

# Results of continuous passive movement method application in physical rehabilitation process of patients with knee joint pathology

Olexander Korolkov<sup>1</sup>  
Pavlo Bolkhovitin<sup>1</sup>  
Anastasia Korolkova<sup>2</sup>  
Nasr Al-Kali<sup>3</sup>

<sup>1</sup>Department of SI "Institute of Spine and Joint Pathology",  
Kharkiv, Ukraine

<sup>2</sup>Kharkiv National Medical University, Kharkiv, Ukraine

<sup>3</sup>Lviv State University of Physical Culture, Lviv, Ukraine

**Purpose:** to evaluate the effectiveness of physical rehabilitation of patients with pathology of knee joints (KJ) in the postoperative period using the method of continuous passive movement in the joints with the help of domestic devices.

**Material & Methods:** a comparative analysis of the results of rehabilitation of two clinical groups of patients was carried out, which were identical by sex, age, type of pathology and type of surgical interventions (52 male and 37 female), at the age of 18 to 60 years with the pathology of KJ who were on inpatient treatment. In the postoperative period, patients of the 2nd group, in addition to standard rehabilitation measures, performed passive development of motions in the affected KJ with the help of domestic devices for automatic development of movements.

**Result:** program of physical rehabilitation of patients with KJ pathology, which consists of several stages, is based on the comprehensive application of a wide range of rehabilitation means with an individual approach to the course of the postoperative period in each particular patient.

**Conclusion:** high efficiency of the use of the developed domestic devices for the automatic development of movements in the joints in the process of complex regenerative treatment of patients with the CS pathology, that allows recommending them for wide introduction in clinical use in rehabilitation centers and orthopedic and traumatological departments are proved.

**Keywords:** physical rehabilitation of patients with pathology of the knee joints, method of continuous passive movement in the joints, devices for the automatic development of movements in the joints.

## Introduction

Injuries and diseases of the musculoskeletal system are among the most frequent pathologies, affecting modern humanity. "The epidemic of injuries" and the increase in diseases of the musculoskeletal system did not bypass our country. In the structure of primary disability, the consequences of trauma and orthopedic diseases have been steadily occupying the third place for several decades after cardiovascular and oncological diseases. Every year in Ukraine more than 20 000 patients from injuries become disabled. Particular importance for the state is the loss of disability in persons of working age, which leads to a reduction in the state's labor potential, additional costs for pension provision, treatment and rehabilitation of disabled people [1–3].

Rehabilitation of patients with pathology of knee joints (KJ) is a very urgent problem in our country, because surgical interventions that are performed in the treatment of such pathology restore certain anatomical structures, but not completely eliminate their functional inferiority (the limitation of movements in the joints, muscle weakness, the cicatricial-adhesive process, the phenomenon of local osteoporosis develops or progresses, etc.), which in turn requires a long-term recovery treatment [4; 5; 7; 8].

In the domestic literature, there are isolated works describing the method of continuous passive movement (MCPM) in the system of physical rehabilitation of patients after surgical interventions at KJ (P. Bolkhovitin et al., 2013) and indicated its method of use. However, by providing some clinical recom-

mendations, they do not detail the timing and duration of this method – a powerful factor in the prevention and elimination of morpho-functional disorders in the postoperative period. They require a methodological solution to the issue of detailing and clarifying the timing of the appointment of MCPM, there was a need to develop a methodology for its application depending on the nature of the surgical procedure (diagnostic arthroscopy, arthroscopic removal of the meniscus, open or arthroscopic restoration of the ligaments of the knee joint, endoprosthesis of the knee joint, interventions for joint injuries and periarticular bone fractures, etc.) and the course of the postoperative period [6; 9].

One of the significant factors hampering the active introduction of the method of continuous passive traffic in Ukraine is the lack of domestic devices for their implementation and the high cost of foreign analogs.

Thus, the creation of domestic devices for the automatic development of movements in KJ and the active introduction of MCPM in the complex physical rehabilitation of patients after knee joint surgery to improve the efficiency and quality of the recovery process is relevant, which led to the choice of the direction of our study.

**Purpose of the study:** to evaluate the effectiveness of physical rehabilitation of patients with pathology of knee joints in the postoperative period using the method of continuous passive movement in the joints with the help of domestic devices.

## Objectives of the study:

1. Compare the results of the rehabilitation treatment of the control (standard rehabilitation program) and the research group (complex restorative treatment with MCPM) of patients with pathology of knee joints in the postoperative period.
2. Analyze the results of clinical data (the volume of joint movements, the presence and magnitude of contracture in KJ, the intensity of the pain syndrome) and instrumental research methods before, during and after rehabilitation treatment in two groups of patients with pathology of knee joints in the postoperative period.

