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ORIGINAL ARTICLES

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The effectiveness of physical therapy in the rehabilitation of patients after arthroscopy of the knee joint

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ABSTRACT

Aim: To determine the effectiveness of physical therapy on the functional state of law enforcement officers' knee joints after surgical intervention.

Materials and Methods: The research involved law enforcement officers from different units of the National Police of Ukraine (n = 56) who had suffered knee joint injuries in the line of duty, and underwent surgical intervention and rehabilitation procedures.

Results: It was found that 78.2 % of respondents had suffered knee joint ligament injuries as a result of falls during rapid movement, while 43.9 % were in full gear (armored protection, helmet, etc.). It was determined that after surgical intervention, the functional state of the knee joint of law enforcement officers who followed the recommendations of physical therapy specialists and systematically performed special sets of physical exercises was significantly different ($p < 0.001$). Worse results were noted in people who partially followed the recommendations of rehabilitation therapists and performed part of the prescribed procedures and physical exercises.

Conclusions: The effectiveness of the complex use of physical rehabilitation means for restoring the functioning of the knee joint after surgical intervention, which included arthroscopy, partial menisectomy of the damaged areas, debridement, vaporization of damaged cartilage, etc. was revealed. The positive effect of physical exercises on the functional state of the knee joint was proven. The sets of exercises that are advisable to use to restore the functioning of the knee joint were determined.

KEY WORDS: arthroscopy, physical therapy, rehabilitation, knee joint, law enforcement officer

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INTRODUCTION

Cases of injuries to the musculoskeletal system of law enforcement officers are among the leading ones in most countries of the world [1, 2]. According to researchers, 21.4 % of such injuries are caused by damage to the menisci of the knee joint, while 17.2 % of cases of meniscus damage (often internal) are combined with a violation of the articular cartilage structure [3, 4]. This is due to the peculiarities of the anatomical structure of these joints, the tendency to post-traumatic complications, and the specifics of service tasks performance by law enforcement officers.

Experts in the field of orthopedics [5] state that the articular ligaments, muscles, and tendons of the knee joints form a complex aggregate that is easily injured when performing sudden movements from an awkward position, in case of overload and bruising. The lateral and cruciate ligaments are most often damaged, as they are designed to passively hold the joints within a certain range of motion. There are also dislocations, sprains, tears, ruptures, and inflammation. Ligament damage mostly occurs during active movements, when a sudden sharp excessive movement occurs in the joint that exceeds the physiological volume (amplitude), in particular during rotation, deviation of the lower leg in the frontal plane with bending of the limb in the knee joint during a fall, walking, running, etc. [6]. Such injuries can result in joint stability disorders, which lead to reduced working capacity, and loss of proprioception, which affects the efficiency of the entire musculoskeletal system. According to researchers [7], knee joint injuries can be accompanied by pathological changes in articular cartilage, manifested in structural disorders, thinning, and delamination. In the future, this can lead

to the development of secondary gonarthrosis, a complication that can be observed in 35.5-69.7 % of cases and develops on average three to five years after injury. It has been established that in people aged 26 years and older, symptomatic gonarthrosis is observed in 5 %, in people aged 45 years and older – in 12.1 %, in people aged 60 years and older – in 11 %, in people aged 70 years and older – in 16.7 % [8].

