Journal of Lasers in Medical Sciences

J Lasers Med Sci 2026;17:e50692 | Review Article

http://journals.sbmu.ac.ir/jlms | doi:10.34172/jlms.50692

Laser Therapy in the Management of Endodontic-Periodontal Lesions: A Comprehensive Review of Clinical Efficacy and Therapeutic Applications

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Received: October 2, 2025
Accepted: November 22, 2025
ePublished: July 22, 2026

Abstract

Introduction: Endodontic-periodontal lesions (EPLs) are diagnostically and therapeutically challenging owing to dual pulpal–periodontal involvement and overlapping clinical features. Conventional management, including scaling and root planing (SRP) and standard endodontic therapy, may fail to achieve predictable outcomes due to persistent microbial contamination and the limitations of mechanical debridement.

Methods: PubMed, Scopus, Web of Science, and Embase were searched for studies published between 1988 and 2025 on laser therapy in EPLs and related endodontic and periodontal conditions. Clinical, experimental, and review articles on diode or other laser approaches relevant to EPL were extracted and qualitatively analyzed.

Results: Two recent randomized clinical trials and one comparative clinical study suggest that an adjunctive 940-nm diode laser may improve probing depth (PD) reduction, clinical attachment level (CAL) gain, and radiographic bone changes when added to conventional endodontic–periodontal therapy. Additional case reports, clinical series, and in vitro studies support the bactericidal effects of diode lasers in root canals and periodontal pockets, as well as enhanced decontamination through laser-activated irrigation and antimicrobial photoactivated disinfection. These studies also highlight benefits for photobiomodulation, wound healing, and pain reduction. However, the evidence base is limited by small sample sizes, heterogeneous laser parameters, variable study designs, and a lack of standardized protocols and long-term outcomes.

Conclusion: Within the limits of the available evidence, diode lasers appear to be a promising adjunct in EPL management, with potential benefits for microbial control and tissue healing when combined with established endodontic and periodontal therapies. Further well-designed studies are required to establish standardized protocols and to confirm long-term efficacy and safety.

Keywords: Laser therapy, Endodontic-periodontal lesions, Endodontics, Periodontics

Introduction

Background on Endodontic-Periodontal Lesions (EPLs)

Endodontic-periodontal lesions (EPLs) represent a significant diagnostic and therapeutic challenge in modern dentistry due to their intricate interplay between the periodontal and endodontic tissues.[1] These lesions can occur in individuals both with and without pre-existing periodontal disease. The pathological communication between the pulp and the periodontium in true combined EPL poses significant clinical challenges, particularly in terms of accurate diagnosis, appropriate treatment planning, and reliable prognosis prediction.[2,3]

These lesions arise from anatomical or pathological pathways that establish communication between the pulp and the periodontium, including exposed dentin, accessory canals, apical foramina, and root fractures. Given their complex etiology, EPLs can occur in both periodontally healthy individuals and those with pre-existing periodontitis, complicating treatment planning and clinical decision-making.[1]

This review aims to provide a comprehensive assessment of the efficacy of diode laser therapy in managing EPLs by synthesizing findings from clinical trials and exploring its therapeutic advantages, limitations, and potential integration into contemporary dental practice.[1]

The lesions are categorized into two main groups, as outlined in the Table 1. This classification enables clinicians to determine whether EPLs are associated with

Please cite this article as follows: Semyari H, Etemadi A, Astaraki P, Ahmadian-Moghadam H, Semyari H. Laser Therapy in the Management of Endodontic-Periodontal Lesions: A Comprehensive Review of Clinical Efficacy and Therapeutic Applications. J Lasers Med Sci 2026;17:e50692. doi:10.34172/jlms.50692

Table 1. Classification of EPL

Category	Subcategory	Description
EPL with Root Damage	Root Fracture or Cracking	Lesions associated with a fractured or cracked root can lead to bacterial infiltration and infection.
	Root Canal or Pulp Chamber Perforation	Lesions caused by iatrogenic or pathological root canal or pulp chamber perforations allow bacterial invasion.
	External Root Resorption	Progressive loss of the root structure due to resorptive processes, often caused by trauma, inflammation, or orthodontic treatment.
EPL without Root Damage	EPL in Periodontitis Patients	Lesions occurring in patients with pre-existing periodontal disease are further classified into:
	Grade 1	Narrow, deep periodontal pocket on one tooth surface.
	Grade 2	Wide, deep periodontal pocket on one tooth surface.
	Grade 3	Deep periodontal pockets on multiple tooth surfaces.
	EPL in Non-Periodontitis Patients	Lesions occurring in patients without pre-existing periodontal disease are further classified into:
	Grade 1	Narrow, deep periodontal pocket on one tooth surface.
	Grade 2	Wide, deep periodontal pocket on one tooth surface.
	Grade 3	Deep periodontal pockets on multiple tooth surfaces.

Abbreviation: Endodontic-periodontal lesions (EPL)

root damage or occur without it, and to differentiate between cases with and without periodontitis. The grading system also guides treatment decisions by assessing lesion severity and prognosis.[2]

Definition and etiology

Endodontic-periodontal lesions (EPLs) are complex conditions that arise from the interplay between endodontic and periodontal diseases. They are characterized by infection in the pulp and surrounding periodontal tissues, often leading to significant tissue destruction. The etiology of EPLs is multifactorial, involving bacterial colonization, particularly by pathogens such as *Actinobacillus actinomycetemcomitans*, which is known to contribute to periodontal tissue loss despite mechanical treatment.[3,4] Results show that various factors, including bacterial infections, trauma, and systemic diseases, can contribute to their development. The presence of a smear layer, which can hinder effective treatment, is often noted in these lesions.[5]

EPLs are characterized by the simultaneous involvement of both the pulp and periodontal tissues, resulting in a complex pathological condition that presents significant challenges in diagnosis and treatment. These lesions arise from the anatomical connections between the root canal system and the periodontium, including apical foramina, lateral and accessory canals, and dentinal tubules. Additionally, pathological factors such as root fractures or perforations can further complicate communication between these structures, making diagnosis more intricate.[1]

