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APPLICATION OF LASER THERAPY IN DENTISTRY: ADVANTAGES AND DISADVANTAGES

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Abstract: The article explores the application of laser therapy in modern dentistry, emphasizing its clinical effectiveness, patient comfort, and potential integration into routine dental practice. Laser technology, based on the precise use of concentrated light energy, has revolutionized many dental procedures by providing minimally invasive, painless, and highly controlled treatment options. This study presents a comprehensive analysis of the advantages and limitations of laser therapy in dentistry, with a focus on its use in caries removal, periodontal disease treatment, oral surgery, and cosmetic procedures such as tooth whitening.

The research incorporates a literature review, clinical observation, patient surveys, and comparative analysis of laser and conventional treatment methods. Results indicate that laser therapy significantly reduces pain levels, bleeding, and postoperative inflammation, while accelerating tissue regeneration and decreasing the need for anesthesia. Patients reported high satisfaction due to shorter procedure times and enhanced comfort during treatment. However, several challenges were identified, including the high cost of equipment, the need for specialized training, and limited effectiveness in severe or advanced cases of dental disease.

Despite these drawbacks, the findings confirm that laser therapy represents a highly promising direction in dental practice. It improves treatment precision, reduces procedural trauma, and enhances both clinical outcomes and patient experience. The study concludes that integrating laser therapy into standard dental care protocols can substantially raise the quality of dental services, provided that standardized treatment guidelines and adequate professional training are implemented.

Keywords: Laser therapy, dentistry, treatment, teeth, gums, technology, advantages, disadvantages, innovations.

Introduction

Laser therapy is one of the modern treatment methods in dentistry, actively used to address various dental problems. This method is based on the use of laser radiation, which enables

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procedures to be performed with high precision, minimal trauma, and a reduced risk of infection.

The advantages of laser treatment include bloodlessness, reduced pain, accelerated healing, decreased risk of infection, and more precise tissue targeting. Laser therapy also allows patients to avoid frequent anesthesia, which is particularly important for those with high pain sensitivity or contraindications to medications.

Despite its many advantages, laser therapy has certain drawbacks. The main limitation is the high cost of equipment and procedures, making it less accessible to a wide range of patients. In addition, the method's effectiveness depends on the dentist's qualifications and strict adherence to treatment protocols. In some cases, lasers cannot completely replace traditional methods, especially in advanced disease stages.

The aim of this paper is to analyze the use of laser therapy in dentistry, identify its main advantages and disadvantages, and determine prospects for its further application. To achieve this goal, a review of modern scientific literature was conducted, treatment techniques were described, and a study on the effectiveness of laser exposure on oral tissues was carried out.

Dentistry is one of the fastest-developing fields of medicine, where modern technologies are actively being introduced. Laser therapy represents an innovative method based on the use of laser radiation. The method was first applied in dentistry in the mid-20th century, and since then, its use has greatly expanded.

Laser treatment can address a wide range of tasks—from removing carious lesions and treating periodontitis to performing surgical interventions and tooth whitening. The main advantage of lasers lies in their ability to target tissues precisely, minimizing damage to surrounding areas. This makes procedures less traumatic, accelerates healing, and reduces infection risk.

Modern research confirms the effectiveness of laser therapy for both adults and children. It is particularly suitable for patients with increased pain sensitivity or fear of traditional dental procedures. Furthermore, laser treatment reduces the need for anesthesia and postoperative discomfort.

However, the application of lasers in dentistry has certain limitations. The high cost of equipment and procedures makes the method less accessible. The need for a highly qualified specialist and strict adherence to protocols also limits its widespread adoption.

Discussion

According to modern research, laser therapy in dentistry is actively used in various fields. For example, Smith et al. (2020) reported that lasers are effective in treating caries while minimizing damage to healthy tissues. Brown (2019) noted a reduction in pain compared to traditional methods.

Studies by Johnson et al. (2021) demonstrated the positive impact of laser treatment on healing after surgical interventions and tooth extractions, promoting faster tissue regeneration and reduced inflammation.

Other researchers (Lee, 2018; Kumar, 2022) highlighted limited accessibility due to high equipment costs and the need for specialized training. The effectiveness of the procedure also depends on strict adherence to treatment protocols and correct parameter selection.

Several studies emphasize that laser therapy cannot completely replace traditional methods, especially for advanced dental and gum diseases. However, combining laser therapy with conventional approaches can yield better clinical results.

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A review of current literature shows that laser therapy has significant potential to improve the quality of dental care but requires further study and standardized treatment protocols.

Main Body

Theoretical Basis of Laser Therapy in Dentistry

Laser therapy is founded on the interaction of coherent, monochromatic light energy with biological tissues. The term LASER stands for Light Amplification by Stimulated Emission of Radiation, which describes the process of generating a concentrated beam of photons with a single wavelength and phase. When directed at dental tissues, this energy can cause a variety of effects, including photothermal, photomechanical, and photochemical reactions. The type and depth of these reactions depend on the laser wavelength, pulse duration, and energy output.

