GRADUATION PROJECT

Degree in Dentistry

THE USE OF LASERS IN BASIC PERIODONTAL TREATMENT

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RESUMEN

Introducción: La enfermedad periodontal es una afección muy común que compromete las estructuras de soporte de los dientes, provocando inflamación, pérdida ósea y, si no se trata, la pérdida dentaria. El tratamiento tradicional suele implicar desbridamiento mecánico y cirugía, procedimientos que pueden generar molestias y tiempos de cicatrización prolongados. En los últimos años, los láseres han surgido como una herramienta complementaria prometedora en la terapia periodontal debido a su precisión y su potencial para favorecer la cicatrización. **Objetivos:** Este estudio explora el papel de los láseres en la periodoncia, evaluando los efectos clínicos y ventajas frente al tratamiento convencional. El objetivo es determinar si el uso del láser es más eficaz en la diminución de la profundidad de sondaje y en el arreglo de la inserción clínica en comparación con las curetas convencionales. **Metodología:** Se hace una revisión completa de la literatura, revisando artículos científicos y ensayos clínicos actuales sobre el efecto de láseres de diodo, Nd:YAG, Er:YAG y CO_2 en el tratamiento periodontal. La revisión consideró los efectos del láser en la diminución de la profundidad de sondaje y la pérdida de inserción clínica. **Resultados:** Los resultados muestran que los láseres tienen gran potencial en la eliminación de cálculo y el desbridamiento de la superficie radicular. En comparación con el tratamiento convencional, los láseres producen menos molestias postoperatorias, menor sangrado y una cicatrización más rápida. Sin embargo, los resultados clínicos varían según el tipo de láser, los parámetros utilizados y la experiencia del operador. **Conclusiones:** Los láseres ofrecen beneficios como herramienta complementaria en el tratamiento periodontal. Aunque no sustituye a las curetas, los láseres potencian los resultados del tratamiento cuando se usan adecuadamente. Se requiere continuar investigando y estandarizando protocolos para integrar plenamente la terapia láser en la práctica periodontal habitual.

PALABRAS CLAVE

Odontología, raspaje y alisado radicular, láseres, profundidad de sondaje, perdida de inserción.

ABSTRACT

Introduction: Periodontal disease is an extensive condition affecting the structures that support teeth, leading to inflammation, bone loss, and eventual tooth loss if untreated. Traditional treatment often involves mechanical debridement and surgery, which may cause some discomfort and longer healing times. In recent years, lasers have become a promising adjunct in periodontal treatment due to their precision and potential for promoting healing. **Objectives:** This study explores the role of lasers in periodontology, evaluating their biological effects, therapeutic applications, and advantages over conventional treatment. The goal is to assess if the use of lasers is more efficient in reducing the probing depth and the clinical attachment than the conventional curettes. **Methodology:** A complete literature review was done, revising current scientific articles and clinical trials on the use of diode, Nd:YAG, Er:YAG, and CO_2 lasers in periodontal treatment. The review considered the effects of lasers in probing depth reduction and clinical attachment loss reduction. **Results:** The findings confirm that lasers show strong potential in calculus removal and root surface debridement. Compared to conventional mechanical treatment, laser-assisted therapy results in less postoperative discomfort, reduced bleeding, and enhanced healing. However, clinical outcomes vary depending on the laser type, settings, and operator experience. **Conclusions:** To conclude, laser technology offers significant benefits as an adjunctive tool in periodontal therapy. While it can be considered a replacement for conventional methods, lasers enhance treatment outcomes when it is used appropriately. Continued research and standardization are needed to optimize protocols and fully integrate laser therapy into routine periodontal practice.

KEYWORDS

Dentistry, scaling and root planning, lasers, probing depth, clinical attachment loss.

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1.INTRODUCTION

1.1. Background of periodontal disease

Periodontal diseases gathered the conditions that attack the tissues that surrounds and support teeth: the periodontium which includes the gums, the bone, the periodontal ligament and the cement (1).

Periodontal treatment is widely performed across dental practices due to the high global prevalence of periodontal diseases (1). Studies indicate that a significant portion of the adult population experiences some form of periodontal condition, ranging from mild gingivitis to advanced periodontitis. As a result, treatments such as scaling and root planning, periodontal maintenance, and surgical interventions are commonly required to manage these issues (1). The demand for periodontal care increases with age, tobacco use, and systemic health conditions like diabetes (1). Early diagnosis and effective treatment are essential to prevent disease progression, tooth loss, and its potential impact on overall health and quality of life (1).

1.1.1. The periodontium

The periodontium is the specialized tissue that surrounds and supports the teeth, functioning to anchor them to the alveolar bone. It is essential for maintaining the stability and health of teeth within the oral cavity (1).

The periodontium consists of several key structures:

Gingiva: The soft tissue that surrounds the teeth, forming the mucosal lining of the oral cavity (2).

Periodontal Ligament (PDL): It is a fibrous connective tissue that attaches the root of the tooth to the alveolar bone, giving support and a cushioning effect when biting and chewing (2).

Cementum: It is a calcified tissue wrapping the root of the tooth, giving a fitting surface for the periodontal ligament fibers (2).

Alveolar Bone: The bone that hold the teeth, housing the tooth roots within the sockets.

These components work together to maintain the stability of the teeth and facilitate the functional role of mastication (2).

Health or disease within the periodontium can lead to conditions such as periodontal disease, which includes gingivitis and periodontitis, potentially resulting in tooth loss if untreated (3).

