

Treatment of Interdental Papilla: A Review

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ABSTRACT

Current dentistry involves both functional and esthetics role. Gingival Recession and loss of Interdental papilla results in Gingival Black Triangle, which is esthetically unpleasing. Interdental papilla loss is strongly associated with increasing age, periodontal diseases and post orthodontic treatment. To achieve reconstruction of the lost interdental papilla is difficult and challenging, as it is associated with the patient smile and esthetics. Absence of interdental papilla raises concern over phonetic problems, food and plaque accumulation, which further deteriorates the present condition along with esthetic problems. Various treatment options for papilla loss are present which involves non-surgical approach (oral hygiene procedures), prosthetic restorations and surgical procedure for increasing tissue volume. The present review discusses the different classifications of papilla loss, etiology associated with open gingival embrasures and all currently available nonsurgical and surgical treatment modalities recommended for papilla preservation and reconstruction.

Keywords- Interdental Papilla, papilla preservation, papilla reconstruction, papilla regeneration, black triangle.

INTRODUCTION

Interdental papilla represents a small visible area present in-between teeth and gingiva of the oral cavity. Interdental papilla plays an important role in esthetics due to its strong association with the patient smile. Gingival black triangle (GBT) is a cosmetic deformity which refers to an absence of papilla resulting in black spaces or open embrasures which impairs esthetic features,

phonetics problems and food accumulation. [1-3] In the absence of contact point, the color disappears leading to black, pyramidal shape formation. [4] Apart from its functional role, increasing public demand for esthetics, place huge pressure on modern clinical dentistry to restore any lost 'white' and 'pink' esthetics. White esthetics denotes natural teeth and pink refers to gingival tissues surrounding the teeth. Balance between soft tissue and teeth adjacent to it with minimal or no tissue deficiencies is key for stable dentition.

The main objective of periodontal therapy is 'prevention of progression of periodontal disease and associated trauma by regeneration of the lost periodontal tissues'. [5-7] Though several surgical techniques have been constantly proposed and experimented, they are mostly invasive and unpredictable. [8] Moreover, the success rate of surgical augmentation of papilla relies on the thickness of gingiva biotype. [9] Hence, a number of nonsurgical, minimally invasive techniques have been developed to preserve and restore interdental papilla. Though many solutions have been proposed to correct lost interdental tissues, no golden standard technique is followed so far due to the absence of long-term clinical results and predictability. The present review discusses the various classifications of papilla loss, etiology associated with Gingival Black Triangle and currently available nonsurgical and surgical treatment modalities recommended for papilla preservation and reconstruction.

Anatomy of interdental papilla

The interdental papilla is defined as the gingival tissue extending from the incisal tip of the papilla to a line tangential to the gingival margins of the two adjacent teeth. Interdental papillae are the extensions of gingiva filling the spaces between adjacent teeth. It is formed by dense connective tissue covered by epithelium and is influenced by the height of alveolar bone, the distance between the teeth and the interdental contact point. [10] Because the tooth mass bordering the interdental papilla is less in anterior teeth, the interdental papilla is narrow and has a pyramidal shape and its tip just below the contact point. In posterior teeth, due to the presence of larger tooth mass, it is wider and with a ridge shaped concaved area called as 'col'. [11]

In the anterior teeth, the location of the contact point varies. For example, the contact point between two central incisors is located at the incisal third of the labial aspect. The contact point between central and lateral incisor, is located at the incisal third. It can be said that interdental papilla between two central incisors is filled with more space than the other teeth in anterior region.

A classical study conducted by Tarnow et al. studied the presence or absence of interdental papilla with the distance between the bone crest and the contact point in 30 patients. The presence of the papilla was observed in 100% of the cases in which the distance was less than or

equal to 5mm in 56% of cases and in which the distance was 6mm, and only 27% of cases in which the distance was 7mm or more. [12] According to Fradeani, the distance between the roots is another factor that can influence the presence or absence of interdental papilla. The author stated that the inter-radicular distance smaller than 0.3mm jeopardizes the presence of the proximal bone and, therefore, it is usually accompanied by the lack of interdental papilla. [13]

CLASSIFICATION OF INTERDENTAL PAPILLA LOSS

Nordland and Tarnow (1998) proposed a classification system regarding the papillary height adjacent to 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 [14] (Fig 1)

Normal: Interdental papilla fills occupies the entire embrasure space apical to the interdental contact point/area.

Class I: Tip of 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 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.

