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Research Paper

Multidisciplinary Consideration for Managing Gingival Black Triangles in Aesthetic Dentistry: A Review

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Abstract
The importance of aesthetics in modern dentistry is paramount. Aesthetics has its different values and perceptions, which may be different from the eyes of the patient and those of the clinician [1]. It is dependent on the socio-economic status and the upbringing and mentality of each individual person. Open gingival embrasures or black triangle cause complex functional and aesthetic problems. Management of such problems requires careful evaluation of the underlying causes. In today's aesthetic environment where both the dentist and the patient are aware of aesthetic value, the real challenge was to reconstruct this lost papilla and moreover to obtain stable and sustainable results. asure area, root angulations, interproximal contact position, triangular-shaped crowns and aging. Treatment of black triangles often requires an interdisciplinary approach, involving of periodontal; orthodontic and restorative treatment. In this review, the authors highlighted the important etiological factors that predispose to the occurrence of the black triangles. In addition to the common biological factors, dimensional changes of papilla during orthodontic alignment, the relevant consequences of periodontal disease treatment and iatrogenic treatment mishaps such as poor veneers and crowns are factors have also been discussed as factors that may lead to black triangles.

Keywords: *Aesthetic; black triangles and interproximal contact areas*

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I. INTRODUCTION

The word aesthetic comes from the Greek word 'aisthētikos'. At the time, it was defined as 'relating to perception by the senses'. This early form of the word was a combination of the Greek words 'aisthēta' meaning 'perceptible things', and 'aisthesthai' meaning 'perceive'. In our modern competitive society, a pleasing appearance often means the difference between success and failure in both our personal and professional lives. There is globalization and modernization in the growing population in the world. Men and women are very conscious about their appearance. The current generation gives utmost importance to their esthetics in every aspect to improve their personality.[1,2,3]

Black triangle can be defined as "Any interproximal soft tissue loss due to periodontal disease, traumatic, mechanical or chemical preparation or crown lengthening procedures"- G.P.T-8.

Open gingival embrasures "black triangles" are defined as the embrasures cervical to the interproximal contact that is not filled by gingival tissues.[2]

Fig. 1: Black Triangles in incisors

The interdental papilla is the part of the gingiva that fills the embrasure space between the contact points of adjacent teeth. It is supported by the underlying alveolar bone and laterally by the borders of the teeth [1,4]. It is comprised of masticatory mucosa and is composed of a dense connective tissue covered by oral epithelium [5[]. The shape of the interdental papilla is influenced by the contact points between adjacent teeth, the width of the interproximal tooth surfaces and the course of the cemento-enamel junction (CEJ). The interdental papilla is pyramidal in shape at the anterior teeth. In posterior regions, there are two papillae joined by a concave saddle region called a 'col' [1[]. The col can be either para-keratinised or non-keratinised [6]. Fig. 1

The papillary height decreases from the anterior to the posterior teeth due to the interproximal contact area being most coronal between the central incisors and becoming progressively more apical along the arch. In contrast, the width of the col increases from the anterior to the posterior regions. The presence of the interdental papilla contributes to the scalloped shape of the gingival margin.[7]

The interdental papilla can be lost due to interproximal bone loss due to periodontitis. The treatment for periodontitis can also lead to formation of black triangles. Both non-surgical therapy and surgical therapy to treat periodontitis, especially pocket elimination or resective surgery, will lead to reduction of loss of the interdental papilla. Episodes of necrotising periodontal disease can also lead to the formation of black triangles.[1-7]

Iatrogenic damage such as over-contoured restorations and tissue damage from crown preparations can lead to the loss of interdental papilla. It can also be self-inflicted by the patient through traumatic brushing or overzealous use of interdental aids, pen chewing and piercings.[8]

Tooth-related factors that can cause loss of the interdental papilla are as follows: loss of the contact point, tooth malposition, abnormal tooth shape, triangular-shaped crowns, diastemas, divergent roots and over-eruption of a tooth.[2,8]

Orthodontic treatment can lead to loss of the interdental papilla. The prevalence of black triangle formation postorthodontic treatment is reported to be 38% in adult patients [9].

A systematic review by Rashid et al. [10] aimed to assess the incidence of black triangles post-orthodontic therapy. Five studies were included and the incidence of black triangles following orthodontics was found to range from 38 to 58%. The authors reported that risk factors associated with the formation of black triangles were age, tooth-related factors, length of treatment and patient factors.

One third of adults have unaesthetic black triangles [4]. Other studies found that black triangles were found in 67% of the population over 20 years of age compared with 18% in the population under 20 years of age [5].

A recent study of patient attitudes found patient dissatisfaction with black triangles to rank quite high among aesthetic defects, ranking third following carious lesions and dark crown margins [6]. There are many problem associated with black triangle like;

I. It causes unesthetic profile of a person.

II. I Increased interdental space may lead to food accumulation.

Class I	Class II	Class III
		
The tip of the papilla is between the interdental cementoenamel junction (CEJ) and the contact point	The tip of the papilla is between the buccal CEJ and the interdental CEJ	The tip of the papilla is apical to the buccal CEJ

Fig.2; Interpapillary loss classification based on Nordland and Tarnow

Nordland and Tarnow [11]classified the loss of papilla height into 4 classes based on three anatomical landmarks: interdental contact point, facial apical extent of CEJ and the interproximal coronal extent of the CEJ (fig.2). They are:

Normal: Interdental papilla fills the gingival embrasure to the apical extent of the interdental contact point/ area.

