

**Panacea for Interdental Papilla: A Review**

Dr. Vishaj Maru, Private Practitioner, Mumbai

Dr. Lalith Vivekananda, Assistant professor, Department of Periodontics, M.R. Ambedkar Dental College and Hospital,  
Bangalore, Karnataka

**Corresponding Author:** Dr. Vishaj Maru, Private Practitioner, Mumbai

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**Abstract**

Aesthetic awareness has improved vastly in last decades. Aesthetic demands more attention from the clinician. The loss of papilla can lead to cosmetic deformities so-called “black triangle disease” Regeneration and reconstruction of the lost interdental papilla is one of the most difficult procedures in the field of Periodontology, which also hampers phonetics, functional and aesthetic problems. And is one of the most challenging and least predictable procedures. Surgical technique aims to re-construct, re-contour, re-define and preserve the soft tissues between the teeth. There are several risk factors leading to the development of black triangles. These factors include periodontal disease, loss of height of the alveolar bone relative to the interproximal contact, length of embrasure area, root angulations, interproximal contact position, triangular-shaped crowns and aging, tissue recession, moderate to severe gingival display, aesthetic defects are some of the problems which need careful assessment.

**Keywords:** Aesthetic; Black Triangles; Injectable Platelet Rich Fibrin and Interproximal contact areas.

**Introduction**

The presence or absence of the interproximal papilla is of great concern 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. ‘Black triangles’ are the triangular spaces present between two teeth. Often the loss of papilla is a consequence of periodontal disease because of gingival inflammation, attachment loss and interproximal bone height resorption. Till date, the most critical situation lies in amplification of lost interdental papillae in the anterior region. A black triangle or an open gingival embrasure occurs as a result of a deficiency or loss of papilla beneath the contact point. The loss of gingival embrasures occurs due to several factors including periodontal disease, length of embrasure area, root angulations, interproximal contact position, changes in papilla during orthodontic alignment and triangular-shaped crowns, soft tissue appearance (thick or thin biotype), minimal buccal plate thickness, type of contact area (triangular versus square), and the biologic width. The papillary form and the corresponding interproximal embrasure share an intricate relationship. An ideal embrasure will house the entire papillae without impinging it with a pointed end extending to the top of the contact point, leaving no space in between the two teeth. One of the most challenging and least predictable problems in the field of periodontal plastic surgery is the reconstruction of the lost interproximal papilla. Anatomical considerations and inadequate blood supply

make papillary reconstruction procedures more challenging for the clinician.

Interdental papilla: Also known as interdental gingiva. Cohen [3] was the first who described the morphology of the interdental papilla. The interdental papilla [1, 2] 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. The gingiva that occupies the space coronal to the alveolar crest is known as interdental gingiva. In the anterior region, 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 has a concave col or is bridge shape. However, when a contact point is absent or when interdental papilla migrates apically as a result of inflammation, the col disappears and interdental papilla takes on a pyramidal shape, which is usually unesthetic and dysfunctional. [4]

Kohl and Zander: [4] studied by stripping 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 other hand, Holmes [5] showed in a clinical study that an excised interdental papilla does not regenerate completely to its original outline and height.

Etiologic of interdental papilla loss:

1. Interproximal space between teeth:[6]

- Represents the distance between the proximal surfaces of the adjacent teeth. Horizontal dimensions of interdental space can affect the shape and maintenance of interdental soft tissue. While a greater width, improved will be the blood supply to papillae tip, which may maintain full papilla, a very

wide interdental width increases the risk of presence of black triangle.

- Teeth with root proximity less than 0.5mm interdental distance possess very thin bone. In return, thin cancellous bone has a greater risk for resorption, thus decreasing the interproximal bone height.
  - Martegani et al. [7] found that the radicular distance and the distance between the contact point and the alveolar crest have independent and combined effects on the presence or absence of the interdental papilla. In particular, when the inter-radicular distance was >2.4 mm, the distance of the bone crest from the contact point lost its influence on the presence or absence of the papilla.
  - Cho et al. [8] measured the interdental space at the osseous crest during flap surgery. It was concluded that the number of papillae that filled the interproximal space decreased with the increasing interproximal distance of the roots. When interdental is distant, the bone crest surpasses 4mm, and complete papillae fill should not be expected.
2. The Distance between Proximal Contact Point to Crest of Alveolar Bone:[6]
- The most important factor for the loss of interdental papillae is the distance between interproximal contact point and alveolar bone crest.
  - Study by Tarnow et al. [9] which determined the presence or absence of gingival black triangle by estimating the vertical distance, reported that papilla was present 98% when the vertical distance between contact point and crest of bone was  $\leq 5$  mm, thus when the distance was estimated to be more than 7 mm, the papilla was mostly missing (73%) and gingival black triangle was noted. Therefore, study inferred that 1mm increase in distance between interproximal contact position and crest of alveolar

