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Efficacy of Photodynamic Therapy in the Treatment of Purulent-Inflammatory Diseases

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ABSTRACT

Photodynamic therapy is a part of photochemotherapy, in which, in addition to light and the drug, oxygen is needed. The mechanisms of the cytotoxic effect of photodynamic therapy have been shown in detail in the works of T.J. Dougherty and can be presented as follows. Photosensitizer molecules introduced into the body are selectively fixed on cell membranes and mitochondria. Moreover, the maximum concentration of the drug in the tissues is reached after 24-72 hours. When photosensitized tumor tissue is irradiated with laser radiation, there is a transition of non-toxic triplet oxygen into singlet oxygen, which has a pronounced cytotoxic effect, which leads to the destruction of the cell membranes of tumor cells. This review article is devoted to the effectiveness of photodynamic therapy in the treatment of purulent-inflammatory diseases.

Keywords: *photodynamic therapy, purulent-inflammatory diseases, treatment efficacy*

INTRODUCTION

Singlet oxygen, despite the short time of action, manages to completely destroy tumor cells. At the same time, the cytotoxic effect depends on the concentration of the photosensitizer and the depth of light penetration into the tumor tissues [1].

Although the concentration of photosensitizer in normal tissues is low, they may become more sensitive to sunlight for several weeks. Until the end of the nineteenth century, phototherapy was still in its infancy.

The first scientific research in the field of medical use of light was made in Copenhagen by the Danish

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physicist N.R. Finsen. His most important discovery was the possibility of using sunlight or light obtained from a carbon arc to treat tuberculous lupus (tuberculous skin lesions). This discovery was widely accepted. The Institute of Medical Light, named after Finsen, was founded in Copenhagen, and in 1903 the author of the invention was awarded the Nobel Prize for his work on phototherapy. Since then, he has been deservedly considered the founder of this discipline.

In the 1930s, Kautsky conducted very simple and elegant experiments, showing that the oxidant involved in the photooxygenation reaction could be gaseous. According to Kautsky, the excited photosensitizer converts the oxygen molecule into an active state.

MATERIAL AND METHODS

We analyzed the literature on the possibility of using photodynamic therapy in the treatment of purulent-inflammatory diseases of various localization. The sources of literature from the most popular databases of sources of scientific information for the period of the last 50 years were analyzed.

RESULTS AND DISCUSSION

Photodynamic therapy is one of the most promising methods of treating patients with purulent-inflammatory diseases [2]. According to a number of authors, this direction is the leading one, which requires careful and further development [3]. The essence of the method is that many biological objects (cells, microbes, etc.) accumulate certain dyes - photosensitizers, as a result of which they become sensitive to the effects of light energy, as well as low-intensity laser radiation of the corresponding wavelength. in particular, tumor cells, microorganisms, etc.

In recent years, scientific publications have appeared on the use of photodynamic therapy for the treatment of purulent wounds, which note the advantages of this type of treatment in comparison with traditional therapy, in particular, a pronounced antibacterial and anti-inflammatory effect. It should be emphasized that the effectiveness of photodynamic therapy does not depend on the spectrum of sensitivity of microorganisms to antibiotics, it is disastrous even for antibiotic-resistant strains of microorganisms [4].

Pathogenic microorganisms do not develop resistance to photodynamic therapy, while photodynamic damage is local, and the bactericidal effect is limited to the zone of laser irradiation of sensitized tissues, which avoids the side effects observed when using traditional methods of treating surgical infection.

Despite the large number of proposed methods for the use of photodynamic therapy, it should be carried out according to a two-step protocol: the first is the delivery of the photosensitizer to the target cells, as well as the creation of conditions for the penetration of the photosensitizer into the cells, the second is the irradiation of the target tissue area with light of the corresponding wavelength [5].

All subsequent reactions lead to the formation of reactive oxygen species. This, in turn, correspondingly leads to the death of cells that have accumulated the sensitizer. The uniqueness of photodynamic therapy lies in the fact that after exposure, both methods of death in target cells can be triggered: apoptosis and necrosis [6].