Class I : The tip of the interdental papilla is located between the contact point and the most coronal extent of the interproximal cemento-enamel junction (CEJ).

Class II: The crest of the papilla is at or apical to the interproximal CEJ but coronal to the facial CEJ.

Class III: Crest of the papilla is at or apical to the facial CEJ.

In 2004, Cardaropoli [12]devised a newer classification of the interdental papilla height called the 'Papilla presence index' (PPI) with a scoring system from one to four. The classification is as follows:

'Score 1: Papilla is completely present

Score 2: Papilla is no longer completely present but the interdental CEJ is not visible

Score 3: Papilla is no longer completely present and the interdental CEJ is visible

Score 4: Papilla is no longer completely present. Both the buccal and interdental CEJ are visible'. Fig. 3

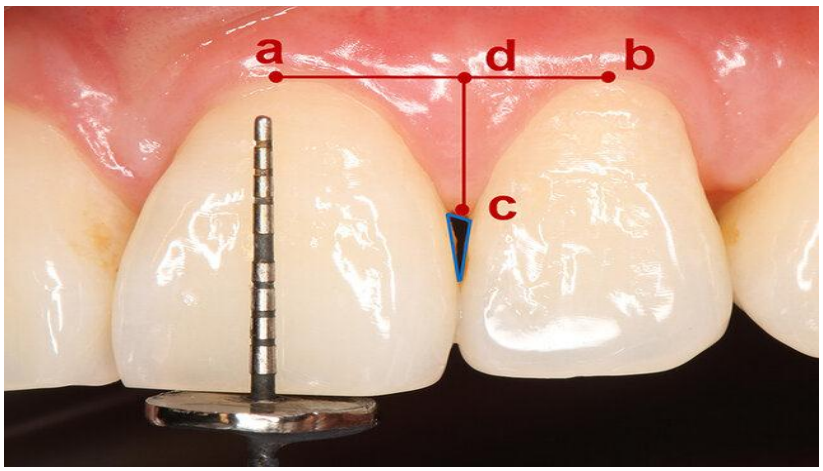

Figure. 3; Description of the methodology used to measure the papilla height and papilla triangle areas. Line ab represents the line connecting the highest point of the adjacent teeth's crowns with the gingival papilla defect. Point c represents the top of the deficient gingival papilla. Line cd is vertical to line ab. cd represents the papilla height, and the papilla triangle area is marked with a blue line.

Its management varies depending on the etiological factor but is favourably managed by teamwork usually including restorative, orthodontic and periodontic treatment. Sometimes, the correction of these problems is not straightforward and may increase both the complexity and duration of treatment. [1,2,5, 13] Sometimes, the decision to close the embrasures or not is difficult especially when the open embrasures are small .[14,15]

The causes of Black triangles are multifactorial and they can occur after various dental therapies. A strong connection is found between their occurrence and post-orthodontic treatment patients. [26,17,18]Various

methods to treat these problems are present. The clinician and the patient should discuss these problems and solutions in depth before starting the treatment.

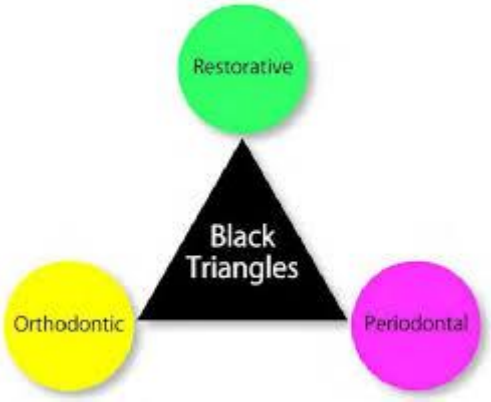

Figure.4;Interdisciplinary approach to overcome the black triangle

In this review, the authors highlighted the important etiological factors that predispose to the occurrence of the black triangles. In addition to the common biological factors, dimensional changes of papilla during orthodontic alignment, the relevant consequences of periodontal disease treatment and iatrogenic treatment mishaps such as poor veneers and crowns are factors have also been discussed as factors that may lead to black triangles. Fig. 4

Management of cases of black triangle

A. 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. [19]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.[20]

Figure.5;Pre-op and post-op photos of the mandibular incisors.

