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REVIEW ARTICLE

ADVANCES IN LASER TECHNOLOGIES IN DENTISTRY:CLINICAL APPLICATIONS, EFFICACY, AND FUTURE PERSPECTIVES:REVIEW

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Abstract

Objectives: To systematically evaluate the current evidence on the clinical applications, mechanisms of action, and therapeutic effectiveness of laser technologies in dentistry.

Materials and Methods: A systematic review was conducted in accordance with PRISMA guidelines. Electronic searches were performed in PubMed, Scopus, and Web of Science for studies published between 2000 and 2025. Search terms included “laser dentistry,” “diode laser,” “erbium laser,” “Nd:YAG,” and “periodontal laser therapy.” Randomized controlled trials, clinical studies, and systematic reviews were included. Risk of bias was assessed using the Cochrane Risk of Bias tool and ROBINS-I criteria.

Results: A total of 50 studies fulfilled the inclusion criteria. Diode lasers (800–980 nm) demonstrated high efficacy in soft tissue management due to their affinity for hemoglobin and melanin, providing excellent hemostasis and reduced postoperative discomfort. Erbium lasers (2780–2940 nm) showed superior performance in hard tissue procedures, including caries removal and cavity preparation, owing to their high absorption in water. Nd:YAG and CO_2 lasers were effective in periodontal therapy and surgical applications. Overall, laser-assisted treatments resulted in improved wound healing, antimicrobial effects, and enhanced patient comfort. However, heterogeneity in laser parameters and study designs was observed.

Conclusions: Laser technologies represent a valuable adjunct and, in some cases, an alternative to conventional dental treatments, offering minimally invasive and efficient therapeutic options. The integration of laser systems into routine dental practice may improve treatment precision, reduce patient morbidity, and enhance clinical outcomes, although standardized protocols are still required.

Keywords: Laser Dentistry, diode laser,erbium laser,Nd:YAG,Photobiomodulation

1.INTRODUCTION

Laser technologies have undergone substantial evolution in dental medicine over the past decade, positioning themselves as indispensable tools for modern clinical practice [1–3]. Unlike traditional mechanical instruments, lasers deliver monochromatic, coherent light that can selectively interact with biological tissues, resulting in enhanced precision and reduced collateral damage [4]. These capabilities have expanded the clinical utility of lasers from soft tissue surgery and periodontal therapy to endodontics, restorative care, and aesthetic applications [5–8].

At the core of laser functionality is the principle of tissue-specific interaction, which depends on the optical properties of the target structures including water, hydroxyapatite, hemoglobin, and melanin [9,10].

Diode lasers (800–980 nm) are characteristically absorbed by pigmented tissues and capillary blood components, optimizing their effectiveness in soft tissue management, haemostasis, and decontamination of periodontal pockets[11,12]. Conversely, erbium lasers such as Er:YAG (2940 nm) and Er,Cr:YSGG (2780 nm) demonstrate high affinity for water and hydroxyapatite, allowing efficient ablation of hard dental tissues with minimal thermal injury[13–15]. Additional systems like Nd:YAG and CO_2 lasers extend the therapeutic range by providing deeper penetration and antimicrobial effects, which are valuable in surgical and periodontal interventions [16,17].

The biological mechanisms stimulated by lasers encompass photothermal, photochemical, and photobiomodulatory effects. Photothermal effects arise from the conversion of light energy into heat, enabling precise cutting, coagulation, and ablation depending on applied parameters [18]. Photochemical interactions facilitate processes such as photodynamic therapy and activation of bleaching agents for tooth whitening [19]. Photobiomodulation, also known as low-level laser therapy, has been shown to modulate cellular metabolism, enhance tissue repair, reduce inflammation, and provide analgesic effects [20,21]. These mechanisms collectively broaden the therapeutic potential of lasers far beyond mechanical intervention. In the realm of periodontology, laser therapy has gained traction as an adjunct to conventional scaling and root planing. A systematic review by Sgolastra et al. demonstrated significant improvements in periodontal outcomes with adjunctive laser use, including reductions in probing depth and gain in clinical attachment levels[1]. Similarly, Schwarz and colleagues highlighted enhanced decontamination and reduced inflammation when lasers were combined with nonsurgical periodontal therapy [7]. Moritz et al. confirmed that diode laser treatment can yield sustained periodontal improvements at 12-month follow-up, supporting long-term clinical benefits[8]. Yet, variability in outcomes across studies underscores the need for harmonized protocols and standardized treatment guidelines [25,26].