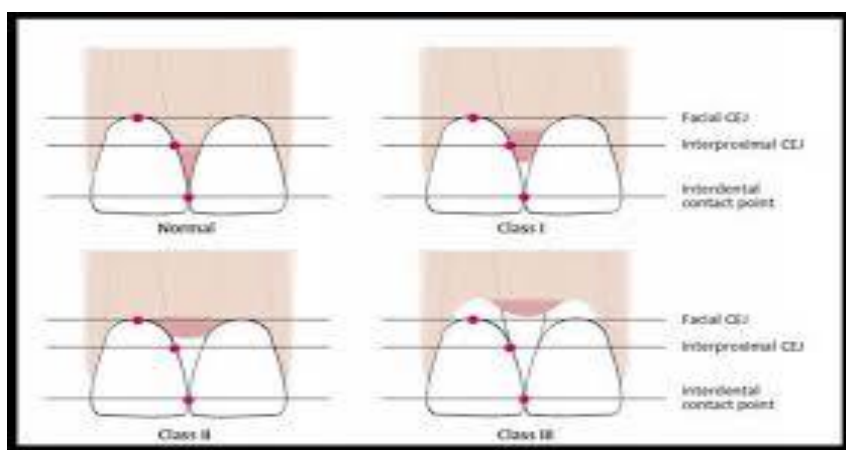


Fig1- Classification by Nordland and Tarnow [14]

The Papilla Presence Index (PPI) (Cardaropoli et al., 2004) [15]

A New System to Assess Interproximal Papillary Levels – proposed by Cardropoli et al. (2004)

- 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.

Nemcovsky introduced a classification system as a papillae index score (PIS) based on a comparison with adjacent teeth: [16] (Fig 2)

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.

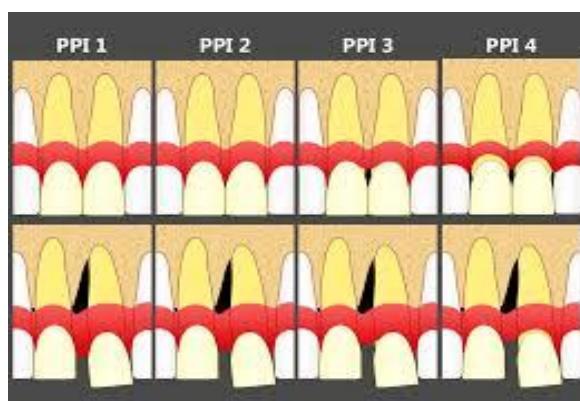


Fig 2- Classification by Nemcovsky [16]

FACTORS THAT DETERMINE THE PRESENCE OR ABSENCE OF INTERDENTAL PAPILLA:

There are multiple factors which determine the presence or absence of interdental papilla. These factors include changes in tooth alignment during orthodontic treatment, loss of periodontal

ligament causing recession, loss of interproximal bone height in relation to interproximal contact, angulation of roots and presence of crowns. Active periodontal diseases are associated with loss of interdental papilla. Periodontal pockets with probing depth more than 3mm will lead to an increase in plaque retention, inflammation and recession. As the resorption of alveolar crest progresses, the distance between the contact point and the alveolar bone crest increases, resulting in loss of interdental papilla.

Factors influencing the presence of interdental papilla are [Etiology (Fig 3)]

Underlying osseous architecture

The shape and form of interdental papilla depends upon underlying bone and its architecture. In general, the positive architecture refers to the osseous crest, which follows the shape on cement-enamel junctions, and the position of the interproximal bone is commonly coronal than the radicular bone; is most commonly associated with interdental papilla. The distance of the contact point to the alveolar crest is an important factor determining the shape and form of papilla. According to Tarnow et al (1992) when distance from the contact point to the alveolar crest was less than or equal to 5mm, the papilla was present in 98% of the times, while at 6mm it dropped to 56% and at 7mm it was present only 27% of the times. [17]

Distance between root surfaces

The distance between root surfaces also influence the presence of interdental papilla. In a study, Tal (1984) analyzed the interproximal distance of roots and the prevalence of infrabony defects. It was concluded that the distance between roots was more than or equal to 3.1mm, two separate infrabony defects were noted. In other words, we can say that a minimum of 3mm interdental distance may be needed in maintaining papilla. [18]