Porcelain veneers are considered an excellent choice to eliminate or reduce the black triangle. Nevertheless, care must be taken when planning for anterior crowns or veneers in order to avoid black triangles occurrence. This complication can be avoided by proper planning and preoperative periapical X-rays to carefully assess the level of the alveolar crest bone. The interproximal contact area can be extended apically to compensate for some bone resorption, and the contact area should be placed at a point within 5.0 mm of the crestal bone as stated by Tarnow .[21] Fig. 5

In a complete denture wearer, knowledge of the ideal papilla location for optimal aesthetics originated from classic literature on prosthetic tooth selection and arrangement. Frush and Fisher [24] attempted to establish guidelines for proper papilla form to enhance denture aesthetics. They described the ideal papilla position and shape in relation to the interproximal contact location and morphology; it was thought that the papilla could enhance a youthful appearance as a complimentary factor in age interpretation.[24]

Orthodontic Approach

Root angulation of the maxillary central incisors is related to open gingival embrasures. Mean root angulation in normal gingival embrasures converges at 3.65°. When mesial crown form, alveolar bone–interproximal contact, and interproximal contact–incisal edge variables are constant, a 1° increase in root divergence increased the odds of an open gingival embrasure by 14% to 21%. [24]Orthodontic treatment can be performed to converge maxillary incisor roots to reduce or eliminate open gingival embrasures.**[21,22]**

The bracket slots must be perpendicular to the long axis of the tooth and not parallel to the incisal edges during bracket placement, especially in adults with grinded incisal edges. It is important to evaluate the panoramic radiography prior to bracket placement.[23] If brackets are placed based on incisal edges, greater root divergence may cause an open gingival embrasure. Bonding brackets with slots perpendicular to the long axis of the teeth will allow roots to converge, and may require the incisal edges to be restored or contoured. As roots become more parallel, the contact point will be larger and move apically toward the papilla, thus reducing black triangles. The cervical portion of the crowns of each incisor will move closer, relaxing the papilla.[23,24,25]

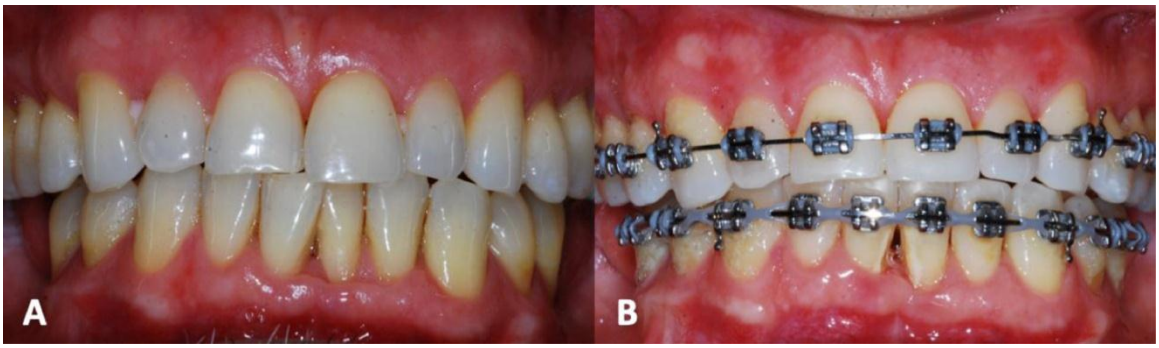

Figure.6;Black triangles: Preventing their occurrence, managing them when prevention

Clinicians also should expect a moderate number of adult patients to have divergent crown shape, making them more susceptible to black triangles .[24] The triangular crown shape results in a more incisally interproximal contact, increasing the roots distance, the length of embrasure area and the distance from the crest of the alveolar bone to the interproximal contact point. Accurate diagnosis of divergent crown shape is essential so that the appropriate contact stripping may be performed.[23,25] This reduction of interproximal enamel (IPR) with the use of diamond strip or discs, is one effective alternative to reduce the length of black triangles. Typically, 0.5 to 0.75 mm of enamel is removed with IPR. [24] Orthodontic closure of the space should be attained with a bodily movement of the two adjacent teeth, keeping the right root angulation. It will increase the interproximal contact point length with its consequent cervical move, decreasing the distance from the crest of the alveolar bone.[23,25,26] Fig. 6

Figure 7. Pre-op and post-op photos of the maxillary incisors.

Pre-existing anterior crowding seems to be related to the presence of black triangles after orthodontic treatment. Even with no direct association, Burke et al. [25] affirmed that a black triangle is a frequent sequela of aligning crowded maxillary central incisors .[1,2]
And because of that, it is very important to inform patients that they may be predisposed to have a black triangle following the incisors level and alignment. Very strong correlation between lower incisor extraction and black triangle appearance was found. [3,5,26] Because of the greater exposure of the lower incisors in adult patients duringthe speech and smile, the black triangles have a very negative repercussion on dental esthetics for layperson. [27,28] Fig. 7

