European Journal of Dental and Oral Health
Vol 6 | Issue 4 | August 2025
ISSN 2684-4443

REVIEW

An Update in the Use of Lasers in Prosthodontics, Orthodontics, and Pedodontics

Zaid Sakarna[1], Anam Fazal[2], Sruthi Kalakota[3], Jayeesha Kothapalle[4], Marina Adly Kaldas Bekheit[5], Amrit Kaur Gill[6], Ridhi Bhola[7], and Sandeep Singh[7,*]

ABSTRACT

Lasers are increasingly used in modern dentistry for both surgical and non-surgical procedures across various specialties. In prosthodontics, lasers such as CO_2, argon, and YAG have improved soft tissue management, enhanced healing, and facilitated precision during prosthetic procedures. In orthodontics, lasers assist in soft tissue contouring, frenectomies, and the removal of resin residues, boosting efficiency and patient comfort throughout treatment. In paediatric dentistry, lasers act as a minimally invasive alternative for caries removal, pulp therapy, and infection control, resulting in reduced pain, better cooperation from children, and greater satisfaction for patients and caregivers. This review highlights recent advancements and clinical benefits of laser integration in prosthodontics, orthodontics, and paediatric dentistry, emphasising their role in improving patient outcomes and modernising dental practice.

Keywords: Dental implant, laser, orthodontics, prosthodontics.

Submitted: June 02, 2025
Published: August 08, 2025

10.24018/ejdent.2025.6.4.391

[1] *DDS, MBA, Uzhhorod National University, Ukraine.*
[2] *BDS, CMH Lahore Medical College, Institute of Dentistry, Pakistan.*
[3] *BDS, Drs. Sudha & Nageswara Rao Siddartha Institute of Dental Sciences, Chinoutpalli, Andhra Pradesh, India.*
[4] *BDS, MPH, AECS, Maaruti Dental College and Research Centre, India.*
[5] *MDS, Faculty of dentistry, Ain Shams university, Cairo, Egypt.*
[6] *BDS, Adesh Institute of Dental Sciences and Research, Bathinda, India.*
[7] *MDS, Post Graduate Institute of Dental Sciences, Rohtak, India.*

* ***Corresponding Author:***
e-mail: drsandeepsingh011@gmail.com

1. Introduction

The application of lasers in medicine and surgery gained widespread attention following the invention of the "Ruby Laser" by Theodore H. Maiman in 1960 [1]. Since then, research has increasingly focused on integrating laser technology into dentistry, opening new possibilities in both clinical practice and dental research. Laser is an acronym for "light amplification by stimulated emission of radiation," and refers to a device that emits a single wavelength of collimated light capable of delivering concentrated energy to target tissues. In 1968, carbon dioxide lasers were used for the first soft-tissue surgeries, followed by the U.S. FDA's approval of the erbium laser for hard-tissue applications in 1997 and the diode laser for soft-tissue surgeries in 1998 [2]. Lasers cut by thermal ablation, a process involving rapid absorption, melting, vaporization, and tissue decomposition. This leads to advantages such as minimal bleeding, reduced operative time, and faster postoperative recovery. Despite the higher operatory and maintenance costs, lasers offer precision and efficiency that continue to transform dental procedures across specialties [3].

Lasers have found widespread applications across various dental specialties, including restorative dentistry, endodontics, periodontics, implantology, oral surgery, and more. Prosthodontics, a core branch of dentistry, has also incorporated laser technology to complement and enhance traditional treatment techniques. Their use has brought significant improvements in procedures involving both fixed and removable prostheses. Lasers offer precise soft tissue modification, reduced bleeding, faster healing, and better postoperative outcomes. In prosthodontic care, they are particularly useful for tasks such as gingival contouring, crown lengthening, impression site preparation, and peri-implant tissue management. These advantages contribute to a more comfortable patient experience and greater clinical efficiency [3], [4].

Orthodontics has undergone significant advancements, incorporating innovations in appliance design, biomechanics, and clinical tools to enhance treatment outcomes.

Among these, laser technology has become an increasingly valuable addition to modern orthodontic practice. Lasers are used to accelerate tooth movement, promote bone remodeling, and facilitate procedures such as enamel etching before bonding and the safe debonding of ceramic brackets. They also aid in reducing pain after force application and help prevent enamel demineralization. Soft tissue challenges during or after treatment, such as excessive gingival tissue, delayed eruption, or frenal attachments, can be effectively managed using lasers for procedures like gingival contouring, frenectomy, operculectomy, and tissue removal around temporary anchorage devices. By offering precision, minimal invasiveness, and improved healing, lasers contribute significantly to more efficient and esthetic orthodontic outcomes [5].