EPLs can manifest in patients with or without periodontitis, adding to their diagnostic complexity. In periodontally healthy individuals, EPLs often result from primary endodontic infections that extend into the periodontal structures. In contrast, bacterial invasion can progress from the periodontal pocket to the root canal system in patients with periodontal disease. Regardless of the primary origin, these lesions frequently present with overlapping clinical signs, including deep periodontal pockets, periapical radiolucencies, tooth mobility, and pain, making it difficult to determine whether the condition is primarily endodontic or periodontal in nature.[1]

Although mixed anaerobic flora is typical for both pathologies, in their isolated presentation, the species composition in the periodontal pocket and root canal differs. In the case of combined EPLs, the pathogenic anaerobic microflora detected in the periodontal pocket and in the root canal of the teeth is identical.[6]

Given the complexities associated with EPLs, evidence-based treatment approaches are essential. Simultaneous endodontic and periodontal interventions have been shown to yield favourable clinical outcomes by reducing probing depth, improving clinical attachment levels, and enhancing bone defect fill. However, further research is needed to refine diagnostic protocols and optimize therapeutic strategies to achieve predictable and long-term success in EPL management.[1]

Challenges in diagnosis and treatment

Early diagnosis and prompt treatment planning are critical for the successful management of EPLs. In cases where lesions are associated with advanced periodontitis surrounding the affected teeth or with vertical root fractures (VRF), the prognosis is generally unfavorable.[7,8] Nevertheless, accurate diagnosis and appropriate intervention by specialists, combined with patient adherence and comprehensive periodontal therapy, can lead to favorable outcomes in carefully selected cases. Moreover, addressing individual predisposing and risk factors (including smoking, parafunctional habits, diabetes, malocclusion, and adherence to regular recall visits) is essential for improving long-term treatment success.[7,8]

One significant challenge is diagnostic complexity, as EPLs involve both endodontic and periodontal infections, making it difficult to determine their primary source. Advanced imaging techniques, such as Cone beam computed tomography (CBCT), have improved diagnostic accuracy; however, proper interpretation requires specialized training. This can lead to misdiagnosis, affecting treatment planning and prognosis.[9–11]

Another challenge is persistent microbial contamination, where pathogens from periodontal pockets and infected root canals share similarities. Bacteria such as Tannerella forsythia, Porphyromonas gingivalis, and *Aggregatibacter actinomycetemcomitans* are present in both environments. Additionally, bacterial colonization in the outer 300 µm of dentinal tubules creates a reservoir for reinfection, thereby increasing the difficulty of complete decontamination [11–13] . The Table 2 summarizes the EPL treatment challenges.

Mechanisms of Laser action in periodontal and endodontic tissues

Lasers operate by delivering focused light energy that can selectively target tissues. Lasers can effectively decontaminate root canals and periodontal pockets in endodontic-periodontal lesions, promoting tissue regeneration and reducing inflammation. The ability of lasers to penetrate tissues allows for the effective removal of bacteria and necrotic tissue, which is crucial in managing infections associated with these lesions.[14]

Erbium-Doped Yttrium Aluminium Garnet (Er:YAG) Lasers: These lasers, operating at a wavelength of 2940 nm, are strongly absorbed by water molecules, leading to rapid expansion, vaporization, and micro-explosions within the target tissue.[15] Er:YAG-based laser-activated irrigation has been demonstrated to effectively open dentinal tubules by removing the smear layer[16,17] and to facilitate the disruption and elimination of bacterial biofilms.[18,19]

Neodymium-Doped Yttrium Aluminium Garnet (Nd:YAG) and Diode Lasers: These lasers exhibit strong bactericidal effects. The diode laser (810–980 nm) is widely used in periodontal therapy to reduce microbial load and inflammation.[20,21] Diode lasers can significantly reduce bacterial populations in periodontal pockets and root canals, particularly in cases involving Enterococcus faecalis and Porphyromonas gingivalis.[22]

Photobiomodulation, also known as LLLT, can be promoted by diode lasers, which stimulate tissue regeneration and healing by enhancing fibroblast proliferation and improving local microcirculation. This is particularly relevant in regenerative periodontal protocols.[23,24]

Lasers used in periodontics are broadly categorized into high-power and low-power systems. High-power lasers (HPL) are applied in soft tissue and osseous periodontal surgery, sulcular debridement, root surface decontamination, and as an adjunct to SRP.[25,26]

Among nonsurgical approaches, the neodymium-doped yttrium aluminum garnet (Nd:YAG; 1,064 nm), erbium-doped yttrium aluminum garnet (Er:YAG; 2,940 nm), erbium, chromium-doped yttrium, scandium, gallium, garnet (Er,Cr:YSGG; 2,780 nm), and high-power diode lasers (DL; 808–904 nm) are the most commonly employed.[25,26]

Clinical evidence suggests that combining diode laser therapy with SRP in patients with moderate to severe periodontitis provides additional benefits compared to SRP alone, while the Er:YAG laser has been shown to achieve outcomes comparable to conventional nonsurgical techniques.[25,26]

In surgical settings, gingival and mucosal vaporization procedures can be performed with diode, CO_2, Nd:YAG, Er:YAG, and Er,Cr:YSGG lasers. Low-level lasers (LLL), on the other hand, are widely used for their photobiomodulation (PBM) effects, which reduce inflammation, accelerate surgical wound healing, and alleviate postoperative pain. In addition, LLL serve as light sources for activating photosensitizing agents in antimicrobial photodynamic therapy (aPDT), further expanding their therapeutic applications in periodontics.[25,26]

Material and Methods

Search Strategy

A comprehensive literature search was conducted to identify studies on the use of laser therapy in the management of endodontic–periodontal lesions and related endodontic and periodontal conditions. The PubMed, Scopus, Web of Science, and Embase databases were systematically searched for articles published between 1988 and 2025. The search combined terms related to endodontic–periodontal lesions and laser therapy (e.g. "endodontic-periodontal lesions," "endo-perio," "combined endodontic-periodontal," "laser," "diode laser," "photodynamic therapy," "laser-activated irrigation") using Boolean operators. The search initially

