Effect of photobiomodulation on postoperative pain of single-session endodontic treatment: a case report

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Abstract
The aim of the study was to evaluate Photobiomodulation (PBM) as an analgesic alternative following endodontic instrumentation. The patient received single-session endodontic treatment on both upper right molars. After standard treatment, PBM was applied to tooth 17, while tooth 16 underwent a simulation. At the end of the procedures, the patient received a Visual Analog Scale to record pain at 4, 8, and 12 hours post-treatment, along with analgesics for use only in case of maximum pain. After 24 hours, a reassessment was conducted. There was a reduction of over 50% in spontaneous pain parameters at all time points, reaching zero at 4 hours. There was a reduction of over 50% in vertical percussion and about 29% in horizontal percussion. Palatal palpation showed an increase of 36%. There was no need for analgesic use. It is concluded that PBM may be an analgesic alternative for post-endodontic instrumentation spontaneous pain.

Introduction
Apical periodontitis (acute and chronic) stands among the most prevalent oral inflammatory diseases worldwide [37], with approximately 50% of the global adult population having at least one affected tooth [39].

While endodontic treatment aims primarily to address apical periodontitis [31,37], persistent post-instrumentation pain remains one of the main challenges [5,7,13,18], with a prevalence ranging from 3 to 58%, being more intense within the first twenty-four hours post-intervention [26].

Performing endodontic procedures in a single session is associated with increased surgical trauma, often cited as a common cause of post-treatment pain [10,38,36].

Pain assessment, being subjective, presents significant difficulties in analysis. Researchers have developed analysis tools to standardize its intensity. The visual analog scale (VAS) is a type of one-dimensional instrument consisting of a 10 cm line with zero at one end representing "no pain" and ten at the other end representing "maximum pain". It is widely agreed that VAS is easy and quick to administer, readily understandable by patients, and represents an appropriate way to estimate pain intensity [25].

However, for a more comprehensive evaluation, the analysis should be associated with clinical maneuvers to assess provoked pain and periapical tissue health. In endodontics, two semiotic resources are recommended: palpation and percussion. Palpation involves gentle digital pressure on the apical region from both vestibular and palatal aspects, aiming to detect bone swelling, exudate, or changes in the patient’s pain status. In percussion examination, the dental element in question is forced against the alveolus, both vertically and horizontally, observing sensitivity changes in the pressured region [21,22].
Given the high prevalence and multifactorial etiology of post-endodontic instrumentation pain, studies have explored alternatives to overcome the limitations of existing systemic medication [18]. In this scenario, photobiomodulation (PBM) has emerged as a possibility due to its capacity to modulate the inflammatory process [1,3,20,32]. Thus, the objective of this study was to evaluate the effect of photobiomodulation (PBM) on spontaneous pain after endodontic treatment in distinct teeth performed in a single session for the same patient.

Case Report

This study was approved by the Ethics Committee of Nove de Julho University (process: 5.495.496) and followed the CARE (Case Report Guidelines) checklist (Figure 9). Patient K.M.C., male, 31 years old, without comorbidities, non-smoker, and non-drinker, sought treatment at the Dental Clinic of Nove de Julho University with significant spontaneous pain and no relief from medication in teeth 16 and 17. Clinical examination revealed two deep carious lesions, approaching the pulp chamber (Figure 3). Radiographically, both teeth showed no periapical lesions. In the thermal test, both exhibited exacerbated pain to cold and heat. With the diagnosis of irreversible pulpitis established, the patient was referred from the undergraduate program to the Master's program at Nove de Julho University, São Paulo, Brazil. Endodontic treatments were performed on both teeth. Photobiomodulation was randomized as an analgesic alternative for postoperative pain in one of the teeth.

Clinical Features

The patient attended two separate dates for procedures, one for the treatment of tooth 16 and another for endodontic treatment of tooth 17. After the procedure appointments, the patient returned within 24 hours for clinical reassessment and delivery of completed pain assessment forms.

Before the start of each appointment, a baseline assessment was conducted, consisting of thermal testing, spontaneous pain index, pain upon vestibular and palatal palpation, and vertical and horizontal percussion pain. Both teeth in question exhibited positive thermal testing before endodontic treatment.

Both teeth were treated identically with the gold standard for the condition, starting with anesthesia using 2% Mepivacaine with 1:100,000 epinephrine, followed by absolute isolation using a rubber dam (Angelus) and gingival barrier (Top Dam® FGM Dental). After isolation, the clinical crown of the tooth was disinfected with 2% chlorhexidine before accessing the pulp chamber. (Figure 1)

The endodontic treatment continued with exploration of the root canal using a manual instrument with a 10.02 taper. Instrumentation of the cervical third was performed using rotary Pre Race files (FKG) 35.08 at a speed of 600 rpm and torque of 3N, coupled to a VDW Silver motor (VDW, Munich, Germany). The working length was determined with an apical locator Gnatus model APX1 (Figure 2), followed by instrumentation of the middle and apical thirds using manual or rotary instruments with tapers of 10.02, 15.02, and 20.02 (Scout - FKG) for patency.

