

PRACA POGLĄDOWA
REVIEW ARTICLE

APPLICATION OF OZONE THERAPY IN SURGICAL PRACTICE

ZASTOSOWANIE OZONOTERAPII W PRAKTYCE CHIRURGICZNEJ

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ABSTRACT

Summarizing the review of literary sources, one can conclude that, despite a significant number of scientific papers devoted to the problem of pyoinflammatory complications of diabetes, there remain issues that require further study and solution.

Taking into account the above facts, it becomes obvious that it is necessary to seek for more effective and advanced methods of complex treatment of pyoinflammatory complications of soft tissues, with an emphasis of search efforts on the introduction of effective therapeutic methods of conservative correction into the medical practice, methods of activation of reparative processes, aimed at restriction of invalidizing limb amputations, combined with further improvement of minimally invasive operational and technical innovations in the surgical direction.

KEY WORDS: surgery, diabetes mellitus, ozone, pyoinflammatory diseases

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INTRODUCTION

Diabetes has been significantly widespread in Ukraine, especially in the last decade. There is an exceptionally rapid increase in its morbidity. [1, 2] The treatment of diabetes and its complications is an overwhelming task. In this regard, research and study of diabetes mellitus which makes it possible to identify the presence of a particular pharmacological activity of medicines or new parts in the mechanism of action of medicinal products, is important [3].

In recent days complex therapy in patients with this pathology has been complemented by a wide arsenal of physical methods of treatment. Hyperbaric oxygenation, quantum autohemotherapy, intrahistological electrophoresis have been widely introduced into medical practice. The use of this complex of therapeutic measures in clinical practice, in case of purulent-destructive manifestations, points to the perspective for further research in this direction. Ozone therapy has been widely used for this purpose in recent years [4,5,6,7].

THE AIM

To study the influence of ozone in the complex treatment of patients with diabetes mellitus.

MATERIALS AND METHODS

Main tasks and methods of research: the study of the course of purulent complications of diabetes mellitus when ozonotherapy is applied.

REVIEW AND DISCUSSION

Progressive course of pathological states, activated by insufficiency of endogenous insulin in the human body, affects the vascular, nervous and musculoskeletal systems. Disorders of endocrine-metabolic processes, which consistently occur, lead to the tissue necrosis and the necessity of performing surgical interventions in this category of patients aimed at the removal of nonviable tissues [6,8].

Currently, in the aspect of the improvement of surgical care, research programs are aimed at fighting against severe purulent-necrotic lesions [7,9].

Pyoinflammatory diseases of soft tissues in patients with diabetes mellitus are a difficult problem of surgery. Hyperglycemia, intoxication, disturbances of lipid peroxidation processes, antioxidant system and oxidative modification of proteins, microcirculatory exchange disorders contribute to the rapid spread of purulent processes with the development of a mutual burden syndrome. Consequently, the course of pyoinflammatory processes of soft tissues in patients with diabetes needs further study in order to optimize its correction [8,10,11].

Integrated therapy of lesions is determined by their pathogenesis and stage of development. A steady compensation of diabetes remains the basis for therapy and prevention [8]. In this case it is necessary to normalize not only glycemia, but also other types of exchange.

Active surgical sanitation of purulent focus (wide opening, excision of necrotic tissues, active flow drainage) is the basis of tactics for inflammatory processes in soft tissues.

The results of the received literature data show that the use of physiotherapeutic methods of treatment provides significant help in achieving the positive effect of complex

treatment of purulent-necrotic complications in patients with diabetes [12,13,14].

Ozone used for therapeutic purposes is an ozone-oxygen mixture obtained from oxygen using a weak electrical discharge by means of medical ozone generators (ozonizers). The principle of medical ozonizers action is as follows. Oxygen enters into two sequentially connected tubes that are under voltage of different power and form an electric field. Under the influence of a powerful electric field, a portion of the oxygen molecules are decomposed into atoms that react with other oxygen molecules and form ozone molecules. Depending on the voltage and velocity of the gas flow, a different concentration of ozone is achieved. The higher the voltage and the lower the flow rate, the higher the concentration of ozone is and vice versa.

To receive medical ozone it is necessary to supply the oxygen mixture only to pure (medical) oxygen to the ozonator. The use of less pure oxygen, and especially air, is unacceptable because of the presence of a large amount of nitrogen, which in the conditions of high voltage is converted into toxic nitrogen oxide. For this purpose, ozone generators are equipped with destructors, where ozone excess is accumulated and regenerated again into oxygen [8].

