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KINESITHERAPY AFTER RECONSTRUCTION OF ANTERIOR CRUCIATE LIGAMENT OF KNEE JOINT

(Preliminary communications)

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Abstract

Research of the available scientific literature on recovery of patients after reconstruction of anterior cruciate ligament of knee joint was conducted and no comprehensive methodology for all periods of recovery of such patients was found. The paper presents and substantiates methodology of kinesitherapy after reconstruction of anterior cruciate ligament of knee joint, covering all periods of recovery process. The application of tools, methods, dosage and immediate effects are chronologically traced. The developed program includes patterns of kinesitherapeutic procedures, relevant structure and content.

Keywords: *program for kinesitherapy, motivating patients, rehabilitation, physical exercises, methods of physical workload, forms of kinesitherapeutic impacts, periods of recovery*

INTRODUCTION

It is well known that most patients underestimate the recovery after the reconstruction of anterior cruciate ligament and limit it to 10 or 20 days rehabilitation. As a consequence, they develop arthrofibrosis in the joint, subsequently reducing its movements, muscle dysfunctions (impaired muscle balance, impaired muscle synergy, impaired proprioception, etc.), which leads to joint instability.

In this context Kostov (Костов), 2009, states that „the impaired arthrokinematic, static and dynamic stabilization, as well as proprioception of the knee, is a prerequisite both for direct secondary injury of the knee`s structures, and also for the injury of other segments in the kinematic chain of the lower limb, and in lumbo-pelvis chain - for secondary dysfunctions and syndromes in the lumbar spine. „

In support of the above said one can cite ~~is~~ the opinion of Popova (Попова), 2007, that "if there is a muscle imbalance in the knee or ankle, it affects adversely the relationship in the whole kinematic chain of the lower limb. „.

Therefore, starting kinesitherapy in the early maximum-protective period and continuing it to the full functional recovery of the patient, is necessary. This drew our attention to the study of the problem.

Aim of the study

Improving the recovery of patients, by means of kinesitherapy, after the reconstruction of anterior cruciate ligament of knee joint, for all periods of recovery.

Tasks of the study

1. Developing a comprehensive program for kinesitherapy after the reconstruction of anterior cruciate ligament of knee joint, for all periods of recovery – from maximum-protective to functional recovery period.

2.Implementation of a detailed program for kinesitherapy in all periods of recovery.

3. Early recovery of full extension, in postoperative day 1 (Georgiev (Георгиев), 2005).

4.Early involvement of exercises for flexion in knee joint, in closed kinematic chain, to develop strength, endurance and active stabilization of the lower limb (Popova (Попова), 2007).

5.Motivating patients in implementing the program of kinesitherapy at home (under instructions) and self activities in gym, swimming complex, etc., which is crucial for their full functional recovery.

RESULTS

To achieve this purpose, we conducted research of the available scientific literature and, didn`t find a comprehensive methodology for all periods of the recovery of patients - from maximum-protective to

functional recovery period, after the referred reconstruction of the knee.

This required its development and approbation, which was held at the Centre for physiotherapy and kinesitherapy „Faith, Hope and Love" – in Blagoevgrad.

The methodology includes tools, methods and forms of organization of the directed impacts and a program of the impacts (with structure and content of the procedures, dosage of the impacts and methodological guidelines for their implementation).

Basic tools are various dosed physical exercises (isometric, isotonic, eccentric and ecocentric) in opened and closed kinematic chain.

Additional tools are: drain massage, lymphodreinage, positional therapy, cryotherapy, postizometric relaxation, proprioceptive nerve-muscle facilitation, stretching, mobilization of the peripheral joints, mechanotherapy, system „Terra - band" - proprioceptive training, techniques for developing strength, stabilization and control of lower limb, aquatherapy, etc.

The most commonly used ***methods of physical workload*** to improve flexibility, strength, endurance and other motor skills are the repeated and homogeneous methods. In the repeated method the impact is through multiple repeat of motor acts, in series, with a break between the series. In the homogeneous method this impact is repeated without a break, continuous, with low intensity.

The dosage of the impact is carried out by the regulation of the repeats, change in the amplitude of the movements, by external resistors (weights, simulators, elastic strips and other tools), by changing the start position, the duration of the impact, etc.

