

# Current Techniques in Interdental Papilla Augmentation: A Review

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## Introduction

**B**lack triangles linked with papilla defects have shown to be a notably displeasing aesthetic element for patients. It is the element of gingiva which resides between the proximal surfaces of the teeth, engaging the span created by the cervical embrasure as it packs the lingual, buccal, and occlusal space of the interdental space, emerging as a pyramid in shape. Title “pink triangle” has been given, due to its clinical appearance. Causes owing to numerous general and local aspects such as; periodontal disease, the culmination of the height of alveolar bone relative to the interproximal contact, length of embrasure area, root angulations, tooth loss, unsound oral hygiene procedures, interproximal contact position, and triangular-shaped crowns.

In perio-plastic procedures, papilla reconstruction or its augmentation is the utmost aesthetically challenging procedure.

## Classification of Interdental Papilla

The classification put forth by Nordland and Tarnow in 1998 is in regards to the height of the papilla skirting the natural teeth, based on three anatomical landmarks- The interdental contact point, the apical extent of the facial cemento-enamel junction (CEJ), and the coronal extent of the proximal CEJ.<sup>(1)</sup>

- **Normal:** Interdental papilla fills the entire embrasure space apical to the interdental contact point/area.
- **Class I:** Tip of the interdental papilla is located between the interdental contact point and the level of the CEJ on the proximal surface of the tooth.
- **Class II:** Tip of the interdental papilla is located at or apical to the level of the CEJ on the proximal surface of the tooth but coronal to the level of CEJ mid-buccally.
- **Class III:** Tip of interdental papilla lies level with or apical to facial CEJ.

Nemcovsky introduced a classification system as a papillae index score (PIS) based on a comparison with adjacent teeth.<sup>(2)</sup>

**PIS 0:** Papilla not present and no curvature of the soft tissue contour.

**PIS 1:** Present papillae height less than half the

height of the papilla in the proximal teeth and a convex curvature of the soft tissue contour.

**PIS 2:** Presence of at least half the height of the papilla in the proximal teeth, but not in complete harmony with the interdental papilla of the proximal teeth.

**PIS 3:** Papillae able to fill the interproximal embrasure to the same level as in the proximal teeth and in complete harmony with the adjacent papillae.

## The Papilla Presence Index (PPI)

A New System to Assess Interproximal Papillary Levels – proposed by Cardropoli et al. (2004)<sup>(3)</sup>

- **PPI score 1** - Papilla completely present
- **PPI score 2** - Apical to contact point
- **PPI score 3** - Apical and CEJ visible
- **PPI score 4** - Apical to both CEJ

The prime focus of periodontal therapy is 'prevention of progression of periodontal disease and associated trauma by regeneration of the lost periodontal tissues. Lately, a respective number of surgical techniques have been continually proposed and investigated, being invasive and unpredictable, in most cases. Furthermore, the success rate of surgical augmentation of papilla depends on the thickness of the gingiva biotype.<sup>(4)(5)(6)</sup>

## Factors that Determine the Presence or Absence of Interdental Papilla:

The presence or absence of interdental papilla can be attributed to multiple factors. These factors are composed of tooth alignment correction with the help of orthodontic treatment, periodontal ligament loss leading to gingival recession, interproximal loss of bone contour concerning interproximal contact areas, root angulations, and presence of prostheses. Ongoing microbial activity in the periodontium is closely linked with interdental papilla loss. Increased plaque retention, inflammatory reactions, and gingival recession is noticed in periodontal pockets with a probing depth of more than 3mm. Continued alveolar crest resorption accelerates gradual increase in the distance amidst the contact point and the alveolar bone crest leading to a compromised interdental papilla.



