

# Rebuilding the Pink Esthetics: Credible Approaches in Interdental Papillary Reconstruction

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## ABSTRACT

**Introduction:** One of the most perplexing aesthetic problems of the periodontium is the formation of black triangles due to the loss of interdental papilla. The complex anatomy of the interdental papillae allows for periodontal disease to progress rapidly, and is the most common cause for the development of 'black triangles'. Not only are esthetics and phonetics compromised, but interdental papillary deficiency increases the tendency for retention of food debris, thereby hampering oral hygiene maintenance leading to periodontal disease. Due to its sparse vascular supply, interdental papillary reconstruction or augmentation remains as a mystifying periodontal plastic procedure.

**Objective:** To evaluate black triangle fill using nonsurgical and surgical techniques for interdental papilla reconstruction.

**Methodology:** In this case report, non-surgical papillary reconstruction was carried out using two separate agents- injectable platelet-rich fibrin (iPRF) and hyaluronic acid (HA) while the surgical technique employed leucocyte PRF (L-PRF) combined with an advanced papillary flap in patients with loss of interdental papilla in the maxillary anterior region.

**Conclusion:** Optimal black triangle fill was noted postoperatively in both surgical and nonsurgical techniques with interdental papilla reconstruction; however, better patient compliance and less morbidity was observed in the non-surgical approach. In the non-surgical approach, iPRF, resulted in a better fill of the black triangle as compared to hyaluronic acid gel.

**Keywords:** *Interdental papillary reconstruction, hyaluronic acid, injectable platelet rich fibrin, leucocyte platelet rich fibrin*

## 1. INTRODUCTION

The shape, size, volume and health of the interdental papilla is imperative in establishing the pink and white harmony of the esthetic zone as well as for the maintenance of oral health. The partial or complete loss of interdental papillae is commonly referred to as "black holes" or "black triangles"[1]. The loss of interdental papilla is a result of a multitude of factors, including inadequate oral hygiene maintenance leading to plaque accumulation and consequent periodontal disease, aberrant morphological features of a tooth like divergent roots and abnormal crown form, traumatic oral hygiene practices along with iatrogenic

factors like improper restorations and crown contours or post orthodontic therapy[2]. Open gingival embrasures can lead to various complications such as food impaction, increased plaque accumulation, and a lack of self-cleansing action, resulting in periodontal disease. Furthermore, it hampers phonetics, and poses a significant esthetic concern, ranking third after caries and crown margin display, thereby collectively affecting the self-esteem of the individual[3].

Various surgical and nonsurgical approaches have been proposed in periodontal literature for satisfactory interdental papilla (IDP) reconstruction. Surgical techniques[4], such as modified papilla preservation flap (MPPF), simplified papilla preservation flap (SPPF), and the use of enamel matrix proteins (EMP), acellular dermal matrix (ADM) allografts, membranes[5], free gingival grafting, pedicle graft procedure[6], and interposed connective tissue grafts [7] have been attempted. However, these surgical techniques are invasive, less predictable due to the peculiar anatomy and sparse vascular supply of the interdental papillary region, and are often associated with pain and morbidity[8].

Nonsurgical modalities include orthodontic tooth movement, prosthetic restorative procedures, autologous cultured fibroblast injections, periodic injectable platelet-rich fibrin and hyaluronic acid (HA) treatments. Hyaluronic acid (HA) is a linear glycosaminoglycan polymer which is frequently used as a soft tissue volumizer in facial tissue rejuvenation[9]. Injecting HA into the connective tissue has been proposed to resolve the issue of interdental papilla recession by promoting fibroblast migration and fibrogenesis[10]. When injected into papillary gingiva, hyaluronic acid integrates well, enhancing microcirculatory perfusion and plumps the interdental papilla, yielding excellent esthetic outcomes owing to its hygroscopic, non-toxic, anti-inflammatory properties whilst minimizing patient discomfort compared to surgical alternatives.

Autologous platelet concentrates, particularly platelet-rich fibrin (PRF), have been under extensive scientific research and development in the past 15 years, and are now incorporated as a filler alongside connective tissue grafts to address interdental space loss and gingival recession[11-13]. The development of an injectable formulation of PRF (termed i-PRF) based on a low-speed concept for blood centrifugation by Ghanaati et al.[14] has been pursued with the aim of intrinsic tissue regeneration by stimulating human mesenchymal stem cell proliferation, migration, and osteogenic differentiation [15].

This case report aims to evaluate both the non-surgical and surgical methods of interdental papillary reconstruction in patients with Papillae Presence Index 2 (PPI 2) and 3 (PPI 3) (Cardaropoli et. al 2004)[16] with no radiographic evidence of bone loss and a vertical distance from the interdental contact point to the crest of the interdental bone <5mm as measured by intraoral periapical radiograph (IOPA). The clinical parameters assessed were black triangle height, width, and PPI score at 1, 3, and 6 months postoperatively. The clinical procedures along with the assessment of the outcomes were carried out by a single trained operator.

