and interproximal distance of the roots.<sup>[11]</sup>

2. Periodontal biotype:<sup>[12]</sup> The morphologies of interdental papilla and the osseous architecture can be categorized into thin and thick periodontal biotype. The thin periodontal biotype are friable, escalating the risk of recession following crown preparation and periodontal or implant surgery. Due to the fragility of the thin tissue, delicate management is essential for avoiding recession and hence visibility of subgingivally placed crown margins at the restoration/tooth interface. Thick biotype is better than thin biotype.<sup>[13]</sup> Thick biotype is fibrotic and resilient, making it resistant to surgical procedures with a tendency for pocket formation (as opposed to recession). While the interdental gingival tissue possesses biological tissue memory, rebound of the gingival tissue is more likely than thin. Therefore, a thick biotype is more conducive for implant placement, resulting in favorable aesthetic outcomes.
3. Periodontal bioforms:<sup>[14]</sup> Periodontal bioforms are categorized into three basic gingival scallop morphologies, high, normal and flat. With a shallow scallop, the interproximal bone is thin, and the interproximal gingival contour nearly parallel to the underlying bone contour. The latter is advantageous for implant therapy since the bone has a congruous relationship with the free gingival margin (FGM) and is less prone to post-surgical recession. With a pronounced or high scallop, the interproximal bone is wider, but the disparity between the bone contour and the FGM is problematic for favorable esthetics (due to possible recession and creation of “black triangles”) following implant or restorative procedures. Flat is better than pronounced and high-scallop.<sup>[13,14]</sup>
4. Tooth morphology:<sup>[12]</sup> The basic tooth forms: Circular, square or triangular, determine the degree of gingival scallop. The triangular teeth form a pronounced scallop and predisposes to the so-called “black triangles;” especially, with a thin biotype. Furthermore, triangular teeth have divergent roots with thicker interproximal bone, resulting in reduced vertical bone loss compared with square teeth. However, squarer teeth yield better interproximal papilla maintenance due to a smaller interproximal distance from the osseous crest to the contact point.
5. Contact points:<sup>[12]</sup> The contact points of the maxillary teeth are relevant for ensuring optimal

“pink esthetics” for patients with a high smile line (or visible cervical margins). The iconic study by Tarnow *et al.*<sup>[8]</sup> who produced the “5 mm rule,” states that when the distance from the contact point to the interproximal osseous crest is 5 mm or less, there is complete fill of the gingival embrasures with an interdental papilla. For every 1 mm above 5 mm, the chance of complete fill is progressively reduced by 50%. For square-shaped teeth with wide contact points, the chances of “black triangles” is minimal compared with triangular teeth having narrow, more incisally positioned contact points.

## LOSS OF INTERDENTAL PAPILLA

The absence or loss of interdental papillae can be due to several reasons, viz.

1. Plaque associated lesions
2. Traumatic oral hygiene procedures
3. Abnormal tooth shape
4. Improper contours of the restoration
5. Spacing between teeth
6. Loss of teeth.

## CLASSIFICATION OF LOSS OF PAPILLA

Nordland and Tarnow:<sup>[15]</sup> Proposed a classification using three reference point: Contact point, facial apical extent of CEJ and interproximal CEJ (iCEJ). They classified it into four categories: Normal: Interdental papilla fills embrasure space to the apical extent of the interdental contact point/area. Class I: The tip of interdental papilla lies between the interdental contact point and the most coronal extent of CEJ. Class II: The tip of the interdental papilla lies at/or the apical to the iCEJ but coronal to the apical extent of the facial CEJ. Class III: The tip of the interdental papilla lies at level with or apical to the facial CEJ.

Jemt:<sup>[16]</sup> Presented an index to clinically evaluate the degree of recession and regeneration of papillae adjacent to single implant restorations through a clinical and photographic examination. The assessment was measured from a reference line through the highest gingival curvatures of the crown restoration on the buccal side and the adjacent permanent tooth. Score 0: No papilla is present, and no curvature of the soft-tissue contour adjacent to single implant restoration. Score 1: Less than half of the height of the papilla is present. A convex curvature of the soft-tissue contour adjacent to single implant crown

and the adjacent tooth is observed. Score 2: At least half of the height of papilla is present. Acceptable soft-tissue contour is in harmony with adjacent teeth. Score 3: The papilla fills up the entire proximal space. There is optimal soft-tissue contour. Score 4: The papilla is hyperplastic. The soft-tissue contour is more or less irregular.