The organizational forms of the realization of the kinesitherapeutic impacts are reduced to:

- procedures, carried out by the kinesiotherapist;
- individual activities at home and outdoors, as prescribed.

In developing the methodology the instructions for loading, facilities and range of motion of Georgiev (Georgiev), 2005, Popova (Попова), 2007 and Kostov (Костов), 2010 are considered.

The methodology with the presented program below covers all periods of recovery: maximum-protective phase 1-4 week, moderate-protective - 4-10 week, minimum-protective- 11-24 week and the period of functional recovery after 6th postoperative month.

PROGRAM
for kinesitherapy after the reconstruction of anterior cruciate ligament of knee joint

1 - 14 day
- protective splint
- ice 3-4 times a day for 5-10 minutes
- positioning - drain position
- isometric contractions for femoral musculature
- extension of the knee
- training for walking on crutches, with partial load and going down and upstairs
- dorsal and plantar flexion of the ankle joint

15 - 20 day (beginning of the rehabilitation)
- ice 3-4 times a day for 5-10 minutes
- drainage massage
- isometric contractions for femoral musculature
- dorsal and plantar flexion of the ankle joint
- full extension of the knee
- lifting the leg, extensioned (straight) in the knee joint with and without splint, in all planes
- leading (aside) the leg with extensive knee
- knee flexion with sliding the heel on the bed (to 45°-60°)
- exercises with light manual resistance
- increasing the load on the operated leg

21 – 45 day
- 1 crutch – to the end of the 1st month
- walking with full load on legs without splint and without crutches - beginning of the 2nd month
- massage femoral musculature
- exercises for femoral musculature against resistance in different angles gradually active flexion to 90 ° -100 °
- veloergometer 20 min - 30% strength
- ice 3-4 times a day for 10 - 15 minutes
- positioning - drain position
- electrostimulation (m.quadriceps femoris)

46 – 60 day
- full extension of the knee joint
- active flexion of knee to 135°
- electrostimulation of femoral musculature
- exercises of femoral musculature, active, against resistance, with weights (in all planes and angles) without squatting
- veloergometer 20 min - 50% strength
- exercises on gladiator
- balance exercises
- proprioceptive exercises
- ice 3-4 times a day for 10 - 15 minutes
- positioning in the evening

Third postoperative month
- full flexion and extension of the knee joint (active and passive)
- exercises for femoral musculature against resistance, with weight 2-3 kg (without squatting)
- stretching
- veloergometer 2 x 20 min - 100% strength
- exercises on gladiator
- swimming (all styles, water temperature - not higher than 35 -36 °C)

Fourth postoperative month
- proprioceptive training
- stretching
- balance exercises

- walking with full load of the leg
- exercises for the muscles of the hip (including with the lever of the rods and with light rods). Starts with weight – 10% of the own weight.
- veloergometer 2 x 20 min - 100% strength
- (Without pain) running on a simulator or track 2 x 20 min at 8-10 km/h
- Swimming

Fifth postoperative month
- proprioceptive training - complicated
- active load 100%
- exercises for femoral musculature on gladiator and with rods
- veloergometer 2 x 30 min at 10-12 km/h
- jumps on 2 and 1 leg – 10 times x 2 series (without causing discomfort)
- exercises for speed and agility
- running program (jogging, sprint stretches, running, stretches with a sudden change of direction)

Sixth postoperative month
- exercises for elasticity and flexibility, speed and agility
- active load
- exercises for femoral musculature on gladiator and with rods
- veloergometer 2 x 30 min - 100% strength
- (Without pain) running on a simulator or track 2 x 30 min at 10-12 km/h
- swimming
- ball game (balance, 21, light short passes with outside edge)
- training with sport trend

COMPLEX FOR KINESITHERAPEUTICAL PROCEDURE
after the reconstruction of anterior cruciate ligament of knee joint

Maximum-protective phase (the first 4 postoperative weeks)
1-12 day (the splint must not be removed)