Periodontal biotype

There are two morphological forms of interdental papilla and the osseous architecture, the thin and thick periodontal biotype. In general, thick biotype is better than thin biotype for the presence of interdental papilla. Thin biotype has fragile periodontium that is more susceptible to recession. Thick biotype is fibrotic and resilient, making it resistant to surgical procedures with a tendency of pocket formation and recession. The interdental gingival tissue possesses biological tissue memory, due to which under favorable conditions the interdental papilla attains its original shape and form. The thick biotype is more conducive for the rebound of gingival tissue than thin biotype. [19]

Periodontal bioforms:

The periodontal bioform denote the basic gingival scallop morphologies. 3 types of gingival scallop morphologies have been described: high, normal and flat. The gingiva scallop morphologies are determined by the underlying bone architecture. For example, in the shallow gingival scallop, the interproximal bone is thin, and the interproximal gingival contour nearly parallel to the underlying bone contour. Flat scallop is better than high scallop for favorable esthetics. This is because, in flat scallop, the bone has a congruous relationship with the free gingival margin and is less prone to post-surgical recession. The high scallop has wider underlying interproximal one, but due to disparity between the bone contour and free gingival margins the esthetics may be compromised due to formation of black triangles. [20,21]

Contact points:

The contact point of maxillary anterior teeth and their distance from the crest of the interproximal bone plays a important role in the form and shape of interdental papilla. In a landmark study, Tarnow et al (1992) described the '5mm rule'. [22-30] The rule states that when the distances from the contact point to the interproximal osseous crest is 5mm or less,

there is complete fill of gingival embrasures with interdental papilla. For every 1mm above 5mm, the chance of complete fill is reduced by 50%. For square shaped teeth with wide contact points, the chances of black triangles; are minimal as compared to triangular teeth having narrow, more incisally positioned contact points. [17]

Crown morphology:

The shape of the crown is an important factor which determines the shape and form of interdental papilla. There are 3 basic crown forms: circular, square and triangular. The square crown yields better interdental papilla maintenance due to wider contact and smaller interproximal distance from the osseous crest to the contact point. The triangular crown form results in a pronounced gingival scallop and thin underlying crestal bone, which predisposes for interdental papilla recession. [19]

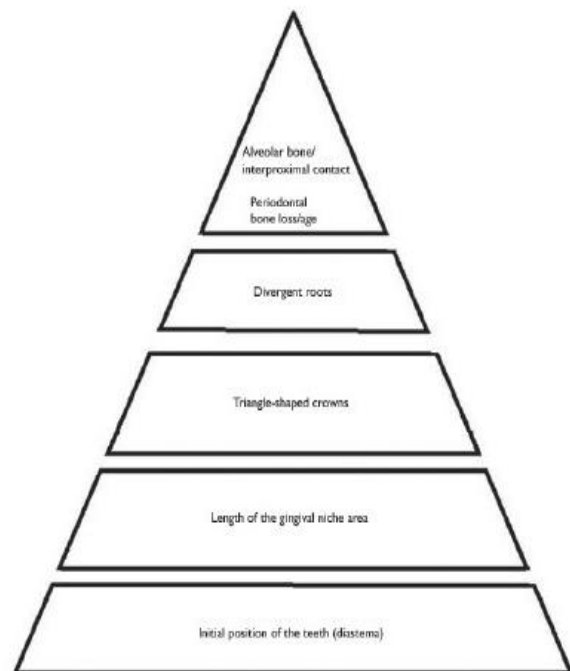


Fig 3- Etiology pyramid of gingival black triangle [17-19]

TREATMENT

Various non-surgical and surgical techniques have been introduced with the sole intension of either reconstruction or regeneration of the lost papilla either by modifying the interproximal spaces or by surgical reconstruction of the lost soft tissue between the teeth. The non-surgical

approach (orthodontic, prosthodontics, restorative) modify the interproximal space, thereby inducing modifications of the soft tissues. Most of the surgical procedures have emphasized gingival grafting.

Non-surgical approach:

Patients may have one or more etiological factors present, thus, managing such patient requires a proper assessment and treatment plan. If the loss of papilla is related to only soft tissue loss, reconstruction techniques are used for restoring it completely or if the loss of papilla is caused by periodontal diseases with interproximal bone resorption, usually a complete reconstruction is not achieved. Though several surgical and nonsurgical treatment options are available, there is no golden standard set due to lack of large scale clinical trials or long term clinical outcomes. When compared to surgical techniques which are less predictable and painful, [9] nonsurgical techniques are preferred due to their cost effectiveness, less stressful and achieve immediate results with high satisfaction rate. Nonsurgical approaches include correction of traumatic oral hygiene procedure, restorative techniques, orthodontic movement, repeated scrapping of the papilla and tissue volumizers.

