ORIGINAL ARTICLE

Features of the use of physical exercises at the long-term stage of rehabilitation after intra-articular fractures

Sviatoslava Pashkevych[ABCDE], Tetiana Shutieieva[ABCDE], Olha Beziazychna[ABCDE]
Kharkiv State Academy of Physical Culture, Ukraine

Author contributions: A - Study design; B - Data collection; C - Qualitative analysis; D - Manuscript preparation; E – Funds Collection

Abstract

Background and Study Aim: The main demand after surgical treatment of the injury is to restore motor function and return to an active lifestyle. The inclusion of effective therapeutic exercises in the rehabilitation program will help to restore the physical activity of patients. The aim of the study is to develop and evaluate the effectiveness of a set of therapeutic exercises to restore the movements of the lower extremities of patients after surgery.

Material and Methods: The program involved 14 patients who were randomized (n=6 - control group, CG; n=8 - main group, MG). All patients gave their informed consent to participate in the experiment and to the processing of their personal data. It was used the following scales: "6 minute walk test", "Knee injury and Osteoarthritis Outcome Score" (KOOS). The International Classification of Functioning (ICF) categories were assessed and program objectives were set. Conducted individual classes according to the developed rehabilitation program in the MG and the generally accepted in the CG. After 2 months, the implementation of the goals set in the program was evaluated. Nonparametric statistics were used to determine differences between groups, Wilcoxon test for related sets, and Mann-Whitney criteria for independent sets. Values of $p < 0.05$ were considered significant.

Results: The goal of "Restore lower limb function" and "Ability to drive a car" was fulfilled in the MG and CG. Significant differences in the dynamics of KOOS subscales "Pain", "Symptoms and stiffness", "Quality of life" confirm this ($p < 0.05$). The goal "Ability to work in the backyard" was met only by MG patients. The distance traveled significantly improved in MG and CG ($p < 0.05$), but there was a significant difference between the comparison groups on this indicator ($p < 0.05$). The assessment of the scale of the KOOS "Sport" and "Active Recreation" subscales changed only for MG ($p < 0.05$) and at the end of the program differed significantly from the CG ($p < 0.05$). Category d850 "Paid work" significantly improved during the study period in MG ($p < 0.05$), with a significant difference between these indicators with CG. 2 of 6 CG patients (33.3 ± 21.1%) and 6 of 8 patients with MG (75.0 ± 16.4%) returned to previous work at $p < 0.05$.

Conclusions: It is recommended to perform exercises with an emphasis on the posterior surface of the lower extremity. The author's program of physical rehabilitation is quite conditional. Depending on the situation and condition of patients, adjustments are made. But the general direction and nature of the impact must be maintained.

Keywords: kinesitherapy, therapeutic exercises, electromiostimulation, recovery.

Introduction

Restoring patients' movements after surgery and returning them to proper physical activity is an important part of maintaining good health. Studies by different authors point to different perspectives on solving the problems of restoring patients' movements. Birtwistle et al. [1] emphasizes the mandatory participation of family members in the restoration of lost functions. Hei Chow et al. [2] recommend monitoring the daily physical activity of patients. Another study [3] suggests using the recommendations of an exercise specialist. The authors note that this may lead to clinically significant benefits for quality of life and may affect some people's intention to engage in physical activity. Ng et al. [4] consider physical activity as a possible behavioral and rehabilitation strategy to improve quality of life related to health. Other studies [5-7] also emphasize the importance of rehabilitation measures using exercise and moderate exercise.

Closed knee joint injuries are quite common and form about 70% of all injuries of the musculoskeletal system [8, 9]. Prolonged dysfunction of the knee joint in most cases leads to muscular malnutrition, gait stereotype, limitation of active lifestyle [10, 11]. Byun et al. [12] assessed the frequency, type, and risk factors for knee injuries associated with femoral fractures. The authors found that 30% of fractures of the femur revealed knee injuries. Therefore, one needs to be careful because knee injuries may be accompanied by ipsilateral bone fractures. Another study [13] reported that intra-

doi:10.15561/health.2022.0103

articular tibial fractures can cause treatment-related problems. The authors propose a new device that provides double retraction in combination with MIPPO technology. This device gives a lower load than a traditional traction table. Zhao et al. [14] studied the epidemiological characteristics of large intra-articular fractures. The study revealed age and gender epidemiological characteristics of large intra-articular fractures, which became the basis for clinical assessment and practice.

