Case report

Photobiomodulation as an adjuvant treatment in managing damaged tissues due to oral trauma: A Case Report

ABSTRACT

Introduction: Photobiomodulation has been reported to accelerate healing of tissues, promote the formation of new blood vessels, reduce inflammation, and manage pain, which can be highly beneficial when treating trauma patients. There is a lack of controlled clinical studies on the use of PBM for dental trauma, likely due to challenges in standardizing the types of trauma for inclusion and treatment, as well as the complexities introduced by the urgent nature of emergency care in clinical practice. Aim: In light of this challenge, the objective of this case report was to evaluate the effects of PBM in tissue damage resulting from a 7-years-old girl trauma due to a fall incident causing a lip injury (contusion and laceration) and a nasal spine bone fracture. Methods: the PBM with a Diode Laser was used aa an adjuvant with a detailed medication regimen. Red light (660 nm, 3J) was applied for 30 seconds at four points on the upper lip, while infrared light (808 nm, 3J) was applied for 30 seconds at two points near tooth 11 and the nasal spine to cover the affected area. It was performed 5 sessions (initial session at Day 1 of trauma, at 24 hours, 48 hours, one week and three weeks). Results: The upper lip and nasal spine regions were submitted to PBM. Complete absorption of the lip hematoma and healing of mucosal abrasion occurred within a few days. The patient remained pain-free throughout the initial week and thereafter, with no pain medication. The radiographic and clinical assessment indicated no dental damage occurred. Follow-up was for seven months, and no subsequent complications were observed. Conclusion: in this case report that PBM was an adjunctive treatment in this orofacial trauma reducing pain and tissue inflammation. However further clinical trials well-designed are necessary to confirm its effectiveness.

Keywords: Photobiomodulation, soft and hard tissue injuries, pain, inflammation, healing.

INTRODUCTION:

Traumatic dental injuries (TDIs) are relatively common among school-aged children, affecting approximately one in four children with permanent dentition. These injuries often result from falls, collisions, or impacts during activities like play, sports, accidents, or incidents

of violence [1]. Injuries to soft tissues can occur, as well as bone fractures, dental fractures, displacement, or loss of one or more teeth [2]. TDIs are well-documented while soft tissue injuries accompanying or occurring independently from bone fractures have received less attention in the literature.

Remarkably, oral injuries, despite constituting only 1% of the body's surface area, contribute to 5% of all injuries to the human body [3]. A study conducted over a two-year period highlighted the prevalence and characteristics of traumatic soft tissue injuries in children aged 0 to 10 years, with a higher occurrence in boys. Falls, particularly at night and during vacations, were identified as common causes. Among the 5949 cases of soft tissue injuries, 34% were associated with dental trauma, while 0.5% involved bone fractures (excluding alveolar fractures). These injuries were often limited to a single site, with the lip and its mucosa being the most frequently affected site, especially in children under 10 years of age [4].

Current guidelines from the International Association of Dental Traumatology and Dental Trauma Guide provide consensus-based recommendations for the diagnosis, prognosis, and treatment of these injuries [2,5].

The use of light therapy, specifically photobiomodulation, which includes lasers, LEDs, and broadband light across visible and infrared spectrums, has been well-documented in medicine and dentistry. It operates by targeting specific biological components in tissues (chromophores) at different wavelengths, leading to pain relief, inflammation reduction, immune response modulation, and tissue healing [6-10].

PBM's effectiveness in promoting wound healing, as documented in numerous studies, extends to pediatric patients, where it is employed independently or as an adjuvant therapy, but unfortunately without clearly specifying the used dosimetry.[11].

In dentistry, lasers of different wavelengths are widely used for various procedures, including surgery, cavity preparation, enamel etching, root canal cleaning, caries detection, and treating periodontal and peri-implant conditions [12]. Positive outcomes are reported for both children and adults, addressing acute and chronic conditions, and PBM effectively reduces pain during orthodontic procedures and tooth extractions [13].