- bone (6-7 mm), the chances of gingival black triangle occurred increasing by 78% to 97% respectively.
- Cho et al.<sup>[10]</sup> measured the distance between contact heights to bone crest during a gingival flap procedure. It was found that the interproximal distance between roots and the distance between the contact point and the alveolar crest have an independent and combined effect on the existence of interproximal papilla.
3. Diverging Roots and Root Angulation:<sup>[6]</sup>
- Root divergence of adjacent teeth is highly associated with open gingival embrasures. This either occurs naturally or is caused by improper bracket placement during orthodontic treatment. Bracket placement results in relaxation of stretched transeptal fibres which aids in filling the gap.<sup>[9]</sup>
  - According to Kurth and Kokich<sup>[11]</sup> the mean of root divergence in normal cases is assembled at 3.65°. However, a 1° increase in angulation may rise the chance of gingival black triangle by 14% to 21%. Therefore, the severity of occurrence of open gingival embrasures in case of root angulation can be reduced by connecting the brackets in such a way it lies perpendicular to the tooth long axis, thus allowing root convergence without causing open embrasures.
  - Burke et al.<sup>[12]</sup> found that movement of crowded anterior teeth can separate the roots and stretch the interdental papilla, increasing the appearance of gingival black triangle between incisors after orthodontic treatment.
4. Traumatic Interproximal Oral Hygiene Procedures:<sup>[6]</sup>
- There is sufficient evident from literatures to prove that brushing is an efficient way of removing plaque and prevention of gingivitis and periodontitis.<sup>[13, 14]</sup> However, its efficacy depends upon the physique and mental attitude of an individual, type of toothbrush, condition of the bristles.<sup>[15]</sup>
- Study by Rosema et al.<sup>[16]</sup> reported that a minimum of  $\geq 1$  mm of gingival recession was observed in 97.8% of the study population using both manual and power toothbrushes. It was found that gingival recession has been related to increase brushing frequency with a hard toothbrush.<sup>[16]</sup> Traumatic flossing may also contribute to open embrasures, in this case interproximal cleaning should be discontinued to allow tissue recovery.<sup>[17]</sup>
5. Abnormal Crown Forms and Tooth Morphology:<sup>[6]</sup>
- The basic tooth forms are circular, square or triangular which determines the degree of gingival scallop. Circular or square teeth produce a shallower gingival scallop, while triangular teeth form have a pronounced scallop. The latter predisposes to gingival black triangles especially with a thin biotype which has a propensity for recession.
  - 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.<sup>[18]</sup>
6. Gingival Biotype:<sup>[6]</sup>
- The periodontal biotype has been classified as scalloped-thin and flat-thick biotype.<sup>[19, 20]</sup>
  - Scalloped-thin tissue is more prone to develop recession leading to trauma or inflammation, while flat-thick tissue is more likely to develop deeper periodontal pockets.<sup>[19]</sup>
  - Chow et al.<sup>[20]</sup> examined papillae fullness in 672 sites in 96 adult patients, they found that there was a positive correlation between gingival thickness and

papilla fill. Limited blood supply is believed to be one of the major reasons of unpredictable regeneration of interdental papilla. Thick tissues respond more favourably due to their increased vascularity and extracellular matrix volume. Therefore, flat-thick biotype is considered more favourable for achieving optimal esthetics.

7. Patient's Age:<sup>[6]</sup>

- Aging results in thinning of oral epithelium, reduced keratinization, decreased papilla height and bone loss which are risk factors of open embrasures.<sup>[21]</sup> It was found that papillary tissue height reduces by 0.012 mm/year of age.<sup>[22]</sup>
- Vandana and Savitha<sup>[23]</sup> attributed that thinning of periodontium effects periodontal disease, traumatic habits, and natural diminishing of keratinization of the tissue during aging.
- Van der Velden<sup>[24]</sup> presented the changes in the periodontal tissue due to aging and concluded that there is insufficient evidence for physiological gingival or apical migration of papilla during aging.

