CHARLES UNIVERSITY
Faculty of Physical Education and Sport
Department of Physiotherapy

CASE STUDY OF A PATIENT FOLLOWING RECONSTRUCTION OF THE ANTERIOR CRUCIATE LIGAMENT

Bachelor thesis

Supervisor:
Mgr. Kateřina Maršáková

Author:
Anna Lalaeva

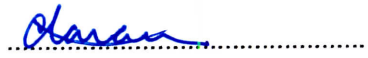
April 2009, Prague

Acknowledgements

I would like to express my appreciation to Mgr. Kateřina Maršáková, for the advice and instructions she gave me during the elaboration of this thesis. I also wish to thank PhDr. Edwin Mahr, my supervisor at my work place, for his advice on the specific subject. Special thanks also to my patient for his corporation and understanding.

Declaration

I declare that this is my personal work which I elaborated using the literature listed and the knowledge I gained throughout my studies at Charles University, Faculty of Physical Education and Sports in the department of Physiotherapy.



Anna Lalaeva, Prague, 2009

Summary

Author: Anna Lalaeva

Title: Case Study of a Patient Following Reconstruction of the Anterior Cruciate Ligament

Supervisor: Mgr. Kateřina Maršáková

Work Place: Centrum Léčby Pohybového Aparátu s.r.o.

Work Period: 26.01.2009 to 19.02.2009

One of the most common knee injuries both to athletes and the wider population is rupture of the anterior cruciate ligament. Over the years, methodology for surgical reconstruction of this ligament has improved but the key to a more stable and functional knee is the rehabilitation that comes with it. Post operative rehabilitation is mainly concerned with restoring soft tissue integrity, muscle strength and range of motion around the knee. Regaining muscle balance and correct muscle coordination is the key for long term stability of the knee joint.

This work is divided into two parts: the general and the special. In the general part the anatomy, function and biomechanics are discussed with relevance to the anterior cruciate ligament as well as issues concerning the injury itself, the treatment options and the rehabilitation options that are possible. In the special part I present one alternative for an accelerated rehabilitation plan after reconstruction of the anterior cruciate ligament with an autogenous patellar tendon. I have used this plan to rehabilitate a patient for one month from 2 to 6 postoperative weeks resulting in evident improvements.

Key words:

Anterior cruciate ligament, knee, reconstruction, rehabilitation, physiotherapy

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1 Preface

Injury to the anterior cruciate ligament are said to be one of the most frequent injuries to the knee. The knee and its stability are crucial for the bearing of our body's weight and for the ability to perform certain sports and exercises. There are two treatment solutions to an anterior cruciate ligament tear: the surgical and the conservative (non surgical). The success of the surgery itself depends on the timing, type of graft and fixation used as well as the placement of the tibial and femoral tunnels. The key to restoring function in the knee, however, lies in the rehabilitation after the surgery.

This post operative rehabilitation is what I focus on in my work. In order to provide worthwhile and safe rehabilitation one must know the anatomy, function, biomechanics and neurologic control of the different structures of the knee. It is also very important to know the course of heeling of the graft inside the joint. This is crucial for setting the correct load on the joint during progressively complex exercises. The desired end effect is full stability of the joint and return to activities prior, to injury, at the same level.

2 GENERAL PART

2.1 Anatomy and Function of the Knee Joint

The genual or knee joint is said to be the largest joint in the human body (36). Together with the hip, ankle and foot, it supports the weight of the body. It consists of two articulations namely the tibiofemoral joint and the patellofemoral joint inside one joint capsule. The proximal tibiofemoral articulation is not considered part of the knee joint. The close packed position of the joint is considered to be extension (30).

2.1.1 Tibiofemoral Joint

The Tibiofemoral joint comprises of articulation between the distal tibia and the proximal femur. Other structures that comprise the tibiofemoral joint are the menisci, four main ligaments, iliotibial band and the bursa. It is a double condyloid joint with medial and lateral compartments (30).

Menisci

The menisci are semicircular fibrocartilaginous disks found between the tibia and femur. The anterior horn of the medial meniscus is attached to the anterior cruciate ligament (ACL) while the posterior horn is attached to the posterior cruciate ligament (PCL). The menisci increase the congruence of the joint. The stress is greatly diminished on the cartilage through increased area of contact that the menisci provide. Removal of the menisci doubles the stress on the femoral cartilage and increases it up to seven times on the tibial cartilage (30).

Ligaments

There are four main ligaments in the knee namely being the medial collateral (MCL), the lateral collateral (LCL), ACL, PCL. These ligaments are essential in restraining excessive motion in the joint. They are said to resist hyperextension, varus, valgus, anterior and posterior displacement of the tibia beneath the femur, internal rotation (IR), external

rotation (ER) of the tibia beneath the femur and combinations of the previously mentioned directions (30).

Lateral Collateral Ligament

The LCL originates from the lateral femoral condyl and attaches to the fibular head. The LCL mainly limits varus stress and that best at full knee extension (30).

Medial Collateral Ligament

The MCL is located on the medial side of the tibiofemoral joint. The MCL is the primary restraint to valgus and ER stresses. It is taut in extension and then can resist these stresses the best. In flexion the MCL has the biggest responsibility for restraining valgus taking as much as 78% of the load in 25 degrees of flexion. The MCL supports the ACL in resisting anterior translation of the tibia on the femur (30).

Posterior Cruciate Ligament

The PCL is an intracapsular and extrasynovial ligament. It attaches to the posterior tibial spine and then travels superiorly and slightly anteriorly to attach to the femur on the lateral aspect of the medial femoral condyl. The PCL is shorter than the ACL but wider with its cross sectional area being up to 150% greater than that of the ACL. The PCL is said to be made up of two bundles namely being the anteromedial (AMB) and the posterolateral (PLB). Functionally, the PCL is the main restraint against posterior translation of the tibia. It absorbs as much as 93% of the load during full extension in the knee. It also acts as a secondary restraint against valgus, varus and IR (30).

Anterior Cruciate Ligament

The ACL is an extrasynovial intracapsular ligament made up mainly of type I collagen (90%) (3). It starts to develop at approximately the 7th gestational weak together with the rest of the knee joint (3, 10). By the end of the 14th gestational week the ACL and the PCL divide into separate ligaments (10). On average the ACL is 38mm long, ranging between 25 and 41mm; and 10mm wide, ranging between 7 and 12mm (35).

It attaches on the tibia to the tibial spine and to the fossa anterior and lateral to that spine (35). The ACL then travels posteriorly, laterally and superiorly to attach to the femur. On the femur the attachment site is on the posteromedial aspect of the lateral femoral condyl. The ACL is said to be made up of two to three bundles: the AMB, PLB and, by some included, the intermediate bundle. These bundles are rather a functional subdivision than an anatomical one (30).

Functionally the ACL is the main restraining force against anterior translation of the tibia below the femur. The AMB is more tight in flexion while the PLB is more tight in extension thus some part of the ACL is tight throughout the whole range of motion (ROM) (figure 1). Together they absorb as much as 75% of the load during extension and 85% of the load during 30 and 90 degrees of flexion (35). In addition the ACL resists hyperextension of the knee and acts as a secondary restraint against valgus and varus stress. It also assists in preventing IR and ER of the tibia. The IR, however, strains the ACL especially between 10 and 15 degrees. During flexion and IR the ACL is tensed over the PCL. During flexion and ER the ACL is stretched over the lateral femoral condyl (30).

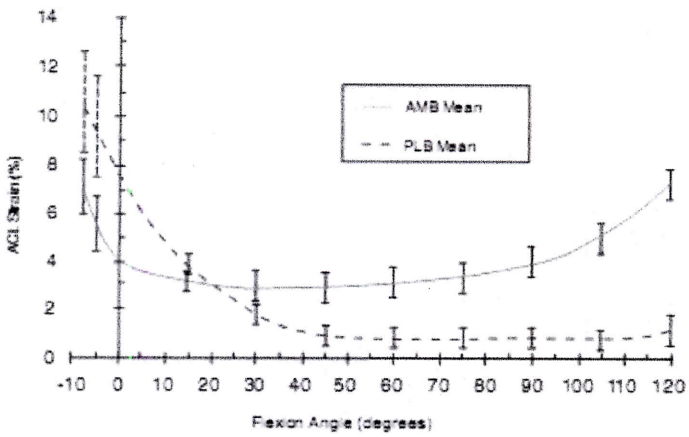

Figure 1 Strain sustained by the AMB and PLB at different flexion angles (30)

Iliotibial Band

The iliotibial band passively reinforces the anterolateral aspect of the knee always remaining tight without regards for flexion or extension either in the knee or hip. It assists the ACL in restraining the anterior tibial translation in both flexion and extension (30).

Bursae

There are three main bursae in the knee namely being the suprapatellar, subpopliteal and gastrocnemius. The bursae are connected to the synovial sheath and allow the synovial fluid to move during movement in the knee. During extension the fluid moves anteriorly (figure 2a). During flexion the opposite occurs (figure 2b). The least amount of pressure is exerted on the fluid during semiflexion (figure 2c) thus being the preferred position during effusion of the joint (30).

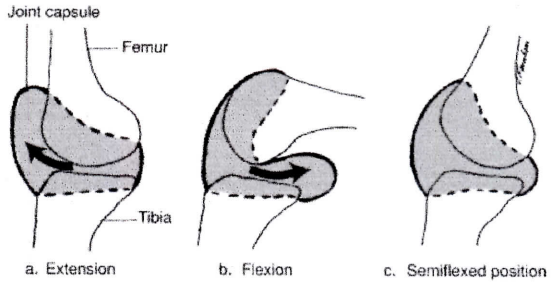

Figure 2 Movement of fluid in joint during (a) extension (b) flexion and (c) semiflexion (30)

2.1.2 Patellofemoral Joint

The patellofemoral articulation comprises of the patella and anterior part of the femur. The patella is trapped in the quadriceps tendon and attached via the patella tendon to the tibial tuberosity. The main function of the patella is to act as a pulley for the quadriceps muscle and reduces the friction between this tendon and the femoral condyles. The incongruence of this joint complicates this task. The patella moves in relation to the movement of the femur and the tibia. Patellar flexion is used to describe the motion of the patella when it moves caudally under the femoral condyles during tibial flexion on the femur. Patellar extension is the opposite movement. The patella is also able to laterally and medially tilt, shift (figure 3) and rotate. Caudal and cranial translation of the patella during flexion and extension are important for the ROM of the knee joint and proper function of the quadriceps (30).

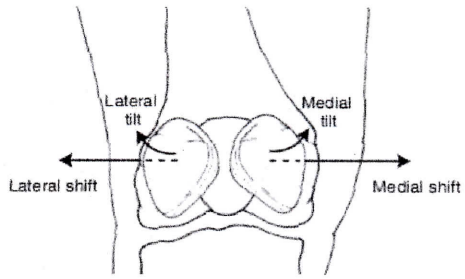

Figure 3 Movement of the patella on the femur (30)

2.1.3 Muscles

Generally speaking the muscles around the knee are divided into the flexor and extensor groups according to the function they have. Although the soleus and gluteus maximus do not cross over the knee they still have a considerable impact on the knee itself. If the leg is fixed on the ground the soleus is able to assist in knee extension by pulling the tibia posteriorly (figure 4). This in fact assists the ACL in resisting the anterior translation of the tibia. Similarly, the gluteus maximus produces a posterior shear force but this time on the femur resulting in an anterior shear force on the tibia and an increased load on the ACL (figure 4) (30).

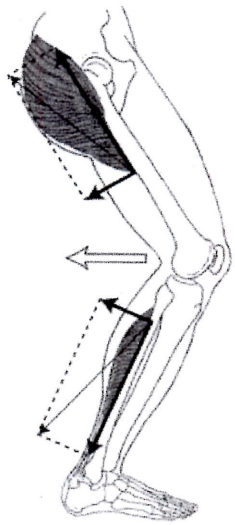

Figure 4 Impact of gluteus maximus and soleus on the knee joint (30)

The Flexor group

The flexor group consists of the following muscles semimembranosus, semitendinosus, biceps femoris, sartorius, gracilis, popliteus, and gastrocnemius. Functionally the hamstrings are best able to flex the knee with a flexed hip joint. With increasing flexion these muscles produce an increasing amount of posterior translation of the tibia thus supporting the role of the ACL (30).

The gastrocnemius contributes minimally to knee flexion and that best at full knee extension. When the muscle actively contracts or is passively stretched it is able to produce anterior shear force on the knee in effect increasing the load on the ACL. The gracilis m. action, along with the other muscles of the pes anserinus, is mainly to dynamically stabilize the medial aspect of the knee. In addition to assisting flexion the popliteus muscle externally rotates the knee and thus is the main muscle in the unlocking mechanism in the joint, further discussed in following sections (9, 30).