-Black Triangles and Periodontal Diseases
Tarnow's study [29] has become a standard in calculation of crestal bone to contact area distance when predicting the stable papilla height. His study, based on 288 patients, showed that when the contact point was within 5.0 mm of the crestal bone, the papilla was present in 100% of samples. However, when the distance was 7.0 mm, the papilla was present in only 27% of samples .[29] Moreover, pocket depths greater than 3 mm will lead to increased plaque retention, inflammation, and possibly gingival recession [7]. Wu YJ also found that a distance of 5, 6, and 7 mm resulted in an open embrasure in 2, 44, and 73% of the cases respectively [30]. These observations indicates that papilla was present in almost 100% of the cases if the distance from the alveolar crest to the contact point was 5 mm or less. When the distance was more than 7 mm, most patients had an open gingival embrasure. Another study by Zetuhas reported similar results [31,32].
For those with periodontal diseases, it is the bone loss that increases the distance between the contact points and alveolar crest and eventually creates open gingival embrasures. Tarnow's 5.0 mm rule might be skewed in a favorable or unfavorable direction because there are many factors that determine the presence of black triangles such as the root angulations, teeth shape, occlusion and previous trauma. **Figure.8**

Figure.8; Pre-op and post-op photos of his closed smile.

For square-shaped teeth with wide contact points, the chances of 'black triangles' is minimal compared with triangular teeth having narrow, more incisally positioned contact points.[33] Furthermore, the degree of interproximal fill is also dependent on the periodontal biotype. A thick periodontal biotype encourages interdental fill, while a thinner tissue type creates unaesthetic hollow gingival embrasures [33,34]. Interdental width seems to be critical in papilla presence. An increased interdental space results in wide papillae base that may be helpful in increasing blood supply to the papilla tip. However, too wide of an interdental distance can be detrimental, stretching and blunting the tip of the papillae and increasing the likelihood of the black triangle

[35]. An extreme form of this is the absolute loss of papilla in periodontal disease that has been associated with loss of the interdental papilla because of alveolar bone loss. Chronic periodontitis and tooth brush trauma are other factors that may cause open embrasures. If interproximal tooth brushing is causing gingival recession, and loss of interdental papilla, it should be discontinued until the tissue recover [36,37]. Plaque accumulation and gingivitis are probably higher in people with crowding, but host susceptibility and other factors may also play a contributory role in the occurrence of open gingival embrasures, especially in patients who have been previously treated for periodontal disease [11,37]. Such patients need to increase their efforts to enhance periodontal maintenance and oral hygiene to avoid further bone loss and recession. The interdental papilla is a small fragile area with minor blood supply which seems to be the major limiting factor in all surgical reconstructive and augmentation techniques [1,35]. Most surgical techniques published involve gingival grafting, but show only limited success because of insufficient blood supply **Figure.9** [10,11,35,36]. However, some case studies have reported some degree of success with the combination of sub-epithelial connective tissue grafts and orthodontic therapy [13,14]. A large number of techniques have been proposed to reconstruct the interdental tissues including a pedicle flap [15,29,]; semilunar coronally repositioned flap [16,17,37]; envelop type flap [18,38]; autogenous osseous and connective tissue grafts [19,39] and microsurgery. However, pedicle flaps have provided better results than free gingival grafts as reported by WuYJ. [10,35,39,40]

-Black triangle and implant

Close attention to both soft tissues and hard tissues around teeth and implants before, during, and after restorative procedures will greatly increase the probability of successful outcomes .[41,42,43] The presence of the dental papilla is critical in achieving esthetic single tooth dental implant restoration. [42,44,45] 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 presenceor absence of the papilla. These criteria are based on studies involved natural teeth and implant restorations .[42,43,46,47]

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. [48,49] Therefore, 7mm of mesiodistal space must be created between the adjacent teeth .[43,50,51] After the appropriate amount of coronal spacehas been determined, it is necessary to evaluate the inter-radicular spacing. The minimum interradicular distance required isgenerally 5-7 mm for a single implant placement.[52,53] **Figure.10**

Figure.10;Pre-operative photograph of the teeth-Frontal view and Post-operative photograph of the teeth with Laminate thickness and color shades

Grunder [44] reported an excellent papilla results for single tooth implant restoration even when the distance from contact point to the implant bone was 9mm, whereas, Tarnow et al [11]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 [41,54,55] crestal bone loss was evaluatedin relation to horizontal interimplant distance. In this study it was reported that increased crestal bone loss would occur if the inter-implant distance was less than 3mm. Their findings lacked statistical analysis that examined significance at an acceptable level of confidence. [42,42]In another study by Mark et al [45]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. [46,56] They also found that there was no difference between delayed or immediate provisionalization and papilla scores.[57,58[

n cases where two implants are placed adjacent to each other, open gingival embrasures are more pronounced .[42]Selective utilization of implant with a smaller diameter at the implantabutment interface may be beneficial when multiple implants are to be placed in th esthetic zone so that a minimum of 3mm of bone can be retained between them at the implant-abutment level .[41,59] **Figure.11**

Figure.11;. Pre-op and post-op photos of the patient's right side buccal retracted view.