№	***Start position***	***Description of the therapeutic exercises***	***Dosage***	***Methodic instructions***
1.	Occipital leg	Isometric contractions (tightness of femoral and gluteal muscle) for 5 sec.	2 series x 25 repeats Break between the series 1-2 min.	5 sec. contractions 10 sec. relaxation.
2.	Occipital leg	Dorsal flexion, plantar flexion in ankle joint.	2 – 3 series x 25 repeats Break between the series 1-2min	Knee joint in extension. Tempo - moderate.
3.	Occipital leg	Lifting the extended in knee joint strained leg	2 series x 25 repeats.	Tempo - moderate.
4.	Occipital leg	Diverging the leg aside - abduction in hip joint	2 series x 25 repeats.	Tempo - moderate. Knee joint in extension
5.	Occipital leg	Adduction in hip joint.	2 series x 30 repeats.	Tempo - moderate. Knee joint in extension
6.	Occipital leg	Flexion the leg in knee. Splint at 30 °.	2 series x 25 repeats.	Tempo – slow to pain
7.	Side leg	Abduction in hip joint. Knee in extension	2 series x 25 repeats.	Tempo – slow
8.	Side leg	Flexion in hip joint Knee in extension	2 series x 20 repeats.	Tempo – slow
9.	Side leg	Extension in hip joint.	2 series x 20 repeats.	Tempo – slow
10.	Side leg	Active flexion – extension of the knee to 60 °.	2 series x 25 repeats.	Tempo – slow
11.	Side leg	Training for walking with support tools. Going up and down stairs with supporting tools	5 – 10 min.	The load on the operated leg increases gradually
12.	Side leg	Cryotherapy with lifted at 45°-60° and extended in knee leg	10 – 15 min.	

PROGRAM
for kinesitherapy after the reconstruction of anterior cruciate ligament of knee joint

1 – 30 day (first month after the operation)
- immobilization with a splint for 30 days (of the operation)
- from 1 to 15 day gradual loading to complete walking with 2 crutches
- from 15 - 30 day full load.Walking with 1 crutch
- after the 30th day full load on the operated limb, without splint and support tools

Changing the bending angle (degrees) of the immobilization splint:
- 1 – 12 day – 60 °
- 12 – 17 day – 75 °
- 17 – 22 day – 90 °
- 22 – 27 day – 105 °
- 30 day – 120 °

As in 4, 5 and 6 month, but with larger load, with the input of the greater strength and power, greater speed, agility and flexibility. Include series with sport or professional orientation. If necessary, carry functional splint.

From 12th to 20th day
Included are all exercises from the previous period, as the number of repetitions increases by 5 - 10. The splint must not be removed.

№	Start position	Description of the therapeutic exercises	Dosage	Methodic instructions
1.	Occipital leg	Drainage massage.	5 min.	The leg is relaxed.
2.	Occipital leg	Active flexion of knee to 75 °.	2 series x 30 repeats Break between the series 1-2 min.	Tempo - moderate.
3.	Occipital leg	Full extension in knee joint.	2 series x 30 repeats.	Under the ankle roller or ball is placed.
4.	Sitting	Extension in knee joint.	10 – 15 min.	Tempo - moderate.
5.	Occipital leg	Cryotherapy.	10 – 15 min. т	Drain position. The leg is lifted at 45° - 60° flexion in hip joint.
6.	Sitting	From the 15-th day –walking with 1 crutch. Going up and down stairs with 1 crutch.		Full load on the operated leg. Do not cause pain or discomfort.

From 21th to 30th day
The exercises from the previous period are repeated as the series are increased by 1.

№	Start position	Description of the therapeutic exercises	Dosage	Methodic instructions
1.	Occipital leg	Flexion in knee joint to 90° - 105°.	3 series x 30-35 repeats	Tempo - moderate.
2.	Occipital leg	Flexion in knee joint to 90° - 105°.	3 series x 30-35 repeats	Ankle - roller under the ankle.
3.	Occipital leg	Full extension in knee joint, as the ankle lifted 5-10 cm from the couch.	3 series x 30-30 repeats	Tempo - moderate.
4.	Sitting	Flexion in knee joint to 90°- 105° and active extension of knee joint.	3 series x 30-30 repeats	Tempo - moderate.
5.	Occipital leg	Cryotherapy.		
6.	Occipital leg	Drain position for knee joint. Flexion in joint – 45° - 60°, knee extended.		Pillow under the ankle.