Table 2. EPL Treatment Challenges

Challenge	Description	Impact on Treatment
Diagnostic Complexity	CBCT imaging helps improve diagnosis but requires specialized training. Overlapping bacterial populations make it difficult to determine whether the infection is primarily endodontic or periodontal.	Misdiagnosis can lead to ineffective treatment and further disease progressio.
Persistent Microbial Contamination	Bacteria from periodontal pockets and root canals are similar and can survive deep within dentinal tubules, increasing the risk of recolonization.	Reinfection is likely, requiring repeated interventions or additional therapies.
Treatment Limitations and Clinical Uncertainty	Traditional mechanical debridement (SRP and SRD) is necessary but not statistically significant in eliminating bacteria. Manual and ultrasonic methods have limitations.	Increases the need for adjunctive treatments, such as lasers or antimicrobial solutions.
Endodontic Challenges and Laser-Assisted Treatment	Various endodontic protocols (CLE, aPAD, LAI) and laser treatments (diode and erbium lasers) aim to improve decontamination but lack standardized protocols.	The effectiveness of laser therapy depends on specific parameters that require further research.

Abbreviations: Antimicrobial Photo-Activated Disinfection (aPAD), Cone beam computed tomography (CBCT), Conventional Laser Endodontics (CLE), Laser-Activated Irrigation (LAI), Surface Root Debridement (SRD), Scaling and Root Planing (SRP).

yielded 531 records. After removal of 51 duplicates, 480 unique records remained for title and abstract screening. Of these, 287 were excluded as clearly unrelated to EPLs or laser therapy. The full texts of the remaining 193 articles were assessed for eligibility, and 100 were excluded (e.g., studies with insufficient methodological detail), resulting in 93 studies that met the inclusion criteria and were included in the qualitative synthesis (Figure 1).

Eligibility Criteria

Studies were included if they met one or more of the following criteria: (1) original in-vivo clinical studies (randomized controlled trials, controlled clinical trials, cohort studies, case series or case reports) in which laser therapy was used in the management of endodontic–periodontal lesions or in endodontic/periodontal conditions directly relevant to EPL treatment; (2) in-vitro or ex-vivo experimental studies evaluating laser-activated irrigation, decontamination or photodynamic therapy in endodontic, periodontal or combined models pertinent to EPLs; and (3) systematic, scoping or narrative reviews and expert consensus documents addressing EPL diagnosis, classification or laser-assisted management. Original clinical and experimental studies served as the primary evidence base and are summarized in the tables. Review articles and consensus papers were used to provide contextual and interpretive background. Exclusion criteria included conference abstracts, letters, opinion pieces lacking sufficient methodological detail, animal-only studies, and articles without transparent outcome reporting.

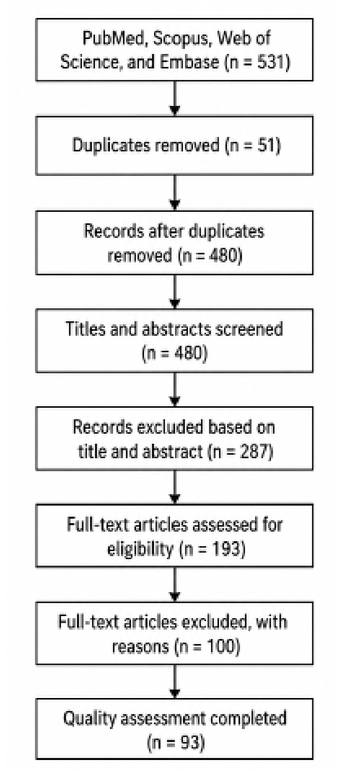

Figure 1. PRISMA flow diagram illustrating the identification, screening, eligibility assessment, and inclusion of studies

Results and Discussion

Pathophysiology and Diagnostic Complexity of EPLs

Communication Pathways Between Pulp and Periodontium

The evidence suggests that the structural and functional relationship between the pulp and periodontium is crucial in the development and management of EPLs. The pulp and periodontium are interconnected through three primary pathways: 1) Main Root Canals: The primary channel for communication between the pulp and periodontal tissues, allowing the spread of infection, 2) Lateral and Accessory Canals: These small canals extend from the pulp to the periodontal ligament, enabling bacterial migration, and 3) Dentinal Tubules: Microscopic channels in the dentin that facilitate the movement of bacteria and inflammatory mediators between the pulp and periodontium.[2,4,27–29]

Moreover, cumulative evidence suggests that advanced periodontitis results in the loss of connective tissues and an increase in periodontal pocket depth. Over time, secondary changes occur in the pulp, initially presenting as reversible pulpitis but progressing to irreversible inflammation if untreated. This interconnected nature of EPLs complicates diagnosis and treatment, requiring a combined endodontic and periodontal approach to manage the condition effectively. It is noteworthy that the communication pathways between the pulp and periodontium are critical in understanding EPLs, as they can facilitate the spread of infection and inflammation [2,4,27–30]. The dental pulp and periodontium maintain an intimate anatomical connection primarily through the apical foramen, lateral root canals, and accessory canals. In addition, dentinal tubules may provide a pathway for communication between these two tissues. Collectively, these structures constitute the three principal routes of interaction, forming the anatomical foundation for the development of EPLs. When infection arises, microorganisms and their byproducts can migrate through these channels, facilitating the bidirectional spread of pathology between the pulp and periodontal tissues.[31]

Evidence suggests that periodontal pockets and infected root canals share highly similar bacterial species, indicating these infections are interconnected. Specific anaerobic bacteria, including *Tannerella forsythia*, *Porphyromonas gingivalis*, and *Aggregatibacter actinomycetemcomitans*, have been identified as dominant pathogens in both environments.[11,13]

Additionally, the evidence highlights that bacteria colonize the outer 300 μm of dentinal tubules, forming reservoirs that can lead to bacterial recolonization even after treatment.[12] Other commonly detected bacteria include Streptococcus, Peptostreptococcus, Eubacterium, Bacteroides, and Fusobacterium. These microorganisms thrive in anaerobic conditions, contributing to the persistence and progression of EPLs.[11,13]

The presence of bacteria in both the endodontium and periodontium suggests that successful EPL treatment must simultaneously address infection in both areas. The document recommends a dual approach, combining mechanical debridement (SRP) with antimicrobial therapies effectively to reduce bacterial loads and prevent reinfection.[11,13,32]

