

## SMALL TISSUE WITH BIG ISSUE

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(Received on Date: 7<sup>th</sup> May 2017

Date of Acceptance: 17<sup>th</sup> July 2017)

### ABSTRACT

Increase in the demand of cosmetics by the patients put emphasis on gingival esthetics and loss of interdental papilla poses for aesthetic, phonetic and functional problems of patients with periodontal disease. The interproximal tissue reconstruction has been reported in literature through both surgical procedures restorative and orthodontic treatment.

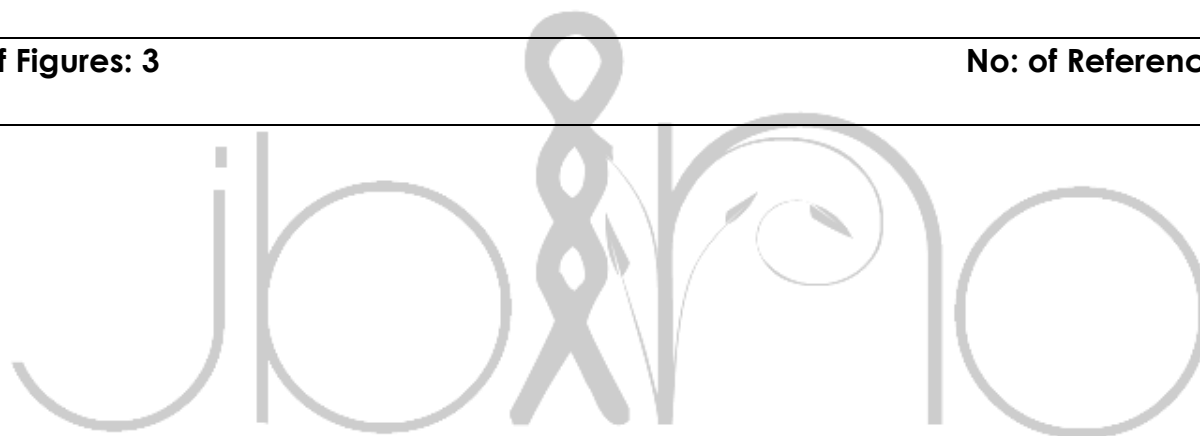
**Keywords:** interdentalpapila, esthetics.

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**No:of Figures: 3**

**No: of References: 28**

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## INTRODUCTION

The inter-dental papilla plays a protective role on the adjacent periodontium, including the alveolar bone crest, acting as a biological barrier against external invaders and preventing food impaction. Loss of interdental papilla could result from periodontal disease, osseous surgery, traumatic tooth extraction and increase in gingival embrasure because of root divergence and can lead to cosmetic deformities and phonetic problems. Papillary regeneration aims to fill the black spaces that occur in interproximal surfaces, one of the most complex cosmetic procedures to be performed among periodontal surgeries. The black spaces are not aesthetic and contribute for food retention as well as they may affect the periodontium health.<sup>1</sup> A correct diagnosis should be performed for either the success or improvement of the treatment of papilla loss, as their etiological factors must be eliminated before considering therapies for reconstruction. It is very important to respect the papillary integrity during the dental procedures and minimize its disappearance. The interproximal papilla first described by Cohen in 1959<sup>2</sup> is the gingival portion, which occupies the space between two adjacent teeth or adequate clinical restorations supported by natural teeth and implants or pontic designs. The interproximal papilla, playing a critical role for esthetics and phonetics, may accordingly appear in different constellations.

### Papillary Anatomy and Morphology

The interdental space is the physical space present between two adjacent teeth, and its shape and volume are determined by the morphology of the teeth. The interdental papilla represents the gingival tissue that fills this space and is formed by dense connective tissue covered by oral epithelium and may be influenced by the height of the alveolar bone, distance between the teeth and interdental contact point.<sup>3</sup> In the area of the incisors, the interdental papilla is narrow and has a pyramidal shape with its tip just below the point of contact. In the posterior region, it is wider and with a ridge shaped concave area so-called the col. This crest, which determines the position and extent of the contact point of the adjacent teeth, is nonkeratinized or parakeratinized and covered with stratified squamous epithelium. The most perceptible papilla, is present in the upper central incisors region, and its absence causes major esthetic problems. It is therefore more difficult to be reconstructed. According to Fradeani,<sup>4</sup> the distance between the roots is another factor that can influence the presence or absence of interdental papilla. The author stated that the a inter-radicular distance smaller than 0.3 mm jeopardizes the presence of the proximal bone and, therefore, it is usually accompanied by the lack of interdental papilla. *The gingival black space has been defined as a distance from the cervical black space to the interproximal contact.*

### Etiology of Papillary Absence

The etiology of the papilla absence is multifactorial. (Figure 1)

### Factors Influencing the Presence of Papilla

Number of factors influencing presence or absence of papilla is as follows.

