***Case report***

Effect of photobiomodulation to control pain after placement of elastomeric spacers: a case report

**ABSTRACT**

The study aimed to evaluate the effect of a single session of photobiomodulation on pain control 24 hours after the placement of elastomeric separators using the Visual Analog Scale (VAS). Two patients aged 27 and 27 years old who required the placement of orthodontic bands on the first lower molars were included. The elastomeric separators were placed on the mesial and distal surfaces of the molars on the right and left sides. The treatment was randomized for the molar on the right side, while the opposite treatment was performed on the left side. The study groups were: Experimental - elastomeric separators + PBM (diode laser, 808 nm, 707 J/cm², 100 mW, with 4 J per point, 3 buccal points and 3 palatal points, in a single session) and a Control - elastomeric separators + PBM (diode laser, 808 nm, 707 J/cm², 100 mW, with 2 J per point, 3 buccal points and 3 palatal points, in a single session) at the opposite side. The patient and the evaluator were blinded to the intervention performed. The primary outcome variables were spontaneous and chewing pain after placing elastomeric separators, measured by the Visual Analog Scale (VAS). The secondary outcome variables were the count of analgesics taken (paracetamol) and local temperature (digital thermometer), and to assess the impact of oral health on the participant's quality of life, the OHIP-14 questionnaire was applied. These results were evaluated at baseline, 24 hours, and 48 hours after the placement of elastomeric separators. Despite an increase in all pain levels compared to baseline, there was a reduction of over 70% in spontaneous pain parameters at all time points, reaching zero at 48 hours. There was a significant reduction on the experimental side of spontaneous pain (more than 78%) and pain when chewing (more than 76%) when receiving 4J concerning the molar that received 2J, which received elastic separators followed by photobiomodulation at 24 hours measurement. There was no need for analgesics in any case. It is concluded that PBM may be an analgesic alternative for controlling local pain and inflammation generated by the placement of elastomeric separators. Larger studies are needed for a more comprehensive analysis of pain.

**Keywords:** photobiomodulation, elastomeric separators, orthodontic bands, orthodontic treatment, low-intensity phototherapy, low-intensity laser therapy

**1.Introduction**

The demand for orthodontic treatments has increased exponentially in recent decades (Dyer et al., 1991; Pacheco-Pereira et al., 2015; Taghavi Bayat et al., 2017), pain, defined as physical discomfort located in a part of the body, caused by the excitation of sensory nerve fibers, can be of greater or lesser intensity, although it is difficult to quantify as it has subjective components. In orthodontic treatments, pain is reported by patients in the clinic and in scientific literature by different authors. It is not only an unpleasant experience but also an influential factor when making the decision to start treatment. Installing bands in orthodontics requires separating the contact point in the interproximal space with separating elastics, which generates pressure, tension, and pain (Tripathi et al., 2019). The placement of elastomeric separators as a procedure before the installation of bands in orthodontic treatment with fixed appliances with multibrackets and multibands is strongly associated with pain and discomfort (Bondemark et al., 2004, Borzabadi-Farahani et al., 2017, Wang S et al., 2024). Generally, pain begins about 4 hours after separator insertion, peaks within 24 hours, remains uncomfortable for the next 3 days, and decreases and disappears within approximately 6 to 8 days (Abtahi et al., 2013, Tripathi et al., 2019, Al-Hanbali et al., 2024). The placement of elastomeric separators is strongly associated with pain and discomfort, being caused by an inflammatory process. Non-steroidal anti-inflammatory drugs, despite being the gold standard for these cases, have undesirable effects, which motivates the implementation of clinical protocols that test new options. Photobiomodulation has been shown to be effective in improving pain; however, to date, there is no ideal application protocol. Therefore, more evidence is needed to determine the best dosimetric and intervention protocol for pain modulation when placing elastomeric separators in bilateral lower molars (Farzan et al., 2021).

Systematic reviews on the topic have shown that the laser application method, dosimetry, wavelength and other laser parameters were widely varied in the protocols tested (Shi Q, et al., 2015; Farzan et al., 2021; Chinta