## **2. CASE PRESENTATION**

### **2.1 CASE I**

A 38-year-old systemically healthy female patient reported with a chief complaint of an unesthetic appearance in the maxillary anterior gingival region due to the presence of black triangles. Intraoral examination revealed black triangles i.r.t 11&12 (site A) (Fig 1a) and 21&22 (site B) (Fig 2a). The height of the black triangles were 2.1 mm and 1.8 mm in sites A and B respectively. The width of both the sites measured 1.6 mm and were scored 2 according to the Papilla Presence Index.

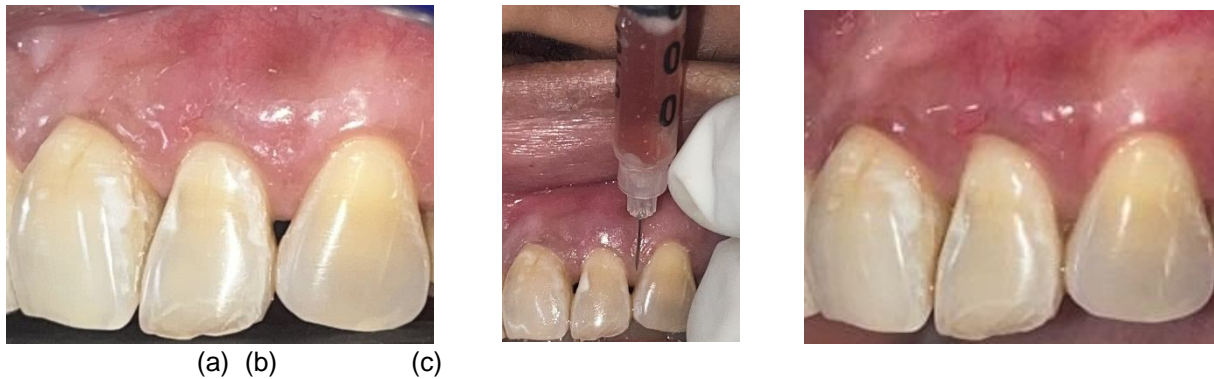
#### **2.1.1 Preoperative Protocol**

Prior to starting the procedure, an informed consent was taken from the patient. The preoperative protocol comprised of Phase I therapy wherein professional mechanical plaque removal was carried out followed by Phase IV maintenance therapy which included reinforcement of oral hygiene instructions. Patients were recalled after 28 days for further treatment. Clinical parameters were measured using an endodontic spreader with a rubber stopper and recorded using a digital vernier caliper.

### 2.1.2 Operative Procedure

Preoperatively, 5ml of blood was drawn into a test tube and centrifuged immediately for the preparation of i-PRF (Ghanaati et. al)[14] after which it was procured from the top most layer of the preparation using an insulin syringe (BD Ultra-Fine™ Needle Insulin Syringe). Topical anesthetic agent 2% Lidocaine gel was applied at both the sites A and B. The surgical procedure was carried out as bilateral split mouth procedure wherein the insulin syringe with 0.2 mm (31G) × 6 mm needle was used to inject the respective biomaterials 2-3 mm from the tip of the papilla and oriented coronally with 45° angulation with respect to the long axis of tooth. i-PRF and 1% hyaluronic acid gel (Dermaheal HSR) were injected in sites A (Fig. 1b) and B (Fig. 2b) respectively for interdental papillary reconstruction. The areas were gently massaged for 1 minute in circular motion for proper drug distribution.

The patient was instructed not to brush on the day of treatment and to avoid using dental floss for 14 days at the sites of treatment, and to resume routine oral hygiene practices after one day using a soft bristle toothbrush. The patient was instructed to continue rinsing their mouth using chlorhexidine gluconate (0.2%) mouthwash twice daily for 14 days, and to take a cold and soft diet for 1 day postoperatively.



**Fig. 1 Injection of i-PRF in site A (a. Preoperative black triangle b. Injection of i-PRF in the site of black triangle c. Postoperatively at 6 months)**



(a) (b) (c)

**Fig 2. Injection of 1% hyaluronic acid gel in site B** (a. Preoperative black triangle b. Injection of HA gel in the site of black triangle c. Postoperatively at 6 months)