-Restorative Treatment

Natural interproximal embrasures are constructed with a wide range of cervical shapes and varying root proximities. The gingival usually adapts to a wide range of teeth cervical area shapes. Clinicians can create convenient interproximal shapes if the restorations are smooth and without sharp marginal edge. Composite, porcelain laminate veneers ;pink auto-cure and heat cured acrylics, resins and thermoplastic acrylics, as well as silicone-based soft materials [21,22] are all treatment modalities for closure of open gingival embrasure space. Composite and porcelain laminate resin can be extended into the gingival sulcus, however, care must be taken not to impinge on the interdental tissue or violate the biological width .[22]

Composite can be placed in close proximity to gingival sulcus as a template for the formation of an interdental papilla8. The benefitsof composite is that it has many colors that are stable and wear resistant; the recently introduced dental bonding agents permits the bonding of composites to dentine.[46,47] The demerits are that there may bechange in color, fluid percolationvia the dental interface and composite.Kimand Cho closed diastema using direct composite resin andmodified Mylar strip technique. [48,49] **Figure.12**

Figure 12. Four sectional matrices (Bioclear DC-203 matrices) are placed incisogingivally after the contact areas were lightened and gently abraded. Low magnification, postoperative view. The cord has been removed.

Clark presented a feature case of management of open gingival spaces that includes restorative treatment followed by papilla regeneration .[13] He used flowable composite resin rather than composite paste for the first increment since paste composite would be nearly impossible to place in such "claustrophobic" area without voids and without disturbing the anatomically shaped matrices(. In an attempt to reduce the interproximal space and improve esthetics and phonetics Barzilay [23]used two types of removable prosthesis; Molloplast B soft lining material and clear acrylic facing .However, this type of prosthesis suffers from few limitations. Retention may be difficult, and because of the inherent porosity of the silicone-based material, staining and plaque accumulation may be a problem. Therefore, it would be better if it is made of heat-curd acrylic resin .Retention can be further enhanced by providing implant supported prosthesis when space is available. **Figure.12** .

Resin composite restoration is a minimally invasive and less costlytreatmentoptionrelativetoa fixedoption.Composite restoration has a long-term survival rate and aesthetic benefit with the advantage of a straight forward maintenance visit such as minor repair or polishing of a chipped composite. [50,51] These failures are less catastrophic relative to the indirect fixed option. A composite restoration, however, will require regular maintenance mostly due to chipping and discoloration.[52,60]

The drawback of this technique was that any incorrect resin composition can result in wear, fracture and limited success rate.Another method is ceramic veneer or crown. Adding pink ceramic to the restoration can handle the presence of interdental papilla deficiency.[53] The benefits of thistechnique are biological compatibility of the material, stable color and non-porous surface, hampering better accumulation of local factors than composite resins. The demerits are technique sensitive and difficult to fix 10.[53,54,60] **Figure.13**

Figure. 13.The Bioclear Smile design gauge is placed intraorally at a 45% angle and locked behind the maxillary canines or maxillary first bicuspids. In this case, the left central incisor is significantly wider.

The patient in ►Fig. 2A complained of black triangle in between teeth 12, 11, and 21 post-orthodontic treatment. Thegingivaishealthy,thereisnobleedingonprobing,andno pocketing can be seen. The treatment of choice is a direct compositelaminateveneer restorationfora minimallyinvasive approach to the treatment.

Restoring the teeth will in variably change the width of the tooth. To create the visuals of an ideal teeth proportion, an optical illusion has to be applied by manipulating light reflection. This can be done by increasing the width of the labial embrasure to reduce shadow while maintaining the width of the flat are a that reflects light. [55,56]When restoring the anterior teeth, the use of a nanohybrid composite is suggested, which has a superior light reflectivity for aesthetics.15 It was also noted that the contact point for this case is situated at the incisal one-third of the tooth. Tarnow etal stated that when the distance between the contact point and the interproximal oss eouscrestis 5mm,there will bea complete fill of interdental soft tissue.16 The opposite happens when the distance is more than 5mm; there is 50% chance of loss of the interdental papilla with every 1mm. With that in mind, the contact point will need to be positioned at the cervical one-third to close the black triangle.[55,56] **Figure.12, Figure.13**

The position of the contact point Is mostly done arbitrarily by a clinician, but it can also be determined with the bone sounding technique.This technique was done by locating the bone crest using a k-file inserted in the anesthetized midpapilla area between teeth 11 and 21.14 This will eventually identify the 5-mm distance required in between the interproximal osseous crest and the start of the contact point position and also avoid the violation of thebiological width. The tooth shape will change from triangular to square, reducing the distance from the contact point to the interproximal osseous crest and produce a longer area of the contact point (►Fig. 2B).

-Prosthetic approach

Porcelain veneers are considered an excellent choice to eliminate or reduce the black triangle. Nevertheless, care must be taken when planning for anterior crowns or veneers in order to avoid black triangles occurrence.