In pediatric dentistry, creating a positive and comfortable first dental experience is essential for establishing lifelong oral health habits. To achieve this, pedodontists increasingly adopt minimally invasive technologies, such as lasers, which reduce discomfort and anxiety during treatment. Lasers offer a gentle alternative to traditional tools and are effective in both diagnostic and therapeutic procedures. They can be used to manage soft and hard tissue conditions, assist in caries detection and removal, and help prevent the progression of dental diseases in children. The reduced need for anesthesia, minimal bleeding, and faster healing make lasers particularly suitable for young patients, improving cooperation and overall treatment success [6].

2. Lasers in Prosthodontics

2.1. Soft Tissue Management and Crown Lengthening

Lasers play a key role in soft tissue management within prosthodontics, offering precise and minimally invasive options for procedures like gingivectomy and gingivoplasty. They reduce bleeding, postoperative pain, and healing time. In crown lengthening, lasers enable controlled removal of soft tissue to expose tooth structure needed for restorations without damaging nearby areas. Lasers are also effective for frenectomy and frenotomy, improving healing and patient comfort. Overall, their use enhances clinical outcomes and patient satisfaction in prosthodontic care [7], [8].

2.2. Removable Prosthodontics (CD & RPD)

Selective laser sintering (SLS) is increasingly used in denture fabrication, where a high-powered CO2 laser fuses polymer or metal powders layer by layer to create strong and durable prostheses from digital models stored in STL format. In removable partial dentures (RPDs), Nd:YAG lasers are employed for welding components, offering significantly higher tensile strength—up to 20%–50% greater, compared to traditional soldering methods. This results in more reliable and long-lasting prosthetic constructions [9].

2.3. Fixed Prosthodontics

For tooth preparation, the Er:YAG laser is preferred due to its precision in removing hard dental tissues, often eliminating the need for anesthesia by numbing the tooth naturally. Unlike high-speed handpieces, lasers avoid causing microfractures in enamel, preserving tooth integrity [10].

Laser trough formation around the tooth simplifies the impression process by removing the need for retraction cords, electrocautery, or hemostatic agents. This technique controls bleeding effectively, reduces postoperative discomfort, and shortens chair time, improving both clinician efficiency and patient experience [11].

2.4. Implantology

Lasers play a vital role in various implant procedures. During second-stage surgery, CO2 and other lasers effectively remove soft tissue, allowing immediate impressions with minimal bleeding and tissue shrinkage. Low-level laser therapy (LLLT), using diode lasers (690 nm), helps disinfect contaminated implant surfaces, reducing bacterial load by up to 92%. Laser-assisted implant site preparation promotes faster healing, better osseointegration, and less patient discomfort. For peri-implantitis, diode, CO2, and Er:YAG lasers are used to remove inflamed granulation tissue and decontaminate implant surfaces, improving treatment outcomes [12].

2.5. Maxillofacial Prosthodontics

3D printing has become a crucial tool for reconstructing both bone and soft tissues in maxillofacial prosthodontics. Using computer-aided design (CAD), models are built layer by layer. Various 3D printing techniques, including stereolithography, multijet modeling, selective laser sintering (SLS), binder jetting, and fused deposition modeling, are widely applied in clinical practice (Fig. 1) [13].

3. Lasers in Orthodontics

3.1. Acceleration of Tooth Movement

Orthodontic treatment duration largely depends on the rate of tooth movement, which involves alveolar bone remodeling and periodontal ligament reorganization. Low-Level Laser Therapy (LLLT) has shown potential to accelerate tooth movement by stimulating bone remodeling and connective tissue reorganization without causing harm to the tooth or surrounding periodontium. This acceleration can help reduce overall treatment time effectively [14].

3.2. Laser Etching of Tooth Surface

Studies show that laser etching offers advantages over traditional 37% phosphoric acid etching. Laser treatment does not create a smear layer, helps inhibit caries, and eliminates the need for water spray and air drying. This reduces procedural errors and saves time during bonding procedures [15].

3.3. Low-Level Laser Therapy in Reducing Orthodontic Pain

Orthodontic treatment often causes pain due to acute inflammation from mechanical forces, commonly experienced after placement of separators, archwires, or during tooth retraction. This pain can discourage patients from