1.1.2. Periodontal disease

It is characterized by an inflammation of these tissues, followed by symptoms like pain, swollen gums, bleeding and can lead to the loss of the tooth as their support decrease (4).
In accordance with a report of the World Health Organization it is estimated that around 19% of the global population (4) is suffering from a severe periodontal disease and other studies estimate that 10 to 15% of the global population loss their teeth because of a periodontal disease (5).

The periodontal disease starts as an accumulation of plaque (which is a deposit of accumulated bacteria/fungi that stick to the tooth surface) accompanied by a local inflammation of the gums (5).

1.1.3. Diagnostic

According to the 2017 classification of periodontal diseases, periodontitis is diagnosed based on staging and grading criteria, considering clinical attachment loss (CAL), radiographic bone loss, and probing depth (PD). Stage I (incipient) involves CAL of 1-2 mm and PD ≤4 mm. Stage II (moderate) includes CAL of 3-4 mm and PD ≤5 mm. Stage III (severe) presents with CAL ≥5 mm, PD ≥6 mm, and potential tooth loss. Stage IV (advanced) involves extensive damage, mobility, and loss of function. Grading assesses progression risk, systemic impact, and response to treatment (6).

1.1.3.1. Periodontal study

Periodontal studies in the clinical setting are essential for accurately diagnosing and managing periodontal diseases, which involve the supporting structures of the teeth, including the gingiva, periodontal ligament, cementum, and alveolar bone (7). A thorough periodontal assessment typically begins with a comprehensive clinical examination, where the appearance, color, and contour of the gingival tissues are evaluated (7). One of the most critical diagnostic tools is periodontal probing, which involves measuring the depth of the gingival sulcus or periodontal pockets using a calibrated periodontal probe (7). Probing depths, bleeding, gingival recession, presence of furcation are assessed in all dental pieces as well as clinical attachment levels. Mobility tests provide further insight into the severity and progression of the condition (7).

Radiographic evaluation, particularly periapical X-rays, plays a crucial role in the diagnostic process by offering a clear view of the alveolar bone surrounding the teeth. These images help detect bone loss patterns, periapical lesions, and anatomical abnormalities that may not be visible during the clinical examination (7). Vertical or horizontal bone loss, as seen on periapical radiographs, is a reliable indicator of periodontal disease severity and guides treatment planning (7). Combined with clinical findings, radiographs provide a comprehensive overview of both hard and soft tissue health (7). Together, these diagnostic methods allow dentists to classify the type and stage of periodontal disease, predict prognosis, and develop individualized treatment strategies. Accurate diagnosis through systematic clinical and radiographic studies is fundamental to preventing disease progression and preserving long-term oral health (7).

Furthermore, Cone Beam Computed Tomography (CBCT) has become an important tool in modern periodontal diagnostics, offering three-dimensional imaging of the teeth, bone, and surrounding structures (8). Unlike traditional two-dimensional radiographs, CBCT provides detailed, volumetric views that enhance the assessment of bone levels, periodontal defects, and anatomical variations (8). It is particularly useful for evaluating complex cases involving furcation involvement, infrabony defects, and the proximity of critical structures like nerves and sinuses (8). CBCT improves diagnostic accuracy, treatment planning, and risk assessment by revealing subtle changes in bone architecture that may not be visible on standard radiographs, ultimately supporting better clinical outcomes in periodontal care (8).

1.1.4. Pathophysiology

The first step of the periodontal disease is known as gingivitis. This step is reversible and is defined as the beginning of the plaque accumulation around the teeth (9). The symptoms are few and usually painless. It can be stop by the maintenance of a good oral hygiene

The next step consists in the transformation of the plaque in a harder and stickier material called tartar or calculus. This matter is more difficult to remove only by tooth brushing and if not removed can lead to the formation of periodontal sockets and the degradation of the surroundings tissues (9)

In later stages, symptoms are more aggressive and gathered inflammation of the gums, pus discharge, pain when chewing, bleeding, gingival recession and usually mobility of the teeth (9). At this stage the periodontium is really in danger and more specific treatments are needed to relieve the tissues from the injury (9).

For this purpose, it exists different types of treatment such as basic ones and surgical ones.

1.2. Overview of periodontal treatments

The goal of the periodontal treatments is to reduce the inflammation and the bacterial load present within the pocket to let the gum heal leading in a reduce probing depth and attachment loss.

1.2.1. Basic treatments

The basic non-surgical periodontal treatment is called scaling and root planning (SRP). Its goal is to eliminate plaque, tartar (calculus), and bacterial toxins from the tooth surfaces and root structures (10). Scaling involves the mechanical removal of supragingival and subgingival deposits, while root planning smooths the root surfaces to eliminate bacterial niches, promote healing, and facilitate reattachment of the gums to the tooth (10). This procedure is typically performed under local anesthesia and is effective in treating early to moderate periodontal disease by reducing pocket depths and inflammation (10).

After scaling and root planning, patients may experience mild discomfort, gum tenderness, and slight bleeding. Temporary tooth sensitivity is common. Good oral hygiene, saltwater rinses, and follow-up visits help ensure proper healing and recovery (10).

Also, topical or systemic antibiotics may be used to decrease the presence of bacteria within the periodontal pocket (10).

