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Knee joint changes in the early postoperative period after arthroscopic resection of menisci under the influence of different treatment methods

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Introduction The rate of effusion or hemarthrosis after arthroscopic operation is in the range of 0.16 – 15.7 %. Changes in the operated joint are reflected in the composition and properties of the synovium. So, the study of hemo-synovial fluid will assess the severity of pathological changes and the effectiveness of treatment. **Purpose** The aim of the research was to study the changes in the hemo-synovial fluid of the operated knee joint and evaluate the effectiveness of treatments applied to hemosynovitis. **Materials and methods** The study included 79 males between the age of 18 and 60 years. At each puncture after full evacuation, the cavity was treated by the author's method in 38 patients of group 1 (patents on invention of Russia № 2457833 and № 2460545), which consisted in the lavage of the joint cavity with an isotonic sodium hydrocarbonate solution cooled down to +5 °C until the fluid was clear followed by intraarticular introduction of 3.0 ml of the mixture consisting of solutions for injections of 5 % ascorbic acid, 5 % unithiol and 0.5 % novocain, taken in equal volumes 1:1:1. At each puncture after full evacuation in 41 patients of group 2, intraarticular introduction of 3.0 ml of 0.5 % novocain solution for injections was performed. The efficiency was studied with magnetic resonance imaging in 24 men (12 subjects from each group) on 3rd and 7th days after arthroscopy. The pH, relative density, level of lipid hydroperoxide, concentration of common SH-groups and cytosis were defined in the hemo-synovial fluid. **Results** It was revealed that inflammatory changes develop in the operated knee joint after arthroscopic resection of the meniscus. **Discussion** The treatment technique proposed for knee joint hemosynovitis reduces faster the severity of the inflammatory reaction, lipid peroxidation and increases concentration of thiol antioxidants.

Keywords: knee joint, arthroscopic operation; hemosynovial fluid, hemosynovitis, management

INTRODUCTION

Arthroscopic meniscectomy is currently a frequent endoscopic intervention in traumatology and orthopedics [1-7]. The incidence of persistent effusion or hemarthrosis after arthroscopic surgery requiring arthrosentesis ranges 0.16-15.7 % [8-9]. The changes that occur in the operated joint are fully reflected in the composition and properties of the synovium [10-15]. Therefore, the study of the hemo-synovial fluid will reveal the severity of pathological changes and the effectiveness of treatment.

Purpose To study the changes in the hemo-synovial fluid of the knee joint that was operated and to determine the effectiveness of the treatment proposed

MATERIAL AND METHODS

Studies of the hemo-synovial fluid in the early postoperative period were performed in 79 males aged 18 to 60 years (mean age 35.1 ± 10.4 years) with hemosynovitis of the knee joint, which developed after arthroscopic resection of menisci. The study was approved by the ethical committee of the PFMRC of the ministry of health of Russia.

The patients included in the study were randomly selected and gave their informed consent. They were divided into two groups.

At each puncture after full evacuation, the joint cavity in 38 patients of group 1 was treated by the lavage with an isotonic sodium hydrocarbonate solution cooled down to +5 °C until the fluid was clear followed by intraarticular introduction of 3.0 ml of the mixture consisting of solutions for injections of 5 % ascorbic acid, 5 % unithiol and 0.5 % novocain, taken in equal volumes 1:1: (patents on invention of Russia № 2457833 and № 2460545). Preclinical studies had been prior performed and included experiments to determine the chemical compatibility of the components of the mixture in vitro, the pH of the isotonic sodium bicarbonate solution, and the mixture of injectable solutions [16]; the study of the effect of

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isotonic sodium hydrocarbonate solution, a mixture of solutions and its components on the tissues of the normal murine knee joints and under conditions of modeled arthritis in vivo [17]. At each puncture after full evacuation in 41 patients of group 2, intraarticular introduction of 3.0 ml of the 0.5 % novocain solution (15 mg) for injections was performed.