## Material and Methods of the research

A comparative analysis of the results of rehabilitation of two clinical groups of patients was carried out, these groups were identical in gender, age, type of pathology and type of surgical interventions (52 men and 37 women) aged 18 to 60 years with KJ pathology (all patients had monolateral joint damage), who were on inpatient treatment in the Sytenko Institute of Spine and joint Pathology, Academy of Medical Science, for the period from 2010 to 2016. In the 1st, the control group included 43 patients, and in the 2nd, main group – 46 patients (Table 1). Criterion of selection in the study groups was: patients with KJ pathology who underwent arthroscopic surgical interventions and who required the application of physical rehabilitation methods in the immediate postoperative period.

In the postoperative period, patients of the 1st group received standard rehabilitation treatment, and patients of the 2nd group, in addition to standard rehabilitation measures, performed passive development of movements in the affected KJ with the help of domestic devices for automatic development of movements (DADM), which we developed together with LLC «Svarcon» (Figure 1) [10; 11].

In the manufacture of DADM, the conditions for medical devices (safety A) are met, and the possibility of changing and

smoothly adjusting the speed of the development of movements, the angle of flexion-extension in the joints and the adjustment of the lodgment length, depending on the patient's anthropometric data.

Patients were examined according to conventional methods before surgical treatment, 9–10 days after the beginning of rehabilitation treatment and 3 months after surgery (questioning patients on a visual analogue scale of pain, measuring the volume of movements, dopplerography and rheovasography of vessels, electromyography of the muscles of the affected limbs) and made a special questionnaire, where they noted the individual anatomical and functional features of the KJ and developed an individual plan of rehabilitation measures and an assessment of the condition of each patient. All data from clinical and special research methods were calibrated for the characteristics obtained and a certain score was given in scores.

## Results of the research and their discussion

We have developed a program for physical rehabilitation of patients with pathology of KJ (Figure 2), which consists of several stages, involves the definition of the goal, clarification of tasks, organizational features, contains guidelines, principles and characteristics of the rehabilitation survey, criteria for assessing their effectiveness, is based on the integrated application of a wide range of rehabilitation tools with a differentiated individual approach, depending on the features of the KJ pathology and the course of the postoperative period in each individual patient.

Patients of each group were: massage (general, local), therapeutic gymnastics (active exercises of the affected limb, corrective passive and active, breathing exercises, regressive gymnastics – according to indications), physiotherapy (electrophoresis, magnetotherapy), in addition, the patients of the main group underwent mechanotherapy by the method of continuous constant passive movements simultaneously with the electrical stimulation of the 4-golem muscle.

**Table 1**  
Distribution of patients by sex and type of pathology of the knee joint

| Pathology KJ  | Number of observations |       |            |       | total number |
|---|------------------------|-------|------------|-------|--------------|
|   | control group          |       | main group |       |              |
|   | men                    | women | men        | women |              |
| damage of the medial meniscus   | 8                      | 5     | 9          | 5     | 27           |
| damage of the anterior cruciate ligament                                    | 15                     | 8     | 16         | 8     | 47           |
| combination of damage of the medial meniscus and anterior cruciate ligament | 5                      | 2     | 5          | 3     | 15           |
| Total   | 28                     | 15    | 30         | 16    | 89           |



a



b

**Fig. 1.** General view of the device for the automatic development of movements in the knee joint

Development of movements with DADM was performed according to the following procedure: on the 2nd day after surgery (and 1st day of rehabilitation treatment) performed a survey and made a decision about the possibility of starting the development of movements in the KJ – 3 times for 5–10 minutes with a minimum rate of development of movements and an angle of flexion-extension in the joint from 5 to 15°; 2nd day of rehabilitation – 3–4 times for 15–20 minutes with minimum speed and volume of movements in the KJ from 10 to 25°; 3rd – 3–4 times for 40–50 minutes with minimum speed and volume of movements in the joint from 25 to 45°; in the following days the multiplicity (up to 6–7 times a day) and the development rate and duration (up to 2 hours per one session) were increased, and the volume of movements was adjusted to 70–90° (depending on the characteristics of the underlying disease and the intensity of the pain syndrome) [10; 11].