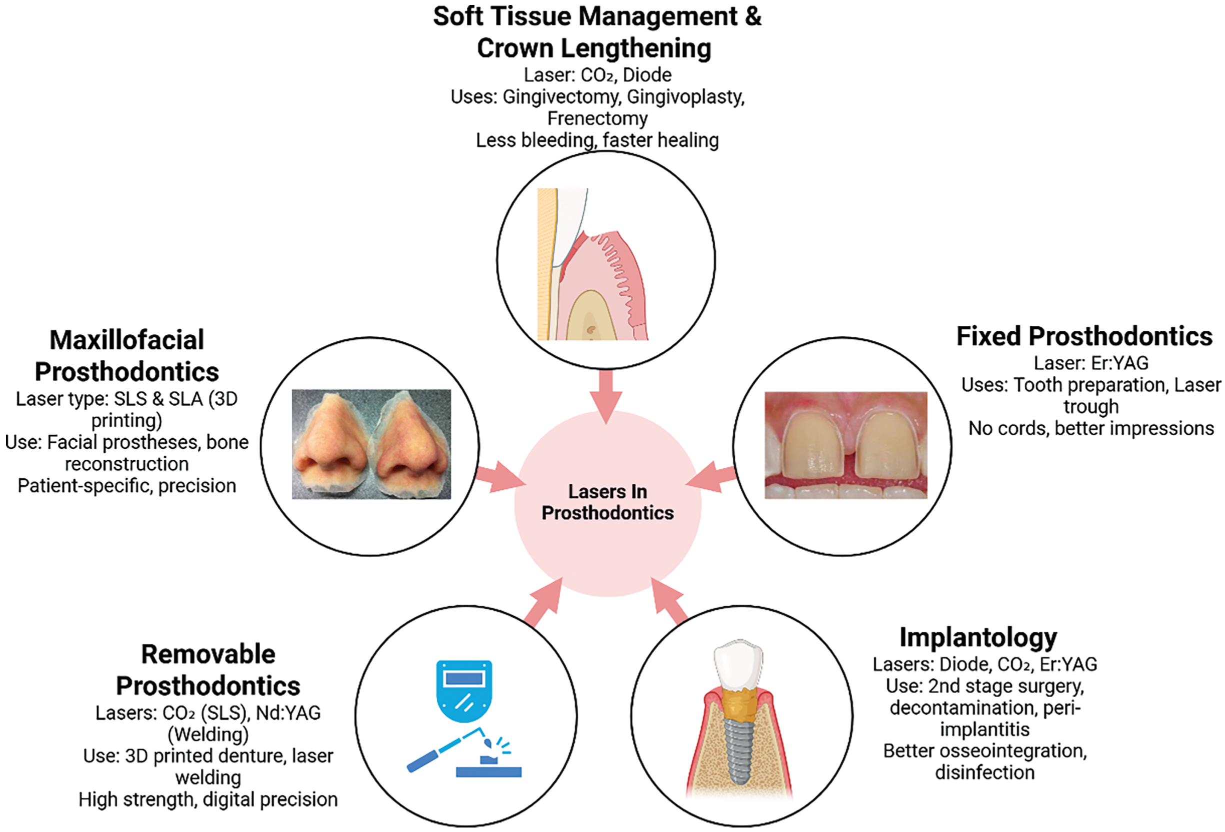

Fig. 1. Lasers in prosthodontics.

maintaining proper oral hygiene. While NSAIDs are commonly used to manage pain, their systemic side effects may slow tooth movement. Low-level laser therapy (LLLT) has emerged as an effective, localized pain management alternative in dentistry. Studies indicate that LLLT can significantly reduce pain immediately following procedures such as separator placement or initial archwire insertion. Both single and repeated LLLT treatments are effective in decreasing pain intensity and duration, although some researchers suggest it may not influence the onset or peak pain day [16], [17].

3.4. Laser Debonding of Ceramic Brackets

Laser debonding of ceramic brackets offers a safer and more efficient alternative to traditional removal methods. While ceramic brackets provide better aesthetics compared to metal ones, their brittleness makes them prone to causing enamel damage or pain during removal. Conventional techniques like using special pliers or thermal methods can be time-consuming and may risk damaging the tooth. Laser devices such as CO2, Nd:YAG, and Er:YAG have been introduced to help by breaking down the adhesive resin that holds the bracket in place. This happens through heating the resin to soften it, rapidly vaporizing it before softening occurs, or using high-energy lasers to break the chemical bonds within the resin. These mechanisms allow the bracket to be removed more easily while keeping the tooth temperature within safe limits, resulting in less discomfort and reduced risk of enamel damage [18].

3.5. Resin Residues Removal after Bracket Debonding

After orthodontic treatment, removing resin residues from teeth is essential to restore a clean surface. Traditional removal methods like burs and scalers can cause enamel damage and increase tooth temperature if not used carefully. Recently, lasers such as CO2 and Nd:YAG have been used effectively to remove resin safely, minimizing enamel harm and heat risks (Fig. 2) [19], [20].

