CLINICAL APPLICATIONS AND ADVANCEMENTS OF SPECIFIC LASER SYSTEMS IN MODERN MEDICINE

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ABSTRACT

This article presents an in-depth analysis of the use of laser technologies in various areas of modern medicine. It examines the physical principles of laser radiation interaction with tissue, the classification of medical lasers, and their application in surgery, therapy, dermatology, dentistry, oncology, and diagnostics. Particular attention is paid to a comparative analysis of the effectiveness of laser methods relative to traditional approaches, an assessment of the benefits and risks, and the prospects for the development of laser medical systems. This paper summarizes the results of many years of research and demonstrates the significant importance of lasers as a tool for improving the precision and safety of medical interventions.

Introduction.

Laser technology has revolutionized healthcare by providing precise, minimally invasive alternatives to traditional surgery. Different wavelengths allow wavelengths to target specific tissues while sparing surrounding healthy structures. This study evaluates the clinical efficacy and safety profiles of three widely used laser systems: Carbon dioxide (CO_2), Neodymium-doped yttrium aluminum garnet (Nd-YAG) and Erbium-doped yttrium aluminum garnet (Er-YAG).

Methods.

A retrospective analysis was conducted on 450 patients treated between 2024 and 2025. The cohort was divided into three groups based on the laser technology applied: Group 1(n=150) underwent fractional CO_2 laser resurfacing for severe scar revision; Group 2 (n=150) received Nd-YAG laser photocoagulation for vascular lesions; Group 3 (n=150) underwent Er-YAG laser ablation for precise hard tissue and deep skin remodeling. Healing time, complication rates, and procedural success were monitored over a six-month follow-up period.

Results.

The overall procedural success rate across all cohorts reached 94.2%. Group 1 (CO_2) exhibited a 78% reduction in scar volume, though with temporary post-operative erythema. Group 2 (Nd-YAG) achieved complete or near-complete closure of vascular structures in 89% of cases due to deep tissue penetration. Group 3 (Er-YAG) demonstrated the fastest reepithelialization and the lowest pain scores due to high water absorption and minimal thermal damage. The incidence of severe adverse effects remained low at 1.8% across the entire sample.

Conclusion.

The findings confirm that wavelength specificity determines clinical outcomes. The high absorption of CO_2 and Er-YAG in water makes them ideal for precise surface ablation, with Er-YAG offering a safer profile for delicate skin. Conversely, the deep penetration of the Nd-YAG laser is superior for targeting deeper vascular targets. High equipment costs remain a primary barrier. Future research should focus on combining these specific wavelengths in single-platform systems to optimize multi-layered tissue treatments

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