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Utilization of Dental Laser for Analgesia to enhance patient comfort in Dentistry: A Review

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ABSTRACT

Background: Pain management is a critical aspect of dental care, impacting patient experience, treatment outcomes, and overall satisfaction. Traditional methods of analgesia, such as local anesthesia, may not always suffice, leading to discomfort and anxiety among patients. Dental lasers have emerged as innovative tools for pain control, offering precise, minimally invasive, and efficient analgesic mechanisms across various dental procedures.

Purpose: This review provides a detailed examination of the current state of utilizing dental lasers for analgesia, encompassing their mechanisms of action, clinical applications, efficacy, safety considerations, and future directions.

Method: By synthesizing evidence from scientific literature and clinical studies, this review aims to elucidate the potential of dental lasers in revolutionizing pain management in dentistry, ultimately enhancing patient comfort and improving treatment outcomes.

Conclusion: Dental lasers show considerable promise in dentistry's pain management domain, providing precise, minimally invasive, and effective analgesic methods during different dental procedures. As technologies advance and research progresses, dental lasers could transform pain management in dentistry, significantly improving patient comfort, satisfaction, and treatment results.

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Introduction

Pain from local anesthetic injection contributes to dental anxiety and is a common clinical challenge during routine dental restorative work [1]. Therefore, the use of non-invasive alternate methods for inducing analgesia becomes desirable. Dental procedures, particularly those involving teeth restoration, and periodontal treatments often induce discomfort and pain in patients, necessitating the use of local anaesthesia. Pain management remains a cornerstone of dental practice, influencing patient satisfaction, treatment adherence, and clinical outcomes.

Dental procedures, particularly those involving teeth restoration, often induce discomfort and pain in patients, necessitating the use of local anaesthesia. However, these approaches may not always be optimal, particularly in patients with needle phobia, allergies to anesthetic agents, or those seeking minimally invasive alternatives [2]. In recent years, dental lasers have garnered considerable attention for their potential to provide efficient and precise analgesia across a spectrum of dental interventions [3]. Many researchers suggest that Photobiomodulation (PBM), utilizing near-infrared lasers, has the potential to induce dental analgesia, offering a non-invasive, non-destructive, and potentially more patient-friendly alternative to traditional injected anesthetic methods [3, 4].

The information submitted to the United States Food and Drug Administration to substantiate the clinical application of the Er: YAG laser for cavity preparation indicated that fewer than 2% of patients necessitated local anaesthesia, and the procedure demonstrated no detrimental long-term effects on dental pulp [5, 6]. This allows for the utilization of PBM-induced analgesia in contexts beyond restorative work, such as addressing dentinal hypersensitivity and performing periodontal debridement [6]. It also removes associated problems such as attendant risks with injections and damage of adjacent tissue with a high-power laser, broad areas of numbness, as well as more predictable analgesia or supporting analgesia in situations difficult to anesthetize [2].

Even though, several theories have been proposed the possible explanations are represented by the photo-acoustic effect and its actions within the gate control pathway, direct and indirect influences of laser energy on nerves and nociceptors, modifications of the Na+-K+ pump systems, and the bio-resonance and biochemical modifications that laser energy can induce [2].

Techniques are available that result in a laser-induced analgesic effect, and methods for computing the energy dose [7, 8] . Notwithstanding, it is not a profound anesthesia since it is unable to suppress all sensations.

This review aims to explore the current landscape of utilizing dental lasers for analgesia, encompassing their mechanisms of action, clinical applications, efficacy, safety considerations, and prospects.

Types of Dental Lasers for Analgesia

Several types of dental lasers have been utilized for analgesic purposes, each offering unique advantages and clinical applications:

Diode Lasers

Diode lasers are the most commonly used lasers for pain management in dentistry [9]. It is referred to as diode low-level laser therapy (LLLT). Emitting wavelengths in the near-infrared spectrum, diode lasers penetrate soft tissues effectively, making them suitable for procedures such as periodontal therapy, soft tissue surgeries, and oral lesions treatment [10]. These lasers offer precise ablation and coagulation of tissues, facilitating pain relief and enhancing patient comfort during dental interventions.

Nd: YAG Lasers

Neodymium-doped Yttrium Aluminum Garnet lasers provide deep tissue penetration, making them effective for pain relief in endodontic procedures, periodontal therapy, and oral surgeries [11]. Nd:YAG lasers emit wavelengths in the infrared spectrum, enabling targeted modulation of neural activity and pain perception. Clinical studies have demonstrated the efficacy of Nd:YAG lasers in reducing post-operative pain and inflammation, and improving patient outcomes in various dental interventions [12].

