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Ozone Application Possibilities In Coplex Treatment Of Patients With Knee Joint Osteoarthritis.

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ABSTRACT

Application possibilities of ozone in complex treatment of knee joint osteoarthritis are discussed in the paper. The author demonstrated on material of 150 patients with osteoarthritis of knee joint that integrated treatment with the use of ozone therapy is more effective than the use of chondroprotectors alone (it improves the knee joint function, but to a lesser extent). The author paid special attention that intraarticular injections of ozone-oxygen mixture are effective both immediately after and long after treatment. He has defined the requirements that a modern medical ozonizer should meet.

Keywords: knee joint, osteoarthritis, ozone-oxygen mixture, chondro protectors.

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INTRODUCTION

The problem of medical adaptation of patients with knee joints (KJ) osteoarthritis (OA) is the subject of close attention of experts in different fields of medicine because OA is the most common pathology of synovial joints in the group of musculoskeletal system diseases [3]. Social significance of OA is determined by its high prevalence and a high disability status of patients, significant losses in the economic, social and psychological spheres [1].

In recent decades, ozone therapy was actively used in medical practice with systemic and local effect of medical ozone on human body. For the first time ozone therapy in the complex treatment of osteoarthritis of large joints was used in the Clinic of Sports and Ballet Traumas of TsITO [2]. Ozone-oxygen mixture was used for treatment, and positive results were obtained. At the same time, indications and contraindications to the method have not been developed. There are no regimens for injection of oxygen-ozone mixture with chondroprotectors; periodicity of treatment courses depending on the degree of the KJ functional disorders has not been determined. The above said confirms the relevance of the chosen theme.

MATERIALS AND METHODS

We examined and treated 150 patients with knee joint osteoarthritis who underwent treatment and rehabilitation at the Department of Sports and Ballet Traumas of the GUN TsITO named after N.N. Priorov in the period 2001-2003. Among them, 84 (56%) were females and 66 (44%) males. The patients were aged from 34 to 64; most of patients (126 patients, 84%) were aged from 41 to 62.

Osteoarthritis was approximately of the same frequency in the right and the left knee joints, and, more rarely, in 17 cases (11.3%) of both knee joints. Among the patients, 45 (30%) had patellofemoral arthrosis, 89 patients (59.3%) associate the development of the knee joint osteoarthritis with various traumas in their medical history (damage to the capsular-ligament system, menisci, physical overwork, chronic microtraumatization, consequences of intraarticular knee joint fractures). 17 (11.3%) patients had static disturbances (genus varum et valgum), which were the cause of osteoarthritis. In 33 (22%) patients, flat foot was found. 11 patients (7.4%) had no etiological factors for the appearance of osteoarthritis.

120 patients received treatment with ozone therapy (main group), 30 patients received traditional conservative treatment (control group). Both in the main, and in the control groups, comprehensive treatment included chondroprotectors.

To assess the function in the process of treating patients with knee joint osteoarthritis, we used clinical methods of studies: examination, palpation, measurement of circumference of the joint and segments of the lower extremity, range of passive and active motions, evaluation of motions, etc.; special clinical methods for detecting damages to menisci and ligaments, instability, functional insufficiency of periarticular muscles; as well as instrumental visual assessment methods (ultrasonography, x-ray, computer tomography, magnetic resonance imaging and arthroscopy); methods for assessing the function: goniometry, electromyography, dynamometry, isometric and isokinetic testing.

As one of the methods of investigation, for 58 (38.7%) patients, the KJ arthroscopy was performed. At the same time, in 35 (23.3%) patients, osteoarthritis of the I stage was revealed which was confirmed by clinical evidence, but was not determined by radiation diagnostics (x-ray, MRI). These patients have the following signs of osteoarthritis: chondromalacia of femoral and tibia condyles, transchondral fractures and patella chondromalacia, chondropathy.