Cardaropoli:<sup>[17]</sup> Proposed a classification based on the positional relationship among the papilla, CEJ, and adjacent teeth to assess interproximal papillary level. Papilla Presence Index score-1 (PPI 1): When the papilla is completely present and coronally extends to the contact point and at the same level as the adjacent papillae. PPI 2: Papilla is no longer completely present and lies apical to the contact point and not at the same level as the adjacent papillae, but the iCEJ is still not visible. PPI 3: Papilla is moved more apical and the iCEJ becomes visible. PPI 4: Papilla lies apical to both the iCEJ and buccal CEJ.

## RECONSTRUCTION OF LOST INTERDENTAL PAPILLA

To avoid interproximal defect in the esthetically important zone, care should be taken when periodontal therapy is performed to eliminate inflammatory processes. This is also valid for non-surgical procedures such as scaling and root planing. If surgical treatment is necessary, adequate flap designs are required to prevent extreme tissue loss and maintain natural gingival contours.

## NON-SURGICAL TECHNIQUES

### Correction of traumatic oral hygiene procedure

Diffuse erythema and denudation of attached gingiva throughout the mouth may be striking sequelae of overzealous brushing. Improper use of dental floss may damage the interdental papilla. Traumatic interproximal hygiene procedures must be initially discontinued and successively modified. Reepithelialization of the traumatic lesion can restore the papilla completely.<sup>[18]</sup>

### Restorative/prosthetic restorations

Abnormal tooth shape may contribute to a “missing” papilla, and an appropriate restorative technique is indicated to favor the creeping of the interdental tissues. By a restorative/prosthetic reshaping of the contours of the teeth, the contact point may be lengthened and located more apically; the embrasure

is reduced, allowing coronal displacement of the interdental gingiva.<sup>[19,20]</sup>

### Orthodontic approach

Orthodontic closure of the interdental space should be attained with a bodily movement of the two adjacent teeth. The aim is to reduce the diastema and create a contact point between the adjacent teeth, without periodontal attempts to build up the missing papilla. In fact, the proper closure of the diastema causes some degree of coronal “creeping” of the interproximal gingival tissue.<sup>[21]</sup>

Ingber<sup>[18,22]</sup> described coronal movement of tooth through application of a gentle and continuous force using orthodontic appliances. The effects are alterations within the supporting structures, causing changes in bone level and the soft tissue contours and thereby creating new papillae, ideally.

### Repeated curettage of the papilla

Repeated curettage every 15 days for 3 months to recreate papillae destroyed by necrotizing gingivitis,<sup>[23]</sup> induce a proliferative hyperplastic inflammatory reaction of the papilla. About 9 months after initial treatment, regeneration of interdental papillae was observed. Some papillae showed complete regeneration, while others did not respond to the periodic curettage.

## SURGICAL TECHNIQUES

Several surgical techniques have been described to prevent and/or solve the esthetic impairments due to loss of the interdental papilla, especially in young patients. The interdental papilla is a small area with minor blood supply. This seems to be the major limiting factor in all surgical reconstructive and augmentation techniques. Most surgical techniques published involve gingival grafting, but show only limited success because of insufficient blood supply.

Surgical approaches included following three treatment modalities.

1. Papilla re-contouring.
2. Papilla preservation.
3. Papilla reconstruction.

### Papilla re-contouring

In the presence of gingival enlargement, the excess tissue should be eliminated to remodel the soft tissue architecture. In cases of drug-induced and idiopathic gingival enlargement, a gingivectomy may be performed. Gingivectomy associated with a free

gingival graft may be indicated in case of localized gingival lesions, such as peripheral giant cell granuloma.

### Papilla preservation

Specific surgical approaches have been reported to prevent or reduce an excessive apical displacement of the gingival margin in the treatment of periodontal defects. Restricting flap elevation can minimize the amount of bone resorption, thus, helping in preservation of interdental papilla. Various soft-tissue surgical procedures have been introduced in an attempt to recreate and preserve the interdental papilla.

