

Photobiomodulation Therapy in the Management of 'Black Triangles' Due to the Absence of Gingival Interdental Papilla

Marwan El Mobadder¹, Samir Nammour¹

1. Department of Dental Sciences, Faculty of Medicine, University of Liege, Liege, BEL

Corresponding author: Marwan El Mobadder, marwan.mobader@gmail.com

Abstract

The absence of interdental papilla, termed "black triangle," presents a challenge in aesthetic restorations. Photobiomodulation (PBM) therapy is the non-thermal therapeutic use of light in order to positively modulate biological activity, has shown promise in tissue regeneration, wound healing, and inflammation reduction. This case report introduces a modified PBM protocol known as "hemolasertherapy" aimed at regenerating gingival interdental papilla to fill the black triangle. In this case report, a 34-year-old female with an unaesthetic black triangle between maxillary central incisors presented for a treatment. Before surgical intervention, our suggested protocol was proposed and explained, detailing potential risks and outcomes. After proper scaling root planning, a suggested protocol with PBM was made. PBM application with a 635 nm wavelength diode laser at four points around the area between the two maxillary central incisors was made: coronal third and apical third of the papilla, mesial and distal of the papilla. Then, bleeding was provoked with a curette inside the sulcus between 11 and 21 (concerned area) by applying pressure on the junctional epithelium and the supracrestal connective tissue. After few seconds, blood spontaneously filled the "black triangle" coronal to the interdental papilla and was left undisturbed. At this point, PBM was applied again on the same four points already described. The irradiation parameters during all PBM treatments were: contact mode and continuous mode, 635 nm wavelength, spot size of 8 mm, power of 50 mW, irradiation time on each point of 50 seconds, energy density of 4.976 J/cm². After intervention, the patient was prohibited from smoking, using mouthwash, drinking or brushing for 2 hours. The exact same procedure was repeated 5 and 10 days after the first intervention. Follow-up was made for 3 months after intervention. The assessment indicated a minor increase in papilla height, which was not enough for a complete closure of the "black triangle". However, there was a reduction in the appearance of the black triangle. This case report suggests that photobiomodulation if used within our suggested protocol can increase the height of the gingival interdental papilla leading to a more pleasant aesthetic appearance. It is important to note that its effectiveness might be limited to specific conditions. In summary, the presented case report showcased a slight extension of the gingival interdental papilla. Further studies are essential to validate these observations.

Categories: Dentistry

Keywords: periodontal regeneration, diode laser therapy, laser treatment, low level laser therapy, photobiomodulation, photobiomodulation therapy, papilla regeneration, gingival recession

Introduction

In contemporary restorative dentistry, the primary aim is to attain aesthetic harmony in what are considered crucial zones—referred to as "white" and "pink" esthetics. "White esthetics" refers to the natural dentition or the repair of dental hard tissues using appropriate materials. On the other hand, "pink esthetics" refers to the neighboring soft tissues, such as the interdental papilla and gingiva, which play a pivotal role in either elevating or detracting from the overall aesthetic outcome [1,2]. In this context, the presence or absence of interdental papilla in the aesthetic zone either between implants or teeth gained attention in past years. In fact, the partial or total absence of interdental papilla is now considered somehow a failure of the treatment in terms of aesthetics from both the patient and operator's point of view. This has led to an increase demand for more approaches aimed at improving the aspect of interdental papilla especially in the aesthetic zone [1].

The partial or complete absence of the gingival interdental papilla can be due to multiple factors [2,3]. These etiologies includes, dimensional changes in the interdental papilla during teeth alignment, gingival recession, periodontitis, destruction of the alveolar bone, the shape of the crowns and the positioning of the inter-proximal contact point [2,3]. A classic study by Tarnow et al. [1] concluded that when the distance between two contact points is 5 mm or less, the papilla between the respective teeth fills the space interdentally around hundred percent of the time. However, if the distance is above six millimeters, the interdental space is filled in around fifty-five percent of the time. At seven millimeters, the concerned space is totally filled only around twenty-five percent of the time [1].

As for the management of the absent and/or partial absence of the interdental papilla, different approaches

were described in literature [3-5]. One such widely described option is the surgical reconstruction of the missing interdental papilla [6]. For instance, sub-epithelial connective tissue graft with coronally advanced flap proved to be a relatively successful approach for different type of papilla loss [7,8]. Nonetheless, the surgical interventions requires strict conditions such as the presence of sufficient blood supply to the grafted tissue to avoid small and confined scaffolds that might often hinders the success rates of the surgical procedures. Additionally, these procedures requires surgeons with skills and expertise in periodontal plastic surgery [7,8].

