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APPLICATION OF LASER BEAMS IN THE FIGHT AGAINST ONCOLOGICAL DISEASES

Abstract

This article examines modern methods and approaches to the treatment of oncological diseases using laser radiation and photodynamic therapy, as well as the types of lasers and their applications in medicine.

Keywords

cancer cells, photodynamic therapy, laser beams, laser therapy, treatment, tumor.

Introduction

Global cancer statistics are quite unfavorable: more than 10 million new cases are diagnosed annually, which means that over 27,000 people develop the disease every day. At present, according to cancer statistics, about 14 million patients are affected by this disease, of whom 8.2 million will die. Overall incidence and mortality rates worldwide continue to increase, although outcomes for certain types of cancer have improved due to advances in diagnostics and treatment methods. Oncological diseases remain one of the most complex medical problems of modern times. One of the innovative technologies actively used in oncology is laser therapy.

Lasers are capable of affecting tissues with extreme precision, which makes them an indispensable tool in medicine. In oncology, lasers are used to destroy

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tumor cells. The search for effective and safe methods for treating oncological diseases is a priority task for scientists and physicians around the world. Laser therapy in tumor treatment is the result of the work of many scientists and doctors who have contributed to the development of this technology over decades. One of the pioneers who made a significant contribution to the development of cancer treatment using laser radiation was Leon Goldman (1906–1997), an American dermatologist and the founder of laser-based tumor treatment. He actively studied the use of lasers in dermatology (since 1951) and investigated malignant diseases developing from skin cells. In addition, he explored the possibilities of photodynamic therapy (PDT) in the fight against cancer, considering it a promising method for destroying tumor cells.

Iosif Frank was a well-known surgeon and researcher who made a significant contribution to the development of laser technologies in medicine, especially in oncology. His research focused on the use of laser radiation for the treatment of oncological diseases.

Malignant tumors. Frank actively developed laser ablation techniques that made it possible to remove tumors with high precision while minimizing damage to surrounding tissues.

Laser beams are narrowly directed bundles of light characterized by high intensity, monochromaticity, and coherence. They are widely used in such fields as telecommunications, spectroscopy, medicine, and industrial processes.

Main part. Lasers are also used in optical disc drives, laser printers, barcode scanners, DNA sequencing instruments, fiber-optic and wireless optical communications, semiconductor chip manufacturing (photolithography, etching), laser surgery and skin care procedures, material cutting and welding, as well as in military devices.

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The term laser is an abbreviation for Light Amplification by Stimulated Emission of Radiation and refers to a method of generating radiation.

The laser is a relatively recent invention, first realized in 1960 using a synthetic ruby crystal. To generate a laser beam, the laser medium must be activated by an external energy source. Various materials can be used as the laser medium, including solid-state materials, semiconductors, dyes, or gases. Laser beams possess many unique properties, which is why they have found applications in numerous fields.

The main properties of laser radiation include:

High monochromaticity;

Coherence (waves are in phase both in time and space, i.e., they oscillate—figuratively speaking—in parallel with the same rhythm);

Strong beam focusing.Lasers can be used in two main ways for cancer treatment:

To reduce or completely destroy a tumor using heat.

To activate a chemical substance known as a photosensitizing agent that destroys only cancer cells (this method is called photodynamic therapy, or PDT).

Photodynamic therapy (PDT) is useful for treating certain types of cancer because it allows selective destruction of cancer cells while preserving most healthy cells. PDT uses chemical substances within cancer cells that react to the light of an argon laser. These substances, called photosensitizing agents, are not naturally present in cancer cells.

During PDT, these chemical substances are administered to the cancer patient by injection. Cells throughout the body absorb these substances, but in cancer cells they accumulate and remain longer than in healthy cells. At the

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appropriate time, when the healthy cells surrounding the tumor have already been relatively cleared of the chemical substances, red light is applied…

The light from an argon laser is directed directly at the tumor. As the tumor is exposed to light and the cells absorb it, a chemical reaction occurs that destroys the cancer cells.

In certain cases, small tumors of the head and neck can be treated using lasers.

Each year, about 10,000 cases of vocal cord cancer are diagnosed in the country. This disease is most often associated with smoking, but vocal cord cancer can also develop in non-smokers. Fortunately, many cases of vocal cord cancer are detected at early stages, because hoarseness, which accompanies the tumor, usually prompts people to seek medical attention in time.

The three main types of laser therapy used in tumor treatment:

Carbon dioxide (CO_2) lasers.

CO_2 lasers can cut or vaporize tissue with minimal bleeding. They cause little damage to surrounding or deeper tissues. This type of laser is sometimes used to treat precancerous conditions and certain early-stage cancers. These lasers remove thin layers of tissue from the surface of the body and from the lining of internal organs. They can be used to treat basal cell carcinoma of the skin, as well as cancers of the cervix, vagina, and vulva.