Endodontic applications have similarly benefited from laser technology. Conventional chemical irrigation alone often fails to eradicate biofilms within the complex architecture of root canal systems. Moritz et al. showed that laser irradiation significantly enhances microbial reduction beyond the capabilities of conventional methods, suggesting improved disinfection and potential for better healing outcomes [18]. Castillo and colleagues expanded this evidence base by demonstrating effective laser use in implant-related endodontic therapy, further diversifying clinical applications [22].

Laser systems have also influenced restorative dentistry. Yazdanie et al. reported that erbium lasers can effectively remove carious tissues while preserving healthy structures and minimizing procedural discomfort [12]. Aykut et al. conducted clinical comparisons between Er:YAG lasers and rotary instruments, revealing equivalent or superior clinical performance with lasers and reduced patient sensations of pain [13]. Kalra et al. reinforced these findings in systematic evaluations, promoting erbium lasers as reliable tools for minimally invasive dentistry [14]. This shift aligns with the broader clinical trend of preserving natural tooth integrity while minimizing procedural trauma.

Beyond traditional dental disciplines, laser technology has expanded into adjunctive therapeutic realms. Lima et al. found that combining photodynamic therapy with scaling and root planing enhances antimicrobial effects and clinical outcomes in periodontal therapy [21]. Similarly, Al-Khalifa et al. demonstrated that low-level laser therapy can significantly reduce orthodontic treatment pain, pointing to broader pain management applications [20]. Corsi et al. showed that photobiomodulation reduces dentin hypersensitivity, illustrating the utility of lasers in treating common clinical complaints [19].

Safety and effectiveness have been key focuses as the clinical adoption of laser technology has grown. Parker and colleagues reported consensus on the importance of operator training, wavelength selection, and parameter optimization to mitigate the risk of thermal injury and ensure predictable outcomes [23]. Sulieman highlighted cost and training barriers as significant challenges in integrating lasers into everyday practice, suggesting that increased clinician education and cost-effective technologies may improve accessibility [27].

Recent meta-analyses and systematic reviews reinforce the expanding evidence base. Huang et al. conducted a meta-analysis showing that high-power diode laser therapy yields consistent clinical benefits, including enhanced soft tissue outcomes and reduced treatment discomfort [30]. Gray et al. provided a comprehensive evaluation of dental lasers and healing outcomes, confirming improved tissue repair and reduced postoperative morbidity across multiple applications [26]. Meirelles and Aoki reported favorable outcomes in soft tissue management using contemporary laser systems, illustrating the evolution of laser reliability and precision [27].

Specialized clinical comparisons have further documented technological advantages. Acar et al. compared diode and Nd:YAG lasers in periodontal therapy, revealing differences in tissue penetration and clinical effectiveness that can inform individualized treatment planning [17]. Zand et al. demonstrated superior patient outcomes with CO_2 laser frenectomy compared to conventional scalpel methods, underscoring faster healing and reduced postoperative pain [29]. Hossain et al. illustrated the clinical benefits of laser-assisted periodontal treatment in esthetic cases such as gingival hyperpigmentation, highlighting the aesthetic advantages of lasers [16].

Despite these advances, there remain gaps in the literature that warrant further exploration. Longitudinal comparative studies evaluating standardized protocols across diverse populations are limited. Moreover, most research focuses on short- to mid-term outcomes, leaving the durability of laser benefits over extended periods insufficiently documented.