## **2.2 CASE II**

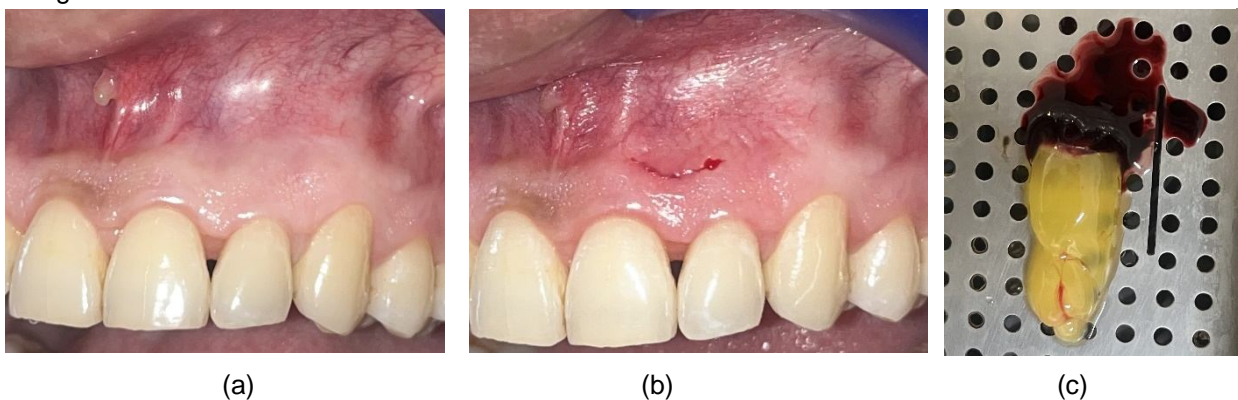
A 42-year-old systemically healthy male patient reported with a chief complaint of unesthetic appearance and food lodgment in the anterior maxillary region. Intraoral examination revealed a gingival black triangle i.r.t 21 & 22 which measured a height and width of 1.7 mm and 1.4 mm respectively and was given a PPI 2 score (Fig 3a).

The pre-surgical protocol was the same as described above in Case I, and an informed consent was taken from the patient prior to the commencement of the procedure.

### **2.2.1 Surgical Procedure**

10ml of blood was drawn into a test tube without an anticoagulant and centrifuged immediately (Chokroun et al.)[17] for the preparation of L-PRF, after which it was extracted from the middle layer of the preparation using tweezers, after which, scissors were used to separate the red lower phase. The L-PRF clot was placed in the PRF box and compressed with a stainless-steel weight to prepare a membrane of uniform thickness (Fig 3c).

Local anesthesia (2% lignocaine with adrenaline 1:100,000) was administered via infiltration. Using a no. 15c blade, a semilunar incision was made at the mucogingival junction above the base of papilla at the site of the black triangle (Fig 3b). A split-thickness pouch was created extending to the tip of the interdental papilla while maintaining caution not to damage the dentogingival unit of adjacent teeth (Fig 3d). The L-PRF membrane was then tucked into the pouch, and the entire gingivopapillary unit was displaced coronally. Simple interrupted sutures using Vicryl 5-0 were taken to seal the incision margin and secure the PRF membrane within the pouch (Fig 3e). The patient was given postoperative instructions as mentioned above and was recalled after 7 days for assessment of the surgical site healing.



Clinical parameter	Technique	Baseline	1 month	3 months	6 months
Black triangle	iPRF	2.1	1.8	1.4	0
	Hyaluronic	1.8	1.5	0.8	0.1

(d)

(e)

(f)

**Fig. 3 Surgical interdental papillary reconstruction** (a.Preoperative black triangle b. Semilunar incision c.Preparation of L-PRF d.Creation of a split thickness pouch e.Placement of L-PRF placement within pouch and suturing f. Postoperatively at 6 months)

### 3. RESULTS

Patients were recalled periodically at 1,3 and 6 months for evaluation of the clinical parameters (Table 1). In Case I, at 6 months, site A which was injected with i-PRF showed 100% papillary fill with complete closure of the gingival embrasure (Fig 1c). The PPI score reduced from 2 to 1 in site A. Site B showed partial papillary fill with a black triangle height and width of 0.1 mm and 0.2 mm respectively (Fig 2c). Therefore, site B showed a 94.5% reduction in black triangle height and 87.5% reduction in width, but there was no change in the PPI score from the baseline.

In Case II, postoperative black triangle height and width was 0.2 and 0.3 mm respectively after 6 months (Fig 3f). Although complete papillary fill was not attained, 88.3% reduction in black triangle height and 78.6% reduction in width was noted. The PPI score remained 2 and did not change from baseline.

**Table 1. Clinical data comparing parameters at baseline and 1,3, and 6 months postoperatively**

<b>height (mm)</b>	acid gel				
	Surgical approach	1.7	1.2	0.7	0.2
<b>Black triangle width (mm)</b>	iPRF	1.6	1.3.	1.0	0
	Hyaluronic acid gel	1.6	1.1	0.5	0.2
	Surgical approach	1.4	1.0	0.6	0.3
<b>Papilla Presence Index Score</b>	iPRF	2	2	1	1
	Hyaluronic acid gel	2	2	2	2
	Surgical approach	2	2	2	2

#### 4. DISCUSSION

Marly Kimie Sonahara Gonzalez et al.(2011) introduced the concept of the interdental papillary “house” to diagnose and manage papillary loss and predict tissue reconstruction[18]. The “house” outline is determined by adjacent teeth in contact, including their proximal contact, contour, cementoenamel junction, interdental distance, and underlying bone crest. Understanding these components aids in interdisciplinary treatment planning, and serves as a practical guide for practitioners for management of patients with multiple etiological factors responsible for papillary loss.