#### Availability of Underlying Osseous Support

the term "positive architecture" which refers to the osseous crest follows the shape of the cemento-enamel junctions, and the position of the interproximal bone is more coronal than the radicular bone described by Ochsenbein<sup>5</sup>. The authors emphasized the concept that a more pronounced gingival scallop had a higher level of the interdental bone when compared with a flatter gingival scallop. According to Tarnow<sup>6</sup> when the distance from the contact point to the alveolar bone was less or equal to 5 mm, the papilla was present in 98% of the times, while at 6 mm it dropped to 56% and at 7 mm it was only present 27% of the times. Wu et al.<sup>7</sup> demonstrated that the distance of 5, 6 and 7 mm resulted in a gingival black space of 2.44% and 73% of the cases, respectively. An increase of 1 mm in the distance between the alveolar bone and the interproximal contact increases the probability of a gingival black space from 78% to 97%. As a rule, the distance between 5 and 6 mm is the most critical and it determines the presence or lack of space in the gingival embrasure.<sup>8</sup>

**Periodontal Biotype<sup>9</sup>** The morphologies of interdental papilla and the osseous architecture can be categorized into thin and thick periodontal biotype. The

thin periodontal biotype are friable, escalating the risk of recession following crown preparation and periodontal or implant surgery. Thick biotype is fibrotic and resilient, making it resistant to surgical procedures with a tendency for pocket formation. Thick biotype is better than thin biotype. Romeo et al.<sup>10</sup> showed that the thick biotype was significantly correlated with the presence of the interproximal papilla. In a study, periimplant biotype was significantly associated with the level of facial marginal mucosa. Sites with a thin tissue biotype should be regarded as having a greater risk for mucosal recession when compared with thick sites.

**Periodontal Bioforms<sup>11</sup>** Periodontal bioforms are categorized into three basic gingival scallop morphologies, high, normal and flat. With a shallow scallop, the interproximal bone is thin, and the interproximal gingival contour nearly parallel to the underlying bone contour. With a pronounced or high scallop, the interproximal bone is wider, but the disparity between the bone contour and the FGM is problematic for favorable esthetics.

**Tooth Morphology<sup>12</sup>** The primary tooth forms circular, square or triangular, direct the degree of gingival scallop. The triangular teeth form a pronounced scallop and predisposes to the so-called "black triangles" especially, with a thin biotype. Triangular teeth have divergent roots with thick interproximal bone, which results in reduced vertical bone loss as compared to square teeth. However, square teeth have better interproximal papilla maintenance due to a small

interproximal distance from the osseous crest to the contact point.

**Contact Points** The contact points of the maxillary teeth are relevant for ensuring optimal “pink esthetics” for patients with a high smile line. The iconic study by Tarnow *et al.*<sup>6</sup> who produced the “5 mm rule,” states that when the distance from the contact point to the interproximal osseous crest is 5 mm or less, there is complete fill of the gingival embrasures with an interdental papilla. For every 1 mm above 5 mm, the chance of complete fill is progressively reduced by 50%. 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.

**Brushing Trauma** the brushing trauma can also cause gingival black spaces. If the loss of papilla height is caused by trauma during brushing, the aggressive cleaning of the interproximal tissue should be interrupted so that the tissue could be recovered.

**Age** The presence of gingival black spaces can also be related to age. The studies of Ko-Kimura *et al.*<sup>13</sup> showed that patients over 20 years-old are more likely to have gingival black space than those under 20 years-old. Gingival spaces were found in 67% of the population over 20 years-old; in the population under 20 years-old, the percentage reached 18%. This is because of the thinning of the oral epithelium, decreasing of the keratinization and a reduction in the height of the papilla as the result of age.

## Classification of Interdental Papilla Loss

**Nordland and Tarnow<sup>14</sup>(1998)** proposed a classification based on three anatomic points: the interdental contact point, the most coronal point of the cementum enamel junction (CEJ) at the interproximal surface and the most apical point of the CEJ at the labial surface. (Figure 2)

Four classes were identified

**Normal** the interdental papilla fills the niche up to the apical extension of the interdental contact point.

**Class I** The tip of the interdental papilla is placed between the interdental contact point and the most coronal point of the CEJ at the interproximal surface.