Importantly, the literature consistently highlights the safety of PBM, with no side effects, contraindications, or adverse incidents reported, making it a minimally invasive treatment option that reduces the need for post-treatment medications [14].

This clinical case report focuses on applying PBM to treat tissue damage resulting from trauma, in a 7-year-old girl with a palatal expander due to a fall-related incident, with the dosimetry parameters used and its achievement.

CASE PRESENTATION

On November 30th, 2022, a 7.5-year-old patient with no systemic diseases was brought to a private dental clinic, 12 hours after experiencing a traumatic incident (Figure 1). PBM was offered as part of the treatment. Both the patient and her guardian provided consent.

Ethical approval for the clinical use of these dosimetry parameters was obtained from the Ethics Committee of Investigation at the XXXXX and the Ethics and Scientific Research Committee in Human Beings of the XXXXXXX, in a research study that was being carried out parallelly. The report follows the PRICE 2020 guidelines for reporting clinical cases in Endodontics [15] and CARE checklist.

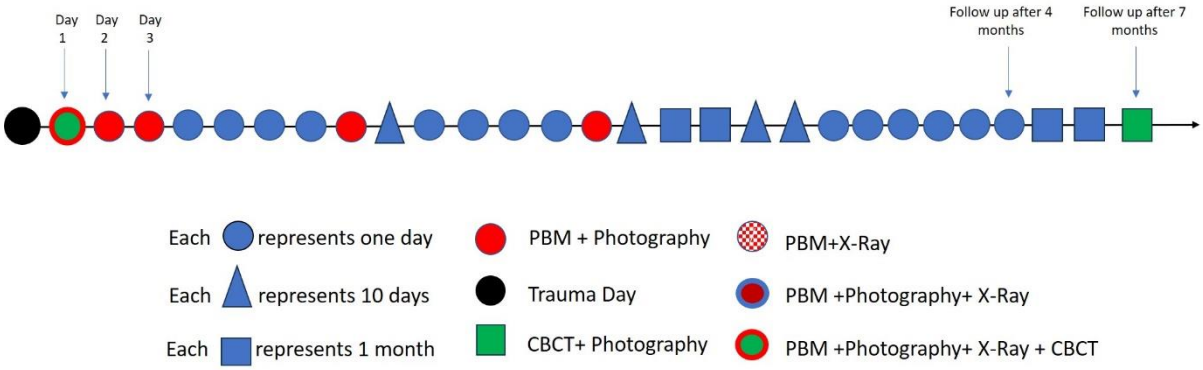

Figure 1: Timeline of the case report.

Trauma History and In-Situ Treatment

On November 29th, 2022, the patient experienced a traumatic incident during her swimming class, impacting her face at the level of her nose and upper lip, causing mouth and nose bleeding. Emergency medical services were called and recommended a dental evaluation. The patient received Ibuprofen (Perifar 200®, Spefar, Uruguay) for pain and inflammation, applied ice compresses intermittently, and used mouth rinses with 0.12% chlorhexidine (Bucoglobin ®, Gador, Uruguay) to disinfect small wounds on the upper lip mucosa. This day is referred to as Trauma Day.

Clinical Examination: Day 1 (Initial Session)

The patient has a good overall health status with no systemic diseases or reported allergies. In her dental history, she was diagnosed at age 7 with labial retrusion, bimaxillary narrowing, and insufficient space for permanent tooth germs and she was under treatment. Extra oral examination showed no significant jaw abnormalities or mouth-opening issues observed.

However, she had noticeable swelling on the skin of the nose and upper lip in the central region, altering her usual profile (Figure 2- A, B, C).