8. Periodontal Disease and Loss of Attachment:<sup>[6]</sup>

- Periodontitis is defined as an inflammatory disease of the supporting tissues of teeth caused by the specific microorganisms resulting in progressive destruction of periodontal ligament and alveolar bone with increased probing depth formation, recession or both. Periodontal disease has been associated with loss of interdental papilla due to the loss of alveolar bone.<sup>[22]</sup>
- The foundation for the gingival support is the underlying contour of the osseous crest. If the distance from the alveolar crest to interdental contact point exceeds 5 mm, it is more likely that the papilla is insufficient to fill the embrasure.<sup>[9]</sup>

Treatment modalities available for regenerating the Papilla:

The purpose of present review is to discuss all the currently available treatment modalities (non-surgical and surgical) recommended for the papilla preservation and re-construction around natural teeth and implants.<sup>[25, 1]</sup>

- The non-surgical approaches such as restorative, prosthetic and orthodontic treatment modalities have been carried out to modify the interproximal space and to maintain the soft tissues.
- The surgical procedures include:<sup>[1]</sup>
  1. Papilla recontouring
  2. Papilla reconstruction
  3. Papilla preservation
    - ✓ Conventional papilla preservation flap
    - ✓ Modified papilla preservation flap
    - ✓ Simplified papilla preservation flap
    - ✓ The "Whale's tail" technique

Classification of loss of papilla:

Nordland and Tarnow:<sup>[26]</sup> proposed a classification using three reference point: Contact point, facial apical extent of CEJ and interproximal CEJ (I-CEJ). They classified it into four categories:

1. Normal: Interdental papilla fills embrasure space to the apical extent of the interdental contact point/area.
2. Class I: The tip of interdental papilla lies between the interdental contact point and the most coronal extent of CEJ.
3. Class II: The tip of the interdental papilla lies at/or the apical to the I-CEJ but coronal to the apical extent of the facial CEJ.
4. Class III: The tip of the interdental papilla lies at level with or apical to the facial CEJ.

Nemcovsky:<sup>[27]</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.

1. Score 0: No papilla is present, and no curvature of the soft tissue contour adjacent to single implant restoration.
2. 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.
3. Score 2: At least half of the height of papilla is present. Acceptable soft-tissue contour is in harmony with adjacent teeth.
4. Score 3: The papilla fills up the entire proximal space. There is optimal soft-tissue contour.
5. Score 4: The papilla is hyperplastic. The soft-tissue contour is more or less irregular.

Cardaropoli: <sup>[28]</sup> Proposed a classification based on the positional relationship among the papilla, CEJ, and adjacent teeth to assess interproximal papillary level.

1. 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.
2. 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 I-CEJ is still not visible.
3. PPI 3: Papilla is moved more apical and the I-CEJ becomes visible.
4. PPI 4: Papilla lies apical to both the I-CEJ and buccal CEJ.

Non-surgical techniques:

1. Repeated scrapping of the Papilla:

- Repeated curettage every 15days for 3months may induce a proliferative hyperplastic inflammatory reaction of the papilla and may be used to reconstruct papillae destroyed by necrotizing ulcerative gingivitis which was advocated by Shapiro et al. in 1985.<sup>[29]</sup> about 9months after initial treatment, regeneration of interdental papillae was observed. Yanagishita et al. observed improvement of interdental papillae in a patient undergoing supportive periodontal therapy.
  - Maintenance of oral hygiene, regular scaling and root planning is instructed. Use of interdental brush is avoided to allow the interdental papilla to recover. A gradual improvement is seen over a period of time with coronal regrowth of the gingival margin.
2. Correction of Traumatic oral hygiene procedure:<sup>[30-34]</sup>
    - Toothbrush abrasion leads to wear of cemento enamel and damage of supporting gingival tissues leading to loss and recession of papilla.
    - A study by Addy and Hunter <sup>[31]</sup> reported that irrespective of manual or power tooth brushing, over or abusive tooth brushing or force applied significantly harms the gingival tissues. Therefore, such traumatic oral hygiene procedures should be identified at an early stage and should be discontinued to allow re-epithelization and restoration of papilla.
    - Usage of flat toothbrush bristle, end-rounded filaments, rubber bristles interdental cleanser are recommended to reduce gingival abrasion. Improper use of dental floss may damage the interdental papilla. Traumatic interproximal hygiene procedures must be initially discontinued and later should be modified.
  3. Restorative and Prosthetic restorations:<sup>[35-38]</sup>
    - Abnormal tooth shape may contribute to gingival black triangle, and an appropriate restorative

technique is indicated to favour the interdental tissues. By a restorative and prosthetic reshaping of the contours of the teeth, the contact point may be lengthened and located more apically; the embrasure is reduced, allowing the coronal displacement of the interdental gingiva. Interproximal embrasures are constructed with a varying range of cervical shapes and varying root proximities. Clinicians can create convenient interproximal shapes if the restorations are smooth and without sharp marginal ledge.

