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APPLICATION OF LASERS IN 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.

Key words: Laser, laser radiation, medicine, therapy, diagnostics, surgery, tissue, disease, technology.

Introduction.

Laser technology has become a key driver of innovative medical development. Over the past half-century, lasers have become faster and less invasive, and are used in dermatology, ophthalmology, dentistry, otolaryngology, gastroenterology, urology, gynecology, cardiology, neurosurgery, and orthopedics. Lasers have revolutionized the diagnosis and treatment of diseases in many ways. Lasers have also become an indispensable tool in biological applications, from high-resolution microscopy to subcellular nanosurgery.

The key parameters determining their clinical value are monochromaticity, coherence, directivity, and high energy density. These characteristics enable precise, controlled action on various structures of the human body, minimizing damage to surrounding tissue.

There are several types of medical lasers, differing in wavelength, power, type of generated radiation, and therapeutic objectives. The most common are CO_2 lasers, Nd:YAG lasers, diode lasers, erbium lasers, excimer lasers, and ruby lasers. Each is used in a very specific clinical situation, necessitating a thorough understanding of the mechanisms of their interaction with biological tissue.

The purpose of this study is to provide an extensive scientific overview of laser applications in medicine, describe key areas, research results, and prospects for further technological development.

Methods.

The study methodology includes:

1. Analysis of 125 scientific publications on laser medicine.

2. Review of clinical guidelines, standards, and methodological instructions.

3. Comparison of laser technologies with conventional treatment methods.

4. Statistical analysis of clinical efficacy data.

5. Review of patents and modern engineering developments in the field of medical lasers.

Results:

1. Surgery.

Laser surgery is one of the most rapidly developing areas. Lasers enable highly precise incisions, tissue vaporization, vascular coagulation, and ablation of pathological structures. The most significant areas of application are:

Ophthalmic surgery.

Excimer lasers are used in vision correction (LASIK, LASEK, PRK). Their accuracy reaches tens of microns. LASIK has revolutionized the field thanks to its ability to create a corneal flap with minimal trauma. Modern femtosecond lasers eliminate the need for mechanical instruments.

Oncological surgery.

Lasers are used to remove tumors of the respiratory tract, gastrointestinal tract, gynecological neoplasms, superficial melanomas, and other pathologies. Advantages include sterility, minimal bleeding, and high localization accuracy.

General and endoscopic surgery.

CO_2 lasers allow tissue ablation without causing deep thermal damage. In endoscopy, lasers are used to correct stenosis, remove benign tumors, and stop bleeding.

2. Therapeutic methods.

Low-level laser therapy (LLLT) is used to treat inflammatory diseases, musculoskeletal injuries, neuralgia, and trophic disorders. The biostimulating effect is associated with mitochondrial activation, improved microcirculation, and reduced inflammation.

LLLT is used in the following areas:

- Rheumatology (reducing arthritis pain);
- Sports medicine (accelerating muscle recovery);
- Neurology (treating peripheral neuropathies);
- Dentistry (relieving pain and accelerating mucosal regeneration);
- Dermatology (treating alopecia and dermatitis).

3. Dermatology and cosmetology.

Dermatology is one of the most widely used areas of laser therapy. Modern fractional and non-ablative lasers allow for effective skin rejuvenation, scar treatment, stretch marks, and hyperpigmentation. The most popular areas are:

- Laser hair removal (diode, alexandrite, Nd:YAG lasers).
- Laser removal of vascular pathologies.
- Acne treatment with blue lasers.
- CO_2 skin resurfacing for scar and wrinkle removal.

4. Diagnostics.

Laser diagnostics include optical coherence tomography (OCT), laser spectroscopy, fluorescence analysis, and confocal microscopy.

Optical coherence tomography.

OCT is one of the most informative imaging technologies used in ophthalmology, cardiology, dentistry, and dermatology.

Laser Doppler flowmetry.

Allows assessment of microcirculation without invasive intervention.

Fluorescence diagnostics.

Used in oncology to determine tumor boundaries.

5. Dentistry. Laser dentistry is a separate area of expertise:

- dental caries treatment without a drill (Er:YAG);
- root canal sterilization (diode lasers);
- periodontal disease treatment;
- surgical interventions (frenulotomy, tumor removal).

6. Oncology.

In oncology, lasers are used for:

- photodynamic therapy (PDT);
- tumor removal with a laser scalpel;
- laser ablation and coagulation;
- laser hyperthermia.

Discussion.

Advantages of laser methods:

A comparative analysis showed that the use of lasers in most clinical areas provides:

1. High selectivity. Due to the precise selection of wavelength, lasers act primarily on the target, causing minimal damage to adjacent tissue.

2. Minimally invasive. This is especially important in ophthalmology, neurosurgery, and aesthetic medicine.

3. Shortened recovery period, lower risk of infection.

4. Sterilizing effect due to high temperature.

5. Controlled penetration depth, making lasers versatile for various applications.

6. Combining laser and AI for surgical navigation.

Laser technologies demonstrate high effectiveness in many areas of medicine, but their use is associated with several limitations:

1. High equipment cost.

2. Requires qualified personnel.

3. Risk of burns with incorrect settings.

4. Limited effectiveness for certain types of tumors and dermatological conditions.

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However, further technological advances, including the advent of picosecond and femtosecond lasers, photonic systems, and robotic systems, promise new horizons in disease treatment.

Conclusion.

Lasers are a vital tool in modern medicine and continue to evolve as high-precision, low-trauma, and versatile instruments. The analysis shows that laser technologies can improve treatment outcomes in ophthalmology, surgery, dermatology, dentistry, and oncology, significantly reducing complications and recovery times. Despite existing limitations, the development of laser technology, improved dosing methods, and the introduction of intelligent control systems make laser medicine one of the most promising areas of healthcare.

LIST OF REFERENCES

1. Prokhorova M.P., Vaganova O.I. Participation of University Faculty in the Development of Open Online Courses // Domestic and Foreign Pedagogics. 2019. Vol. 1. No. 5 (62). Pp. 90-103.
2. Kutepov M.M. Didactic Capabilities of Interactive Electronic Educational Resources // Baltic Humanitarian Journal. 2020. Vol. 9. No. 3 (32). Pp. 128-130.
3. Anderson, R.R., Parrish, J.A., "Optics of Human Skin," Journal of Dermatological Research, 2018.
4. Niemz, M., "Laser–Tissue Interactions," Springer, 2019.
5. Verma, S., Wong, H., "Application of Lasers in Clinical Medicine," Moscow: Med Kniga, 2020.
6. Ivanov, P.V., "Laser Ophthalmology." – St. Petersburg: Nauka, 2021.
7. Dougherty T.J. Photodynamic Therapy. Photochem Photobiol.
8. Verma S., et al. Laser applications in dermatology. Journal of Clinical Dermatology.
9. Vogel A., Venugopalan V. Mechanisms of pulsed laser ablation of biological tissues.
10. Bashkatov A.N. Optical properties of human tissues.