

Rehabilitation Program after Post-Traumatic Reconstruction of the Anterior Cruciate Ligament (With a Clinical Case Report)

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Abstract

The Anterior Cruciate Ligament (ACL) is an important stabilizer of the knee, providing almost 85% of the joint stability to forward force (especially in some aggressive twisting and jumping sports, as skiing and basketball). The common orthopedic surgical intervention is the reconstruction, performed as soon as possible after the traumatic injury.

After the orthopedic surgery, a period of rehabilitation must begin and the consultation with a medical doctor - specialist in Physical and Rehabilitation Medicine (PRM) is required.

The goal of current article is to suggest a complex PRM-algorithm of care of these patients, based on detailed literature review and on our own clinical practice.

In all traumatic knee conditions with a knee surgery, the PRM Algorithm traditionally includes functional evaluation of the knee mobility and stability and a complex PRM programme of care, including natural and preformed physical modalities. The pre-defined PRM protocol includes only physiotherapy (analytic exercises) combined with cryotherapy.

Authors consider that the traditions of some rehabilitation schools (e.g. Bulgarian) can be used. We suggest a detailed complex PRM-algorithm, including physiotherapy, cryotherapy, hydro or balneotherapy; and many preformed physical factors: functional electrical stimulations of the quadriceps femoris muscle (accentuating on the heads m.vastus lateralis and m. vastus medialis, especially on m.vastus medialis obliquus); interferential currents; Deep Oscillation; low intensity low frequency magnetic field; ultrasound or ultra-phonophoresis with non-steroidal anti-inflammatory drugs.

We propose a practical schema for a patient after ACL reconstruction, through a clinical case presentation: a male patient after reconstruction of the right ACL, after traumatic rupture of the ACL. Immediately after the orthopedic surgery, the patient was treated as inpatient in the PRM Clinic of a Bulgarian University hospital and after - as outpatient in the PRM-Department of an ambulatory Medical Center. We expose the detailed PRM-program and the obtained results in this patient.

In conclusion, we emphasize the impact of the complex PRM-programme in case of ACL-reconstruction and the efficacy for: pain relief; enhancement of the range of motion of the knee; enrichment of the functional capacity; amelioration of the neuro-muscular coordination; stabilization of the gait; improvement of the quality of life.

Keywords: Rehabilitation; Anterior Cruciate Ligament; Physical Medicine; Electrotherapy; Magnetic Field; Deep Oscillation; Laser

Abbreviations

ACL: Anterior Cruciate Ligament; DO: Deep Oscillation; FES: Functional Electrical Stimulations; IFC: Interferential Currents; LTh: LASER Therapy; MF: Magnetic Field; MMT: Manual Muscle Test; NSAIDs: Non-Steroidal Anti-Inflammatory Drugs; PRM: Physical and Rehabilitation Medicine; PT: Physiotherapy; ROM: Range of Motion; SUG: Standing Up and Go Test; TENS: Transcutaneous Electroneurostimulation; US: Ultrasound; QF: Quadriceps Femoris Muscle; 6 MWT: 6 Minutes' Walk Test

Introduction

The Anterior Cruciate Ligament (ACL) is an important stabilizer of the knee, providing almost 85% of the joint stability to forward force (especially in some aggressive twisting and jumping sports, as skiing and basketball) [1,4]. The function of ACL is prevention of the anterior translation of the tibia relative to femur and is a secondary limiting factor of varus angulation during knee extension [4,7]. The most frequent mechanism of ACL damage is a non-contact pivoting stress [7].

The common orthopedic surgical intervention is the reconstruction, performed as soon as possible after the traumatic injury [4]. After the orthopedic surgery, a period of rehabilitation must begin, with the support of some helping devices, as knee brace and crutches [2,6]. During this period, the patient usually requires consultation with a medical doctor - specialist in Physical and Rehabilitation Medicine (PRM) [6,9,15,19].

The goal of current article is to suggest a complex PRM-algorithm of care of these patients, based on detailed literature review and on our own clinical practice.

Summarized PRM algorithm after ACL reconstruction

In all traumatic knee conditions with a knee surgery, the PRM Algorithm traditionally includes functional evaluation of the knee mobility and stability, and a complex PRM programme of care, including natural and preformed physical modalities. The pre-defined PRM protocol includes only physiotherapy (analytic exercises) combined with cryotherapy [10,11,16,17].