The Extensor group

The extensor group comprises entirely of the quadriceps muscle. The action of the muscle, as already mentioned, greatly depends on the patella and its position. The patella acts as a

complex pulley, with the tension in the quadriceps tendon being always greater than the tension in the patellar tendon. With increased extension of the knee, by way of the patella, the quadriceps muscle is able to produce greater and great force, not only into extension, but also an anterior pull of the tibia. This shear force is greatest at almost full extension and greatly diminishes beyond 60 degrees of flexion (figure 5). In effect the extension of the knee via the quadriceps muscle greatly strains the ACL (30).

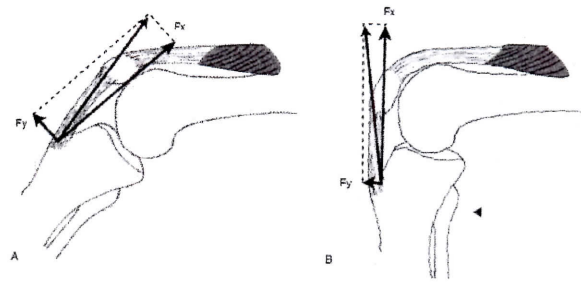

Figure 5 Force exerted on tibia by the quadriceps during (A) extension and (B) flexion (30)

2.2 Biomechanics

2.2.1 Kinematics

The primary movements of the knee are the flexion and extension. IR and ER of the tibia beneath the femur are also possible as are adduction and abduction. Joint play mainly the anteroposterior, and to a lesser extent the medial lateral, translation of the tibia are crucial for normal motion of the knee joint but if are in excess or are not checked by the passive or active stabilizers may cause damage to the integrity of the joint (30).

Flexion and Extension

Generally speaking, the axis of tibiofemoral flexion and extension is a horizontal line through the femoral epicondyles. The range of these motions greatly depends on the position of the hip and ankle as most muscles around the knee cross two joints. Normal passive ROM for flexion is approximately 130 to 140 degrees and for extension 0 – 5 degrees. Active knee flexion, in combination with hip flexion, can be as much as 160 degrees. Gait on level ground

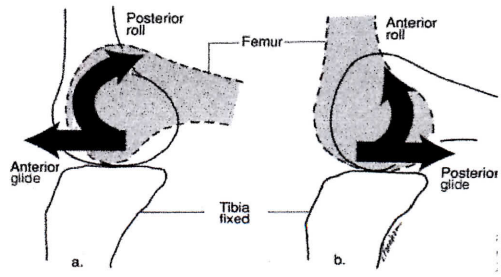

Figure 6 Movement of the femur on the tibia during (a) flexion and (b) extension (30)

requires a mere 60 – 70 degrees of flexion while walking up stairs approximately 80 degrees (30).

In the first 25 degrees of flexion of the femur on the fixed tibia, the femoral condyles roll posteriorly on the tibial plateaus. If flexion is continued beyond this angle the roll of the condyles has to be accompanied by an anterior translation of the femur (figure 6a). In extension exactly the opposite happens (figure 6b). In flexion of the tibia on the fixed femur the tibia roles and glides posteriorly on the femoral condyles. Again in extension the opposite happens (30).

As the knee is flexed and the femur roles posteriorly on the tibia the ACL checks this movement and exerts an anterior translation force on the femur (figure 7A). In opposite the PCL exerts a posterior translation force on the femur in extension (figure 7B). Muscles that perform these movements have been discussed in previous sections (30).

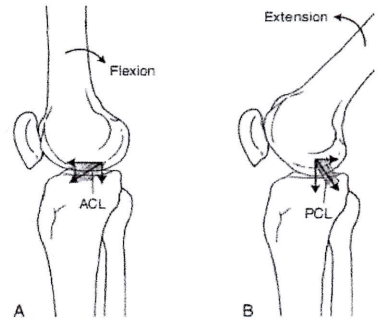

Figure 7 Force exerted (A) by the ACL during flexion and (B) by the PCL during extension (30)

Internal and External Rotations

Internal and external rotations refer to the movement of the tibia on the femur. The longitudinal axis for these movements runs through the medial tibial intercondylar tubercle. The ROM of these movements largely depends on the degree to which the knee is flexed. When the knee is extended there is little or no rotation possible because of the close pack position of the joint. Maximal rotation occurs at 90 degrees of knee flexion. The internal rotation is approximately 0 – 15 degrees while the external rotation is 0 – 20 degrees. The amount of rotation again decreases when full flexion is approached. Internal rotation of the tibia is produced by the popliteus, gracilis, sartorius, semimembranosus, and semitendinosus muscles while the external rotation by the biceps femoris muscle (30).

Valgus and Varus

Valgus and varus occur to a small degree in the knee joint but, again, are important to normal knee function. In full extension only about 8 degrees of either movement can occur. At 20 degrees of knee flexion this increases to 13 degrees. Excessive varus or valgus indicate ligamentous insufficiency. Valgus moments on the knee are produced by the lateral group of muscles namely the biceps femoris, lateral head of the gastrocnemius, and the popliteus. Varus moments are produced by the medial group namely being semimembranosus, semitendinosus, medial head of the gastrocnemius, sartorius, and gracilis (30).

Coupled Motions

Most of the above mentioned movements do not occur by themselves but in combination with one another. Flexion is considered to occur with abduction while extension with adduction. Automatic rotation is referred to the coupling of internal rotation with extension in the last 30 degrees of the movement. This is also known as locking or the screw home mechanism. Unlocking the knee is necessary prior to the initiation of flexion and this occurs with external rotation of the tibia (30).

2.2.2 Load

Tibiofemoral Joint Load

Both muscle tension and weight bearing contribute to compression and shear forces on the joint during activities of daily living. Compressive forces are prevailing in extension. These forces increase up to three times the body weight during stance phase and four times body weight during ascent of stairs. The menisci can absorb as much as 45% of the total load. The shear stress on the knee begins to occur when flexion of the knee increases to 90 degrees. This shear stress is what causes anterior translation of the tibia and has to be controlled by both passive and active stabilizers as already mentioned (9).

Patellofemoral Joint Load

As the tibiofemoral joint, the patellofemoral joint can undergo great stress during activities of daily living (30). These forces increase up to half the body weight during normal walking and three times body weight during ascent of stairs. Besides the fact that increasing flexion increases the compressive component of force, increasing flexion also requires greater activity or tension from the quadriceps muscles to prevent buckling (9).

2.2.3 Biomechanics of the ACL

During normal gait there is a load of about 400N to 500N on the ACL. This load is increased up to 1700N, or up to four times, during cutting and accelerated movements. The ultimate tensile load that the ACL can bear is 2160 ± 157 N and the stiffness is about 242 ± 28 N/mm. The greatest stress on the ligament has been found to be between 0 and 45 degrees while the greatest translation allowed by it between 20 and 30 degrees of knee flexion (4, 35).

If the ACL is sectioned the iliotibial band produces the greatest passive restraint (24%) against anterior translation of the tibia. This is followed by the middle of the medial capsule (22%), the middle of the lateral capsule (20%), the MCL (16%) and lastly the LCL (12%) (35).

2.3 ACL Injury

ACL injuries are the most common injuries to the knee especially in sports (10). Main high-risk sports that contribute to ACL injuries are basketball, football, gymnastics and skiing. Women are 2.4-9.7 times more likely to have an ACL tear than men. In younger patients it is most often due to football and basketball while skiing is the most common cause for the older patients (11, 35). The ACL may be elongated up to 30% of its length before any tear occurs. It tears when it is stretched beyond its elasticity. After the tear the ligament is unable to heal (11, 17).

The ACL injury can be classified according to the extent of the injury as follows (22):
Grade 1, in which the ligament is stretched, but not torn.
Grade 2, where the ACL is partially torn.
Grade 3, in which the ACL is completely torn and instability, or looseness of the joint, occurs.

2.3.1 Mechanism of Injury

The Non Contact mechanism is one in which the patient usually hears a popping sound caused by deceleration, changing directions, cutting (fast running with lateral movement) or landing from a jump. Hyperextension and pivoting forces are the main factors responsible for this (35). Concerning jumps, planting and cutting is responsible for about 29% of injuries, straight knee landing for 28% and landing with hyperextended knee 26%. Quadriceps excentric contraction is said to produce as much as 6000N force which is much more than the ACL can endure, thus it may be one of the main reasons for non contact ACL tears. If quadriceps activation causes an ACL tear this means that there is a problem with hamstring activation (delayed activation) as these muscles act as dynamic stabilizers helping the ACL, a static stabilizer. An especially dangerous position of landing has been found to cause ACL injuries: flexed trunk, abducted hips, IR/ER knees with valgus and pronated foot (17).

Contact mechanism is usually associated with injuries to other structures in the knee. An example of which is the so called "terrible triad" where a lateral blow to the knee causes valgus stress resulting in injury to the ACL, MCL and medial meniscus (11).

2.3.2 Symptoms

An acute injury usually involves a popping sound (60%), hemarthrosis and pain. As much as 75% of patients with acute hemarthosis have an ACL rupture (5). Other symptoms may include decreased strength, range of motion, inability to bear weight, poor balance and

coordination (26). Great instability will be present in two thirds of the patients while only minimal instability will be present in the remainder (35).

About one third of ACL tears are associated with the menisci tears at the time of the injury. Further meniscal tears are caused by the anterior instability that results from an ACL tear. This is also said to cause degenerative arthritis. The longer that an ACL injury goes untreated the more damage it causes to the cartilage in the knee (35).

2.3.3 Risks and Gender Differences

There are many factors that predispose people especially women to ACL injuries. Generally the risk factors can be divided into anatomical, biomechanical, neuromuscular and hormonal.

Anatomical and Biomechanical

- A smaller intercondylar notch width index is said to be found especially in women, as well as athletes that sustain ACL injury, and probably causes a shearing effect on the ACL by the femur. It could, however, be only an indication of a smaller thus weaker ACL.
- The actual width of the female ACL has been found to be 14mm smaller than that of a male.
- Increased laxity of the ligaments is usually found in females but is a controversial topic.
- Increased Q angle in the knee results from a wider pelvis in the females. This increased angle causes additional stress on the knee and also causes femoral anteversion, tibial external torsion, and subtalar pronation (17, 26).

Neuromuscular

- Unsatisfactory balance between the quadriceps – hamstring mechanism with a greater use of the quadriceps and a delayed firing of the hamstrings.

- Incorrect landing strategies that cause an increased valgus force can lead to an ACL injury (17, 26).

Hormonal

This is still a controversial point in research. While some studies support the fact that female hormones may alter the laxity of the ligament during the menstrual cycle others deny it altogether. Those in support claim that there is a greater laxity and thus a risk of injury during the high estrogen phase of the cycle (17, 26).

2.4 Examination

2.4.1 Anamnesis

This is one of the most important parts of the examination. Popping sound, as already mentioned is heard by most patients with almost immediate swelling following. The symptoms and mechanism of the injury should be assessed according to the previous sections.

2.4.2 Physical Examination

The physical examination is more important in the acute state of the injury. It is important to look for signs of swelling, contusion and bleeding under the skin, decreased ROM and antalgic gait. Patients might also minimize quadriceps usage during gate. Decrease in ROM may be due to hamstrings spasm, blockage of the joint with the torn ACL, swelling or associated injuries. Examination of other soft tissues in the knee should be made as they are often injured together with the ACL (4).

2.4.3 Imaging

Radiographs and Magnetic Resonance Imaging

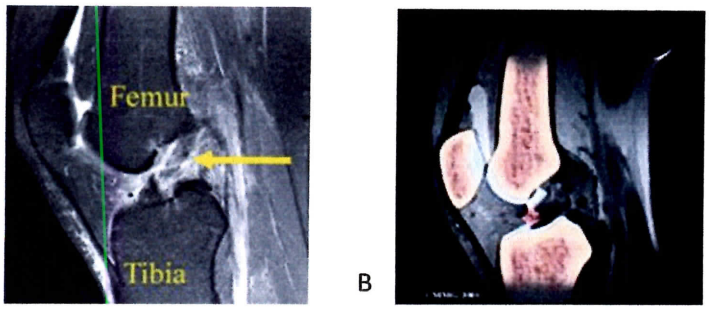

Figure 8 MRI of torn ACL shown with (A) an arrow and (24) (B) artistic enhancement (6)

Radiographic images are usually negative but can be used to exclude fractures of the tibia. Magnetic resonance imaging is used to confirm an ACL tear and evaluate associated pathological findings (figure 8). It has 90 – 98% sensitivity for ACL tears. It is also possible to see bone bruising which is present in 90% of the ACL tears (11).