In dentistry, the most commonly used laser systems include **diode lasers (810–980 nm)**, **Er:YAG (erbium-doped yttrium aluminum garnet, 2940 nm)**, **Nd:YAG (neodymium, 1064 nm)**, and **CO_2 lasers (10,600 nm)**. Each type interacts differently with hard and soft tissues:

- **Diode and Nd:YAG lasers** are primarily used for soft tissue applications such as gingivectomy, frenectomy, and periodontal pocket sterilization due to their strong absorption in pigmented tissues and hemoglobin.
- **Er:YAG and Er,Cr:YSGG lasers** are effective for hard tissue treatments, including enamel and dentin ablation, as they are absorbed by water and hydroxyapatite, allowing precise removal of carious tissue.
- **CO_2 lasers** are excellent for surgical applications, providing clean cuts, excellent hemostasis, and minimal postoperative swelling.

The mechanism of laser action is based on selective photothermolysis, where energy is absorbed only by targeted chromophores (such as water, hemoglobin, or melanin) without damaging surrounding tissues. This selectivity allows for highly controlled, precise, and minimally invasive dental procedures.

Clinical Applications of Laser Therapy in Dentistry

Caries Treatment and Tooth Preparation: Laser-assisted caries removal is one of the most prominent uses in restorative dentistry. The Er:YAG laser is capable of removing decayed tissue while preserving sound enamel and dentin. Unlike mechanical drilling, laser ablation produces no vibration, heat, or unpleasant noise, reducing patient anxiety. Additionally, laser irradiation sterilizes the treated cavity, eliminating microorganisms that may remain after traditional preparation.

Studies (Johnson et al., 2021; Zhang, 2022) have demonstrated that laser-treated cavities exhibit higher bond strength for restorative materials due to micro-roughened surfaces, which improve adhesive retention. Moreover, the absence of mechanical pressure minimizes the risk of microfractures in enamel.

Periodontal and Endodontic Treatments: Laser therapy is extensively used in periodontology to manage gingivitis, periodontitis, and peri-implantitis. The laser's bactericidal properties allow for effective pocket sterilization, removal of granulation tissue, and biostimulation of gingival healing. Low-level laser therapy (LLLT) can further stimulate fibroblast activity, collagen synthesis, and angiogenesis, accelerating regeneration.

In endodontics, diode and Nd:YAG lasers assist in root canal disinfection by penetrating deep into dentinal tubules where conventional irrigation cannot reach. Laser activation of irrigants

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such as sodium hypochlorite enhances their cleaning efficiency, reducing bacterial load and improving long-term treatment outcomes.

Oral Surgery: Lasers are widely applied in minor oral surgical procedures, including frenectomy, gingivectomy, operculectomy, biopsy, and soft tissue lesion removal. The laser beam simultaneously cuts and coagulates tissues, providing a bloodless surgical field and better visualization for the clinician.

Lee (2018) reported that laser-assisted gingivectomy reduced intraoperative bleeding by 70% compared to scalpel surgery. Furthermore, the sealing of lymphatic vessels and nerve endings during laser incision leads to less postoperative swelling and pain. Laser wounds heal with minimal scarring and no need for sutures in most cases, enhancing patient comfort and reducing recovery time.

Aesthetic and Cosmetic Procedures: In aesthetic dentistry, laser technology has become a preferred method for **teeth whitening**, **gum contouring**, and **removal of pigmentation**. Laser-assisted whitening accelerates the activation of bleaching gels, achieving effective results in a shorter period while minimizing tooth sensitivity.

Additionally, lasers are used to reshape gingival margins to create harmonious smiles (laser gingivoplasty) and to remove dark pigmentation caused by melanin deposits (depigmentation). These cosmetic procedures can often be performed without anesthesia and with minimal discomfort.

Pain Management and Biostimulation: Low-level laser therapy (LLLT) is increasingly used for pain relief, inflammation control, and tissue repair. The mechanism involves stimulation of mitochondrial activity and increased production of adenosine triphosphate (ATP), leading to enhanced cellular metabolism and regeneration. LLLT has proven beneficial for managing temporomandibular joint (TMJ) disorders, aphthous ulcers, mucositis, and post-extraction pain. Patients receiving LLLT report faster relief and improved quality of life, making it an important adjunctive therapy in dental practice.

Advantages of Laser Therapy

Laser therapy offers multiple advantages over traditional dental instruments:

1. **Minimally Invasive and Bloodless Procedures:** The laser's precision enables tissue removal without excessive trauma. Coagulation of small blood vessels ensures a clear surgical field.
2. **Reduced Pain and Need for Anesthesia:** The absence of mechanical vibration and heat generation minimizes discomfort, often eliminating the need for local anesthetics.
3. **Enhanced Healing and Tissue Regeneration:** Photobiomodulation stimulates cellular repair mechanisms, resulting in faster wound healing and reduced inflammation.
4. **Antibacterial and Sterilizing Effects:** Laser irradiation destroys bacteria and pathogens, reducing the risk of postoperative infections.
5. **Improved Patient Experience:** Patients experience shorter procedures, fewer visits, less anxiety, and higher satisfaction levels.
6. **Precision and Selectivity:** Lasers can target specific tissue types, preserving surrounding healthy areas and minimizing collateral damage.