Clinical and Radiographic Diagnosis

Patients with EPLs may present with a variety of symptoms, including pain, swelling, and impaired tooth mobility. Radiographically, these lesions can manifest as periapical radiolucencies or bone loss around the affected teeth. Clinical examination often reveals periodontal pockets with significant depth, which can be indicative of an underlying infection.[3–5] Moreover, clinical presentations of EPLs include deep periodontal pockets, bone resorption, and altered pulp responses, which can complicate diagnosis.[30]

The evidence suggests the use of clinical PD, clinical attachment level (CAL), and radiographic bone fill as diagnostic tools to assess treatment outcomes in EPL patients. Diagnosing EPLs can be challenging due to overlapping symptoms with other dental conditions. Diagnostic tools include probing to assess periodontal pocket depth and imaging techniques such as periapical radiographs. Evidence suggests that the use of lasers, such as the 980-nm diode laser, has shown promise in enhancing treatment efficacy by providing antimicrobial effects.[3,4,30,33,34]

Diode Laser Technology in Dentistry

Wavelengths commonly used in EPL management

The evidence reveals the applications of diode lasers in periodontal and endodontic treatments, particularly highlighting the 940 nm wavelength due to its bactericidal effects, soft tissue debridement, and wound healing properties.[35]

In periodontal therapy, diode lasers are used as an adjunct to SRP, enhancing bacterial reduction in periodontal pockets. They target anaerobic bacteria responsible for bone loss, thereby reducing bone lysis and improving tooth retention. The document suggests that laser-assisted therapy significantly reduces periodontal pocket depth, thereby minimizing inflammation and promoting better healing outcomes [36].

For endodontic applications, diode lasers play a crucial role in LAI. This technique involves placing a 200–400 µm fiber optic applicator approximately 4 mm from the apex to deliver laser energy, allowing for deeper penetration into dentinal tubules and lateral canals [5,37]. The combination of diode laser, 5.25% NaOCl solution, and 17% EDTA ensures 100% elimination of Enterococcus faecalis, a key pathogen in persistent root canal infections.[38]

However, while studies support diode lasers as a beneficial adjunct in EPL treatment, the document acknowledges variability in laser settings, power ranges (0.84W to 2.5W), and treatment protocols, making direct comparisons between studies challenging. Further research is needed to establish standardized guidelines for diode lasers used in periodontal and endodontic therapies.[27,39–43] The Table 3 summarizes the application of diode lasers in EPL management.

Another piece of evidence in the field of peri-implantitis suggests that adjunctive 940 nm diode laser therapy with nonsurgical debridement yields early improvements in clinical indices and lower PICF levels of IL-1β, IL-17, and sclerostin at 3 months, with no between-group differences by 6 months.[44] Moreover, another piece of evidence in the field of gingival depigmentation suggests that both ablative 940 nm and non-ablative 445 nm techniques improve pigmentation indices (DOPI/MI/GPI); 940 nm achieves greater pigmentation reduction, while 445 nm produces less 24-hour postoperative discomfort[44] (Table 3).

Therapeutic Mechanisms in EPL Treatment

Antimicrobial action

The use of non-toxic intracanal therapeutic medicaments is crucial for destroying bacteria and encouraging tissue healing.[49] The evidence briefly notes that the diode laser has additional antibacterial effects, which can be beneficial for the regeneration of periodontal tissues.[47] Further evidence demonstrated that the 980-nm diode laser possesses significant antimicrobial properties, effectively reducing bacterial counts in the root canal and periodontal pockets. This laser wavelength has been shown to eliminate bacteria that have penetrated deep into dentin, thus improving treatment outcomes in endodontic therapy.[3,4,34]

Decontamination of root canals and periodontal pockets

Despite thorough cleaning and disinfection during endodontic treatment, bacteria from periodontal lesions may re-invade the root canal system.[49] The evidence demonstrates that the diode (980 nm) laser completely removes the pocket epithelium when used on periodontal tissues.[47] Moreover, Evidence showed that laser therapy possesses significant antimicrobial properties, effectively reducing the bacterial load in both root canals and periodontal pockets. Laser therapy facilitates the decontamination of root canals and periodontal pockets by delivering energy that disrupts bacterial cell walls and promotes the removal of biofilms. This is particularly important in cases where traditional mechanical cleaning methods might be insufficient.[41] Lasers can enhance the decontamination process of infected root canals and periodontal pockets, promoting a cleaner environment for healing.[4] Another piece of evidence suggests that a single session of Nd:YAG laser treatment can eliminate endotoxins, comparable to calcium hydroxide treatment, over a period of seven days.[3,4,35]

Stimulation of tissue healing and bone regeneration

The timing of endodontic treatment (ET) is crucial, as it can significantly impact the outcome of periodontal treatment, promoting a more favorable environment for tissue repair.[49] The findings indicate that the diode laser provides adequate coagulation without damaging adjacent healthy tissues and may stimulate new bone formation when applied correctly.[47] Another piece of