Arthroscopy

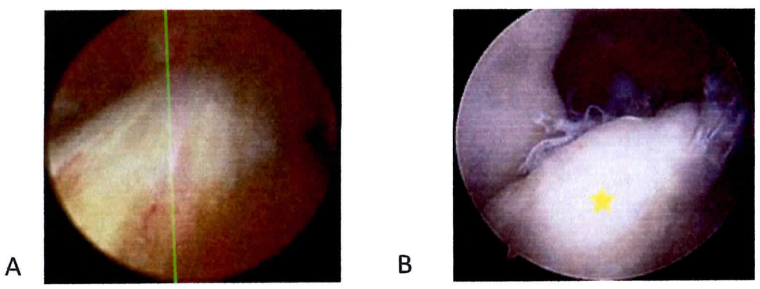

Figure 9 Arthroscopic image of (A) normal ACL and (B) torn ACL indicated by star (24)

Arthroscopy can be used both for diagnostics and surgery. In this procedure it is possible to see, by means of camera, inside the joint. Arthroscopy, as a diagnostic tool is used when in doubt as to what is really causing the symptoms or if there are multiple injuries (6). Figure 9 shows the difference between an intact and a torn ACL as seen through the arthroscope.

2.4.4 Anterior Instability Tests

The following tests may be positive if there is an ACL tear (25, 35):

- Lachman Test - the most sensitive test
- Pivot Shift
- Clunk test or Hughston's jerk test
- Losee's test
- Anterior Drawer test - not every ACL rupture has a positive anterior drawer test.
- Slocum's anterolateral rotary instability test

4.5 Other Tests

KT 1000

This is a device or arthropometer that measures laxity of the ligament similar to the Lachman test. It is said to be positive, or indicate ACL tear if there is greater than: 11mm of anterior translation, 3 mm of side to side translation (than on the uninvolved lower extremity), or 2mm compliance index (35).

One leg hop test

Patient is asked to hop the greatest distance with one leg. The mean of the three jumps is compared to the healthy side as a percentage. The grading is as follows: Normal: greater than 90%, Nearly Normal: 89% - 76%, Abnormal: 75% - 50%, Severely Abnormal: less than 50% (25).

Subject Tests

There are several tests used to asses the subjective feeling and function that is intact. Several accepted subjective forms exist such as the International Knee Documentation Committee (IKDC) Subjective Form (see supplement). The results of this form can be calculated and used for later comparison (12).

2.5 Treatment

2.5.1 Decision

Once the patient is diagnosed with an ACL rupture, a decision as to what kind of treatment is best for that individual has to be made considering several factors.

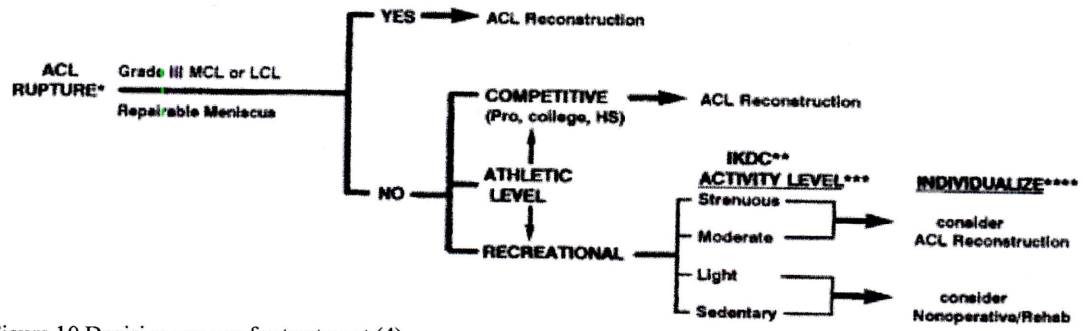

Figure 10 Decision process for treatment (4)

The diagram above illustrates the way one author approaches the decision process. Some authors think it necessary to include age as one of the factors but others say more weight should be given to the level of activity that is necessary for the person's life, work or sport activities and the functional disability that the person may experience with his knee (24). This information can be partially received from the subjective forms previously mentioned.

The possibility of altering the present activities to decrease risk of knee instability should always be considered first. If there is, however, a high incidence of functional instability then there is a high risk of developing secondary damage to the knee and the surgical method is advised (24).

Associated injuries are a major factor in making the decision. As seen in Figure it is the first step in the decision making process because it is said that most combined injuries produce better results with a surgical solution (24). Age can be a significant factor in adolescent top sport athletes because surgery may damage the growth plates and result in complications. One solution is to have non-surgical treatment first and then surgical when

the child is closer to skeletal maturity. Another option is to perform surgery but with a modified technique (5).

2.5.2 Surgical Treatment

Once surgical treatment is decided to be the best option, many other things have to be considered. First of importance is the time of the surgery in relation to the injury. The outcome of the surgery may mainly depend on the graft used, the tunnel placement, type of graft fixation used and the rehabilitation used before and after the surgery.
Surgical approaches are divided into three types (11, 24):

- Primary repair – recommended only for patients with bony avulsions, usually adolescents.
- Extra-articular – usually tenodesis of the iliotibial tract which prevents pivot shift but not anterior tibial translation
- Intra-articular – arthroscopic technique which uses one or two incisions and reconstruction using a graft. Currently this is the most popular technique. It involves firstly the removal, trimming and/or repair of menisci and cartilage as well as the removal of the torn ACL. Depending on the type of graft, it may need to be harvested. Then tunnels are drilled into the tibia and femur and the graft threaded through and fixated.

2.5.2.1 Timing

Most authors agree that too early a surgery can be later complicated by arthofibrosis limiting the postoperative ROM (11). Some authors suggest that this limitation of ROM and muscle power difference is only significant in the first phase post operation and the difference ceases to be significant later in the recovery process (23). Very delayed reconstruction is also unfavorable as it can result in meniscal injuries and degenerative changes (2). Thus by most authors the recommended time for surgery would be between the 3rd and 12th week after injury. At least one author, however, says that early surgery takes advantage of the second phase of healing or arthofibrosis to revascularize and

regenerate the graft (5). Thus the author suggested that surgery should be done no later than a weak after the injury.

Some factors have to be considered when deciding upon the time of the surgery (29):

- mental preparation of the patient
- school, work, family, and social schedules
- preoperative condition of the knee
  - minimal or no swelling
  - good strength
  - good leg control
  - full ROM
- associated ligamentous and/or meniscal injuries

2.5.2.2 Graft

Quite a lot of research has been put into the efficiency of the varying type of grafts that are available. Most graft types may be separated into autografts, allografts, and syntheric grafts.

Autograft

Patellar tendon (BPTB) Figure 11

Figure 11 Patellar tendon autograft prepared for ACL reconstruction. (24)

This is the most common choice of graft. Suitable for athletes that participate in high risk sports with cutting and pivoting movements. Not suitable for people who do a lot of kneeling (24). The graft is taken from the central third portion of the patellar tendon with bone plugs from the tibia and patella.

Advantages

- lower rate of failure 1.9% (24)
- bone to bone healing considered fastest and strongest

- tendon length almost equals ACL length (26)
- excellent early strength (17)
- higher percentage of stable knees (11)
- longer history of success
- greater number return to high level of activity (10, 11)

Disadvantages

- more frontal knee pain – 10 – 40% (10, 11)
- more kneeling pain (26)
- harvest site morbidity
- patellar tendonitis, which usually subsides after the first year
- quadriceps weakness
- patellar stiffness which may lead to patello-femoral compression and late chondromalacia of the patella
- late patellar fracture (17)
- higher incidence of numbness around the scar
- higher extension deficit
- perhaps greater prevailance of osteoarthritis (4)

Hamstrings / Semitendinosis

Hamstring graft is taken from the semitendinosis and sometimes gracilis as well. The graft can be made into 2 or 4 bundles.

Advantages

- four bundles are stronger than the patellar tendon – 250% stronger than ACL
- four bundle (semitendinosis gracilis) is 2x as stiff as the patellar tendon and 3 times that of ACL (17)
- faster recovery (11)
- less frontal knee pain – semitendinosis has only 3 – 21% (10, 17)
- little or no weakness of hamstrings (17)

- less post operative stiffness
- smaller incision (than for the patellar tendon graft (24)

Disadvantages

- residual hamstring weakness (10, 24)
- more prone to elongation or laxity (11, 34)
- graft harvest difficult especially if tendons are cut short
- graft healing is longer – 10-12 weeks
- graft must be fixated to bone (17)
- single bundle is only 70% as strong as the ACL
- more prone to graft failure – 4.9% (24)

Quadriceps tendon

Used mainly for patients who are having re-surgery due to previous graft failure. It is suitable for tall heavy patients as large grafts may be harvested. The middle third of the quadriceps tendon is used with a bone plug from the patella at one end (24).

Advantages

- less harvest site morbidity
- large area from which to take the graft (17, 24)

Disadvantages

- bone block only at one end – graft fixation not as solid
- anterior knee pain
- patellar fracture (17, 24)

Allograft

Allografts are grafts taken from cadavers. Usually the patellar or Archilis tendon are used. They are suitable for patients who are going for re-surgery or whose own ligaments will not suffice for the job (17, 24).

Advantages

- good fixation if patellar tendon is used
- no pain associated with the harvest site
- no harvest site morbidity (17, 24)

Disadvantages

- risk of infection
- longer time necessary for healing
- strength depends on donor (older donors will have weaker grafts)
- not readily available (17, 24)

Synthetic

There have been made attempts to design a successful synthetic graft which would iliminate all the problems associated both autografts and allografts. Most of the trials have been unsuccessful (11, 17).

Advantages

- no harvest site morbidity
- no risk of infection (11, 17)

Disadvantages

- higher rate of late graft failure
- compression and late chondromalacia of patella may occur
- late patellar fracture
- risk of loss of range of motion
- aseptic effusion (11, 17)

2.5.2.3 Tunnel position

Proper tunnel position is the first step to a successful reconstruction of the ACL. Bad tunnel positioning may result in stiffness, laxity or impingement leading to graft failure

Table 1). Both the tibial and femoral tunnels have to be made using the anatomical footprints of the original ACL.

Table 1 The effect that bad tunnel positioning has on graft laxity. Reproduced from (3)

		Too posterior	Too anterior
Femur position	Extension	Tight	Loose
	Flexion	Loose	Tight
Tibia position	Extension	Tight	Loose
	Flexion	Loose	Tight with impingement

2.5.2.4 Potential Complications

- graft failure (8% rate)
    - arthrofibrosis secondary to inflammation of synovium and fat pad
    - motion limited by pain
    - instability secondary to graft laxity or poor surgical technique (2 – 10%)
    - re-rupture due to re-injury or rehabilitation (2.5%) (11, 24)
- frontal knee pain especially if BPTB autograft was used (4 – 45%)
- kneeling pain in BPTB (up to 42%)
- knee stiffness in general (5- 25%) (24)
    - into extension secondary to arthrofibrosis, Cyclops lesion – residual tissue anterior to ACL graft (4), graft impingement, degenerative change
    - into flexion secondary to arthrofibrosis, PCL impingement, degenerative changes (34)
- limitation of ROM by scar tissue (10)
- numbness lateral to the incision
- occasional swelling
- infection especially with allograft (0.2 – 0.048%)
- patellar fracture in patellar tendon or quadriceps tendon autografts
- patellar tendon rupture in patellar tendon autograft
- reflex sympathetic dystrophy (< 1%)
- neurovascular complication (<1%)

- deep venous thrombosis (0.12%)
- weakness or paralysis of leg or foot
- accelerated degenerated arthritis
- ankylosis
- fat pad fibrosis
- heterotopic ossification (4, 11, 24)

2.5.2.5 Prognosis and Return to Activities

Long term success rate of surgical treatment of ACL is about 82 – 95%. Failure rate is about 8%. Residual knee pain and instability is seen in 3 -10% of patients. An estimated 40 – 50% of patients have pain and swelling only when engaged in strenuous sport. The remaining 50 – 60% have pain and swelling even with milder activities (26).

Full reincorporation and revascularization of the graft tissue occurs at about 5 – 6months. This is when the graft is stable and resembles normal connective tissue. Other things to be considered before return to activities is allowed are full ROM, strength and coordination (28). Sport specific activities may be started once the quadriceps strength reaches 65% of the healthy lower extremity (LE) usually between 5 – 8 weeks after the operation. Athletes may return to sport when quadriceps strength reaches at least 80% usually after the 3rd month after the operation (11). Sport specific training is usually a requirement for this. Most doctors allow patients to compete in sports after the 6th month (28).

