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### Low-Level Laser Therapy in Periodontology: A Review

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#### ABSTRACT

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Low Level Laser Therapy (LLLT) has emerged as a promising adjunct treatment for periodontal diseases, characterized by its anti-inflammatory and analgesic effects. This review assesses the efficacy of LLLT in managing periodontal conditions, highlighting its mechanisms of action, clinical applications, and outcomes. Studies suggest that LLLT promotes tissue healing, reduces pain, and enhances the effectiveness of conventional periodontal treatments. Furthermore, the review discusses the optimal parameters for laser application, including wavelength, energy density, and duration. Through an analysis of current clinical trials, this review aims to provide a comprehensive understanding of LLLT as a viable option in periodontal therapy.

#### Introduction

Periodontal diseases, primarily caused by bacterial infections, lead to inflammation and destruction of supporting tissues of the teeth. Traditional treatments, including scaling and root planing, aim to remove plaque and calculus, but often fall short in significantly improving patient outcomes.<sup>1</sup> In

recent years, Low Level Laser Therapy (LLLT) has garnered attention due to its non-invasive nature and ability to promote tissue regeneration. This introduction outlines the fundamental concepts of LLLT, its biological effects, and the rationale for its integration into periodontal treatment protocols. The review will explore current literature on LLLT's effectiveness, safety, and potential therapeutic roles

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in the management of periodontal diseases, setting the stage for further research and clinical applications.<sup>2</sup>

**Low-Level Laser Therapy:** Low-Level Laser Therapy (LLLT), commonly referred to as “Soft Laser Therapy,” has been utilized in healthcare for over three decades. The concept was first introduced by Mester and his colleagues, who demonstrated that laser applications at an energy density of 1 J/cm<sup>2</sup> could promote lesion repair in mice. LLLT employs red or infrared light, characterized by its low absorption in water, allowing it to penetrate both soft and hard tissues to depths ranging from 3mm to 15mm.<sup>3,4</sup>

The mechanism by which low-level lasers exert their therapeutic effects is complex. A key aspect of this process involves the absorption of light by sub-cellular photo-receptors, particularly in the electron transport chain of mitochondrial membranes. When light is absorbed by these components, it triggers a transient activation that leads to the oxidation of NADH. This oxidative phosphorylation process results in enhanced mitochondrial activity, subsequently revitalizing cellular function and promoting healing.

Moreover, LLLT is thought to influence various biological processes, including enhanced ATP production, improved collagen synthesis, and reduced inflammation. As a result, LLLT not only aids in tissue repair but also enhances the overall efficacy of traditional medical and dental treatments. The potential applications of low-level laser therapy span a wide range of conditions, making it a valuable tool in both clinical practice and ongoing research.

In summary, LLLT represents a significant advancement in therapeutic modalities, harnessing the power of light to stimulate healing and recovery at the cellular level. Continued exploration of its mechanisms and applications may further establish its role as a standard adjunctive treatment in various fields of medicine and dentistry.<sup>4-6</sup>

Low-Level Laser Therapy (LLLT) has garnered significant attention for its potential effects on inflammation, tissue repair, and pain modulation. Here’s a detailed examination of each of these areas:<sup>7-9</sup>

### Impact on Inflammation

**Reduction of Inflammatory Markers:** LLLT has been shown to decrease the levels of pro-inflammatory cytokines, such as interleukins and tumor necrosis factor (TNF). This reduction aids in minimizing the inflammatory response that typically follows injury or infection.

**Enhanced Blood Circulation:** The application of LLLT can improve microcirculation in the treated area. Enhanced blood flow facilitates the delivery of oxygen and nutrients while promoting the removal of waste products, thus contributing to the reduction of inflammation.

**Modulation of Immune Response:** LLLT influences immune cell activity. For instance, it can enhance the function of macrophages and lymphocytes, promoting a more

effective immune response while also controlling excessive inflammation.

**Inhibition of Matrix Metalloproteinases (MMPs):** LLLT can inhibit the activity of MMPs, enzymes that are involved in tissue degradation during inflammatory responses. By regulating these enzymes, LLLT helps maintain tissue integrity during the healing process.

### Impact on Tissue Repair

**Stimulation of Cell Proliferation:** LLLT promotes the proliferation of fibroblasts and other cells essential for tissue repair. This is crucial for wound healing, as fibroblasts are responsible for synthesizing collagen and extracellular matrix components.

**Promotion of Collagen Synthesis:** One of the significant effects of LLLT is its ability to stimulate collagen production, enhancing the structural integrity of tissues. Collagen is vital for the healing of wounds and the repair of damaged tissues.