**Class II** The tip of the papilla is placed between the most coronal point of the CEJ at the interproximal surface and the most apical point of CEJ at the labial surface.

**Class III** The tip of the interdental papilla is at the CEJ or it is apically to the most apical point of CEJ at the labial surface.

## Classification for loss of interdental papilla around implants

**Jemt<sup>15</sup>(1997)** presented an index to clinically evaluate the degree of recession and regeneration of papillae adjacent to single implant restorations through a clinical and photographic examination. The assessment was measured from a reference line through the highest gingival curvatures of the

crown restoration on the buccal side and the adjacent permanent tooth. (Figure 3)

**Score 0** No papilla is present, and no curvature of the soft-tissue contour adjacent to single implant restoration.

**Score 1** Less than half of the height of the papilla is present. A convex curvature of the soft-tissue contour adjacent to single implant crown and the adjacent tooth is observed.

**Score 2** At least half of the height of papilla is present. Acceptable soft-tissue contour is in harmony with adjacent teeth.

**Score 3** The papilla fills up the entire proximal space. There is optimal soft-tissue contour.

**Score 4** The papilla is hyperplastic. The soft-tissue contour is more or less irregular.

**Cardaropoli<sup>16</sup>** Proposed a classification based on the positional relationship among the papilla, CEJ, and adjacent teeth to assess interproximal papillary level.

**Papilla Presence Index score-1 (PPI 1)** When the papilla is completely present and coronally extends to the contact point and at the same level as the adjacent papillae.

**PPI 2** Papilla is no longer completely present and lies apical to the contact point and not at the same level as the adjacent papillae, but the iCEJ is still not visible.

**PPI 3** Papilla is moved more apical and the iCEJ becomes visible.

**PPI 4:** Papilla lies apical to both the iCEJ and buccal CEJ.

### Reconstruction of Lost Interdental Papilla

Various methods may be used in an attempt to achieve the reconstruction of interdental papilla, including manipulating soft tissue, increasing of the hard tissue and the restorative and orthodontic treatment.

### Non-Surgical Techniques

**Correction of Traumatic Oral Hygiene Procedure** Diffuse erythema and denudation of attached gingiva throughout the mouth may be striking sequelae of overzealous brushing. Improper use of dental floss may damage the interdental papilla. Traumatic interproximal hygiene procedures must be initially discontinued and successively modified. Reepithelialization of the traumatic lesion can restore the papilla completely.

### Restorative/Prosthetic Restorations

Abnormal tooth shape may contribute to a "missing" papilla, and an appropriate restorative technique is indicated to favor the creeping of the interdental tissues. In case of incisors with an incisal edge much wider than the cervical third, the contact point is located coronally. In this situation, the cervical pyramid of the interdental space is increased and the papilla does not fill the space completely. By a restorative/prosthetic reshaping of the contours of the teeth, the contact point

may be lengthened and located more apically; the embrasure is reduced, allowing coronal displacement of the interdental gingiva.

**Orthodontic Approach** Orthodontic closure of the interdental space should be attained with a bodily movement of the two adjacent teeth. The focus of this approach is to reduce the diastema and create a contact point between the adjacent teeth, without periodontal attempts to build up the missing papilla. The proper closure of the diastema causes some degree of coronal "creeping" of the interproximal gingival tissue. Ingber<sup>17</sup> described coronal movement of tooth through application of a gentle and continuous force using orthodontic appliances. The effects are alterations within the supporting structures, causing changes in bone level and the soft tissue contours and thereby creating new papillae.

**Repeated Curettage of the Papilla<sup>18</sup>** Repeated curettage every 15 days for 3 months to recreate papillae destroyed by necrotizing gingivitis, induce a proliferative hyperplastic inflammatory reaction of the papilla. About 9 months after initial treatment, regeneration of interdental papillae was observed. Some papillae showed complete regeneration, while others did not respond to the periodic curettage.

### **Surgical Techniques**

Several surgical techniques have been described to prevent and/or solve the esthetic impairments due to loss of the interdental papilla, especially in young

patients. The interdental papilla is a small area with minor blood supply.

Surgical approaches included following three treatment modalities.

