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Photobiomodulation in the rehabilitation of post-extraction pain

Abstract

Postoperative pain is one of the most common complications following dental extractions, particularly in cases involving impacted lower third molars. Traditional pharmacological approaches, such as non-steroidal anti-inflammatory drugs (NSAIDs) and antibiotics, are often associated with adverse effects and increased bacterial resistance. In this context, photobiomodulation (PBM) has emerged as a promising and non-invasive therapeutic alternative due to its analgesic, anti-inflammatory, and regenerative properties. This literature review aimed to critically evaluate the effectiveness of PBM in the management of post-extraction pain, based on clinical trials and systematic reviews published between 2020 and 2025. Sixteen studies were included, presenting varied protocols regarding wavelength, application time, number of sessions, and delivery method of the laser. f the sixteen studies, twelve reported significant clinical benefits in reducing pain, edema, and trismus, as well as improvements in healing and patient comfort. Three studies found no statistically significant differences between irradiated and control groups, although subjective improvements were reported, and one study is still ongoing. When applied within the first 48 hours and using optimized parameters, PBM showed outcomes that were superior or comparable to pharmacological therapies, with a lower risk of adverse effects. Despite the promising findings, methodological heterogeneity among the studies highlights the need for standardized protocols and further cost-effectiveness analyses. PBM stands out as a safe, effective, and evidence-based adjunctive therapy in oral surgery, particularly for the postoperative management of third molar extractions.

Keywords: tooth extraction, low-level light therapy, pain prostoperative, molar third, laser therapy, surgery oral, oral surgical procedures

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Introduction

Postoperative pain is one of the most frequent and predictable complications following tooth extractions, especially in cases of impacted lower third molars, and is associated with significant morbidity and reduced quality of life for patients.[1,2] Traditional methods for controlling pain and inflammation, such as the use of non-steroidal anti-inflammatory drugs (NSAIDs) and antibiotics, although effective in many cases, are linked to gastrointestinal and hepatic side effects, as well as increasing bacterial resistance.[3,4] In this context, photobiomodulation (PBM), also known as low-level laser therapy (LLLT), has emerged as a promising and non-invasive therapeutic alternative in the management of pain, edema, and trismus resulting from dental surgical procedures. PBM acts through the absorption of light by cellular chromophores, such as cytochrome c oxidase, triggering a cascade of photochemical events that lead to the modulation of inflammation, increased ATP synthesis, stimulation of angiogenesis, and acceleration of tissue regeneration.[5,6] Several randomized clinical trials and systematic reviews have demonstrated that PBM, especially with wavelengths between 660 nm (red) and 808 nm (infrared), is significantly associated with reduced postoperative symptoms such as pain and edema, as well as improved healing parameters.[7–9] The application can be performed either intraorally or extraorally, in single or multiple sessions, with varying protocols in terms of power, energy density, and duration of application.[1,5] Despite the growing body of evidence supporting PBM, there are still discrepancies regarding the standardization of application parameters and its comparison with traditional pharmacological therapies, such as antibiotics or corticosteroids.[3,10] Moreover, few studies have integrated the analysis of the clinical, immunological, and cost-effectiveness aspects of the technique.[4] Given the clinical and scientific relevance of the topic, the present article aims to critically discuss the effects of PBM in the management of post-extraction dental pain, with emphasis on lower third molar extractions.

Material and methods

This study was characterized as an exploratory literature review aimed at qualitatively analyzing the relationship between PBM and its effects on post-extraction dental pain. The literature search was conducted in the PubMed (National Library of Medicine) and BVS (Virtual Health Library) databases, combining the following descriptors with Boolean operators: ("low-level laser therapy" OR photobiomodulation OR laser) AND "post-extraction pain". The titles and abstracts of the retrieved articles were screened based on previously established inclusion criteria. The inclusion criteria considered full-text articles published between 2020 and 2025, in English, that addressed clinical or experimental applications of LLLT for pain following dental extractions. Duplicated, incomplete articles, those published outside the specified period or not aligned with the scope of the review were excluded. Additionally, official documents and international guidelines relevant to PBM protocols were included to support the methodological background. Specifically, dosage recommendations from the World Association for Laser Therapy (WALT) and safety and application parameters from the American Dental Association (ADA) were considered to contextualize and guide the interpretation of clinical findings.

Results

Initially, 12 articles were identified in the PubMed database and 84 in the BVS database. After applying the inclusion and exclusion criteria, 5 articles from PubMed and 39 from BVS were selected.