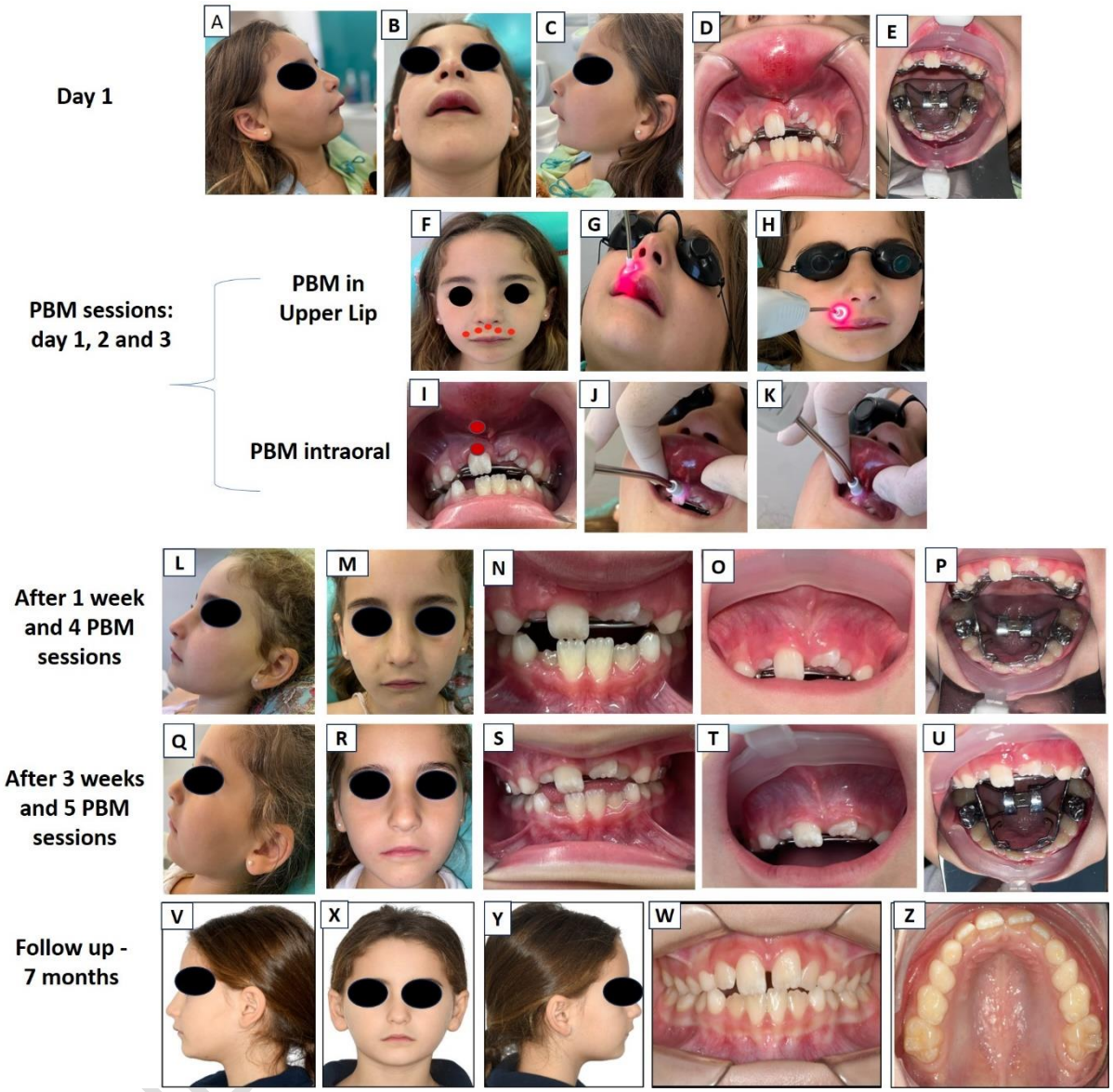

Figure 2: Photos of the case report patient in all periods evaluated and PBM procedure.