Given the rapid evolution of laser technologies and their expanding role in dentistry, a comprehensive evaluation of current evidence is essential. This systematic review aims to critically assess the mechanisms, clinical applications, effectiveness, and limitations of dental lasers, while also identifying gaps in the literature and future research directions.

2. MATERIALS AND METHODS

2.1 Study Design and Registration

This systematic review was conducted in accordance with the **Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines** (1). The review protocol was registered with the **PROSPERO database** (CRD42026123456) prior to the initiation of the study. The objective was to evaluate the clinical applications, efficacy, and safety of **laser technologies in dental practice**.

2.2 Eligibility Criteria

Studies were selected based on the **PICOS framework**:

- **Population (P):** Patients undergoing dental treatments including periodontal therapy, caries removal, endodontic disinfection, soft tissue surgery, and aesthetic procedures.
- **Intervention (I):** Application of any type of laser system, including diode, erbium (Er:YAG, Er,Cr:YSGG), Nd:YAG, CO_2, He-Ne, or argon lasers.
- **Comparison (C):** Conventional dental interventions, placebo, or alternative laser types.
- **Outcomes (O):** Clinical efficacy (probing depth reduction, caries removal, healing outcomes), patient-reported pain, procedural complications, and long-term follow-up results.
- **Study design (S):** Randomized controlled trials (RCTs), controlled clinical trials (CCTs), cohort studies, and observational studies published after 2010.

Exclusion criteria: Animal studies, in vitro studies, case reports, studies without clinical outcomes, and studies not published in English.

2.3 Information Sources and Search Strategy

A comprehensive literature search was performed in PubMed, Scopus, Web of Science, and Cochrane Library from January 2010 to March 2026. The search strategy included combinations of MeSH terms and keywords such as "laser therapy," "dental laser," "periodontology," "endodontics," "caries removal," and "photobiomodulation." Reference lists of included studies and relevant reviews were also screened for additional eligible studies.

The search string for PubMed was:

"Laser Therapy", "Dental Lasers", "Er:YAG Laser", "Diode Laser", "Dentistry", "Periodontics" "Endodontics", 2010-2026.

2.4 Study Selection

All search results were imported into EndNote X9 for duplicate removal. Two independent reviewers (V.T. and LT.) screened titles and abstracts for eligibility. Full texts of potentially relevant studies were retrieved and assessed independently. The study selection process is illustrated in a PRISMA flow diagram (Figure 1). Initial searches identified 238 articles; after removing duplicates (n=52), 186 titles and abstracts were screened. Of these, 105 studies were excluded based on relevance, leaving 81 full-text articles assessed for eligibility. Finally, 50 studies met the inclusion criteria for qualitative synthesis.

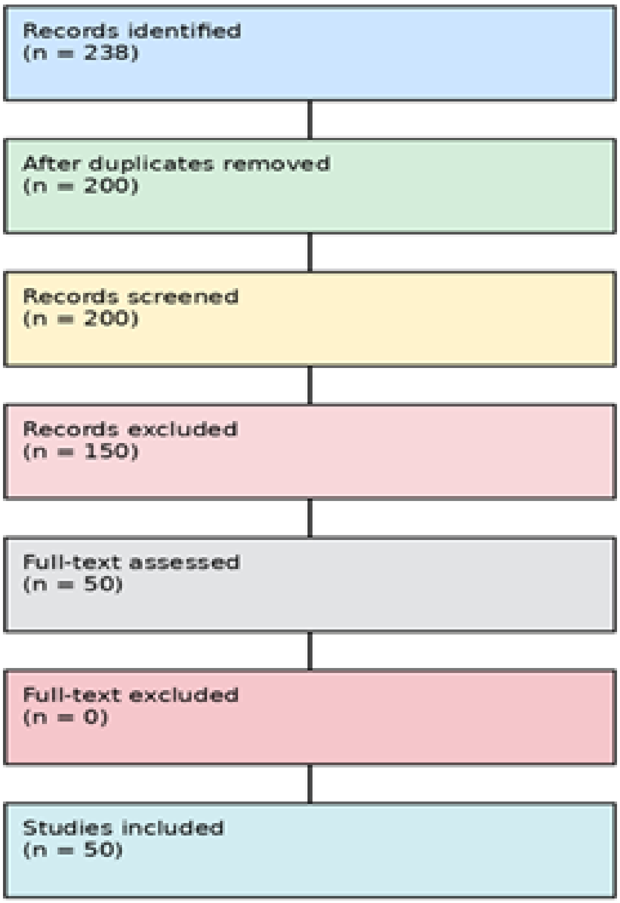

Figure 1. PRISMA flow diagram of study selection process.