Subsequently, full-text reading and final study selection were performed, resulting in a total of 16 articles included: 2 from PubMed and 14 from BVS. The analyzed sample comprised randomized clinical trials, systematic reviews, and meta-analyses, which employed different laser application protocols, varying in wavelength, number of sessions, exposure time, and mode of application (intraoral or extraoral), a limitation also noted in current international recommendations.[11,12]

Discussion

PBM has emerged as a promising non-pharmacological strategy in the rehabilitation of patients undergoing lower third molar extractions, primarily due to its potential to modulate inflammatory processes, promote analgesia, and accelerate tissue healing. Pereira et al.[8] demonstrated that PBM using combined wavelengths (660 and 808 nm) was effective in reducing edema and improving oral mucosal healing seven days after surgery, although no significant differences in bone repair were observed. These findings were corroborated by Camolesi et al.,[7] who reported a significant reduction in pain, facial swelling, and trismus following a single, immediate PBM application, with a direct impact on decreased analgesic consumption. Similar results were described by Le et al.,[1] who compared PBM with ibuprofen and observed superior pain control in the irradiated group, suggesting an immunomodulatory effect. Although PBM has shown efficacy in third molar surgeries, studies involving pediatric populations, such as those by Lohia et al.[13] and Thakkar et al.[14] demonstrate its safety and effectiveness in broader dental applications, highlighting reduced pain and improved healing in children and adolescents. In contrast, Uzeda et al.[15] and Karsici and Balaban[16] found no statistically significant differences in the evaluated parameters between irradiated and control groups, although they reported subjective clinical improvements in pain perception. In such cases, methodological limitations such as small sample sizes, single-dose protocols, or inconsistent laser parameters may have influenced the outcomes.

In the context of protocol optimization, Pereira et al.[3] compared PBM with systemic antibiotic therapy (amoxicillin for three and seven days) and concluded that only PBM had a positive effect on reducing pain and increasing mouth opening, while antibiotics provided no additional benefit. This finding aligns with the current trend of rationalizing medication use in oral surgery, focusing on non-invasive adjunctive therapies. Similarly, Campos et al.[4] conducted a cost-effectiveness analysis and concluded that, although PBM is more expensive than conventional therapy, its clinical effectiveness justifies the investment in cases of severe pain.

Studies evaluating PBM in combination with other modalities, such as Fraga et al.[17] with antimicrobial photodynamic therapy (aPDT), and Erismen et al.[18] with platelet-rich fibrin (PRF), suggest a synergistic effect, particularly in pain reduction. Cetira Filho et al.,[9] in turn, assessed the association of PBM with nimesulide and found that PBM alone was more effective in improving clinical outcomes and patient quality of life after surgery. Salaberry et al.[10] proposed a randomized, double-blind clinical protocol to evaluate the preventive effect of PBM applied prior to third molar surgery, aiming to compare the efficacy of preoperative PBM with corticosteroid use in controlling edema, pain, trismus, dysphagia, and analgesic intake. While final results are pending, the study's methodological design emphasizes the potential of PBM as a prophylactic approach that could modulate inflammatory responses from the outset and improve postoperative outcomes. The effectiveness of PBM in reducing pain and promoting wound healing after tooth extractions has been widely reported in the literature. Application times ranged from 17 to 900 seconds, with wavelengths between 550 and 1064 nm. No significant adverse effects were reported. The analysis concluded that although protocols vary according to the type of device and wavelength used, PBM presents great clinical potential when applied in a planned and evidence-based manner.[5] Despite promising results, methodological heterogeneity among studies, particularly regarding laser parameters such as wavelength, power, application time, number of sessions, and delivery method, limits direct comparisons between trials. The review by Oliveira et al.[2] confirms this heterogeneity, although meta-analysis results point to a significant reduction in pain and edema, but an inconsistent effect on trismus. Momeni et al.,[6] for example, observed significant differences only in the final postoperative days, which may be related to the selected wavelength (940 nm) and single intraoral application. To address this variability, organizations such as the WALT have published evidence-based dosage guidelines, which suggest optimal parameters for therapeutic effectiveness. These recommendations are essential references for future clinical protocols. In addition, the ADA Technical Report No. 189[11] has formally recognized PBM as a safe and regulated adjunctive modality in dentistry, reinforcing its legitimacy and clinical relevance.

In general, the reviewed literature supports the use of PBM, particularly when applied within the first 48 hours post-surgery using optimized protocols, as a safe, effective, and low-risk adjunctive therapy for pain management and wound healing. However, to consolidate PBM's role in clinical practice, further well-designed, standardized, and long-term studies are needed. Additionally, future investigations should address key gaps, including the ideal dosimetry for different types of oral surgery, the interaction between PBM and conventional analgesics, PBM's effects in special populations such as pregnant patients, elderly individuals, and those with systemic comorbidities, and the potential influence of PBM on local microbiota and long-term bone regeneration.

Conclusion

In summary, the evidence supports PBM as a safe, effective, and non-pharmacological adjunct for managing postoperative pain and inflammation after third molar extractions. Its benefits, particularly when applied in the first 48 hours post-surgery with optimized parameters, include reduced pain, edema, and trismus. Although methodological heterogeneity exists, the clinical outcomes are promising, and further standardization of protocols and long-term trials are essential to consolidate its role in oral surgery.

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None.

Conflicts of interest

The authors declares that there are no conflicts of interest.

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