**Activation of Mitochondrial Activity:** The effects of LLLT on mitochondrial activity lead to increased ATP production, which provides energy for various cellular functions, including repair and regeneration processes.

**Angiogenesis Promotion:** LLLT aids in the formation of new blood vessels (angiogenesis) in the healing tissue. This process is essential for ensuring that the repaired tissue receives adequate blood supply, nutrients, and oxygen.

**Enhanced Epithelialization:** In cases of wound healing, LLLT accelerates epithelial cell migration and proliferation, leading to quicker closure of wounds and restoration of skin integrity.

### Impact on Pain

**Analgesic Effects:** LLLT has been shown to provide pain relief in various conditions, including musculoskeletal disorders and postoperative pain. The mechanism involves modulation of peripheral and central pain pathways.

**Decreased Nociceptive Activity:** LLLT can reduce the activity of nociceptive (pain-sensing) neurons. This helps diminish the perception of pain at the site of injury or inflammation.

**Trigger Point Relief:** In myofascial pain syndromes, LLLT has been effective in alleviating pain associated with trigger points by promoting relaxation of muscle tissues and improving circulation.

**Endogenous Opioid Release:** LLLT may stimulate the release of endogenous opioids, such as endorphins, leading to natural pain relief within the body. This biochemical response enhances the overall pain management effects of the therapy.

**Neuroprotection:** LLLT may exert neuroprotective effects,

decreasing the susceptibility of nerve cells to damage and promoting regeneration and recovery in injured nerves.

**Objectives of Using LLLT in Periodontal Procedures:** The primary objective of using Low-Level Laser Therapy (LLLT) in periodontal diseases is to enhance the overall effectiveness of conventional treatments while promoting tissue healing and regeneration. LLLT aims to reduce inflammation and pain associated with periodontal conditions, facilitating a more comfortable treatment experience for patients. Additionally, it seeks to stimulate the proliferation of fibroblasts and the synthesis of collagen, thereby accelerating the healing of damaged periodontal tissues. Another key objective is to support the antimicrobial effects of standard periodontal therapies, helping to control bacterial infections that contribute to periodontal disease. By enhancing microcirculation and oxygenation in the affected areas, LLLT optimizes the conditions for tissue repair and regeneration, ultimately improving clinical outcomes in patients with periodontal diseases. Overall, the integration of LLLT into periodontal treatment protocols aims to promote faster recovery, reduce the risk of complications, and improve patient satisfaction.

**LLLT as adjunct to scaling root planning:**

LLLT can serve as a valuable adjunct to scaling and root planning (SRP) in periodontal treatment. By stimulating tissue repair, LLLT enhances healing in the gums after SRP procedures. It also plays a significant role in reducing inflammation, leading to a more comfortable recovery for patients. Additionally, LLLT may alleviate pain and discomfort associated with SRP, making the experience more tolerable. Its antimicrobial effects can help reduce harmful bacteria in periodontal pockets, contributing to improved clinical outcomes such as better attachment levels and decreased pocket depth. As a non-invasive treatment option, LLLT is suitable for a wide range of patients, including those who are cautious about more invasive procedures. Therefore, incorporating LLLT into the treatment plan can enhance the overall effectiveness of periodontal therapy while prioritizing patient comfort.<sup>10</sup>

Mathew PA et al. conducted a study comparing clinical parameters, HbA1c levels, and Tumor Necrosis Factor-alpha (TNF- $\alpha$ ) levels in gingival crevicular fluid in type 2 diabetes patients with chronic generalized periodontitis. Thirty patients were divided into two groups: a control group receiving scaling and root planing (SRP) only, and an experimental group receiving SRP along with six sessions of low-level laser therapy (LLLT). Results showed that all periodontal parameters, HbA1c, and TNF- $\alpha$  levels improved significantly in the experimental group after three months. The study concluded that adjunctive laser therapy positively affects clinical parameters and TNF- $\alpha$  levels for three months,

while it has sustained effects on HbA1c levels and plaque index for six months in type 2 diabetes mellitus patients.<sup>11</sup>

**LLLT in Gingivectomy:** Gingivectomy is a surgical procedure designed to remove supra-bony periodontal pockets, specifically those that do not extend beyond the muco-gingival junction. This technique is utilized for several purposes, including the elimination of diseased tissue for aesthetic or prosthetic reasons and the restoration of normal gingival architecture. After a gingivectomy, an open wound is created that can take more than five weeks to heal. During this healing period, patients may experience discomfort and pain associated with the open wound and the subsequent healing process. To address this, various studies have explored the use of medications, antibiotics, and amino acids to alleviate pain and expedite the repair process.