1. Papilla preservation flap: In this technique,<sup>[24]</sup> the facial surface is prepared with sulcular incision around each tooth with no incision being made through the interdental papilla. The lingual or palatal flap design consists of a sulcular incision along the lingual or palatal aspect of each tooth with a semilunar incision made across the each interdental papilla. This can be elevated intact with the facial flap. In posterior areas with a narrow interdental space, trim-off the tip of the papilla in order to preserve the intact papilla through the embrasure space.
2. Modified papilla preservation flap:<sup>[25]</sup> Technique was a variation of the papilla preservation technique. This was modified to achieve and maintain primary closure of the flap in the interdental space over the GTR membrane. A buccal and interproximal intrasulcular primary incision to the alveolar crest, involving the two teeth neighboring the defect, was performed. A horizontal incision with a slight internal bevel was given in the buccal gingiva at the base of the papilla, just coronal to the bone crest, and the papilla was elevated towards the palatal aspect.
3. Simplified papilla preservation flap:<sup>[26]</sup> Technique is indicated in narrow interdental space (less than 2 mm) in anterior and posterior region. This approach includes a first oblique incision across the associated papilla, starting from the gingival margin at the buccal-line angle of the involved tooth to reach the mid-interproximal portion of the papilla under the contact point of the adjacent tooth. This oblique interdental incision is continued intrasulcularly in the buccal aspect of the teeth neighboring the defect.
4. Cortellini and Tonetti:<sup>[27]</sup> Further improved the results by using microsurgical approach.

Surgeries were performed with the aid of an operating microscope at a magnification of  $\times 4-16$ . Microsurgical instruments and blades were utilized for the procedure. The advantage includes improved illumination, access and magnification of the surgical field.

### Papilla reconstruction

After elimination of the inflammation, specific techniques have been proposed to reconstruct the interdental tissues.

1. Pedicle flap: Technique<sup>[28]</sup> basically combined the roll technique<sup>[29]</sup> and papilla preservation technique.<sup>[30]</sup> In correspondence to the lost interproximal papilla, a palatal split-thickness flap is dissected and labially elevated. The flap is folded on itself and sutured to create the new papilla between the two incisors.
2. Semilunar coronally repositioned flap: Approach<sup>[21,31]</sup> based on a flap design reported previously by Tarnow.<sup>[32]</sup> In their modification for papilla reconstruction, they recommended placing the semilunar incision in the interdental region. Intrasulcular incisions are also made around the mesial and distal half of the two adjacent teeth to free the connective tissue from the root surfaces to allow the coronal displacement of gingivo-papillary unit. To maintain position, the measured amount of the sub epithelial connective tissue obtained from the palate is stuffed further into the semilunar incision and in to the pouch like space coronal to the incision.
3. Envelop type flap:<sup>[33]</sup> An intrasulcular and buccal incision is made across the interdental papilla to be reconstructed, at the level of CEJ. An envelope type split thickness flap is elevated buccally and palatally. The buccal portion of flap is dissected well beyond the mucogingival line, leaving the periosteum and a thin layer of connective tissue on the bone. The palatal portion of flap, is also split thickness, includes the interdental papilla. A connective tissue graft of adequate size and shape was placed under the flaps in recipient site.
4. Autogenous osseous and connective tissue grafts:<sup>[34]</sup> Technique involves an intrasulcular incision is made around the neck of the lateral and central incisors on the buccal and palatal aspects, retaining as much gingiva as possible. A horizontal incision starting at the mucogingival junction, extending in to the alveolar mucosa and apically up to the labial vestibular fold, is performed to elevate a split-thickness flap. The entire gingivo-papillary

unit is displaced coronally. Reshape the osseous graft obtained from the maxillary tuberosity to form a saddle that will fit over the interdental crest and stabilized with a titanium screw. Crushed cancellous bone is packed around the grafted bone in the shape of the reconstructed interdental bone. A large connective tissue graft harvested from the palate is placed on top of the bone graft to cover the entire augmented area.

5. Microsurgery: A case report<sup>[35]</sup> of three cases described the microsurgical technique for augmentation of the Interdental Papilla. The surgery is accomplished without the use of releasing incisions, thereby increasing the likelihood of donor tissue survival and minimizing tissue trauma, excessive bleeding, scarring, and pain. Because, the vascular supply remains intact, donor tissue survival is optimized.

### CONCLUSION

Rebuilding the pink gingival esthetic is an important issue in modern esthetic dentistry. An increased cosmetic demand from the profession and patients has resulted in more emphasis on the gingival esthetic. Thorough treatment planning is essential for maintenance of the height of the interproximal papillae following tooth removal. Periodontal plastic procedures can be used to enhance the ultimate outcome. In esthetically compromised cases, restorative intervention can mask the loss of tissues but rarely can they achieve ideal esthetics. Once the potential problems are known, additional procedures can be performed or anticipated. It has been proven that by maintaining or trying to correct the height of bone in the interproximal area, an esthetic reconstruction of the papilla can be achieved.

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