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The role of preoperative kinetic physical treatment in patients with complete rupture of the anterior cruciate ligament

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Abstract

Introduction: The present research has highlighted the role of preoperative kinetic physical therapy in patients with complete rupture of the anterior cruciate ligament.

Material and method: The study took place at the *Fizionova* Medical Recovery Center in Târgu Mureş, for 12 weeks, between November 2020 and March 2021, on a sample of 20 subjects, aged between 21 and 45 years. The inclusion criterion was the anterior cruciate ligament reconstruction surgery. The research methods were largely experimental. Statistical analysis included elements of descriptive statistics (mean, median, standard deviation) and elements of inferential statistics. The Shapiro-Wilk test was applied to determine the distribution of the analyzed data series. For the comparison of means, the t-Student test for unpaired data was applied. For the comparison of medians, the Mann-Whitney test was applied for unpaired data.

Results: The experimental group regained its knee flexion degrees earlier than the control group following the preoperative kinetic physical treatment.

Conclusion: Our investigation concluded that immediate postoperative recovery has significant importance on the knee's functionality, which is much more challenging to recover in case of prolonged immobilization.

Key words*: physical kinetic treatment, anterior cruciate ligament, physical therapy.*

Rezumat

Introducere: Cercetarea de faţă a evidenţiat a evidenţia rolul tratamentului fizical kinetic preoperator în cazul pacienţilor cu ruptură completă a ligamentului încrucişat anterior.

Material şi metodă: Studiul a avut loc la Centrul de Recuperare Medicală *Fizionova* din Târgu Mureş, pe o durată de 12 săptămâni, între luna noiembrie a anului 2020 şi luna martie a anului 2021, pe un eşantion de 20 subiecţi cu vârsta cuprinsă între 21 şi 45 ani. Criteriul de includere a fost intervenţia chirurgicală de reconstrcuţie a ligamentului încrucişat anterior. Metodele de cercetare utilizate au fost preponderent experimentale. Analiza statistică a cuprins elemente de statistică descriptivă (media, mediana, deviatia standard) şi elemente de statistică inferenţială. Testul Shapiro-Wilk a fost aplicat in vederea determinării distribuţiei seriilor de date analizate. Pentru compararea de medii, am aplicat testul t-Student pentru date nepereche. Pentru compararea medianelor a fost aplicat testul Mann-Whitney pentru date nepereche.

Rezultate: În urma tratamentului fizical kinetic preoperator, lotul experimental şi-a redobândit gradele de flexie a genunchiului mai precoce, comparativ cu lotul control.

Concluzii: Concluziile investigaţiei noastre au evidenţiat că recuperarea postoperatorie imediată are o importanţă majoră asupra funcţionalităţii genunchiului, aceasta redobândindu-se mai mult mai greu în cazul unei imobilizări prelungite.

Cuvinte cheie*: tratamentul fizical kinetic, ligamentul încrucişat anterior, kinetoterapie.*

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Introduction

People with various pathologies or injuries may need rehabilitation throughout their lives. The timing and type of intervention a rehabilitation therapist selects depends on several factors, including the etiology and severity of the person's condition, prognosis, how it affects the person's ability to function in the environment, and the individual's identified personal goals [1], [2], [3].

Damage to the articular cartilage has an inherently limited healing potential, so it remains a complex problem. Due to hypocellularity and vascularization, the articular cartilage has a limited capacity to regenerate after its injury. In this respect, the conservation and wellbeing of articular cartilage are imperative for joint wellbeing. Sports and recreational activities can usually cause cartilage joint injuries, and their non-treatment leads, over time, to osteoarthritis [4].

Anterior cruciate ligament lesions often lead to joint spillage, altered knee and gait kinematics, muscle weakness, and reduced functional performance, associated with long-term clinical sequelae such as meniscal lesions, chondral lesions, and development of early-onset post-traumatic osteoarthritis [5].

ACL ruptures often occur with other concomitant ligament injuries, meniscus ruptures, bone marrow injuries, articular cartilage injuries, and intra-articular fractures. The rates of concomitant lesions of the lateral collateral ligament (LCL) and posterior cruciate ligament (PCL) are generally low, while the concomitant lesions of the medial collateral ligament (MCL) and meniscal ruptures are common (prevalence of 30% and 42%, respectively) [6].