1. Papilla re-contouring.
2. Papilla preservation.
3. Papilla reconstruction.

### **Papilla Re-Countouring**

In the presence of gingival enlargement, the excess tissue should be eliminated to remodel the soft tissue architecture. In cases of drug-induced and idiopathic gingival enlargement, a gingivectomy may be performed. Gingivectomy associated with a free gingival graft may be indicated in case of localized gingival lesions, such as peripheral giant cell granuloma.

### **Papilla Preservation**

Specific surgical approaches have been reported to prevent or reduce an excessive apical displacement of the gingival margin in the treatment of periodontal defects. Restricting flap elevation can minimize the amount of bone resorption, thus, helping in preservation of interdental papilla. Various soft-tissue surgical procedures have been introduced in an attempt to recreate and preserve the interdental papilla.

**Papilla Preservation Flap** In this technique the facial surface is prepared with sulcular incision around each tooth with no incision being made through the interdental papilla. 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 the each interdental papilla. This can be elevated intact with the facial flap. In posterior areas with a narrow interdental space, trim-off the tip of the papilla in order to preserve the intact papilla through the embrasure space.

**Modified Papilla Preservation Flap<sup>19</sup>**

Technique was a variation of the papilla preservation technique. This was modified to achieve and maintain primary closure of the flap in the interdental space over the GTR membrane. A buccal and interproximal intrasulcular primary incision to the alveolar crest, involving the two teeth neighboring the defect, was performed. A horizontal incision with a slight internal bevel was given in the buccal gingiva at the base of the papilla, just coronal to the bone crest, and the papilla was elevated towards the palatal aspect.

**Simplified Papilla Preservation Flap<sup>20</sup>**

Technique is indicated in narrow interdental space (less than 2 mm) in anterior and posterior region. This approach includes a first oblique incision across the associated papilla, starting from the gingival margin at the buccal-line angle of the involved tooth to reach the mid-interproximal portion of the papilla under the contact point of the adjacent tooth. This oblique interdental incision is continued intrasulcularly in the buccal aspect of the teeth neighboring the defect.

**Cortellini and Tonetti<sup>21</sup>**

Further improved the results by using microsurgical approach. Surgeries were performed with the aid of an operating microscope at a magnification of ×4-16. Microsurgical instruments and blades were utilized for the procedure. The advantage includes improved illumination, access and magnification of the surgical field.