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## Factors influencing the presence of interdental papilla are:

### Underlying osseous architecture

The underlying bone and its architecture give rise to the shape and form of interdental papilla. In general, the positive architecture of osseous crest, observes the shape towards the cemento-enamel junctions, with interproximal bone being often positioned coronal to the radicular bone; is most commonly associated with interdental papilla. The distance of the contact point to the alveolar crest is considered to be a key factor for ascertaining the shape and form of the papilla. According to Tarnow et al (1992) when the distance from the contact point to the alveolar crest was less than or equal to 5mm, the papilla was present 98% of the time, while at 6mm it dropped to 56% and at 7mm it was present only 27% of the times.<sup>(7)</sup>

### Distance between root surfaces

The appearance of interdental pink triangle is also dominated by the distance between root surfaces. In a study by Tal et al, they analysed the roots with interproximal between them and the generality of infra-bony defects. Thus, the distance between roots was comparatively more or equal to 3.1mm when, two distinct infra-bony defects were noted. In conclusion, a minimal of 3mm distance in the interdental area may be necessary for prolonging the papilla.<sup>(8)</sup>

### Periodontal biotype

The morphological forms of interdental papilla and osseous architecture are considered to be thin or thick that is termed as periodontal biotype. It has been observed that a thick biotype is better as compared to a thin biotype due to the presence of interdental papilla. Thin biotype is composed of a frail periodontium that is favourable to recession. However, a thick biotype is considered fibrotic and resilient, imparting resistance towards surgical procedures along with a propensity of pocket development. The interdental gingival tissue harbours biological tissue memory, which in turn, under favourable situations allows the papilla to bounce back to its previous shape and form. The thick biotype has a higher predisposition for the rebound of gingival tissue as compared to the thin biotype.<sup>(9)</sup>

### Periodontal bioforms:

The basic morphologies of the periodontal bioform are mainly of three types, described as; high, normal, and flat. The underlying bone architecture is determined by this gingival scallop morphologies. For instance, in a shallow gingival scallop, the interproximal bone is thin, and the interproximal gingival contour is practically parallel to the underlying bone profile. A flat scallop is preferable to a high scallop for pleasing aesthetics. The reason behind it is that, in a flat scallop, the bone has a congruous relationship with the free gingival margin and is less vulnerable to post-surgical recession. The high scallop has an extensive underlying interproximal bone, however; the disparity between the bone contour and free gingival margins may hamper the aesthetics due to the emergence of black triangles.

### Contact points:

The form and shape of the interdental papilla are determined by the contact point pertaining to anterior maxillary teeth and the respective distance from the crest of the interproximal bone. Tarnow et al (1992), In a landmark study, described the '5mm rule'.<sup>(7)</sup> The rule asserts that if there is less or equal to 5 mm distance from the contact point between the teeth to the interproximal osseous crest, it will be accompanied by the complete fill of gingival embrasures with the respective interdental papilla. For every 1 mm above 5mm, the likelihood of complete fill gets decreased by 50%. In case of square-shaped teeth which are composed of wide contact points, the probability of black triangles; are negligible in comparison to triangular teeth composed of narrow, more incisively disposed contact points.

### Crown morphology:

The crown's shape constitutes to be an essential factor in determining the form and shape of the papilla. The principal crown forms being: circular, square, and triangular. While a square crown provides finer interdental papilla preservation which can be imparted to its comparatively wider contact and a shorter interproximal distance from the crest of the bone to the point of contact, the triangular crown form provides a conspicuous gingival scallop and a thinner crestal bone. Hence, a triangular crown makes its corresponding interdental papilla prone to recession.

### Single crown Esthetics:

To evaluate clinically the extent of recession and papillae regeneration pertaining to solitary implant restorations, Jemt et al (1997) introduced an index with the help of a clinical and photographic examination. The assessment measured from a line through the highest gingival curvatures of the crown restoration on the buccal side and the adjacent permanent tooth.<sup>(10)</sup>

**Score 0:** Papilla is absent, and no curvature of the soft-tissue contour adjacent to single implant restoration.

**Score 1:** Papilla is present but less than half of the height. A convex curvature of the soft-tissue contour adjacent to the 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, in harmony with adjacent teeth.