Table 3. Applications of Diode Lasers in EPL Management

Application	Description from Document	Wavelength & Benefits	References
Periodontal Therapy	Used as an adjunct to SRP to enhance bacterial reduction in periodontal pockets and to support healing in endodontic–periodontal lesions when combined with endodontic treatment.	940 nm: Reduces periodontal pocket depth, minimizes bone loss, and improves tooth retention. In randomized EPL trials, adjunctive 940-nm diode laser significantly improved probing depth reduction, clinical attachment gain and radiographic bone defect/bone density outcomes compared with conventional therapy alone.	Saydjari et al. [35]; Dembowska et al. [11]; Behera et al. [45]
Bacterial Elimination	Targets anaerobic bacteria responsible for EPLs, such as *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans*; can be used intracanal and in periodontal pockets as an adjunct to chemomechanical debridement.	940 nm: Strong bactericidal effect due to high absorption in melanin and hemoglobin, enhancing disinfection in root canals and pockets and supporting improved clinical outcomes in EPL when used as an adjunct.	Wadhwa et al. [38]; Dembowska et al. [11]; Behera et al. [45]
Laser-Activated Irrigation (LAI)	Uses a 200–400 µm fiber optic applicator placed short of the apex to deliver laser energy for root canal disinfection, improving penetration of irrigants and disruption of biofilm.	940 nm: Enhances dentinal tubule penetration, improving endodontic decontamination; in EPL settings, intracanal 940-nm diode LAI combined with periodontal lasing contributed to greater pocket reduction and bone fill vs non-laser protocols.	George et al. [46]; Sippus et al. [37]; Dembowska et al. [11]
Combination with Irrigants	Used alongside 5.25% NaOCl and 17% EDTA solutions in root canal disinfection to enhance smear-layer removal and microbial killing.	940 nm: Achieves near-complete elimination of Enterococcus faecalis in experimental models and augments conventional irrigants, thereby reducing reinfection risk.	Wadhwa et al. [38]
Soft Tissue Debridement & Healing	Facilitates epithelial removal, degranulation, and photobiomodulation, promoting tissue healing in periodontal pockets associated with EPL.	940 nm: Stimulates angiogenesis, collagen synthesis, and hemostasis; when used around EPL-affected teeth, it contributes to improved soft-tissue healing, alongside the radiographically visible hard-tissue changes.	Romanos et al. [47]; Sgolastra et al. [32]; Dembowska et al. [11] Behera et al. [45]
Limitations & Variability	Laser settings, power ranges (0.84–2.5 W), modes (continuous vs pulsed), and clinical protocols differ between studies; only a few EPL-specific randomized trials are available.	800–1064 nm: Parameter variability limits direct comparison and standardization of protocols. Despite promising results with 940-nm diode lasers in two EPL randomized trials, more high-quality studies are required to define optimal settings and indications.	Caruso et al. [39]; Kamma et al. [42]; Dukić et al. [43]; Yadwad et al. [40]; Fenol et al. [27]; Lopes et al. [41]; Dembowska et al. [11]; Behera et al. [45]
Periimplantitis	An adjunctive diode laser is used with mechanical debridement to support early clinical improvement and inflammation control around implants.	940 nm: At 3 months, adjunctive diode with nonsurgical debridement improved clinical indices and significantly reduced PICF IL-1β, IL-17, and sclerostin; no significant between-group differences at 6 months.	Erduran et al. [48]
Gingival Depigmentation	Laser-assisted removal of melanin-associated gingival pigmentation to improve esthetics.	940 nm: A split-mouth RCT comparing 940 nm ablative vs 445 nm non-ablative treatments showed both improved esthetics; 940 nm achieved a greater reduction in DOPI/MI/GPI, while 445 nm had less 24-h postoperative discomfort.	Singh et al. [44]

Abbreviations: Ethylene DiamineTetraacetic Acid (EDTA), Scaling and Root Planing (SRP), Sodium Hypochlorite (NaOCl), Dummet Gupta Oral Pigmentation Index (DOPI), Melanin Index (MI), Gingival Pigmentation Index (GPI)

evidence suggests that laser therapy not only aids in decontamination but also stimulates tissue healing and bone regeneration, which are vital for the recovery of affected teeth. The findings suggest that laser applications can enhance the healing process in EPL cases.[41]

Additional evidence suggests that laser therapy targets bacteria and also stimulates tissue healing and bone regeneration. The application of the 980-nm diode laser has been associated with enhanced healing responses in periodontal tissues, contributing to improved clinical outcomes.[33] Moreover, laser therapy has been linked to enhanced healing and regeneration of bone and soft tissues. The thermal effects of the laser promote tissue repair processes, which are crucial in managing EPLs.[3]

Clinical Applications of Diode Laser in EPL Management

The evidence showed that the laser-assisted group experienced significantly better outcomes, including a notable reduction in pocket depth, decreased bone loss, and improved tooth mobility, bringing it closer to physiological levels. These findings suggest that incorporating a diode laser into conventional treatment protocols can enhance the overall efficacy of periodontal and endodontic therapy.[11]

Another piece of evidence suggests that diode lasers may enhance periodontal healing by reducing the bacterial load and improving the efficacy of debridement.[1]

In addition to periodontal improvements, bone regeneration following diode laser application was notably superior in the treated groups. Another piece of evidence suggested a significant increase in bone defect fill in the experimental group (52.5%) compared to the control group (27%) ($P < 0.05$), reinforcing the potential of diode lasers in promoting osteogenic activity and accelerating periodontal repair. Furthermore, diode laser therapy was associated with reduced tooth mobility, indicating improved periodontal stability.[1]

These findings highlight the potential role of diode laser therapy as an effective adjunct in the management of EPL. Diode laser treatment may be a valuable tool for improving treatment outcomes in patients with EPLs by facilitating bacterial reduction, enhancing soft tissue healing, and contributing to bone regeneration. However, while these preliminary findings are encouraging, further randomized controlled trials with long-term follow-ups are necessary to establish standardized protocols and confirm the long-term efficacy of diode laser therapy in clinical practice.[1]

Additional evidence demonstrated that combining a diode laser as an irrigation activation system (IAS) and applying it to buccal and palatal mucosa resulted in significant pain reduction over 14 days [50]. Additionally, it suggests that diode lasers can activate irrigation solutions, creating rapid turbulence that enhances the efficacy of root canal cleaning.[51–54] This mechanism, also known as LAI, improves the removal of bacterial biofilms and debris from infected canals.[55,56]

Another piece of evidence suggests that the complete removal of the pocket epithelium by the diode laser may be advantageous in EPL management, potentially retarding epithelial down-growth and creating a more favorable environment for connective tissue reattachment and bone regeneration. Although the study does not directly report on long-term periodontal healing or regenerative outcomes, the immediate histological results suggest that diode laser application may enhance the clinical efficacy of combined endodontic-periodontal treatment protocols.[47]

Although these findings are encouraging, it is important to note that many of the studies cited are small case series or single-case reports, often without control groups or long-term follow-up. In addition, several of the laser protocols were developed for chronic periodontitis or general endodontic disinfection rather than specifically for true combined EPLs. As a result, the clinical benefits observed cannot yet be generalized to all EPL scenarios, and the current evidence should be viewed as hypothesis-generating rather than definitive.