2.5.3 Non-Surgical

Non surgical treatment generally involves physiotherapy, changing of activities and some physicians also recommend the use of a brace. Physiotherapy is aimed at strengthening the muscles on the lower extremities (LEE) especially around the knee to substitute for the ACL. In general the rehabilitation, as part of the non-surgical solution, is said to be faster and less painful than the post operative rehabilitation. Since the ligament itself will still be torn after the treatment the patients will probably have to continue with, a less vigorous,

exercise program for the rest of their life in order to maintain knee stability. Return to normal activities can be expected after the first month. These activities would have to be modified so as to not put the knee in further danger. All high risk sports that involve cutting and pivoting mechanisms would have to be eliminated. Cyclic activities such as jogging and cycling can be continued. Most people return to their previous activities, though at a lower level, by the 3rd year after the injury and are said to be symptom free for another 15 years (10).

2.6 Rehabilitation

In general there are three rehabilitation programs that patients are referred for. The pre-operative rehabilitation may or may not be considered depending on the state of the patient and the time before surgery. Non-operative rehabilitation is prescribed for all patients that will not be undergoing a surgical procedure in the near future. Post operative rehabilitation is one of the most controversial of the three rehabilitation programs and this is the area that I will give most wait to, seeing that in the following section this knowledge will be applied practically.

Early Weight Bearing

Tyler et al compared immediate weight bearing as tolerated and a delay of any weight bearing until 2 post operative weeks. The study showed that there were in fact no bad implications of early weight bearing and may even bring to an early regain of vastus medialis oblique thus decreasing anterior knee pain. In practice, most practitioners, however, recommend the use of crutches till the 2nd postoperative week (38).

Postoperative Bracing

This has remained a very controversial problem. It is not only the question of whether to brace after surgery but also for how long this brace should stay on and what ROM should it allow. In essence braces limit the ROM to set ranges in order to protect the knee from excessive varus and valgus stress. Most studies do not show worse outcomes in patients that were not braced. Studies have shown that there was no increase in postoperative

injuries, pain, knee laxity or a decrease in ROM in non braced individuals. Thus, braces are not a necessary part of rehabilitation program after surgery (38).

Continuous Passive Motion

Continuous passive motion is the use of a machine for passive movement of one LE. The use of this machine has been confirmed not to increase laxity but also has not seen many advantages besides the possibility to decrease pain (38).

Active versus Passive Extension

Early active extension doesn't seem to increase knee laxity and thus there should not be any reason to exclude it from the therapy plan (33).

Neuromuscular Electrical Stimulation

Neuromuscular electrical stimulation does not seem to be very beneficial unless applied in high intensity early in the postoperative rehabilitation. It may help improve quadriceps strength but is not a necessity for successful rehabilitation (39).

Accelerated Rehabilitation Program

Accelerated rehabilitation is generally accepted as a rehabilitation plan of 5 or 6 months. This type of plan does not seem to have any bad effect and may even have a better compliance rate by the patients probably because of the shorter time. It is now quite common to use the accelerate rehabilitation program (39).

Open versus Closed Kinetic Chain Exercises

Closed kinetic chain (CKC) exercises are said to better the neuromuscular control of the hamstrings. Open kinetic chain (OKC) exercises have been said to put more strain on the body's joints and their components. OKC have been shown not to increase knee laxity if added in addition to CKC at 6 postoperative weeks and might also improve quadriceps strength and better the return to sports. Another study, however, suggests that early implementation of OKC can result in increased knee laxity. The use of OKC seems not to increase postoperative pain (33, 39).

Proprioceptive training

It is known that patients with a ruptured ACL have decreased proprioception. Proprioceptive and neuromuscular control deficiencies persist up to 6 to 12 postoperative months and seem to be worse in females. Proprioceptive training seems to be as beneficial as strength training. It should be included in the exercise plan first with CKC exercises and instable platforms followed by plyometric exercises (33, 39).

Eccentric Exercises

Eccentric exercises are those in which a muscle is required to do negative work against a load. These muscle contractions produce 2 to 3 times greater force than do isometric or isotonic contractions and may thus overload muscles more. If these exercises are introduced gradually into the therapy program after the third week they have been found to increase muscle strength and mass while being safe for the joint (8).

Other issues

It seems that water based therapy, stair climbers and slide board exercises don't pose any threat to the patient and may be used to diversify the program. Psychological intervention aimed at relaxation may facilitate recovery (39).

2.6.1 Major problems to be addressed in Rehabilitation

Major issues that must be addressed in rehabilitation are muscle weakness, decreased range of motion, scar, swelling, decreased proprioception, pain, psychological problems, incorrect gait, blockages in sacro-iliac joint, patella, fibula, peripheral joints and altered movement stereotypes.

2.6.2 Pre – operative Therapy

Goals of pre operative therapy are to: reduce swelling, regain full extension and maximum pain free flexion, regain strength of the LE and gait training. Contraindications are open chain exercises, pivoting and cutting movements.

2.6.3 Non – Surgical Therapy

In addition to the goals mentioned in preoperative therapy, non surgical therapy also involves proprioceptive, neuromuscular training, correction of bad stereotypes and specific training according to need (7).

2.6.4 Post Operative Rehabilitation

This is a general idea of how an accelerated rehabilitation plan would look like (tables 2 to 6). It is my own compilation of several sources (3, 5, 19, 26, 27, 33, 37) as well as knowledge I gained from my practice. Stages subsequent to the first one indicate only additions or changes that are added to the program in that period. Most techniques are used until the desired physiologic effect is achieved. An arrow (>) indicates progression from one exercise to another during that stage of therapy.

Week 1 – 2

Table 2 Rehabilitation plan for week 1 and 2

Type	Description, muscles, joints involved	Goals, notes
Pain	analgesics	
Swelling	cryotherapy	
Scar	soft tissue techniques	
Gait	with crutches, bearing as much weight	
ROM	knee	passive, active F 90, E 0
	hip	in all directions
	ankle	in all directions, pump
Mobilization	patella	
	fibula	
	peripheral joints	
Stretch	iliopsoas	
	hamstrings	hip and knee parts
	quadriceps	
	triceps surea	
Strengthen	quadriceps	isometric>assistive active>active
	hamstrings	isometric>active to 90
	hip muscles	F, E, ABD, ADD
	closed chain	mini squat
	sit to stand (+visa versa) exercise	
Modalities	cryotherapy	
	electrical stimulation	
	biofeedback	

Week 3 – 4

Table 3 Rehabilitation plan for weeks 3 and 4

Type	Description	Goals
Pain	controlled	
Gait	bearing as much weight training without crutches	gradually lay off crutches normal > heal, toe
ROM	knee	active F 120, E 0
	hip, ankle	against resistance
Mobilization	as long as blockage is present	
Strengthen	hamstrings	active > against resistance
	plantar flexors	heal raise 2 LE > 1LE
Proprioceptive	balance boards	2 leg stance > 1 leg stance. Step up
	weight bearing	forward, back, side to side
Modalities	only if necessary	

Week 5 – 6

Table 4 Rehabilitation plan for weeks 5 and 6

Type	Description	Goals
Gait	walking on treadmill	forward, side, back
	heal, toe, straight line	
ROM	knee	active F 135, E 0
	bicycle	with minimal resistance
Strengthen	quadriceps, hamstrings	against resistance, free weights, machines
	closed chain	wall sits
Proprioceptive	+ posturomed	multiple boards, 1 LE stance > with closed eyes, ball throwing > with weights
	soft mat	gait with correct joint position
Other	pool	
	stair climber	low resistance
	ski machine	
Modalities	magnet	
	whirlpool	

Week 7 – 12

Table 5 Rehabilitation plan for weeks 7 through 12

Type	Description	Goals
Gait	heal, toe, straight line	> closed eyes
ROM	LE	equal to opposite LE
	bicycle	resistance
Strengthen	closed chain	leg press
Proprioceptive	+ trampoline	multiple boards, ball throwing in different directions, mini squat
Other	swimming	crawl

Week 13 – 24

Table 6 Rehabilitation plan for weeks 13 through 24

Type	Description	Goals
Gait	treadmill, level surface	jogging >running> backwards
Agility	running	zig zag, figure 8, shuttle
	stairs > hills	up > down
Proprioceptive	+ balance shoes	combination of equipment, jumping, running on tramp, squats with greater flexion
Other	jog > run	

> Week 25

- Agility training
- Sport specific training (if required)
- Full return to sport, hobbies, work

2.6.5 Different Approach to Therapy in Prague

In the city of Prague, as most other places, there are different views on bracing, rehabilitation and when and how it is safe to return to sport. The following (table 7) is a summery of the major differences in the therapy approach in patients after reconstruction of ACL in 8 hospitals/clinics in Prague (31). These facilities namely being Fakultní nemocnice Královské Vinohrady (FNKV), Rehabilitační klinika Malvazinky (Malvaz.), Fakultní nemocnice Na Bulovce (Bulovka), Nemocnice Na Homolce (Homol), Ústřední vojenská nemocnice (UVN), Fakultní nemocnice v Motole (Motol), Centrum léčby pohybového aparátu s.r.o. (CLPA)

Table 7 Comparison of therapy approach in Prague

	FNKV	Malvaz.	Bulovka	Homol.	ÚVN	Motol	C.L.P.A.
Brace	Yes	No	Yes	Yes	Yes	Yes	Yes
Brace ROM	60-70°	x	0-90°	0-90°	20-40°	0-90°	0-60° 0-90°
Brace–time indicated	3 weeks	x	4 weeks	4 - 6 weeks	24 hours	10 days*	4 weeks
Rehabilitation	No	No	Yes	No	No	Yes	Yes
Sport training	End of 4.month	End of 4.month	End of 6.month	End of 5.month	End of 8.month	End of 6.month	End of 4.month
Brace for sport	Yes	Yes	Yes**	No	No	Yes**	No

* in practice patients usually wear it for up to 2 months
** individually decided

3 SPECIAL PART

The special part elaborates the case of one patient with reconstruction of the ACL who attended rehabilitation in CLPA starting on 27.01.2009 twice a week on Tuesdays and Thursdays for one to one and a half hours. I worked with the patient for one month, until 19.02.2009, but the patient continued with the rehabilitation afterwards in the same clinic.

In the examination the manual muscle testing was done according to Kendall (18); the muscle length test (15), goniomery (16) and movement patterns (13) according to Janda; and joint play according to Lewit (20).

For the therapy several techniques were used including soft tissue techniques and joint mobilization according to Lewit (20). Post isometric relaxation was used in combination with stretching which was implemented after the end range was reached at the end of the relaxation phase. The positions used for this technique are described by Liebenson (21). Stretching was done at the end of the therapy by the patient himself to prevent muscle cramps and shortening of muscles. Post neuromuscular facilitation was done according to Kabat (1). Gait training was done mainly with demonstration and instructions.

Sensomotoric training, being a major part of the therapy, involved several articles of equipment. These include wabble boards and rocker boards (together called label platforms), propriomed, trampoline, large long flat rope as well as a rubber spiky surface for stimulation before each therapy session. Training itself followed the guidelines laid out by Janda (14) with the exception of the small foot training. Three point stance, described by Vele (32), was constantly emphasized throughout the therapy and trained instead of the small foot described by Janda.

Other equipment that was used includes ergometers (treadmill, stepper, bicycle), free weight machines (into knee extension and into knee flexion), wide bands (or straps) used for stretching, and a stretcher board for triceps surea with adjustable angles.

Patient consent form and approval by the ethics committee can be found in the supplements.

Examined person: B.T.

Gender: Male

Date of Birth: 1981

Main Diagnosis: M23.9 Internal derangement of knee: distortion of right knee with hemarthrosis, detachment lesion of the medial meniscus and ACL

3.1 Anamnesis:

Personal: No diagnosed chronic illnesses.

Childhood Illnesses: Common childhood illnesses

Injuries: 2006 – partial tear of right ACL, 2008 – tear of right ACL

Operations: Appendectomy at 4 years, 05.2006 – arthroscopy of right knee,
13.01.2008 - autograft reconstruction of right ACL

Family: Father, mother alive and healthy. No diabetes mellitus, no cardiovascular diseases

Pharmacologic: None

Allergy: None

Abuse: Does not smoke. Occasional consumption of coffee and alcohol.

Work: Works as geodesist (terrain work) – currently on sick leave. Plays football twice a week (one training and one match), goes to gym 4 times a week for all-round muscle strengthening.