**Score 3:** The papilla fills up the entire proximal space. Optimal soft-tissue contour

**Score 4:** The papilla is hyperplastic. The soft-tissue contour is not regular.

As stated by Eugenio Romeo et al, the integrated approach of surgical and prosthetic plans represents the key factor to optimise predictability in single-implant aesthetics. The recommended interproximal distance between the implant and the adjacent tooth is 2.5 to 4 mm. The distance from the contact point to the interdental bone is recommended to be <7 mm. Papilla presence is also correlated with a thick gingival biotype.<sup>(11)</sup>

Vincent Choquet et al., demonstrated the influence of the bone crest on the presence or absence of papillae between implants and adjacent teeth. The data also showed a positive

influence for the modified surgical technique, aimed at reconstructing papillae at the implant uncovering.<sup>(12)</sup>

From the systematic review performed by Mario Roccuzzo et al. There is limited evidence that the vertical distance from the base of the interproximal contact point to the crestal bone level, at single implant adjacent to teeth, seems to affect the interproximal papilla height. As a general trend, the lower is the distance the higher is the percentage of papilla fill, even though it is not possible to set up a threshold value correlated with the complete presence of the papilla. Complete embrasure fill between an implant restoration and the adjacent tooth seems to be related to the integrity of the periodontal ligament, as assessed by the radiographic bone levels in the studies included in the review.<sup>(13)</sup>

## Treatment Approach

### Non-surgical

To prevent surgical intervention numerous Non-surgical propositions have been inculcated to encompass correction of traumatic oral hygiene procedures while providing oral hygiene instructions, restorative techniques, orthodontic movement, repeated scrapping of the papilla, and tissue volumizer.

### Surgical

Papilla recontours and papilla reconstruction are the primary constituents of the surgical approach.

### Recent Treatment Approaches

**Tissue Volumizer:** As observed in the extant approaches, tissue volumizers have been instituted in the non-surgical approach along with the minimally invasive surgical procedures.

**Autologous Fibroblast injection:** A randomised controlled trial by McGuire and Scheyer in 2007, set out to use autologous fibroblast injection conservatively a minimally invasive papilla priming procedure to aid in the augmentation of interdental papilla space. Achieving statistically significant results when compared to the placebo. Hence, inferred that using cell transplantation of autologous cultured and expanded fibroblasts with a papilla priming procedure is suggestive of a successful management approach for treating papillary insufficiency.<sup>(14)</sup>

Keep in mind that this procedure is composed of an extensive surgical step considering the tissue is taken from keratinized tissue of the maxillary tuberosity which is harvested with a 3-mm punch biopsy instrument.

**Hyaluronic Acid as Tissue Volumizer:** The hyaluronic acid derivative has been another major tissue filler in recent research and development.

HA derivatives are biodegradable fillers comprising of natural glycosaminoglycan known as HA which occurs in human skin.

A case series in 2019, aimed to advance a cosmetically enhanced surgery to reconstruct lost interdental papillae with the help of hyaluronic acid (HA) dermal filler. The cross-linked HA gel used by them was derived from *Streptococcus* species fermentation. In the case series, three female patients were

treated for four interdental papilla defects. The surgery initiated with a horizontal incision which was placed apically to the area of papillary loss in the alveolar mucosa just beyond the mucogingival junction which was followed by an interdental subperiosteal tissue space which created by tunnelling towards and under the dental papilla, the tunnel was then filled by dermal filler beneath the papillary defect. Cyanoacrylate and additional dermal filler was injected as needed to achieve ideal papillary fill and sealing of the papillary margins. Post six months there was an improvement in patient's satisfaction with the papilla fill demonstrated by a mean increase in visual analog scale (VAS) measurements of 62.46%. Mean papilla fill was 1.75 mm.<sup>(15)</sup>