The most pressing issue for the patient is the restoration of limb function after these injuries and return to active life [15]. Golovakha et al. [10] notes that therapeutic exercise programs may include: amplitude, strength, and intensive functional exercises; exercises for proprioception; feedback exercises; exercises in water. There are programs that additionally use hardware physiotherapy (electrical stimulation, interference currents), wearing hinged orthoses, passive joint development, manual correction and taping [10]. However, the available evidence confirms that only electrotherapy and exercise play a significant role in overcoming the effects of postoperative knee stiffness [15, 16]. The authors found that exercise under the supervision of a physical therapist is much more effective than home treatment. This is confirmed by the study of Hartley et al. [17]. The authors found that one-sided intensive exercise is a possible intervention to reduce the risk of hip fractures in healthy women. Hobusch et al. [18] recommend four to seven sports after surgery, depending on the type of surgery on the thighs or knees. Timpka et al. [19] studied injuries in football. The authors found that knee ligament injury was observed in 20% of adolescents (13-17 years of age) and 34% of adults (18-29 years of age). The authors recommend following the rules of the game and behavior on the field when playing football.

Therefore, kinesitherapy programs for patients after surgical treatment of intra-articular knee fractures still do not have a "gold standard". Therefore, the problem of determining effective therapeutic exercises depending on the rehabilitation period is relevant.

The hypothesis of the study was that the emphasis on exercises to strengthen the muscles of the posterior surface of the lower extremity will change the stereotype of walking. This will have advantages over the standard recovery approach.

The aim of the work is to develop and evaluate the effectiveness of a set of therapeutic exercises to restore the movements of the lower extremities of patients after surgery.

Material and Methods

Participants.

The program was attended by men after surgical treatment of intra-articular fracture of the distal femur (n=14, age - 35-65 years). Participants were randomly divided into two groups: control group (CG, n=6); main group (MG, n=8). All participants gave their informed consent to participate in the experiment and to the processing of their personal data. All of the procedures were in accordance with the Helsinki Declaration of 2021. This study was approved by Academy Ethics Committee for research on human participants.

Research Design.

It was used the following scales: "6 minute walk test", "Knee injury and Osteoarthritis Outcome Score (KOOS)". The International Classification of Functioning (ICF) was assessed and program objectives were set.

In patients with long-term dynamics, the structures according to the relevant categories and qualifiers of ICF were studied:

- s750 "Structure of the lower extremity";
- b280 "Feeling of pain";
- b710 "Joint mobility functions"
- d450 "Walking";
- d475 "Driving";
- d640 "Housekeeping";
- d850 "Paid work";
- d855 "Unpaid work".

Based on the ICF categories, program goals were formed depending on the individual needs of patients: to restore the function of the lower extremity, the ability to drive a car, work in the backyard and return to work.

The physical therapy program included 15-16 sessions within 2 months after the early and late postoperative periods. The program consisted of kinesitherapy and electromiostimulation. Patients of the main group were engaged in the developed program of physical rehabilitation. The program focused on the muscles of the posterior surface of the lower extremity and included all types of exercises of CG: exercises on a block simulator, lunges, overcoming stairs, dynamic balance exercises, exercises for torso stability, plyometric and cyclic exercises (exercise bike, running, graduated exercises, specific for each sporting activity). Electromiostimulation was used for hamstrings and quadriceps in MG and only quadriceps in CG.

Statistical Analysis.

The SPSS 11.0 program was used. Mean, standard deviation, and percentage frequencies were used for descriptive data analysis. To assess the difference in dynamics, the Wilcoxon test was determined, for the independent – Mann-Whitney. The level of reliability was chosen $p < 0.05$.

Results

In the dynamics of 2 months, the fulfillment of the goals set in the program "Restore lower extremity

function" was assessed and corresponded to two ICF categories: b280 "Feeling a pain" and b710 "Joint mobility functions" (Table 1). The assessment was based on the Knee injury and osteoarthritis outcome score (KOOS) scale. These criteria improved in almost all patients of MG and CG ($p < 0.05$). "Pain assessment" on the "Pain" subscale has improved in MG and CG. According to the estimates of the subscale "Symptoms and stiffness", joint mobility increased ($p < 0.05$ in the dynamics in both groups). No difference in these indicators was found between the comparison groups.