4. Lasers in Pediatric Dentistry

4.1. Pulpal Therapy

In pediatric dentistry, lasers have gained attention for pulpotomy procedures, which involve removing infected coronal pulp while preserving the healthy radicular pulp. The American Association of Endodontists acknowledges lasers' role in root disinfection through photodynamic therapy and photon-induced acoustic streaming, though challenges like canal curvature, heat generation, and limited long-term evidence remain. Among lasers, the diode is most commonly FDA-approved for pulpotomies and apicoectomies, with others like CO_2, Er:YAG, and Nd:YAG also used. While lasers offer a medicament-free option and have shown comparable success rates (around 80% at 24 months), they do not consistently outperform traditional agents like MTA or formocresol. Based on current, low-quality evidence, the AAPD conditionally supports laser use for pulpotomies in primary teeth [21], [22].

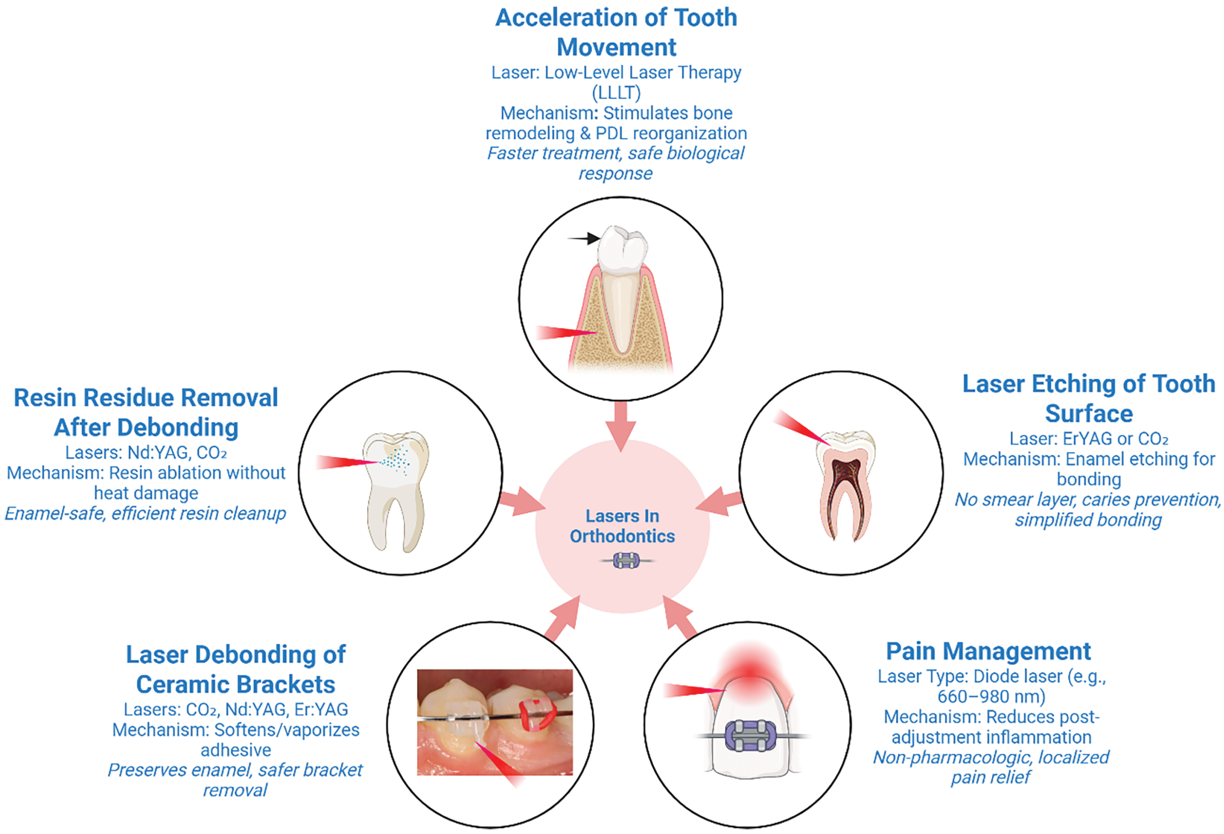

Fig. 2. Lasers in orthodontics.

4.2. *Dental Trauma and Oral Surgery*

Dental trauma is common among children, with around 20% affecting primary teeth and 15% involving permanent dentition. While lasers have been explored in managing pulp tissue injuries, such as complicated crown fractures, current evidence remains limited or inconclusive compared to traditional medicaments. However, for traumatic injuries like luxation, subluxation, or avulsion, diode and Nd:YAG lasers can help decontaminate periodontal pockets or tooth sockets, promoting better healing. Additionally, LLLT has shown promising results in enhancing soft tissue, gingival, and bone healing, and in reducing pain and inflammation in oral surgery. Still, more pediatric-specific research is needed to confirm effectiveness and develop clinical guidelines [23], [24].

