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"Restoring Smiles: A Review Article on Addressing the Black Triangle Dilemma in Esthetic Dentistry"

Harshita Wadhwa[1], Rahul Sharma[2], Sakshi Verma[3], Soumyashree Mishra[4], Yamini Kindra[5]

[1,2,3,4,5]Post Graduate Student, Post Graduate Institute of Dental Sciences, Rohtak

ABSTRACT

Black triangles, gaps in the gingival embrasure below interproximal contacts, can negatively impact both aesthetics and function, leading to issues like food impaction and speech difficulties. Management requires an interdisciplinary approach involving orthodontics, prosthodontics, periodontics, and restorative dentistry. Treatment options include nonsurgical methods such as orthodontic correction, prosthetic crowns, restorative reshaping, and nonsurgical periodontal care. Surgical approaches may involve gingival flaps and tissue grafts. Recent non-invasive treatments, such as the application of hyaluronic acid (HA), have shown promising results in addressing papillary deficiency. Additionally, the BioClear Injection Molding technique, which uses composite resin to close gaps and improve tooth appearance, offers a novel solution for managing black triangles.

INTRODUCTION

The interdental papilla is a portion of the gingiva that fills the gingival embrasure, the space between teeth below their contact points. When observed in two dimensions, it appears triangular, and in three dimensions, it takes on a pyramidal shape[1](Figure 1). The papilla narrows toward the interproximal contact area on both the facial and lingual surfaces, while the mesial and distal surfaces are slightly concave. It consists of dense connective tissue, which is covered by oral epithelium. The shape, size, and presence of the interdental papilla are primarily determined by the underlying alveolar bone structure, the position of the tooth contact points, and the alignment of the adjacent teeth[2].The absence of any one of the above factors can lead to an empty space between teeth called a black triangle. Several other factors can also result in black triangles which include [2–6]–

- Periodontal disease,
- Root angulations,
- Triangular-shaped crowns,
- Faulty brushing technique,
- Aging,
- Tooth loss,
- Length of embrasure area

Prevalance
Some studies reported that the preponderance of black triangles was[7–9]–

- >67% of people above 20 years
- <= 18% of people under 20 years

(Figure 1- Black triangles)

Classification of black triangles

Nordland and Tarnow[5] proposed a classification for the loss of interdental papilla based on three reference points: the contact point, the facial apical extent of the cementoenamel junction (CEJ), and the interproximal CEJ. Using these reference points, they defined the following categories:

- **Normal**: The interdental papilla fills the embrasure space up to the apical extent of the interdental contact area.
- **Class I**: The tip of the interdental papilla is positioned between the interdental contact point and the most coronal aspect of the CEJ.
- **Class II**: The tip of the interdental papilla is located at or below the iCEJ but remains coronal to the apical extent of the facial CEJ.
- **Class III**: The tip of the interdental papilla is at or below the level of the facial CEJ.

This classification helps assess the degree of papilla loss in relation to the key anatomic landmarks of the tooth.

Jemt[10] developed a classification system to evaluate the degree of recession and regeneration of papillae adjacent to single implant restorations, based on clinical and photographic examination. A reference line is drawn through the highest gingival curvatures of the crown restoration on the buccal side and the adjacent natural tooth. The following scores are used to assess the papilla:

- **Score 0**: No papilla is present, and there is no visible curvature of the soft tissue contour adjacent to the implant restoration.
- **Score 1**: Less than half of the papilla's height is present, with a convex soft-tissue contour adjacent to the implant and the adjacent tooth.
- **Score 2**: At least half of the papilla's height is present, and the soft-tissue contour is acceptable, matching the contour of the adjacent tooth.
- **Score 3**: The papilla completely fills the proximal space, creating an optimal soft-tissue contour.
- **Score 4**: The papilla is hyperplastic, and the soft-tissue contour appears irregular.
  Cardaropoli[11] proposed a classification system to assess the interproximal papillary level based on the positional relationship between the papilla, the cementoenamel junction (CEJ), and adjacent teeth. The Papilla Presence Index (PPI) is defined as follows:
- **PPI 1**: The papilla is completely present, extending coronally to the contact point, and is at the same level as the adjacent papillae.
- **PPI 2**: The papilla is not fully present and lies apical to the contact point, not at the same level as the adjacent papillae, but the interproximal CEJ remains hidden.
- **PPI 3**: The papilla has moved further apically, revealing the interproximal CEJ.
- **PPI 4**: The papilla lies apical to both the interproximal CEJ and the buccal CEJ.
  This classification, proposed by Cardaropoli, provides a structured method for evaluating the presence and position of the interdental papilla in relation to key anatomical landmarks.

MANAGEMENT AND TREATMENT CONSIDERATIONS

Over the years, various surgical and nonsurgical techniques have been developed to reconstruct or regenerate lost interdental papillae. Nonsurgical approaches focus on modifying the interproximal space, which in turn induces changes in the soft tissues. These techniques are often preferred over surgical options due to their cost-effectiveness, lower patient stress, and the ability to achieve immediate results[12,13].