The goals of management for a person with an ACL rupture are: (1) restoring the knee function, (2) addressing psychological barriers to resuming daily activities, (3) preventing other knee injuries and reducing the risk of osteoarthritis of the knee, and (4) optimizing the quality of life in the long run. Active young adults poorly tolerate the conservative treatment of ACL lesions. This often leads to recurrent instability and development of chondral and meniscal lesions [7].

A study identified by reviewers found that 39% of randomized participants in the nonoperative treatment group underwent anterior cruciate ligament reconstruction for continued knee instability or meniscus repair within two years of ACL rupture, while 51% did this within five years. [8]

In the technique of anterior cruciate ligament reconstruction, there are several debates between surgeons and orthopedic researchers. Specifically, the timing of repair and rehabilitation, and the type of graft used are areas of conflict [9].

Allograft versus autograft has also been a subject of controversy. As regards the type of intervention, the description of the double-packaged technique created expectations for a more anatomical technique, but there are disputes about the validity of this statement [10].

The allograft options for LIA reconstruction are the patellar, Achilles, and tibial tendon. The main advantages of allografts are the lack of morbidity at the donor site, the shorter surgical time, and the guarantee of adequate graft tissue. In contrast, allografts are associated with the risk of disease transmission, potentially delayed incorporation, and the immune response, while increased costs may also be a concern [10].

The timing of reconstruction of the anterior tangled ligament may influence rehabilitation outcomes, as it has been associated with delays in quadriceps recovery, as well as a loss of range of motion. Several articles demonstrate reduced quadriceps resistance at several intervals after early ligament reconstruction (post-accidental days 0–7) compared to delayed reconstruction (post-injury days 8–21), as well as significant losses in the terminal extension of the knee [11], [12].

This highlights an increasing trend in the use of preoperative rehabilitation. Preoperative rehabilitation should maintain quadriceps strength and knee movement, as deficiencies in both parameters are associated with poorer functional outcomes [11], [12].

For patients intending to undergo surgery, preoperative rehabilitation should be performed to improve post-surgical outcomes. Restoration ought to start as before long as conceivable after the conclusion. Preoperative rehabilitation follows the principles of acute and intermediate rehabilitation (described below), but deficits in the passive movement of knee extension and quadriceps strength should be specifically targeted, as these factors are associated with poor postoperative outcomes [13].

The risk of sports injury increases with the sudden increase in load (combining intensity and frequency of participation). Proper load management can also be used to reduce the risk of injury to the knee and other parts of the body [14].

Also, living a healthy lifestyle [15], [16] and controlling the body mass index [17] can also help in the prevention of accidents in sports.

Material and method

The hypothesis of the research

Following the reconstruction of the anterior cruciate ligament surgery, the patients who benefited, in the preoperative period, from a personalized recovery program for six weeks, developed by us, reached the optimal degrees of flexion faster, having a better functionality of the knee, compared to patients who received only the postoperative kinetic recovery program.

Objectives of the research

The main objective of this study was to demonstrate the importance of preoperative recovery programs in patients with complete rupture of the anterior cruciate ligament, regain the degree of flexion, and reduce postoperative pain after the reconstruction of the anterior cruciate ligament.

Methods of research

This research included 20 patients who underwent surgical treatment of the anterior cruciate ligament.

All patients followed the same postoperative kinetic recovery protocol, except that 10 of them underwent preoperative kinetic physical therapy for six weeks.

The computer program used: Microsoft Office– Microsoft Excel, Microsoft Word.

Equipment used: Compex SP 8.0; Cryopush cryotherapy and compression system; Arthromot; Bicycle; Elastic bands; BOSU ball; Fitness ball;

Place and period of the research:

The research was carried out over 12 weeks, between November 2020 and March 2021 and took place at Fizionova Târgu-Mureş Medical Recovery Center.

Group of subjects and inclusion/exclusion criteria:

The research included a total of 20 subjects with anterior cruciate ligament reconstruction. All patients in the study received approval from the specialist to participate in the preoperative and/or postoperative kinetic recovery program.