Erbium Lasers

Erbium lasers, including Er:YAG and Er,Cr:YSGG, offer precise ablation of hard and soft tissues, enabling analgesia in cavity preparation, soft tissue surgeries, and dental implantology [13]. Erbium lasers emit wavelengths that are well-absorbed by water and hydroxyapatite, making them suitable for precise tissue ablation with minimal thermal damage. These lasers have shown promise in providing immediate pain relief and accelerating tissue healing, particularly in minimally invasive dental procedures [14].

The mechanisms of action of Dental Laser in Analgesic Effects

The mechanisms of action underlying the analgesic effects of dental lasers are multifaceted and involve various physiological processes within the oral tissues. One prominent mechanism involves neural modulation, where laser energy interacts with peripheral nerve endings, altering their excitability and transmission of pain signals [14]. This neural modulation may occur through a combination of thermal, biochemical, and biophysical interactions induced by laser energy [15].

Another mechanism by which dental lasers exert analgesic effects is through tissue heating and desensitization. Laser energy applied to oral tissues generates heat, which can desensitize nerve endings and alter pain receptor activity [16]. By raising tissue temperature within a controlled range, dental lasers can induce thermal analgesia, effectively numbing the treatment area and reducing pain sensitivity. Additionally, the thermal effects of laser energy may promote vasodilation, increasing blood flow to the affected tissues and facilitating the removal of inflammatory mediators, further contributing to pain relief and tissue healing [2].

Furthermore, certain dental laser wavelengths possess anti-inflammatory properties, which can complement their analgesic effects [17]. By targeting inflamed tissues and modulating inflammatory pathways, dental lasers help alleviate tissue inflammation, a common source of pain in various dental conditions. Laser-induced anti-inflammatory effects may involve the suppression of pro-inflammatory cytokines, the promotion of anti-inflammatory mediators, and the modulation of immune responses within the oral microenvironment [18]. By mitigating tissue inflammation, dental lasers not only provide immediate pain relief but also contribute to improved tissue healing and long-term treatment outcomes in dental practice.

The Clinical applications, efficacy and safety considerations of Dental Laser in Analgesic Effects

Dental lasers offer a wide range of clinical applications for analgesic effects across various dental procedures. In periodontal therapy, diode lasers are commonly utilized to reduce pain and inflammation associated with scaling and root planing procedures. Their ability to selectively target diseased periodontal tissues while sparing healthy surrounding structures makes them effective tools for pain management in patients with periodontal disease [19]. Additionally, erbium lasers have found applications in soft tissue surgeries such as gingivectomy and frenectomy, providing precise analgesia and minimizing post-operative discomfort for patients undergoing oral surgical interventions [20]. Moreover, Nd:YAG lasers have been employed for pain relief during endodontic procedures, helping to alleviate post-operative pain and inflammation in patients undergoing root canal therapy [11].

Clinical studies have demonstrated the efficacy of dental lasers in providing analgesic effects across various dental interventions. Research findings indicate that laser-assisted analgesia can result in reduced post-operative pain, faster recovery, and improved patient comfort compared to traditional methods of pain management [12]. For instance, studies have shown that diode lasers can effectively reduce pain and discomfort during periodontal therapy, leading to enhanced patient satisfaction and treatment outcomes. Similarly, Nd:YAG lasers have been shown to decrease post-operative pain levels in patients undergoing root canal therapy, contributing to improved healing and recovery following endodontic interventions [11, 12]. Moreover, erbium lasers have demonstrated efficacy in minimizing post-operative discomfort and accelerating tissue healing in patients undergoing soft tissue surgeries.

Safety considerations are paramount when utilizing dental lasers for analgesic effects to ensure optimal patient outcomes and minimize the risk of adverse events. Key safety measures include proper eye protection for both patients and dental practitioners to prevent laser-induced ocular injuries during laser-assisted dental procedures [21]. Additionally, clinical training and competence are essential to ensure safe and effective use of dental lasers, with dentists and dental staff undergoing comprehensive training and certification in laser safety and operation [22]. Patient selection and informed consent are also critical considerations to assess individual risk factors and ensure patient understanding of laser-assisted procedures, thereby promoting patient safety and satisfaction. Overall, adherence to strict safety protocols and guidelines is essential to maximize the benefits of dental lasers for analgesic effects while minimizing potential risks and complications.

Conclusion

Dental lasers represent a promising frontier in pain management in dentistry, offering precise, minimally invasive, and efficient

analgesic mechanisms across various dental procedures. With evolving technologies and rigorous research, dental lasers have the potential to revolutionize pain control in dentistry, ultimately enhancing patient comfort, satisfaction, and treatment outcomes.