Intraoral Clinical Examination

The patient was wearing a palatal expander, which remained undamaged despite the impact (Figure 2- E). She had an abrasion on the internal surface of the upper lip and a superficial laceration. A noticeable hematoma was present on the mucosa surface of the upper lip, extended along the sulcus from the primary molar to its counterpart on the opposite side (Figure 2-D). Regarding to teeth: no.11, was almost fully erupted, while teeth 21 and 22 were only visible in their incisal thirds. Absence of pathologic mobility (up to 0,5mm), digital percussion without symptoms and normal sound, determined no teeth involvement. (Intrusion and subluxation were dismissed) A radiograph was taken, and no abnormalities were found. (Figure 3-D) However, due to the extensive hematoma in the sulcus, a Cone Beam Computed Tomography (CBCT) was requested for diagnosis, to rule out a bone fracture.

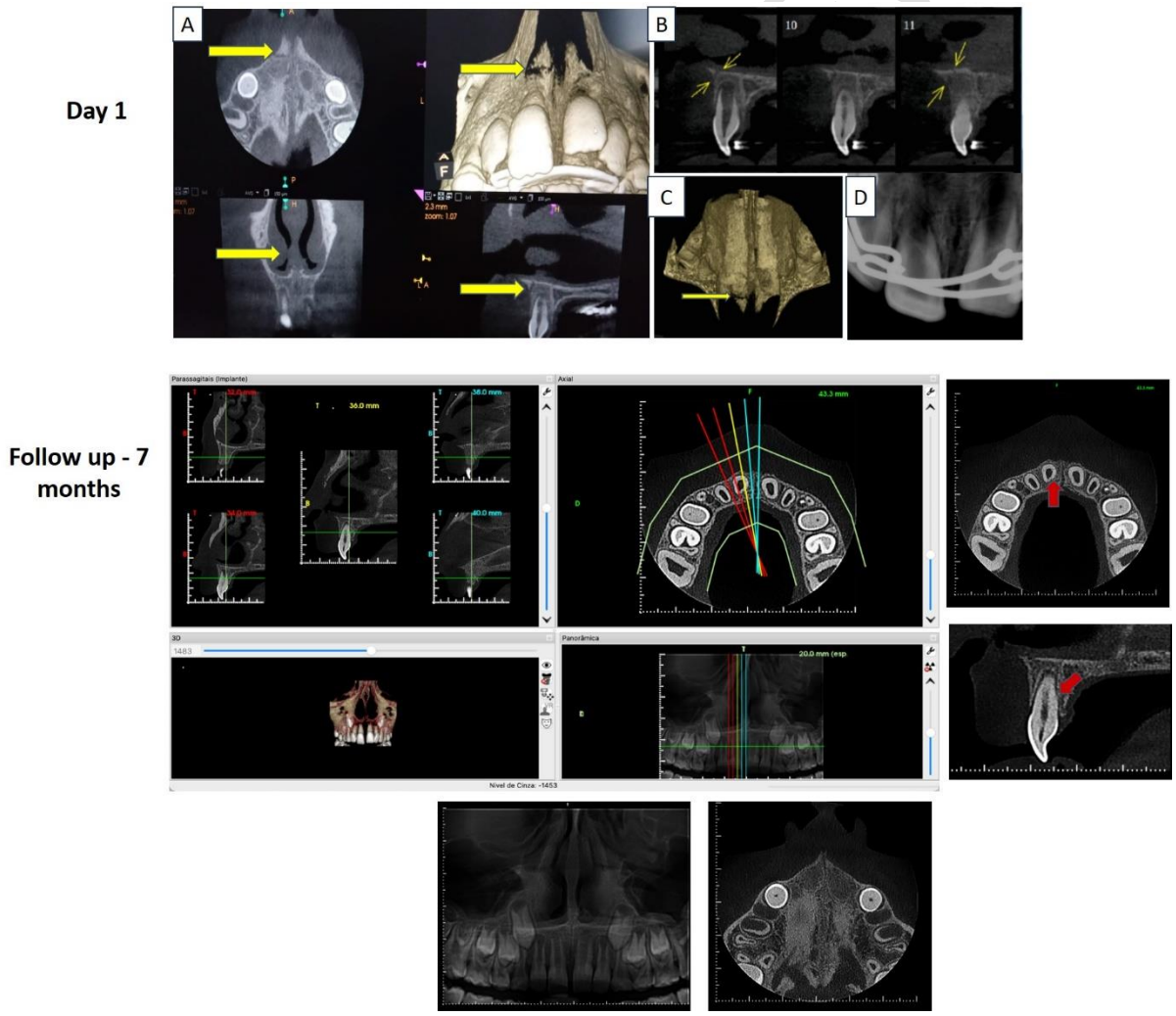

Figure 3: Imaging exams of the patient on the day of the trauma and after 7 months. (A, B,C): Cone Beam Computed Tomography (CBCT); D: X-ray and images of CBCT in the 7-months

follow up (E-I). The images illustrate the initial findings at the time of injury (nasal spine fracture- A and C) and the subsequent changes observed during the follow-up period, providing insight into the progression and recovery.

Request for Paraclinical Examinations

A Cone Beam Computed Tomography (CBCT) with 1mm slices was requested and performed one hour after the initial clinical session on Day 1, as shown in Figure 3-A, B and C.

Diagnosis, Prognosis and Treatment

-Maxillary fracture at the nasal spine level without displacement was found.

-Soft tissue injuries diagnosed as superficial laceration on the mucosa of the upper lip and the gingival papilla of tooth 21, as well as an abrasion on the mucosa of the upper lip. Edema in soft tissue was present.

-No teeth were involved. The prognosis was favorable for both bone and soft tissues.