Indications for performing knee joint puncture were presence of positive symptoms of fluctuations and/or "patellar balloting"; increased edema of soft joint tissues by more than 2.0 cm; excessive free fluid in the cavity and joint folds according to imaging studies (ultrasound, MRI). The joint was punctured the next day after the operation, then every other day, according to the standard method. In the absence of indications, the puncture of the operated joint was not performed due to ethical reasons.

Magnetic resonance imaging (MRI) was used in 24 patients (12 in each group) to assess the effectiveness of the treatment on a Siemens Magnetom Essenza 1.5 T (Germany) on the 3rd and 7th day after arthroscopy. In the hemosynovial fluid, pH was determined using the universal ionometer EV-74 (RF); relative density in g/cm^3 with a pycnometer for 5 ml and laboratory scales VL-120 (RF); the level of lipid hydroperoxides was determined with the method of L.A. Romanova and I.D. Stalnaya (1977) [18] with the spectrophotometer SF-56 (RF), using a 480 nm light filter; the concentration of total SH-groups was defined with the Folomeeva's method (1981) [19] using a 500 nm filter and calculating the concentration in μmol/L by comparing with the pilot and control samples; the number of cell elements in the hemosynovial fluid was calculated in the Goryaev's chamber [20, 21]. Cytosis was expressed in cells per μl.

Statistical processing of the results was carried out using the standard package of statistical programs Statistica 6.0 and MS Excel 2007 for Windows XP. Quantitative data were presented as the arithmetic mean (M) ± standard deviation (SD). To judge the significance of the differences within one group, the Wilcoxon test was used, and the Mann-Whitney U test was used for the values of the various groups. The changes were considered significant at $p < 0.05$.

RESULTS

A retrospective analysis of 533 patients who had arthroscopic knee joint interventions for 7 years in two traumatology departments showed that the frequency of punctures after surgery was 16 %.

In patients of both groups, a moderate amount of free fluid was detected on the 3rd day after arthroscopy in the cavity of the operated joint with MRI. A week after the operation, three patients (25 %) of group 1had no free fluid in the knee cavity and a small amount of fluid was detected in 9 (75 %). At the same time point, a moderate amount of free fluid in the cavity of the operated joint was preserved in all the patients of group 2 (100 %).

The results of laboratory studies are presented in Table 1.

Table 1

Changes in the hemo-synovial fluid of the operated knee joint

Parameters	Group 1			Group 2			Reliability, pM-U	
	1st day, n = 38 (100.0 %)	3rd day, n = 17 (44.7 %)	1st day, n = 41 (100.0 %)	3rd day, n = 29 (70.7 %)	5th day, n = 15 (36.6 %)	7th day, n = 7 (17.1 %)		
	1	2	3	4	5	6	1-3	2-4
Hydrogen index – pH	7.33 ± 0.31	7.76 ± 0.26	7.37 ± 0.31	7.53 ± 0.16	7.60 ± 0.18	7.70 ± 0.11	0.837 (NS)	< 0.001
Relative density, g/cm^3	1.0216 ± 0.0026	1.0164 ± 0.0021	1.0210 ± 0.0024	1.0201 ± 0.0025	1.0197 ± 0.0024	1.0187 ± 0.0023	0.480 (NS)	< 0.001
Lipid hydroperoxide, rel. units	0.546 ± 0.055	0.233 ± 0.060	0.541 ± 0.072	0.407 ± 0.045	0.328 ± 0.048	0.254 ± 0.047	0.314 (NS)	< 0.001
SH-groups, total, μmol/l	23.19 ± 3.10	50.09 ± 4.18	23.07 ± 2.98	27.95 ± 2.89	31.93 ± 3.85	38.74 ± 3.57	0.830 (NS)	< 0.001
Cytosis, cells/μl	2638 ± 283	623 ± 196	2605 ± 276	1972 ± 204	1192 ± 184	604 ± 135	0.454 (NS)	< 0.001

Note. NS – not significant ($p > 0.05$).