During the war, there was a significant increase in the number of cases of traumatic injuries among law enforcement officers to various parts of the body, including knee joints. According to scientists [9], surgical intervention is a radical method of treatment for knee ligament injuries. Arthroscopy is considered the least traumatic method of recovery, which is a modern minimally invasive surgical method of visual examination of the internal structures of the joint and the contents of the joint sinus, as well as therapeutic effects on them, using thin optical and mechanical devices [10]. The restoration of knee joint function relies on a set of rehabilitation measures after surgical intervention. According to the results of studies by experts [11], the effectiveness of physical rehabilitation depends on the correct assessment of functional disorders that need to be corrected after arthroscopic surgical intervention. The researchers are convinced that the implementation of clear step-by-step physical therapy, which is considered a functional restorative therapy, will help improve treatment outcomes, including rehabilitation exercises, massage, natural and preformed factors [13]. Physical rehabilitation, depending on the nature, course, and consequences of the disease or injury, and the period and stage of the rehabilitation process, is used for prevention or treatment, or recovery. It mobilizes the body's reserve forces, activates its protective and adaptive mechanisms, increases psycho-emotional tone; prevents complications, accelerates the recovery of functions of various organs and systems and reduces the time of clinical and functional recovery; trains and hardens the body, adapts to physical activity of a domestic, educational and professional nature, restores working capacity, and improves the quality of life [13]. The systematic performance of motor actions stimulates and adapts the human body to physical activity, which gradually increases and leads to functional adaptation. The health-promoting effect of physical exercises is due to the interaction of the nervous and humoral systems as well as motor-visceral reflexes. Any muscle contraction irritates the numerous nerve endings inherent in them, and the flow of impulses is directed to the central nervous system, changing its functional state and ensuring the regulation and restructuring of the activity of internal organs through the autonomic centers. Physical rehabilitation means, in particular the use of physical exercise sets, allow for a short period to reduce pain, increase the movement amplitude, gradually enhance the load on the damaged joint, fully or partially return to vigorous service activities, and adapt to everyday life [14].

Thus, the analysis of the literary sources showed that a significant number of publications have been devoted to the study of the effect and effectiveness of physical therapy for the restoration of the functional state of the knee joint after injury and surgical intervention, while the effectiveness of physical rehabilitation and, in particular, exercise sets after arthroscopy of the knee joint in modern conditions is not sufficiently disclosed, which determined the relevance of our research.

AIM

The aim is to determine the effectiveness of physical therapy on the functional state of law enforcement officers' knee joints after surgical intervention.

MATERIALS AND METHODS

The research involved the use of several theoretical and empirical methods, including analysis, synthesis, classification, generalization, questionnaire surveys, observation, and methods of mathematical statistics. The research was conducted in 2022-2024. Determining the effectiveness of physical therapy during the rehabilitation of law enforcement officers after knee arthroscopy involved the conduct of the questionnaire survey. The survey was carried out in three stages. Stage 1 – one month after the surgical intervention; stage 2 – 2 months, stage 3 – 5 months after the surgical intervention. The survey involved law enforcement officers from various structural units of the National Police of Ukraine (n = 56) who had sustained knee injuries in the line of duty and underwent surgical intervention and rehabilitation. The grounds for surgical intervention were based on the appropriate diagnosis. In particular, the law enforcement officers had persistent pain in the knee joint, degenerative changes and damage to the posterior horn of the medial meniscus, chondral damage and ulceration of the cartilage of the lateral condyle of the femur, subtotal tear of the anterior cruciate ligament, chondromolysis of the knee joint, etc. The surgical intervention included: arthroscopy of the knee joint, partial menisectomy of the damaged areas, debridement, vaporization of the damaged cartilage segments, synovial membrane, chondral damage, and osteoperforation.

The questionnaire survey included several questions

related to anthropometric data (weight, height), age, conditions of injury, the list of physical therapy tools used during the rehabilitation procedure, and questions from the KOOS (Knee injury and Osteoarthritis Outcome Score) questionnaire [15]. The KOOS questionnaire is designed to study the subjective assessment of the functional status of the injured knee joint using a special rating scale. The scale contains five subsections, including:

- symptoms – 7 points (swelling of the knee joint, feeling of friction, crunching, pinching, stiffness, bending amplitude, etc.);
- pain – 9 points (frequency of pain; degree of pain in different positions and the course of various movements in the knee joint);
- daily activities – 17 items (moving up and down stairs, bending and extending the knee joint from different positions, changing positions, different types of walking, and performing various household tasks aimed at self-care, etc.);
- sports and recreational function – 5 items (questions related to the peculiarities of performing active motor activities: squats, running, jumping, twisting, etc.);
- quality of life – 4 items (frequency of discomfort, degree of difficulty in everyday life due to the knee joint problem).