1.2.1.1. Curettes as a conventional technique

Curettes are essential hand instruments commonly used in scaling and root planning. They are the first treatment for managing periodontal disease in a non-surgical way (11). They are designed with a rounded tip and double cutting edges. They curettes allow dentists to remove effectively subgingival plaque, calculus, and diseased cementum from tooth surfaces while minimizing trauma to surrounding soft tissues (11). There are two main types of periodontal curettes: universal and area specific. Universal curettes are versatile instruments designed to adapt to all tooth surfaces, both anterior and posterior, using a 90-degree blade angle relative to the shank. In contrast, area-specific curettes, such as Gracey curettes, have an offset blade typically angled at 70 degrees, providing enhanced access and precision in specific areas of the mouth. This design enables improved adaptation to root contours, furcation, and deep periodontal pockets, which are often challenging to reach with universal instruments (11). The use of curettes in SRP plays a critical role in detaching the biofilm and smoothing the root surfaces, promoting soft tissue healing and reattachment (11). Proper instrument selection, technique, and maintenance are vital to achieve optimal clinical outcomes and patient comfort. Curettes require regular sharpening to maintain their cutting efficiency and prevent operator fatigue (11). Though advancements in ultrasonic instrumentation have supplemented mechanical debridement, curettes remain indispensable in periodontal therapy, especially for fine scaling, root planning, and areas where powered instruments may be less effective. Their tactile sensitivity, precision, and adaptability continue to make them a cornerstone in the comprehensive nonsurgical management of periodontal disease (11).

1.2.1.2. Antibiotic therapy

Antibiotics are sometimes prescribed as a supplement to mechanical periodontal therapy to help control bacterial infections, especially in severe or aggressive cases. They can reduce specific pathogenic bacteria, support healing, and enhance treatment outcomes, though their use should be carefully evaluated and limited (11).

1.3. Introduction of lasers in periodontics

Lasers have become an innovative tool in the non-surgical treatment of periodontal diseases, such as periodontitis. They provide several advantages, including the reduction of periodontal pathogens, improved tissue healing, and enhanced removal of biofilm and calculus (12)
"Laser" stand for Light Amplification by Stimulated Emission of Radiation (12). They are used in periodontic treatments since the 1980s (12).

Lasers used in periodontal treatments operate by emitting light energy that interacts with the tissues of the periodontium, including the gums, root surfaces, and bone (13). The wavelength and type of laser determine how the energy is absorbed and utilized for therapeutic effects. Different types exist, namely: Neodymium, Erbium, Diode or Co2 lasers. They are employed for various purposes based on their interaction with tissues and bacteria in periodontal pockets. (13)

1.3.1. Lasers: how it works

Radiation can be delivered in continuous, pulsed, or running pulse waveforms. The energy beam consists of coherent, unidirectional, monochromatic photons that are collimated into a highly focused beam (14). Since laser beams are in the infrared spectrum and are not visible, a quartz fiber emitting red light is incorporated into the device to serve as an aiming guide (14).

When the laser beam interacts with target tissue, it can either be absorbed, reflected, or scattered (14). In biological tissues, absorption is the primary effect, with scattering occurring primarily when the beam penetrates deeply (14). The wavelength of the laser is the main factor influencing energy absorption, though the optical properties of the tissue also play a significant role. Periodontal tissues are complex, with variations in water and mineral content, pigmentation, and tissue density, all of which affect their optical characteristics. Factors such as power, pulse duration, exposure time, delivery angle, and waveform type (pulsed or continuous) also influence energy absorption (14).

When energy is absorbed by tissue, it can result in four different actions: warming, coagulation, vaporization, or in the case of hard tissue, melting and recrystallization (14). Therefore, selecting the appropriate laser technology is crucial to achieve the desired clinical outcomes based on specific treatment goals (14).

1.3.2. Types of lasers – technical aspects

Lasers are classified by their active medium and wavelength (15). They can be continuous or pulsed. Different lasers, like CO_2 (infrared) and Erbium (Er:YAG) (middle infrared), target water-rich tissues and cause vaporization, while Neodymium (Nd:YAG) and diode lasers (near-infrared) affect pigments and macrophages (15). Lasers are also categorized by power: low-power lasers stimulate tissue healing, helping in conditions like gingivitis and periodontitis, while high-power lasers cause tissue removal for procedures like gingivectomies. Each type of laser has specific uses in periodontal therapy (15). The following table compares the physical properties of each laser according to their wavelength.

Table 1. *Difference in physical properties of lasers (11)*

Erbium Lasers	Diode Lasers	Neodymium Lasers	Co2 Lasers
Water absorption: high thermal reduction ER:YAG : 2940nm ER,CR:YSGG : 2790nm	655-990nm	1064nm	10600nm

1.3.3. Types of lasers – purpose aspect

1.3.3.1. Erbium lasers

Erbium lasers can be used alone or as a supplement to scaling and root planning. They show advantages over SRP for reducing probing depth, clinical attachment level, and bleeding on probing (BOP) when set to 160 MJ/pulse (16). Careful attention is needed not to exceed 200 MJ/pulse, as higher settings don’t offer added benefits. Erbium lasers are particularly effective for treating deeper pockets (4-6 mm), with proven long-term improvements (16).