COMPLEX FOR KINESITHERAPEUTICAL PROCEDURE
after the reconstruction of anterior cruciate ligament of (moderate-protective phase)
From 30th to 60th day
Second month after the operation. The exercises from the end of the first month are repeated, as in this period manual resistance or weight is applied. At the beginning it is light (from 2 to 4 kg.) and it gradually increases

№	Start position	Description of the therapeutic exercises	Dosage	Methodic instructions
1.	Occipital leg	Trophic massage of femoral musculature.	5 – 10 min.	If necessary
2.	Occipital leg	Electro stimulation of femoral musculature.	5 – 10 min.	
3	Occipital leg	Dorsal flexion, plantar flexion in ankle joint.	3 series x 30 repeats.	Knee joint in extension. Tempo - moderate.
4.	Occipital leg	Lifting (flexion in hip joint) of tight (strained) leg (extended in knee joint).	2 series x 20 repeats.	With weight 2,0 -2,5 kg or against manual resistance.
5.	Occipital leg	Diverging the leg aside (abduction in hip joint), as the knee is extended.	2 series x 20 repeats.	With weight 2, 0 -2, 5 kg or against manual resistance.
6.	Occipital leg	Adducting the leg (in hip joint), as the knee joint is extended.	2 series x 20 repeats.	With weight 2,0 -2,5 kg or against manual resistance
7.	Occipital leg	Flexion of the knee to 135°.	2 series x 20 repeats	Against manual resistance, at the final degrees, if needed, active assistance
8.	Side leg	Abduction in hip joint. Knee in extension	2 series x 30 repeats	With weight 2, 0 -2, 5 kg on the ankle.
9.	Side leg	Flexion in hip joint. Knee in extension	2 series x 30 repeats	With weight 2, 0 -2, 5 kg on the ankle.
10.	Side leg	Extension in hip joint. Knee in extension.	2 series x 30 repeats	With weight 2, 0 -2, 5 kg on the ankle.
11.	Leg	Active flexion of knee joint to 135° against resistance (manual or with weights).	2 series x 30 repeats	If needed - at the final degrees active assistance.
12.	Leg	Lifting of tight (strained) leg (extension in hip and knee joint).	2 series x 30 repeats	With weight 2, 0 -2, 5 kg.
13.	Sitting	Active flexion and extension of knee joint	2 series x 20- 30 repeats.	With weight 2, 0 -2, 5 kg.
14.	Sitting on a high chair	Flexion of knee joint - 90°of the healthy leg. The operated leg lifted and placed on a rubber ball the size of volleyball. Pressures and rolling the ball in front-back direction in the sagittal plane.	Many times for 2 min without a break	The amplitude of the movement is not big and it is down to rolling the ball from toes to heel and back.
15.	Sitting on a high chair	Pressures and rolling the ball in the frontal plane – to the left and to the right. Striving for continuing pressure on the ball during its rolling.	Many times for 2 min without a break.	Rolling from medial to lateral edge of the foot and back.
16.	Sitting	Veloergometer.	20 min.	50% strength, pedal at height the height of full extension of the knee.
17.	Sitting	Exercises on gladiator for femoral musculature, gluteal and muscles of the lower leg.	10 - 15 min.	50% strength, pedal at height of incomplete extension of the knee.
18.	Occipital leg	Cryotherapy.	3-4 times a day x 15 min.	In drain position.
19.	Occipital leg	Positioning - drainage.	3-4 times x 15-20 min.	At flexion in hip joint 45°-60°, pad under ankle joint.

3 months after the operation
Minimum-protective phase from 3 to 6 months

The exercises from the previous complex with bigger resistance added (weight) and more repetitions (without squatting) are applied