The canal shaping stage was performed using reciprocating WaveOne Gold instruments (Dentsply Sirona, Charlotte, USA) 20.07 and 25.07, complementing the palatal canal with a 35.06 file in both cases. The instruments were attached to the VDW Silver motor (VDW, Munich, Germany), set to 400 rpm and 4N in reciprocating motion, accompanied by irrigation and suction of 2.5% sodium hypochlorite at each file change. The final irrigation protocol was performed with the agitation of 2.5% Sodium Hypochlorite and 17% EDTA-T with the aid of Easy Clean (Bassi, Belo Horizonte, Brazil). This was followed by the drying of the canals and obturation using the single cone technique according to the gauge of the last instrument with WaveOne Gold cones (Dentsply Sirona, Charlotte, USA) and EndoFill Cement (Dentsply Sirona, Charlotte, USA). The access cavity sealing was performed using glass ionomer restorative material (Figure 3).

Photobiomodulation

It was observed that the majority of studies used a wavelength of 880nm (infrared) [2,4,23,29,40]. Therefore, we adapted the protocol, detailed in Table 1 [23]. To eliminate possible placebo effects, the patient remained
unaware of the procedures, using the website https://www.sealedenvelope.com to determine which tooth would be treated with laser. Tooth 16 was the first tooth to be treated and underwent a photobiomodulation simulation, while tooth 17 received actual photobiomodulation treatment.

After the obturation and sealing of the cavity, the rubber dam was removed, and both the patient and the operator were equipped with protective glasses. For tooth 16, photobiomodulation simulation was applied using recorded sounds from the device. Meanwhile, for tooth 17, the protocol was applied with an 808nm laser at 3 points at the apical area, each point for 30 seconds, using the MMOptics (Figure 2) device (Power of 100mW), totaling 90 seconds and 9J of total energy delivered as described in Table 1 (Figure 4; Figure 5).

Table 1 – Dosimetric parameters

Pain assessment

The 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 pain at each moment: immediately before treatment (baseline) and at intervals of 4h, 8h, 12h, and 24h after treatment (Figure 6; Figure 7).

Similarly, pain upon palpation (vestibular and palatal) and percussion (vertical and horizontal) were measured in both teeth immediately before treatment (baseline) and 24 hours after treatment (Figure 8).

The amount of analgesic required was also analyzed by the patient’s markings on the provided form if needed.

Results

All levels of pain (spontaneous, palpation, and percussion) in both teeth (PBM and Control) were increased compared to baseline. Regarding spontaneous pain, the patient reported reduced postoperative pain by more than 50% in tooth 17, which received endodontic treatment followed by photobiomodulation at all measured time intervals: 4h, 8h, 12h, and 24h. (Table 2)

In the case of percussion, it was observed that tooth 17 (PBM) exhibited approximately a 29% reduction in pain on vertical percussion and over a 50% reduction in pain on horizontal percussion when compared to tooth 16 (Control). (Table 3)

Similarly, in palpation, both teeth showed an increase in pain intensity in both vestibular and palatal palpation 24 hours after the procedure. However, tooth 17 (PBM) exhibited a 36% increase in the palatal palpation index compared to tooth 16 (Control) and similar indices to the control in vestibular palpation. (Table 4)

In both treatments, the patient reported not needing to use the analgesic medication (Paracetamol 750mg) provided and instructed in case of maximum pain (level 10 on the Visual Analog Scale). (Table 5)

Discussion

This case report showed an increase in all pain parameters (spontaneous and provoked by palpation or percussion) in both teeth compared to baseline, suggesting that single-session endodontic treatment may cause increased postoperative pain scores [46,37].

After treatment, only one session of photobiomodulation was applied (total time of 90 seconds), as also described by other authors [4,40,2,29,28,23,14,34,27] with good results. A study on acute pain showed that a single session of photobiomodulation (lasting 30 to 60 seconds) is sufficient to cause analgesia [9], however, not all semiotic tests were performed.

In terms of spontaneous pain, different indices were observed between the dental elements. Tooth 17 (PBM) showed a reduction of over 50% in all analyzed periods (4h, 8h, 12h, and 24h) compared to post-treatment of tooth 16 (control), reaching zero pain level within the first 4 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 PBM [11,20], reducing post-endodontic instrumentation
pain [1, 6, 30, 52], as demonstrated in Lopes, et al., 2018; Naseri, et al., 2020; Yildiz, E.D. et al., 2018; and Ismail et al., 2019. In Nabi et al., 2018, 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 periapical tissue damage activate peripheral nociceptors causing pain. It has been observed that chemical, mechanical, or microbial lesions in the pulp and periapical tissues lead to increased expression of neuropeptides from C-type nerve cells present in the periodontal ligament, contributing to the pathophysiology of peripheral inflammation [26, 28, 1, 8, 53]. Light at the infrared wavelength (880nm) has neural action specifically on Aδ and C fibers, allowing it to be used for acute pain relief [8].