A systematic review by Patel et al. (2024) substantiated that that amongst many different treatment modalities available for reconstruction of the interdental papilla, hyaluronic acid injections, PRF, surgical grafting using subepithelial connective tissue graft and orthodontic therapy seem to improve outcomes within a minimum period of 3 months[19]. However, they also highlighted that it is not possible to draw any direct conclusions or comparisons between the different modalities due to the high level of heterogeneity amongst the studies.

Miron et al. (2017)in their invitro study, demonstrated that i-PRF releases higher concentrations of growth factors such as PDGF, TGF-β1, VEGF, FGF, and IGF, leading to increased fibroblast migration and collagen expression[20]. Compared to L-PRF, reducing centrifugation force enhances injectable Platelet-Rich Fibrin (i-PRF) formation by preserving the growth factors crucial for tissue regeneration. In a study by Nikhila Chandramohan et al, clinical outcomes of using i-PRF gel for interdental papillary enhancement in anterior teeth was assessed at 3 weeks postoperatively, and it was shown that the papillary volume enhancement could be achieved, although the highest papillary fill of 63% was noted[21]. Owing to its properties, i-PRF has been employed in other applications such as gingival phenotype augmentation, treatment of gingival recession, and alveolar bone regeneration.

A study by Habashneh RA et al. (2018) aimed to evaluate hyaluronic acid (HA) efficacy in treating interdental papilla (IDP) loss in the esthetic zone[22].Eighty-six interdental sites were treated with 0.2 ml HA injections, and at 3 months, 39% reduction in black triangle height was noted. Application of HA gel for the reconstruction of IDP was successful in 6 months, and the study concluded that iinjectable HA gel is a promising minimally invasive therapy for enhancing papillary esthetics. The clinical outcomes attained from papilla reconstruction using 1% HA gel in this case report were in accordance to the study conducted by Kapoor et al. (2022) who evaluated the changes in buccal triangle dimensions i.e. buccal

triangle area (BTA), buccal triangle width (BTW), buccal triangle height (BTH) at baseline and 6 months using commercially available 2% HA gel[23]. In her study, HA treated sites showed gradual and constant improvement in interdental papilla enhancement while the control sites did not show any improvement. Complete interdental papilla reconstruction was seen in 63.3% of test sites at 6 months while 365 of test sites showed partial interdental papilla reconstruction thereby affirming that HA is a noninvasive volumizing alternative treatment modality for interdental papilla deficiency.

The findings of a study by Ashima Trivedi et al. (2021) were in accordance with this case wherein an attempt to evaluate the efficiency of autologous Injectable Platelet-rich fibrin (i-PRF) in comparison to commercially available hyaluronic acid injections in the reconstruction of small, deficient interdental papilla, with PPI2 and PPI3 types of interdental loss was done[24]. Results revealed a statistically significant difference in both the groups in terms of Papillae presence index and black triangle area as measured from baseline to 1 month and 3 months follow-up, and the study concluded that Injectable Platelet rich fibrin can be a viable alternative to hyaluronic acid injections in the treatment of gingival black triangles.

## **5. CONCLUSION**

From the findings in this case, it was concluded that optimal black triangle fill was attained postoperatively in both non-surgical and surgical techniques. Both the techniques were effective in reconstruction and augmentation of the interdental papilla; however, better patient compliance and less morbidity was observed in the non-surgical approach. Moreover, in comparison of both the biomaterials used in the non-surgical therapy, iPRF, resulted in a better papillary fill of the black triangle as compared to hyaluronic acid gel. With the added benefits of the non-surgical approaches, injecting soft tissue volumizers serves as a viable yet reliable alternative to the surgical techniques in interdental papilla reconstruction. The advent and advancement in biomaterials like hyaluronic acid and i-PRF have resulted in a paradigm shift towards painless perioplastic procedures restoring esthetics, health, functionality with greater patient gratification. The procedures aiming at papillary reconstruction not only transform the smile of an individual from a state of deficit in the soft tissues to harmony, but also promote long-term health and stability of the periodontium.

## **6. CONSENT**

All authors declare that written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editorial office/Chief Editor/Editorial Board members of this journal.

## **7. ETHICAL APPROVAL**

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki. There were no ethical issues in any of the above-mentioned procedures.

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- 3.

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