We consider that the traditions of some rehabilitation schools (e.g. Bulgarian) can be used [8]. We apply preformed physical factors: functional electrical stimulations (FES) of the quadriceps femoris muscle (QF - accentuating on the heads m.vastus lateralis and m. vastus medialis, especially on m.vastus medialis obliquus); interferential currents (IFC); Deep Oscillation (DO); low intensity low frequency magnetic field (MF); ultrasound (US) or ultra-phonophoresis with non-steroidal anti-inflammatory drugs (NSAIDs).

Physical examination and functional assessment

During the initial patient's exam, we must determine the exact post-operative day (post-op day) and we should evaluate [3,5,12]: active and passive range of motion (ROM) of the knee joint (through goniometry); muscle strength (dynamometry) and muscle weakness (Manual muscle test - MMT); joint oedema (centimetry of the knee joint); muscular hypotrophy (centimetry of the thigh - at 10 cm and 20 cm over the patella); pain (Visual analogue scale - 0-10); skin sensibility (negative sensitive patterns, as hypoesthesia; thermosensibility and vibration sensibility - through vibroesthesiometry); joint position sense (proprioception); autonomic gait (with orthosis) - through Standing-Up and Go test (SUG-test) or 5 meters test; patient's functionality and autonomy - through the International Classification of Functioning, Disability and Health (ICF-assessment) [18-20].

PRM programme Immobilization

The knee-standardized immobilization is through application of: orthosis (with possibility of fixation and regulation of the flexion/extension), tape, elastic bandage or brace. During the first 2-3 weeks the orthosis is locked in full extension (if necessary - in 5 - 10 degrees of flexion) - except during the active exercises. During the first post-op month, the patient will receive a prescription for a lying or sitting position for a minimum 2 hours daily (afternoon) and 8 hours (at night). Immediately after the trauma and during the primary post-operative

period, we prescribe the strict execution of the RICE protocol (Rest, Ice, Compression, Elevation).

Preformed modalities

From the group of preformed physical modalities we can apply [8,14]: Functional electrical stimulations - for the quadriceps muscle (QF), especially for m.vastus medialis obliquus (VMO); Interferential currents (IFC - resulting frequency 90 - 140 Hz; 10 - 20 min.) - for the knee joint; Low frequency pulsed magnetic field (MF - 16 000 A/m, 10 - 20 min.) - for the knee joint; Ultra-sound (US) or ultra-phonophoresis with NSAID (0.4 - 0.8 W/cm², 4 - 8 min.) - for the knee joint.

Cryotherapy or hydrotherapy

We recommend ice massage for 5 - 10 minutes, 3 - 5 sessions daily [14]. After the 3rd month post-op - hydro and balneotherapy can be applied (or balneophysiotherapy - underwater exercises) [13].

Kinesitherapy (Physiotherapy)

We apply a standard kinesitherapy programme, adapted to the level of pain and functional disability [8].

We begin with passive mobilizations (under the level of pain perception) for augmentation of the active ROM of the knee joint; after that we introduce (gradually) active exercises for the range of motion and strengthening exercises (at the beginning - from a lying position; after - in sitting position, in few days - from standing position - with locked orthosis or brace). Gradually we increase the range of motion (of the orthosis and of the exercise).

We accentuate on analytic exercises for m.quadriceps femoris (QF - especially for m.vastus medialis and m.vastus lateralis) and for the hip abductors (especially for m.gluteus medius). At the beginning we use isometric exercises; gradually we include isotonic exercises, with a progressive increase of the applied resistance during exercises.

We recommend post-isometric relaxation for the m.rectus femoris, and gait training (with gradually rise of the weight bearing and progressive transition from the crutches to gait without aids).

We apply passive and mixt exercises (initiating with passive mobilizations); post isometric relaxations for the m.rectus femoris, Mobilizations of the patella (in medial - lateral and proximal-distal directions).

During the training with active exercises - the rule is from isometric to isotonic, and contra-resistance: For muscles around the knee joint (bilaterally): analytic exercises for the knee dynamic stabilizers and for knee mobility - strengthening exercises for the muscles quadriceps femoris (QF), m.triceps surae (TS); m.semitendinosus, m.semimembranosus, etc. The training of muscles of the hip joint and of the ankle joint must be done bilaterally. In some cases, we apply training of the proprioception, stretching and Theraband exercises for QF, TS and hamstring muscles.