Correction of Traumatic Oral Hygiene Procedure

Toothbrush abrasion causes cement and enamel wear and can damage supporting gingival tissues leading to recession and papilla loss. A study by Addy and Hunter reported that irrespective of manual or power tooth brushing, over or abusive brushing or force applied significantly harm the gingival tissues. These traumatic oral hygiene procedures should be identified early and discontinued to allow re-epithelialization and restoration of papilla. Usage of flat trim toothbrush bristle, end-rounded filaments, rubber bristles interdental cleaner are recommended to reduce gingival abrasion. Improper use of dental floss can damage the interdental papilla. Traumatic interproximal

hygiene procedures should be initially discontinued and then successively modified. Re-epithelialization of the traumatic lesion can restore the papilla completely. [31-35]

Restorative and Prosthetic Approaches

Prosthetic approaches include use of porcelain, acrylics, silicone-based soft materials or co-polyamide and composite resin. Composite resin is available in pink shades for gingival reproduction and can be used on restorations to replace missing soft tissue. Though pink porcelain can mask the interdental papilla, porcelain shades and optical properties are limited. Removable acrylic or silicone can be used as a gingival veneer to camouflage lost gingival tissues and is indicated only when the interdental defects present are with >5mm gap between contact point and alveolar crest. The removable prosthesis facilitates a larger volume of tissue replacement without disturbing other dental units that allows proper cleaning, while the fixed restorations of soft tissue in the esthetic zone, can be treated by pink porcelain which will recreate natural tooth proportions and provide a realistic alternative to surgery. Maintenance of Hygiene is strongly recommended to improve the performance of prosthesis. Kimand Cho used modified Mylar strip technique to close diastema by using direct composite resin. Though the technique adapted was less stressful and economic, incorrect resin composition may result in wear, fracture and limited success rate. By using restorative or prosthetic techniques, the contact point can be lengthened apically, reducing open embrasure and creeping of interdental gingiva. [2, 36-39]

Orthodontic Approach

Diastema reduction and creeping of gingival tissue towards the interdental space can be achieved by conventional orthodontic movement of adjacent teeth that creates new contact point. In conjunction with orthodontic treatment, interproximal reduction of enamel is one of orthodontic approach to achieve contact point. Inter Proximal Reduction of enamel on triangular

crown will convert contact point to a broader contact area thereby reducing Black Triangles. Normally 0.5-0.75mm enamel is removed to prevent occurrence of open embrasures. A study by Livas mentioned that a maximum of 50% of interproximal enamel can be removed without causing dental risk. By application of gentle, continuous pressure on tooth, coronal movement can be seen resulting in closure of interdental space. This effects alterations within the supporting structures and causes changes in bone level and the soft tissue contours, thereby creates new papillae. Cardaropoli et al. presented a study evaluating a combined approach of orthodontic-periodontal treatment for reconstruction of the interdental papillae between upper central incisors, demonstrating that the soft tissues adapted to the new emergence profiles during intrusion of the teeth as the interproximal spaces were reduced. [40-42]

Repeated Scrapping of the Papilla

Recreation of papillae which were previously destroyed by necrotizing gingivitis is done by repeated curettage every 15 days for 3 months. This instrumentation induces a proliferative hyperplastic inflammatory reaction of the papilla. Approximately 9 months after initial treatment, regeneration of interdental papillae was observed. Few papillae showed complete regeneration, while others did not respond to the periodic curettage. Yanagishita et al. observed improvement of interdental papillae in a patient undergoing supportive periodontal therapy. All the patients undergone initial periodontal therapy for periodontitis, including oral hygiene instruction, scaling and root planing. Patients were asked to stop the use of an interdental brush to allow the interdental papillae to recover. A gradual improvement was observed in recession of the interdental papillae over a period of several years together with coronal regrowth of the gingival margin. [43,44]