Necrosis, or passive cell death, is an irreversible process, which is mainly accompanied by the loss of membrane integrity and metabolic homeostasis due to uncontrolled cellular disintegration [7]. Apoptosis, or "active cell death," is a regulated cellular suicide. The process of apoptosis is controlled by both intracellular and extracellular factors.

Regardless of the factor that triggers the process, it always ends with a characteristic sequence of morphological, biochemical, and energetic changes [8]. The process of apoptosis prevents the uncontrolled release of intracellular material into the surrounding space and prevents damage to neighboring cells and tissue inflammation.

Studies by a number of authors have experimentally proved [9] that the use of photodynamic therapy in the treatment of purulent wounds of soft tissues is a promising development that increases the success in the treatment of purulent processes of soft tissues, is pathogenetically and economically justified, and reduces the duration of the patient's stay in the hospital.

Another undeniable advantage of this method is its ease of use and the absence of significant material and physical efforts.

In the studies of M.R. Dadalov et al. [10] It has been shown that photodynamic therapy and laser radiation have a high antibacterial efficacy against periodontal pathogenic microorganisms and have a bacteriostatic effect. At the same time, photodynamic therapy has a number of disadvantages. According to the authors, the use of laser radiation of two wavelengths - 765 nm and 1265 nm, which are at the maximum oxygen absorption in tissues, will increase the production of reactive oxygen species without the use of photosensitizers with si-

multaneous laser curettage of periodontal pockets using pigment-free laser photoablation.

Studies conducted in various scientific and practical centers around the world have shown that this method is effective and well tolerated in the treatment of various diseases. Photodynamic therapy can be used to treat a wide range of conditions, including skin problems, inflammatory diseases, infections, precancerous conditions and tumors, as well as prostate and infertility problems in men and women. The method of photodynamic therapy is an effective alternative to standard methods of treating these diseases and can be used both independently and in combination with other methods of treatment. It has a number of advantages, such as low toxicity to healthy tissues, minimal risk of severe pain, lack of resistance mechanisms, the possibility of treatment on an outpatient basis and combination with other methods. Because of these advantages, photodynamic therapy is a promising object for further research [11].

The study of the antibacterial effect of photodynamic therapy against the leading causative agents of chronic osteomyelitis is one of the promising areas today. In order to assess the antibacterial efficacy of photodynamic therapy against Staphylococcus aureus and Pseudomonas aeruginosa, I.V. Shipitsyn and E.S. Spirkina [12] conducted a study using the ALOD-01 laser device in the presence of photoditazine. The studies included diurnal museum cultures of gram-positive and gram-negative microorganisms belonging to two taxa: Staphylococcus aureus (No 25923), Pseudomonas aeruginosa (No 27853). The antibacterial effect after laser exposure in the presence of photoditazine on the microbial cells of the studied cultures was evaluated by the absence of microorganism growth in the area of the beam action. When exposed to laser in combination with photoditazine (concentration 0.5-1.0 mg/ml) on S. aureus for two minutes at 200-300 J in the area of the beam, the authors observed a bactericidal effect. The absence of bacterial growth on the entire surface of the Petri dish was achieved with a light exposure of 400 J for 5 minutes and a photoditazine concentration of 1.0 mg/ml. Exposure to the laser for 2 minutes in the presence of photoditazine at a concentration of 0.5 mg/ml and 1 mg/ml had no antibacterial effect against P. aeruginosa strains. A continuous growth of microorganisms was observed on the dish. An increase in the light dose and exposure time contributed to a decrease in the growth of microbial cells. The bactericidal effect was obtained only in the center of the dish when treating the bacterial suspension with photoditazine at a concentration of 5 mg/ml.