The Er:YAG laser is well-suited for procedures involving both soft and hard oral tissues due to its precise ablation capabilities (16). Its recent applications include the efficient removal of granulation tissue, treatment of gingival hyperpigmentation, and correction of gum discoloration. It also allows for bone contouring and cutting with minimal thermal damage, often promoting equal or accelerated healing compared to conventional methods (16). Additionally, Er:YAG laser irradiation demonstrates strong antibacterial properties for an effective removal of dental plaque and calculus, all while affecting only a very thin surface layer (16)

1.3.3.2. Diode lasers

Diode lasers should be used in conjunction with scaling and root planning, not as a standalone treatment (16). They help reduce microbial growth when used together with SRP. To prevent thermal damage, low power settings (1-1.5 W) should be used (16). Diode lasers are effective in treating moderate pockets (4-6 mm), providing additional microbial control (16).

1.3.3.3. Neodymium lasers

Neodymium lasers can be used as supplement to manual debridement to reduce subgingival bacteria (16). While this treatment may not significantly improve probing depth or clinical attachment level, it is effective for microbial disinfection in challenging areas like furcation (16). The optimal settings for ND lasers are around 100 MJ/pulse to minimize any damage that could happen with thermic overload. However, the long-term effectiveness of laser use in this context remains uncertain (16).

1.3.3.4. Co2 lasers

CO2 lasers are primarily used for soft tissues. Indeed, they can damage the hard ones. When used alongside scaling and root planning, they should be set to low power to protect healthy tissues (16). For root conditioning, pulsed defocused mode is preferred, providing both bactericidal effects and conditioning benefits (16). However, studies with larger sample and a longer follow-up are needed to better understand the benefits and limitations of CO2 laser use in periodontal treatment (16).

2.OBJECTIVES

The primary objective of this study is to evaluate, in adult with periodontal pockets, the efficiency of lasers as a tool in basic periodontal treatment for reducing probing depth and attachment loss in comparison to traditional methods, such as the use of curettes.

P(population): adults with periodontal pockets.
I (intervention): use of lasers for basic periodontal treatments.
C(comparator): traditional methods: curettes.
O(outcome): reduction of probing depth and attachment loss.

3.MATERIALS AND METHODS

A. Design

This study employed a documental research approach to analyze the application of lasers in basic periodontal treatment. The research involved reviewing and synthesizing information from academic and clinical literature, including peer-reviewed journals. The focus was on understanding the mechanisms, efficacy, and clinical outcomes of laser use in scaling and root planning regarding the reduction of the probing depth and attachment loss of and on finding significant clinical outcomes differences with the use of curettes.

B. Data Sources

Primary sources included articles from PubMed, Scopus, and Web of Science databases.
Key words used were periodontics, periodontics disease, gingivitis, periodontitis, attachment loss, periodontal sockets, probing depth, basic periodontal treatments, scaling and root planning, lasers in periodontics,
Literature published between 2000 and 2024 was included to ensure up-to-date and relevant findings.

C. Inclusion and Exclusion Criteria

Inclusion criteria consisted of studies investigating laser applications in periodontal therapy, focusing on their role in scaling and root planning, reducing the probing depth, and gain in attachment loss. Articles in English, randomized controlled trials were prioritized. Articles that were written in the last decade were studied first. Excluded were studies focusing exclusively on surgical periodontal treatments or those not directly addressing basic periodontal therapy. Also, meta-analysis, review and articles published before the 2000.

D. Data Extraction

Data extraction focused on study objectives, laser types (e.g., diode, Er:YAG), treatment protocols, clinical outcomes (e.g., reduction in probing depth, attachment gain), and patient-reported outcomes. Information was organized using a table to facilitate comparative analysis.

E. Analysis

The analysis involved descriptive and thematic synthesis to evaluate the advantages and limitations of lasers in basic periodontal treatments compared to traditional methods. Trends in laser applications, success rates, and safety profiles were highlighted to draw meaningful conclusions about their efficacy and practicality in routine periodontal care.