Adjunct to Endodontic Treatment

In endodontics, lasers enhance canal disinfection when used in conjunction with mechanical instrumentation. When used adjunctively with NaOCl and EDTA, diode lasers enhance microbial elimination. In endodontics, lasers enhance canal disinfection when used in conjunction with mechanical instrumentation. When used in conjunction with NaOCl and EDTA, diode lasers enhance microbial elimination.[57–59] Evidence confirmed that these outcomes depend on the proper selection of laser wavelength, output power, duration, and mode of application.[57]

Adjunct to Periodontal Treatment

Accumulative evidence suggested the application of SRP combined with diode laser therapy (non-aPDT) for periodontal pocket decontamination. After six months of treatment, the PD reduced from 10 mm to 3 mm, indicating significant improvement. Combining SRP and diode laser therapy enhanced periodontal healing and reduced tooth mobility. These findings support the claim that diode laser-assisted SRP provides better results than SRP alone.[60,61] Another study suggests that Er:YAG lasers may increase root roughness post-SRP, although the difference was not statistically significant compared to conventional debridement. However, since diode lasers were not tested, separate clinical studies should support claims about their impact on root surfaces and bacterial removal.[62] In periodontics, adjunctive laser application with SRP results in improved clinical parameters in some studies (such as reductions in bleeding on probing (BOP), PD, and inflammatory markers). However, results vary depending on the type of laser and protocol.[57]

One of the significant advantages of laser therapy is its ability to minimize the risk of introducing bacteria during the healing phase. Traditional methods may involve the aggressive removal of periodontal tissues, which can adversely affect healing. In contrast, lasers can achieve debridement with less trauma to surrounding tissues, thereby enhancing the prognosis of the treatment.[14,63,64]

Evidence-Based Clinical Efficacy

The clinical efficacy of various treatment modalities for endodontic-periodontal lesions (EPL) has been systematically evaluated through multiple clinical trials.

To date, only two recent randomized clinical trials have specifically evaluated diode lasers as an adjunct in the treatment of true endodontic–periodontal lesions. Dembowska et al. (2022) conducted a 6-month pilot randomized trial on 12 molars with endodontic–periodontal lesions and stage III periodontitis, comparing conventional combined endodontic–periodontal therapy with and without a 940-nm diode laser applied to both root canals and periodontal pockets. The laser group showed significantly greater reductions in probing depth and tooth mobility, as well as a larger reduction in CBCT-measured bone defect volume, compared to the control group.[11] Behera et al. (2024) subsequently reported a 40-patient randomized clinical trial in which adjunctive 940-nm diode irradiation after root canal treatment and scaling and root planing produced greater short-term improvements in probing depth, clinical attachment level, and radiographic bone density than conventional therapy alone.[45] Beyond these two trials, the clinical evidence consists of one comparative clinical study with immunologic endpoints and several diode-laser case reports or small series, which should be regarded as supportive but lower-level evidence (Table 4).

Taken together, these studies provide only preliminary evidence for the use of diode lasers in EPLs. Most of them are single-center investigations with small sample sizes, short follow-up periods, and heterogeneous laser parameters. Additionally, blinding and standardized outcome reporting are often lacking. As a result, the magnitude and generalizability of the reported laser benefits remain uncertain, and the current evidence should be considered hypothesis-generating rather than definitive.

The studies reviewed highlight the impact of diode laser therapy, PRF, bone grafting, and simultaneous endodontic-periodontal therapy on periodontal healing, PD reduction, CAL gain, and bone defect fill.[1] Moreover, clinical evidence showed a faster reduction in periodontal pocket depth (from 10 mm to 3 mm), decreased tooth mobility (from grade III to I), and enhanced bone regeneration, as seen in post-treatment radiographs [60]

Table 5 summarizes key findings from the reviewed clinical trials, providing a comparative analysis of different treatment strategies:

Evidence suggests that diode laser therapy enhances

Table 4. Randomized clinical trials of diode-laser adjunctive therapy in endodontic–periodontal lesions (design, interventions, follow-up, and main clinical outcomes)

Study	Design/sample	Intervention	Follow-up	Primary outcomes for the laser group vs the control group
Dembowska et al. [11]	Pilot randomized controlled trial; 12 patients / 12 molars with endodontic–periodontal lesions and stage III periodontitis (6 laser, six control)	Both groups received conventional root canal treatment and periodontal debridement. The test group additionally received a 940-nm diode laser (Epic X) applied intracanal and in periodontal pockets in short-pulsed cycles during treatment.	6 months	The laser group showed significantly greater reduction in probing pocket depth, improved tooth mobility, and greater reduction in CBCT bone-defect volume compared with the control group.
Behera et al., [45]	Randomized clinical trial; 40 patients with endo–perio lesions (20 laser, 20 control)	Both groups received root canal treatment and scaling and root planing. The test group also received adjunctive 940-nm diode laser treatment after SRP (continuous-wave, ~1.5 W, ~20 seconds per site).	8 weeks	The laser group achieved a larger reduction in probing pocket depth (approximately 3.2 mm vs 2.0 mm), greater clinical attachment gain (approximately 3.6 mm vs 2.3 mm), and a greater increase in radiographic bone density (approximately 20% vs 12%) than the control group.