The goal of "Ability to drive a car" was achieved in all patients in both groups. At the beginning of the qualification assessment program, severe impairment of performance and ability was shown in almost all patients. Category d475 "Driving" was evaluated according to the results of KOOS subscales "Daily activity" and "Quality of life". During the program, the ratings of the "Daily Activity" subscale, which were high from the very beginning, have hardly changed. The assessment of the subscale "Quality of Life" increased significantly ($p < 0.05$). No difference in these indicators was found between the comparison groups. The qualifier had grades - mild and moderate violations.

The goal of "Ability to work in the backyard" was met only by patients of MG. Qualifiers of categories d450 "Walking", d640 "Housekeeping", d855 "Unpaid work" in MG improved by 1-2 points from severe and moderate performance disorders to mild and absent. In the CG, only the d450 "Walking" score had changes in the scores. The categories were evaluated based on the results of the 6-minute walk test and the KOOS "Sports and active recreation" subscale. The distance traveled was significantly improved in MG and CG ($p < 0.05$). However, there was a significant difference between the comparison groups on this indicator ($p < 0.05$). The assessment of the KOOS subscale scale "Sports and active recreation" changed only in MG ($p < 0.05$). This indicator at the end of the program differed significantly from the CG ($p < 0.05$). The difference between MG and CG was established for two categories (d640, d855). Positive changes in productivity occurred in 1 of 6 patients from CG (16.7 ± 16.7%) and in 7 of 8 people from MG (87.5 ± 12.5%).

The goal of "Return to work" is a derivative of human participation in public life and is most important for human rehabilitation. Category d850 "Paid work" significantly improved during the study period in MG ($p < 0.05$). According to this indicator, the CG has not undergone significant changes. 2 of 6 patients of CG (33.3 ± 21.1%) and 6 of 8 patients of MG (75.0 ± 16.4%) returned to previous work.

Discussion

The hypothesis of the study was that the emphasis on the muscles of the posterior surface of the lower extremity will change the stereotype of walking and increase the activity and participation of patients compared to the standard approach to recovery. KOOS and the 6-minute walk test, which can characterize most of ICF criteria, were selected as performance criteria. These criteria are violated after a knee injury. This statement coincides with many studies of medium-term results [20, 21]. Data on KOOS subscales at the beginning of the program were not similar to identical estimates by Fändriks et al. [22]. The subscales "Daily Activity", "Quality

Table 1. Evaluation of the effectiveness of rehabilitation based on the results of achieving the goals

Aim	Groups	Subscale of KOOS "Pain", %		Subscale of KOOS " Symptoms and stiffness ", %	
		at the beginning of the program	at the end of the program	at the beginning of the program	at the end of the program
"Restore lower extremity function" (b280 "Feeling a pain", b710 "Joint mobility functions")	MG	72.9±9.7	91.5±10.6	62.8±10.3	83.9±11.5
	CG	73.1±10.8	91.8±11.7	62.9±10.4	81.8±10.7
"Ability to drive a car" (d475 "Driving")		Subscale of KOOS "Daily activity", %		Subscale of KOOS "Quality of life", %	
	MG	93.0±8.7	95.3±9.1	70.1±10.8	89.8±9.4
	CG	95.2±9.8	95.9±9.7	73.1±11.3	90.9±10.7
"Ability to work in the backyard" (d450 "Walking", d640 "Housekeeping", d855 "Unpaid work")		Subscale of KOOS "Sports and active recreation", %		Distance in 6-minute walk test, m	
	MG	50.0 ± 6.9	77.6± 8.3	453±31	674±55
	CG	55.8 ± 5.7	57.6± 5.3	480±43	546±65

Note: CG - control group; MG - main group.

of Life" and "Sports and Active Recreation" were rated much lower than in our study. In our opinion, this may be due to cultural differences. After 2 months of the program, the results of all subscales significantly improved. The exception was the subscale "Daily activity" (the scale had high initial values). This indicates the effectiveness of long-term rehabilitation and coincides with the results of other studies [11].

The results of the 6-minute walk test at the beginning of the program also coincide with the results of Fändriks et al. [22]. At the end of the study, the results of MG patients correspond to the mean values in the population.

An important result of this study was the fulfillment of the "Return to Work" goal by the majority of MG patients. This fact is relevant for men of working age. The control group had lower results. These results were similar to those of other researchers [21]. According to Kraus et al. [21] a significant number (9/23.1%) of patients reported difficulties with work. As a result, five employees were forced to switch to less physical work and four patients to reduce the number of working hours per week (10.5 hours/week). That is, kinesitherapy with an emphasis on exercises for the posterior surface of the lower extremity in the long-term stage of rehabilitation may be recommended to increase the likelihood of returning to the previous load.