All items have five possible answers, ranging from 0 (no problems) to 4 (extreme problems), and each of the five scores is calculated as the sum of the selected items. Scores from 0 to 100 are a percentage of the total possible score. The total score is not calculated, as the selected aspects are analyzed and interpreted separately. The scores on the scales were calculated using the following formulas:

Symptoms = 100 – (average score on the scale (S1-S7) × 100/4)

Pain = 100 – (average score on the scale (P1-P9) × 100/4)

Daily activities = 100 – (average score on the scale (A1-A17) × 100/4)

Sports and recreational function = 100 – (average score on the scale (SR1-SR5) × 100/4)

Quality of life = 100 – (average score on the scale (Q1-Q4) × 100/4)

The determination of physical exercise sets that had a positive effect on the restoration of knee joint function during rehabilitation under restrictions caused by the introduction of martial law was based on the analysis of the results of the questionnaire survey.

Statistical analysis was applied to correctly process the data and identify the difference between the indicators under study. The significance of the difference in the results was determined during the studying based on the Student's t-test. The significance for all statistical tests was set at $p<0.05$. This research followed the regulations of the World Medical Association Declaration of Helsinki. Informed consent was received from all participants who took part in this research.

RESULTS

The results of the questionnaire survey revealed that 78.2 % of respondents suffered knee ligament injuries as a result of falls during rapid movement, while 43.9 % were wearing equipment (armored protection, weapons, helmet, etc.), 34.3 % of employees experienced pain and swelling after prolonged movement and staying in an upright position. 21.8 % of people said that the surgical intervention was prompted by an exacerbation of a long-standing injury. It was found that among the respondents there were 13 people under the age of 25; 19 people – 26-30 years; 13 people aged 31-35 years; 8 – 36-40 years; and 3 people – 41-45 years. The average age of the operated employees was 29.9 ± 0.80 years, the average weight was 83.4 ± 1.43 kg.

The analysis of issues related to the attitude of law enforcement officers to physical therapy, compliance with the recommendations of rehabilitation specialists, and the list of physical exercises used to restore knee joint functioning gave grounds to distinguish three groups of people. In particular, group 1 (n = 9) included law enforcement officers who, despite the difficulties caused by martial law, followed the recommendations of physical therapy specialists and attended most of the prescribed procedures (physiotherapy, massage, hydromassage) and systematically performed special sets of physical exercises throughout all stages of rehabilitation. Individuals in group 2 (n = 32) partially followed the recommendations of rehabilitation therapists, participated in some of the prescribed procedures and exercises at the first stage of rehabilitation; not systematically at the second stage of rehabilitation, and did not use physical exercises to restore knee joint function at the third stage of rehabilitation. Individuals in group 3 (n = 15) did not follow the recommendations of physical therapy specialists and did not engage in procedures and exercises to restore knee joint function more quickly at any stage of rehabilitation.

A thorough study of the questions provided by the KOOS questionnaire showed significantly better ($p < 0.001$) results of subjective assessment of the functional state of the knee joint in group 1 (Table 1). This was true for all three stages of the questionnaire survey. In particular, stage 1 revealed the most significant difference in the manifestation of postoperative symptoms (knee joint swelling, feeling of friction, crunching, pinching, stiffness, bending amplitude, etc.), which were estimated at 32.2 ± 0.52

Table 1. Results of the questionnaire survey of law enforcement officers (n = 56) who underwent knee surgical intervention, points (according to the KOOS scale)