Social: Lives with spouse in an apartment on the third floor without an elevator.

Previous Rehabilitation:

For arthroscopy in 2006 received magnet, whirlpool, exercise with physiotherapist including the use of one label platform 2x/week for a total of 10x. Patient remembers having a prolonged problem with decreased extension in the knee.

For present condition patient has had post operational rehabilitation in Motol.

Post-operation rehabilitation included rest for the first 2 days with training of gait and instruction on exercises two days after the operation. A brace was placed on the right knee after the operation with no limitation in movement. On the third day patient was released and instructed on exercises to be done at home.

Statement from medical documents:

22.11.08 – emergency room after distortion of knee, puncture with 70 ml of blood, X-ray negative, prescribed rigid orthesis (brace)

27.11.08 – puncture of 50 ml, ROM of 0-0-100 in knee, valgus test negative, Lachmann test positive, indication to reconstruction of ACL

12.01.09 - Motol – arthroscopic ACL reconstruction using BPTB with the use of screws for attachment. Surgery without complications

History of present problem: in 2006 received partial tear in the right ACL after small non-contact unnoticed movement. There was an arthroscopy done to remove any debris after which the patient was not bothered by the problem and continued with previous sports regime. On 22.11.08, during football the patient ran, stopped and then quickly turned around after which the ligament fully tore and resulted in the present diagnosis. Arthroscopic reconstruction of the ligament was done on the 13.01.2008 using the middle portion of the patella ligament.

Indication to Rehabilitation:

Therapeutic exercises, mobilization, soft tissue techniques, whirlpool (30 minutes)

Present State:

Weight: 98 kg, Height: 184 cm, Body Mass Index: 28.9

Two weeks after arthroscopic BPTB reconstruction of the ACL. Patient is allowed to put full weight bearing on the right lower extremity (RLE) with commencing of rehabilitation. He feels occasional pain and has a problem with the swelling of the knee. Range of motion is 85 F and 10 E in the knee.

3.2 Initial Kinesiology Examination (27.01.09):

3.2.1 Static Examination:

Back:

- rather narrow base
- valgosity of ankle and standing on the lateral side of the heal only on the right side
- swelling around the right Archilis tendon
- almost equal hypertone (obstructed palpation by hematoma on the most part) of cranial part of the calf muscles but the left calf has its most concave part more cranially than does the right one
- large hematome of purple and yellow is visible on almost the whole right calf and feels hard
- popliteal lines equal.
- general hypotonus of right hamstrings but with taught strands especially towards the caudal part of the muscle with painful insertion sites
- sub gluteal line lower on the right side
- decreased tonus of the right gluteus maximus.
- ER of LEE especially the RLE
- posterior superior iliac spines and crests equal
- mostly flat back
- slightly raised and abducted scapulas.
- thorocolumbar triangle on the right side is much wider and longer than on the left side
- head is erect.
- plumbline passes slightly closer to the RLE than the LLE and slightly to the right edge of the spine.

Side:

- significantly more flexed right knee (figure IA)
- slight anterior tilt of the pelvis bilateral
- upper torso slightly leaned posterior with the head anterior
- shoulders protracted bilaterally

Front:

- rather narrow base
- ER in both hips but more on the RLE
- slight valgosity visible
- left calf has biggest concavity higher up than the right one
- much decreased tonus of quadriceps on RLE but palpable tightness around the quadriceps tendon
- scar extends from the mid patellar region to right below the tibial tuberosity
- knee is very swollen, Figure IIA shows the knee in horizontal position
- the area is warm and soft if compared with the other leg
- skin is slightly discoloured being more whitish and scaly
- area closely around the scar is pink and tender
- anterior superior iliac spines are equal
- short scar in the caudal right part of the abdomen from appendectomy
- very protracted shoulders
- upper extremities are IR
- head straight

Standing on two weights: Right – 38kg Left – 60kg

3.2.2 Dynamic Examination

Dynamic Spine Mobility

Physiological range of spine mobility for flexion and lateral flexion. Slightly decreased mobility to extension. During flexion, extension and lateral flexion there is visible decreased mobility of thoracic spine especially the upper part. The cervical and lumbar areas seem to be the most mobile during all three movements.

Gait:

Patient has been walking with the use of two French crutches (3-point style) for the past 2 weeks and has not trained any gait without the crutches. When instructed to lay off the crutches and try normal gait the patient was very afraid to step on the operated leg.

- the gait looked more like hopping on one leg or marked antalgic gait
- during the very short stance phase on the RLE the patient would markedly flex it and lean whole body to that side
- the stride length on the right side was incomparably shorter

Once he was instructed to put equal wait on both legs and flex and extend the operated as he does the healthy one, the gait markedly improved but still some mistakes could be found.

- persistent leaning or lateral flexion of the trunk with every step with slight rotation to the left side when stepping on the RLE
- elevation of pelvis on both sides
- the RLE was not fully extended in hip and knee at the end of the stance phase
- contact with the ground was made with almost the whole sole at once bilaterally
- on the right side the midstance phase was spent more on the lateral side of the foot especially the heal
- toes clawed for greater stability during the stance phase on the right side
- little or no push off made at the end of the stance of the RLE

- upper extremities were placed widely from the body in order to help in keeping balance

Other types of gait were not possible to test.

3.2.3 Scar Examination: (figure IIIA)

Location: between the caudal border of the patella and the tibial tuberosity with small incisions also on the medial and lateral side of the RLE

Orientation: vertical

Length: 8 cm

Width: 2 cm (including area with stitches)

Pain: yes, especially in caudal part

Adherence to underlying tissue: yes especially around the tibial tuberosity

Stretch-ability: very poor longitudinal stretch-ability but better on the cranial portion

Texture of skin around scar: scaly for about 0.5 to 1 cm around each part of the scar

Swelling: prominent around whole joint

Colour: pink for up to 1cm around the scar

Subjective feeling of scar limiting ROM: yes into flexion

3.2.4 Palpation

On the RLE there is poor stretch-ability of the soft tissue around the joint especially in caudo-cranial direction as well as on the calf area. Skin and subskin have increased sensitivity to pain and decreased mobility. Skin was described in the previous section. On both LEE the facia are mobile but less so on the calf. Fascia of the thigh has good movement in the cranial part. Gluteal, lumbar and sacral fascias were mobile bilaterally. Generally muscles are tense around the knee area even if they are in hypotonus. See summary of muscle tonus bellow (table 8).

Table 8 The tonus of muscles on the LEE with N indicating normal tonus, + indicating hypertonus, - indicating hypotonus and - - indicating great hypotonus

Muscle	Innervations (18)	RLE	LLE
Iliacus	Femoral n.	+	+
Psoas	Lumbar plexus	+	+
Piriformis	Sacral plexus	N	N
Gracilis	Obturator n.	N	N
Adductor magnus		N	N
Gluteus maximus	Inferior gluteal n.	-	N
Gluteus medius	Superior gluteal n.	-	N
Tensor faciae latae		N	N
Rectus femoris	Femoral n.	- -	N
Vastus medialis		- -*	N
Vastus lateralis		- -*	N
Biceps femoris	Sciatic n.	-	N
Semitendinosus	Sciatic n. (tibial branch)	-	N
Semimenbranosus			
Soleus	Tibial n.	+*	+
Gastrocnemius		+*	+

* difficulty in palpation due to swelling and/or hematoma

3.2.5 Antropometrics

See results of antropometric measurements of length (table 9) and circumference (table 10) for both lower extremities.

Table 9 Length of both lower extremities

Length	Right /cm	Left /cm
Anatomical	86	86
Functional	95	95
Femur: trochanter mj. to fibular head	46	46
Distal leg: fibular head to lat. malleolus	41	41

Table 10 Circumference of both lower extremities

Circumference around	Right /cm	Left/cm
Thigh: 16cm above patella	52	55
Knee: right above patella	44	42
Knee: mid patella	43	40
Knee: tuberosity tibie	38	36

3.2.6 Range of Motion: (according to Janda & Pavlu) (16)

Below is a summary of the active and passive ROM recorded using the SFTR method (table 11).

Table 11 Range of motion of both lower extremities

		Active		Passive	
		Right	Left	Right	Left
Hip	S	5-0-80	10-0-90	10-0-80	10-0-90
	F	40-0-10	45-0-10	40-0-10	45-0-10
	R	30-0-20	35-0-15	30-0-20	35-0-20
Knee	S	-10-0-85	0-0-130	-10-0-90	0-0-130
Ankle	S	0-0-45	5-0-45	5-0-45	10-0-45
	T	15-0-30	15-0-35	15-0-30	15-0-35

3.2.7 Muscles length test (according to Janda) (15)

Bellow is the summary of the degree of muscle shortness according to Janda (table 12).

Table 12 Muscle length

Muscles	RLE	LEE
Gastrocnemius	1	0
Soleus	1	0
Iliopsoas	1*	1*
Rectus femoris	1*	0*
Tensor fascie latae	0*	0*
Hamstrings	1**	0
Adductors	0	0
Piriformis	0	0

*Due to decreased ROM inability to perform test in literature for rectus femoris, iliopsoas, tensor fascie latae but orientation test was done in supine position with both LEE off the table and the unexamined LE supported on a chair. This test revealed that there was no shortness of rectus femoris bilaterally but there was short of iliopsoas – 1 bilaterally. For iliopsoas a second orientation test was pefromed in prone position with passive extension of the LE with flexed knee. This revealed slight shortness which was greater on the right side.

** It was not possible to achieve neutral position (with no flexion) in the knee at any angle

2.8 Muscle Strength (according to Kendall) (18)

Results of manual muscle test for lower extremities can be seen below (table 13).

Table 13 Muscle strength test

	Muscle	Innervations	RLE	LLE
Hip	Iliopsoas	Lumbar plexus, femoral n.	4-	5
	Adductors	Obturator n.	4	5
	Gluteus maximus	Inferior gluteal n.	3	4+
	Gluteus minimus	Superior gluteal n.	3-	5
	Gluteus medius		3-	5
	meidial rotators		4+	5
	Tensor faciae latae		4	5
	lateral rotators	Sacral plexus, Obturator n.	4+	5
	Sartorius	Femoral n.	4	5
Thigh	Quadriceps femoris		2+*	5
	Biceps femoris	Sciatic n.	2+*	5
	Semitendinosus	Sciatic (tibial branch) n.	2+*	5
	Semimembranosus			
Calf	Soleus	Tibial n.	3-	5
	plantar flexors	Tibial n., superficial peroneal n.	3-	5
	Peroneus longus, brevis	Superficial peroneal n.	3	4
	Tibialis posterior	Tibial n.	5	5
	Tibialis anterior	Deep peroneal n.	4	5
	Peroneus teritus		5	5

* Inability to perform movement through whole ROM due to restriction in the joint

3.2.9 Movement Patterns: (according to Janda) (13)

Extension in hip joint:

- Right: First started with both glutei maximi and right biceps, then both sides of lumbar spine and thoracic spine and lastly shoulder. 1, 2+3+4+5, shoulder
- Left: Started with gluteus maximus and biceps, then both sides of lumbar spine then both sides of thoracic spine and shoulder. 1, 2+3, 4+5, shoulder

Abduction in hip joint:

- Right: First activated is the quadratus lumborum followed by gluteus medius and minimus and finally by tensor fascia latae and iliopsoas followed by abdominal and back muscles. 3, 1, 2+4, 5 (quadrates mechanism)

- Left: the glutei (minimus and medius) were activated first followed by quadratus, then tensor fascia latae and iliopsoas and finally abdominal and back muscles. 1, 3, 2+4, 5

3.2.10 Neurologic exam.

Reflexes

Below are the results for tests of physiologic reflexes (table 14) and pathologic reflexes (table 15).

Table 14 Physiological Reflexes

Physiologic Reflex	RLE	LLE
Achilles tendon	3	3
Medioplantar	3	3
Plantar skin	3	3

Table 15 Pathological Reflexes with (-) indicating negative

Pathologic Reflex	RLE	LLE
Minganzini	-	-
Vitek summation	-	-
Babinski	-	-
Chaddock	-	-
Oppenheim	-	-
Rosolimo	-	-
Zukovsky	-	-

Sensitivity

Superficial sensitivity: is decreased around the scar area especial in the cranial part of the scar. Otherwise superficial sensitivity on the rest of the leg is similar to the left one.

Deep sensitivity: patient is able to identify which toe is being touched and the beginning and end of movement with slight delay. Not able to place the toes in the same angle on both LEE. Angle placement in the knee was difficult to perform due to limited ROM and pain. Stereognosia is not very good: not always being able to identify the qualities pertaining to the objects. Unable to test taxis due to limited ROM of the affected LE. Taxis on upper extremities is normal.