- Composite, laminate veneers, pink auto-cure and heat-cured acrylics resins and thermoplastic acrylics, as well as silicone-based soft materials are all treatment modalities for closure of open gingival embrasure space. Removable acrylic or silicone can be used as a gingival veneer to camouflage lost gingival tissues. It is indicated when interdental defects with >5mm gap between the contact point and alveolar crest.
- Porcelain veneers are considered as an excellent choice to eliminate or reduce the black triangle.
- Restorative considerations, it should be noted that to change the position of the point of contact, one of them with ceramic veneer or crown. If possible, to add pink porcelain to the restoration to manipulate the presence of interdental papilla loss. [39, 40]

**Advantages:** Biocompatibility of the material, stable colour and non-porous surface, preventing better plaque attachment than composite resins.

**Disadvantages:** Hard to fix

- Composite can be inserted near gingival sulcus as a guide for the formation of an interdental papilla. [39, 40]

**Advantage:** Composite has many colours that are stable and wear resistant; the latest generation of dental bonding agents enables the bonding of composites to dentine.

**Disadvantage:** That there may be changes in bonding, discoloration, fluid seepage through the dental interface and composite.

- Composite and porcelain laminate resin can be extended into the gingival sulcus, thus care must be taken not to impinge on the interdental tissue or violate the biological width.
- Clark [41] presented a case of management of open gingival spaces that includes restorative treatment followed by papilla regeneration. He used flowable composite resin rather than composite paste for the first increment since paste composite would be nearly impossible to place in such small area without voids and without disturbing the anatomy of shaped matrices.
- In an attempt to reduce the interproximal space and improve aesthetics and phonetics, [42] used two types of removable prosthesis; Molloplast B soft lining material and clear acrylic facing. However limitations included were retention may be difficult, and because of the inherent porosities of the silicone-based material, staining and plaque accumulation may be a problem. Therefore, it would be better if it is made of heat-cured acrylic resin.
- A very simple but effective procedure for managing a good gingival recession and loss of interdental papillae is the use of gingival prosthesis. Gingival epithesis is a removable mask for aesthetic and functional prosthesis covering the missing gingival tissue. [40]

**Indication:** Defective in interdental with a gap between the contact point and alveolar crest > 5mm, in patients unable to undergo repeated surgical procedures.

**Contra indications:** patients with poor and unstable periodontal health, poor oral hygiene, and high caries risk.



Advantages: Non-invasive, easy maintenance, splinting on the teeth can be done, more economical.

**Disadvantages:** required patient's cooperation, food impaction and place of bacteria growth, possibly can damage or change the colour of prosthesis.

Various materials that can be used are: Auto and heat polymerizing acrylic resin, rigid, flexible material, copolyamide, soft silicone material

- Nevertheless, care must be taken when planning for anterior crowns or veneers in order to avoid re-occurrences of black triangles. This complication can be avoided by proper planning and pre-operative periapical X-rays to carefully assess the level of the alveolar crestal bone.
- 4. Orthodontic approach
  - Orthodontic closure of the interdental space can be attained with a bodily movement of the two adjacent teeth. The aim is to reduce the diastema space and create a contact point between the two adjacent teeth.
  - The basic tooth forms such as circular, square or triangular, determine the degree of gingival scallop and should be taken into consideration during treatment planning. divergence of adjacent teeth either occurs
  - Treatment should be designed to create parallelism of the roots and a favourable position of the proximal contact point of the crowns. In cases where incisors are malposed or overlapped they should be up-righted and moved mesially to correct the inclination of the roots. The mesial cementum enamel junctions of each incisor will then be closer to each other thus causing the stretched transeptal fibers to relax. The same soft tissue will occupy the gingival embrasure.
  - Kurth et al. <sup>[11]</sup> noticed that a mean root angulation of 3.65° in normal gingival embrasures and an

increase in root divergence by 1° increased the probability of occurrence of an open gingival embrasure from 14 to 21%. Bracket repositioning can be performed to gain the coverage of maxillary incisor roots to decrease or eliminate the open gingival embrasures as paralleling divergent roots decreases the severity of a black triangle.<sup>[11]</sup> During orthodontic treatment bracket's slots should be bonded perpendicular with the long axis of the tooth. If brackets placement is done based on incisal edges, greater root divergence may result leading to an open gingival embrasure. In case where the crowns are triangular, interproximal reduction will broaden the contact area and also move it gingivally leading to reduced open gingival embrasures. Typically, 0.5-0.75 mm of enamel is removed with interproximal reduction for correction of black triangles. The severity of crowding does not influence the incidence of open embrasures as they were found to occur in a similar percentage in patients with incisor crowding of less than 4 mm and those with 4-8 mm of incisor crowding. It was found that when the crowding was more than 8 mm, the occurrence of black triangles increased by only 7%. However, these results were not statistically significant. It was also found that the orthodontic treatment duration did not have any significant effect on the occurrence of open gingival embrasures.<sup>[11]</sup>

- Ingber et al. <sup>[10, 43]</sup> described coronal movement of tooth through application of 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, thus creating new papillae.