Photobiomodulation therapy (PBMT) previously known as low level laser therapy is the non-thermal therapeutic utilization of light within red and near-infrared wavelengths to modulate biological activity [9-11]. In two thousands and seventeen, North American Association of Laser Therapy (NAALT) and World Association of Laser Therapy (WALT) collectively established the nomenclature of PBM as the application of light in non-thermal mode for therapeutic purposes [12,13]. Recent advancements in technical, clinical, and photo-biological comprehension have propelled the rapid evolution of PBM [9-14]. For instance, numerous studies currently demonstrate the significant impact of PBM in reducing inflammation, alleviating pain, preventing fibrosis, stimulating the healing of the wound and the regeneration of the tissues [11]. Despite the abundance of evidence supporting the therapeutic modifications induced by PBM in biological functions, the exact biological mechanisms underlying its effects remain incompletely understood [11]. These mechanisms vary depending on tissue conditions, cell types, irradiation parameters, and other influencing factors [11]. It is now well established that PBM enhance ATP production and provoke a brief modulation of reactive oxygen species (ROS) [14,15]. The prevailing theory suggests that within specific parameters of irradiation of light and/or infrared light stimulate cytochrome c oxidase (CcO), leading to increased ATP production [11]. Furthermore, current investigations propose that PBM may activate transcription factors and signaling pathways, suggesting potential protective mechanisms [11]. Hence since PBM therapy was proved to enhance ATP production, vasodilatation and notably tissue regeneration; it was suggested in this case report in the aim of regenerating gingival interdental papilla to fill the “black triangle”. The protocol followed is a modification of a previous protocol suggested by Brugnera et al. under the nomenclature of “hemolasertherapy”.

Case Presentation

Presentation and Informed consent

A 34-year-old female patient presented to the clinic complaining of an unaesthetic aspect during her smile due to the black triangle coronal to the interdental papilla between the two maxillary central incisors (#11 and #21) (Figure 1). The patient is a light smoker (smokes shisha less than two times a week), with no systemic disease that can affect her periodontal or dental health. Before suggesting any surgical periodontal plastic surgery, our proposed protocol including PBM was suggested and explained for the patient for the management of her “black triangle” in the concerned area. The risks, potential side effects, and the possibility of no improvement after treatment were clearly explained. Afterwards, the patient agreed on the treatment and signed a written informed consent before her enrollment. At this point, pre-operative intra-oral photography (Figure 1) and peri-apical radiography were made (Figure 2). The patient received oral hygiene instructions, including guidance on an adequate tooth brushing technique and on the use of interdental brushes for interdental cleaning. Then, professional sub-gingival plaque removal was performed using an ultrasonic piezoelectric scaler for the entire mouth scaling root planning (SRP). Furthermore, instrumentation with curesttes (Universal and Gracey curesttes) was made and chlorhexidine 0.12% (GUM PAROEX, 0,12% Intensive Action Mouthwash) solution was used to irrigate the sulcus for an average duration of almost 10 seconds using an endodontic seringue needle tip. The non-surgical treatment was made based on the recommendations of the European Federation of Periodontology (EFP). Afterwards, with a periodontal probe (Hu-Friedy), the gap from the contact point to the peak of the alveolar bone was assessed with the application of local anesthesia, using pressure to reach the crestal bone. The noted distance was 6 mm. After one week of scaling root planning, there was no sign of any gingival inflammation and the periodontium was considered as healthy.



FIGURE 1: Clinical examination of the patient's maxillary arch emphasizes the presence of a black triangle coronal to the interdental papilla between the two maxillary central incisors

