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Editorial

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Photobiomodulation for Dental Extractions: Enhancing Postoperative Pain Relief and Accelerating Wound Healing

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Abstract

Dental extractions, whether for impacted wisdom teeth or tooth decay, often result in postoperative complications such as pain, swelling, and delayed healing. Photobiomodulation (PBM) therapy has recently garnered attention as an effective modality for enhancing the healing process and alleviating pain following dental procedures, including extractions. This review aims to explore the efficacy of PBM in reducing postoperative pain and promoting wound healing in patients undergoing dental extractions. We examine the mechanisms underlying PBM, the evidence from clinical studies, and its potential benefits in clinical dentistry. Furthermore, the safety and practicality of PBM therapy in routine dental practice are discussed, along with future perspectives for its broader application in oral surgery.

Keywords: Photobiomodulation (PBM); Dental extractions: Postoperative pain; Wound healing

Introduction

Dental extractions are among the most common procedures performed by oral and maxillofacial surgeons and general dentists. Despite being routine, extractions can lead to several postoperative challenges, including pain, inflammation, and delayed wound healing. The healing process following dental extractions involves tissue repair, regeneration, and inflammation, all of which can be influenced by various factors such as the patient's age, general health, and the complexity of the extraction itself. Postoperative pain is one of the most significant issues faced by patients and can severely affect their quality of life during recovery. Current management strategies often involve pharmacological interventions such as analgesics and anti-inflammatory drugs; however, these approaches have limitations, including side effects and potential complications.

Over the past few decades, photobiomodulation (PBM) has emerged as a non-invasive therapeutic technique that utilizes low-level light (usually in the red or near-infrared spectrum) to promote tissue repair and reduce pain. PBM works by interacting with cellular components, enhancing mitochondrial function, and increasing the production of adenosine triphosphate (ATP), which accelerates cellular processes like proliferation, migration, and collagen synthesis. Studies have suggested that PBM can reduce postoperative pain, swelling, and inflammation while accelerating wound healing, making it a promising adjunctive treatment following dental extractions. This article explores the role of PBM in the treatment of dental extractions, focusing on its potential to reduce postoperative pain and enhance wound healing. By reviewing the mechanisms of action, clinical evidence, and safety considerations, we aim to provide a comprehensive understanding of PBM's application in dental extractions [1-5].

Mechanisms of Photobiomodulation

Photobiomodulation works by delivering light energy to the tissues, typically using lasers, light-emitting diodes (LEDs), or other light sources. The light energy is absorbed by chromophores within the tissue, most notably cytochrome c oxidase, a key enzyme in the mitochondrial respiratory chain. This absorption leads to an increase in ATP production, which is essential for cellular energy and function. PBM has been shown to influence various cellular processes, including:

1. **ATP production**: The primary mechanism through which PBM enhances cellular function is by stimulating ATP production. The increased availability of ATP enables faster cell division, enhanced protein synthesis, and improved cellular repair processes.

2. **Anti-inflammatory effects**: PBM has been found to modulate inflammatory responses by reducing the production of pro-inflammatory cytokines such as interleukin-1 (IL-1) and tumor necrosis factor-alpha (TNF-α). By regulating inflammation, PBM can reduce the pain and swelling associated with dental extractions.

3. **Collagen synthesis and wound healing**: PBM stimulates fibroblasts, the cells responsible for collagen production, leading to enhanced wound healing. Collagen is a critical component of the extracellular matrix, and its synthesis is necessary for tissue repair. Increased collagen deposition can result in faster and more robust healing of the extraction site.

4. **Vascularization**: PBM has been shown to promote angiogenesis, the formation of new blood vessels. Enhanced blood flow at the site of injury ensures better oxygen and nutrient delivery to the healing tissues, accelerating the recovery process.

5. **Pain Reduction**: PBM has analgesic effects, which can be attributed to the modulation of neural activity and the reduction of inflammatory mediators. This pain-relieving effect is particularly beneficial in the postoperative period following dental extractions.

Clinical evidence of PBM in dental extractions

A growing body of research supports the use of PBM in the management of postoperative pain and wound healing following dental extractions. Several studies have investigated the effects of

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PBM on pain reduction, swelling, and tissue healing in patients undergoing tooth extractions, with promising results. One of the primary concerns for patients following dental extractions is pain management. Conventional treatments, including nonsteroidal anti-inflammatory drugs (NSAIDs) and opioids, have their drawbacks, including side effects and dependency risks. In contrast, PBM offers a non-pharmacological alternative that can reduce pain without the associated risks. A randomized controlled trial by AlGhamdi et al. (2016) evaluated the effect of PBM on pain following third molar extractions. The study demonstrated that patients who received PBM therapy reported significantly less pain and required fewer analgesic medications compared to those who did not receive PBM treatment. Similarly, a study by [7] found that PBM reduced pain and swelling in patients undergoing dental extractions, with a marked improvement in the recovery process.

