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BLACK TRIANGLE MANAGEMENT IN ORTHODONTICS USING HYALURONIC ACID: A CASE REPORT

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ABSTRACT

The presence of interdental papillary deficiency, commonly termed a black triangle, is a frequent aesthetic and functional concern encountered during or after orthodontic treatment. Although orthodontic tooth movement aims to improve alignment and occlusion, it may inadvertently lead to loss of interdental papilla, compromising smile aesthetics and patient satisfaction. Black triangles are multifactorial in etiology and are strongly influenced by periodontal status, tooth morphology, root angulation, and the relationship between the contact point and the alveolar bone crest. Traditional management strategies include orthodontic space modification, restorative reshaping, and periodontal surgical reconstruction; however, these approaches may be invasive, irreversible, or associated with patient morbidity. Recently, minimally invasive injectable hyaluronic acid (HA) has emerged as a promising adjunctive modality for the management of black triangles. This article presents a comprehensive review of the etiopathogenesis, diagnosis, and management of black triangles, followed by a detailed clinical case report describing the successful closure of a post-orthodontic black triangle using HA dermal filler. The clinical protocol, measurement technique, postoperative care, and outcomes are discussed in detail. The findings suggest that HA is a safe, effective, and patient- friendly option for mild to moderate interdental papilla deficiencies.

INTRODUCTION

Smile aesthetics is a primary objective of modern orthodontic treatment. Apart from well-aligned teeth, healthy gingival architecture plays a crucial role in determining overall facial and dental aesthetics. One of the most common esthetic challenges following orthodontic treatment is the appearance of black triangles, which are spaces formed due to the absence or loss of interdental papilla. These spaces can negatively impact phonetics, food impaction, periodontal health, and patient confidence.[1,4] A black triangle is defined as an open gingival embrasure resulting from incomplete fill of the interdental space by the interdental papilla. Clinically, it appears as a dark triangular space between adjacent teeth, most commonly observed in the maxillary anterior region.[2,5]

The interdental papilla is a specialized gingival tissue occupying the space between adjacent teeth, extending from the alveolar crest to the contact point. Its presence and stability depend on the distance from the contact point to the alveolar bone crest, tooth morphology, interproximal bone height, periodontal biotype, and tooth position and angulation.[1,6] Tarnow et al. demonstrated that a distance of ≤5 mm between the contact point and the alveolar crest is generally associated with complete papillary fill, whereas distances greater than 5 mm significantly increase the likelihood of papilla loss.[1,5]

Black triangles occur due to a multifactorial interplay of orthodontic, periodontal, anatomical, and iatrogenic factors.[7,14] Orthodontic factors include alignment of crowded teeth leading to relocation of contact points incisally, proclination or retroclination of incisors, root divergence following treatment, and triangular tooth relationships during space closure.[3,7,18] Periodontal factors include reduced alveolar bone height, loss of periodontal attachment, thin gingival biotype, and pre-existing periodontal disease.[1,14] Tooth morphology, particularly triangular-shaped crowns and narrow cervical embrasures, also predisposes to papillary loss.[6] Additionally, age-related changes such as decreased gingival vascularity and reduced regenerative capacity of soft tissues further contribute to this condition.[14]

Black triangles are commonly observed during initial alignment of crowded incisors, after space closure in extraction cases, and following orthodontic treatment in adults with compromised periodontal support,[7,18] Patients most susceptible include adults, those with thin gingival biotype, periodontally compromised individuals, cases with triangular crown morphology, severe anterior crowding, and extraction cases.

Traditional management strategies include orthodontic root parallelism correction and interproximal enamel reduction, restorative approaches such as composite build-ups and veneers, and periodontal surgical techniques including papilla reconstruction and connective tissue grafting.[7,9,23,25] However, these methods may be invasive, irreversible, or associated with unpredictable outcomes. In this context, injectable hyaluronic acid has emerged as a conservative, nonsurgical option for interdental papilla augmentation.[11-13,16]

Hyaluronic acid is a naturally occurring glycosaminoglycan present in connective tissues, gingiva, and periodontal ligament. It exhibits high water-binding capacity, excellent biocompatibility, anti-inflammatory properties, and the ability to promote angiogenesis and wound healing.[15,16] HA provides volumetric augmentation, enhances fibroblast proliferation, improves collagen synthesis, promotes tissue hydration and elasticity, and supports angiogenesis, thereby facilitating papilla regeneration.[11,15,16]

CASE REPORT

A 23 -year-old patient undergoing fixed orthodontic treatment presented with a chief complaint of unaesthetic spacing in the maxillary anterior region. Clinical and radiographic examination revealed generalized horizontal bone loss, consistent with a compromised periodontal phenotype. During the phase of orthodontic space closure, the patient developed a pronounced black triangle between the maxillary central incisors (teeth 11 and 21) and mandibular central and lateral incisor (teeth 32and 33). The interdental papilla showed deficient fill, resulting in an unaesthetic gingival embrasure.