This complication can be avoided by proper planning and preoperative periapical X-rays to carefully assess the level of the alveolar crest bone. [61,61] The interproximal contact area can be extended apically to compensate for some bone resorption, and the contact area should be placed at a point within 5.0 mm of the crestal bone as stated by Tarnow .[21]

In a complete denture wearer, knowledge of the ideal papilla location for optimal aesthetics originated from classic literature on prosthetic tooth selection and arrangement. Frush and Fisher [24,63] attempted to establish guidelines for proper papilla form to enhance denture aesthetics. They described the ideal papilla position and shape in relation to the interproximal contact location and morphology; it was thought that the papilla could enhance a youthful appearance as a complimentary factor in age interpretation.[24,61,63]

Gingival prosthesis can be used to treat interdental papillary defeciency. Removable acrylic or silicone can be utilised as a gingival veneer to mass lost gingival tissues and is indicated in interdental defect with a space in between the contact point and alveolar crest>5 mm and in patients who cannot afford to undergo consecutive surgical procedures.[61, Contraindications are patients with compromised periodontal health, poor oral hygiene, patients who are at risk of caries. Materials that can be used are: Auto and heat polymerizing acrylic resin, rigid, flexible material, copolyamide, soft silicone material[64,65]

Figure.14;**Gingival Veneer**

Gingival prostheses (Gingival veneer) may be used to replace tissues lost due to periodontal diseases, surgical gingival procedures, trauma, ridge resorption or traumatic tooth extraction all of which can result in open inter dental spaces, elongated clinical crowns, phonetic problems as well as unanticipated expectoration during speech.[2,61] A gingival veneer is defined as a prosthesis worn in the labial aspect of the dental arch, which aims to restore the mucogingival contour and esthetics in areas where periodontal tissues are deficient.[3] Gingival veneers were first introduced in 1955 by Emslie and were used to mask the unesthetic appearance of gingival recession in a patient who underwent a gingivectomy.[4] L'Estrange et al. in year 1970 reported on a number of patients that had worn gingival veneers for over 3 years.[5] Porcelains, pink auto cure and heat-cured acrylics, composite resins and thermoplastic acrylics, as well as silicone-based soft materials are being used to make gingival veneers.[62,63] **Figure.14**

Chronic Periodontal disease results in the loss of the bone and supporting tissues. Leading to gingival recession, reduce keratinized tissue height, mobility of the teeth. Unfortunately the successful treatment of chronic periodontitis not only will often lead to gingival recession as a result of shrinkage of flap after healing but also lead to an unaesthetic end result. There are various predictable methods to cover gingival recession, but only in situation of Miller class I and II cases, complete root coverage is possible.[63] To overcome these problems second surgical procedure is time consuming and cause surgical trauma to the patient.[61,62] In our case series, patients with moderate to severe periodontitis were treated with periodontal flap surgical procedure and there was increase in post operative recession and black triangles leading to millers class III and IV recession, where there is no predictable surgical method for correcting esthetic deformities. The only way to improve the esthetics is to try and mask the tissue loss especially in generalized recession situation[62]. The gingival veneer is a viable treatment option for restoring anterior esthetics in clinical situations where there are esthetic concerns caused by significant gingival recession and black triangles. Case selection is an important factor for predictable and successful outcome.[8,63]

Hyaluronic acid

The ultimate goal of periodontal therapy is to arrest the progress of periodontal disease and regenerate the lost periodontal support.[1,7,64] Hyaluronic acid (HA) is a high molecular weight, nonsulphated glycosaminoglycan component which is produced during various phases of cell's life cycle. HA forms a major and critical component of connective tissue. It contributes in tissue hydrodynamics, cell migration, and proliferation, and improves healing properties of the tissue.[2] It acts as barrier to various gram negative bacteria.[3] Its physiological, structural, and biochemical properties prove that it provides elasticity and stability to tissues and is critically beneficial in tissue regeneration.[4,65] **Figure.15**

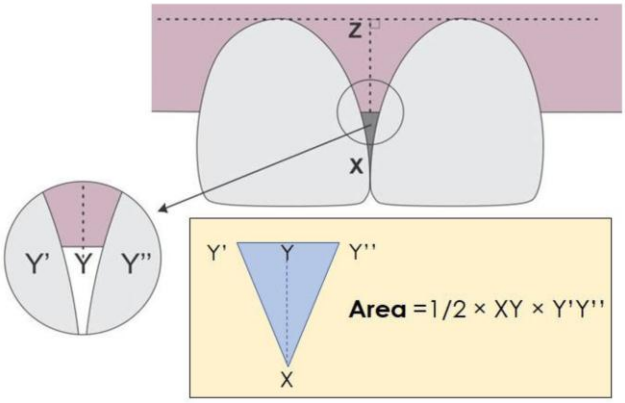

Figure. 15; Schematic representation of the reference points. Point X = Interdental Contact Point; Point Y = Crest of the Interdental Papilla; Point Z = Point perpendicular to the imaginary line joining the facial CEJ of adjacent teeth; Y'Y" = Papillary Width; XY = Papillary Deficient Height; YZ = Papillary Height; XZ = Expected Papillary Heigh