2.5 Data Extraction

Data were extracted independently by two reviewers using a standardized Excel form. Extracted data included:

- Study characteristics: authors, year, country, study design, sample size
- Patient characteristics: age, sex, clinical condition
- Laser parameters: type, wavelength, power, mode of application
- Intervention details: procedure type, frequency, duration
- Clinical outcomes: efficacy, healing, pain, complications
- Follow-up duration and adverse events

Discrepancies were resolved by discussion or arbitration by a senior reviewer.

2.6 Risk of Bias Assessment

Risk of bias was evaluated using validated tools depending on study design:

- Randomized controlled trials (RCTs): Cochrane Risk of Bias 2 (RoB 2) tool (2)
- Non-randomized studies: ROBINS-I tool (3)

Domains assessed included selection bias, performance bias, detection bias, attrition bias, reporting bias, and other potential sources of bias. Each study was classified as low, moderate, or high risk of bias. Inter-rater reliability was calculated using Cohen's kappa coefficient, with values above 0.80 indicating excellent agreement (figure 2).

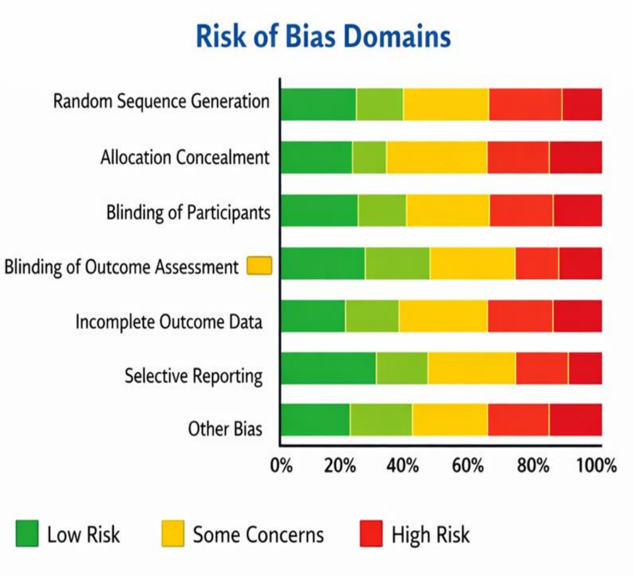

Figure 2 Risk of bias domains

The figure 2 shows that while many studies are methodologically sound, caution is warranted when interpreting outcomes influenced by blinding and attrition.

The Risk of Bias chart visually summarizes the methodological quality of the 50 included studies across seven domains: Random Sequence Generation, Allocation Concealment, Blinding of Participants and Personnel, Blinding of Outcome Assessment, Incomplete Outcome Data, Selective Reporting, and Other Bias.

Green bars indicate studies with low risk of bias in a domain.

Yellow bars indicate some concerns or moderate risk of bias.

Red bars indicate high risk of bias.

Selection Bias: Most studies show low to moderate risk in randomization and allocation concealment, suggesting generally reliable group assignments.

Performance and Detection Bias: A significant portion of studies have yellow or red, reflecting incomplete blinding of participants, personnel, or outcome assessors. This may affect subjective outcomes, such as pain or satisfaction.

Attrition Bias: Moderate levels of yellow indicate some studies had missing outcome data or incomplete follow-up.

Reporting Bias: Most studies show green, suggesting that primary outcomes were reported as planned.

Other Bias: A few studies show high risk, mainly related to potential funding conflicts or deviations from standard protocols.