- Burke et al. <sup>[12]</sup> recommend bringing the roots closer by mesial torqueing movement to rectify presence of black triangle. In combination with orthodontic treatment, proximal enamel can be re-contoured to change the contact area to a broader surface along with relocating the contact more apically.
  - Cardaropoli et al. <sup>[28]</sup> presented a study evaluating a combined approach of orthodontic- periodontal treatment to reconstruct the interdental papilla between upper central incisors, demonstrating that the soft tissues adapt to the new emergence profiles during intrusion of the teeth as the interproximal spaces were reduced.
5. Tissue volumizing
- Among several minimally invasive techniques proposed, injecting various fillers and biological preparations has been studied for papilla reconstruction.
  - Hyaluronic acid (HA) is a large molecule and non-sulphated glycosaminoglycan present in connective tissues like skin and cartilage. Under physiological conditions, it contributes to tissue hydrodynamics, thereby binding to water to provide elasticity and stability resulting in tissue regeneration and healing. Its non-immunogenic, biocompatibility and bacteriostatic in nature.
  - HA in tissues is digested by macrophages in blood or lymphatic system and broken HA reaches bloodstream to get disintegrated in liver for excretion. HA is thus eliminated through urine at a very minute quantity.
  - HA acts as an antioxidant by scavenging reactive oxygen species, which helps in the regulation of immune response implying its anti-inflammatory properties.
- A study by Becker et al. <sup>[44]</sup> aimed to evaluate the efficacy of commercially available hyaluronic acid gel to eliminate deficient papillae. A total of 14 gingival black triangle were treated by injecting HA gel 2-3 mm apical to the tip of the papilla up to three times at 3 weeks intervals. They concluded that it is possible to enhance papillae that do not entirely fill the interdental space. Thus the results of this study were promising, even after 25 months and no relapse was seen.
  - A series by Lee et al. <sup>[45]</sup> evaluated the clinical efficacy of using hyaluronic acid gel on enhancing interdental papilla deficiency using radiographic assessment. The study reported that when HA was repeated up to 5 times every 3 weeks and post follow up period of 6months, there was a significant improvement in interdental papilla reconstruction with contact point and bone crest reaching upto 6 mm.
  - Mansouri et al. <sup>[46]</sup> assessed the efficacy of using HA gel for reconstruction of interdental papilla. It was reported that application of HA gel successfully treated interdental papilla deficiencies in a 6month period.
  - A clinical trial by Awartani and Tatakis <sup>[47]</sup> examined effects of using injectable, non-animal based, HA gel in reconstruction of interdental papilla loss. The study concluded that there was a significant improvement in treating interdental papilla loss at 6 months post HA gel injection. Also, it was reported that patients were satisfied with the results obtained and raised concerns regarding associated procedural discomforts.
  - However, according to Tanwar and Hungund, <sup>[48]</sup> though, HA is biocompatible and safe to use, with no evidence of cytotoxicity, HA is associated with



allergic reactions and patients should be warned of this possible treatment side effect.

### Surgical techniques

Surgical techniques may be used pedicle flaps, free gingival and sub epithelial connective tissue graft. Some case reports have demonstrated success with sub epithelial connective tissue graft and orthodontic therapy. According to Wu et al., flap surgery has shown better results than free gingival graft. Grupe et al. [49] stated that the techniques with pedicle flaps showed better results than free gingival graft techniques, because the blood supply is provided by the base of the pedicle.

Procedure: [50]

- Intraoral antiseptics is performed by rinsing with 0.12% chlorhexidine digluconate for 30 seconds.
- Local anaesthesia 2% lignocaine hydrochloride is given.
- Split thickness semilunar incision is given about 1mm coronal to the mucogingival junction in the interdental region of the involved teeth through the semilunar incision towards the interdental papilla, the split thickness flap is continued to create a pouch in the interdental area.
- Curettage is done around the neck of the involved teeth to remove the tissue attachment.
- PRF is obtained from the patient blood as per Choukroun's guidelines.
- The prepared PRF is removed using sterile tweezers and trimmed with scissors and transferred on to sterile gauze.
- This PRF was squeezed to form a membrane which was eased into the pouch and pushed coronally, enabling to fill the bulk of the interdental papilla.
- Incisions are then secured using sutures.
- Sutures are secured with composite stops on the labial surface.