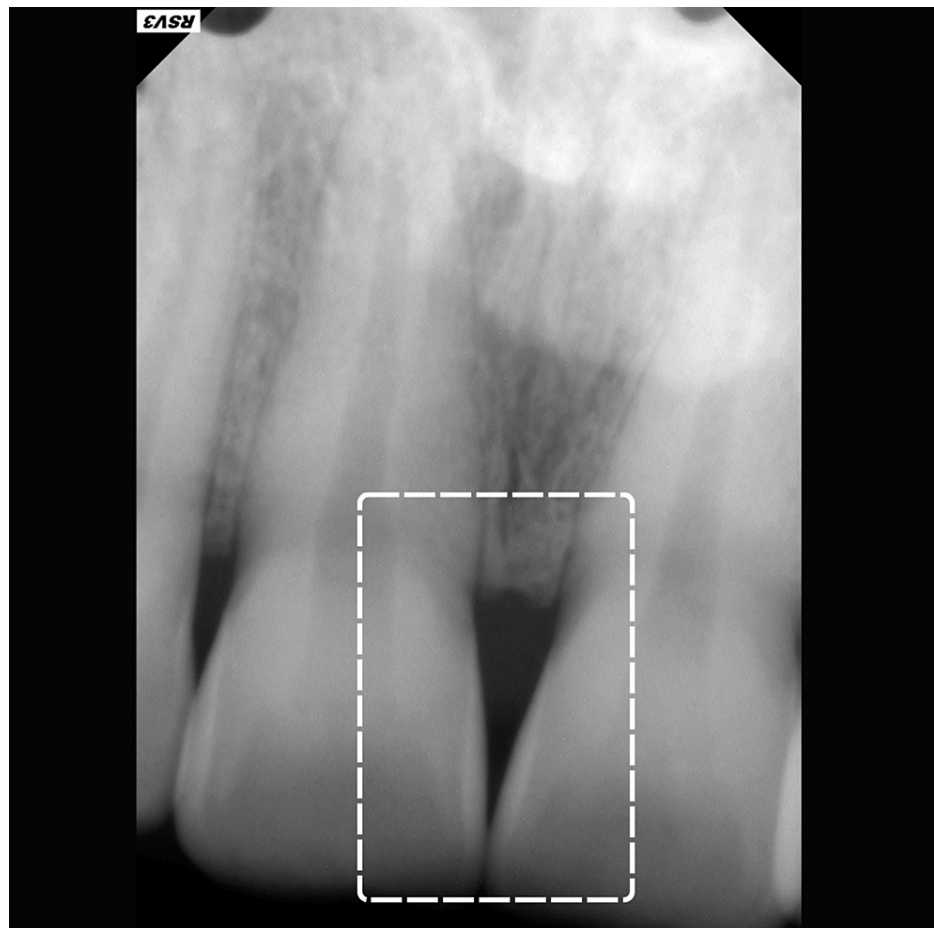


FIGURE 2: Peri-apical radiographs of the two central incisors illustrating the distance between the marginal alveolar bone and the contact point between the incisors

Treatment protocol

PBM within a specific protocol known as hemolasertherapy was followed with modifications. At the first session (T1) initial PBM application was made with a 635 nm wavelength diode laser (Smart M, Lasotronix, Warsaw, Poland) at four points around the area between the two maxillary central incisors: coronal third of the the papilla, apical third of the papilla, mesial and distal of the papilla (Figure 3). Later, bleeding was provoked inside the concerned sulcus (between 11 and 21) by applying pressure on the junctional epithelium and the supracrestal connective tissue using a curette (1/3 Gracey curettes, a premium instrument from the United Kingdom). After few seconds, the stimulated blood spontaneously filled the “black triangle” coronal to the interdental papilla and was left undisturbed. At this point, PBMT was applied again on the same four points already described (Figure 4). Irradiation parameters during all PBM treatments were: contact mode and continuous mode, 635 nm wavelength, spot size of 8 mm, power of 50 mW, irradiation time on each point of 50 seconds, energy of 2.5 J, energy density of 4.976 J/cm² (Table 1). After intervention, the patient was prohibited from: smoking for 48 hours, using any kind of mouthwash or brushing for 2 hours. The exact same procedure was repeated 5 and 10 days after T1. The aspect of the new formed gingival papilla and the presence or absence of black triangle were evaluated at different times of follow-up. Additionally, the height of this new formed papilla was measured. Follow-up was made one month and three months post-operative.



FIGURE 3: Illustration of the four points of Photobiomodulation therapy applied on the concerned papilla

Parameters	Values
Wavelength	635 nm
Mode of delivery	Continuous mode
Irradiation mode	Contact mode
Power (per point)	50 mW
Irradiation time (per point)	50 seconds per point
Energy (per point)	2.5 J
Tip diameter (per point)	8 mm
Energy density (per point)	4.976 J/cm ²

TABLE 1: Photobiomodulation therapy irradiation parameters per point



FIGURE 4: Aspect of the concerned area between the two maxillary central incisors after provoked bleeding and application of the PBM

Three months after intervention, a clinical inspection of the interdental papilla between teeth #11 and #21 revealed a slight lengthening of the interdental papilla leading to a slight reduction of the black triangle. This suggests a possible reparation or "regeneration" of the gingival papilla (see Figure 5). It's crucial to highlight that while the "black triangle" wasn't entirely absent, there was a slight improvement from an aesthetic point of view due an increase of the height of the interdental papilla.