№	Start position	Description of the therapeutic exercises	Dosage	Methodic instructions
1.	Sitting	Veloergometer.	2 x 20 min.	100 % strength.
2.	Sitting	Exercises on gladiator	2 x 20 min.	Resistance =10 % of the own weight.
3	Sitting	Swimming (all styles).	2 times a week	Starts with 30 min tempo – slow to moderate. Afterwards 40 – 45 min.
4.	Sitting	Walking on toes.	3 min.	Tempo - moderate.
5.	Standing	Walking on heels.	3 min.	Tempo - moderate.
6.	Standing	Walking on rope laterally .	3 min.	Tempo - moderate.
7.	Standing	Walking with high raised leg (flexed in the knee), as the foothold on 1 leg holds 5 sec. (in balanced posture).	3 min.	Tempo - slow.
8.	Standing	Lunge forward to maximum range (without pain). Change the legs. Hold in lunge 5-8 sec. (can also be done with springing - till pain).	20 repeats with the one and 20 repeats with the other leg	Ensure that feet are not detaching the floor.
9.	Standing	Lunge sideways. To the left - 20 times, to the right – 20 times. Hold 5-8 sec (can also be done with springing till pain).	20 repeats for each leg.	Without detaching the feet from the floor
10.	Standing	Scale. The foothold changes. Around the middle of 3 months it can be done on an unstable support (for example stepped on a thick sponge gymnastic mattress).	x 10 repeats.	Hold for 6-8 sec. for left and right leg.
11.	Standing	Attempts to deviate the patient out of balance in position “Shun!” by pushing his body in different directions. The pressure force – to barrier stepping. In the middle of the 3-rd month the exercise can be performed on an unstable support	4-5 min.	
12.	Standing	Switching from walking to jogging (leg).	2 x 5-10 min a day.	Only on simulator
13.		If needed - cryotherapy.	3 - 4 times a day x 10 min.	

4 months after the operation

№	Start position	Description of the therapeutic exercises	Dosage	Methodic instructions
1.	Standing	Veloergometer.	2 x 20 min.	100 % strength.
2.	Standing	Jogging switches gradually to running. Running on simulator or track	2 x 20 min.	At 8 – 10 km/h.
3	Sitting	Swimming (all styles).	2 times a week.	
4.	Standing	Exercises on gladiator, with Increasing resistance for all muscles of the lower limb	3 times a week fitness.	Starts with 20% of of the own weight.
5.	Standing	Exercises for femoral muscles (including with rod).	3 times a week	Gradually rises to 30%, 50% under the control of fitness instructor.
6.	Standing	Exercises on balance - board		
7.	Standing	Exercises against resistance of the own weight. Squat. Without pain and discomfort.	3 series x 10 repeats.	
8.	Standing	Lunges – alternation, in all directions- with springing.		

5th month (minimum-protective)

№	Start position	Description of the therapeutic exercises	Dosage	Methodic instructions
1.	Standing	Exercises for strength of the femoral muscles – squat on gladiator and with rods, as the loading and the intensity carefully increase, under the control of fitness instructor.	3 times a week.	Gym. Performed without causing discomfort and pain.
2.	Standing	Veloergometer of bicycle.	2 x 30 min.	At speed of 10–12 km/h.
3.	Standing	Running on simulator or track.	2 x 30 min.	At speed of 10–12 km/h.
4.	Standing	Include sprint stretches with length of 20-30 m.		
5.	Standing	Running in figure eight.		At first - slow. Gradually, the speed increases
6.	Standing	Swimming – all styles		

6th month (minimum-protective phase)

All exercises from 5-th month are applied, as the resistance and the intensity increase.

№	Start position	Description of the therapeutic exercises	Dosage	Methodic instructions
1.	Standing	Carefully starting a specific sport activity, for example elements of basketball, elements of football – game all – passes with outside edge, etc.		At the beginning without a contact.
2.	Standing	Running. Stretches with sudden change of the direction.		The speed increases gradually.
3.	Standing	Running with sudden stop. Sudden start.		The speed increases gradually.
4.	Standing	Running in figure eight.		Fast.

Functional phase (after 6th postoperative month)

CONCLUSION

The program provides basic guidelines to the kinesitherapist. The individual program is based on the requirements of a surgeon - orthopedist (e.g. some orthopedists do not prescribe supporting tools - crutches after reconstruction of the anterior cruciate ligament, or there is a difference in load degrees). It is pursuant with the individual abilities of the patient (functional, age, sex, athlete, non athlete, etc.) and is mostly pursuant with the rate and complexity of the damage to the knee complex.

Often the rupture is combined with lesion of meniscus, collateral ligaments, cartilaginous lesions, etc., which we strictly abide with in preparing the individual program and complex of kinesitherapy.

1. The proposed methodology of kinesitherapy has a good recovering effect.
2. The developed methodological guidelines for the entire recovery period can facilitate significantly kinesitherapeutists in conduct of their procedures as well, as in the preparation of prescriptions for the individual activities of patients.
3. Setting an algorithm of the therapeutic process at the indicated pathology, orients the kinesitherapist in the chronology of impacts.

The diagnostics of the indicators is permanent and accompanies the entire kinesitherapeutical process, helping tracking the intensity of the recovery.

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