valakorn et al., 2022). The ideal parameters for reducing pain with this tool are the focus of several authors (Qamruddin et al., 2015; Abtahi et al., 2013; Borzabadi-Farahani et al., 2017; Farzan et al., 2021) and, Meanwhile, more evidence is needed to define the optimal dosimetric protocol to mitigate pain after placement of elastomeric separators (Ren C, et al., 2015; Shi Q, et al., 2015; The protocol most used by the authors are diode lasers, such as aluminum gallium arsenide, applied continuously and in direct contact with areas irradiated in the near-infrared range (Ren C, et al., 2015; Shi Q, et al. , 2015; Farzan et al., 2021). It was also observed that double irradiation had no advantage over single dose irradiation. It has also been noted that it is best to start treatment as early as possible, preferably immediately after placement of elastomeric separators (Farzan et al., 2021). Clinical trials have reported that Low Intensity Laser Therapy (LLLT) has an analgesic effect on the pressure and pain induced by orthodontic separators and bands (Bicakci et al., 2012; Shi Q et al., 2015; Almallah et al.., 2016, Farias et al., 2018), but the quality of the evidence was low (Zhi et al., 2021). However, more evidence is needed to determine the best dosimetry and intervention protocol (Ren C, et al., 2015; Shi Q, et al., 2015; Farzan et al., 2021).

**2.Case Report**

This case report meets the criteria for the design of a clinical trial under the CARE Statement. It was submitted to the Research Ethics Committee (CEP) of the Catholic University of Uruguay (#221014b). After a verbal and written explanation of the study, participants who agreed to participate signed the Informed Consent. The treatments were carried out at the Orthodontics Clinic of the Specialization course in Orthopedics and Orthodontics at the Catholic University of Uruguay in the city of Montevideo, Uruguay

Two patients, PP female, 27 years old, and BT female, 27 years old, without comorbidities, non-smokers, healthy permanent dentition, and preserved proximal spaces, were treated at the Orthodontics Clinic of the Specialization course in Orthopedics and Orthodontics at the Catholic University of Uruguay in the city of Montevideo, Uruguay, for the placement of elastomeric separators in the lower 6 molars prior to the installation of the molar bands.

Photobiomodulation was randomized as an analgesic alternative to control postoperative pain in both molars with a difference of 2 J between the lower right and left molars.

**2.1 Clinical Features**

The participants attended the clinic for 3 consecutive days. On the first visit, the separating gums were placed and a single application of photobiomodulation was performed on both lower molars 6 with the previously defined dosimetry.

Thus, 2J was applied to the right molar, and 4J to the left side. The temperature in the molar area was measured with the thermographic camera, and spontaneous pain and chewing pain were measured using the EVA scale.

After the procedure appointments, the patient returned within 24 and 48 hours for clinical reassessment and delivery of completed pain assessment forms, and the local temperature was measured again.

Before each appointment, a baseline assessment consisted of temperature testing, spontaneous pain index, and chewing pain index.

Both molars received the same type of elastomeric separator, but the right molars received lower dosimetry than the left side molars.

**2.2 Photobiomodulation**

A study (Ortega et al., 2019) used a wavelength of 880nm, so we adapted the protocol detailed in Table 1. To eliminate possible placebo effects, the patient remained unaware of the procedures, so the website [https://www.sealedenvelope.com](https://www.sealedenvelope.com/) was used to determine which tooth would be treated with a laser. Tooth 36 was the first tooth to be treated and underwent a photobiomodulation of 4J, while tooth 46 received an actual photobiomodulation treatment of 2J.

Immediately after placing the elastomeric separators, photobiomodulation was performed as follows: 3 applications per buccal and 3 applications per lingual on the lower first molars in a single session. Two applications were made in the cervical third (mesial and distal of the first molar) and one application in the apical third of the roots. (Figure 1

A Ga-Al-As laser (Therapy XT, DMC Equipamentos, São Carlos, Brazil) was used with an output power of 100 mW. Subjects received irradiation in continuous mode at a wavelength of 808 nm. The device's tip was positioned perpendicular to the mucosa, in contact, but without exerting pressure. Each point was irradiated with 2J for 20 seconds, totaling 12 J per tooth (6J on the buccal side and 6J on the lingual side) on the right molar and 4 J for 40 seconds, totaling 24 J per tooth (12 J on the buccal side and 12 J on the lingual side) on the left molar. (Figure 2)

**Una imagen que contiene en su interior, mesa, pequeño, café

Descripción generada automáticamente**

Figure 1: EC therapy equipment (DMC Equipment, São Carlos, Brazil) used for FBM application.

In Table 1, dosimetric parameters were listed, which were selected based on previous studies in the literature.