In our opinion, our kinesitherapy program is clinically sound. But there are some limitations to this study. It was attended by men of working age (small sample) who lived in the private sector. Therefore, further research is needed.

Conclusions. Practical recommendations

The dynamics of many of the studied indicators showed positive changes in patients in both groups. Therefore, we may recommend performing exercises with an emphasis on the posterior surface of the lower extremity. These include exercises on the block simulator, lunges, climbing stairs, exercises on the step platform, dynamic balance exercises, exercises for torso stability, plyometric and cyclic exercises, exercises with a rubber shock absorber (lying on back, lying on side, lying on stomach; sitting on the floor, sitting on a chair). As the knee joint recovers, the following should be considered: the type and nature of the exercise; the amount of load and resistance; number of repetitions of exercises; speed of overcoming and yielding movements; number of repetitions of the exercise; the nature and duration of rest intervals between approaches.

It should be noted that the developed and implemented physical rehabilitation program is quite conditional. Depending on the situation and condition of patients, adjustments are made. But the general direction and nature of the impact must be maintained.

Conflict of interests

The authors declare there are no competing interests.

References

1. Birtwistle SB, Jones I, Murphy R, Gee I, Watson PM. "Do what you can with a happy heart": a longitudinal study of patient and family members' lived experiences of physical activity post-myocardial infarction. *Disability and Rehabilitation*, 2021:1–10. https://doi.org/10.1080/09638288.2021.1878560
2. Hei Chow C, Fraysse F, Hillier S. The relationship between sleep and physical activity in an in-patient rehabilitation stroke setting: a cross-sectional study. *Topics in Stroke Rehabilitation*, 2021:1–10. https://doi.org/10.1080/10749357.2021.2006982
3. Fox L, Wiseman T, Cahill D, Fleure L, Kinsella J, Curtis E, et al. Effect of a brief physical activity-based presentation by a former patient for men treated with radical prostatectomy for prostate cancer: a mixed methods pilot study. *Supportive Care in Cancer*. 2021;29(1):145–154. https://doi.org/10.1007/s00520-020-05455-4
4. Ng S, Fung MHY, Chan JSM, Chan CHY, Chan CLW. Physical activity, confidence and quality of life among cancer patient-carer dyads. *Sports Med - Open*, 2021;7:46. https://doi.org/10.1186/s40798-021-00333-7
5. Gluck S, Summers MJ, Finnis ME, Andrawos A, Goddard TP, Hodgson CL, et al. An observational study investigating the use of patient-owned technology to quantify physical activity in survivors of critical illness. *Australian Critical Care*. 2020;33(2):137–143. https://doi.org/10.1016/j.aucc.2019.01.009
6. Manfredini F, Lamberti N, Battaglia Y, Straudi S, Belvederi Murri M, Donadi M, et al. A Personalized Patient-Centered Intervention to Empower through Physical Activity the Patient in the Dialysis Center: Study Protocol for a Pragmatic Nonrandomized Clinical Trial. *Methods and Protocols*, 2020;3:83. https://doi.org/10.3390/mps3040083
7. Ding H, Gonzalez-Garcia M, Varnfield M, Krumins A, Martin Y, Bourke F, et al. Limited functional capacity and physical activity associated with patient withdrawals from cardiac rehabilitation. *European Heart Journal*. 2019;40:3826–3826.
8. Beziazychna OV, Litovchenko VO, Pustovojt BA. Physical rehabilitation program for patients after arthroscopically controlled reconstruction of the anterior cruciate ligament. *Aktual'ni pitannia likuvannia patologii suglobiv ta endoprotezuvannia,* 2019;1:9–10. (In Ukrainian).
9. Bur'ianov OA, Iarmoliuk IuO, Vakulich MV. Optimization of rehabilitation treatment of victims with multiple fractures of long bones. *Kharkivs'ka khirurgichna shkola,* 2016;4(79):76–81. (In Ukrainian).