4.3. *Restoration and Pit & Fissure Sealants*

Lasers, particularly erbium lasers, can be used for tooth surface preparation before applying pit and fissure sealants. They assist in cleaning, conditioning, and disinfecting fissures. For carious fissures, lasers help with fissurotomy and caries removal, while for sound teeth, they are used for macro-roughening. However, studies show that using lasers alone without acid etching leads to high microleakage. Even when combined with acid etching, laser use may sometimes increase microleakage due to enamel cracks and debris. Some suggest argon lasers for curing sealants to enhance acid resistance, though evidence is mixed [25].

4.4. *Caries Prevention*

Lasers, particularly Erbium and CO_2 types, have shown potential in increasing enamel resistance to acid attacks, especially in newly erupted permanent teeth in children and adolescents. These lasers—operating at wavelengths such as 9600, 9300, 10,600 nm (CO_2) and 2780, 2940 nm (Erbium)—can alter the tooth surface to resist caries. Studies also suggest that combining laser treatment with fluoride therapy, such as using an argon laser with acidic phosphate fluoride (APF), can significantly enhance caries prevention, reducing lesion depth by up to 50% compared to laser use alone [25], [26].

4.5. *Exposure of Unerupted Teeth for Orthodontic Purposes*

Lasers such as Er,Cr:YSGG, Er:YAG, diode, and Nd:YAG are commonly used to expose unerupted teeth for orthodontic treatment. While erbium lasers are effective for both soft and hard tissue removal, they carry a risk of enamel damage at the surgical site. In contrast, diode and Nd:YAG lasers pose no such risk due to their tissue-specific wavelengths, making them safer options for soft tissue procedures in orthodontics (Fig. 3) [27].

5. Advantages and Limitations

5.1. *Advantages*

5.1.1. *Precision*

Lasers allow for highly controlled and focused cutting or ablation of both hard and soft tissues, minimizing

Fig. 3. Lasers in pedodontics.

damage to surrounding structures. This precision is especially beneficial in delicate procedures within pedodontics and prosthodontics, such as gingival contouring and frenectomies.

5.1.2. *Reduced Bleeding and Swelling*

The coagulative effect of lasers during soft tissue procedures results in minimal bleeding and edema, enhancing visibility during treatment and reducing post-operative complications.

5.1.3. *Better Healing and Reduced Infection Risk*

Laser-assisted procedures promote faster tissue regeneration and healing due to their sterilizing effect, which reduces the microbial load at the surgical site. This is particularly advantageous in pediatric patients and immunocompromised individuals.

5.1.4. *Improved Patient Compliance and Comfort*

Lasers often eliminate the need for local anesthesia and mechanical drills, reducing discomfort and anxiety. This is especially helpful in pediatric and orthodontic settings where patient cooperation is crucial.

5.1.5. *Minimally Invasive and Time Efficient*

Many laser procedures are less invasive compared to conventional methods, leading to shorter chair time and fewer post-operative visits. This is beneficial for both the clinician and the patient.

5.1.6. *Versatility Across Specialties*

Lasers can be effectively used for a variety of procedures, including soft tissue surgery, hard tissue ablation, biostimulation, desensitization, bleaching, and debonding of orthodontic brackets [28], [29].

5.2. *Limitations*

5.2.1. *High Equipment Cost*

The initial investment and maintenance cost of dental laser units can be prohibitive, particularly for solo practices or clinics in low-income regions.

5.2.2. *Steep Learning Curve*

Mastery in laser use requires additional training and certification. Inadequate understanding can lead to suboptimal outcomes or tissue damage.

5.2.3. *Limited Access in Rural and Under-resourced Settings*

The availability and accessibility of laser equipment are limited in remote and economically weaker regions, hindering widespread adoption.

5.2.4. *Not Universally Applicable*

Lasers cannot completely replace conventional tools for all procedures. For instance, crown preparations, large-scale bone removals, or specific orthodontic treatments still rely on traditional mechanical techniques.

5.2.5. *Risk of Overuse or Misuse*

Inadequate training may lead to inappropriate application of lasers, potentially causing unnecessary tissue damage or patient discomfort.

5.2.6. *Regulatory and Safety Considerations*

Proper safety protocols including protective eyewear and controlled settings are mandatory, and non-compliance may pose health hazards to both patients and practitioners [28], [29].

6. Dental Laser Safety

6.1. *Laser Safety Officer*

A Laser Safety Officer (LSO) ensures safe laser use in dental settings. Often a trained assistant, the LSO is responsible for posting warning signs, securing the laser key, enforcing protective eyewear use, checking laser function (test fire, cleave check), and maintaining equipment. The LSO also oversees staff training, documentation, and adherence to safety guidelines. Additional precautions include high-volume suction to control the laser plume and high-filtration masks to protect against airborne contaminants [30].