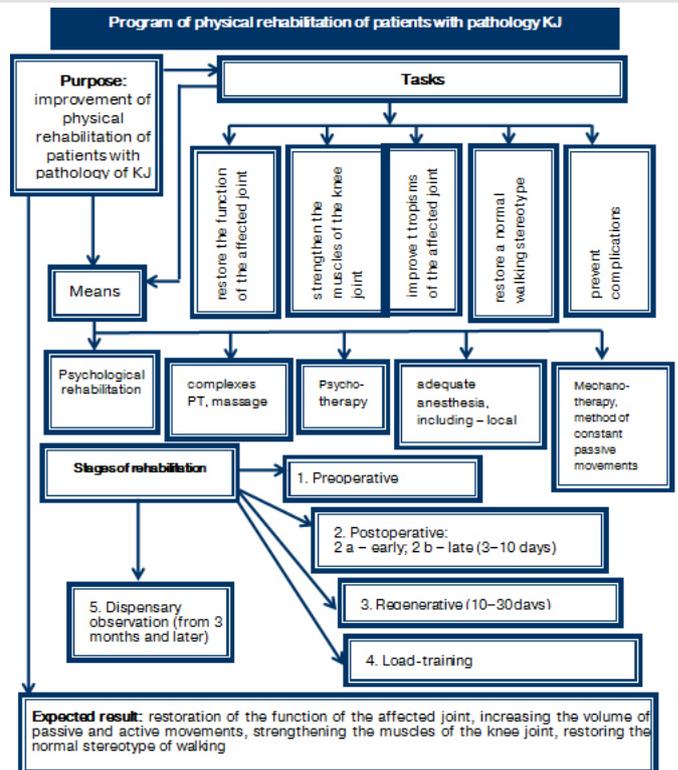
It should be noted that restorative treatment was carried out taking into account the psychological characteristics of patients:

- many patients had a negative psychological reaction to the “white coat”, and also a slight local pain in the development of movements without DADM often caused severe pain and myotonic reactions, with the development of rigidity of the operated and adjacent joints;

- when carrying out rehabilitation measures, there is a need for a constant reminder of the frequent and prolonged repetition of certain exercises or procedures and movements, etc., which in itself can cause a negative reaction.

A retrospective evaluation of clinical data and indices of instrumental research methods showed the positive effect of MCPM on the process of restoring the volume of movements in the joints in the main group as compared to the control group (Table 2).

Dynamics of recovery of the volume of movements in the joints was determined primarily by the initial condition of the joint and the severity of the pathology and, as can be seen from the data in Table 2, the volume of movements in the joints of both groups was approximately the same: before surgery – 81±4,5 in main group and 82±5,1 – in control; immediately after the intervention – 86±6,3 in main group and 85±5,5 – in



**Fig. 2. Program of physical rehabilitation of patients with KJ pathology using the method of permanent passive movements in the postoperative period**

control (data are given in% to the normal volume of movements, which is taken as 100%). 3 weeks after the first course of restorative treatment in the joints of the patients of the main group, the volume of movements in the joints increased to 97±2,5% of the norm, and in the control group – to 90±3,1%. In 3 months after the repeated course of restorative treatment in the control group of patients, the volume of movements averaged 96±2,4% of the norm, and in the main – 98 ± 1,6%, which demonstrates a clear tendency to a better volume of movements in the main group.

Comparing the intensity of the pain syndrome according to the VAS scale, we determine that the indices differ in two groups. Thus, in the control group before the treatment, pa-

**Table 2**

**Dynamics of indicators of the dynamics of pain syndrome, the volume of movements in the knee joints, the tone of the vessels of the lower extremities, and the degree of edema around the joint tissues in patients of the control and main groups, %**

| Indicators   | Distribution of indicators by maturity<br>(in brackets - the data of the control group) |                       |  |   |
|--|---|-----------------------|--|---|
|  | before treatment  | after treatment       | 3 weeks after the onset of restorative treatment | 3 months after the onset of restorative treatment |
| Volume of movements in the joint (in% to norm)   | 81±4,5<br>(82±5,1)  | 86±6,3<br>(85±5,5)    | 97±2,5*<br>(90±3,1)*                             | 98±1,6*<br>(96±2,4)*                              |
| Degree of pain syndrome by VAS (0 to 100)  | 75±10,5<br>(76±10,1)  | 51±9,5*<br>(49±11,5)* | 28±11,5*<br>(39±8,5)*                            | 23±10,5*<br>(33±9,5)*                             |
| Reduction of the degree of edema of tissues (in% of the opposite limb)                         | 33±5,5<br>(34±6,0)  | 37 ±6,5<br>(39±7,5)   | 15±4,5*<br>(24±5,5)*                             | 5±4,5*<br>(9±5,5)*                                |
| Tone of the vessels of the lower extremities (the elasticity index) (in% of the opposite limb) | 97±11,5<br>(96±7,5)   | 61±9,5*<br>(59±10,5)* | 81±10,5<br>(69±8,5)*                             | 93 ±7,0<br>(81±8,5)                               |

**Note.** \* – changes are reliable in comparison with the initial state, P>0,05.

tients noted a degree of pain syndrome by 76 units (possibly a discrepancy  $\pm 10,1$ ), which is 0.4% more than in the main group (75 units, possibly a discrepancy  $\pm 10,5$ ). After the rehabilitation treatment for 3 weeks after the intervention, a significant reduction in the pain syndrome in the main group was obtained in comparison with the control group, in the control group there was a reduction in the pain syndrome to 27 units in the main group and 39 – in control (possibly a discrepancy  $\pm 8,5$ ). After a second course of restorative treatment, the degree of pain syndrome is 19 units ( $\pm 6,5$  difference) in the main group and 33 units in the control group (discrepancy  $\pm 7,5$ ), the final difference in the VAS score is 14% reduction in pain in favor of the main group.