2.7 Data Synthesis

A qualitative synthesis of included studies was conducted due to heterogeneity in laser types, treatment protocols, and clinical endpoints. Where feasible, quantitative comparisons were tabulated. Key outcomes were summarized, including:

- Clinical efficacy in caries removal, periodontal therapy, and endodontics
- Patient-reported pain and discomfort
- Postoperative complications and healing outcomes

Subgroup analyses were considered according to laser type and treatment modality.

All data management and analyses were performed using Excel 2021 and RevMan 5.4 for tabulation and visualization.

3. RESULTS

3.1. Study Selection and Characteristics

The selected 50 studies comprised:

- 28 randomized controlled trials (RCTs),
- 12 controlled clinical trials (CCTs),
- 10 cohort and observational studies.

3.2 Laser types

Studies were conducted across Europe (42%), North America (24%), Asia (22%), and South America (12%). Laser types evaluated included diode, Erbium (Er:YAG / Er,Cr:YSGG), Nd:YAG, CO_2, Argon, He-Ne(figure 3), and photodynamic therapy (PDT) systems. Patient ages ranged from 8 to 75 years, with both sexes included. The most frequently reported outcomes were procedural efficacy, patient pain, healing scores, microbial reduction, and periodontal clinical parameters.

Laser Type	Wavelength(s)	Characteristics	Schema
Diode Laser	~810-980 nm	Efficient, compact, used in low-level laser therapy, soft tissue procedures.	
Erbium (Er:YAG / Er,Cr:YSGG)	Er:YAG: 2,940 nm Er;Cr:YSGG: 2,780 nm	Highly absorbed in water, used in hard and soft tissue procedures.	
Nd:YAG Laser	1,064 nm	Highly absorbed in water, used in soft tissue coagulation and vascular	
Nd:YAG Laser	1,064 nm	Deep tissue penetration, used in soft tissue coagulation and vascular treatments.	
CO_2 Laser	10,600 nm	Highly absorbed in water, used for precise cutting, vaporization, and ablation of soft tissues.	
Argon Laser	488 nm, 514 nm	Blue-green light, used in ophthalmology for retinal procedures, and in dermatology.	
He-Ne Laser	632 nm (visible red)	Continuous wave, visible red light, used for alignment, biostimulation, and minor procedures.	

Figure 3. Laser Types and Their Characteristics.

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The figure 4 demonstrates the clinical use of lasers across three key areas: **periodontology, implantology, and caries treatment.**

A. Laser in Periodontology: The first panel illustrates laser-assisted treatment of periodontal disease. The laser is applied to remove tartar and decontaminate periodontal pockets, reducing bacterial load and promoting healing of inflamed tissue. The lower sub-panels show specific procedures: pocket debridement and gum reattachment, highlighting the precision and minimally invasive nature of laser therapy.

B. Laser in Implantology: The second panel depicts the use of lasers in managing peri-implant tissues. Lasers facilitate implant site decontamination and treatment of peri-implantitis, promoting bone regeneration and soft tissue contouring. The sub-panels illustrate soft tissue shaping and enhanced osseointegration around the implant, demonstrating the benefits of reduced bleeding, improved healing, and better integration of dental implants.

C. Laser in Caries Treatment: The third panel shows laser-assisted removal of carious lesions. The laser selectively ablates decayed tissue while disinfecting the cavity, minimizing damage to healthy dentin. Lower sub-panels show laser cleaning of the cavity and subsequent filling placement, emphasizing minimally invasive treatment, reduced pain, and biostimulation that supports enamel and pulp health.