6.2. *Fire and Explosion Hazards*

Dental lasers pose a significant risk of fire and explosion if not used with appropriate precautions. To ensure safety, only fire-retardant or wet materials should be used in the operative field. The use of alcohol-based topical anesthetics and alcohol-moistened gauze during laser activation must be strictly avoided, as they are highly flammable. Instead, non-combustible anesthetic agents are recommended. Surrounding tissues should be adequately protected to prevent accidental ignition. It is essential to keep all flammable and explosive substances outside the laser's hazardous zone and to be familiar with the location and use of fire extinguishers in the clinic. Additionally, nitrous oxide should not be used during laser surgery, as it supports combustion. Adhering to ANSI safety standards and staying updated with the latest guidelines is critical for maintaining a safe laser-operating environment [30]–[33].

6.3. *Connections and Traffic*

Dental lasers require proper connection to their cooling systems, which may include internal fans, radiators, or external water or air supplies. These systems must be correctly connected and activated before the laser is powered on. Electrical cords and footswitch cables should be inspected regularly to ensure they are in safe working condition. All laser components, including cables and fiber-optic delivery systems, must be positioned away from high-traffic areas in the clinic to prevent tripping hazards or damage. Fiber-optic cables, which can be several meters long, must be carefully managed to avoid being rolled over or pinched by equipment, as this can result in breakage or disruption of the laser function [30]–[33].

6.4. *Eye Protection*

Eye protection is a critical aspect of laser safety in dental practice, as lasers emit intense, focused beams that can cause severe and often irreversible damage to the eye. Since the advent of lasers like the ruby laser in the 1960s, it has been recognized that different laser wavelengths can harm specific parts of the eye depending on their absorption characteristics. For instance, carbon dioxide and erbium-based lasers are absorbed by the water content of the cornea, potentially leading to corneal burns. Erbium and holmium lasers may also damage the aqueous humor, vitreous humor, and lens, possibly resulting in cataract formation. Meanwhile, lasers with shorter wavelengths such as diode, argon, and Nd:YAG penetrate deeper and pose a risk of retinal injury. These types are particularly dangerous because the eye's natural focusing mechanism intensifies the beam on the retina, making it around 100,000 times more sensitive than skin to laser damage. To mitigate these risks, all individuals within the laser's nominal hazard zone—including the dentist, assistants, and patient, must wear laser-specific protective eyewear with an optical density (OD) appropriate to the laser's wavelength. It is essential to verify that the eyewear matches the exact emission of the laser in use, as even devices with the same generic name may emit different wavelengths requiring distinct protection. Information about the OD and the protected wavelength must be clearly printed on the eyewear. Additionally, safety glasses should include side shields to protect against stray reflections. The Laser Safety Officer (LSO) must ensure that proper eyewear is used consistently and that no one looks directly at or inadvertently activates the laser outside of the treatment target area. Ultimately, understanding the nominal hazard distance and adhering strictly to safety guidelines are vital steps to prevent ocular injuries during laser procedures [30]–[33].

7. Conclusion

Dental lasers represent a significant advancement in modern dentistry, offering precision, enhanced patient comfort, reduced bleeding, and improved healing across a range of clinical applications from pedodontics, orthodontics, to prosthodontics. Despite their clear benefits, challenges such as high equipment costs, steep learning curves, and limited accessibility, especially in resource-poor settings, limit widespread adoption. Strict adherence to safety protocols, including the critical role of Laser Safety Officers and protective measures against fire hazards and ocular injury, remains paramount. Looking forward, innovations in laser delivery systems, integration with digital dentistry, regenerative therapies, and AI promise to expand laser applications and optimize clinical outcomes. Continued research, clinical trials, and efforts to make laser technology more affordable and user-friendly are essential to fully realize its potential and broaden its impact in dental practice worldwide.

7.1. *Future Directions*

7.1.1. *Advancements in Laser Delivery Systems*

Future developments in laser systems are expected to focus on more ergonomic handpieces and flexible fibre-optic delivery mechanisms. These innovations aim to enhance precision, improve accessibility within the oral cavity, and reduce practitioner fatigue during complex prosthodontic procedures. [34]

7.1.2. *Wavelength Specificity and Customization*

Lasers with greater wavelength specificity and customizable parameters are being developed to target different tissue types more effectively. This customization allows for precise control of tissue interaction, enabling clinicians to optimize outcomes based on individual treatment objectives [35].

7.1.3. *Integration with Digital Dentistry*

The integration of laser systems with digital imaging and CAD/CAM technologies is an emerging trend. Using lasers in combination with digital impressions and intraoral scanning will enable more accurate treatment planning, better design of prostheses, and increased efficiency in workflow [35].