- Surgical area is protected with periodontal dressing.
- Sutures are removed after 10days.

Post-treatment: [50]

Analgesics- Ibuprofen 400mg twice daily for 3days.

Along with chlorhexidine digluconate (0.12%) rinse twice daily is prescribed for 10days.

### Advantages

- Using PRF is that the need for donor site is eliminated.
- Making the technique less invasive.
- Lessens postsurgical discomfort.
- Promotes rapid soft tissue healing with less edema compared to connective tissue graft and enamel matrix derivative technique.
- Thus, it is easy to prepare and lacks biochemical handling of blood, which makes this preparation strictly autologous.

### Other surgical treatments

1. Papilla Re-contouring: [51] In the presence of gingival enlargement, the excess tissue should be removed to remodel the soft tissue architecture in the case of drug-induced hyperplasia, idiopathic gingival hyperplasia etc., and a gingivectomy can be performed.
2. Papilla Re-construction:
  - a. Beagle (1992) described a pedicle graft procedure as utilizing the soft tissues palatal of the interdental papilla. [52]

Technique: A split thickness flap is dissected on the palatal aspect of the interdental area. The flap is elevated labially, folded and sutured to create the new papilla at the facial part of the interdental area. A periodontal dressing is applied on the palatal aspect, to support the papilla. [52]

Advantages: [53, 54]

- Promotes wound healing and hemostasis.
- Additional surgical site is not involved.

- Increasing patient compliance and comfort.

b. Semilunar coronally repositioned papilla: [55, 56, 57]

Han and Takie (1996) proposed an approach for papilla reconstruction based on the use of free connective tissue graft.

**Technique:** A semilunar incision is placed in the alveolar mucosa facial the interdental papilla and a pouch like preparation is made into the interdental area. Intrasulcular incision is made around the mesial and distal half of the two adjacent teeth to free the connective tissue from the root surface to allow coronal displacement of the gingival papillary unit.

A section of sub-epithelial connective tissue graft is used which is taken from the palate and is placed into the pouch to support the coronally positioned interdental tissue.

**Disadvantages:** [53, 58]

- The need for a second surgical site.
- Morbidity linked with autogenous palatal donor mucosa.
- It is time-consuming.
- Technique sensitive.

c. Azzi et al. (1998) described a technique, an envelope type flap was prepared for coverage of connective tissue graft. [59]

**Technique:** A crevicular incision is made at the tooth surface facing the interdental papilla to be reconstructed. An incision is placed across the facial aspect of the interdental papilla and an envelope type split thickness flap is elevated into the proximal site as well as apically to and beyond mucogingival junction. [59] A connective tissue graft is harvested from the tuberosity area, trimmed to adequate size and shape, and is placed under the flap in the interdental papillae area; the flaps are brought together and sutured with the connective tissue graft. Conventional techniques are unpredictable due to small working spaces and limited blood supply to the area. Vertical releasing

incisions can further jeopardize vascular supply and leave unpleasant scarring after healing. [59]

d. Autogenous osseous and connective tissue grafts: [60]

**Technique:** It involves an intrasulcular incision which 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 gingivopapillary unit is displaced coronally. Reshape the osseous graft obtained from the maxillary tuberosity to form a saddle that will fit over and around the interdental crest and will be stabilized with a titanium screw. Crushed cancellous bone is packed around the grafted bone in a 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.

e. Nordland in 2008 described microsurgical technique for augmentation of the interdental papilla. [61] 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. [61]

3. Papilla preservation

a. Conventional Papilla Preservation Flap: [62]

Takei et al. in 1985 introduced conventional papilla preservation technique.

Sulcular incisions are given around each tooth with the lingual or palatal flap, a semilunar incision is made across each interdental papilla that dips apically from the line angles of the tooth so that the papillary incision line angle is at least 5mm from the gingival margin allowing the

interdental tissues to be dissected from the lingual or palatal aspect so that it can be elevated with facial flap.

b. Modified Papilla Preservation Flap:<sup>[63]</sup>

Cortellini et al. (1995) introduced a new modification of conventional papilla preservation flap.