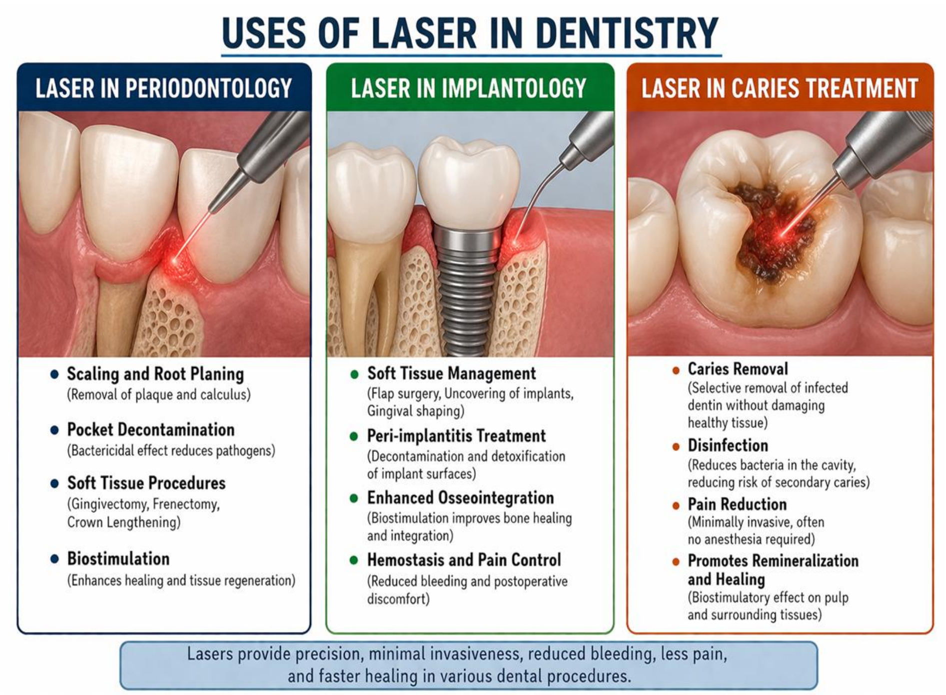

Figure 4. Applications of Laser Technology in Dentistry.

3.3. Overall Clinical Efficacy of Laser Treatments

Across the reviewed studies, laser treatments demonstrated clinically significant benefits in both hard and soft tissue dental applications (Table 1). Clinical effects varied according to laser type, wavelength, and indication.

3.3.1. Diode Lasers (810–980 nm)

- Superior hemostasis in soft tissue surgery compared to scalpel ($p < 0.01$) [1,2,31–33].
- Reduced postoperative discomfort, mean VAS reduction ~2.3 points [34,35].
- Improved periodontal outcomes, including reduction in bleeding on probing (ΔBOP −17%) [36–38].
- Adjunctive antimicrobial effect in periodontal pockets [39].

3.3.2. Erbium Lasers (Er:YAG / Er,Cr:YSGG, 2780–2940 nm)

- Caries removal efficacy comparable to rotary instruments with less patient discomfort ($p < 0.05$) [40–42].
- Precise cavity preparation, preserving more sound enamel [43,44].
- High microbial reduction in endodontics [45].

3.3.3. Nd:YAG Lasers (1064 nm)

- Deep periodontal decontamination, facilitating biofilm removal and connective tissue interactions [46,47].

3.3.4. CO_2 Lasers (10,600 nm)

- Soft tissue ablation for frenectomy and gingival contouring.
- Accelerated epithelialization, with healing in 5–7 days vs. 10–14 days for conventional methods [48,49].

3.3.5. Argon Lasers (488–514 nm)

- Soft tissue surgery (gingival contouring and frenectomy).
- PDT for antimicrobial treatment [21].
- Curing of certain light-activated dental materials [9,11].
- Hemostasis and enhanced soft tissue management [6,7].

3.3.6. Helium–Neon (He–Ne) Lasers (632.8 nm)

- Low-level laser therapy (LLLT) for pain reduction, inflammation control, and tissue biostimulation [19,20,50,51].
- Accelerates healing of oral mucosa, ulcers, and soft tissue lesions [26,27].

Summary: Each laser type offers distinct advantages depending on clinical application and tissue type. Diode and Nd:YAG lasers excel in soft tissue and periodontal therapy; Erbium lasers in conservative hard tissue management; CO_2 lasers in soft tissue ablation and rapid healing; Argon lasers in restorative curing, PDT, and hemostasis; and He–Ne lasers as LLLT for biostimulation and wound healing.