7.1.4. *Expanding Applications in Regenerative Therapies*

Lasers have demonstrated potential in stimulating tissue regeneration and improving osseointegration around dental implants. Their use in regenerative therapies is expanding, with ongoing research exploring their role in enhancing healing and improving the biological response in prosthetic treatment [36].

7.1.5. *Synergy with Nanotechnology and Biomaterials*

Combining laser technology with nanotechnology is facilitating the creation of novel biomaterials. These advancements aim to improve the biocompatibility, bioavailability, and long-term durability of implants and restorative materials used in prosthodontics [36], [37].

7.1.6. *Pain Management and Neuromodulation*

Low-level laser therapy (LLLT) is an emerging technique showing promise in postoperative pain relief, inflammation control, and possibly nerve regeneration. Its application in prosthodontics may lead to improved patient comfort and better post-treatment recovery [37].

7.1.7. *Bio-Stimulation and Tissue Engineering*

Laser-induced bio-stimulation is being studied for its ability to promote regeneration of both soft and hard tissues. While standardized protocols are still lacking, the potential of lasers in tissue engineering, particularly in bone regeneration, is significant and warrants further investigation [37].

7.1.8. *Artificial Intelligence (AI) Integration*

AI-driven technologies are expected to assist in laser-assisted prosthodontics by optimizing treatment planning, laser settings, and predictive outcome modeling. This integration will enhance precision and personalization in patient care [38].

7.1.9. *Translational Research and Clinical Trials*

To support widespread clinical adoption, continuous translational research and robust clinical trials are essential. These studies will help validate the efficacy, safety, and long-term benefits of laser-based interventions in dentistry [38].

7.1.10. *Environmental and Economic Considerations*

Future directions also include the development of energy-efficient laser systems that reduce power consumption and heat production, aligning with environmental sustainability goals. Simultaneously, making laser technology more affordable and accessible will expand its use in routine dental practice, benefiting a broader patient population [38].

Conflict of Interest

Authors declare that they do not have any conflict of interest.

References

[1] Maiman TH. Stimulated optical radiation in ruby. *Nature*. 1960;187(4736):493–7.
[2] Kravitz ND, Kusnoto B. Soft-tissue lasers in orthodontics: an overview. *American J Orthodon Dentof Orthop*. 2008;133(4):110–4.
[3] Binrayes A. An update on the use of lasers in prosthodontics. *Cureus*. 2024;16(3):e57282.
[4] Strauss RA, Fallon SD. Lasers in contemporary oral and maxillofacial surgery. *Dent Clin North Am*. 2004;48:861–88.
[5] Heidari S, Torkan S. Laser applications in orthodontics. *J Lasers Med Sci*. 2013;4(4):151–8.
[6] Nazemisalman B, Farsadeghi M, Sokhansanj M. Types of lasers and their applications in pediatric dentistry: a review. *J Lasers Med Sci*. 2015;6(3):96–101.
[7] Yadav A, Verma S, Keshri GK, Gupta A. Role of 904 nm super-pulsed laser-mediated photobiomodulation on nitroxidative stress and redox homeostasis in burn wound healing. *Photodermatol Photoimmunol Photomed*. 2020;36:208–18.
[8] Kekovic V, Schicho K, Perisanidis C, Mikovic N, Stanimirovic D, Soldatovic I, *et al.* Effect of low-level light therapy on post-operative healing of secondary chronic osteomyelitis of the jaws–a prospective study. *Ann Maxillofac Surg*. 2023;13:200–4.
[9] Gounder R, Gounder S. Laser science and its applications in prosthetic rehabilitation. *J Lasers Med Sci*. 2016;7(4):209–13.
[10] Fred M. Erbium laser. *J Can Dent Assoc*. 2004;70(5):334–5.
[11] Parker S. The use of lasers in fixed prosthodontics. *Dent Clin North Am*. 2004;48:971–98.
[12] Adams TC, Pang PK. Lasers in aesthetic dentistry. *Dent Clin North Am*. 2004;48:833–60.
[13] Tukuru N, Gowda KP, Ahmed SM, Badami S. Rapid prototype technique in medical field. *Res J Pharm Tech*. 2008;1(4):341–4.
[14] Doshi-Mehta G, Bhad-Patil WA. Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: a clinical investigation. *Am J Orthod Dentofacial Orthop*. 2012;141(3): 289–97.
[15] Kwon JH, Kwon OW, Kim HI, Kwon YH. Effectiveness of an Er:YAG laser in etching enamel surface for orthodontic bracket retention. *Dent Mater J*. 2005;24:45–52.
[16] Fujiyama K, Deguchi T, Murakami T, Fujii A, Kushima K, Takano-Yamamoto T. Clinical effect of CO2 laser in reducing pain in orthodontics. *Angle Orthod*. 2008;78(2):299–303.
[17] Turhani D, Scheriau M, Kapral D, Benesch T, Jonke E, Bantleon HP. Pain relief by single low-level laser irradiation in orthodontic patients undergoing fixed appliance therapy. *Am J Orthod Dentofacial Orthop*. 2006;130(3):371–7.
[18] Tocchio RM, Williams PT, Mayer FJ, Standing KG. Laser debonding of ceramic orthodontic brackets. *Am J Orthod Dentofacial Orthop*. 1993;103(2):155–62.
[19] Eminkahyagil N, Arman A, Cetinsahin A, Karabulut E. Effect of resin-removal methods on enamel and shear bond strength of rebonded brackets. *Angle Orthod*. 2006;76(2):314–21.
[20] Pus MD, Way DC. Enamel loss due to orthodontic bonding with filled and unfilled resins using various clean-up techniques. *Am J Orthod*. 1980;77(3):269–83.
[21] Smaïl-Faugeron V, Courson F, Durieux P, Muller-Bolla M, Glenny AM, Fron Chabouis H. Pulp treatment for extensive decay in primary teeth. *Cochrane Database Syst Rev*. 2014 Aug 6;(8):CD003220.