The Treatment Plan was based on a medication approach as recommended, including pain killers, anti-inflammatories: Ibuprofen 200 (1 tablet every 8 hours for 2 days, Perifar®, Spefar, Uruguay) and antibiotics Amoxicillin 500 mg (1 tablet every 8 hours for five days, Amoxidal ® 500mg Roemmers, Uruguay). An antiseptic mouthwash with 0.12% chlorhexidine (Bucoglobin ®, Gador) was recommended for rinsing (twice a day for 5 days), along with intermittent use of ice during the first 24 hours.

In this clinical case, PBM with Diode Laser (Therapy EC) ® was incorporated into the detailed medication regimen. Red Light (660 nm, 3J) was applied for 30 seconds per point to four points on the upper lip (**table 1**). Following the CBCT diagnosis of the anterior nasal spine fracture, a fifth point was added at the base of the nose, precisely as indicated by the photographs and schematics (Figure 2- F, G, H).

In the mucosal area adjacent to tooth 11 and the nasal spine, Infrared Light (808 nm, 3J) was administered for 30 seconds per point at two points in the attempt to cover all the affected area. (Figure 2- I, J, K). This treatment was administered during the initial session (Day 1), at 24 hours (Day 2) and 48 hours (Day 3), in a week (Day 4), and at 3 weeks (Day 5) following the trauma, as shown in Figure 1.

The dosimetric parameters (table 1) were based on those used in the study by Sierra et al. (2016), with the energy increased point by point to improve the results.

Table 1- Dosimetry Parameters of Study

Parameters	Infra red	Red
Wavelength [nm]	808	660
Operating mode	continuous	continuous
Radiant power [W]	0,1W or 100mW	0,1W or 100mW
Irradiance [mW/cm2]	12W/cm2 or 12.000mW/cm2	12W/cm2 or 12.000mW/cm2
Beam area [cm2]	0.0078	0.0078
Exposure time [s]	30	30
Radiant exposure [J/cm2]	384J/cm2	384J/cm2
Radiant energy [J]	3J per point	3J per point
Total energy [J]	6J	15J
Number of irradiated points	2 points 1 cm between them.	5 points 1 cm between them.
Local of irradiation	Cervical of tooth 11 at nasal spine regions	Upper lip
Application technique	In contact, 90 degrees to the surface	In contact, 90 degrees to the surface