Table 1. Dosimetry parameters. (adapted from Ortega et al., 2019).

| **Parameters** | **Values/RIGHT MOLAR** | **Values/LEFT MOLAR** |
| --- | --- | --- |
| Wavelength [nm] | 808 | 808 |
| Operating mode | Continuous | Continuous |
| Radiant power [mW] | 100 mW | 100 mW |
| Irradiance [mW/cm²] | 35 W/cm² | 35 W/cm² |
| Beam area [cm²] | 0.002826 cm² | 0.002826 cm² |
| Exposure time [s] | 20 seconds per point | 40 seconds per point |
| Radiant exposure [J/cm²] | 707 J/cm² | 707 J/cm² |
| Radiant energy [J] | 2 J | 4 J |
| Number of irradiated points | 6 points per tooth, divided into: Vestibular (2 cervical and 1 apical) Palatal (2 cervical and 1 apical) | 6 points per tooth, divided into: Vestibular (2 cervical and 1 apical) Palatal (2 cervical and 1 apical) |
| Application technique | In contact, at 90 degrees to the surface | In contact, at 90 degrees to the surface |
| Number of sessions and frequency | Single session, immediately after the placement of the elastomeric separator | Single session, immediately after the placement of the elastomeric separator |

**2.3 Outcomes**

**Pain assessment**—Pain was measured using the visual analog scale (VAS), consisting of a 10 cm line, from 0 (no pain) to 10 (worst possible pain). The patient was instructed to mark a vertical line at the point that best corresponded to the intensity of spontaneous pain and chewing pain at each moment: immediately before treatment (baseline) and at intervals of 24h and 48h after treatment (Figure 3).

Figure 2 Visual Analog Scale (VAS) for Pain Assessment

Imagen que contiene texto

Descripción generada automáticamente

The image shows a printed form used for pain assessment through the Visual Analog Scale (VAS). The document includes sections to record spontaneous pain and pain during mastication, both on the right and left sides. There is also a field to note the number of analgesics taken by the participant. The form features horizontal lines representing the pain scale, where participants mark the intensity of their pain. A pen and a ruler are placed beside the document for size reference and ease of completion.

**Local Temperature assessment -** Likewise, thermographic measurements were carried out at the same time as pain control with the thermographic camera; they were measured in both teeth immediately before treatment (baseline), 24 hours after treatment, and 48 hours after treatment (Figure 3A and B).The patient's markings on the provided form also analyzed the needed analgesic.

Figure 3 A and B - Thermal Imaging in Intraoral Temperature Assessment Using the FLIR C5 Camera

![Cámara de video

Descripción generada automáticamente con confianza baja]() Una caricatura de una persona

Descripción generada automáticamente con confianza baja

Figure 3A: A FLIR C5 thermal imaging camera, a compact device designed for capturing infrared thermal images. This camera is commonly used for temperature analysis in various fields, including healthcare, engineering, and diagnostics. Figure 3B: A thermal image captured using the FLIR C5 camera, displaying a temperature distribution map. Warmer areas appear in red and yellow, while cooler regions are represented in blue and green. The image shows an intraoral view, highlighting temperature variations in the oral cavity, which may be useful for clinical assessments and research applications.

**Results**

All pain levels (spontaneous and chewing) in both teeth PBM (2J and 4J) increased compared to baseline.

Regarding spontaneous pain, the patients reported reduced postoperative pain by more than 70% in 4J compared to 2J molar, which received elastic separators followed by photobiomodulation at 24-hour measurement. (Table 2)

Table 2. Spontaneous Pain

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **PP**  **(PBM)** | **BT**  **(PBM)** |
|  |  |  |  |
|  |  | 2J     4J | 2J     4J |
|  |  |  |  |
| **Baseline** |  |  |  |
|  |  | 0,5 cm          0,5 cm | 0 cm         0 cm |
|  |  |  |  |
|  |  |  |  |
| **24Hours** |  |  |  |
|  |  | 7,3 cm          1,6 cm | 4,2 cm          0 cm |
|  |  |  |  |
| **48 Hours** |  |  |  |
|  |  | 0 cm          0 cm | 0 cm        0 cm |
|  |  |  |  |
|  |  |  |  |

PBM-photobiomodulation cmVAS (0-10)

In the case of chewing pain, it was observed that the participants reduce pain sensibility more than 70% in 4J compared to 2J molar, which received elastic separators followed by photobiomodulation at 24 hours measurement. (Table 3)

Table 3. Chewing Pain

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Patient 1- PP**  **(PBM)** | **Patient 2 - BT**  **(PBM)** |
|  |  |  |  |
|  |  | 2J     4J | 2J     4J |
|  |  |  |  |
| **Baseline** |  |  |  |
|  |  | 0,5 cm       0,5 cm | 0 cm            0 cm |
|  |  |  |  |
|  |  |  |  |
| **24Hours** |  |  |  |
|  |  | 8,3 cm          2,0 cm | 6,2 cm          0 cm |
|  |  |  |  |
| **48 Hours** |  |  |  |
|  |  | 0 cm          0 cm | 0 cm          0 cm |
|  |  |  |  |
|  |  |  |  |