When HA is “merely” injected into deficient papillae, a randomised controlled trial demonstrated no significant changes in papilla fill as compared to control (saline) injections. Detaching the gingiva by tunnelling, as was done in our technique, imparts a subperiosteal space that provides for mobilisation of the papilla prior to the injection. Older studies have banked on the potential of HA to absorb water overtime with the use of up to five separate injections in order to procure a meaningful papilla expansion.<sup>(16),(17),(18)</sup>

**I-PRF as Tissue Volumizer:** I-PRF has shown to be a potent inducer of cell proliferation, migration and angiogenesis, inducer of higher fibroblast migration and expression of PDGF, TGF- $\beta$ , and collagen, thereby playing a vital role in tissue regeneration.<sup>(19)</sup> In 2021, Chandramohan et al, conducted a pilot study to investigate the efficiency of i-PRF in achieving interdental papillary enhancement as development of a non-invasive papilla enhancement technique. Results at the first follow up (3 weeks after the injection) showed a 10-20% papillary enhancement with a mean of  $13.38 \pm 3.07\%$ . In the second follow up (three months later) a 15-63% enhancement with a mean of  $29.52 \pm 18.72\%$  was seen, and at the third follow up (6 months after the injection) a 33-69% enhancement with a mean of  $47.33 \pm 20.20\%$  were noted.<sup>(20)</sup>

### Prosthetic treatment as a non-invasive approach

**Silicone gingival veneer:** The gingival veneers are easily constructed, inexpensive, and practical devices to optimise the aesthetic and functional outcome and where patients do not need to undergo second surgical procedure for recession coverage of denuded roots and black triangles. As demonstrated in the case series conducted by Dr Priya Vijay Thakkar et al, acrylic gingival veneer has been used successfully and after repeated follow-up, the veneers did not produce any problems indicating that such prostheses can be made, can be used effectively whenever indicated.<sup>(21)</sup>

Another case report by El GhoulbzouriHouda et al (March, 2018) presents interest in gingival prosthesis especially in advanced periodontal disease among young patients with esthetic and functional requirements. Good esthetic results were achieved hereby, renewing the patient's self-confidence. Gingival veneers are easy to make, have light weight and are inexpensive. However, a good case selection with adequate oral hygiene is a key factor in the success of this conservative approach.<sup>(22)</sup>



## Minimal Invasive Surgical Techniques

In recent development of surgical treatment, microsurgical techniques have been developed for a minimal invasive treatment approach.

Although many conservative surgical techniques were introduced in the late 90s like papilla preservation technique introduced long back in 1995 by Cortellini et al, and in 1996, Han and Takei described the application of a facial approach with the help of a semilunar incision to harness access towards papillary area for its augmentation in the last decade, more conservative treatments have been evolved especially to keep a check on the vascular supply.<sup>(23)(24)</sup>

A case series of microsurgical techniques for interdental papilla augmentation described a microsurgical procedure for positioning donor tissue underneath a deficient interdental papilla. The surgery is devoid of releasing incisions hence, increasing the chances of donor tissue survival along with minimal tissue trauma, bleeding, scarring, and pain. This technique by Norland and Sandhu recently became popular.<sup>(25)</sup>

## Procedure

To visualise the morphology of the entire interdental papilla area the surgical dissecting microscope is used. Using a microscalpel with blade width of 0.9 mm (Nordland Papillae N-6900 Micro-Scalpel, Sable Industries) a circumferential sulcular incision is made to the crest of the bone followed by a sulcular incision to the crestal bone, severing the marginal gingiva in the process. This incision extends around the adjacent teeth circumferentially.

The micro-scalpel blade modified to form a j-hook configuration to allow it to completely undermine the delicate papillary tissue. The minimal circumferential sulcular incision is given, followed by a split-thickness flap is raised. The customized blade allows any individual variations. Thus, another micro-scalpel is modified mimicking the precise buccal contours of the gingiva. As the incision extends past the mucogingival junction, mobility of the undermined tissue can be appreciated.