In clinical practice, concentrations of ozone-oxygen mixtures at the outlet of an ozonizer in a wide range from 800 µg/l [8] to 100000 µg/liter [8] are used for the preparation of the saline solution for intravenous administration.

After being prepared, the solution should be injected as soon as possible. This is due to the fact that ozone dissolves rapidly in the solution. According to Maslennikov O.V., the concentration of dissolved ozone in the saline solution at room temperature is reduced by 17% after 5 minutes, by 29% after 10 minutes, by 37% after 15 minutes, by 43% after 20 minutes, and twice after 30 min. It should be noted that nowadays there has been developed a device that allows stabilizing the concentration of dissolved ozone in the physiological solution after barbotage during the infusion [7, 15].

The conducted complex research on the determination of the effectiveness of ozone therapy at the local and systemic application indicate its significant advantages compared with other physical methods of local and systemic effects on the metabolic, reparative, detoxification and sanitation processes in the use of this type of treatment in patients with diabetes, complicated with pyoinflammatory processes. It is proved that the systemic application of ozone significantly increases the permeability of cell membranes for glucose, due to the possibility of its direct stimulation of the pentosophosphate shunt and the activation of the processes of aerobic glycolysis, which is sharply suppressed in case of diabetes.

Clinical and experimental studies have found that ozone stimulation of pentosophosphate shunt and activation of aerobic glycolysis increase the production of glutathione, which participates in the synthesis of glycogen and fat from glucose and is involved in the synthesis of proteins. The systemic application of ozone promotes complete oxidation of glucose to the final products of its decomposition, resulting in the restoration of its energy potential. Due to the active ozone action in case of DM, an adequate supply of energy

needs of the body cells is provided and their functionality increases. Blocking of gluconeogenesis process (endogenous glucose formation from glycogen and proteins), which is realized under conditions of parenteral administration of ozonated solutions of 0.9% sodium chloride solution, reduces the rate of proteins decomposition and suppresses catabolic processes in the body of patients with DM. The level of lipid peroxidation is also reduced, which results in the normalization of the energy intensity of the body cells and the restoration of their functional activity [8,16].

The activation of glucose metabolism under the influence of ozone leads to the formation of 2,3-diphosphoglycerate in erythrocytes, which improves the oxygen-exchange function of red blood cells and eliminates hypoxic phenomena in the tissues of the body. A decrease in the level of glucosylated hemoglobin in erythrocytes of patients with diabetes has been confirmed, hence there is a significant improvement in the processes of releasing oxygen from erythrocytes and elimination of tissue hypoxia. On the basis of the results of laser fluometry, analysis of coagulogram, dynamics of malonic aldehyde and diene conjugates, the positive effect of ozonotherapy on microcirculation and metabolic processes has been confirmed, along with lowering blood glucose, cholesterol, triglycerides, accompanied with normalization of lipid peroxidation and increased activity of the antioxidant system of the organism. Reducing the level of hyperglycemia and normalizing the processes of absorption of glucose by body tissues, with a significant reduction in cell hypoxia, inhibits the rate of accumulation of sorbitol in the tissues of the body, preventing the development of macro- and microangiopathy. A similar dynamics of changes in metabolic transformations is observed in the study of the level of accumulation of glycosaminoglycans, glucoproteins in the tissues that activate the process of angiopathy and arthropathy development [16, 17].

The use of systemic and local ozonotherapy in patients with pyoinflammatory complications concomitant with diabetes is perspective [6,7, 18]. Studies carried out in recent years have noted that under the conditions of a critical level of changes in metabolic processes in the body tissues caused by angiopathy, the development of purulent-necrotic processes in the presence of polymorphically associated microflora and intoxication of the organism, occurring in the result of it, large-scale autoimmune aggression, the combination of local and the overall healing effect of ozonotherapy has allowed to almost halve the time of cleansing the wound surface from purulent-necrotic masses and to trigger an early activation of regenerative processes [8, 19]. The bacterio-, fungi-, and virucidal effects of ozone with the external use of its modifications, is explained by its oxidative influence on the membrane structures of bacteria and organelles of bacterial cells. In turn, this results in the loss of their viability and reproductive capacity [19, 20].

The indirect effect of ozonolysis products is also significant in this aspect. When the effect of ozonolysis occurs the oxidative cytotoxic properties of formed ozonides, in direct interaction with lipid structures of the membrane of the bacterial cell, stimulate the development of secondary oxidative cytotoxic reactions, which have a detrimental effect on the viability of the bacterial cell [19].

