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ADVANTAGES AND LIMITATIONS OF LASER TECHNOLOGIES IN ENDODONTIC TREATMENT

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Abstract: This article explores the application of laser technologies in endodontic procedures, highlighting their effectiveness, advantages, and certain limitations. It analyzes laser-assisted root canal disinfection, pain reduction, and biostimulation capabilities. Research shows that laser technologies significantly enhance the quality of dental treatment; however, proper application is crucial for achieving optimal outcomes.

Keywords: Endodontics, endodontic treatment, laser technologies, diode laser, canal disinfection, biostimulation, painless dentistry, minimally invasive procedures, root canal sterilization, photothermal effect, pulpitis, periodontitis.

Introduction

Endodontics is a branch of dentistry that studies the structure and function of the dental pulp and periapical tissues, as well as therapeutic methods for treating pathological changes resulting from trauma, pulpitis, periodontitis, and other conditions. The endodontium consists of morphologically and functionally interconnected tissues of the pulp and dentin. These are linked via odontoblastic processes that pass through dentinal tubules.

Endodontic treatment is commonly applied in cases of pulp inflammation (pulpitis) or necrosis. The main objective of such procedures is to remove infected tissues, disinfect the root canal, and ensure proper sealing. Traditional methods typically involve chemical irrigants such as sodium hypochlorite (NaOCl) and EDTA. However, these approaches often fail to eliminate bacteria residing in deeper layers.

In recent years, the use of laser technologies in dentistry has gained increasing scientific and clinical interest. Laser beams exert therapeutic effects through thermal, photoactivation, and bioactivation mechanisms. Laser approaches offer notable advantages, especially in cleaning complex root canal systems, reducing pain, and eliminating infections.

The integration of laser technology into endodontic procedures is a key direction in modern dentistry, improving treatment quality and accelerating patient recovery. Various laser types are currently employed in root canal therapy, differing in wavelength and tissue interaction.

• Er:YAG laser (2940 nm) is highly effective in moist environments due to its sensitivity to water. It thoroughly removes the smear layer on dentin surfaces and smoothens the canal walls.
• Nd:YAG laser (1064 nm) is ideal for eliminating deeply located bacteria within the canal, providing smooth canal walls and targeting microorganisms causing inflammation.
• Diode laser (810–980 nm) is widely used for disinfection, pain relief, and inflammation reduction, due to its strong interaction with blood pigments and natural tissue components.

Key benefits of laser technologies in endodontic procedures include:
• Infection elimination: Laser energy disrupts the genetic structure of microorganisms, facilitating deep tissue disinfection—particularly effective against resistant bacteria like Enterococcus faecalis.
• Pain reduction: Low-level laser therapy (LLLT) soothes nociceptive nerve endings, reducing postoperative discomfort and enhancing treatment comfort.
• Accelerated tissue regeneration: Laser stimulation enhances cellular activity and promotes new cell formation, enabling faster healing of damaged tissues.
• Efficient smear layer removal: Er:YAG lasers eliminate smear layers within the canal, improving adhesion of sealing materials.

Research Findings
A review of relevant literature highlights the following major advantages of laser technologies in endodontic practice:

1. Disinfection Efficiency:
Gutknecht N. (2015) conducted a study involving 60 patients divided into two groups:
- Group 1: Conventional method using NaOCl irrigation
- Group 2: Er:YAG laser-assisted canal disinfection

Results: In Group 2, 93% of patients reported pain relief within three days. Re-infection was observed two times less frequently than in Group 1. Inflammation reactions resolved almost entirely within a week.

2. Smear Layer Removal:
According to Olivi G. and DiVito E. (2016), laser treatment effectively removed the smear layer and bacterial biofilm from the dentinal walls, ensuring optimal adhesion of the filling material to the canal surface.

3. Pain Reduction and Healing Time:
Studies have shown that patients treated with diode lasers experienced significantly lower postoperative pain. Moritz A. (2017) reported that patients treated with diode lasers had an average VAS pain score of 2, compared to 5–6 in those treated with conventional methods.

4. Biostimulation and Tissue Recovery:
Low-intensity laser therapy (LLLT) was found to activate fibroblasts and osteoblasts, accelerating the regeneration of inflamed tissues.

Conclusion
Numerous studies and clinical observations confirm that laser-assisted endodontic treatment offers significantly greater effectiveness than conventional methods. Laser disinfection using Er:YAG, Nd:YAG, and diode lasers allows for deep microbial elimination, smear layer removal, and faster tissue regeneration.

Research demonstrates that patients treated with lasers experience less pain, shorter recovery

times, reduced recurrence of inflammation, and decreased reliance on antibiotics.

However, the broader implementation of laser technology in dental practice requires consideration of several factors: high equipment costs, the need for well-trained professionals, correct parameter settings, and thorough understanding of clinical protocols.

It is important to note that laser therapy should complement, not replace, traditional methods. Its role lies in enhancing treatment outcomes within an integrated approach to endodontic care.

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