The analgesic effect of PBM can be attributed to its ability to modulate nociceptive pathways. PBM therapy reduces the release of substance P and other neuropeptides involved in the transmission of pain signals, thus reducing the sensation of pain. Postoperative wound healing is another critical aspect of dental extractions. Delayed or impaired healing can lead to complications such as infection, dry socket, and prolonged discomfort. PBM has been shown to accelerate the healing of soft tissues and bone following dental procedures.

In a study by da Costa [8] patients who received PBM treatment following dental extractions demonstrated faster healing, with reduced inflammation and tissue breakdown at the extraction site. Another study by examined the effects of PBM on bone healing following tooth extractions. The results showed that PBM treatment promoted better bone regeneration and increased the density of the newly formed bone, suggesting a positive effect on both soft tissue and hard tissue healing. Swelling and inflammation are common after dental extractions and can contribute significantly to patient discomfort. PBM has demonstrated an ability to reduce these postoperative effects, improving patient comfort and recovery time. In a study by Hamblin, patients who received PBM therapy after dental extractions showed significantly less swelling and a faster reduction in inflammation compared to control groups. The anti-inflammatory effects of PBM are thought to arise from its ability to reduce the production of pro-inflammatory cytokines and promote the activity of anti-inflammatory mediators. The integration of PBM into routine dental practice is becoming increasingly feasible, as advances in technology have made light-based devices more accessible and user-friendly. Several types of light sources are used for PBM, including lasers and LEDs, with varying wavelengths and power densities depending on the desired therapeutic effect.

Devices Used in PBM

Low-level laser therapy (LLLT): Lasers emit coherent light, which can penetrate tissues at specific wavelengths. In dental practice, lasers with wavelengths between 600 and 1000 nm are commonly used for soft tissue healing and pain relief.

Light-emitting diodes (LEDs): LEDs provide non-coherent light and are increasingly used in PBM. They offer ease of use, lower cost, and versatility for a range of clinical applications, including wound healing and pain management. The effectiveness of PBM therapy depends on several factors, including the wavelength of light, energy dose, and duration of treatment. Commonly, PBM is applied in multiple sessions, starting immediately after the extraction procedure and continuing for several days or weeks, depending on the severity of the surgical site and the patient's healing response.

A typical PBM treatment protocol for dental extractions involves delivering light to the extraction site for 30-60 seconds per treatment session, with a dosage range of 1-4 J/cm². Treatment frequency may range from daily to bi-weekly, depending on the patient's condition and the clinician's judgment.

Safety and side effects

PBM is generally considered safe when performed according to established protocols. The most common side effects are mild and transient, including temporary erythema (redness) or slight discomfort during the treatment. There are few reported cases of adverse effects, and PBM is contraindicated only in specific situations, such as in patients with photosensitivity or active malignancies.

The safety of PBM also extends to its non-invasive nature, which eliminates the risks associated with pharmaceutical pain relief treatments, such as gastrointestinal disturbances or addiction.

Future perspectives

Despite the promising results from clinical studies, further research is needed to optimize the parameters for PBM treatment, including light wavelength, energy dosage, and treatment frequency. Additionally, large-scale, multicenter clinical trials are required to confirm the long-term benefits of PBM in dental extractions and its potential role in other oral and maxillofacial procedures.

There is also potential for the development of new PBM devices that combine the advantages of both lasers and LEDs, improving treatment outcomes and expanding the clinical applications of PBM in oral surgery [9,10].

Conclusion

Photobiomodulation represents a promising and effective therapeutic modality in the management of postoperative pain and wound healing following dental extractions. The growing body of evidence supports its ability to reduce pain, inflammation, and swelling while promoting tissue repair and faster healing. The non-invasive nature of PBM, coupled with its minimal side effects, makes it an appealing adjunct to conventional pain management and healing strategies. As research continues to explore the optimal parameters for PBM therapy, it is likely that PBM will become a more integral part of clinical practice in oral and maxillofacial surgery, offering patients a safer, more comfortable and efficient recovery after dental extractions.

Acknowledgment

None

Conflict of Interest

None

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