Balance

Rhomberg I – no visible movement
Rhomberg II– slight play of muscles on leg and small swaying movement of body
Rhomberg III –instability: had to step forward and open eyes to stabilize self
Vele test – excessive clawing of toes on both feet
Standing on one leg – RLE – possible to remain standing for 8 s but with great instability
– LLE – not possible to remain standing for 8 s

3.2.11 Joint Play: (according to Lewit) (20)

Blockage was found in:

- between I and II metatarsal (MT) bones on right side
- Metatarsal phalangeal (MTP) and interphangeal (IP) joints in dorsal and ventral directions on I – IV bilaterally
- patella caudally on right side
- fibula dorsally on the right side

3.2.12 Special Tests

Anterior shift test was negative on both sides but there seemed a harder end feel on the RLE.
Lachman test was also negative on both sides with a tighter feel on the right side.
Menisci test was negative on both sides.

3.2.13 Subjective:

Patient filled out the 2000 IKDC Subjective Knee Evaluation Form as to the condition of the knee prior to the surgery scorring 48 out of a possible 87 putting him into less than the 5th percentile compared with the same age and gender (see supplements).

3.2.14 Conclusion of Examination

Patient 14 days after reconstruction of a torn ACL using mid patellar tendon with local swelling, active scar, limited ROM of the knee and faulty gait.

3.3 Rehabilitation Plans

3.3.1 Short-term rehabilitation plan

- decrease swelling
- improve scar healing
- regain physiologic ROM in the knee
- regain muscle strength especially in quadriceps, hamstrings, glutei muscles, plantar flexors
- regain physiologic muscle length especially of hamstrings, triceps surea
- improve stability especially on one LE
- improve gait pattern

3.3.2 Long-term rehabilitation plan:

- optimize muscle balance especially on the RLE
- improve running and jumping style to decrease risk of future injury
- return to work and sports

3.4 Rehabilitation – Day to Day Therapy

Date: 27.01.09

Session 1, Week 1

Subjective: Afraid of walking without crutches as it is the first time.

Objective: See previous sections.

Goal of today's therapy unit:

- scar care
- mobilise blocked joints (mentioned above)
- to improve walking pattern without crutches
- increase ROM into flexion and extension
- strengthen hamstrings, quadriceps, gluteus medius
- Stretching of hamstrings and quadriceps

Procedure:

- Soft tissue techniques (STT) (according to Lewit):
  - swelling (also with soft balls)
  - scar
- Mobilization (according to Lewit):
  - MIP and IP – antero-dorsal direction
  - patella- caudal and cranial direction, circular mobilization
- Lengthening:
  - triceps surea in supine position combined with breathing
  - hamstrings for both medial and lateral parts in supine position (described below in stretching) combined with breathing
- Post isometric relaxation (PIR) with stretching to increase knee ROM:
  - quadriceps–in prone position (also self PIR with stretching with strap around ankle)
  - hamstrings (knee part) in supine position
- Increasing ROM: Knee - into flexion – supine with overball under the heal and rolling it into full flexion and full extension. 15x
- Strengthening:
  - quadriceps – supine with overball under the knee and extending the LE 3x10
  - hamstrings – prone with 1kg weight attached to ankle- flexion in the knee

- gluteus medius – on the side with slight IR of LE and 1 kg attached to the ankle – abduction of the upper LE with extension in the knee without pelvic movement
- gluteus maximus – in prone with flexed knee, 1kg weight on the ankle and extension of the LE in the hip

- Sensomotoric:
  - train three point contact of foot described by Vele in sitting and standing
- Stretching:
  - hamstring - supine position with a strap slung around the foot, flexion in the hip with extension in the knee (assisted with one upper extremity)
  - semitendinosis and semimembranosus – as above but with abduction and ER of the LE in the hp
  - biceps femoris. – as above but with adduction and IR
- Gait correction - started with gait with over-exaggerated flexion (up to 90) of the leg in swing phase. Afterwards normal gait was taught to make sure that there was proper extension flexion mechanism in both LEE and that there was no pathological lateral flexion of the body.

Results:

Subjective: Some pain felt during the exercise. Walking was difficult and patient had fare of stepping on the operated LE.

Objective: Good reaction to mobilization. Scar seemed to loosen up a bit. Muscles being legthened improved but not to the optimal length. Patient continued to have lateral flexion and hip elevation with every step but much to a lesser extent than in the beginning of the session. Stretched muscles improved but did not reach the desired position.

Self-therapy: cryotherapy for swelling, scar care, strengthening of quadriceps, hamstrings, glutei muscles; Stretching for hamstrings, self-PIR with stretching of quadriceps, walking.

Date: 29.01.09

Session 2, Week 1

Subjective: exercised 3 times daily and it is getting better every day, has decreased the use of crutches.

Objective: 90F, 10E, scar slightly more mobile, blocked IP joints anterodorsal direction and patella in caudo cranial direction.

Goal of today's therapy unit:

- improve walking pattern (also on toes and heals)
- mobilize blocked joints (mentioned above)
- increase ROM into flexion and extension
- strengthen hamstrings, quadriceps, glutei
- lengthen hamstrings, gastrocnemius and quadriceps
- scar care
- sensomotoric training

Procedure:

- STT:
    - scar
    - swelling (also with soft balls)
- Mobilization:
    - MIP and IP – antero-dorsal direction
    - patella- caudal and cranial direction, circular
- Lengthening:
    - triceps surea in supine position combined with breathing
    - hamstrings for both medial and lateral parts in supine position combined with breathing
    - iliopsoas in prone position

- PIR with stretching:
    - quadriceps – in prone, also self PIR with stretching with band
- ROM: knee - into flexion with overball
- Strengthening:
    - quadriceps - overball under knee, also with ER for medial vastus
    - hamstrings – prone with 2 kg weight
    - gluteus medius - on the side with 2 kg weight
    - gluteus maximus – prone with 2 kg weight
    - plantar flexors – heal lifts, standing position both LEE at same time
- Stretching:
    - hamstring - supine position with a band slung around the foot.
    - semitendinosis and semimembranosus – with abduction and ER
    - biceps femoris – with adduction and IR
- Sensomotoric:
    - posturomed – two leg stance, lunge steps
- Gait: with instruction not to laterally flex torso and not to elevate the pelvis. Walking on tip toes and on heals was instructed as well.

Results:

Subjective: sensomotoric training was quite difficult Patient still experienced pain during the strengthening and increasing of ROM exercises.

Objective: good reaction to mobilisation and scar treatment. Lengthening of iliopsoas brought it to equal length if compared with the LLE. Hamstrings and triceps surea length improved but not to the optimal length. Walking on toes was possible but with semiflexion in the RLE. Walking on heals was almost impossible but the patient tried.

Self-therapy: continue with previous therapy, in addition strengthening of plantar flexors.

Date: 3.02.09

Session 3, Week 2

Subjective: Better but some pain after more intensive exercise at home, has stopped using crutches inside the house.

Objective: 5 E, 95F, blocked peripheral MTP, IP joint in anterodorsal direction, fibula in dorsal direction, patella in caudocranial direction, scar not fully mobile, slight circumduction of RLE and persistent lat F in gait, swelling and increased temperature still persistent.

Goal of today's therapy unit:

- improve walking pattern (also on toes and heals)
- mobilize blocked joints (mentioned above)
- increase ROM into flexion and extension
- strengthen hamstrings, quadriceps, glutei muscles
- lengthen hamstrings, gastrocnemius and quadriceps
- scar care
- sensomotoric training

Procedure:

- STT:
    - scar
    - swelling (also with soft ball)
- Mobilization:
    - MIP and IP – antero-dorsal direction
    - patella- caudal and cranial direction, circular
    - fibula – dorsal direction
- Lengthening:
    - triceps surea in supine position combined with breathing

- hamstrings for both medial and lateral parts in supine position combined with breathing

- PIR with stretching:
  - quadriceps – in prone, also self PIR with stretching with band
  - hamstrings – prone with leg over table
- ROM: Knee into flexion – overball
- Strengthening:
  - quadriceps - overball under, also with IR for lateral vastus
  - hamstrings – prone with 2 kg weight
  - gluteus medius - on the side with 2 kg weight
  - gluteus medius – prone with 2 kg weight
  - plantar flexors–heal lifts, both LEE and one LE at a time
- Post neuromuscular facilitation (PNF) strengthening:
  - for tibialis antr., quadriceps (rectus med, vastus med.), glutei (minimus and medius) biceps femoris, 1st diagonal into F (with E knee) and into E (with F knee), using slow reversal and slow reversal hold techniques
- Stretching:
  - hamstring - supine position with a band slung around the foot
  - semitendinosis and semimembranosus – with abduction and ER
  - biceps femoris – with adduction and IR
  - triceps – on stretch board 10 degrees
- Sensomotoric:
  - posturomed – two leg stance, lunge steps, stance on one LE (figure IV)
- Gait with instruction not to laterally flex torso and not to elevate the pelvis. Walking on tip toes and on heals was instructed as well.

Results:

Subjective: Patient found PNF easy to understand. Patient felt more confident on the posturomed, had pain in the insertion of the Triceps surea and difficulty standing on the heals.

Objective: Excellent reaction to PIR with stretching of quadriceps and hamstrings. Hamstrings and triceps length was normal after lengthening. At the end of the session F increased to 100. During strengthening of biceps patient unable to keep the straight axis of the leg and has the heal facing medially but with no ER in the hip. Patient was able to complete the PNF diagonal but it was rather difficult concerning the strength of the muscles .Better at sensomotoric training with ability to stand on one LE and keep balance. Heal walking still a major problem with inability to step properly on either LE with generally great flexion of the trunk forward. Toe walking is better but still has lat F.

Self-therapy: continue with previous therapy in addition self mobilization of patella and self PIR with stretching for hamstrings.

Date: 05.02.09
Session 4, Week 2

Subjective: Getting better, swelling decreasing.
Objective: F 95, E -10, scar still not mobile esp. cranial part, blocked IP joints in anterodorsal direction, fibula in dorsal direction patella not blocked, gait slight elevation of pelvis.

Goal of today's therapy unit:

- improve walking pattern
- mobilize blocked joints (mentioned above)
- increase ROM into flexion and extension
- strengthen hamstrings, quadriceps, glutei
- lengthen hamstrings, gastrocnemius and quadriceps
- scar care
- sensomotoric training

Procedure:

- STT:
    - scar
    - swelling (also with soft ball)
- Mobilization:
    - MIPand IP – antero-dorsal direction
    - fibula – dorsal direction
- PIR with stretching:
    - quadriceps – in prone, also self PIR with stretching with band
    - hamstrings – prone with leg over table
- ROM: Knee into flexion – overball
- Stregthening:
    - quadriceps - overball under, also with IR for lateral vastus
    - hamstrings – prone with 2 kg weight
    - gluteus medius - on the side with 2 kg weight
    - plantar flexors–heal lifts, both LEE and one LE at a time
    - gluteus maximus – prone with 2 kg weight
- PNF strengthening:
    - see previous therapy above
- Stretching:
    - hamstring - supine position with a band slung around the foot.
    - semitendinosis and semimembranosus – with abduction and ER
    - biceps femoris. – with add and IR
    - triceps surea – on stretch board 10 degrees
- Sensomotoric:
    - posturomed – two leg stance, lunge steps, stance on one LE, stepping over
    - Rocker board - two leg stance in 3 direction
- Gait: normal, heals, toes

Results:

Subjective: Patient found PNF easy to understand but was not motivated to perform it. He did not feel confident on the rocker board and started to feel some anterior knee pain at the end of the session.

Objective Excellent reaction to PIR with stretching of quadriceps and hamstrings. At the end of the session F increased to 105 and extension to -5. During strengthening of biceps patient unable to keep the straight axis of the leg and has the heal facing medially but with no ER in the hip. Patient was able to complete the PNF diagonal but it was rather difficult concerning the strength of the muscles. Better at sensomotoric training with ability to stand on one LE and bring the other LE forward (swing phase) and make contact with the ground. Good stability on the rocker board on both LEE. Heal walking still a major problem with inability to step properly on either LE with generally great flexion of the trunk forward. Toe walking is better but still has lat F of the trunk.

Self-therapy: continue with previous therapy, in addition anti gravity PIR with stretching over edge of table for hamstrings to increase E.

Date: 10.02.09

Session 5, Week 3

Subjective: better and better, no pain, no difficulties with activities of daily living.