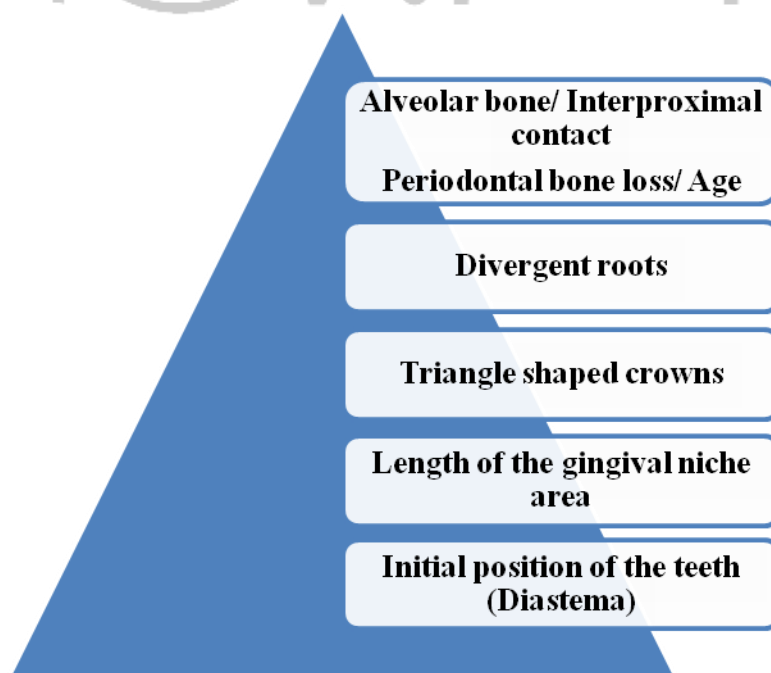


Fig 1: Etiology pyramid of the gingival black space

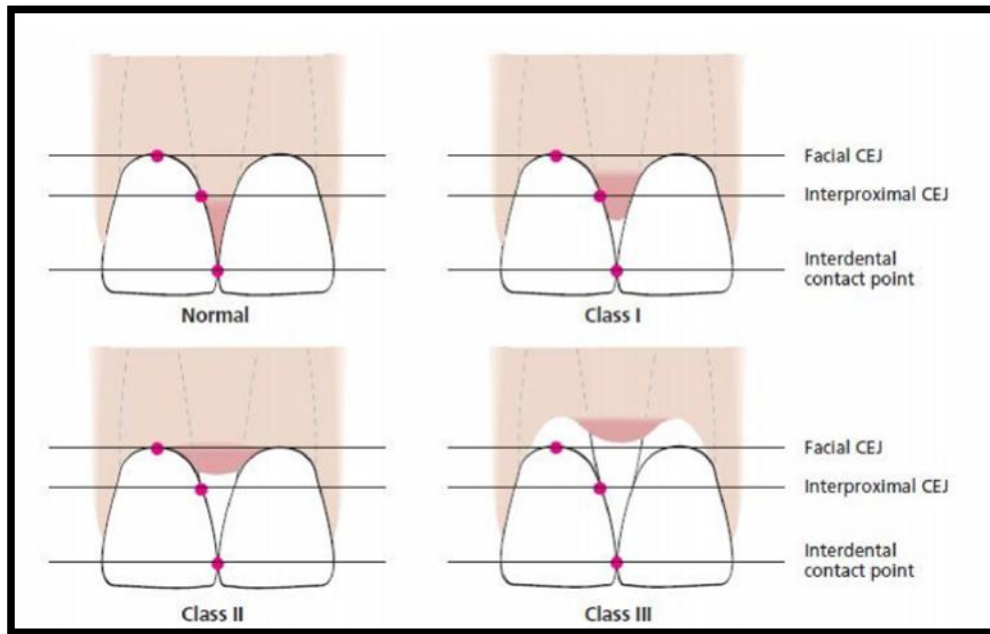


Fig 2: Schematic drawing illustrating the classification system for papilla height (Nordland & Tarnow 1998)

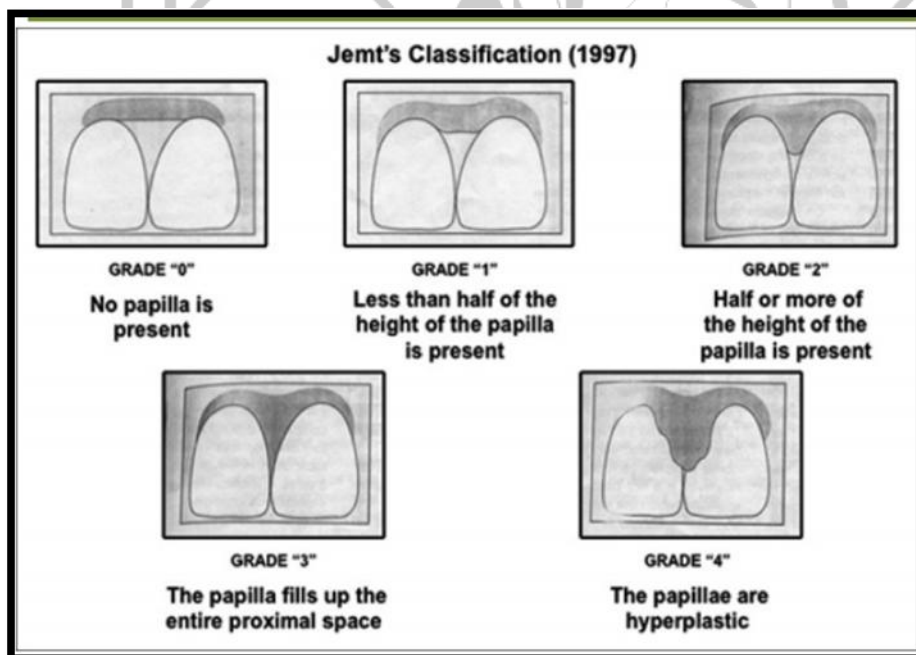


Fig 3: Schematic drawing illustrating the classification system to assess the degree of recession and regeneration of the papillary contour around single implant restorations (Jemt 1997)



## Papilla Reconstruction

After elimination of the inflammation, specific techniques have been proposed to reconstruct the interdental tissues.

**Pedicle Flap**<sup>22</sup> this technique combines the roll technique and papilla preservation technique. In correspondence to the lost inter proximal papilla, a palatal split-thickness flap is dissected and labially elevated. The flap is folded on itself and sutured to create the new papilla between the two incisors.