Period (post-op day/week/month)	Localization -of rehab	Goal and Tasks	Weight bearing	Technical aids (brace, orthosis)	CRYO-Th (Ice)	KINESI-Th (active exercises, passive mobilizations, soft tissue techniques)	Training of everyday activities (ADL)	Prefomed modalities	Notes
Post-operative Day 0-3	In-patient OT Department	Functional recovery: First mobilization of the knee joint - in bed; Reduction of pain, oedema; First steps	Partial weight-bearing (25%), gait - using crutches	Crutches (or cane - in the altered side); Locked orthosis or brace (Flexion 75-80°)	10 min, 3 - 7 sessions per day	Range of motion exercises: • Flexion: heel slides; • Extension: Passive - using towel rolls; Strengthening exercises: • Quadriceps isometry; • Begin ankle strengthening exercises: plantar/dorsal flexion.		Magnetic field Deep Oscillation (DO)	Active exercises - to patient tolerance; Gradually increase of ROM and strength; Observation for eventual post-operative complications (deep vein thrombosis, pulmonary thromboembolism)
Post-op Days 4-15	In-patient PRM and Rehab Department of the Hospital	Mobilization of the knee joint - in sitting and in standing position; Obtain full knee extension (0°) and 90° of the knee flexion; Gait training	Partial weight-bearing (50-75 %), Gait - with crutches (or cane)	Crutches (or cane); Locked orthosis or brace (Extension 0°)	15 min, 3 x daily	Range of motion exercises: • Flexion: knee bends, wall slides, heel slides • Extension: Passive - using prone hangs and towel rolls Strengthening exercises: • Quadriceps sets with knee support; • Hamstring digs with knee support; • Ankle strengthening exercises: plantar/dorsiflexion, inversion/eversion Verticalization Balance training Gait training	Getting up from a seated position (with support on crutches)	Magnetic field Interferential currents (IFC) Deep Oscillation (DO)	
Post-op Weeks 3-6	Out-patient PRM Department of the Medical Center	Gait training	Partial weight-bearing -WB (75 - 100 %), Gait - with crutches (or cane)			Stretching exercises: • For Flexors: of the ankle and hip joints (especially for soleus and ilio-psoas muscles); • For Extensors: of the ankle and hip joints (especially for m.tibialis anterior and gluteal muscles); Strengthening exercises: • Quadriceps sets with knee support; • Hamstring digs with knee support; • Ankle strengthening exercises: plantar/dorsiflexion, inversion/eversion Range of motion exercises: • Flexion: knee bends, wall slides, heel slides • Extension: Passive - using prone hangs and towel rolls	Walking uphill or downhill (with support, but gradually eliminate the support)	FES for m.vastus medialis obliquus Magnetic field (MF) IFC DO	NB! Without pressing on the popliteal fossa

Post-op Weeks 7-8	Out-patient PRM Depart of the Medical Center or AT HOME Rehab	Gait training Goal - to obtain normal ROM and Normal walking	TWB Gait - with cane or without technical aids			Manual therapy: Mobilizations of the patella (in proximal, distal; lateral and medial directions) Stretching exercises: For Flexors: of the ankle and hip joints (especially for soleus and ilio-psoas muscles); For Extensors: of the ankle and hip joints (especially for m.tibialis anterior and gluteal muscles); Strengthening exercises: <ul style="list-style-type: none"> • Quadriceps sets with knee support; • Hamstring digs with knee support; • Ankle strengthening exercises: plantar/dorsiflexion, inversion/eversion 	Getting up from a seated position (without support); Going up or down stairs	FES for m.vastus medialis obliquus or Ultrasound of the knee or MF or IFC	
Post-op Months 2 - 4	Out-patient PRM Depart of the Medical Center or AT HOME Rehab	Participation in all ADL Training of working activities				MANUAL therapy: <ul style="list-style-type: none"> • Tibio-femoral distraction, • Anterior tibial glide, • Posterior glide; • Techniques of Maitland and Mulligan Stretching exercises: <ul style="list-style-type: none"> • For Flexors: of the ankle and hip joints (especially for soleus and ilio-psoas muscles); • For Extensors: of the ankle and hip joints (especially for m.tibialis anterior and gluteal muscles); Strengthening exercises: <ul style="list-style-type: none"> • Quadriceps sets with knee support; • Hamstring digs with knee support; Ankle strengthening exercises: plantar/dorsiflexion, inversion/eversion ERGO-Therapy	Kneeling, squatting Some sports training - swimming, sitting bicycle; Training of working activities	FES for m.vastus medialis obliquus or MF	PRM Control
Post-op Months 5-6	AT HOME Rehab	Every day				Stretching exercises Exercising Muscles that Surround the Knee Working the Hip Stabilizers Increasing Muscle Endurance Cardio-respiratory fitness - including stationary bicycle, swimming, etc.			OT control
Longlife maintenance rehabilitation programme	AT HOME Rehab	3 seances weekly				Stretching exercises Exercising Muscles that Surround the Knee Working the Hip Stabilizers Increasing Muscle Endurance Cardio-respiratory fitness - including stationary bicycle, swimming, etc.	Sports Working activities Leisure activities	Periodically (monthly or every 2 months): 10-15 seances DO or MF or IFC	
Control by MD, specialists in PRM and OT									