Objective: E -5, F 110, scar quite mobile, quadriceps in hypotonus but better than in the beginning with 5cm difference in circumference with other side, swelling has decreased, patella free, fibula free, peripheral IP joints blocked in anterodorsal direction.

Goal of today's therapy unit:

- strengthening of muscles on the LEE
- correction and practice of gait
- proprioceptive training
- increase ROM especially into E

- stretch lengthen hamstrings and gastrocnemius
- scar care

Procedure:

- STT:
    - scar
    - swelling (also with soft ball)
- Mobilization:
    - MTP and IP – antero-dorsal direction
- PIR with stretching:
    - quadriceps - with the same band in prone
    - hamstrings – prone with leg over table
- ROM: LEE
    - bicycle ergometer 5 minutes
    - stepper 5 minutes
- PNF strengthening:
    - see previous therapies above
- Strength training:
    - quadriceps - with suspended weight 2.5kg (2x10)
    - hamstirings – with suspended weight 11kg (2x10)
- Sensomotoric:
    - posturomed - lunge steps, stance on one LE, stepping over
    - label platforms – walking over several with increased stance phase on each LE (figure V)
- Gait training: treadmill 2 minutes for each gait forward, right side, left side, backward
- Stretching:
    - hamstring - supine position with a band slung around the foot.
    - semitendinosis and semimembranosus – with abduction and ER
    - biceps femoris. – with add and IR

- gastrocnemius – on stretch board 10 degrees

Results:

Subjective: Enjoyed the bicycle and stepper ergometer exercise. Patient was surprised that 2.5 kg into knee extension seemed to be quite heavy for the RLE. PNF was not very much looked forward to.

Objective: Good ability bicycle and stepper. There is a tendency to bend the knees in side and backward walking on the treadmill, otherwise much better gait with increased stance and push off on the RLE. Quadriceps significantly weaker on the RLE than on the LEE and become tired quickly with tremor present after the second set. Hamstrings have more endurance but harder to relax to increase ROM into E. Passive E was 0 after therapy but active remained at between -10 and -5 depending on level of tiredness. Active flexion increased to 120. PNF proved time consuming.

Self-therapy: continue with previous therapy but change ROM for those performed in this session.

Date: 12.02.09

Session 6, Week 3

Subjective: no pain, satisfied.

Objective: E -5, F 110, blockage of IP joints in anterodorsal direction, scar slightly attached at the caudal part.

Goal of today's therapy unit:

- strengthening of muscles on the LEE
- correction and practice of gait
- proprioceptive training
- increase ROM especially into E
- stretch lengthen hamstrings and gastrocnemius
- scar care

- mobilization of joints

Procedure: (Whirlpool before therapy: 30 minutes, 38 °C)

- STT
    - scar –especially on caudal part
    - swelling (also with soft ball)
- Mobilization:
    - MTP and IP – antero-dorsal direction
- PIR with stretching:
    - quadriceps - with the same band in prone
    - hamstrings – prone with leg over table
- ROM: LEE
    - bicycle ergometer 5 minutes
    - stepper 5 minutes
- Strength training:
    - quadriceps - with suspended weight 2.5 kg (3x10)
    - hamstirings – with suspended weight 11 kg (3x10)
- Sensomotoric:
    - posturomed- lunge steps, stance on one LE, stepping over, mini squat on LE
    - label platforms–walking over, throwing up ball during, stance on one LE
    - flat rope – forward (figure VI), sideways (figure VII) walking
- Gait training:
    - treadmill 2 minutes for each gait forward, right side, left side, backward
    - forward gait with attention paid to fully extending the knee and hip in the last part of the stance phase and pushing of with equal force from both LEE
- Stretching:
    - hamstring - supine position with a band slung around the foot.
    - semitendinosis and semimembranosus – with abduction and ER
    - biceps femoris – with add and IR
    - gastrocnemius – on stretch board 10 degrees

Results:

Subjective: Patient found more confidence walking on the platforms. Painful long stance on posturomed on one leg in flexed position so this time was shortened and extent of flexion decreased.

Objective: E 0 even active right after PIR with stretching, active F 120. Gait – ability to almost fully extend the LEE in stance in slow walking but this is lost in faster walking or "subjectively normal pace" by the patient. At this pace the stride length of and pushing off with the RLE is also decreased.

Self-therapy: continue with previous therapy, in addition ROM on bicycle ergometer and strengthening of quadriceps and hamstrings using free weights.

Date: 17.02.09

Session 7, Week 4

Subjective: last two days some pain present perhaps due to over exercising at home.

Objective: F 120, E -5, scar free in all places, no blockages.

Goal of today's therapy unit:

- strengthening of muscles on the LEE
- correction and practice of gait
- proprioceptive training
- increase ROM especially into E
- stretch lengthen hamstrings and gastrocnemius
- scar care

Procedure: (Whirlpool before therapy: 30 minutes, 38 °C)

- STT:
  - scar – especially on caudal part
  - swelling (also with soft ball)
- PIR with stretching:
  - quadriceps - with the same band in prone
  - hamstrings – prone with leg over table
- ROM: LEE
  - bicycle ergometer 5 minutes
  - stepper 5 minutes
- Strength training:
  - quadriceps - with suspended weight 5 kg (3x10)
  - hamstirings – with suspended weight 11 kg (3x10)
- Sensomotoric:
  - posturomed - lunge steps, stance on one LE with ball throwing, stepping over, mini squat on LE
  - label platforms – walking over and passing ball over head
  - flat rope – forward, sideways
  - trampoline - stop hopping, side (figure VIII) and forward bearing of weight, hopping on toes and heals
- Gait training: treadmill 2 minutes for each gait forward, right side, left side, backward forward gait with attention paid to fully extending the knee and hip in the last part of the stance phase and pushing of with equal force from both LEE
- Stretching:
  - hamstring - supine position with a band slung around the foot.
  - semitendinosis and semimembranosus – with abduction and ER
  - biceps femoris. – with add and IR
  - gastrocnemius – on stretch board 15 degrees

Results:

Subjective: Patient was less stable on the label platforms perhaps due to slight pain. Also felt slight instability during backward walking on the treadmill

Objective: E 0, F 135 which is slightly more that on the healthy side.

Self-therapy: will slightly decrease the exercise program at home to diminish pain.

Date: 19.02.09

Session 8, Week 4

Subjective: patient rested yesterday from exercise due to pain in the knee which is now gone.

Objective: E -5, F 130, no improvement in swelling since last time, no blockages.

Goal of today's therapy unit:

- strengthening of muscles on the LEE
- correction and practice of gait
- proprioceptive training
- increase ROM especially into E
- stretch lengthen hamstrings and gastrocnemius
- scar care

Procedure: (Whirlpool before therapy: 30 minutes, 38 °C)

- STT
    - scar – especially on caudal part
    - swelling (also with soft ball)
- PIR with stretching:
    - quadriceps - with the same band in prone
    - hamstrings – prone with leg over table
- ROM: LEE
    - bicycle ergometer 5 minutes

- stepper 5 minutes

- Strength training:
  - quadriceps - with suspended weight 5kg (3x10)
  - hamstirings – with suspended weight 11kg (3x10)
- Sensomotoric:
  - posturomed - lunge steps, stance on one LE with ball throwing, stepping over
  - label platforms – walking over and passing ball over head and under one LE
  - flat rope – forward, sideways
  - trampoline - stop hopping, side and forward bearing of weight, hopping on toes and heals, one leg stance (figure IX)
- Gait training:
  - treadmill 2 minutes for each gait forward, right side, left side, backward
  - forward gait with attention paid to fully extending the knee and hip in the last part of the stance phase and pushing of with equal force from both LEE
- Stretching:
  - hamstring - supine position with a band slung around the foot.
  - semitendinosis and semimembranosus – with abduction and ER
  - biceps femoris. – with add and IR
  - gastrocnemius – on stretch board 10 degrees

Results:

Subjective: Very good toleration of therapy, patient had no pain.

Objective: Patient was quite stable on the label platforms and really progressed from the previous session.

Self-therapy: continue with exercise program as before

3.5 Final kinesiologic examination (19.02.09)

(improvements are in bold)

3.5.1 Static Examination

Back:

- valgosity of ankle especially on RLE
- standing on the lateral side of the heal only especially on the right side
- very **small swelling** of the Archilis tendon remains on the lateral part of the RLE
- shape and tone of calf muscles is equal
- popliteal lines equal
- **tonus of hamstrings is nearly equal** with the right one being only slightly less
- LEE are ER with the RLE more so
- **sub gluteal lines equal** with **same tonus of glutei maximi** on both sides
- posterior superior iliac spines and crests are equal
- back is mostly flat, spine is straight
- thoracolumbar triangle are of same depth but right one is longer
- left scapula abducted and right scapula is higher that the left one
- head is straight
- plumbline passes slightly closer to the RLE than the LLE and slightly to the right edge of the spine

Side:

- left knee is in a greater extension than the right one but **difference is much less** than in the beginning (figure IB)
- slight anterior tilt of the pelvis bilateral
- upper torso slightly leaned posterior with the head anterior
- shoulders protracted bilaterally

Front:

- rather wide base
- valgosity especially on the right side
- ER in both hips but more on the RLE
- left calf has biggest concavity higher up than the right one
- hypotonus of right quadriceps but comparatively a **better tonus than in the initial** examination
- scar extending from the mid patellar region to right below the tibial tuberosity
- still some swelling in the area mainly above the patella. Figure IIB shows the knee in horizontal position
- **skin is not scaly** but still has different colour compared to the uninvolved leg
- anterior superior iliac spines are equal
- short scar in the caudal right part of the abdomen from appendectomy
- very protracted shoulders
- upper extremities are in IR
- head straight

Standing on two weights: **Right – 47 kg** **Left – 48 kg**

3.5.2 Dynamic Examination

Dynamic Spine Mobility

Physiological ranges of spine mobility for flexion and lateral flexion. Slightly decreased mobility to extension. During flexion, extension and lateral flexion there is visible decreased mobility of thoracic spine especially the upper part. The cervical and lumbar areas seem to be the most mobile during all three movements.

Gait:

- slightly shorter stance phase on the RLE than on the LEE
- the **stride length is the same**
- contact with the ground is made more with the lateral side of the heal on the right side
- fist part of stance phase involves **correct rolling** of the contact on the sole of the foot
- followed by **almost full extension in the knee**
- in the last phase of stance there is improper lifting of foot with still much of the foot being lifted at once
- there is almost no movement in the spine, pelvis or upper extremities

Toes: very narrow base, there was largely exaggerated lateral flexion of the trunk in both directions. Small circumduction of the RLE

Heal: subjective feeling of instability, lateral flexion of the trunk in both directions, exaggerated swing of the right upper extremity

Squat: almost not possible to perform due to subject feeling of instability in the right knee and fear of putting strain on it

Backward: able to perform pretty well with slightly less extension in the right knee than in the left knee

Tandem: lateral flexion to the right side which increased during stance on that LE

Closed eyes: able to walk in a straight line without significant lateral flexion of the trunk

3.5.3 Scar Examination: (Figure IIIB)

Location: between the caudal border of the patella and the tibial tuberosity with small incisions also on the medial and lateral side of the RLE

Orientation: vertical

Length: 7.5 cm

Width: 2 mm (not including the area with stitches)

Pain: **no**

Adherence to underlying tissue: **no**

Stretch-ability: **good but worse on the caudal part**

Texture of skin around scar: **normal**

Swelling: above patella, **very slight** around scar region

Colour: light pink, skin around **normal colour**

Subjective feeling of scar limiting ROM: **no**

3.5.4 Palpation

On the RLE there is **very good stretch-ability** of the soft tissue around the joint. Skin, subskin and periost are **not painful** to touch. Skin was described in the previous section. On the LEE the facia are mobile but less so on the calf. Gluteal, lumbar and sacral fascias were mobile bilaterally. Muscle insertions around the knee are **not very tense** in comparison to the general tonus of the muscles. See summary of muscle tonus bellow (table 16).

Table 16 The tonus of muscles on the LEE with N indicating normal tonus, + indicating hypertonus, - indicating hypotonus and - - indicating great hypotonus

Muscle	Innervations (18)	RLE	LLE
Iliacus	Femoral n.	+	+
Psoas	Lumbar plexus	+	+
Piriformis	Sacral plexus	N	N
Gracilis	Obturator n.	N	N
Adductor magnus		N	N
Gluteus maximus	Inferior gluteal n.	**N**	N
Gluteus medius	Superior gluteal n.	**N**	N
Tensor faciae latae		N	N
Rectus femoris	Femoral n.	-	N
Vastus medialis		**-**	N
Vastus lateralis		-	N
Biceps femoris	Sciatic n.	**N**	N
Semitendinosus	Sciatic n. (tibial branch)	**N**	N
Semimenbranosus			
Soleus	Tibial n.	+	+
Gastrocnemius		+	+

3.5.5 Antropometrics

See results of antropometric measurements of length (table 17) and circumference (table 18) for both lower extremities.