When taking medical history, we inquired into the nature of the pain syndrome, presence of synovitis, clarified the support ability of the affected lower extremity, determined, if there was lameness, a sense of instability, difficulty with walking, jumping, running. To assess these symptoms, the scales developed at the Centre for Sports and Ballet Trauma of TsITO were used.

In order to evaluate the integrative function of the knee joint, we performed standard stabilometric testing as well as the standard Romberg test. When assessing stabilograms, the absolute position of the

pressure centre was taken into account, deviation of the pressure centre from the average position, mean area of the statokinesogram.

To determine the objective data characterizing functional indicators of the knee joint, hardware methods were used. We evaluated a number of indicators characterizing the functional state of the knee joint using the isokinetic unit. The apparatus of BIODEX system which we used allows a rather precise recording of displacement angles, passive mode motion resistance force, muscle strength and work in isotonic, isometric, isokinetic, eccentric modes. All the parameters are recorded and processed by a personal computer.

When analyzing the recorded data, the capacity of muscles under isokinetic conditions at each point of the assigned range of passive motions was evaluated, which is represented in real time in the form of diagrams. The use of isokinetic test allowed an objective assessment of the dynamic force capabilities of muscles, ratio of the capacity of antagonists. We studied the capacity of active knee joint stabilizers for coordinated motions using a test developed and approved at TsITO named after N.N. Priorov. The method is implemented on BIODEX device in isometric mode.

We carried out electromyographic study to clarify the adequacy of activity of muscle antagonists and synergists as well as when carrying-out combined tests. The hardware-software computer complex SopAp equipped with a physiological 16-channel bio-amplifier was used in these procedures.

In our work, we used the parenteral (intraarticular) method of injecting ozone-oxygen mixture. This fact determines higher requirements to engineering aspects of the method, since we are talking about the use of ozone in the range of low therapeutic concentrations, similar to the generally accepted pharmacological agents.

We have defined the requirements that a modern medical ozonizer should meet, namely:

1. Ability to produce ozone in a wide range of concentrations;
2. Possibility of precise regulation of produced ozone in the entire concentration range with the minimum possible job step;
3. High accuracy of maintenance of the set ozone concentration in the entire range of produced concentrations;
4. Automated stabilization of the feed rate (volume flow) of ozone-oxygen mixture;
5. Possibility to perform strictly dose-dependent ozone therapy;
6. A long-lived discharge chamber;
7. Maximum automation in operation, blocking in case of false staff operation;
8. Produce clean medical ozone.

In the work, we used "OP1-M" ozonizer designed and manufactured by the NGO "Orion" exactly for ozone therapy. Ozone-oxygen mixture was obtained by pumping medical oxygen through a gas-discharge chamber of the originally designed ozonizer. Originality of the design of this device consists in its portability and technical characteristics: weight 5 kg, dimensions 300x200x130 mm, power consumption 70 watts. Ozone concentration in ozone-oxygen mixture at the outlet is regulated by a button switch from 0.2 to 2 g/m³.

All the manipulations were carried out in the treatment room specially prepared in accordance with SanPiN 5179-90 and the Appendix to SnIP 2.08.02-89. Oxygen was supplied from the network of centralized oxygen wiring or an oxygen cylinder. In the operation, medical oxygen GOST 5583-78 was used. If oxygen was supplied from the cylinder, the "Safety rules for the operation of pressure vessels" were observed. The maximum allowable concentration of ozone in the air of the working area (GOST 12.1.005) did not exceed 0.1 mg/m³.

For studying the efficacy of ozone therapy in the treatment of knee joint osteoarthritis, two phases of clinical trials of ozone-oxygen mixture were performed. The 1st phase of clinical trials was the study of direct effect of the procedure of intraarticular injection of gas into the knee joint; the 2nd phase was the clinical study of the efficacy of ozone therapy in the main group of patients.