**Semilunar Coronally Repositioned Flap Approach**<sup>23</sup> based on a flap design as described previously by Tarnow. In their modification for papilla reconstruction, they recommended placing the semilunar incision in the interdental region. Intrasulcular incisions are also made around the mesial and distal half of the two adjacent teeth to free the connective tissue from the root surfaces to allow the coronal displacement of gingivo-papillary unit. To maintain position, the measured amount of the sub epithelial connective tissue obtained from the palate is packed into the semilunar incision and into the pouch like space coronal to the incision.

**Envelop Type Flap**<sup>24</sup> An intrasulcular and buccal incision is made across the interdental papilla to be reconstructed, at the level of CEJ. An envelope type split thickness flap is elevated buccally and palatally. The buccal portion of flap is dissected well beyond the muco gingival line, leaving the periosteum and a thin layer of connective tissue on the bone. The palatal portion of flap, is also split

thickness, includes the interdental papilla. A connective tissue graft of adequate size and shape was placed under the flaps in recipient site.

**Autogenous Osseous and Connective Tissue Grafts**<sup>25</sup> Technique involves an intrasulcular incision is made around the neck of the lateral and central incisors on the buccal and palatal aspects, retaining as much gingiva as possible. A horizontal incision starting at the muco gingival junction, extending into the alveolar mucosa and apically up to the labial vestibular fold, is performed to elevate a split-thickness flap. The entire gingivo-papillary unit is displaced coronally. Reshape the osseous graft obtained from the maxillary tuberosity to form a saddle that will fit over the interdental crest and stabilized with a titanium screw. Crushed cancellous bone is packed around the grafted bone in the shape of the reconstructed interdental bone. A large connective tissue graft harvested from the palate is placed on top of the bone graft to cover the entire augmented area.

## Loss of Inter proximal Papilla in the Treatment with Dental Implants

Peri-implant soft tissue recession is a major aesthetic complication, especially in the anterior maxilla. Preservation of the available hard and soft tissue structure is far more important than reconstructing. The aesthetic quality of the implant restoration mainly depends on the morphology of the edentulous crest and the accompanying bone volume. Ridge preservation is a predictable method to maintain the ridge height, width and

position. Socket augmentation has been developed for a traumatic extraction of tooth and the space is maintained by means of a bone graft with or without a membrane. These modern techniques focus on rebuilding the alveolar ridge while maintaining the soft-tissue surroundings. Implant placement at an alveolar ridge with a reduced crestal height would result in a more apical location of the implant platform and a more apical level of the mucosal margin. Keeping inter proximal bone crest intact is critical for the stability of both inter proximal papilla and facial mucosa. Fu et al 2011<sup>26</sup> proposed a management triad to help clinicians better understand the significance of soft tissue on implant aesthetics. The PDP triad management suggests the use of implant design with parallel walls and platform switching, the use of implants with smaller diameter with its position more palatal and apical in the anterior maxilla, and the concave prosthesis design. This preserves the buccal bone thickness, allows growth of soft tissue around the abutment level, increasing the soft tissue thickness and minimizing the potential of recession of the peri-implant mucosa. Raes et al, in 2011<sup>27</sup> suggest that flapless surgery can also prevent periimplant recessions, when performing immediate implants, as long as the patients have thick biotype.

Single implants have a significant chance of creating black triangle due to the increase of the distance from the contact point to the alveolar crest. To preserve the papilla in the implant, it is important to keep the distance from the point of contact to the bone level of 5 mm or less.

The distance from the adjacent natural tooth to the alveolar crest is more critical than that from the height of the contact point of the implant to the bone.<sup>28</sup> Black spaces are even more pronounced when two adjacent implants are placed. This inadequacy in the soft tissue of 1 to 2 mm arises from the biological space around the implant abutment apically to the abutment platform. In Ideal conditions maxillary anterior implants should be at 4 mm apically to the alveolar bone crest. To prevent bone loss and papilla loss, it is important to consider that the distance between the two implants is of 3 mm which allows that the interproximal bone be held above the implant platform. In the anterior region, it is difficult to obtain this ideal mesial-distal distance. There are several considerations that do not allow the papilla regeneration, but they help in preventing the inter proximal bone loss and in the aesthetic achievement.

**Conclusion:** The etiology of the gingival black space is multifactorial and it is important to diagnose properly the etiologic factor for establishing an appropriate treatment planning.

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