During each session, the following procedures were conducted:

a. Verification was done to confirm the patient's compliance with the prescribed medication, and the patient consistently adhered to the recommendations.

b. The VAS (Visual Analog Scale) assessment, which ranges from 0 (absence of pain) to 10 (highest pain), was used in four out of the five sessions to quantify the patient's initial spontaneous pain intensity upon presentation. Although the recorded score consistently remained at 0, the patient did express mild discomfort during palpation of both extraoral and intraoral soft tissues, observed during the Day 1 and Day 2 sessions (at 24 hours). However, this transient discomfort had subsided by the one-week follow-up session, and no pain was reported in any of the sessions.

c. A comprehensive visual examination was conducted to monitor tissue repair progression and identify any potential complications. No complications were observed.

d. The patient's plaque index was recorded using the adapted Green and Vermillion modified Index. On Day 1, a biofilm was found on the cervical third surface in the buccal aspect of tooth 11, but it did not hinder the healing process (Table 2).

Table 2- Description, performance assessment, and frequency. *(insert table 2)*

SESSION	VAS	NSAIDs	PBM	CLINICAL EVALUATION	PHOTOS	BIOFILM	XR EXAM
1 (Trauma Day)	0	+	+	Yes	Yes	1	RVG - CBCT
2 (24h)	0	+	+	Yes	Yes	0	NO
3 (48h)	0	-	+	Yes	NO	0	NO
4 (1 week)	0	-	+	Yes	Yes	0	NO
5 (3 weeks)	-	-	-	Yes	Yes	0	NO

VAS (Visual Analog Scale)- With PBM

At the 4th session, one week after the trauma (Figure 2- L, M, O), a significant decrease in swelling and intraoral hematoma was observed. By the 5th session, the skin swelling had completely solved (Figure 2- P, Q, R, S). The patient missed the one-month follow-up appointment.

Four Month Follow-up

The evaluation included a clinical examination and photographic documentation, with no changes in the patient's systemic condition in the preceding three months.

Clinical assessment revealed the expander's removal and normal dental eruption, consistent with previous observations. Gingiva appearance and color remained unchanged, with no discomfort upon palpation.

Teeth 12, 11, and 21 continued erupting, with a biofilm index of 2. No changes in tooth color or structural transparency were noted. Sensitivity to percussion was observed, but no pain. Physiological Mobility, and dental development remained unaltered. Radiographs showed no pathological changes.

Seven Month Follow-up

New photos were taken. (Figure 2-V, X, Y) Teeth 12, 11, 21, 22, 41, 42, 31, and 32 were present, with improved bimaxillary occlusion alignment. (Figure 2-W, Z). The modified Green and Vermillion Index recorded a biofilm score of 0, and there were no changes in tooth

color or structural transparency in the anterior teeth. Tooth percussion remained sensitive but painless, with normal sound, and with physiologic mobility unchanged.
Fragment synthesis was observed in a new CBCT, along with a remodeling zone on the palatal root surface in the middle third (Figure 3 Follow-up-7months).

DISCUSSION

This study presents a novel approach using PBM combining two different wavelengths for treating dental trauma and associated soft tissue injuries in children. Given the frequency of orofacial and dental traumas in children, PBM emerges as a promising, painless, and well-received treatment option, as observed in the present case, with no adverse effects for managing both hard and soft tissue injuries.

Previous research, such as Guiselini et al. [16], has shown superior tissue penetration capabilities of infrared wavelengths compared to red wavelengths in the alveolar bone. In addition, the comprehensive review conducted by Amaroli et al. [17] underscored the positive impact of FBM on bone surgeries by influencing cellular mechanisms and enhancing cellular metabolism, oxygen consumption, and ATP production. These effects were observed to promote bone formation and enhance vascular circulation.