Analysis of the degree of edema of the tissue shows that in the control group for surgical treatment the degree of edema of the tissues in % to the opposite limb is 34%  $\pm 6,0$ , and the degree of edema of the tissues in % to the opposite limb in the main group was 33%  $\pm 5,5$ . After the treatment and the beginning of rehabilitation activities in the main group, edema of the limb was 37%  $\pm 6,5$ , in control; – 39%  $\pm 7,5$ . 3 weeks after the commencement of rehabilitation, there was a significant reduction in edema to 15%  $\pm 4,5$  in the main group and 24%  $\pm 5,5$  in the control group, which is 9% less in the main group when compared with the control group. A significant decrease in the degree of edema of the tissues in % to the opposite extremity occurred after 3 months after the onset of restorative treatment: in the main group – 5%  $\pm 4,5$  and in the control – 9%  $\pm 5,5$ ).

Analyzing the data of the study of the vascular tone of the lower extremities in % to the opposite extremity (elasticity index according to the data of rheovasography), the following data were demonstrated: before treatment in the main group – 91%  $\pm 11,5$  respectively in the control – 96%  $\pm 7,5$ ), after the surgical treatment, the reduction to 61%  $\pm 9,5$  and 59%  $\pm 10,5$  respectively, which is caused by low motor activity of patients.

After restorative treatment, improvement in the elasticity index up to 81%  $\pm 10,5$  in the main group and up to 69%  $\pm 8,5$  in the control. The results after 3 months of restorative treatment were 94%  $\pm 6,0$  and 81%  $\pm 8,5$ , respectively, with the difference between the main and the control group was 13%.

## Conclusions

1. Evaluation of the results of clinical data and instrumental research methods of the two groups shows that the method of continuous passive movement using domestic DADM devices in the complex physical rehabilitation of patients with pathology of the knee joints reliably leads to a reduction in the duration of rehabilitation, an increase in the volume of movements by an average of 7% in the immediate postoperative period (up to 3 weeks after the operation) compared with the control group, with a significant reduction in pain (according to the VAS scale, pain reduction is 14% in favor of the main group), myotonic and neurotrophic syndromes.

2. The expediency and high efficiency of using the developed domestic devices for the automatic development of joint movements in complex restorative treatment of patients with KJ pathology, which significantly improve the quality of life of patients in the first 3 weeks of the postoperative period, which allows them to be recommended for widespread use in clinical use at the stages of physical rehabilitation in rehabilitation centers and orthopedic and trauma units.

**Prospect for further research.** In this direction are the wide introduction of the method of continuous passive movement in the joints at the stages of physical rehabilitation in rehabilitation centers and orthopedic and traumatological units with the simultaneous establishment of industrial production of developed domestic devices for automatic development of movements.

**Conflict of interests.** The authors declare that no conflict of interest.

**Financing sources.** This article didn't get the financial support from the state, public or commercial organization.

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Received: 11.06.2017.  
Published: 31.08.2017.

## Information about the Authors

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**Olexander Korolkov:** *Doctor of sciences (Medical), Department of SI "Institute of Spine and Joint Pathology": street Pushkinskaya 80, Kharkiv, 61024, Ukraine.*

**ORCID.ORG/0000-0002-6791-1891**  
**E-mail: korolkovmd@gmail.com**

**Pavlo Bolkhovitin:** *PhD (Medical), Department of SI "Institute of Spine and Joint Pathology": street Pushkinskaya 80, Kharkiv, 61024, Ukraine.*

**ORCID.ORG/0000-0002-5207-3282**  
**E-mail: bolkhovitin@ukr.net**

**Anastasia Korolkova:** *Kharkiv National Medical University: Avenue of Science, 4, Kharkiv, 61000, Ukraine.*

**ORCID.ORG/0000-0002-5687-4861**  
**E-mail: caralis@gmail.com**

**Nasr Al-Kali:** *Lviv State University of Physical Culture: Street. Kosciuszko, 11, Lviv, 79000, Ukraine.*

**ORCID.ORG/0000-0003-3520-5797**  
**E-mail: nasr.alkali@yahoo.com**