Indicators	Group 1 (n = 9)	Group 2 (n = 32)	Group 3 (n = 15)	Reliability of the difference		
				p1–p2	p2–p3	p1–p3
Stage 1 (1 month after the surgical intervention)						
Symptoms	32.2±0.52	21.3±0.45	19.7±0.53	$p<0.001$	$p<0.05$	$p<0.001$
Pain	38.9±0.35	33.3±0.39	32.2±0.49	$p<0.001$	$p>0.05$	$p<0.001$
Daily activities	48.6±0.82	44.1±0.37	43.5±0.26	$p<0.001$	$p>0.05$	$p<0.001$
Sports and recreational function	30.1±0.55	22.5±0.38	16.5±0.28	$p<0.001$	$p<0.001$	$p<0.001$
Quality of life	31.2±0.66	18.8±0.30	17.7±0.48	$p<0.001$	$p>0.05$	$p<0.001$
Stage 2 (2 months after the surgical intervention)						
Symptoms	67.8±0.71	57.1±0.52	55.6±0.96	$p<0.001$	$p>0.05$	$p<0.001$
Pain	69.4±0.60	61.1±0.41	59.4±0.65	$p<0.001$	$p<0.05$	$p<0.001$
Daily activities	75.0±0.65	72.1±0.30	69.1±0.22	$p<0.001$	$p>0.05$	$p<0.001$
Sports and recreational function	52.5±0.74	32.5±0.71	29.9±0.42	$p<0.001$	$p<0.01$	$p<0.001$
Quality of life	62.5±0.67	40.5±0.62	39.6±0.48	$p<0.001$	$p>0.05$	$p<0.001$
Stage 3 (5 months after the surgical intervention)						
Symptoms	92.8±0.48	85.7±0.76	82.1±0.86	$p<0.001$	$p>0.05$	$p<0.001$
Pain	98.2±0.43	86.4±0.45	85.7±0.75	$p<0.001$	$p>0.05$	$p<0.001$
Daily activities	98.2±0.33	88.3±0.59	87.5±0.30	$p<0.001$	$p>0.05$	$p<0.001$
Sports and recreational function	96.4±0.38	80.2±0.59	78.5±0.30	$p<0.001$	$p<0.05$	$p<0.001$
Quality of life	98.9±0.21	85.7±0.77	85.1±0.39	$p<0.001$	$p>0.05$	$p<0.001$

p1-p2, p2-p3, p1-p3 – significance of the difference between the indicators of law enforcement officers of groups 1, 2, 3 using the Student's t-test.

points ($p < 0.001$). The employees of groups 2 and 3 were characterized by 21.3 ± 0.45 and 19.7 ± 0.53 points, respectively ($p < 0.05$). The results of the assessment of the effectiveness of sports and recreational functions (squats, running, jumping, twisting, etc.) differed significantly in all three groups. In law enforcement officers of group 1, this indicator was 30.1 ± 0.55 points ($p < 0.001$), in group 2 – 22.5 ± 0.38 points, and 16.5 ± 0.28 points in group 3 ($p < 0.001$). The results show that the systematic and comprehensive use of the recommended means of physical therapy has a more pronounced effect on reducing the manifestations of symptoms after surgical intervention, promoting more effective restoration of knee joint mobility. This has a positive effect on the indicators of daily activities and quality of life. In particular, the items of the KOOS questionnaire, which determined the frequency of discomfort, the degree of difficulty in everyday life, etc. were significantly better ($p < 0.001$) in law enforcement officers of group 1 – 31.2 ± 0.66 points, which is 12.4 points higher than in group 2 (18.8 ± 0.30) and 13.5 points higher than in group 3 (17.7 ± 0.48). There was no significant difference in the quality of life indicators among the employees in groups 2 and 3 ($p > 0.05$). The representatives of group 1 showed less pain ($p < 0.001$) and higher rates of daily activities ($p < 0.001$) during all three stages.

The analysis of the results of the questionnaire survey at stage 2 showed the effectiveness of physical therapy means, in particular dosed exercise sets, to restore the functioning of the knee joint. There was a more than 10 points difference between group 1 and individuals of other groups in the items that determine the quality of life, symptoms, sports, and recreational function ($p < 0.001$). Among law enforcement officers of groups 2 and 3, a significant difference was found in the items of the KOOS scale characterizing the feeling of pain ($p < 0.05$) and sports and recreational function ($p < 0.01$).

At stage 3, the representatives of group 1 scored more than 90 points on all items of the KOOS scale, which was significantly higher ($p < 0.001$) than in groups 2 and 3. In particular, the indicators of group 1, which determine pain, daily activities, and quality of life, are close to the level that characterizes the absence of any problems – 98.2 ± 0.43, 98.2 ± 0.33, and 98.9 ± 0.21 points, respectively. Among the persons of groups 2 and 3 the studied indicators differed significantly only in the item concerning sports and recre-

ational function ($p < 0.05$). These results demonstrate the effectiveness of physical exercise sets for the restoration of knee joint function after surgical intervention.