It is brought into practice as Minimally Invasive Surgical Technique. A horizontal incision is given buccally on the interdental space at the base of the papilla. The papilla is elevated toward the palatal aspect. It is mostly suitable for thick interdental papilla in wider interdental spaces.

c. Simplified Papilla Preservation Flap:<sup>[64]</sup>

Simplified papilla preservation technique is suitable for narrow interdental spaces ( $\leq 2$  mm). This technique is a modification of Modified papilla preservation which is given by Cortellini.<sup>[64]</sup>

The horizontal incision is replaced by an oblique incision and also is placed on the buccal aspect of the interdental papilla, and the papilla is elevated towards the palatal aspect. An oblique incision is given along the defect associated papilla from the gingival margin at the buccal line angle of the involved tooth to reach the mid interproximal portion of the papilla of the adjacent tooth. The oblique incision is carried forward intrasulcularly in the buccal aspect of the teeth adjacent the defect and extended to partially dissect the papillae of the adjacent interdental spaces allowing the elevation of a buccal flap with 2-3mm exposure of alveolar bone.

d. Cortellini and Tonetti:<sup>[65]</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.

Advantages: Improved illumination, access and magnification of the surgical field.

e. The “Whale’s tail” technique:<sup>[66]</sup>

Bianchi and Bassetti in 2009 introduced a technique known as Whale’s tail technique.

This is a surgical technique that preserves the interdental tissue by guided tissue regeneration. It is used for the treatment of wider intrabony defects in the esthetic zone which involves the elevation of a large flap from the buccal to the palatal side allowing accessibility and visibility of the intrabony defect and to perform guided tissue regeneration while maintaining interdental tissue over grafting material. The reflected flap looks like a tail of a whale, hence named as Whales Tail technique.<sup>[66]</sup>

Thus limited blood supply is believed to be one of the major reasons why papilla preservation and regeneration are difficult. Due to small and restricted space interdentally, any form of free grafting cannot be utilized since the surface area for blood supply to the donor tissue is minimal. A specific incision design (papillary sparing) is used presently to retain maximum vascularity and minimize scar tissue formation.<sup>[50]</sup>

What is PRF....?

Platelet rich fibrin (PRF)<sup>[67, 68]</sup> is a form of platelet gel; a matrix of autologous fibrin, which has scored over platelet rich plasma by virtue of its properties, easier preparation, and cost effectiveness. PRF was first developed in France for use in the field of oral and maxillofacial surgery. Choukroun’s platelet-rich fibrin (PRF) is a leukocyte and platelet rich fibrin biomaterial with a specific composition and three-dimensional architecture. PRF has a dense fibrin network with leukocytes, cytokines, structural glycoproteins and also growth factors such as transforming growth factor  $\beta 1$ , platelet-derived growth factor, vascular endothelial growth factor and glycoproteins such as thrombospondin-1 during  $\geq 7$  days.<sup>[69]</sup> Leukocytes that are concentrated in PRF scaffold play an important role in a growth factor release, immune

regulation, anti-infectious activities, and matrix remodelling during wound healing.

Role of PRF: <sup>[68, 69]</sup>

PRF was first described by Dr. Choukroun and his associates. PRF is a 2nd generation natural fibrin-based biomaterial made from an anticoagulant-free blood harvest without any artificial biochemical modification, thereby attaining fibrin enriched by platelets and growth factors. Choukroun's PRF is a matrix, in which cytokines and cells are entrapped which are released after a short period, and can serve as a resorbable membrane.<sup>[70]</sup> The healing of hard and soft tissues is carried out by various intra-cellular and extra-cellular events that are mediated by protein signals. Platelets are involved in the process of wound healing by blood clot formation and release of growth factors. On activation they have an opposite effect on tissue repair. Platelets are collected from blood and are concentrated in small volume of plasma known as platelet-rich plasma.

Classification of PRF: <sup>[71]</sup>

On the basis of leukocytes and fibrin content:

1. Pure platelet rich plasma (PRP), such as cell separator PRP
2. Vivostat PRF or Anitua's PRGF
3. Leucocyte – and platelet- rich plasma (L-PRP)
4. Pure platelet rich fibrin(P-PRF)
5. L-PRF, such as Choukroun's PRF

Injectable platelet rich fibrin (i-PRF)

Platelet rich plasma (PRP) has been utilized in regenerative dentistry as a supra-physiological concentrate of autologous growth factors capable of stimulating tissue regeneration. Despite this, concerns have been expressed regarding the use of anti-coagulants, agents known to inhibit wound healing. In this study, a liquid formulation of platelet rich fibrin (PRF) termed injectable-PRF (i-PRF) without the use of anti-coagulants was investigated.