When percussion pain was analyzed, tooth 17 showed better scores compared to the control, with a reduction of over 50% in horizontal percussion and approximately 20% in vertical percussion. 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 periapical tissues [9, 35, 23, 8, 29]. However, some authors did not find statistical differences in percussion maneuver between the laser and control groups post-treatment [2, 3, 14, 40].

In the semiotic maneuver of palpatation, the results obtained are controversial. Besides the similar pain indices for vestibular palpation, the pain index for palatal palpation was found to be 36% higher for tooth 17 (PBM) compared to the control. Anatomical difficulties and the more posterior position of tooth 17 in relation to tooth 16 may have contributed to this result, as additional anesthesia was needed at the site. Only Yildiz et al., 2018 analyzed this outcome; however, they did not find a statistical difference between the groups.

Few clinical studies analyze pain more extensively, incorporating semiotic maneuvers such as palpation and percussion. Evaluations typically focus on spontaneous pain, and more robust studies utilizing these complementary assessment parameters are needed.

There is a phenomenon known as "hormesis" where very low doses of parameters such as irradiance (mW/cm²) may result in no significant effect [9]. Studies show that irradiance exceeding 300 mW/cm², when absorbed, can inhibit Aδ and C pain fibers [9]. In this case report, the irradiance presented was 127mW/cm², which may have led to underdosing, and the analgesic effect may not have been sufficient for palpation or superficial tissue analgesia. Perhaps reducing the application tip area or implementing complementary points in the visible red wavelength [12, 16, 17] could be considered as alternatives in future studies.

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 restrictions [11, 14, 29, 27, 40]. In the treatment of both dental elements in this study, the patient reported not reaching the maximum pain level, thus not requiring the use of the provided analgesic medication (paracetamol 750mg), following the findings of Yildiz et al., 2018, and Fazlyab et al., 2021.

Some authors have found statistical differences, with the laser group showing a lower amount of medication use [27, 29, 11]. Perhaps in a study with a larger sample size, this difference could be achieved.

Finally, the limitations of this case report lie in the subjective nature of pain assessment [25], preoperative conditions such as increased patient anxiety, anatomical difficulties (intra-radicular and positioning of the elements in the arch), and the fact that it represents only one patient. However, it suggests evidence that the association of photobiomodulation after endodontic treatment may be used as an alternative in cases of post-instrumentation pain for upper molars treated in a single session, especially in the parameter of spontaneous pain.

Referências Bibliográficas
## CARE Checklist of information to include when writing a case report

<table>
<thead>
<tr>
<th>Topic</th>
<th>Item Code</th>
<th>Checklist item description</th>
<th>Applicable to Law</th>
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<tbody>
<tr>
<td>Title</td>
<td>1</td>
<td>The diagnosis is a rare/unique feature or the work is a rare/unique feature.</td>
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<tr>
<td>Abstract (no references)</td>
<td>2</td>
<td>2 or more words that identify diagnosis or interventions in the case report, including &quot;new report&quot;</td>
<td></td>
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<tr>
<td>Introduction</td>
<td>3</td>
<td>Introduction: What is unique about this case and what does this add to the scientific literature.</td>
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<tr>
<td>Nature of symptoms and their importance</td>
<td>4</td>
<td>Nature of symptoms and important clinical findings.</td>
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<tr>
<td>Other Patient Information</td>
<td>5</td>
<td>Other patient information including any additional comments, research, or follow-up.</td>
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<tr>
<td>Clinical Findings</td>
<td>6</td>
<td>Clinical findings (e.g., disease activity, imaging, laboratory data).</td>
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<tr>
<td>Timeline</td>
<td>7</td>
<td>Timeline of events described in the case report, organized in a timeline.</td>
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<tr>
<td>Diagnostic Assessment</td>
<td>8</td>
<td>Diagnostic findings including lab and radiology data.</td>
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<td>Therapeutic Intervention</td>
<td>9</td>
<td>Information on therapeutic interventions such as treatment or surgery.</td>
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<tr>
<td>Follow-up and Outcome</td>
<td>10</td>
<td>Follow-up and outcomes including any additional comments, research, or follow-up.</td>
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<tr>
<td>Discussion</td>
<td>11</td>
<td>Discussion of the relevance of the findings and the implications for future research.</td>
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<td>Patient Perspective</td>
<td>12</td>
<td>The patient’s perspective or the impact of the findings.</td>
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<td>Informed Consent</td>
<td>13</td>
<td>Informed consent? (Patient provided the consent for this case report).</td>
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This is a preprint and has not been peer-reviewed. Data may be preliminary.
Hosted file

Table1 Dosimetric Parameters.docx available at https://authorea.com/users/669131/articles/991199-effect-of-photobiomodulation-on-postoperative-pain-of-single-session-endodontic-treatment-a-case-report

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