The group of subjects was divided as follows: 10 patients made up the experiment group, and the other 10 made up the control group. Patients in the first group had a kinetic recovery program for six weeks in the preoperative period and a kinetic postoperative recovery program to regain flexion and pain relief. The other subjects benefited from the same postoperative recovery program, but without performing the preoperative recovery program.

The group included 20 patients, 12 males, 8 females, aged between 21 and 45 years. The inclusion criterion was the anterior cruciate ligament reconstruction surgery.

Statistical analysis

The statistical analysis included elements of descriptive statistics (mean, median, standard deviation) and elements of inferential statistics. The Shapiro-Wilk test was applied to determine the distribution of the analyzed data series. For the comparison of means, the t-Student test for unpaired data was applied. For the comparison of medians, the Mann-Whitney test was applied for unpaired data. The significance threshold chosen for p was 0.05. The statistical analysis was performed using the GraphPad Prism 9 utility trial version.

Table 1. Pre- and postoperative programs

	Preoperative recovery program
Week I	Dorsal/Plantar flexion; Isometric contractions of the quadriceps; Flexion of the lower limb in the hip joint; Abduction of the lower limb from the hip joint; Abduction of the lower limb from the hip joint with resistance; Extension of the knee joint on the roller; Cryotherapy.

Week 2	Isometric contractions of the quadriceps; Plantar/dorsal flexion; Flexion + abduction of the lower limb from the coxofemoral joint with resistance; Flexion of the lower limb from the hip joint – isometry; Abduction of the lower limb from the hip joint – isometry; From ventral decubitus: extension of the lower limb from the hip joint; From ventral decubitus: extension of the lower limb from the coxofemoral joint with resistance; From lateral decubitus: flexion of the lower limb from the coxofemoral joint with resistance; From lateral decubitus: abduction of the lower limb from the coxofemoral joint with resistance; Cryotherapy.
Week 3	Flexion + abduction of the lower limb from the coxofemoral joint with resistance; Flexion + abduction of the lower limb from the coxofemoral joint with resistance-isometry; Pool lifts; Pool lifts with a ball with a circumference of 30 cm; Knee flexion, the heel remains on the bed; Sitting: knee extension; Sitting: flexion of the hip joint with the knee flexed; Sitting: abduction of the hip joint with the knee bent; Sitting: ball adductions with a circumference of 30 cm; Cryotherapy.
Week 4	From sitting position: knee extension with resistance; Sitting: flexion + abduction of the hip joint with the knee bent – isometry; From orthostatic position, with truss support: flexion of the lower limb in the hip joint; From orthostatic position, with truss support: abduction of the lower limb from the hip joint; From orthostatic position, with truss support: extension of the lower limb from the hip joint; Semi-squats; From the semi-flexion position: adductions with the ball between the knees; From orthostatic position, with truss support: triple flexion; Cryotherapy.
Week 5	From orthostatic position, with truss support: flexion + abduction + extension of the hip joint; From orthostatic position, with truss support: flexion + abduction + extension of the hip joint-isometry; Semi-squats with placement on the box; Semi-squats-isometry; Triple flexion with knee extension, with trellis support; From orthostatic position, with trellis support, with slightly bent knees, and truss support: abductions from the hip joint; From orthostatic position, with slightly bent knees, and truss support: extensions from the hip joint; Lifts on trestle tops; Cryotherapy.
Week 6	Bicycle; Semi-squats; Semi-squats isometry; Castings; Bending-isometry; Lateral movement with resistance; Lifts on tops from the semi-flexion position; Knee extension at the press; Cryotherapy.
Postoperative recovery program	
Week I	Mobilization of the patella; Electrical muscle stimulation; Dorsal/Plantar flexion; Isometric contraction of the quadriceps; Flexion of the lower limb in the hip joint; Cryotherapy.
Week 2	Mobilization of the patella; Electrical muscle stimulation; Dorsal/Plantar flexion; Isometric contraction of the quadriceps; Flexion of the lower limb in the hip joint; Abduction of the lower limb from the hip joint; Flexion of the lower limb from the hip joint-isometry; Abduction of the lower limb from the hip joint-isometry; Cryotherapy.
Week 3	Electrical muscle stimulation; Dorsal/Plantar flexion; Isometric contraction of the quadriceps; Flexion + abduction of the lower limb from the hip joint; Flexion + abduction of the lower limb from the hip joint-isometry; From ventral decubitus: extension of the lower limb from the hip joint; From lateral decubitus: flexion of the lower limb from the hip joint; From lateral decubitus: abduction of the lower limb from the hip joint; From lateral decubitus: extension of the lower limb from the hip joint; From supine position with the ball between the ankles: adductions of the lower limbs from the hip joint; Cryotherapy.
Week 4	Isometric contraction of the quadriceps; From supine position: flexion + abduction of the lower limb from the hip joint-isometry; From lateral decubitus: flexion + abduction + extension of the hip joint-isometry with resistance; From ventral decubitus: extension of the lower limb from the hip joint-isometry; Knee flexion, the heel remains on the bed; Arthromot-assisted passive flexion; Pool lifts; From supine position: knee extension; Cryotherapy.
Week 5	From orthostatic position, with truss support: flexion of the lower limb in the hip joint; From orthostatic position, with truss support: abduction of the lower limb from the hip joint; From orthostatic position, with truss support: extension of the lower limb from the hip joint; From orthostatic position, with truss support: flexion + abduction + extension of the hip joint; Walking on the back belt; From orthostatic position, with truss support: triple flexion; Semi-squats with placement on the box; From sitting position: knee extension; From sitting position: knee extension-isometry; Cryotherapy.