Based on the analysis of the questionnaire surveys, physical exercise sets that contribute to more effective restoration of knee joint function were determined. During the first stage of rehabilitation, isometric exercises to strengthen the quadriceps femoris and hamstrings were effective. In the second stage – isotonic exercises without load. During the third stage of recovery – strength exercises with moderate load. The selection and dosage of physical exercises depends on the complexity of the injuries sustained before the surgical intervention, the presence of concomitant diseases, the age of the person, individual characteristics, including the level of physical fitness, the degree of soft tissue damage, etc.

DISCUSSION

Scientists state that significant subjective factors that lead to injuries to law enforcement officers are neglect of personal safety measures, fatigue, and lack of attention [2, 16]. To ensure full recovery from musculoskeletal injuries, physical therapy exercises, combinations of various physiotherapy procedures, and massages are used. These means accelerate the reduction of acute manifestations of pain and help accelerate adaptation processes. Experts [17] state that therapeutic exercises for meniscectomy are prescribed on the second day after surgical intervention. This is due to the need to improve blood circulation in the area of surgical intervention, normalize knee joint trophism, gradually eliminate joint mobility restrictions, stimulate the contractility of the thigh muscles, and improve overall working capacity. During the first stage of rehabilitation, in particular the first four days after the surgical intervention, the patient should perform general strengthening and special exercises in the starting position lying on the back, then sitting and standing. Given that the movements in the knee joint improve blood and lymph circulation, as well as the secretion of synovial fluid, relax muscles, relieve pain, and affect tissue regeneration, healing, and complete restoration of morphological structures [18].

According to scientists, the second stage of rehabilitation (from 3-4 weeks to 2-2.5 months after surgical intervention) is aimed at eliminating postoperative synovitis with residual knee joint contracture and severe muscle hypotrophy. The objectives of rehabilitation during this period are the complete removal of contractures in the knee joint, restoration of normal gait and adaptation to prolonged walking, training of strength endurance of the thigh muscles, and restoration of general working capacity [19]. The third stage of recovery, which lasts from 2-2.5 to 4-5 months after surgical intervention, is aimed at adaptation to slow running, and restoration of thigh muscle strength. The signs of clinical and functional recovery are the performance of several motor tests, including: squatting with full amplitude; walking in a full crouch; squatting on the operated leg (75 % of the number of squats on a healthy leg); not excessive running for 30 minutes. The data obtained confirm the findings of scientists [20] regarding the positive effect of exercise on the restoration of knee joint function after surgical intervention. Thanks to the use of a specially selected set of exercises, the connections between muscles and nerve endings are restored faster and the lost mobility is restored. This is due to the therapeutic effect of the main mechanisms of physical exercises: toning, trophic, compensation, and normalization of functions.

CONCLUSIONS

Based on the research, the causes and characteristics of law enforcement officers' injuries that led to the need for surgical intervention were identified. It was been found that the largest number of law enforcement officers who underwent knee arthroscopy were aged 26-30 years, with the average age of the operated officers being 29.9 ± 0.80 years.

It was found that after surgical intervention, the functional state of the knee joint of law enforcement officers who attended most of the prescribed procedures (physiotherapy, massage, hydromassage) and systematically performed special sets of physical exercises during all periods of rehabilitation was significantly better ($p < 0.001$) for all items of the KOOS scale (symptoms; pain; daily activities; sports and recreational function; quality of life). Worse results were observed in people who partially followed the recommendations of rehabilitation therapists, and performed part of the prescribed procedures and physical exercises at the first stage of rehabilitation and not systematically at the second stage.

It has been stated that isometric exercises to strengthen the quadriceps femoris and hamstrings at the first stage of rehabilitation; isotonic exercises without load at the second stage; and strength exercises with moderate load at the third stage of recovery have a positive effect on the faster recovery of the knee joint after surgical intervention, which included arthroscopy, partial menisectomy, debridement, vaporization of damaged cartilage segments.

PROSPECTS FOR FURTHER RESEARCH

We plan to study the effect of hydrotherapy and massage on the restoration of knee joint performance at the second stage of rehabilitation.

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CONFLICT OF INTEREST

The Authors declare no conflict of interest

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