Cell behaviour in response to i-PRF:

I-PRF, exhibited high biocompatibility of human gingival fibroblasts as well as significantly induced higher cell migration when compared to control tissue-culture plastic in vitro. It was found that i-PRF induced significantly higher migration. Also it showed significantly highest mRNA levels of TGF- $\beta$  at 7days, PDGF at 3days and collagen1 expression at both 3 and 7 days.<sup>[72]</sup>

Development of an injectable PRF (i-PRF) following the low speed centrifugation concept (LSCC):

Use of solid PRF-based matrices alone or in combination with biomaterials were successfully established. However, in clinical settings, there is still an existing necessity for a fluid biological system. The introduction of i-PRF has since broadened the fields of PRF applications in various medical and surgical indications, especially in combination with biomaterial-based regenerative medicine.

According to the low speed centrifugation concept,<sup>[73]</sup> reduction of RCF to 700rpm(60g) and the use of plastic tubes allowed for the introduction of an injectable PRF matrix (i-PRF). After centrifugation, the blood is separated into a yellow orange upper phase (i-PRF) and a red lower phase (red cell fraction). I-PRF is collected using a syringe by controlled aspiration of the upper fluid phase. The collected i-PRF maintains its fluid phase for up to 10 to 15min after centrifugation due to the fact that it does not contain anti-coagulants and is therefore able to coagulate within a short period of time. Reduction of the RCF led to an enrichment of i-PRF with platelets and leukocytes. I-PRF includes the highest number of platelets and leukocytes among all the solid PRF-based matrices. Moreover, a comparative analysis of the total cells number in i-PRF and further liquid blood concentrates systems such as PRGF and PRP showed a significantly higher

number of platelets, leukocytes, monocytes and granulocytes in i-PRF.

#### Technique using I-PRF

1. Give a cervicular incision around the mesial and distal aspect of the papilla so as to slightly relieve and make the tissue moveable towards the contact point.
2. Then inject the I-PRF so that it creates a bulge filling the papilla and thereby covering the open embrasure.
3. Apply slight digital pressure to adapt the tissue close to the tooth.
4. If the embrasure space is minimum, inject the I-PRF to fill the papilla and compress the tissue digitally.
5. Sutures are placed in position.
6. Sutures are then secured on the facial surface with composite stops.
7. If esthetically concerned, sutures can be taken to the palatal aspect and can be secured with composite.
8. Sutures to be removed after 10days.
9. Post-operative protocol remains the same.

#### In Implants:

- Close attention is paid to both soft and hard tissues around teeth and implants. The presence of the dental papilla is critical in achieving anaesthetic single tooth dental implant restoration.<sup>[74, 75, 76]</sup> The vertical and horizontal distances from the implant to the natural teeth, and the distance from the restoration contact point to the bone level of the natural teeth are paramount criteria that could be utilized to predict the presence or absence of the papilla. To preserve the interdental papilla and allow for adequate oral hygiene, 1.5 - 2.0 mm of space is needed between the implant and the tooth on each side. Therefore, 7 mm of mesio-distal space must be created between the adjacent teeth.<sup>[77]</sup> After the appropriate amount of coronal space has been determined, it is necessary to evaluate the inter-radicular spacing. The minimum

inter-radicular distance required is generally 5-7 mm for a single implant placement.

- Grunder et al.<sup>[78]</sup> reported an excellent papilla results for single tooth implant restoration even when the distance from contact point to the implant bone was 9 mm, whereas Tarnow et al.<sup>[74]</sup> concluded that all papilla were present in the natural teeth when 5mm or less was present from the contact point to the crestal bone and less than 50% when the distance was over 6mm.
- In another study by Tarnow et al.<sup>[75]</sup> crestal bone loss was evaluated in relation to horizontal inter-implant distance. In this study it was reported that increased crestal bone loss would occur if the inter-implant distance was less than 3 mm. Their findings lacked statistical analysis that examined significance at an acceptable level of confidence.
- In another study by Mark et al.<sup>[79]</sup> describing the relationship between horizontal implant-tooth distances and the presence of papilla, they reported that the distance from the contact point to the implant increased the chance of loss of papilla significantly. They also found that there was no difference between delayed or immediate provisionalization and papilla scores.

#### Conclusion

Rebuilding the gingival aesthetics is an important issue in modern aesthetic dentistry. An increased cosmetic demand from the profession and patients has resulted in more emphasis on the gingival aesthetics. Thorough treatment planning is essential for maintenance of the height of the interproximal papillae following tooth removal. Periodontal procedures can be used to enhance the ultimate outcome.

In aesthetically compromised cases, restorative intervention can mask the loss of tissues but rarely can



they achieve ideal aesthetics. 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 aesthetic reconstruction of the papilla can be achieved.

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