The efficacy of photodynamic therapy depends on the type of microorganism, the anatomical location of the focus of infection, as well as the properties of the photosensitizer and the laser used. Depending on the structure of the cell wall, different susceptibility of bacteria to photodynamic effects is observed. Strains of S. aureus can be successfully photoinactivated with photoditazine. For P. aeruginosa strains It was not possible to find a regimen in which the growth of microbial cells was absent on the entire dish. A photodynamic reaction occurs only when adequate doses of light energy are applied to photosensitizers in the presence of oxygen in the medium, while photodynamic damage is local, and the bactericidal effect is limited to the zone of light exposure [13].

The use of photodynamic therapy for suppuration of postoperative wounds, regardless of the localization of the latter and the presence of nosocomial infection in it, made it possible to significantly reduce the duration of treatment of the inflammatory process.

CONCLUSION

Photodynamic therapy in the complex treatment of suppurated postoperative soft tissue wounds can be used both in surgical hospitals and in outpatient surgical practice. Thanks to its use, it is possible to reduce the time for restoring the ability to work, which ultimately has social and economic significance.

Conflict of interest – none

Study funding – none

REFERENCES:

1. Prospects for the use of photodynamic therapy in the treatment of recurrent miscarriage associated with recurrent herpesvirus infection (literature review) / E.A. Markova, A.Z. Khashukoeva, O.A. Svitich, T.V. Netudykhatko // Vestnik Rossiyskogo gosudarstvennogo meditsinskogo universiteta. – 2014. – № 4. – P. 22-26. (in Russian)
2. Efficacy of photodynamic therapy in pediatric practice / S.A. Osipov, M.A. Aliev, N.A. Daribaeva et al. // Perm Medical Journal. – 2024. – T. 41, No 3. – P. 60-76. (in Russian)
3. Possibility of using photodynamic therapy in bacterial infection of the anterior segment of the eye (preliminary data) / E.G. Mironova, G.V. Nikolaeva, A.A. Gubanov, I.N. Stepanov // Russian children's ophthalmology. – 2018. – № 2. – P. 42-44. (in Russian)
4. Chernyak L.A. Integrated approach in the treatment of patients with phlegmons of the maxillofacial area and neck with the use of phototherapy // Parinskiye cht-

eniya 2024. Diagnosis, treatment, recovery period and clinical examination of patients with surgical pathology of the cranio-maxillofacial region: Proceedings of the National Congress with international participation, Minsk, May 03, 2024. – Minsk: Izd. center of BSU, 2024. – P. 96-101. (in Russian)

5. Khamdamov B.Z. Morphological changes in the application of photodynamic therapy in the treatment of wound infection in the experiment. – 2020. – T. 157, No 2-3. – P. 223-224. (in Russian)
6. Comparative Analysis of the Quality of Treatment of Periodontal Diseases with Inclusion in the Traditional Scheme of Laser Photodynamic Therapy // New in the Theory and Practice of Dentistry: Materials of the XV Forum of Scientists of the South of Russia in the Framework of the Scientific Conference, Stavropol, October 27–28, 2016. – Stavropol: Stavropol State Medical University, 2016. – P. 30-33. (in Russian)
7. Talalaiko Y.V. Antibacterial photodynamic therapy in the treatment of nosocomial sinusitis in patients of intensive care units: specialty 14.01.03 "Diseases of the ear, throat and nose": abstract of the dissertation for the degree of candidate of medical sciences / Talalaiko Yuriy Vladimirovich. Moscow, 2012. – 24 p. (in Russian)
8. Talalaiko Y.V. Antibacterial photodynamic therapy in the treatment of nosocomial sinusitis in patients of intensive care units: specialty 14.01.03 "Diseases of the ear, throat and nose": dissertation for the degree of candidate of medical sciences. Moscow, 2012. – 130 p. (in Russian)
9. Gaibov A.D., Kalmykov E.L., Kamolov A.N. Amputations of the lower extremities in their chronic ischemia. Cardiology and cardiovascular surgery. - 2009. - №2. - P.40-46. (in Russian)
10. Study of the effectiveness of laser technologies and photodynamic therapy when periodontal pathogens affect microbial biofilms / M.R. Dadalova, A.A. Chunikhin, E.A. Bazikyan et al. // Russian Dentistry. – 2022. – T. 15, No 1. – P. 47-49. (in Russian)
11. Levkovskaya Zh.S., Gritskevich O.Y. Possibilities of using photodynamic therapy // Issues of establishing the severity of harm caused to human health as a result of the impact of a biological factor, Sevastopol, May 23, 2024. – Moscow: OOO "Publishing Center RIOR", 2024. – P. 56-63. (in Russian)
12. Antibacterial action of a semiconductor laser against the bacteria S. aureus and P. aeruginosa, the leading pathogens of osteomyelitis. – 2024. – T. 30, No 5. – P. 670-676. (in Russian)
13. Gasanov R.R., Glushkov A.A. Application of photodynamic therapy in the treatment of fungal keratitis // Unresolved issues of etiotropic therapy of actual infections: Materials of the All-Russian Annual Scientific and Practical Conference, St. Petersburg, December 12–13, 2024. – St. Petersburg: St. Petersburg Public Organization "Man and His Health", 2024. – P. 42-48. (in Russian)