Table 5. Comparative analysis of different treatment strategies

Intervention	Probing Depth (PD) Reduction	Clinical Attachment Level (CAL) Gain	Bone Defect Fill / Radiographic change	Key Findings	References
Diode laser + conventional endodontic–periodontal therapy vs conventional therapy alone	10 mm to 3 mm (laser) vs no significant reduction (control)	Not reported	Significant vertical and horizontal alveolar bone regeneration was observed radiographically.	Diode laser (980 nm non-aPDT plus 660 nm aPDT) significantly improved PD reduction, reduced tooth mobility (Grade III → I), and enhanced bone regeneration in a tooth with an initially hopeless prognosis.	Derikvand et al. [60]
Diode laser + conventional endodontic–periodontal therapy vs conventional therapy alone	1.88 ± 0.40 mm (laser) vs 0.23 ± 0.09 mm (control) (P < 0.05)	Not reported	52.5% (laser) vs 27% (control) reduction in CBCT-measured defect volume (P < 0.05)	Adjunctive 940-nm diode laser (intracanal and periodontal pockets) significantly improved PD reduction and three-dimensional bone defect fill compared with conventional therapy alone in EPL molars.	Dembowska et al. [11]
Diode laser + conventional endodontic–periodontal therapy vs conventional therapy alone	≈3.2 ± 0.5 mm (laser) vs 2.0 ± 0.4 mm (control) (P < 0.05)	≈3.6 ± 0.6 mm (laser) vs 2.3 ± 0.5 mm (control) (P < 0.05)	≈20% increase in radiographic bone density (laser) vs ≈12% (control) (P < 0.05)	Adjunctive 940-nm diode laser (after RCT and SRP) produced significantly greater short-term PD reduction, CAL gain, and radiographic bone density increase than conventional treatment alone in patients with endo–perio lesions.	Behera et al. [65]
Gutta-percha (GP) vs mineral trioxide aggregate (MTA) vs bone graft + MTA	GP: 4.8 ± 0.89 mm; MTA: 3.8 ± 0.75 mm; Bone graft: 3.1 ± 0.59 mm (P = 0.025)	Not reported	Bone graft group: highest defect fill (100%) (P < 0.05)	Bone grafting, in conjunction with obturation using MTA, resulted in the highest bone defect fill and PD reduction compared with GP and MTA alone.	Aljasser et al. [30]
Endodontic treatment (ET) + periodontal therapy vs supragingival scaling alone	1.8 ± 0.05 mm (P < 0.05)	Not reported	Alveolar bone resorption was significantly reduced only in the combined treatment group (P < 0.05)	Combining ET with periodontal therapy led to better outcomes compared with supragingival scaling alone.	Yan et al. [66]
PRF vs titanium-prepared PRF (T-PRF) in infrabony defects	2.56 mm (PRF) vs 2.51 mm (T-PRF) (P > 0.05)	2.52 mm (PRF) vs 2.41 mm (T-PRF) (P > 0.05)	Not reported	No significant differences between PRF and T-PRF in PD reduction or CAL gain.	Razi et al. [67]
SRP + 940 nm diode laser (adjunct) vs SRP alone	2.08 mm vs 1.76 mm reduction in control	1.69 mm vs 0.68 mm in control	Not reported	SRP + 940 nm diode yielded significantly lower post-treatment PPD and CAL than SRP alone in stage I–II periodontitis at 6 weeks.	Elmeligy et al. [68]
Nd:YAG (LANAP), 1,064 nm + SRP vs SRP alone	4 mm median reduction vs 3 mm at 3 months	3 mm median gain vs 2 mm at 3 months	+ 4.68 vs + 0.71 in control (radiographic bone fill index)	In deep pockets, LANAP achieved greater PD reduction and CAL gain than SRP alone; radiographs showed earlier and greater bone fill in the LANAP group.	Kaya Dadas et al. [69]

Clinical attachment level (CAL), Endodontic treatment (ET), Gutta-percha (GP), Laser-assisted new attachment procedure (LANAP), probing depth (PD), mineral trioxide aggregate (MTA), Neodymium-Doped Yttrium Aluminium Garnet (ND:YAG), Scaling and Root Planing (SRP), titanium-prepared PRF (T-PRF),

periodontal healing. The results suggest that diode laser therapy improves PD reduction and bone defect fill when used adjunctively with conventional endodontic-periodontal treatments. The antimicrobial effects and bio-stimulation properties of diode lasers may contribute to these enhanced outcomes.[11,70]

Additional evidence suggests that bone grafting, in combination with obturation using MTA, yields superior regenerative outcomes. Results suggest that combining bone grafting with MTA resulted in the highest levels of bone defect fill, supporting the use of regenerative materials in EPL management.[30]

Simultaneous Endodontic and Periodontal Therapy Accelerates Healing. Results suggest that performing periodontal treatment concurrently with endodontic therapy leads to faster improvements in PD and CAL than delayed interventions.[66,71]

While PRF-based therapies are suggested as regenerative tools, the results indicate that there is no significant difference between PRF and T-PRF in PD reduction and CAL gain, suggesting the need for further studies to determine their true advantage in EPL management.[67,72]

Another evidence suggests that immediate versus delayed periodontal surgery following ET does not significantly affect long-term healing, offering flexibility in treatment planning.[72]

Moreover, clinical trials strengthen the evidence that supports diode lasers as a valuable adjunct in EPL management, particularly for pain reduction and enhanced bacterial elimination. Patients who received a diode laser experienced the least postoperative pain.[50]

The evidence from an endodontic-periodontal therapy study showed that the group treated with the diode laser achieved an average lesion reduction of 52.5%, indicating significant tissue regeneration. In contrast, the control group exhibited a lesion reduction of only 27%. These findings demonstrate the effectiveness of STL modelling and CBCT imaging in objectively measuring treatment outcomes in periodontal and endodontic therapies.[11]

Evidence suggests that Er:YAG laser-assisted SRP has no significant difference in root roughness compared to conventional methods. However, the results showed that the surface ultrastructure is more irregular than that of traditional methods.[62]

Moreover, another piece of evidence showed that adding lasers can be beneficial in specific situations. In the early stages of periodontitis, the use of a 940 nm diode laser after scaling and root planing resulted in greater short-term improvements at 6 weeks compared to scaling alone.[68] Another evidence showed that in deep pockets (≥ 7 mm), LANAP (Nd:YAG 1,064 nm) used with scaling produced a larger median pocket-depth reduction over 3 months and a larger median gain in attachment than scaling alone; X-rays also showed more early bone fill at 1 month with LANAP, while the 3-month difference was not significant.[69]

Advantages and Limitations of Diode Laser Therapy

Advantages

Non-invasive and minimally invasive approaches

The study also reports that diode lasers facilitate improved healing by accelerating wound closure, supporting collagen synthesis, and enhancing angiogenesis. These benefits contribute to better overall treatment outcomes, including reduced periodontal pocket depth, decreased bone loss, and improved tooth stability.[32,73] Moreover, the treatment is a minimally invasive treatment option, which is beneficial for patients, avoiding pharmacological pain manageme.[74]