According to microbiological studies, ozone is capable of destroying all known types of gram-positive and gram-negative bacteria, in particular, the *Pseudomonas aeruginosa*, the legionella, all types of lipophilic and hydrophilic viruses, including hepatitis A, B, C viruses and spores of all known pathogenic fungi and protozoa. It has been confirmed that ozone concentrations of 1 to 5 mg/l destroys 99.9% of *E. coli*, *Streptococcus faecalis*, *Micobacterium tuberculosis*, *Cryptosporidium parvum*, *Varavium*, and others within 4-20 minutes. At the ozone concentration of 0.1 mg/l with the time exposure 15-20 minutes, the persistent spores of *Penicillium notatum* [10] are completely destroyed.

The confirmed antiviral effect of ozone on the culture of lymphocytes infected with HIV-1 [6,7,8,18] and the bactericidal effect of ozonized vegetable oil (oral dose – 5 to 10 mg/l and for external use – 12 to 24 mg/l) caused by the presence of ozonides contained in it, formed as a result of the reaction of ozone with its carrier in the places of double bonds of fatty acid. At the expense of oxygen combinations of the ozone-unsaturated acid with the cellular envelope of body cells, a protective zone of their defense is formed, which further prevents the contact of the aggressive agent with the body cells [20].

An important biological effect observed in the systematic application of ozone therapy is the optimization of pro- and antioxidant systems in the body. It is noted that in response to the parenteral administration of ozone, there is a compensatory increase in the activity of antioxidant enzymes: superoxide dismutase, catalase and glutathione peroxidase in the tissues of the body. The activation of the enzyme and non-enzyme antioxidant systems of the body restores the activity of lipid peroxidation (LPO) process, activates metabolic reactions, with the help of which the precipitated NAD (nicotinamide adenine dinucleotide) and NADP (nicotinamide adenine dinucleotide phosphate) are accumulated in the Krebs cycle and the function of the pentose phosphate shunt is activated, the last is the protons donor for the restoration of the oxidative components of the non-enzyme antioxidant system (glutathione, vitamin E, ascorbic acid) [6,8].

Shublazde D.K. showed the effectiveness of local use of ozone in the treatment of purulent-necrotic complications in patients with diabetes, namely, the dynamics of wound healing, its epithelization, the number of bed-days spent in the hospital .

Gazin I.K. estimated the positive influence of methods of local ozonotherapy on the process of healing of purulent foot wounds in patients with diabetes mellitus.

Kantsaliyev L.B. used, along with the local application of ozone, the intravenous droplet administration of ozonized saline solution and showed that this method allows to reduce the volume of intervention, to reduce the frequency and volume of high amputations, and also to reduce the frequency of postoperative complications of the stump and to improve the quality of its preparation for orthopedic rehabilitation .

Tsariuk Yu.S. proved that the local effect of therapeutic ozone concentrations and ozone-containing medications possess ex-

tremely strong bactericidal, immunomodulatory, anti-inflammatory, virolytic, fungicidal, cytostatic, analgesic properties and open new prospects for the application of ozone in the treatment of pyoinflammatory complications in patients with diabetes.

The conducted studies on the use of ozonotherapy at the local and systemic application indicate its effectiveness compared to other physical methods. Therapeutic concentrations of ozone (in a physiological solution from 1 mg/l to 6 mg/l, on average 3-4 mg/l with a single dose of 1.2-1.6 mg) activate the immunomodulatory function of the body. When it is injected, on the membranes of phagocytic cells (leukocytes, monocytes, macrophages) hydrophilic compounds – ozonides are adsorbed, through which stimulation of cytokines in these cells is carried out, which, in their turn, promote activation of cellular and humoral immunity, which increases the level of nonspecific system of the organism protection.

CONCLUSIONS

Taking into account the above facts, it becomes obvious that it is necessary to seek for more effective and advanced methods of complex treatment of pyoinflammatory complications of soft tissues, with an emphasis of search efforts on the introduction of effective therapeutic methods of conservative correction into the medical practice, methods of activation of reparative processes, aimed at restriction of invalidizing limb amputations, combined with further improvement of minimally invasive operational and technical innovations in the surgical direction.

Summarizing the review of literary sources, one can conclude that, despite a significant number of scientific papers devoted to the problem of pyoinflammatory complications of diabetes, there remain issues that require further study and solution.

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Authors' contributions:

According to the order of the Authorship.

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The Authors declare no conflict of interest.

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