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COMPUTER SIMULATION OF THE PHOTON ENDOSCOPE EFFECT IN THE TREATMENT OF GASTRIC CANCER

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Introduction. Stomach cancer remains one of the most common and dangerous oncological diseases that require innovative approaches to treatment [1]. One of the promising methods is photodynamic therapy (PDT) [2], which uses laser radiation to destroy cancer cells. However, the effectiveness of PDT is limited due to the heterogeneity of the optical properties of biological tissues, such as their ability to absorb and scatter radiation. This leads to the fact that some of the laser radiation does not reach deeply located cancer cells, which reduces the therapeutic effect and increases the risk of damage to healthy tissues [3].
The development of a photonic endoscope [4] capable of delivering laser radiation with high accuracy and minimal intensity losses is an urgent task. Such a device will increase the effectiveness of treatment, minimize side effects and improve the quality of life of patients.

Main Body. In the course of the work, the following results were achieved:

- The analysis of modern methods of gastric cancer treatment and existing photon therapy technologies is carried out. A detailed patent search and analysis of the scientific literature were performed, which allowed us to gain a deep understanding of the current state of developments in the field of photon therapy and identify promising areas for improving treatment methods. The key advantages of the photon endoscope, such as high accuracy of exposure to the tumor and minimal damage to healthy tissues, are identified.
- A mathematical model describing the process of photon radiation exposure to gastric tissues is developed. The model includes equations of heat transfer, absorption, and scattering of photon radiation, and also takes into account the physical properties of stomach and tumor tissues. Boundary conditions such as the initial tissue temperature, tumor size, and optical characteristics of biological media are taken into account.
- Numerical experiments are performed to determine the optimal parameters of photon exposure. Optimal parameters were determined, such as the wavelength (in the range of 600-800 nm), radiation intensity, and duration of exposure, which ensure maximum efficiency of tumor destruction with minimal damage to healthy tissues. Graphs of the distribution of temperature and photon energy in tissues were constructed, which confirmed the high accuracy of the model.
- 3D models and animations have been created that demonstrate the effect of photon radiation on stomach tissues. Visualization is used to present the project and explain the mechanism of operation of the photonic endoscope.

Conclusion. The results of the project open up new opportunities for improving the effectiveness of treatment of gastric cancer using a photonic endoscope. Thanks to computer modeling, it was possible to accurately determine the optimal parameters of photon exposure to tumor tissues, minimizing damage to healthy cells. This makes it possible to develop safer and more personalized treatment methods adapted to the individual characteristics of the patient

References

1. Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F: Global Cancer Statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA Cancer J Clin. 2021, 71:209-49.

2. Brown SR, Hall A, Buckley HL, Flanagan L, Gonzalez de Castro D, Farnell K, Moss L, Gregory R, Newbold K, Du Y, Flux G, Wadsley J. *Investigating the potential clinical benefit of Selumetinib in resensitising advanced iodine refractory differentiated thyroid cancer to radioiodine*

therapy (SEL-I-METRY): protocol for a multicentre UK single arm phase II trial. BMC Cancer. 2019 Jun 14;19(1):582.

3. Zhao Z, Yang Y, Liu W, Li Z. *T59, a New Compound Reconstructed from Curcumin, Induces Cell Apoptosis through Reactive Oxygen Species Activation in Human Lung Cancer Cells.* Molecules. 2018 May 24;23(6):1251.

4. Посольство медицины. – Режим доступа: http://m.medicus.ru/news/science/finalistka nacionalnoj-premii-rossiya-strana-vozmozhnostej-sozdala-fotonnyj-endoskopa-dlya-lecheniya-onkologii-182202.phtml