Table 1

Ergotherapy (Occupational therapy)

We introduce gradually different everyday activities, including sports: stationary bicycle, swimming, etc.

Gait training

The gait training must be effectuated with progressive weight bearing - from non-weight bearing during the first 2 - 4 weeks, 50% to full weight bearing and normalization of the gait at the 6th month (at the beginning - with crutches, after that - with cane, finally - without technical aids).

Clinical PRM algorithm after ACL reconstruction

Management of the patient after ACL reconstruction

The clinical PRM-algorithm after ACL reconstruction is presented on the table 1.

Prevention of complications

In every period of the rehabilitation process, the patient is strictly observed for possible complications: deep vein thrombosis, pulmonary thromboembolism, muscle or joint contracture, etc.

Prognosis

The ACL reconstruction is a highly successful operation. 90-95% of patients can be expected to return to full sports participation with 6 months and with aggressive (but well dosed) rehabilitation.

Practical schema for a patient after ACL reconstruction (clinical case presentation)

We will present a case of a male patient with operation of the right ACL (alloplastic reconstruction), after traumatic rupture of the ACL. Immediately after the orthopedic surgery, the patient was treated as inpatient in the PRM Clinic of a Bulgarian University hospital and after - as outpatient in the PRM-Department of an ambulatory Medical Center.

Personal data (History of the disease)

Patient's complaints

The patient suffer from moderate pain in the right knee and stiffness of muscles around it. He has difficulties in long time mobility, decrease in autonomy in activities of daily living (ADL). Movements of the right knee are painful, likewise the gait. Patient's complaints increase at the end of the day and after physical activity.

Anamnesis

This is a post interventional procedure (ACL alloplasty) rehabilitation status. The traumatic injury of the right knee was consequence of a fall during bicycling. The patient realized most of 5 PRM-courses (of 5 days each) and actually he has the full ROM of the knee joint.

Comorbidities

Cystic formation in the fossa poplitea of the left knee (the healthy knee); Lumbar osteochondrosis.

Clinical data

From the clinical assessment of the patient: Age-correspondent with the real. Thorax: Pulmo-vesicular respiration, without crepitations. Cor-rhythmic cardiac activity with normal frequency, RR 120/60 mm Hg, Pulsus = 62 beats per minute. Abdomen: soft, no painful. Hepar and lien - non-palpable.

From the Neurological exam: Vertebral syndrome with paravertebral muscle spasm, limitations of the lumbar spine ROM. Radicular syndrome L5 bilaterally (S > D), with hypoesthesia L5 and knee hyporeflexia.

From the Orthopedical exam: Upper limbs and left leg: ROM of joints and muscle strength with normal values. Limited range of motion of the right knee joint. Post-operative cicatrix - without complications.