Week 6	From sitting position: knee extension, with ankle weights; From orthostatic position, with truss support: flexion + abduction + extension of the hip joint-isometry; Knee extension from resistance orthostatic position; Triple flexion with knee extension, with trellis support; Semi-squats; Semi-squats-isometry; Knee extension at the press; Lateral movements; Peak lifts; Cryotherapy.

Results

Table 2. Results of the control group

Subjects	Age	Gender	Flexion in the 3rd week postoperatively	Flexion in the 6th week postoperatively
M.L.	40	M	91°	110°
B.D.	24	F	89°	108°
O.A.	26	M	94°	115°
A.R.	30	M	90°	105°
T.A.	21	F	88°	103°
B.F.	41	M	93°	112°
M.R.	25	F	94°	112°
S.E.	31	M	87°	105°
R.I.	30	M	92°	110°
F.P.	38	M	89°	107°

Table 3. Results at the experimental group

Subjects	Age	Gender	Flexion in the 3rd week postoperatively	Flexion in the 6th week postoperatively
G.E.	45	M	97°	120°
C.I.	24	F	95°	118°
C.D.	26	F	92°	117°
M.D.	43	F	97°	120°
N.R.	35	M	93°	117°
M.T.	29	F	98°	118°
T.S.	37	M	94°	115°
F.E.	22	M	96°	115°
P.P.	44	M	92°	118°
G.H.	25	F	99°	120°

The experimental group was also given the VAS scale, the pain scale, at 3 and 6 weeks after surgery to monitor the analgesic effect of the treatment and the evolution of pain in subjects.

The VAS scale assesses pain by identifying the degree of pain according to its intensity, namely from level 0 (no pain) to 10 (the most significant possible pain).

According to the pain measurement scale, following the preoperative physical kinetic treatment, the experimental group had a lower pain than the control group.

Table 4. VAS scale results - control group (CG) and experiment group (EG)

Subjects	Age	Gender	VAS week 3 - CG	VAS week 6 - CG	VAS week 3 - EG	VAS week 6 - EG
M.L.	40	M	8	5	6	3
B.D.	24	F	7	4	5	3
O.A.	26	M	7	3	7	4
A.R.	30	M	8	5	5	2
T.A.	21	F	8	4	6	3
B.F.	41	M	8	5	6	2
M.R.	25	F	6	4	5	2
S.E.	31	M	5	3	3	0
R.I.	30	M	7	5	5	1
F.P.	38	M	6	5	4	1

Statistical interpretation

Table 5. Value of P regarding age

Age	Experiment group	Control group
Number of values	10	10
Median	32,00	30,00
Mean	33,00	30,60
Std. Deviation	8,919	6,995
Unpaired t-test		
P value	0,5116	

The t-Student test shows that there is no statistically significant difference between the mean ages in the two groups (p> 0.05).