Three cases were discussed in Norland's paper. First, a patient who underwent orthodontic treatment pertaining to closure of embrasure space experienced incomplete movement of maxillary right central incisor due to ankyloses. Second, a patient who underwent four unsuccessful attempts at surgical repairs. Positive result was appreciated after 6 months of follow up. Third, a patient demonstrated with a papillary defect created by a surgical complication. There was a horizontal depression at that region. A surgical correction performed in one single stage was achieved. Subsequently, as normal tissue contours were appreciated, a new crown was placed. Uneventful healing was noted during the 3 years follow up.

In the same year, Francesco Cairo et al introduced fibre retention using papilla preservation technique using a microscope to treat infra-bony defects. The study aimed to describe microsurgical flap access for the treatment of periodontal pockets with infrabony defect conserving the aesthesis of the interdental papilla and preventing marginal gingiva loss.<sup>(26)</sup>

## Tunnelling Technique

In 2018, Feuillet et al introduced tunnel approach to microsurgical technique reconstruction of interdental papilla, using a 4x magnifying loops and straight and curved microsurgical instruments (Deppeler) to create a mucoperiosteal tunnel on the buccal side without disrupting the papilla. The full thickness mucoperiosteal flap was extended laterally and apically around half of the adjacent teeth and beyond the mucogingival line to avoid any stress. On the palatal side, two vertical 7-10mm parallel release incisions were made halfway along the scalloped gingival margin, and a split-thickness dissection was performed through the incision. A 2 mm tunnelling instrument was then used to connect buccal and palatal created under the interdental papilla. Papillary mobility is essential for the formation of a recipient space under the papilla, the positioning of the CTG, and the coronal placement of papilla.<sup>(27)</sup>

In preparation of donor site, a distal wedge procedure is used to harvest a thick CTG. It is precisely contoured to the dimension of the expected papilla and partially split-lengthwise to create a T shape with two lateral wings and a main body.

Three stabilising sutures are then given to stabilise the custom made T shaped graft under the papilla. Out of the three patients, two patients achieved good results. The third patient was referred for intrabony defect with papilla loss. So the above treatment was done in the second phase to improve soft tissue profile. In this patient papilla regeneration was limited compared to the positive results of the first two patients.

## Papilla Regeneration in Implant supported Units

Back in 1995 when several surgical techniques were being developed for regeneration of interdental papilla, Palacci et al had suggested elevation of a full-thickness flap from the buccal and palatal aspects of the ridge followed by rotating it to about 90-degrees filling the interproximal area adjacent to an implant.<sup>(28)</sup> Similar to Feuillet's tunnel technique, a surgical technique previously introduced by Stuart Froum et al was introduced in 2016, where they treated missing papilla in anterior maxilla, which were either between adjacent implants, or between an implant and an adjacent natural tooth, or between an implant and an adjacent pontic site. The treatment commenced as such: Any provisional restorations was removed followed by a full-thickness oblique incision made in the vestibule, apical to the deficient papilla. Followed by elevation of another full-thickness oblique incision on the palatal aspect.<sup>(29)</sup> The rationale behind oblique incisions was to preserve blood supply at the recipient site.<sup>(30)</sup> Then atranslingual curette is used to elevate the periosteum or flap, and to create a subperiosteal tunnel toward the crest of the alveolar ridge, coronal to the interproximal region. The same was then performed towards the palatal side, leading to formation of a tunnel between the buccal and lingual incisions. CTG was harvested from the palate, followed by closure using two 4/0 chromic gut sutures at the mesial and distal margins of the subepithelial connective tissue graft. So, ten consecutively treated cases from the implant connective tissue graft to ease the insertion and stabilisation of the graft over the defect.

## Conclusion

The main objective of advancement of the known treatment is to reduce the invasiveness and develop a minimally invasive treatment approach which encourages the development of non-surgical modules. Hence, the extensive research on newer materials such as hyaluronic acid and iPRF. Similarly, the need to reduce the degree of invasiveness of surgical approach, brings about the development of conservative surgical techniques discussed in the article.

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