Considering the patient's esthetic concerns and reluctance to undergo surgical intervention, a minimally invasive approach using hyaluronic acid dermal filler was planned. After obtaining informed consent, the site was prepared under strict aseptic conditions. Local anesthesia was administered to ensure patient comfort.

A cross-linked hyaluronic acid dermal filler (Restylane®, Galderma) was used for papillary augmentation. The injection point was selected approximately 2–3 mm apical to the tip of the interdental papilla. A 30-gauge fine-gauge needle was inserted at an angulation of approximately 45° to the long axis of the tooth, with the bevel oriented apically. A volume of 0.1–0.2 mL of the filler with 30-gauge syringe was slowly injected per session using a retrograde technique to ensure uniform distribution within the papillary tissue. Following the injection, gentle digital massage of the papilla was performed for approximately 1 minute using sterile gauze to facilitate even dispersion of the material and to contour the soft tissue optimally. The procedure was repeated at baseline, 3 weeks, and 6 weeks.

Measurement Protocol

The dimension of the black triangle was measured using a UNC-15 periodontal probe (GDC, India). Measurements were recorded from the tip of the interdental papilla to the contact point of the associated teeth. All readings were taken by the same examiner.

Postoperative Instructions

The patient was advised to refrain from mechanical cleaning of the treated area on the day of the procedure. From the following day, gentle brushing with a soft-bristled toothbrush was permitted. The use of interdental cleaning aids was avoided for a period of 2 weeks.

RESULTS

At baseline, the black triangle between teeth 11 and 21 measured 1 mm and between 32 and 33 measured 2 mm. Progressive improvement in papillary fill was observed at the 3-week and 6- week follow-up visits. At the 6 weeks evaluation, complete closure of the gingival embrasure was achieved, with the measurement reducing from 2 mm and 1 mm at baseline to 0 mm. The interdental papilla exhibited a healthy contour and stable volume without signs of inflammation, necrosis, or relapse. The patient reported high satisfaction with the esthetic outcome.

Coss-linked hyaluronic acid dermal filler (Restylane®, Galderma)

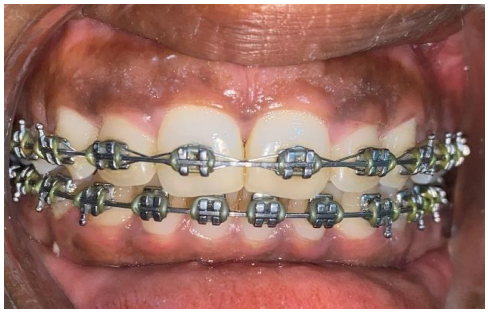
30-gauge syringe

UNC 15 probe (GDC)