Recently, a study conducted by Jana Neto et al [18] assessed the efficacy and safety of multiple wavelengths (420, 660, and 850 nm LEDs) in healing soft tissue injuries associated with ankle or tibia fractures in individuals aged 18 and older, hospitalized for these injuries. The results demonstrated the efficacy and safety of PBM in cases of soft tissue injuries related to bone fractures, suggesting that PBM using LED could be a promising technique for treating such injuries. Furthermore, Redman et al. [19] conducted a systematic review to evaluate the efficacy of PBM for oral mucositis in children with cancer. The results seem to indicate that it is safe and effective in reducing the severity of mucositis and the level of oral pain.

Sierra et al. [20] compared the effects of PBM at two different wavelengths, intra-oral and extra-oral, following impacted mandibular third molar extractions. The study emphasizes the importance of selecting the right irradiation parameters and the combination of irradiation site and laser wavelength to optimize PBM outcomes after oral surgery and concludes that the best results were achieved with an infrared laser (808 nm, 100 mW, 12 J).

In present study, we employed different lasers to optimize treatment for both skin and deeper tissues. Specifically, we used a red extraoral laser (660nm) for skin applications and an intraoral infrared laser (808nm) for treating hard tissues.

Considering the side effects and contraindications associated with traditional medications for pain management, alternative options such as PBM have been explored, showing promising results for both hard and soft oral tissues. Several studies have demonstrated the effectiveness of PBM in this context [21,22,23].

This case report introduces the use of PBM as an additional treatment for a child who had bone and soft tissue injuries from a swimming-related fall. It's important to highlight the limited literature and clinical research on PBM's use in children and adolescents with orofacial trauma-related bone fractures and soft tissue injuries. Only one publication was found where PBM was mentioned as part of treatment for a young, traumatized patient. The authors reported that PBM effectively managed pain, reduced post-trauma stress, and improved the patient's compliance with necessary clinical procedures [11] but with no details or dosimetry pointed out. The present case showed a significant reduction in the patient's reported pain, consistent with results from related studies. Medication was taken the first 24 hours only.

Further clinical investigations are needed to expand our understanding of this therapeutic approach and broaden the options available for managing tissue damage. Based on the presented results, it can be concluded that the utilization of PBM as an adjunctive treatment in this trauma case, which involved nasal spine fracture, resulted in a reduction in tissue inflammation. Furthermore, complete resolution of inflammation, absorption of the lip hematoma, and healing of mucosal abrasion occurred within a few days. The patient remained pain-free throughout the initial week and thereafter, with no pain medication. The radiographic assessment indicated normal dental development at this stage, with a CBCT conducted for an orthodontic purpose, confirming also bone healing (Figure 2 Follow-up- 7 months).

CLINICAL IMPLICATIONS

- ✓ Traumatic injuries to the face and mouth can impact children and adolescents (aged 0 to 19) and may occur due to falls, collisions, or impacts from various objects during recreational or sports activities, whether at home, school, or on the sports field. Consequently, soft tissue injuries, tooth injuries affecting both deciduous and permanent dentition, and, less frequently, bone injuries can be observed.
- ✓ The use of laser light (Photobiomodulation) in both medicine and dentistry is well-documented. While the interaction between laser light and biological tissue leads to pain and inflammation relief, immune response modulation, and tissue healing and regeneration, no publications on this specific topic were found.

- ✓ Photobiomodulation, whether used as a treatment or as an adjuvant, has no reported side effects or contraindications. It is considered noninvasive, induces analgesia, and reduces the need for post-treatment medication. Moreover, it is easy to apply, and well-received by young patients.

- **data availability Statement -** all data will be available for the readers.
- **conflict of interest disclosure -** All authors disclose any financial and personal relationships with other people or organizations that could inappropriately influence (bias) this study.
- **ethics approval Statement –** This case report received approval from the Research Ethics Committee of the Catholic University (UCU) number: 25072022.
- **patient consent Statement** – The participants signed an Informed consent.
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- **clinical trial registration –** it is not necessary for case reports.
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