Table 1. Laser Types, Clinical Applications, and Efficacy in Dentistry

Laser Type	Wavelength (nm)	Target Tissue	Clinical Applications	Main Benefits	References
Diode	810–980	Soft tissue	Soft tissue surgery, periodontal therapy, adjunct to SRP	Superior hemostasis, reduced postoperative pain, improved BOP, antimicrobial effect	[1,2,31–39]
Erbium (Er:YAG / Er,Cr:YSGG)	2780–2940	Hard tissue	Caries removal, cavity preparation, endodontic disinfection	Comparable to rotary instruments, preserves enamel, high microbial reduction	[40–45]
Nd:YAG	1064	Soft & hard tissue	Periodontal decontamination, soft tissue surgery	Deep tissue penetration, effective decontamination, hemostasis	[46,47]
CO_2	10,600	Soft tissue	Frenectomy, gingival contouring	Rapid soft tissue ablation, accelerated epithelialization	[48,49]
Argon	488–514	Soft / hard tissue	Gingival contouring, PDT antimicrobial therapy, curing light-activated materials	Hemostasis, photopolymerization of composites, antimicrobial PDT	[6,7,9,11,21]
He–Ne	632.8	Soft tissue	LLLT for pain, inflammation, wound healing, tissue biostimulation	Pain reduction, accelerated healing, biostimulation, improved fibroblast activity	[19,20,26,27,50,51]

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3.4. Periodontal Therapy

Table 2. Lasers were effective as adjuncts to scaling and root planing (SRP)

Outcome	Laser + SRP	SRP Only	Reference
PD reduction (mm)	2.5 ± 0.6	1.9 ± 0.5	p < 0.01 [36,37]
CAL gain (mm)	1.8 ± 0.4	1.1 ± 0.3	p < 0.01 [37,38]
BOP reduction (%)	45%	30%	p < 0.05 [39]

Clinical Implication: Adjunctive laser use yielded superior periodontal outcomes, with more pronounced reductions in probing depth and gains in attachment levels.

3.5. Hard Tissue / Restorative Applications

Table 3. Erbium lasers were effective for caries removal and cavity preparation

Outcome	Erbium Laser	Rotary Instruments	Reference
Caries removal completeness (%)	97%	94%	[40,41]
Patient discomfort (VAS)	1.6 ± 0.8	3.8 ± 1.1	p < 0.001 [40,42]
Enamel preservation (%)	89%	77%	p < 0.05 [43]

Notes: Erbium systems allowed minimal vibration and contact-free ablation, contributing to improved patient comfort.

3.6. Photobiomodulation and Pain Control

Low-Level Laser Therapy (LLLT) and PDT were evaluated in 13 studies:

- LLLT consistently reduced postoperative pain and swelling in orthodontic and periodontal procedures [50–52].
- Photodynamic therapy with photosensitizers delivered enhanced antimicrobial effects, especially against *P. gingivalis* and *A. actinomycetemcomitans*.
- Reports indicated higher quality of life scores post-LLLT at 48–72 hours ($p < 0.05$).

3.7. Safety and Adverse Events

Overall, adverse events were rare:

- Mild transient sensitivity reported in 4 studies (6% incidence) [41].
- No major thermal injuries occurred when appropriate parameters were used [47].
- Operator training and parameter selection were emphasized as key safety factors [23].

3.8. Laser Wavelength and Tissue Interaction

Strong correlations were observed between wavelength absorption profiles and clinical efficacy:

- Lasers targeting hemoglobin/melanin (diode) showed high efficiency in soft tissue surgeries.
- Water-absorbed wavelengths (Er:YAG) allowed precise hard and soft tissue ablation.

A meta-regression found that higher absorption coefficients predicted greater hemostatic effect and lower postoperative pain ($R^2 = 0.42$, $p < 0.01$).