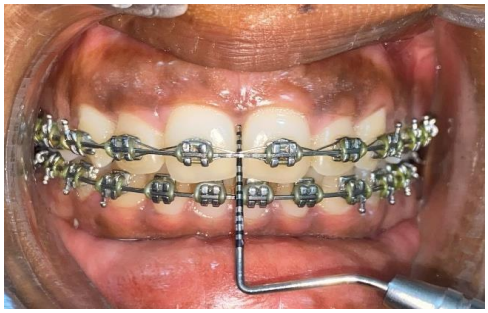
Black triangle site 1 between 11 and 21

Baseline

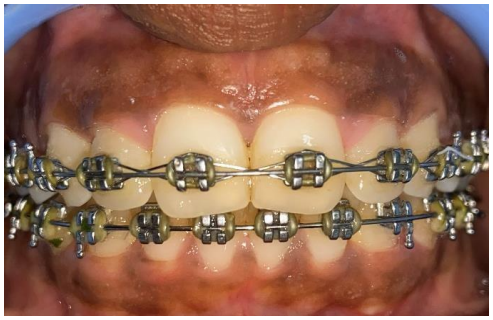
Baseline measurements



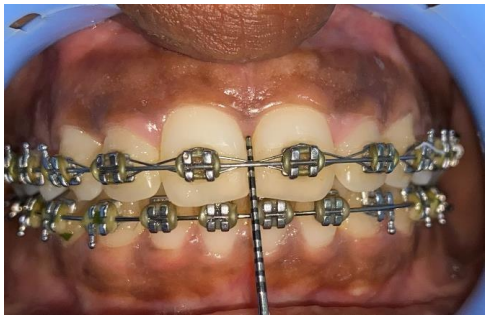
3 weeks



3 weeks measurements

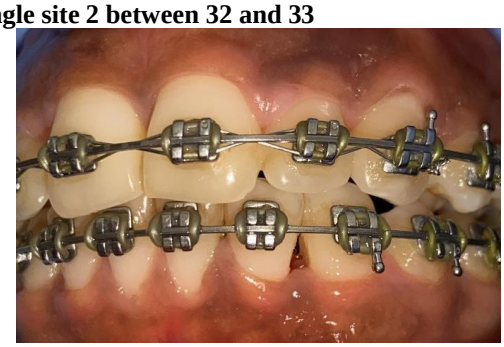


6 weeks

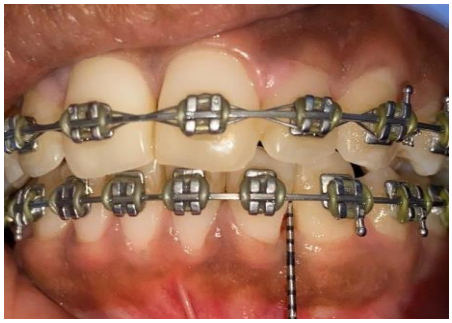


6 weeks measurement

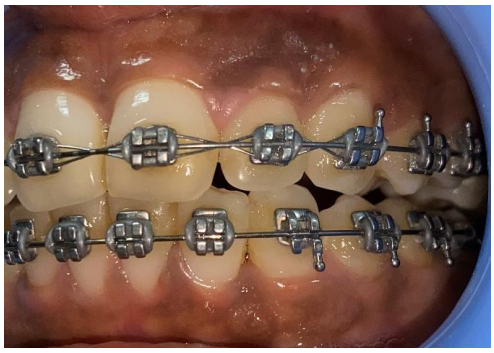
Black traingle site 2 between 32 and 33



Baseline

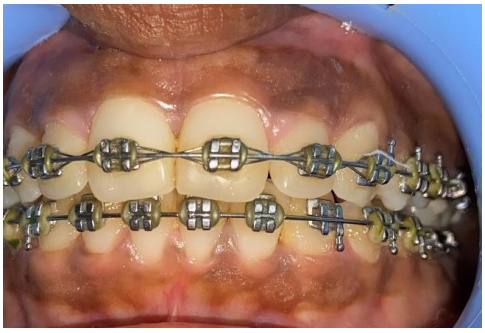


Baseline measurement

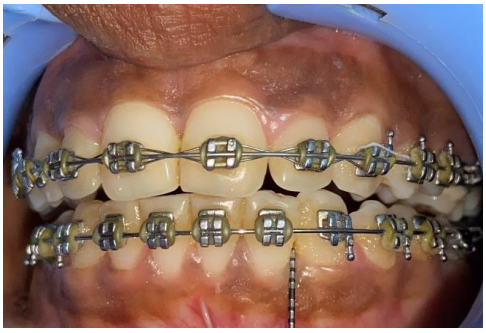


3 weeks

3 weeks measurements



6 weeks



6 weeks measurement

DISCUSSION

Black triangle formation following orthodontic treatment is a common esthetic concern, particularly in adult patients and those with compromised periodontal support. Its occurrence is multifactorial and is strongly associated with changes in contact point position, root angulation, alveolar bone height, and gingival biotype. During orthodontic alignment, irregular and broad contact areas are converted into smaller, more incisally positioned point contacts, which increases the vertical distance between the contact point and the alveolar crest. When this distance exceeds 5 mm, the predictability of complete papillary fill decreases significantly, leading to the appearance of open gingival embrasures.[1,5] In the present case, generalized bone loss further increased this critical distance, predisposing the patient to papillary deficiency despite adequate orthodontic alignment.