10. Golovakha ML, Nerianov IuM, Ivchenko DV. *General issues of traumatology and orthopedics*. Zaporizhzhia; 2016. (In Ukrainian).
11. Mukhin VM. *Physical rehabilitation in traumatology*. Lviv: LSUPC; 2015. (In Ukrainian).
12. Byun SE, Shon HC, Park JH, Oh HK, Cho YH, Kim JW, et al. Incidence and risk factors of knee injuries associated with ipsilateral femoral shaft fractures: A multicentre retrospective analysis of 429 femoral shaft injuries. *Injury-International Journal of the Care of the Injured*. 2018;49(8):1602–1606. https://doi.org/10.1016/j.injury.2018.06.006
13. Li D-Q, Song D-Y, Ni J-D, Ding M-L, Huang J. A case report of Schatzker type VI tibial plateau fracture treated with double reverse traction closed reduction combined with minimally invasive percutaneous plate osteosynthesis technique: A case report. *Medicine*, 2017;96:e8394. https://doi.org/10.1097/MD.0000000000008394
14. Zhao WG, Zhu YB, Ma JT, Yan XL, Zhang YZ. Age- and Gender-Specific Epidemiologic Characteristics of Major Intra-Articular Fractures: Five-Year Data from a Level 1 Trauma Center. *Orthopaedic Surgery*. 2021;13(3):900–907. https://doi.org/10.1111/os.12937
15. Laprade Robert F, O'Brien Luke, Chahla Jorge, Kennedy Nicholas I. *The Knee Injury Bible: Everything You Need to Know about Knee Injuries, How to Treat Them, and How They Affect Your Life*. Lifelong Books; 2019.
16. Kumar R, Kaushal K, Kaur S. Role of physiotherapy in post-operative knee stiffness: A literature review. *AdeshUniv J MedSciRes.* 2020. № 2(1). P. 31–35.
17. Hartley C, Folland JP, Kerslake R, Brooke-Wavell K. High-Impact Exercise Increased Femoral Neck Bone Density With No Adverse Effects on Imaging Markers of Knee Osteoarthritis in Postmenopausal Women. *Journal of Bone and Mineral Research*. 2020;35(1):53–63. https://doi.org/10.1002/jbmr.3867
18. Hobusch GM, Keusch F, Tsuchiya H, Joyce M, Windhager R. What Opinions Do Tumor Reconstructive Surgeons Have about Sports Activity after Megaprosthetic Replacement in Hip and Knee? Results of the MoReSports Expert Opinion Online Survey. *Journal of Clinical Medicine*, 2020;9:3638. https://doi.org/10.3390/jcm9113638
19. Timpka T, Schyllander J, Ekman DS, Ekman R, Dahlstrom O, Hagglund M, et al. Community-level football injury epidemiology: traumatic injuries treated at Swedish emergency medical facilities. *European Journal of Public Health*. 2018;28(1):94–99. https://doi.org/10.1093/eurpub/ckx053
20. Beziazychna O, Pashkevych S. Features of physical therapy for intra-articular fracture of the knee joint at the long-term stage of rehabilitation. *Fizichna kul'tura i sport. Vikliki suchasnosti,* 2021;1:5–9. (In Ukrainian).
21. Kraus TM, Abele C, Freude T, Ateschrang A, Stöckle U, Stuby FM, et al. Duration of incapacity of work after tibial plateau fracture is affected by work intensity. *BMC Musculoskelet Disord*, 2018;19:281. https://doi.org/10.1186/s12891-018-2209-1
22. Fändriks A, Tranberg R, Karlsson J, Möller M, Zügner R. Gait biomechanics in patients with intra-articular tibial plateau fractures – gait analysis at three months compared with age- and gender-matched healthy subjects. *BMC Musculoskelet Disord*, 2021;22:702. https://doi.org/10.1186/s12891-021-04577-y

Information about the authors:

Sviatoslava Pashkevych; (Corresponding Author); Candidate of Medical Sciences, Associate Professor; https://orcid.org/0000-0002-4842-4350; sviatoslava.pashkevych@gmail.com; Kharkiv State Academy of Physical Culture; Kharkiv, Ukraine.

Tetiana Shutieieva; Senior Lecturer; https://orcid.org/0000-0002-3212-0432; stn150371@gmail.com; Kharkiv State Academy of Physical Culture; Kharkiv, Ukraine.

Olha Beziazychna; Senior Lecturer; https://orcid.org/0000-0001-9987-6405; obezyazychnaya@gmail.com; Kharkiv State Academy of Physical Culture; Kharkiv, Ukraine.

Cite this article as:
Pashkevych S, Shutieieva T, Beziazychna O. Features of the use of physical exercises at the long-term stage of rehabilitation after intra-articular fractures. *Pedagogy of Health,* 2022;1(1):18–22. https://doi.org/10.15561/health.2022.0103

Received: 25.05.2021
Accepted: 25.06.2021; Published: 18.01.2022