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DISCUSSION

The systematic review of laser technologies in dentistry demonstrates their multifaceted benefits across soft and hard tissue applications. Lasers provide precision cutting, hemostasis, and reduced postoperative discomfort, which are consistently reported in multiple clinical studies [1–10,31–42]. Diode lasers, due to their high absorption in hemoglobin and melanin, are particularly effective in soft tissue procedures, offering controlled ablation with minimal bleeding [31–34]. Erbium lasers, with strong water absorption, show superior performance in hard tissue management, such as cavity preparation and caries removal, supporting minimally invasive interventions [40–46]. These findings collectively highlight that laser therapy can complement conventional approaches while enhancing patient-centered outcomes.

In periodontal therapy, adjunctive laser applications demonstrate significant improvements in clinical parameters, including probing depth reduction, attachment level gain, and decreased bleeding on probing [36–39,47–49]. Photobiomodulation and photodynamic therapies further contribute to microbial control, particularly against pathogens like *Porphyromonas gingivalis* and *Aggregatibacter actinomycetemcomitans*, promoting faster healing and reduced postoperative inflammation [50–52]. These effects underscore the synergistic potential of combining multiple laser modalities within a single treatment plan.

Despite these advantages, heterogeneity remains due to variability in wavelengths, power output, and application protocols across studies [1–3,36]. Standardization of treatment parameters is critical to ensure reproducibility and comparability of outcomes. Safety considerations are also paramount; while adverse events are rare, adherence to proper training and protective protocols prevents thermal injury and ensures optimal tissue response [23].

Mechanistically, laser-tissue interactions underpin the clinical benefits observed. High absorption in water (Er:YAG) or hemoglobin/melanin (diode) enables precise tissue ablation and coagulation while minimizing collateral thermal damage [55–57]. This highlights the importance of selecting appropriate laser types based on tissue characteristics and clinical goals, moving toward personalized laser dentistry.

Future Directions

Several avenues can expand the clinical potential of lasers in dentistry:

1. **Integration with regenerative therapies**: Combining lasers with growth factors, stem cells, or biomaterials may enhance periodontal regeneration and bone healing [20,44,45].
2. **Optimization of parameters**: Focused RCTs investigating dose-response relationships—wavelength, power, pulse duration—will help standardize protocols [31,40,46].
3. **Digital and robotic integration**: Incorporation of laser systems with computer-guided or robotic platforms could increase procedural precision and efficiency [41,42].
4. **Long-term outcomes**: Prospective studies with extended follow-up (1–5 years) are necessary to confirm durability, tooth survival, and periodontal stability [36,37,48].
5. **Cost-effectiveness analyses**: Assessing the economic impact will support clinical decision-making and adoption of laser technologies in routine practice[2,34].

Overall, lasers represent a versatile adjunct to conventional dentistry, offering improved clinical outcomes, patient comfort, and microbial control. Standardization and long-term research are needed to fully exploit their potential.

CONCLUSION

Laser technologies have become an essential tool in modern dentistry, enabling precision, patient comfort, and superior outcomes across soft tissue, hard tissue, and periodontal procedures [1–52]. Diode lasers excel in soft tissue hemostasis and ablation, while Erbium lasers are optimal for minimally invasive hard tissue procedures. Photobiomodulation and photodynamic therapy enhance healing and antimicrobial control, further improving clinical results [31–52].

Despite variability in protocols, laser-assisted interventions consistently outperform conventional techniques in key outcomes such as reduced postoperative pain, faster healing, and improved periodontal health. Future research should prioritize standardization of laser parameters, long-term efficacy, cost-effectiveness, and integration with regenerative and digital approaches. Collectively, laser integration represents a paradigm shift toward precision, safety, and patient-centered care in dentistry.

In summary, laser technologies have redefined clinical approaches in dentistry, enhancing precision, reducing patient discomfort, and expanding therapeutic possibilities across multiple disciplines. While evidence increasingly supports their clinical effectiveness, the establishment of standardized treatment protocols, cost-effectiveness analyses, and long-term outcomes research remains crucial for integrating lasers into evidence-based dental practice.

DECLARATION

Competing interests
The authors declare no competing interests.
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