In a split-mouth randomized clinical trial titled "Clinical Study of the Gingiva Healing after Gingivectomy and Low-Level Laser Therapy," Amorim et al. studied 20 patients with increased gingival volume around premolar teeth. After performing gingivectomy, the test group received low-level laser therapy for 80 seconds immediately, and again at 24 hours, three days, and seven days post-operation. A diode laser with a 685 nm wavelength and 50 mW power in continuous mode was used. Periodontal dressings were applied and renewed at 24 hours, three days, and seven days post-op. Photographic images were captured on days 3, 7, 14, 21, and 45 following the surgeries to assess healing. The photographs were evaluated by three experienced periodontists based on tissue color, contour, and clinical wound condition. For biometrical assessment, a reference composite was placed at the medial section of the buccal plane to measure the distance to the gingival margin, pocket depth, and keratinized gingival distance. Clinical evaluations on day three post-op indicated better wound healing in the laser group, while biometric assessments showed more significant improvements on days 21 and 28. Overall, the study concluded that low-level laser therapy combined with gingivectomy leads to enhanced healing and quicker tissue repair.<sup>12</sup>

**Low-Level Laser and Periodontal Flaps:** Gingival recession is a common issue encountered during periodontal visits. When this recession leads to root sensitivity, aesthetic concerns, or caries, a treatment protocol becomes necessary. Various approaches exist to treat gingival recession, with one effective method being the Coronally Advanced Flap (CAF). Several techniques have been proposed to enhance the effectiveness of CAF as a treatment option, including the use of low-level laser therapy.

Ozturan S et al. explored the Coronally Advanced Flap (CAF) technique and its modifications in their research. They found that Low-Intensity Laser Therapy (LILT) can enhance wound healing. This split-mouth randomized controlled pilot study aimed to evaluate the effects of LILT on root

coverage following the CAF procedure for treating multiple-recession type defects (MRTDs). The study included ten patients with symmetrical Miller Class I and II gingival recessions, divided into two groups (37 sites each for test and control). A diode laser (588 nm) was applied to the test sites before and immediately after surgery, as well as daily for 5 minutes for 7 days post-operatively. Clinical measurements were used to compare the surgical sites. The results, within the study's limitations, suggested that LLLT may enhance the predictability of CAF when addressing multiple recessions.

**Low-Level Laser Therapy In Managing Aggressive Periodontitis:** Low-Level Laser Therapy is increasingly recognized as a supportive treatment for managing aggressive periodontitis, a condition known for rapid attachment loss and significant bone destruction. LLLT offers several benefits, including enhanced healing and tissue regeneration, which can help patients recover more quickly from periodontal procedures. Additionally, the therapy has anti-inflammatory properties that reduce swelling and discomfort associated with aggressive periodontitis, while also providing pain relief for affected individuals. Moreover, LLLT can assist in decreasing microbial activity in periodontal pockets, complementing traditional treatments like scaling and root planing. Research indicates that combining LLLT with conventional periodontal therapies may lead to improved clinical outcomes, such as reduced pocket depth and better attachment levels. As a non-invasive option, LLLT is suitable for a wide variety of patients, including those hesitant about more invasive interventions. Overall, LLLT presents a promising adjunctive treatment for aggressive periodontitis by promoting healing, alleviating inflammation and pain, and enhancing overall treatment effectiveness.<sup>14</sup>

### Advantages of LLLT in Periodontal Applications:<sup>15,16</sup>

1. Enhanced Healing
2. Reduced Inflammation
3. Pain Relief
4. Microbial Reduction
5. Improved Treatment Outcomes
6. Non-invasive
7. Quick Application

### Limitations of LLLT in Periodontal Applications:<sup>15,16</sup>

1. Variability in Response
2. Limited Depth Penetration
3. Cost
4. Lack of Standardization
5. Insufficient Evidence
6. Not a Standalone Treatment

**Future Prospective:** Future research should focus on standardizing LLLT protocols, assessing its effects over extended periods, and exploring its applications in different periodontal diseases. Investigating the optimal parameters for LLLT, such as wavelength, intensity, and treatment duration, will enhance its effectiveness. Additionally, integrating LLLT into comprehensive periodontal care guidelines could further establish its role in modern dentistry, paving the way for improved patient outcomes and treatments.

## Conclusion:

Low-Level Laser Therapy (LLLT) shows promising benefits in periodontal applications, enhancing healing, reducing inflammation, and improving clinical outcomes when used alongside traditional treatments. Its non-invasive nature and ability to alleviate pain make it an attractive option for managing various periodontal conditions, including aggressive periodontitis. However, the variability in response and limited research on long-term efficacy highlight the need for further investigation.

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