Conflict of interest

The authors declared that there is no conflict of interest in any materials or products that were mentioned in our study manuscript.

References

1. Armfield J (2012) The avoidance and delaying of dental visits in Australia. Aust Dent J 57: 243-247.
2. Poli R, Parker S, Anagnostaki E, Mylona V, Lynch E, et al. (2020) Laser Analgesia Associated with Restorative Dental Care: A Systematic Review of the Rationale, Techniques, and Energy Dose Considerations. Dent J (Basel) 8: 128.
3. Kulkarni S, George R, Love R, Ranjitkar S (2022) Effectiveness of photobiomodulation in reducing pain and producing dental analgesia: a systematic review. Lasers Med Sci 37: 3011-3019.
4. Keller U, Hibst R, Geurtsen W, Schilke R, Heidemann D, et al. (1998) Erbium:YAG laser application in caries therapy. Evaluation of patient perception and acceptance. J Dent 26: 649-656.
5. Pelagalli J, Gimbel CB, Hansen RT, Swett A, Winn DW (1997) 2nd. Investigational study of the use of Er:YAG laser versus dental drill for caries removal and cavity preparation--phase I. J Clin Laser Med Surg 15: 109-115.
6. Dostálová T, Jelínková H, Krejsa O, Hamal K, Kubelka J, et al. (1997) Dentin and pulp response to Erbium:YAG laser ablation: a preliminary evaluation of human teeth. J Clin Laser Med Surg 15: 117-121.
7. Liang R, George R, Walsh LJ (2016) Pulpal response following photo-biomodulation with a 904-nm diode laser: a double-blind clinical study. Lasers Med Sci 31: 1811-1817.
8. Teo CYJ, George R, Walsh LJ (2018) Dispersion of near-infrared laser energy through radicular dentine when using plain or conical tips. Lasers Med Sci 33: 251-255.
9. Ren C, McGrath C, Yang Y (2015) The effectiveness of low-level diode laser therapy on orthodontic pain management: a systematic review and meta-analysis. Lasers Med Sci 30: 1881-1893.
10. Azma E, Safavi N (2013) Diode laser application in soft tissue oral surgery. J Lasers Med Sci 4: 206-211.
11. Huang Q, Li Z, Lyu P, Zhou X, Fan Y (2023) Current Applications and Future Directions of Lasers in Endodontics: A Narrative Review. Bioengineering (Basel) 10: 296.
12. Toopalle SV, Yadav I, Gupta A, Chauhan N, Abraham D, et al. (2023) Effect of Laser Therapy on Postoperative Pain and Endodontic Retreatment: A Systematic Review and Meta-Analysis. International Dental Journal 18: 00945.
13. Stübinger S (2010) Advances in bone surgery: the Er:YAG laser in oral surgery and implant dentistry. Clin Cosmet Investig Dent 2: 47-62.
14. Verma SK, Maheshwari S, Singh RK, Chaudhari PK (2012) Laser in dentistry: An innovative tool in modern dental practice. Natl J Maxillofac Surg 3: 124-132.
15. JW L (2008) Laser Analgesia with Pulsed Infrared Lasers: Theory and Practice. J Oral Laser Applications 8: 7-16.
16. Mankar N, Burde K, Agrawal P, Chandak M, Ikhar A, et al. (2023) Application of Low-Level Laser Therapy in Endodontics: A Narrative Review. Cureus 15: e48010.
17. Asnaashari M, Safavi N (2013) Application of Low-level Lasers in Dentistry (Endodontic). J Lasers Med Sci 4: 57-66.
18. Lee JH, Chiang MH, Chen PH, Ho ML, Lee HE, et al. (2018) Anti-inflammatory effects of low-level laser therapy on human periodontal ligament cells: in vitro study. Lasers Med Sci 33: 469-477.
19. Mokhtari MR, Ahrari F, Dokouhaki S, Fallahrastegar A, Ghasemzadeh A (2021) Effectiveness of an 810-nm Diode Laser in Addition to Non-surgical Periodontal Therapy in Patients with Chronic Periodontitis: A Randomized Single-Blind Clinical Trial. J Lasers Med Sci 12: e37.
20. Seifi M, Matini NS (2017) Laser Surgery of Soft Tissue in Orthodontics: Review of the Clinical Trials. J Lasers Med Sci 8: S1-S6.
21. Wamsley CE, Hoopman J, Kenkel JM (2021) Safety Guidelines Concerning the Use of Protective Eyewear and Gauze During Laser Procedures. Aesthet Surg J 41: 1179-1185.
22. Smalley PJ (2011) Laser safety: Risks, hazards, and control measures. Laser Ther 20: 95-106.