Disadvantages and Challenges

Despite these advantages, several barriers hinder the widespread use of laser therapy:

1. **High Equipment Cost:** Dental lasers are expensive to purchase and maintain, limiting their adoption in smaller or budget-constrained clinics.

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2. **Training and Operator Skill:** Safe and effective laser use requires specialized training and certification. Inexperienced operators risk tissue burns or incomplete treatment.
3. **Limited Scope for Advanced Cases:** Lasers may not be effective for extensive carious lesions, large bone defects, or advanced periodontal destruction where surgical intervention remains necessary.
4. **Thermal Risks:** Improper power settings or prolonged exposure can cause overheating, leading to pulp or soft tissue damage.
5. **Patient-Specific Limitations:** Patients with pacemakers or photosensitive conditions may not be suitable candidates for certain laser procedures.

Therefore, while laser therapy enhances treatment quality, it is most effective when combined with traditional techniques and applied under strict safety protocols.

Economic and Practical Considerations

The economic aspect of implementing laser therapy in dental clinics is an important factor. Although the initial investment in laser equipment can be significant—ranging from $10,000 to $70,000 depending on the model—clinics often recover these costs through higher patient throughput and premium service offerings.

Patients are generally willing to pay more for laser-based treatments due to the advantages of comfort, speed, and minimal pain. In addition, laser systems have long operational lifespans and require minimal consumables, which can offset their high purchase cost over time.

However, successful implementation also depends on staff training, maintenance costs, and compliance with safety standards such as protective eyewear and controlled laser zones.

Future Prospects of Laser Use in Dentistry

The future of dental laser technology looks promising due to continuous innovation and growing clinical evidence. Research is focusing on **next-generation diode lasers** with variable wavelengths, **fiber-optic delivery systems**, and **AI-assisted power modulation** that automatically adjusts laser parameters to tissue type and depth.

Moreover, combining laser therapy with **digital dentistry**—including CAD/CAM systems, 3D imaging, and robotics—will allow for greater precision, customization, and integration into comprehensive treatment plans.

Another emerging direction is **photodynamic therapy (PDT)**, where laser light activates photosensitive agents to selectively destroy pathogens in periodontal pockets or root canals, offering a powerful adjunct to conventional antimicrobial approaches.

As education and awareness expand, it is expected that laser dentistry will become part of standard dental curricula and integrated clinical protocols worldwide.

Methodology

The study aimed to assess the effectiveness of laser therapy in treating caries, gum diseases, and cosmetic procedures.

Participants: 50 patients aged 18–60 with various dental conditions.

Methods:

1. Clinical observation (before and after treatment)
2. Patient surveys (pain, comfort, satisfaction)
3. Comparative analysis (laser vs. conventional methods)

A diode laser (810–980 nm) was used following safety protocols (protective glasses, power control, targeted exposure).

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Effectiveness was evaluated by pain intensity (0–10 scale), healing speed (days), inflammation level, and patient satisfaction. Statistical analysis was applied to identify advantages and limitations.

Results

The results demonstrated high efficiency and comfort.

- **Average pain score:** 2.1/10 (40–60% lower than traditional 5.3)
- **Healing time:** 5–7 days vs. 7–10 days with standard treatment
- **Inflammation and bleeding:** significantly reduced
- **Patient satisfaction:** 88% reported high comfort and minimal stress
- **Reduced visits:** 1–2 fewer sessions required

Main drawbacks: high cost, dependence on dentist skill, and minor tissue burns in 10% of cases due to protocol violations.
Overall, laser therapy proved effective for early caries, gum treatment, and cosmetic applications, reducing pain and healing time while improving patient experience.

Conclusions

Laser therapy in dentistry demonstrates high clinical efficiency and patient comfort. It reduces pain, accelerates tissue healing, and minimizes inflammation—particularly effective in early caries, periodontal disease, and cosmetic procedures.
Advantages: minimal trauma, bloodlessness, antibacterial effect, reduced sessions, and faster recovery. Patients report higher satisfaction and confidence in dental treatment.
Disadvantages: high cost, limited accessibility, dependence on operator skill, and reduced effectiveness in severe cases.
Comparative analysis shows that combining laser therapy with traditional methods yields optimal results and fewer patient visits. The method is promising for integration into standard dental protocols to improve treatment quality and reduce complications.
Laser therapy is thus a modern, effective tool in dentistry, ensuring fast, safe, and comfortable procedures. Further development requires standardization of protocols, advanced training for dentists, and reduced equipment costs. Overall, laser therapy contributes to improved oral health, reduced pain, and greater treatment efficiency.

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