4.RESULTS

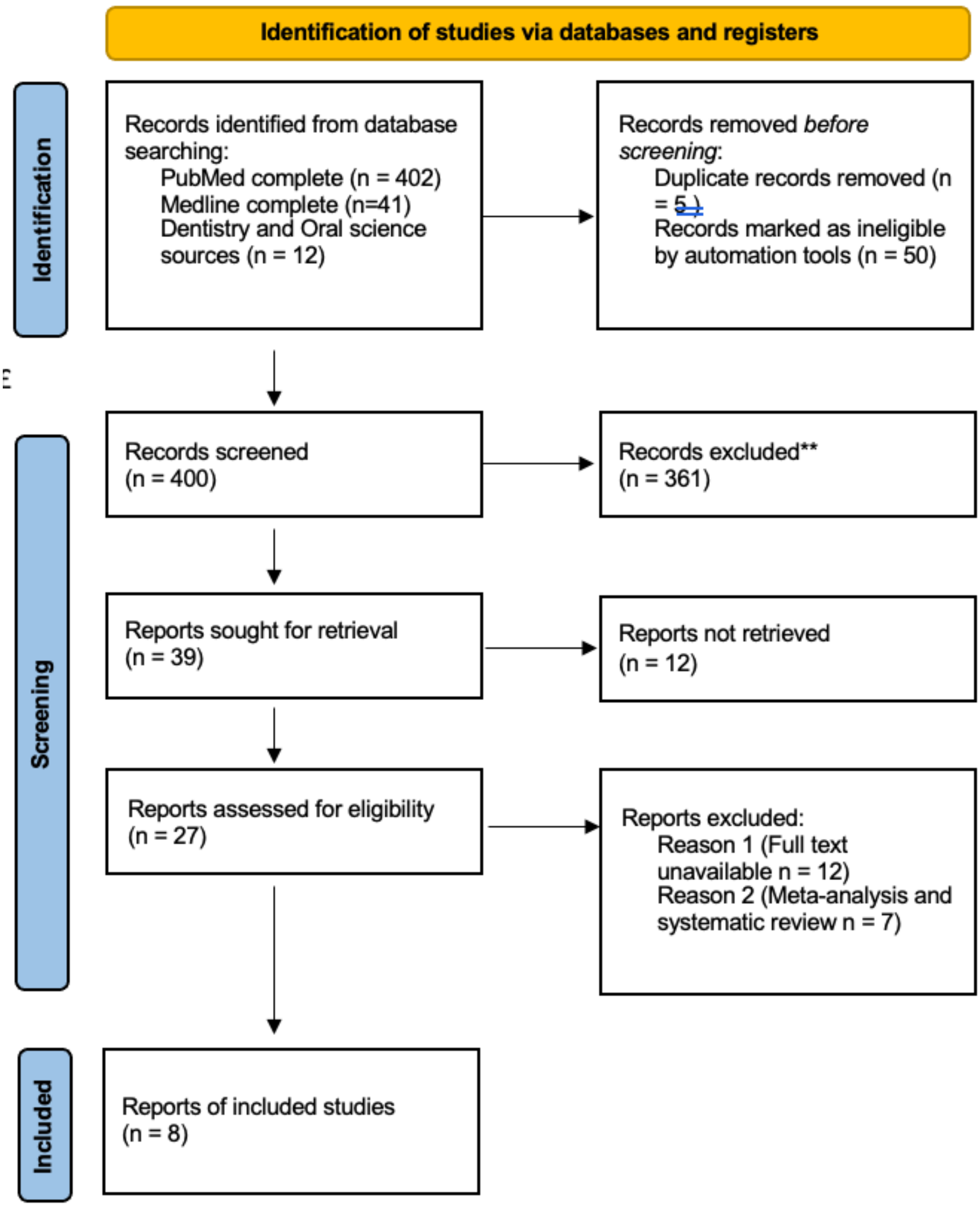

Figure 1. PRISMA Flowchart of the included reports in the study

Source : Page MJ, et al. BMJ 2021;372:n71. doi: 10.1136/bmj.n71.

A thorough review of scientific articles was conducted using three databases with different keywords, yielding 455 records. A PRISMA diagram (Figure 2) was used to outline the identification process. After removing 5 duplicates, and 50 articles excluded using automation tools research, 400 records remained. Screening by title and abstract led to the exclusion of 361 records due to irrelevance, leaving 39 articles for retrieval. However, 12 full texts were unavailable, and 7 meta-analyses/systematic reviews were excluded. Ultimately, 8 studies met the inclusion criteria and were incorporated into the final analysis (Table 1).

Table 2. Summary of the 8 studies comparing the Probing depth (PD) and clinical attachment loss gain (CAL) using basic SRP or laser or both

Reference	Study design	Sample size	Treatment used	Probing depth gain (in mm)	Clinical attachment loss gain (in mm)
Sinha and al., 2024 (17)	Randomized clinical trial (RCT)	60	Scaling and root planning (SRP) Laser assisted periodontal treatment (LAPT)	2.2 2.5	2.5 2.8
Diwan and al. 2024 (18)	RCT	100	SRP LAPT	2.0 2.5	1.3 1.8
Zhou and al. 2019 (19)	RCT	27	SRP ER.YAG	0.9 1.8	0.9 1.8
Park and al. 2024 (20)	RCT	12	SRP SRP+ ER,CR:YSGG	1.37 1,67	Not specified
Lopez and al. 2008 (21)	RCT	21	SRP SRP + Er:Yag	0.5 0.7	0.4 0.5

Wang and al. 2017 (22)	RCT	27	SRP ER:Yag	2.3 2.0	2.0 1.8
Lin and al. 2009 (23)	RCT	18	SRP Diode laser (810nm)	1.49 1.54	0.7 0.65
Saglam and al. 2020 (24)	RCT	30	SRP Diode laser (940nm)	0.8 1.9	2.7 3.4

4.1. Sinha and al. (2024)

The study by Sinha et al. compared the efficacy of laser-assisted periodontal therapy (LAPT) with conventional curettes debridement in treating chronic periodontitis. The randomized clinical trial gathers 60 patients separated into two groups: one treated with SRP and the other undergoing LAPT. Outcomes were assessed by measuring reductions in probing depth and gains in clinical attachment level. The results demonstrated that the LAPT group achieved a mean PD reduction of 2.5 mm and a CAL gain of 2.8 mm, while the SRP group showed a mean PD reduction of 2.2 mm and a CAL gain of 2.5 mm (17).

4.2. Diwan and al. (2024)

The study by Diwan et al. assessed the efficacy of laser-assisted periodontal therapy compared to curettes debridement in managing chronic periodontitis. This randomized clinical trial included 100 participants, who were separated into two groups: one receiving SRP alone and the other undergoing LAPT. The study evaluated treatment outcomes by measuring probing depth reduction and clinical attachment level gain. The results showed that the LAPT group achieved a mean PD reduction of 2.5 mm and a CAL gain of 1.8 mm, while the SRP group demonstrated a mean PD reduction of 2.0 mm and a CAL gain of 1.3 mm (18).