Exams (Lab and Imagery)

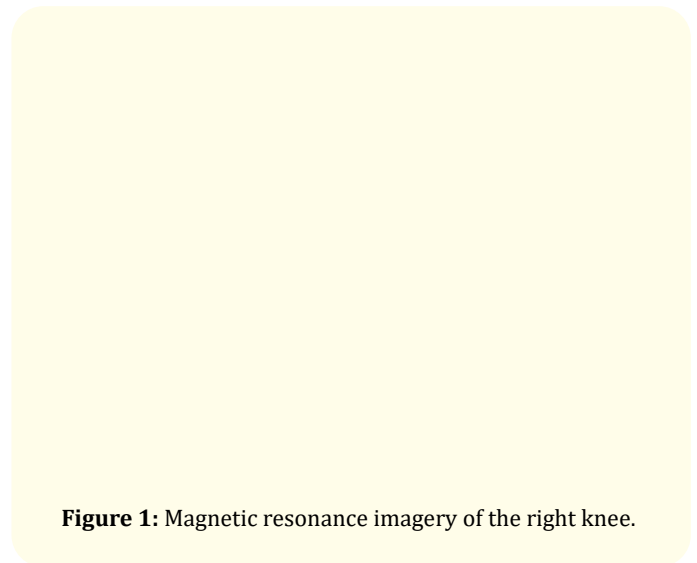


Figure 1: Magnetic resonance imagery of the right knee.

Functional assessment

We applied detailed kinesiological analysis. The results of the goniometry of the right knee joint was S 0-0-165. The patient has a developed vertebral syndrome with paravertebral muscle spasm, limitations of the range of motion of the lumbar spine. He has a good rehabilitation potential.

Results of the ICF assessment: Our patient has impairments of body functions (knee pain, muscle weakness, and restricted knee ROM) and changes in body structures; activity limitations (limited walking & staying ability and endurance); participation restrictions (reduced participation in leisure activities, especially sports); decrease of the patient's quality of life.

The evaluation of the physical performance was realized by the 6 Minutes Walk Test (6 MWT) - 450 m - with pain - before rehabilitation; after 1 week - 550 meters.

Complete diagnosis

Before the operation: Ruptura ligamentum cruciatum anterius dex. (ACL rupture).

After the operation: Status post reconstructionem ligamentum cruciatum anterior (pro LCA rupturam) (ACL-alloplastic reconstruction).

Comorbidities: Osteochondrosis lumbalis. Radiculopathia L5 bilateralis (S > D).

PRM programme

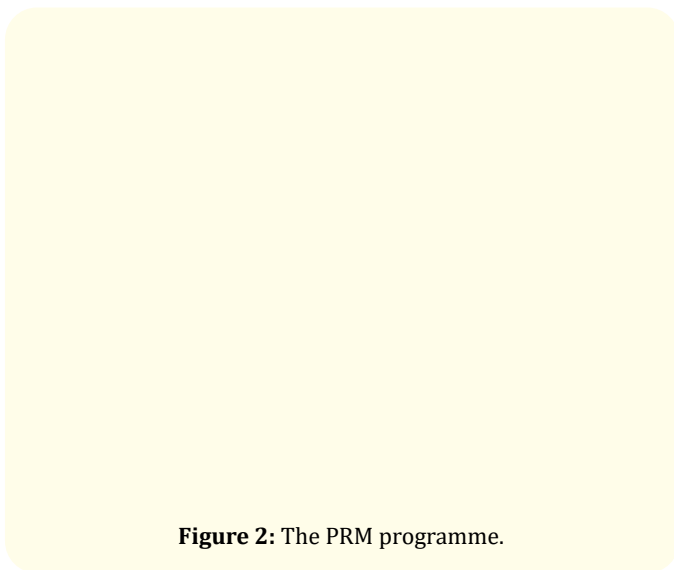


Figure 2: The PRM programme.

Results of the applied PRM course

The functional assessment at the end of the PRM-course demonstrated an increase of the joint ROM (goniometry of the right knee: S 0-0-180). The pain was significantly reduced (from VAS 7 to VAS 1). The results of the 6 minutes' walk test was 610m (at the end of the PRM course).

Conclusion

In conclusion, we must emphasize the impact of the complex PRM-programme in case of ACL-reconstruction and the efficacy for pain relief; enhancement of the range of motion of the knee; enrichment of the functional capacity; amelioration of the neuromuscular coordination; stabilization of the gait; improvement of the quality of life.

Recommendations

After the dehospitalization the patient must continue with the PT-programme (auto-training - at home). The recommended sport's activity is swimming. The next control and respective PRM-course must be effectuated in 3 months.

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Conflict of Interest

No conflict of interest.

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