Periodontal status plays a decisive role in determining the presence and stability of the interdental papilla. Tarnow et al.[1] demonstrated that papilla presence is highly dependent on the contact point–bone crest relationship, with a sharp decline in papillary fill as this distance increases beyond 6–7 mm. In patients with reduced alveolar bone support, spontaneous papillary regeneration is biologically limited. This explains why orthodontic correction alone may not be sufficient to restore interdental esthetics in periodontally compromised individuals, thereby necessitating adjunctive soft tissue augmentation procedures.

Traditional surgical papilla reconstruction techniques, although effective in selected cases, are invasive, technique-sensitive, and associated with variable outcomes.[23] Furthermore, surgical approaches may not be ideal for patients with reduced bone height or those unwilling to undergo surgical intervention. Hyaluronic acid (HA) has recently gained attention as a minimally invasive alternative due to its volumizing properties and biological effects, including enhanced fibroblast proliferation, angiogenesis, and extracellular matrix remodeling.[15,16] These properties make HA particularly suitable for the management of mild to moderate papillary deficiencies, as observed in the present case.

The clinical success of HA therapy is highly dependent on the injection technique. In this case, the filler was deposited 2–3 mm apical to the papillary tip, with the needle oriented at a 45° angle to the long axis of the tooth and the bevel directed apically. This approach allows placement of the filler within the connective tissue core of the papilla, minimizing superficial ischemia and promoting uniform tissue expansion. Gentle digital massage following injection further facilitated the redistribution of the material, optimizing the soft tissue contour. The staged injection protocol at baseline, 3 weeks, and 6 weeks was adopted to allow progressive tissue adaptation and minimize the risk of overcorrection.[11-13]

Objective measurement of papillary gain is essential for evaluating treatment outcomes. In this case, the distance from the papilla tip to the contact point was measured using a UNC-15 probe, which is a reliable and reproducible method used in previous clinical studies.[11,13] The reduction of the black triangle from 1 mm at baseline to complete closure at 6 weeks indicates a favorable soft tissue response. These findings are consistent with existing literature, where HA injections have demonstrated significant improvement in papillary

fill and high patient satisfaction.[11,12,21]

Despite its advantages, HA therapy has certain limitations. The effects may be temporary due to gradual biodegradation, necessitating maintenance injections. Moreover, HA is less effective in cases with severe bone loss, large embrasure spaces, or advanced periodontal destruction.[12] Therefore, careful patient selection is crucial. From an orthodontic perspective, early identification of risk factors such as triangular tooth morphology, thin biotype, and reduced bone height can aid in preventive planning. The integration of minimally invasive soft tissue augmentation procedures like HA injections into orthodontic finishing protocols may significantly enhance post-treatment esthetics and patient satisfaction.

Factor	Mechanism	Clinical Impact	Reference
Incisor proclination/retroclination	Change in axial inclination	Contact point displacement	Kokich
Triangular crown morphology	Narrow cervical width	Poor papilla support	Chang
Thin gingival biotype	Low collagen & vascularity	High recession risk	Awartani & Tatakis
Factor	**Mechanism**	**Clinical Impact**	**Reference**
Incisal shift of contact point	Alignment moves contact point incisally	Papilla loss due to ↑ CP–bone distance	Tarnow et al.
Root divergence	Poor torque control or finishing	Widened cervical embrasure	Kurth & Kokich
Space closure mechanics	Tipping during sliding mechanics	Triangular embrasure	Rasperini et al.
Factor	**Mechanism**	**Clinical Impact**	**Reference**
Reduced alveolar bone height	Loss of osseous scaffold	Papilla absent if >5 mm	Tarnow et al.
Adult orthodontic patients	Reduced regenerative capacity	Higher prevalence	Kurth & Kokich
Iatrogenic factors	Excessive IPR, poor finishing	Worsening embrasure	Blatz et al.

CONCLUSION

Black triangle formation is a common esthetic challenge in orthodontics, particularly among adult patients with compromised periodontal support. Understanding its etiology, risk factors, and prevention is essential for comprehensive orthodontic care. Hyaluronic acid offers a promising, minimally invasive solution for managing mild to moderate interdental papilla deficiencies, with high patient acceptance and minimal morbidity.[11-13,21] Further long-term studies are required to evaluate the stability of outcomes.

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