4.3. Zhou and al. (2019)

The study by Zhou et al. evaluated the effectiveness of Er:YAG laser as an adjunct to scaling and root planning in the treatment of periodontitis through a split-mouth randomized controlled trial involving 27 participants. Clinical outcomes, including probing depth reduction and clinical attachment level gain, were assessed at multiple time points post-treatment (19).

At one month, the group receiving SRP combined with Er:YAG laser therapy showed a greater reduction in PD and a significant improvement in CAL compared to the SRP-only group. The mean PD reduction was 1.2 mm in the laser-assisted group, while the SRP-alone group achieved a 0.5 mm reduction. Similarly, CAL gain was more pronounced in the laser group, with an increase of 1.1 mm compared to 0.5 mm in the SRP group (16).

At three months, the trend continued, with the SRP + Er:YAG laser group achieving a PD reduction of 1.5 mm and a CAL gain of 1.5 mm, while the SRP-only group recorded a PD reduction of 0.7 mm and a CAL gain of 0.7 mm (19).

At six-month, the adjunctive laser treatment demonstrated the most substantial improvements. The laser-assisted group exhibited a PD reduction of 1.8 mm and a CAL gain of 1.8 mm, while the SRP-only group showed a PD reduction of 0.9 mm and a CAL gain of 0.9 mm (19).

4.4. Park and al. (2024)

The study by Park et al. investigated the effectiveness of erbium, chromium-doped: yttrium, scandium, gallium, and garnet (Er,Cr:YSGG) laser-assisted periodontal therapy using a radial firing tip as an supplement to scaling and root planning in a split-mouth randomized controlled trial. Clinical outcomes, including probing depth reduction and clinical attachment level gain, were assessed at multiple time points throughout the early healing period (20).

At one month, the SRP + Er,Cr:YSGG laser group demonstrated greater improvements in periodontal parameters compared to the SRP-only group. The laser-assisted group showed a mean PD reduction of 1.1 mm, whereas the SRP-alone group exhibited a 0.6 mm reduction. Similarly, CAL gain was more pronounced in the laser group, with an increase of 0.9 mm compared to 0.4 mm in the SRP-only group (20).

At three months, the positive effects of adjunctive laser therapy remained evident. The PD reduction in the SRP + laser group increased to 1.5 mm, while the SRP-only group recorded a reduction of 0.9 mm. The CAL gain was also more substantial in the laser group, measuring 1.3 mm, compared to 0.7 mm in the SRP-alone group (20).

At six months, the laser-assisted treatment demonstrated the most significant improvements. The laser group exhibited a PD reduction of 1.67 mm, while the SRP-alone group showed a reduction of 1.37 mm. Although the study did not specify exact CAL values at this stage, the trend suggested that laser-assisted therapy continued to provide superior clinical benefits over time (20).

4.5. Lopez and al. (2008)

The experience by Lopes et al. reports the short-term clinical and immunologic effects of Er:YAG laser treatment as a supplement to scaling and root planning in patients suffering from chronic periodontitis. It compared periodontal outcomes between SRP alone and SRP combined with Er:YAG laser therapy over multiple time points (21).

At one month, both treatment groups showed improvements in probing depth reduction and clinical attachment level gain. The SRP + Er:YAG laser group demonstrated a larger reduction in PD compared to the SRP-only group, with mean reductions of approximately 0.7 mm and 0.5 mm, respectively. CAL gain was also higher in the laser-assisted group, showing a mean gain of 0.5 mm, whereas the SRP-alone group exhibited a 0.4 mm gain (21).

At three months, the laser group continued to show better clinical outcomes. The mean PD reduction in the SRP + Er:YAG laser group increased to 1.2 mm, while the SRP-only group showed a decrease of 0.8 mm. The CAL gain in the laser group also improved to 1.0 mm, compared to 0.6 mm in the SRP-alone group (21).

By six months, the adjunctive use of Er:YAG laser therapy resulted in the most pronounced improvements. The mean PD reduction in the laser group reached 2.0 mm, whereas the SRP-only group demonstrated a reduction of 1.5 mm. The CAL gain followed a similar trend, with the laser group achieving a mean gain of 1.8 mm, compared to 1.2 mm in the SRP-alone group (21).

4.6. Wang and al. (2017)

In the study by Wang et al. (2017), the researchers compared the clinical, microbiological, and biochemical effects of Er:YAG laser therapy and conventional periodontal treatments. This randomized controlled trial utilized a split-mouth design, where one side of the patient's mouth received the Er:YAG laser treatment and the other side received conventional scaling and root planning (22).

At 1-month, the Er:YAG laser-treated sites exhibited a 2.3 mm reduction in PD, while the SRP-treated sites had a 1.7 mm reduction. Similarly, at the 3-month follow-up, the PD reduction for the laser group was 3.0 mm, whereas the SRP group showed a 2.1 mm reduction. The Er:YAG laser group also showed greater improvement in CAL, with an average gain of 2.5 mm at 1 month and 3.2 mm at 3 months, compared to 1.7 mm and 2.2 mm gains, respectively, in the SRP group (22).

4.7. Lin and al. (2009)

In the study by Lin et al. (2011), the researchers compared the effects of laser treatment and gingival curettage in patients with chronic periodontitis. This randomized controlled trial utilized a split-mouth design, where one side of the mouth received treatment with a laser (specifically, a diode laser), and the other side was treated with traditional hand instruments (23).