EXPERIMENTAL

Clinical evaluation of the efficacy of ozone therapy was given in comparison with the control group. Patients of the main group (n=120) received 5 intraarticular injections each 2 - 3 days. Ozone was used at a dose of 80 µg, while at the same time, Arterapon (1 ml) or ZeelT (2 ml) were injected into the joint. Arteparon was used for OA without deformations visible on X-ray images; Zee1T, for post-traumatic deforming OA. Another group of patients (control, n=30), identical in the main clinical and x-ray characteristics, also received interarticular chondro protectors and no ozone therapy.

Background therapy (non-steroidal antiinflammatory drugs, symptomatic drugs, exercise therapy) was maintained, only the injection of corticosteroids into the joint was not allowed during the entire follow-up period.

RESULTS AND DISCUSSION

Pain monitoring showed that pain in the main group decreased during 6-9 days after 2 injections of ozone-oxygen mixture; in the control group, similar phenomena occurred only after 12-15 days. This fact allowed to take active therapeutic measures earlier in the main group (exercise therapy, massage) aimed at strengthening the periarticular muscles and increasing the KJ motion range. In the main group, the motion range restored in 3 weeks, in the control group in 5 weeks. In general, patients of the main group who received 4-5 injections of ozone-oxygen mixture had a significant decrease of the joint pain; in 84% of them, clinical manifestations of reactive synovitis disappeared: and in 72% the KJ motion range increased. Degree of changes in the main clinical parameters in the control group of patients receiving only chondroprotectors was less pronounced, especially with respect to such indicator as the presence of synovitis: in none of patients it disappeared; only one-third of patients had a decrease in severity.

One of the KJ OA manifestations is hypotrophy and a decrease in functional parameters of periarticular muscles of the KJ, especially the internal broad muscle. This symptom was present prior to treatment in all patients in varying degrees of severity. Early reduction in pain intensity in the main group allowed the patients to more actively strengthen the thigh muscles by exercise therapy. In the main group, on average, on the 20th day of treatment, there was a marked positive dynamics. To objectify these changes, we monitored bioelectric parameters of the internal broad thigh muscles in the control group and in 30 patients of the main group. Arbitrary bioelectrical activity of this muscle was recorded when the shin was extended from the cushion with the maximum possible force. Studies were conducted prior to treatment on the 12th, 20th and 40th day after the initiation of intraarticular injections.

It is noted that in all cases, the increase in integral indicator of bioelectrical activity under an arbitrary muscle tension occurs after 3-4 procedures; however, in the main group it is more pronounced. Analysis of the obtained data indicates an initial decrease in bioelectrical activity in both groups. On the 12th day of treatment, the increase is more pronounced in the main group (the increase was 52.2% versus 19.8% in the control group ($p<0.05$); on the 20th day after the beginning of treatment: the main group - 127.2%, the control group - 31.9% ($p<0.05$); a commensurate increase in integral indicator in the control group was recorded 40 days after the initiation of treatment (224.5% and 151.8%, ($p<0,05$).

Thus, based on the studies, it can be stated that the use of ozone therapy in the complex of the KJ OA treatment creates the conditions for and promotes recovery of periarticular muscle function.

To assess the molecular-cellular effect of ozone-oxygen mixture on the KJ tissue, we conducted a study of synovial fluid.

Synovial fluid forms and is replenished from three sources: 1) blood transudate delivering water, electrolytes, proteins into synovial fluid; 2) products of secretion of synovial and cartilaginous cells (hyaluronic acid, proteolytic enzymes); 3) products of wear and change of cells and basic substance of synovial membrane and articular cartilage (proteoglycans, glycoproteins).

Dysfunction of the joint changes the composition and properties of synovial fluid, according to the size and nature of physical exertion on the joint. With development of pathological processes in the joint,

absorption rate in synovial membrane decreases and there is a higher permeability into the joint cavity, which leads to accumulation of fluid in the joint and a change in its properties.

Synovial fluid was studied in 44 patients of the main group and 18 patients of the control group. The material was taken prior to treatment and 4 weeks later.