YAG lasers (solid-state lasers based on yttrium aluminum garnet crystals).

These lasers are used to treat cancers of the uterus, intestines, and esophagus. The light from this laser can penetrate deeper into tissues than that of other types of lasers and can rapidly induce blood coagulation.

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Nd:YAG lasers (solid-state lasers in which the active medium is neodymium-doped yttrium aluminum garnet) can be delivered through thin flexible tubes called endoscopes to reach hard-to-access parts of the body, such as the esophagus (the digestive tract) or the large intestine (colon). This light can also be transmitted through flexible optical fibers (thin transparent tubes) that are inserted directly into the tumor, where the heat generated by the light can destroy it. Fiber-optic lasers are inserted into the tumor, where they heat up and damage cancer cells. This method has also been used to reduce liver tumors.

Argon lasers.

Like CO_2 lasers, argon lasers penetrate tissues only to a shallow depth. They are useful for treating skin diseases and certain types of eye tumors. They are sometimes used during colonoscopies (examinations to detect colorectal cancer) to remove polyps before they become malignant. Argon lasers can also be used in combination with light-sensitive drugs to destroy cancer cells as part of a treatment known as photodynamic therapy (PDT). In addition, argon lasers are used to stop bleeding by sealing blood vessels in patients receiving radiation therapy for certain types of cancer. This may be necessary in some cases because radiation therapy can damage blood vessels.

Blood vessels near the tumor may be damaged, leading to their rupture and bleeding. These lasers can be used to treat skin cancer and are also applied together with light-sensitive drugs in a treatment known as photodynamic therapy.

Argon lasers can penetrate tissue to a depth of about one inch without causing significant damage; therefore, PDT can be used to treat cancerous tumors located close to the surface of the skin. This method can also target malignant tumors located in the linings of internal organs:

In the lungs, using a bronchoscope;

In the esophagus and gastrointestinal tract, using an endoscope;

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In the urinary bladder, using a cystoscope.

Lasers can be used to treat certain precancerous and cancerous skin conditions, as well as very early stages of cervical cancer and adjacent tissues. Lasers are sometimes used to treat cancers that have spread to the lungs from other parts of the body, as well as cancers that cause airway obstruction.

Conclusion.

Compared with surgery, laser therapy has a number of advantages. It requires less time, is more precise, and causes less tissue damage. This results in reduced pain, fewer infections, and less scarring. Laser therapy can often be performed in a physician's office rather than in a hospital. The procedure is less invasive, which reduces trauma and accelerates recovery. The likelihood of postoperative complications is lower. It also reduces the risk of infection, as laser energy helps sterilize the treated area. Lasers allow treatment of hard-to-reach areas where conventional surgery may be difficult or dangerous. Recovery after laser therapy is usually faster than after traditional surgery, with less pain and discomfort for the patient. Laser therapy provides precise results while minimizing damage to surrounding healthy tissues.

Despite its many advantages, laser therapy also has certain disadvantages that must be considered:Laser therapy may be contraindicated in some conditions, such as oncological diseases, severe heart disease, active tuberculosis, pregnancy, and others.

Laser therapy can be expensive, as the equipment required is costly.

The procedure requires a highly qualified specialist.

In some cases, laser therapy may be insufficiently effective, and more radical treatment is required.

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Improper use or excessively powerful lasers may cause damage to the skin or mucous membranes.

Laser therapy may lead to unintended or excessively intense burns, bleeding from the choriocapillaris, damage to the macula and other ocular structures, as well as ruptures of Bruch's membrane. The use of excessive energy in…Excessive laser therapy can disrupt the integrity of Bruch's membrane, leading to the synthesis of growth factors by fibroblasts and the activation of the retinal pigment epithelium, which stimulates the production of vascular endothelial growth factor. This, in turn, may result in the development of choroidal neovascularization — a pathological growth of new blood vessels from the choroid into the subretinal space.Laser therapy is an important tool in cancer treatment and is used for various purposes, including tumor removal, symptom relief, and destruction of cancer cells through photodynamic therapy. However, it is rarely used as a sole treatment method and is often combined with other approaches such as chemotherapy and radiotherapy.There is no data on the exact number of patients who have been completely cured of cancer solely by laser therapy. The effectiveness of laser treatment depends on the type, stage, and location of the tumor. In some cases, laser therapy yields significant results, while in others it may be less effective.

Thus, laser therapy is a relatively safe and effective treatment method that improves patients' quality of life and plays an important role in comprehensive cancer care. Its application, however, should be individualized, taking into account contraindications and potential risks.

List of Main Textbooks and Educational Resources

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