The results demonstrated that the laser-treated sites showed betters results in term of clinical criteria compared to the hand instrument-treated sites. Specifically, the laser group exhibited a reduction in probing depth of 2.1 mm at the 6-month follow-up, while the hand instrument group showed a PD reduction of 1.5 mm. Similarly, clinical attachment level gain was also greater in the laser group, with an average gain of 1.8 mm, compared to a 1.2 mm gain in the hand instrument group (23).

4.8. Saglam and al. (2020)

In the study by Saglam et al. (2014), the researchers assessed the clinical and biochemical effects of diode laser therapy as an adjunct to nonsurgical treatment of chronic periodontitis. The results showed that the combination of diode laser treatment with scaling and root planning (SRP) significantly improved clinical outcomes compared to SRP alone. At the 1-month follow-up, the group treated with diode laser exhibited a 1.8 mm reduction in probing depth (PD), while the SRP-only group had a 1.4 mm reduction (24).

At 3-month follow-up, the laser-assisted therapy group demonstrated a 2.4 mm reduction in PD, compared to 1.9 mm in the SRP-only group (24).

At 6-month follow-up, the reduction in PD for the laser group was 2.7 mm, while the SRP group showed a 2.1 mm reduction (24).
Regarding clinical attachment level, the diode laser group experienced a 1.4 mm improvement at 1 month, 2.0 mm at 3 months, and 2.5 mm at 6 months. The SRP group showed 1.0 mm, 1.5 mm, and 1.8 mm improvements, respectively (24).

5.DISCUSSION

1.4. Efficacy of SRP alone

The efficacy of scaling and root planning alone in managing periodontal disease is well-documented, as demonstrated by the studies analyzed. Across multiple randomized clinical trials (RCTs), SRP consistently leads to a reduction in probing depth and improvements in clinical attachment level (17-24).

Scaling and root planning remains the gold standard for non-surgical periodontal therapy due to its ability to mechanically remove plaque, calculus, and bacterial biofilm from the root surfaces. Several studies, including those by Sinha and al., emphasize that SRP effectively reduces probing depth and improves clinical attachment level, leading to a reduction in periodontal inflammation (17).

While SRP alone is beneficial for mild to moderate periodontitis, its limitations become evident in cases with deep pockets, furcation involvement, and aggressive periodontal infections. Diwan and al. reported that while SRP provides significant clinical improvements, its ability to eliminate subgingival bacteria is sometimes inadequate, leading to persistent inflammation in certain sites (18). Additionally, Zhou and al. highlighted that SRP alone may not be sufficient in eradicating bacteria within periodontal pockets exceeding 5 mm, suggesting that adjunctive treatments may be necessary to enhance clinical outcomes (19).

Another consideration is that while SRP improves clinical parameters, the healing response varies among patients**.** Park et al. pointed out that some patients experience a rebound in bacterial colonization over time, which may necessitate additional interventions. This highlights the need for long-term maintenance therapy to sustain the benefits of SRP and prevent disease recurrence (20).

The analysis supports the theory that the curettage technique is still a competitive treatment to reduce the probing depth and the attachment loss. Although slight differences can be observed in favor of the lasers, it is not enough to discard the use of SRP in the treatment of periodontal pockets.

1.5. Efficacy of lasers alone

The use of laser therapy alone in periodontal treatment presents both advantages and limitations (17). While certain laser types have demonstrated potential in reducing periodontal pockets and improving attachment levels, their effectiveness varies depending on factors such as wavelength, power settings, and tissue interaction (19,23,24). Additionally, the absence of mechanical debridement may limit their ability to fully remove biofilm and calculus, which are key contributors to periodontal disease. Deeper research is necessary to determine if the outcomes are stable in a long-term perspective and to establish standardized protocols for optimal results (18).

The use of lasers in dentistry has gained attention due to their potential antimicrobial effects and ability to modulate the host inflammatory response. Various laser systems, including diode, Er:YAG, and Er,Cr:YSGG lasers, have been investigated as standalone therapies for periodontitis**.** Saglam and al. and Zhou and al. demonstrated that laser treatment alone can reduce bacterial load, promote healing, and lead to moderate improvements in PD and CAL. However, the mechanical debridement achieved by SRP is often lacking in laser monotherapy, which can limit its overall effectiveness (19,24).

One of the main benefits of laser therapy is its capacity to target infected tissue in a selective way while preserving healthy structures. Jiang Lin and al**.** found that diode lasers at 810 nm provided bactericidal effects and stimulated tissue healing (23). Similarly, Lopes and al. observed that Er:YAG lasers were effective in biofilm disruption and tissue regeneration. However, despite these advantages, lasers alone may not be as effective as mechanical debridement in removing hard deposits like calculus (21).

Additionally, Sinha and al. pointed out that laser monotherapy often produces variable outcomes, with effectiveness depending on parameters such as wavelength, power settings, and treatment duration. While lasers show promise in enhancing periodontal healing, their role as a primary treatment without SRP remains controversial. Further research with larger sample sizes and standardized protocols is needed to determine the long-term efficacy of laser monotherapy (17).

1.6. Using laser supplementing the SRP

The combination of SRP and laser therapy has been widely studied as a means of enhancing periodontal treatment outcomes. Several studies, including Diwan and al., Park and al., indicate that adjunctive laser therapy with SRP provides superior results compared to either modality alone. The synergistic effect of SRP's mechanical debridement and the laser's bactericidal properties leads to greater reductions in PD and improved CAL gain (18,20).