[22] De Coster P, Rajasekharan S, Martens L. Laser-assisted pulpotomy in primary teeth: a systematic review. *Int J Paediatr Dent*. 2013;23:389–99.
[23] Dhar V, Marghalani A, Crystal Y, Kumar A, Ritwik P, Tulunoglu O, *et al.* use of vital pulp therapies in primary teeth with deep caries lesions. *Pediatr Dent*. 2017 Sep 15;39(6):173–86.
[24] Nematollahi H, Sarraf Shirazi A, Mehrabkhani M, Sabbagh S. Clinical and radiographic outcomes of laser pulpotomy in vital primary teeth: a systematic review and meta-analysis. *Eur Arch Paediatr Dent*. 2018;19(4):205–20.
[25] Olivi G, Margolis FS, Genovese MD. *Pediatric Laser Dentistry: a User's Guide*. Chicago: Quintessence Publishing; 2011, pp. 73-6.
[26] Rezaei Y, Bagheri H, Esmaeilzadeh M. Effects of laser irradiation on caries prevention. *J Lasers Med Sci*. 2011;2(4):159–64.
[27] Haytac MC, Ozcelik O. Evaluation of patient perceptions after frenectomy operations: a comparison of carbon dioxide laser and scalpel techniques. *J Periodontol*. 2006;77(11):1815–9.
[28] Nammour S. Laser dentistry, current advantages, and limits. *Photomed Laser Surg*. 2012;30(1):1–4.
[29] Theodoro LH, Marcantonio RAC, Wainwright M, Garcia VG. LASER in periodontal treatment: is it an effective treatment or science fiction? *Braz Oral Res*. 2021;35(Suppl 2):e099.
[30] Piccione PJ. Dental laser safety. *Dent Clin North Am*. 2004;48(4):795–v.
[31] Sweeney C. Laser safety in dentistry. *Gen Dent*. 2008;56(7):653–7.
[32] Laser safety eyewear. *Health Devices*. 1993;22(4):159–204.
[33] Takac S, Stojanović S. Klasifikacija laserskog zračenja i mere opreza [Classification of laser irradiation and safety measures]. *Med Pregl*. 1998;51(9–10):415–8.
[34] Beuer F, Schweiger J, Edelhoff D. Digital dentistry: an overview of recent developments for CAD/CAM generated restorations. *Br Dent J*. 2008;204:505–11.
[35] Wang W, Liao S, Zhu Y, Liu M, Zhao Q, Fu Y. Recent applications of nanomaterials in prosthodontics. *J Nanomater*. 2015;2015:3.
[36] Dabra S, Chhina K, Soni N, Bhatnagar R. Tissue engineering in periodontal regeneration: a brief review. *Dent Res J (Isfahan)*. 2012;9:671–80.
[37] Tung TV, Nga NTT, Van HT, Vu TH, Kuligowski K, Cenian A, *et al.* Energy efficiency and environmental benefits of waste heat recovery technologies in fishmeal production plants: a case study in Vietnam. *Sustainability*. 2023;15:17.
[38] Dhayanidhi A, Mudiarasu N, Mathivanan A, Gopalkrishnan JR, Nagarajan SK, Bharathan K. Laser Dentistry–the need of the hour: a cross-sectional study. *J Pharm Bioallied Sci*. 2020;12(Suppl):S295–8.