Table 6. P-value of the third week postoperatively

Third week postoperatively	Experiment group	Control group
Number of values	10	10
Median	95,50	90,50
Mean	95,30	90,70
Std. Deviation	2,497	2,497
Unpaired t-test		
P value	0,0006	

In the T-Student test, p <0.05, meaning there is a statistically significant difference between the mean values of the degree of flexion in week III, postoperatively, in the 2 groups.

Table 7. P-value of the sixth week postoperatively

Sixth week postoperatively	Experiment group	Control group
Number of values	10	10
Median	118,0	109,0
Mean	117,8	108,7
Std. Deviation	1,874	3,773
Unpaired t-test		
P-value	P<0.0001	

In the T-Student test, p <0.05, meaning there was a statistically significant difference between the mean values of the degree of flexion in week VI, postoperatively, in the 2 groups.

Table 8. Results of the VAS score in week III postoperatively

VAS week III postoperatively	Experiment group	Control group
Number of values	10	10
Median	5,000	7,000
Mean	5,200	7,000
Std. Deviation	1,135	1,054
Unpaired t-test		
P value	0,0017	

In the T-Student test, p <0.05, meaning there was a statistically significant difference between the mean values of the visual analog scale (VAS) score from week III, in the two groups.

Table 9. Results of the VAS score in the week IV postoperatively

VAS week IV postoperatively	Experiment group	Control group
Number of values	10	10
Median	2,000	4,500
Mean	2,100	4,300
Std. Deviation	1,197	0,8233
Unpaired t-test		
P value	0,0010	

We found a statistically significant difference between the mean of visual analog scale between the two groups (VAS score values from week VI, postoperatively).

Discussions

Following the rupture of the anterior cruciate ligament, patients need to follow a physical kinetic program in the preoperative period, which relieves pain and regains early flexion following surgery to reconstruct the anterior cruciate ligament.

In a specialized article [18], Mathew J Failla et al. analyzed the effects of preoperative kinetic physical treatment in patients with front cruciate tendon break two years after its surgical reconstruction. The authors confirmed that after the preoperative kinetic treatment patients had better knee function than the control group according to the study. The authors concluded that preoperative rehabilitation should be considered as a complement to the standard recovery program for anterior cruciate ligament rupture to maximize functional outcomes after surgical ligament reconstruction.

Other authors [19] showed that the preoperative kinetic treatment in the case of anterior cruciate ligament rupture is effective for improving results after surgery by increasing the early functionality of the knee and increasing muscle strength.

In the article Evidence for the effects of rehabilitation before ACL-reconstruction on return to sport-related and self-reported knee function: A systematic review [20], Florian G. et al., Showed that preoperative physical kinetic treatment improved significantly the physical function of the affected knee.

Another research that analyzed the effects of preoperative kinetic treatment [21] is that of H. Grindem et al., who compared the standard recovery protocol with the one that includes the preoperative program in case of anterior cruciate ligament rupture. Following the study, the authors highlighted significant differences in favor of preoperative recovery treatment in terms of KOOS score, ADL, sports, and quality of life.

Do Kyung Kim et al. [22] concluded that the preoperative recovery program prevented a decrease in quadriceps muscle tone and accelerated the recovery of muscle strength, which helped patients quickly adapt to the rehabilitation environment. Also, the increase in muscle strength leads to the prevention of recurrences, which is substantial after the rupture of the anterior cruciate ligament.

Developing the strength [23] of lower limbs [24] can help reducing ACL accidents and avoiding anxiety and post-traumatic stress [25], [26], [27].

Conclusions

Following our study, the positive role of preoperative physical kinetic treatment in patients with complete anterior cruciate ligament rupture, i.e. the hypothesis of our research, was confirmed; namely the preoperative physical kinetic treatment is of great importance for regaining a better functionality of the affected knee after cruciate ligament reconstruction.

Our final evaluation highlighted that the active range of motion, functionality, and pain level is significantly improved when subjects perform a preoperative physiotherapy rehabilitation program.

After the anterior cruciate ligament reconstruction surgery, the immediate postoperative recovery is also very important for the functionality of the knee, which is much more challenging to recover in the event of prolonged immobilization.

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