Reduced microbial load and improved healing

The evidence highlights several benefits of using diode lasers (940 nm) as an adjunct to standard periodontal and endodontic treatments. It emphasizes the effectiveness of the laser in reducing bacteria, particularly in periodontal pockets and root canals, where it enhances decontamination by eliminating pathogens that contribute to endo-perio lesions.[11] The laser treatment also reduced inflammation by minimizing bacterial recolonization and promoting tissue healing.[32,73] Accumulative evidence suggests that diode lasers offer multiple therapeutic benefits. Diode lasers enhance bacterial decontamination and reduce postoperative pain through photobiomodulation effects that suppress inflammatory mediators and improve tissue healing.[50,75–78]

Ease of use and precision

The evidence showed that the diode (980 nm) laser demonstrated easy handling and precision, achieving complete removal of the pocket epithelium irrespective of the clinician's level of surgical experience.[47] Laser systems are designed for ease of use, allowing clinicians to target specific areas with precision. This precision minimizes damage to surrounding tissues, making laser therapy a favorable option in EPL management.[41]

Moreover, the use of diode lasers in EPL management is characterized by ease of use and precision. The compact design and user-friendly operation allow clinicians to target specific areas with minimal discomfort to the patient, making it an attractive option for both endodontic and periodontal treatments.[33]

Limitations

Cost training

Laser outcomes depend heavily on wavelength, power settings, exposure time, and clinical context. Moreover, there is a lack of large-scale, long-term, randomized controlled trials evaluating the effectiveness of laser therapy, specifically in endo-perio lesions. Therefore, clinicians should use lasers judiciously and within the scope of validated protocols, which consequently increases the cost of training and validating protocols.[57] Evidence showed that lasers are not a substitute for conventional mechanical debridement or irrigation but are to be used as adjuncts. Moreover, heterogeneity in study protocols, laser settings, and outcome measures makes comparison difficult.[57]

Standardized guidelines and variability in protocols

The evidence shows that diode laser settings vary across studies, with power levels ranging from 0.84W to 2.5W and wavelengths between 800 nm and 1064 nm. These differences make direct comparisons between studies difficult [50,56,79]. Moreover, some studies show significant bacterial reduction with diode lasers, while others find no statistically significant difference due to inconsistencies in fiber tip placement, exposure time, and laser application frequency [50]

Moreover, other evidence suggests several limitations of the study, including a small sample size, which affects the ability to generalize the results. Long-term evidence and standardized clinical protocols are lacking, especially in combined endodontic-periodontal lesions. Future research should also focus on detailed three-dimensional evaluations of bone regeneration to improve the understanding of treatment outcomes.[10,11,57]

The absence of standardized post-treatment assessment methods further complicates evaluation, as studies employ various outcome measures, including CBCT imaging, STL models, or periodontal PD. Future research should focus on developing standardized laser protocols, including fixed power settings, exposure durations, and treatment intervals, to ensure predictable and reproducible treatment outcomes.

Consequently, the overall quality of evidence for diode lasers in true EPLs remains low to moderate, and current data are insufficient to define an evidence-based “standard” protocol for routine clinical use.

Integration into Clinical Practice

Protocol Recommendations for EPL Management

The results suggest using the diode laser at a low-power setting (2 Watts) in continuous wave mode with a 300-μm glass fiber for effective epithelial removal. It cautions that using a higher power setting (4 Watts) results in significant thermal damage to the underlying connective tissues.[47] Best practices for diode laser use include proper calibration, understanding the specific settings for different tissues, and integrating laser therapy with conventional treatment methods. The evidence suggests that the laser should be applied in a sweeping motion along the root surface to ensure thorough treatment.[3,33,41]

ET should generally be initiated before any periodontal therapy to remove the intracanal infection, thereby avoiding complications and providing a favorable environment for tissue repair.[49] Evidence suggests that the timing and frequency of laser applications should be tailored to the individual patient’s needs, considering the severity of the lesion and the response to initial treatments.[33,41] Another piece of evidence suggests that the timing and frequency of laser applications should be tailored to the individual patient’s needs, considering the pocket depth and the extent of infection. For instance, deeper pockets may require longer exposure times.[3]

Training and Skill Development

The evidence suggests that effective epithelial removal with the diode laser was independent of the operator’s level of surgical experience, indicating that the technique is relatively straightforward.[47] Moreover, various courses and certification programs are available for dental professionals seeking to enhance their skills in laser therapy. These educational opportunities are crucial for staying updated on the latest techniques and technologies in the field.[33]

Future Directions and Research Needs

The finding suggests expanding the study to a larger sample size to improve the reliability and generalizability of the findings. It also recommends further research on the long-term effects of diode laser therapy in treating EPLs to understand its sustained benefits and potential limitations. Additionally, there is a need for standardization of laser parameters and treatment protocols, as variations in these factors across different studies make it challenging to compare results and establish consistent clinical guidelines.[10,11]

Conclusion

Current evidence suggests that diode laser therapy can be a promising adjunct in the management of endodontic–periodontal lesions. In particular, two recent randomized clinical trials and one comparative clinical study suggest that adding a 940-nm diode laser to conventional endodontic–periodontal protocols may enhance probing depth reduction, clinical attachment gain, and radiographic bone healing in selected cases. However, these data are derived from small single-center trials and limited case-based reports, with substantial heterogeneity in laser parameters, treatment timing, and outcome measures.

On this basis, diode lasers cannot yet be considered a standardized or universally recommended therapy for EPLs. Instead, they should be viewed as a potentially useful adjunct in carefully selected patients, delivered by clinicians who are familiar with the relevant parameters and limitations. Further well-designed, multi-center, randomized controlled trials with adequate sample sizes, clearly defined EPL subtypes, and standardized laser protocols are required to confirm long-term efficacy and establish evidence-based guidelines. Until such data are available, clinicians should integrate diode laser therapy into EPL management within an evidence-based framework, alongside established endodontic and periodontal treatments rather than as a replacement for them.

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Competing Interests

The authors declare no conflict of interest.

Ethical Approval

This article is a review of previously published studies and does not involve any new research on human participants, animals, or identifiable personal data. Therefore, ethical approval was not required.

Funding

This research received no external funding.

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