PBM-photobiomodulation; cmVAS (0-10)

Similarly, in thermographic pictures, both participants elevate a few degrees at the molar zone in response to the inflammatory process caused by the elastomeric separators. (Table 4)

Table 4. Thermographic Picture

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | **Patient 1- PP**  **(PBM)** | **Patient 2 - BT**  **(PBM)** |
|  |  |  |  |
|  |  | 2J     4J | 2J     4J |
|  |  |  |  |
| **Baseline** |  |  |  |
|  |  | 30,8 °        28,8 ° | 32,2 °         26,6 ° |
|  |  |  |  |
|  |  |  |  |
| **24Hours** |  |  |  |
|  |  | 33,1 °          32,9° | 36,4 °          36,1° |
|  |  |  |  |
| **48 Hours** |  |  |  |
|  |  | 33,1 °           34,4° | 36,8 °         36,0° |
|  |  |  |  |
|  |  |  |  |

PBM-photobiomodulation; ° C

In both treatments, the patient reported not needing to use the analgesic medication (Paracetamol 500mg) provided and instructed in case of maximum pain (level 10 on the Visual Analog Scale).

**Discussion**

This case report showed an increase in all pain parameters (spontaneous and provoked by chewing) in both participants compared to baseline when elastomeric separators were placed at inferior molars.

After treatment, only one session of photobiomodulation was applied (4J total time of 240 seconds), as experimental dosimetry also described by other authors11,12,15,16,13,17 with good results. A study on acute pain showed that a single session of photobiomodulation (lasting 30 to 60 seconds) is sufficient to cause analgesia31. However, the protocols expressed in the literature are not conclusive.

Different indices of spontaneous and chewing pain were observed between the dental elements. 4J dosimetry showed a reduction of over 70% in 24 hs post-treatment, compared to post-treatment of 2J (control), reaching a zero pain level at 48 hours.

Such reduction is found in several studies in the literature and appears to be directly associated with the modulation effect of the inflammatory process by PBM10,19, reducing pain sensibility when using elastomeric separation 16,33,26, as demonstrated in the literature the laser group did not have a significant result compared to the group that ingested Ibuprofen 400mg associated with laser, but still had a significant reduction compared to the control group. Fazlyab et al., 2021 found positive results precisely at the 4 hours, as in this case report, but did not find statistical differences in the other analyzed periods.

Evidence has shown that elevated levels of inflammatory mediators induced in periodontal tissue damage activate peripheral nociceptors, causing pain. Chemical and mechanical processes lead to increased expression of neuropeptides from C-type nerve cells present in the periodontal ligament, contributing to the pathophysiology of inflammation4,8,16,20. Light at the infrared wavelength (880nm) has neural action specifically on Aδ and C fibers, allowing it to be used for acute pain relief20.

When elastic separation treatment pain was analyzed, 4J dosimetry showed better scores compared to the control, with a reduction of over 70% in spontaneous and chewing pain at 24 hours treatment. This result once again suggests the inflammatory modulation of photobiomodulation, especially when used at 880nm, which, due to its better penetration (up to 5mm) and reach of periapical cells, even considering light dispersion by tissue chromophores, promotes the effects of photobiomodulation in the region, making it eligible to affect periodontal tissues18,13,20,14. However, some authors did not find statistical differences in pain reduction maneuver between the laser and control groups post-treatment11,9,17,15.

Few clinical studies analyze pain more broadly, incorporating digital thermography to assess the inflammatory process and how the temperature of the area treated with the separating gums is expressed. Evaluations usually focus on spontaneous pain and chewing. More robust studies using these complementary endpoints are needed.

In addition to these analyses, evaluating the amount of oral analgesic medication required has been mentioned to assess PBM as an alternative for patients with medication restrictions19,17,14,15. In treating both dosimetry in this study, the patient reported not reaching the maximum pain level, thus not requiring using the provided analgesic medication (Paracetamol 500mg), following the findings15,17.

Some authors have found statistical differences, with the laser group showing a lower amount of medication use 14, 19. Perhaps this difference could be achieved in a study with a larger sample size.

Finally, the limitations of this case report lie in the subjective nature of pain assessment6, preoperative conditions such as increased patient anxiety, anatomical difficulties (positioning of the elastomeric elements between the molars), and the fact that it represents only two patients. However, it suggests evidence that the association of photobiomodulation after placement of elastomeric separators treatment may be used as an alternative for controlling pain in a single session, especially in spontaneous and chewing pain.

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