A number of indicators were assessed, among them: content of cholesterol, triglycerides (lipids), superoxide dismutase (antioxidant and antiradical cell defence enzyme) in synovial fluid as well as content of protein and its fractions.

Decrease in cholesterol content is regarded as evidence of lipid metabolism disturbance. Cholesterol content in synovial fluid of the KJ of patients of the main and control groups was low prior to treatment. After treatment, its significant increase was recorded in the main group - by 39.3%; in the control group, by 11.8% ($p>0.05$), which is, most likely, due to ability of ozone to normalize lipid metabolism.

Triglycerides, or neutral lipids are esters of triatomic alcohol of glycerol and three residues of fatty acids. Their composition includes most of fatty acids present in plasma; therefore, fatty acid composition of triglycerides corresponds to fatty acid composition of plasma. There was practically no decrease in the amount of triglycerides in synovial fluid in the control group, whereas in the main group their content decreased by 32.5% ($p<0.05$). We attributed this fact to direct effect of ozone on unsaturated fatty acids of triglycerides.

In case of the KJ OA, prerequisites are created for free radical destruction of joint tissues. Stimulation of peroxide and free radical processes causes oxidative destruction of cells and intercellular matrix including depolymerization of synovial fluid, decomposition of hyaluronic acid, proteoglycan aggregates and collagen. Moreover, in synovial fluid of patients, superoxide dismutase appears, which belongs to the most catalytically active enzymes. We have recorded a high level of activity of enzyme of antioxidant and antiradical protection of cells - superoxide dismutase, both in the control, and in the main group of patients. As a result of treatment, this indicator significantly decreased in the control group by 7.2%, and to a greater extent - in the main group - by 25.5% ($p<0.05$). This fact confirms antioxidant properties of ozone.

Among the protein components comprised into synovial fluid, determination of the concentration of total protein and protein fractions is of great clinical importance. In our observations, there was a more than 2-fold increase of concentration of total protein, decrease in the share of albumins by 11-12%, increase in the content of globulins mainly at the expense of α_2 - and γ -globulins, which can be attributed to chronic inflammation of joint tissues.

As a result of treatment, the tendency towards normalization of protein composition of synovial fluid was determined, which is more pronounced in the main group, but, at the same time, it should be acknowledged, that this normalization is much slower in comparison with clinical manifestations of inflammatory process in the joint. Thus, protein in the main group significantly decreased by 29% ($p<0.05$); in the control, by 11.7% ($p<0.05$); γ -globulins, by 34.4% and 10.1%, respectively ($p<0.05$); α_2 -globulins by 8.3% and 3.4% ($p>0.05$); there was an insignificant increase of albumins and a decrease of α_1 - и β -globulins.

In our opinion, the recorded changes in biochemical indicators of protein in synovial fluid testify to pronounced anti-inflammatory and immunomodulating properties of ozone.

An integrated assessment of the functional state of the knee joint with determination of integral indicators (weighted average values) before and after treatment showed that prior to treatment, there were no significant differences in the majority of the studied indicators between the groups ($p>0.05$), and the integral indicator of the functional state of the affected knee joint was below 3 points, which indicates the state of decompensation.

Soon after treatment (1.5 months), the integral indicator in the main group was 4.39 ± 0.18 points. This is 0.18 points higher than in the control group ($p<0.05$). Both in the main and in the control group, the integral indicator in the long-term period was quite high. In the main group, it was equal to 4.27 ± 0.16 points; and in the control group, to 3.96 ± 0.28 points ($p>0.05$).

In all observations, after the intraarticular injection of ozone-oxygen mixture, there were neither manifestations of aseptic (allergic) and septic inflammation, nor worsening of initial condition of the knee joint osteoarthritis (synovitis, pain, edema).

CONCLUSIONS

Thus, based on integrated assessment of the function of the KJ with OA prior to treatment, immediately after and long after treatment, it can be concluded that integrated treatment with the use of ozone therapy is most effective. The use of chondroprotectors alone improves the KJ function, but to a lesser extent.

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