Pharmacologically, the content of HA in the tissues is often broken down by the blood stream or by lymphatic drainage and its turnover rate is found to be 20–30%. After being broken down, it reaches the blood stream and is removed by the liver. Excretion is in very minute quantities in the urine 2–10%. Its plasma half‐life is 2–3 days depending upon how it is eliminated.[3] HA is also known as hyaluronan or hyaluronate.[5] HA was discovered in 1934 from cow's eye by Karl Meyer and John Plamer and was first used in 1942 by Endre Balazs as a substitute for egg white in b akery products. [65,66]The chemical structure of HA shows alternate units of N‐acetyl glucosamine and D‐glucorounic acid, both of the components linked through glycosidic bonds. Its nonimmunogenic nature increases its use in clinical applications. It is a highly biocompatible polysaccharide molecule with anti‐edematous and bacteriostatic properties. HA acts as an antioxidant by scavenging reactive oxygen species, which helps in the regulation of immune response implying its anti‐inflammatory properties.[6,67] **Figure.15**

Figure.16; Hyaluronic acid gel injection. The asterisk indicates the treated papilla. (**A**) Interdental papillary loss at baseline. (**B**) Application of HA. (**C**) Follow up at 3 weeks. (**D**) Follow up at 12 weeks.

HA has also reported as a diagnostic biomarker of inflammation in gingival crevicular fluid and repair of tissues. Recently, HA has been added as a local chemotherapeutic agent to tissues. It is available in various forms.[11] Low molecular weight HA shows angiogenesis whereas high molecular weight is opposite to it.[12,67,68] **Figure.16**

Recent investigations have indicated that HA induces mineralization of dental pulp cells through CD44 cell surface glycoprotein and is considered to be a principle ligand for receptor CD44.[13]

Hyaluronic acid was found to have extensive actions in various periodontal therapies such as topically applied in subgingival regions reduces microbial activity, bone regeneration in deep periodontal bony defects, guided bone regeneration, nonsurgical treatment of peri‑implantitis pockets, peri‑implant maintenance of immediately placed implants, and gingival augmentation in mucogingival surgery. HA may act as a scaffold for other molecules such as Bone morphogenic protien‑2 and platelet derived growth factor‑BB, used in guided bone regeneration techniques and tissue engineering research.[14] HA when applied to patients with chronic periodontitis showed reduction in bleeding on probing (BOP), probing pocket depth (PPD), and clinical attachment level, and hence, can be used as an adjunct to scaling and root planning.[15,68,69]

HA is biocompatible and intrinsically safe to use, with no evidence of cytoto,71,72,73xicity. HA gel, injections, or oral (by mouth) should not be used in patients with allergies.[70]

B.Surgical approach

Surgical approach Several surgical techniques have been used over the years to reconstruct the lost interdental papilla.[61,62] The interdental papilla is a small area with limited blood supply which acts as a major limiting factor in its reconstruction. [63]Surgical techniques can be classified under the following three major treatment modalities: **Figure.17**

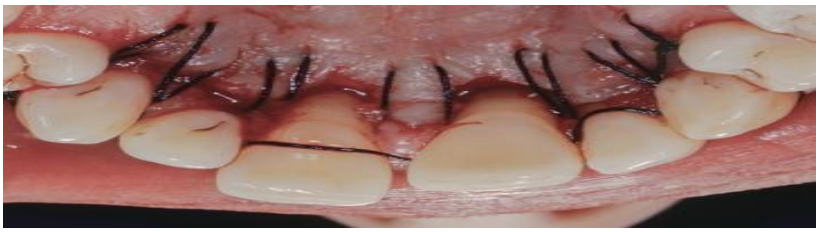

Figure.17;The palatal flap is sutured to the intact proximal and buccal mucosal surfaces using horizontal or vertical mattress sutures to ensure good attachment of the flap to the bone

-Papilla recontouring

Excess gingival tissue should be removed in the presence of gingival enlargement to remodel the soft-tissue architecture. A gingivectomy is performed in cases of drug-induced or idiopathic gingival enlargement. In cases of localized gingival lesions, such as peripheral giant cell granuloma, a gingivectomy associated with a free gingival graft might be indicated .[61,63]

-Papilla preservation

In an attempt to recreate and preserve the interdental papilla, various soft-tissue surgical procedures have been introduced. These include the following:

-Papilla preservation flap

In this technique,[16] the lingual or palatal flap design consists of a sulcular incision along the lingual or palatal aspect of each tooth with a semilunar incision made across each interdental papilla. Trim the tip of the papilla in posterior areas with narrow interdental space to preserve the intact papilla through the embrasure space.[61,62]

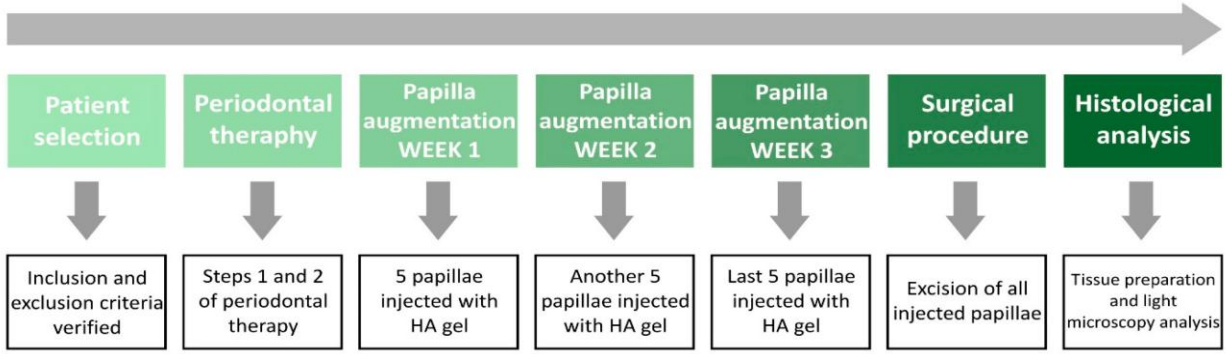

Figure.18; Time diagram.