FIGURE 5: Aspect of the area between the two maxillary central incisors three months after intervention

Discussion

In this specific case report, PBM was applied to target the "black triangle" between the two maxillary central incisors by promoting gingival papilla growth. After three sessions of the suggested protocol an improvement in the papilla height was noted; however, it wasn't substantial enough to assert a complete closure of the black triangle or achieve entirely satisfactory results. Unlike the case report by Zanin et al. [11], in this study, we measured and reported the distance between the contact point of the two central incisors and the crest of the alveolar bone (6 mm). This enhances the predictability of further research within our protocol. Additionally, while Zanin et al. [11] conducted two sessions, our protocol required three sessions to achieve what we considered necessary to achieve a significant stimulation of the interdental papilla.

Today, there is a plethora of clinical and laboratory research that supports the conclusion that PBM actively modulates biological functions [16-18]. Present data suggest that PBM acts predominantly on cytochrome c oxidase (CcO) in the mitochondrial respiratory chain by facilitating electron transport resulting in an increased transmembrane proton gradient that drives adenosine triphosphate (ATP) production [18, 19]. ATP is the universal energy source in living cells essential for all biologic reactions, and even a small increase in ATP levels can enhance bioavailability to power the functions of cellular metabolism [9]. Additionally, the adequate absorption of light within PBM showed to result in a transient and short burst of reactive oxygen species (ROS) which is followed by an adaptive reduction in oxidative stress. This action, impairment of ROS production, has been suggested to mimics the activity of molecular agents that attenuate tissue damage (examples include amifostine, N-acetyl cysteine, and superoxide dismutase) Moreover, mild levels of ROS have significant implications on various cellular functions, including the activation of crucial transcription factors like nuclear factor kappa B (NF-κB). Consequently, this activation leads to the expression of genes that stimulate and safeguard cellular growth, encompassing growth factors within the fibroblast growth factor family, pro-inflammatory cytokines, and chemokines essential for tissue repair [9]. Clinically, these demonstrated biological effects results in the facilitation of wound healing and tissue regeneration by influencing various stages of injury resolution. Moreover, PBM stimulates the proliferative phase after injury, which involve activation of fibroblasts, macrophages, and other reparative elements, and the stimulation of the remodeling phase, characterized by collagen deposition and the reconstruction of the extracellular matrix in the vicinity of the wound [16-19].

Despite the mentioned well-documented activity of PBM, the slight improvement observed, or lack thereof of a complete lengthening of the gingival papilla, in this case could be attributed to multiple factors that cannot be modified by PBMT. Such factors are anatomical factors, periodontal phenotype, distance between bone crest and contact point of the two central incisors [1], tooth form/shape, curvature of the marginal gingiva and the interproximal thickness of the gingiva [20]. For instance, the patient in this case report presented a distance between the contact point and the crestal bone that is more than 5 mm. This can be considered unfavorable based on the clinical study of Tarnow et al. [1]. For instance, for such cases, reconstructive periodontal plastic surgeries are usually indicated. Indeed, Tarnow et al. discovered that when the distance between the bone crest and the contact point was ≤ 5 mm, the papilla was present in 98% of cases. However, this occurrence decreased to 56% and 27% when the distance between the bone crest and the contact point reached 6 and 7 mm, respectively. Specifically, the proximity of the bone crest to the contact points (≤ 5 mm) and the thickness of the gingiva in the interproximal area (≥ 1.5 mm) strongly affect the presence of an interdental papilla, which are considered requirements for an ideal case [1]. Hence, this suggested treatment protocol yields a slight improvement in the papilla height point out that PBM therapy can most likely stimulate the growth or "regeneration" of the interdental papilla to fill out the "black triangle" which can be considered promising especially due to the unaggressive nature of PBM and the absence of any reported side effects. The protocol proposed herein can be regarded as a primary treatment option for papilla regeneration, addressing interdental papilla deficiency due to its non-invasive, non-surgical nature.

However, this study is on a single patient (case report); therefore, further research, especially randomized clinical trials, is imperative to validate the efficacy of such protocols. Moreover, investigating the impact of this suggested protocol on different distances between the crest of the alveolar bone and the contact point as suggested by Tarnow et al [1].

Conclusions

In this case report, the proposed protocol involving two sessions of photobiomodulation therapy followed by blood clot stimulation showed an increase in gingival interdental papilla length; nevertheless, it did not entirely eliminate the unaesthetic black triangle between the central incisors.

Additional Information

Disclosures

Human subjects: Consent was obtained or waived by all participants in this study. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the

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