Restorative approach
Restorative treatment for black triangles can involve adjusting contact points with ceramic veneers or crowns, adding pink porcelain to address papilla loss. Benefits include biocompatibility, color stability, and a non-porous surface, but the technique requires advanced skills[14].

Composite resin can also be used to guide papilla formation in the cervical mesial region, offering color stability and strong bonding to dentin. However, drawbacks include potential bonding issues, discoloration, and fluid seepage at the interface[7].

Orthodontic approach
Orthodontic treatment effectively reduces black triangles by closing interdental spaces and creating contact points between adjacent teeth, often without periodontal intervention. The approach involves aligning the roots, correcting malposed incisors, and mesially moving teeth to bring the cementoenamel junctions closer, relaxing transeptal fibers. Techniques such as interproximal stripping and root parallelism support papilla regeneration, while mesial torquing helps close gaps. Additionally, recontouring enamel and adjusting the contact area apically, along with extrusive or intrusive movements, can maintain bone levels and further reduce black triangles[13].

Prosthodontic approach
A gingival prosthesis is a non-invasive, removable solution for gingival recession and interdental papilla loss, especially when surgical options are contraindicated. It is useful for cases with >5 mm of space between the papilla and contact point, but not recommended for patients with poor periodontal health, compromised hygiene, or high caries risk.Advantages include ease of maintenance, tooth splinting, and cost-effectiveness, while disadvantages include reliance on patient cooperation, food impaction, and bacterial growth affecting color. Materials used include auto and heat-polymerizing resins, copolyamide, and soft silicone[13,15].

Tissue Engineering
Advances in tissue engineering offer less invasive options for addressing black triangles. Gerus et al[16]. conducted a study involving 12 patients (mean age 55) with 38 insufficient papillae, using a surgical approach combined with an injectable regenerative acellular dermal matrix. After five months, significant improvement in papilla restoration was observed. Additionally, the injection of periodontal cells, particularly fibroblasts, has shown promise in treating both oral and skin defects. A randomized, double-blind, placebo-controlled study demonstrated notable papilla regeneration after injecting fibroblasts from the tuberosity[17].

Hyaluronic Acid (HA) Volumizing
Hyaluronic acid (HA), commonly used in facial tissue rejuvenation, has also been applied to treat black triangles in the aesthetic zone[18]. Becker et al[19]. treated 14 black triangles by injecting HA gel 2-3 mm below the papilla tip, with up to three injections at three-week intervals. The results were promising, with no relapse observed even after 25 months, and all patients reported high satisfaction, with the procedure being painless.

Surgical approaches
Periodontal plastic surgery has long been used to address gingival black triangles, but the poor blood supply to the papillae remains a major challenge in reconstruction. Damaged papillae are difficult to repair, making preservation and minimizing trauma crucial during restorative procedures[20]. Kotchy and Lacky have combined papilla preservation flaps with enamel matrix proteins to improve outcomes.

Seibert and Lindhe[21] categorized papillary surgical techniques into releasing, reflecting, and stabilizing the papillae. Over time, various methods, including different flap designs, bone augmentation, and membranes, have been developed. More recently, modified and simplified papilla preservation flaps, combined with enamel matrix proteins and acellular dermal matrix allografts, have shown promising results in enhancing tissue regeneration.

Treating black triangles, gaps and restoring posterior teeth with BioClear Injection Molding Technique
Bioclear was founded in 2007 by Dr. David Clark, a dentist and inventor, with the aim of creating a modern, patient-centered approach to restorative dentistry. The Bioclear Method is an innovative technique for non-invasive anterior and posterior composite restorations, including a groundbreaking approach to closing black triangles.It is cost-effective method for closing gaps, aligning teeth, covering chips, and improving color. It uses clear forms filled with composite material matched to the tooth shade, which is then shaped and smoothed to create a natural, glossy finish. The form sits just below the gum line, promoting a natural emergence of teeth and restoring the papilla, closing black triangles. This procedure, which requires no enamel removal or tooth grinding, is completed in one visit, is stain-resistant, durable, and less expensive than porcelain veneers[22]. (Figure 2)

Figure 2

CONCLUSION

This review focuses on the etiology and management of black triangles (BTs) adjacent to natural teeth. Black triangles are primarily caused by the absence of interdental papillae, which results from various factors, including the position of the alveolar crest and teeth. Orthodontic treatments can both contribute to and help correct the formation of black triangles. The presence of a black triangle can negatively affect dental aesthetics, as well as the health of the gingiva and speech. Early detection of papilla loss, its monitoring by dental professionals, and the implementation of preventive measures are essential components of good clinical practice. Management of black triangles should be considered when planning proximal restorations and may include non-invasive procedures such as tooth recontouring. Emerging treatments, including the use of hyaluronic acid (HA), require further research to establish their efficacy.

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