DISCUSSION

Our studies found that inflammatory changes were observed after arthroscopic intervention that are characterized by an increase in the values of cytosis, relative density up to exudate values, and by the presence of a moderate amount of free fluid in the cavity of the operated joint according to MRI. In both groups, the number of patients requiring repeated puncture decreased, indicating a reduction in the severity of inflammatory exudation. So, by the end of the week only 17.1 % of group 2 patients needed puncture. However, when comparing the results on day 3 after surgery, repeated punctures in group 1 were performed in 44.7 % of patients while in group 2 in 70.7 %. The presence of a moderate amount of free fluid in the cavity of the operated joint according to MRI on day 7 in group 2 (100 %) indicated a more pronounced inflammatory response as compared to group 1.

Due to the therapy administered in group 1, the degree of inflammatory reaction decreased more rapidly in comparison with group 2. In group 2, the values of the relative density significantly decreased by 0.0020 g/cm^3 for seven study days; cytosis values decreased 4.3 times ($pw < 0.001$) while in group 1 for three study days by 0.0050 g/cm^3 and by 4.2 times, respectively ($pw < 0.001$). However, in both groups the values of the studied parameters did not reach the norm (the relative density was higher than the values of the transudate 1.0150 g/cm^3, cytosis up to 200 cells/μl [20]), which indicated the presence of inflammation, although the degree of its expression was significantly lower than in the 1st day.

In group 1, intra-articular administration of two antioxidants (ascorbic acid and unithiol) significantly decreased the degree of lipid peroxidation and increased the concentration of total SH-groups when comparedn with group 2 (Table 1).

Despite the fact that a 0.5 % solution of novocain has pH in the range of 3.8 to 4.5, a significant increase in the hydrogen index by 0.33 ($pW < 0.001$) was observed in group 2 after seven days. In group 1, after washing the joint cavity with isotonic sodium hydrocarbonate solution (pH 8.01-8.07) and subsequent intra-articular injection of 3 ml of the mixture (pH 5.30-6.60), on the third day there was a significant increase in pH by 0 , 43 ($pW < 0.001$), which indicates an improvement in the acid-base state of the operated joint. It is somewhat problematic to compare the obtained values of the hydrogen index of the hemosynovial fluid with physiological values, since, according to various authors, the synovial pH norm has different values. So, according to VN. Pavlova (1980), its pH is 7.768 [22]; VA. Bobkov et al. (1999) report the pH value of 7.80 [23]; V.V. Dolgov et al. (2006) – 7.31-7.64 [20]; E.L. Matveyeva (2007) – 7.29-7.45 [24]. Rather large differences in the physiological values of the pH of the synovial fluid appear to be due to the difficulties in obtaining a sufficient biosubstrate from a living person and using different equipment.

The use of an isotonic sodium bicarbonate solution cooled to + 5°C has several advantages. A solution that meets the requirement of isotonicity is devoid of negative properties of hypotonic (cytolysis) and hypertonic (plasmolysis) solutions. Washing the cavity of the operated joint with a cooled solution creates intra-articular hypothermia, and group 1 patients noted the analgesic effect of this procedure. When interviewed, all the patients in group 1 could not distinguish between a cold or warm solution, but at the same time they clearly noted an increase in the intra-articular pressure when a certain amount of solution was administered. Again, it confirmed that there are no temperature exteroceptors in the joint, but there are proprioceptors.

Similar data on the treatment of patients after arthroscopic meniscectomy were described in the literature. Thus, intra-articular administration of 4 % isotonic magnesium sulfate solution increased the average duration of postoperative analgesia and reduced the need for additional analgesics in comparison with intra-articular bupivacaine administration [25].

CONCLUSIONS

1. Knee joint hemosynovitis, requiring treatment, develops in 16 % after an arthroscopic resection of the meniscus.

2. In the early postoperative period, the treatment proposed reduces faster the severity of the inflammatory reaction and lipid peroxidation as well as increases the concentration of thiol antioxidants in the knee joint.

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