Tissue Volumizing

Among several minimally invasive techniques proposed, the injection of various fillers and biological preparations has been studied for papilla reconstruction. Hyaluronic acid (HA) is a large molecule, non-sulphated glycosaminoglycan present in connective tissues of skin and cartilage. Physiologically it contributes to tissue hydrodynamics, by binding to water to provide elasticity and stability resulting in tissue regeneration and healing. It is non-immunogenic, biocompatible and bacteriostatic which enhances its clinical significance. Initially it was used as dermal filler, but the recent findings have suggested its use to treat interdental papilla loss. 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 eliminated through urine. HA has antioxidant property by which it scavenges reactive oxygen species that further helps in the regulation of immune response implying its anti-inflammatory properties. HA's this anti-inflammatory response makes it ideal for biomedical usage. Chemical modified hyaluronic acid preparations degrade slowly than biological HA extending its clinical efficacy by 6-12 months. Such preparations are used as fillers which are usually manufactured from animal sources and more recently Streptococcus species of bacteria was used to extract gel form of hyaluronic acid which was chemically cross-linked with butanediol diglycidyl ether, stabilized and suspended in neutral phosphate buffered saline. A study by Becker et al, aimed to evaluate the efficacy of commercially available hyaluronic acid gel to eliminate deficient papillae. A total of 14 GBTs were treated by injecting HA gel 2-3mm apical to the tip of the papilla up to 3 times at 3 weeks intervals. The study concluded that it is possible to enhance papillae that do not entirely fill the interdental space with an injectable hyaluronic gel and the results were promising, even after 25 months and no relapse was observed. A series by Lee et al. evaluated the clinical efficacy of using

hyaluronic acid gel on enhancing interdental papilla deficiency using radiographic assessment and it reported that when HA was repeated up to 5 times every 3 weeks and the post follow up period of 6 months, there was a significant improvement in interdental papilla reconstruction with contact point and bone crest reaching 6mm. Mansouri et al. 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 6 months period. A clinical trial by Awartani and Tatakis examined effects of using injectable, non-animal based, HA gel in reconstruction of interdental papilla loss. This study concluded that there was a

significant improvement in recreation of interdental papilla at 6 months post HA gel injection. However, according to Tanwar and Hungund, 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. [45,46,7,9]

Surgical approach:

Papilla Recontouring

In the presence of gingival enlargement, the excess tissue should be eliminated to remodel the soft tissue architecture in the case of drug-induced hyperplasia, idiopathic gingival hyperplasia etc., a gingivectomy may be performed. (Fig 4)



Fig 4- Pre and post-operative pictures of Gingivectomy. (Department of Periodontology, Bharati Vidyapeeth Dental College and Hospital, Pune)

Papilla reconstruction

Several case reports have been published regarding surgical technique for reconstruction of deficient papilla (Beagle 1992 Han and Takie 1996, Azzi et al. 1998). However, the predictability of the various procedures has not been documented, and no data are available in the literatures providing information on the long-term stability of surgically regained interdental papillae. Beagle (1992) described a pedicle graft procedure utilizing the soft tissues palatal of the interdental papilla. [47,48]

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. Han and Takie (1996) proposed an approach for papilla reconstruction (semilunar coronally repositioned papilla) based on the use of free connective tissue graft (Fig 5)



Fig 5- Han and Takei 'Semilunar Coronally Advanced Flap' [47]

Technique

A semilunar incision is placed in the alveolar mucosa facial to the interdental

papilla and a pouch like preparation is performed 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 a coronal displacement of the gingival papillary unit. A connective tissue graft, taken from the palate, is placed into the pouch to support the coronally positioned interdental tissue [49,50] Azzi et al. (1998) described a technique, in which envelope type flap was prepared for coverage of connective tissue graft. [47] (Fig 6)

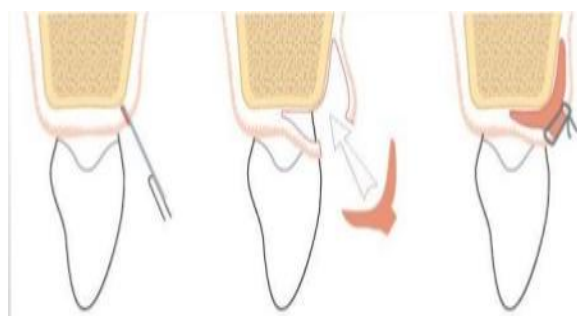


Fig 6- Azzi et al Envelope flap technique [47]

Technique:

A crevicular incision is made at the tooth surface facing the interdental papilla to be reconstructed. Subsequently, an incision 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 line. A connective tissue graft is harvested from the tuberosity area, trimmed to adequate size and shape and placed under the flap in the interdental papillae area; the flaps are brought together and sutured with the connective tissue graft. In 2001, to increase the volume of the interdental tissue additional to the flap described in the aforementioned study, Azzi et al. (2001) associated an autogenous bone graft from the region of the maxillary tuberosity with a connective graft tissue from the region of the palate. 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. Nordland in 2008 described Microsurgical technique for augmentation of the interdental papilla.