YIRINGLI YALLIG'LANISH KASALLIKLARINI DAVOLASHDA FOTODINAMIK TERAPIYANING SAMARADORLIGI

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ABSTRAKT

Fotodinamik terapiya fotokimyoviy terapiyaning bir qismi bo'lib, unda yorug'lik va preparatdan tashqari kislorod talab qilinadi. Fotodinamik terapiyaning sitotoksik ta'sirining mexanizmlari T.J. Dugerty ishlarida batafsil ko'rsatilgan va quyidagicha taqdim etilishi mumkin. Tanaga kiritilgan fotosensibilizator molekulalar hujayra membranalari va mitoxondriyalarga selektiv ravishda o'rnatiladi. Bundan tashqari, to'qimalarda preparatning maksimal konsentratsiyasiga 24-72 soatdan so'ng erishiladi. Fotosensibilizatsiya qilingan o'simta to'qimalari lazer nurlanishlari bilan nurlanganda, toksik bo'lmagan triplet kislorodning aniq sitotoksik ta'sirga ega bo'lgan singlet kislorodga o'tishi kuzatiladi, bu esa o'simta hujayralarining hujayra membranalarini yo'q qilishga olib keladi. Ushbu maqola yiringli-yallig'lanish kasalliklarini davolashda fotodinamik terapiyaning samaradorligiga bag'ishlangan.

Kalit so'zlar: fotodinamik terapiya, yiringli-yallig'lanish kasalliklari, davolash samaradorligi

ЭФФЕКТИВНОСТЬ ФОТОДИНАМИЧЕСКОЙ ТЕРАПИИ ПРИ ЛЕЧЕНИИ ГНОЙНО-ВОСПАЛИТЕЛЬНЫХ ЗАБОЛЕВАНИЙ

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АБСТРАКТ

Фотодинамическая терапия - часть фотохимиотерапии, при которой помимо света и препарата необходим кислород. Механизмы цитотоксичного действия фотодинамической терапии были детально показаны в работах T.J. Dougherty и представить их можно следующим образом. Введенные в организм молекулы фотосенсибилизатора избирательно фиксируются на мембранах клеток и митохондриях. Причем, максимальная концентрация препарата в тканях достигается через 24-72 часа. При облучении фотосенсибилизированной опухолевой ткани лазерным излучением происходит переход нетоксичного триплетного кислорода в синглетный кислород, обладающий выраженным цитотоксичным действием, что приводит к разрушению клеточных мембран опухолевых клеток. Данная обзорная статья посвящена эффективности фотодинамической терапии при лечении гнойно-воспалительных заболеваний.

Ключевые слова: Фотодинамическая терапия, гнойно-воспалительные заболевания, эффективность лечения