-Modified papilla preservation flap

Papilla preservation technique was modified to achieve and maintain primary closure of the flap in the interdental space over the guided-tissue regeneration membrane. A buccal and interproximal intrasulcular primary incision to the alveolar crest, involving the two teeth neighboring the defect, was performed. In the buccal gingiva at the base of the papilla, just coronal to the bone crest, a horizontal incision with a slight internal bevel was made, and the papilla was elevated toward the palatal crest.[19,63] **Figure.18**

-Simplified papilla preservation flap

This technique is indicated in narrow interdental space (<2 mm) in anterior and posterior regions. An oblique incision is made across the associated papilla to reach the mid-interproximal portion of the papilla under the contact point of the adjacent tooth, beginning at the gingival margin at the buccal line angle of the involved tooth. This oblique interdental incision is continued intrasulcularly in the buccal aspect of the tooth neighboring the defect.[20,61,62]

-Cortellini and Tonetti

Using a microsurgical approach improved the results even more. Surgeries were performed with the aid of an operating microscope at a magnification of × 4–16 and with microsurgical instruments. The benefit includes improved surgical field illumination, access, and magnification.[37,63]

0Papilla reconstruction

After the elimination of inflammation, specific techniques have been proposed to reconstruct the interdental tissues. Pedicle flap This technique[38] basically combined the roll technique[39,61] and papilla preservation technique.[15,61,62] In correspondence to lost interproximal papilla, a palatal split-thickness flap is dissected and labially elevated. To form the new papilla between the two incisors, the flap is folded on itself and sutured.[63]

- Semilunar coronally repositioned flap

This approach[40,41,62] is based on a flap design previously reported by Tarnow.[42] They recommended placing the semilunar incision in the interdental region in their modification for papilla reconstruction. Intrasulcular incisions are also made around the mesial and distal half of two adjacent teeth to free the connective tissue from the root surfaces to allow the coronal displacement of gingivopapillary unit. To maintain position, the measured amount of the subepithelial connective tissue obtained from the palate is stuffed further into the semilunar incision and into the pouch-like space coronal to the incision.[61,62] **Figure.18**

-Envelope‑type flap

At the level of the CEJ, an intrasulcular and buccal incision is made across the interdental papilla to be reconstructed. An envelope-type split-thickness flap is elevated buccally and palatally. The buccal portion of the flap is dissected well beyond the mucogingival line, leaving the periosteum and a thin layer of connective tissue on the bone. The palatal portion of the flap, which is also split thickness, includes the interdental papilla. In the recipient site, a connective tissue graft of appropriate size and shape was placed beneath the flap.[43,62,63]

-Autogenous osseous and connective tissue grafts

This technique involves an intrasulcular incision made around the neck of the lateral and central incisors on the buccal and palatal aspects, retaining as much gingiva as possible. To elevate a split-thickness flap, a horizontal incision is made beginning at the mucogingival junction, extending into the alveolar mucosa, and ending apically at the labial vestibular fold.[64] The entire gingivopapillary unit is displaced coronally. Reshape the maxillary tuberosity osseous graft to form a saddle that will fit over the interdental crest and be stabilized with a titanium screw. Crushed cancellous bone is packed around the grafted bone in the shape of reconstructed interdental bone. To cover the entire augmented area, a large connective tissue graft harvested from the palate is placed on the top of the bone graft.[44,61]

-Microsurgery

The microsurgical technique for interdental papilla augmentation was described in three case reports.[45] The surgery is performed without the use of releasing incisions, which increases the chances of donor tissue survival while minimizing tissue trauma, excessive bleeding, scarring, and pain. As the vascular supply remains intact, donor tissue survival is optimized.[61-64]

II. CONCLUSION

Open gingival embrasures resulting into black triangles often pose complex functional and esthetic problems. Management of open embrasures requires careful evaluation of the underlying causes. A multidisciplinary approach is critical. A multidisciplinary approach must be considered mandatory if a successful clinical outcome is to be achieved. All the etiological factors and treatment alternative must be discussed with the patient before starting the treatment.

COMPETING INTERESTS
Authors have declared that no competing interests exist.

- **CONTRIBUTION OF AUTHORS**

Research concept- Dr. Abdulgani Azz.
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Materials- Dr. Abdulgani Azz., **- Dr.** Abu-Hussein M.
Data collection-Dr. Abdulgani M. ,
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