The above techniques showed that using an interposed subepithelial connective tissue graft can regenerate lost interdental papilla, and the reconstructed papilla remained stable and without any clinical signs of inflammation for 4 years after surgical procedure, but the long-term survivability and the technique sensitivity involved in the surgery to considered. In the case of implant therapy, the absence of inter-implant papillae impairs esthetics. Some attempts have been proposed in the literature to recreate the scalloped and positive architecture of the soft tissue around implants (Palacci et al., 1995). One novel technique consists of buccal dislodgment of a full-thickness flap raised from a site slightly more palatal with respect to the implants. To ensure and stabilize the most coronal position of the flap, the ramp mattress suture technique is performed. This new suturing approach provides a coronal pulling traction, whereas the palatal flap receives compression on its underlying layers. After 4-5 weeks, a vestibular scalloped gingivectomy is performed in correspondence to the vestibular surface of the abutments to create a positive architecture of the gingival margin. [51-53]

Papilla preservation

Various flaps have been described for the preservation of interdental papilla.

A] Conventional Papilla Preservation flap

Takei et al. in 1985 introduced conventional papilla preservation technique. Sulcular incisions are given around each tooth and with the lingual/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/palatal aspect so that it can be elevated intact with facial flap. [54] (Fig 7)

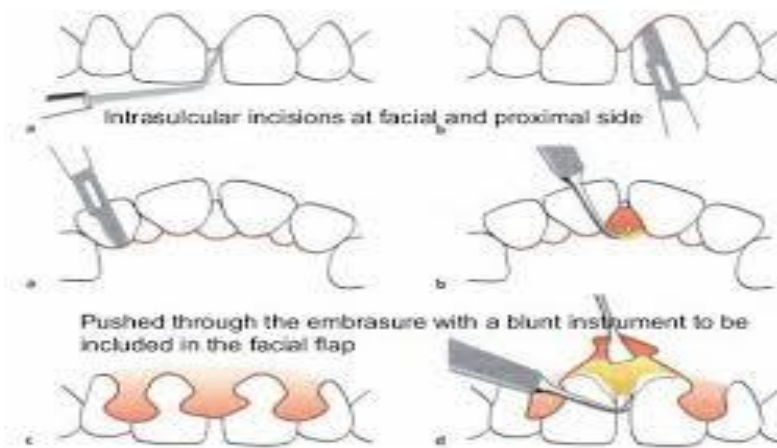


Fig 7- Conventional papilla preservation flap technique. [54]

B] Modified Papilla Preservation Flap

Cortellini et al. (1995) introduced a new modification of conventional papilla preservation flap. It was brought in 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 wide interdental spaces. [55] (Fig 8)



Fig 8- Modified Papilla Preservation flap [55]

C] Simplified Papilla Preservation Flap

Simplified papilla preservation technique is suitable for narrow interdental spaces (≤ 2 mm). This technique is a modification of Modified papilla preservation which is given by Cortellini. The horizontal incision given in Modified Papilla Preservation flap is replaced by an oblique incision and 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. [56] (Fig 9)



Fig 9- Simplified Papilla Preservation Flap [56]

D] The “Whale’s tail” technique

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 wide intrabony defects in the esthetic zone that 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 GTR while maintaining interdental tissue over grafting material. The reflected flap looks like a tail of a whale, hence the name Whales Tail technique. [57] (Fig 10)

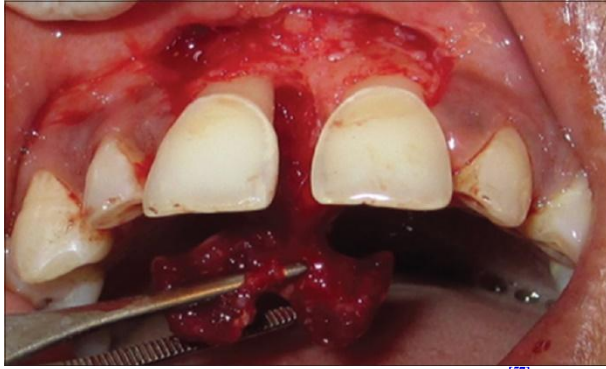


Fig 10- Whales technique for papilla preservation [57]

Although there are many approaches showing good clinical results and have been proposed to restore the lost interdental papilla, the predictability of various procedures has not been completely documented, and no data on the long term stability are available in the literature.

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