Sinha and al. found that SRP combined with laser therapy significantly improved periodontal parameters compared to SRP alone, suggesting that lasers enhance healing by reducing inflammation and promoting tissue regeneration (17). Similarly**,** Zhou and al. observed that Er:YAG lasers used as an adjunct to SRP improved both short-term and long-term periodontal outcomes, particularly in deeper pockets (19).

One of the key advantages of combining SRP with laser therapy is the ability to reach areas that are difficult to debride mechanically. Lopes and al. reported that lasers help eliminate residual bacteria in deep periodontal pockets, reducing the risk of reinfection (21). Furthermore**,** Park and al. highlighted that the adjunctive use of lasers may accelerate the early healing phase by modulating host immune responses (20).

Despite these benefits, the effectiveness of SRP combined with lasers may vary depending on factors such as laser type, power settings, and patient-specific conditions. Standardization of laser protocols remains a challenge, and further studies are needed to establish optimal treatment guidelines for combined therapy.

1.7. Limitations

While the reviewed studies provide valuable insights into the efficacy of SRP and laser therapies, several limitations must be acknowledged. A common issue among the studies is the small sample size, which may limit the generalizability of the findings. Lopes and al. emphasized that larger, multicenter trials are needed to confirm the clinical benefits of laser-assisted periodontal therapy (21).

Another limitation is the variability in study designs and treatment protocols. Differences in laser types, power settings, exposure times, and patient populations make it difficult to draw direct comparisons between studies. Zhou and al. and Saglam and al. highlighted the need for standardized treatment parameters to ensure consistency across clinical trials (19,24).

Additionally, many studies have short follow-up periods, making it challenging to determine the long-term effectiveness of laser therapy. Diwan and al. and Park and al. noted that while immediate improvements in PD and CAL were observed, the sustainability of these benefits over months or years remains uncertain (18,20).

Moreover, the cost and accessibility of laser technology may impact its widespread adoption in clinical practice. Lin and al. pointed out that while lasers offer promising advantages, their high costs and the need for specialized training may limit their routine use in periodontal therapy (23). Future research should consider cost-effectiveness analyses to evaluate the practical implications of laser-assisted treatments.

Finally, factors such as patient compliance, operator skill, and individual healing responses were not always controlled, potentially influencing the outcomes.

1.8. Recommendations and future directions

Based on current findings, future research should focus on standardizing laser protocols to optimize clinical outcomes. Studies such as those by Sinha and al. and Zhou and al. highlight the need for consensus on laser settings, treatment duration, and adjunctive use with SRP (17,18). Large-scale, long-term clinical trials are necessary to assess the sustained effects of laser therapy beyond initial improvements. Additionally, cost-effectiveness analyses should be conducted, as noted by Lin and al., to determine the practicality of laser-assisted periodontal treatment in routine clinical settings (23).

The integration of personalized treatment approaches based on disease severity, patient-specific factors, and microbial profiles may enhance periodontal therapy outcomes. Future studies should also investigate biomarkers and host response modulation, as suggested by Saglam and al., to assess the regenerative potential of laser therapy. Lastly, advancements in minimally invasive technologies, such as artificial intelligence-driven laser adjustments, could refine periodontal treatment strategies, improving precision and patient comfort (24).

6. CONCLUSION

In conclusion, the reviewed studies collectively answer the main objective of this review by demonstrating that laser-assisted periodontal therapy, when used either alone or as a supplement to scaling and root planning, can offer improved clinical outcomes in adults with periodontal pockets. Across various trials, lasers consistently showed greater reductions in probing depth and gains in clinical attachment level compared to traditional methods such as curettage alone. While SRP remains the keystone of nonsurgical periodontal treatment, the addition of laser therapy appears to enhance its efficacy, particularly in sites with deeper pockets or persistent inflammation. However, the marginal improvements observed in some cases, along with variability in outcomes depending on laser type, settings, and study design, suggest that lasers should be considered a complementary tool rather than a replacement.

Moreover, clinicians should carefully assess patient-specific factors, disease severity, and anatomical considerations when incorporating laser therapy into treatment plans. Patient preferences, cost-effectiveness, and accessibility are also important factors that may influence clinical decision-making. The current body of evidence highlights the need for well-designed, standardized, and longer-term studies to clarify optimal laser parameters and establish clear clinical guidelines. Until then, laser-assisted therapy remains a valuable adjunct in periodontal care, offering potential benefits when applied thoughtfully and judiciously.

7. SUSTAINABILITY

From a sustainability perspective, the integration of laser-assisted periodontal therapy into standard clinical practice must consider not only clinical efficacy but also long-term viability and resource efficiency (24). While lasers may offer improved outcomes in periodontal treatment, their widespread adoption raises concerns regarding cost, energy consumption, and the need for specialized training and equipment (26). These factors may limit accessibility, particularly in low-resource settings, thus challenging the sustainability of laser use on a broad scale (27). Additionally, the economic price/benefit for patients must be carefully evaluated, as higher initial treatment costs may be offset by reduced need for future interventions, fewer complications, and improved long-term oral health outcomes (27). Moreover, the environmental impact of manufacturing and maintaining high-tech laser systems should be weighed against their clinical benefits (27). For LAPT to be a sustainable addition to periodontal therapy, deeper research should focus on finding cost-effective, energy-efficient technologies and creating standardized, user-friendly protocols that can be implemented across diverse healthcare settings without compromising accessibility or environmental responsibility (28).

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