Table 17 Length of both lower extremities

Length	Right /cm	Left /cm
Anatomical	86	86
Functional	95	95
Femur	46	46
Distal leg	41	41

Table 18 Circumference of both lower extremities

Circumference around	Right /cm	Left/cm
Thigh: 16cm above patella	52	54
Knee: right above patella	**41**	40
Knee: mid patella	40	39
Knee: tuberosity tibie	38	36

3.5.6 Range of Motion (according to Janda & Pavlu) (16)

Below is a summary of the active and passive ROM recorded using the SFTR method (table 19).

Table 19 Range of motion of both lower extremities

		Active		Passive	
		Right	Left	Right	Left
Hip	S	**10-0-85**	10-0-90	**15-0-90**	15-0-90
	F	40-0-10	45-0-10	40-0-10	45-0-10
	R	30-0-20	35-0-20	35-0-20	45-0-20
Knee	S	**0-0-135**	0-0-130	**0-0-140**	0-0-135
Ankle	S	0-0-45	5-0-45	5-0-45	10-0-45
	T	15-0-30	15-0-35	15-0-30	15-0-35

3.2.7 **Muscle Length Test** (according to Janda) (15)

Bellow is the summary of the degree of muscle shortnes according to Janda (table 20).

Table 20 Muscle length

Muscles	RLE	LEE
Gastrocnemius	0	0
Soleus	0	0
Iliopsoas	0*	0*
Rectus femoris	0*	0*
Tensor fascie latae	0*	0*
Hamstrings	0	0
Adductors	0	0
Piriformis	0	0

* For comparison purposes test for rectus femoris and iliopsoas was done as in initial examination. This test revealed that there was no shortness of rectus femoris or iliopsoas bilaterally

3.5.8 **Muscle Strength** (according to Kendall) (18)

Results of manual muscle test for lower extremities can be seen on the following page (table 21).

Table 21 Muscle strength test

	Muscle	Innervations	RLE	LLE
Hip	Iliopsoas	Lumbar plexus, femoral n.	**5**	5
	Adductors	Obturator n.	**5**	5
	Gluteus maximus	Inferior gluteal n.	**5**	**5**
	Gluteus minimus	Superior gluteal n.	**5**	5
	Gluteus medius		**5**	5
	meidial rotators		**5**	5
	Tensor faciae latae		**5**	5
	lateral rotators	Sacral plexus, Obturator n.	**5**	5
	Sartorius	Femoral n.	**5**	5
Thigh	Quadriceps femoris		**4**	5
	Biceps femoris	Sciatic n.	**5**	5
	Semitendinosus	Sciatic (tibial branch) n.	**5**	5
	Semimenbranosus			
Calf	Soleus	Tibial n.	**5**	5
	plantar flexors	Tibial n., superficial peroneal n.	**5**	5
	Peroneus longus, brevis	Superficial peroneal n.	**5**	**5**
	Tibialis posterior	Tibial n.	5	5
	Tibialis anterior	Deep peroneal n.	**5**	5
	Peroneus teritus		5	5

3.5.9 **Movement Patterns** (according to Janda) (13)

Extension in hip joint:

- Right: first started with gluteus maximus and right biceps, then both sides of lumbar spine and thorasic spine 1, 2+3+4+5
- Left: started with gluteus maximus and biceps, then both sides of lumbar spine then both sides of thoracic spine. 1, 2+3, 4+5

Abduction in hip joint:

- Right: **first activated glutei** (minimus and medius) first followed by, iliopsoas, quadrates, tensor fascie latae and finally abdominal and back muscles. 1, 4, 3, 2, 5

- Left: the glutei (minimus and medius) were activated first followed by, iliopsoas, tensor fascie latae, quadratus and finally abdominal and back muscles. 1, 4, 2, 3, 5

3.5.10 Neurologic exam.

Reflexes

Below are the results for tests of physiologic reflexes (table 22) and pathologic reflexes (table 23).

Table 22 Physiological Reflexes

Physiologic Reflex	RLE	LLE
Achilles tendon	3	3
Medioplantar	3	3
Plantar skin	3	3

Table 23 Pathological Reflexes with (-) indicating negative

Pathologic Reflex	RLE	LLE
Minganzini	-	-
Vitek summation	-	-
Babinski	-	-
Chaddock	-	-
Oppenheim	-	-
Rosolimo	-	-
Zukovsky	-	-

Sensitivity

Superficial sensitivity is decreased only on the caudo-medial part of the scar – about 2cm in length.

Deep sensitivity: patient is able to identify which toe is being touched and the beginning and end of movement **with less delay**. Patient is not able to move the toes to a certain position but is able to do so with the ankle and knee. **Stereognosia is good** – patient able to identify objects with the foot. Taxis of LEE is good bilaterally.

Balance

Rhomberg I – no visible movement
Rhomberg II– **no visible movement**
Rhomberg III – **slight play of muscles on leg**
Vele test – excessive clawing of toes on both feet but **less on the left one**
Standing on one leg – possible to remain standing for 8s on **both LEE**

3.5.11 Joint Play (according to Lewit) (20)

No blockages were found

3.2.12 Special Tests

Anterior shift test was negative on both sides but **with similar end feel**
Lachman test was also negative on both sides **with similar end feel**
Menisci test was negative on both sides

3.5.13 Subjective

Patient filled in the IKDC Subjective Knee Evaluation Form according to the current condition of the knee (see supplements) scoring **64** out of a possible 87 points putting him into the **10th percentile**.

3.6 Therapy Evaluation and Prognosis

3.6.1 Therapy Effect Evaluation

Table 24 Summary of Improvements on the Right Lower Extremity (continued on next page)

Examination	Specific tests	Before	After
Static	standing on weights (RLE/LLE)	38/60	47/48
Scar	pain	yes	no
	adherence	yes	no
	stretch-ability	very poor	good
	skin texture	scaly	normal
	limiting motion	yes	no
Muscle tone	gluteus maximus and medius	-*	N*
	quadricepts femoris	- -*	-*
	hamstrings	-*	N*
ROM - active	knee - E/F	-10/85	0/135
	hip - E/F	5/80	10/85
Muscle length	tricepts surea	1	0
	iliopsoas	1	0
	rectus femoris	1	0
	hamstrings	1	0
Muscle strength	iliopsoas	4-	5
	adductors	4	5
	gluteus maximus	3	5
	gluteus minimus and medius	3-	5
	meidial and lateral rotators	4+	5
	tensor faciae latae	4	5
	sartorius	4	5
	quadriceps femoris	2+	4
	hamstrings	2+	5
	soleus	3-	5
	plantar flexors	3-	5
	peroneus longus, brevis	3	5
	tibialis anterior	4	5

* In muscle tone examination: N indicates normal tonus, + indicates hypertonus, - indicates hypotonus and - - indicates great hypotonus

Table 24 Summary of Improvements on the Right Lower Extremity (continued from previous page)

Examination	Specific tests	Before	After
Superficial sensitivity	touch (decreased)	around scar	2 cm **
Deep sensitivity	movement (delay)	slight	very slight
	steregnosia	not good	very good
Balance	rhomberg II	sway	stable
	rhomberg III	instable	stable
	one leg stance (8 seconds)	no	yes
Joint play (blockage)	patella	yes	no
	fibula	yes	no
	MTP	yes	no
	IP	yes	no
Subjective	IKDC form	48	64

** In superficial sensitivity to touch: decreased sensitivity in the caudo-medial part of the scar

Many of the short term rehabilitation goals have already been achieved (table 24). To start with, the condition of the scar has improved drastically with only small caudal part of scar left in less than perfect state. Swelling has also decreased but has to be decreased even further. This of course was a set back for some of the therapeutic procedures such as sensomotoric training but is understandable after surgery. Subjective evaluation of the patient has also improved if compared with the evaluation before the surgery.

According to muscle strength (Kendall) all muscles, but the quadriceps, have regained equal strength as on the LLE with a perfect score of 5. The absolute strength of the muscles may however vary as seen in the amount of free weights that the patient is able to lift with the hamstrings varies greatly between the two LEE. Muscle length has also been improved and equalized on both lower extremities.

Knee ROM has been equalized with the uninvolved LE. Further work must be done to maintain this ROM. The most effective method for this has been the PIR with stretching in prone position for both the quadriceps and hamstrings. This therapy drastically improved the ROM of the knee every time but when the patient returned in the next session the ROM would have decreased again but would still be better than before. Having said that, the

increased ROM helped the patient correctly perform exercises during the session and in my opinion was a very important procedure. Increasing and maintaining extension was harder than flexion. This could have been due to the fact that the patient still had semi-flexion during regular gait and that his quadriceps were quite weak in the beginning.

Gait has improved drastically from markedly antalgic gait to near – normal gait. It is, however, still not perfect and instability and unsureness are evident in gait on toes, heals and especially the squat position. This improvement is partially due to constant instruction and correction but great difference can be seen before and after training on instable surfaces (proprioceptive training). Besides functioning as proprioceptive training itself, it greatly helped improve especially the stance phase on one LE and the confidence of correct gait itself. Correct rolling of the foot on the ground was also taught as part of this training and had good results if the patient concentrated on correct gait but was lost when the patient walked regularly without any concentration.

Sensomotric training is also said to improve muscle coordination and motor regulation which was rather faulty in this patient on both LEE as seen by the incorrect movement patterns. A downfall of the examination was the inability to measure vibration as the main sign of deep sensitivity, due to instrumental deficiency, which could have given unbiased numeric data as to whether there was true improvement in the deep sensation. Nonetheless, stability and proprioception have improved as seen in the better outcome of the stereognosia examination and increasingly better balance on propriomed and label platforms. In my opinion further training is necessary to further improve the movement patterns and muscle coordination which is ever so important for gait and to decrease the possibility of injury of the ACL, among other structures around the knee joint, on either of the LEE. In standing the patient almost equalized the weight bearing on both lower extremities compared with an almost 20kg difference in the beginning.

The use of PNF mainly to improve, among other muscles, vastus medialis strength, didn't prove as helpful as anticipated. Although the patient did put effort into the exercise, it proved quite difficult perhaps due to the awkwardness of the movement. After the first 2

sessions the patient also lost motivation for this exercise and it was aborted all together seeing that the patient could improve quadriceps strength by other methods as well and that the coordination of the muscles, trained in sensomotirc training was more important than any pure muscle strength.

If compared with the example of post operative rehabilitation program given in the general part, my rehabilitation program was quite similar for the period week 3 through 6. Perhaps the use open chain exercise was implemented slightly earlier than is mentioned to be completely safe in literature but the patient was able to perform closed chain exercises and had no pain or discomfort during the exercises. In addition the anterior drawer test and Lachman test did not show the graft to be more lax than the intact ligament on the other LE at the end of the therapy. A single shortcoming is that it would have been better to receive the patient right after surgery as starting a rehabilitation program at the 3rd postoperative week is difficult seeing that the patient was at home without supervised rehabilitation.

3.6.2 Prognosis

Overall the prognosis is a good one as the patient is very motivated and disciplined in the self exercise program and strictly follows all instructions given to him. In the past month he has made great improvements and thus it follows that in the following months he will make similar strides to a fully recovered state.

4 Conclusion

This work has addressed the importance and methodology of rehabilitation for patients who have undergone reconstruction of the anterior cruciate ligament. The patient that participated in the study was well motivated and always followed therapeutic sessions in the clinic by self therapy at home. After one month of therapy, or at the end of the 6th post operative weak, the patient made great strides to improving the condition and stability of the knee and lower extremities as a whole. This improvement, however, has to be further enhanced as the end result was not enough for the patient to return to his pre-injury activities. The healing of the graft itself has its own limitations on the course of the rehabilitation program and thus the aim of full recovery was beyond the scope of this practice which lasted only one month. I am, however, satisfied with the results that have been achieved in this month and can only recommend a similar program for the rehabilitation of this diagnosis.

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6 Supplements

List of Supplements

List of Abbreviations

ABD	abduction
ACL	anterior cruciate ligament
ADD	adduction
AMB	ateromedial bundle
BPTB	bone patellar tendon bone (grapht)
Bulovka	Fakultní nemocnice Na Bulovce
CKC	closed kinetic chain
CLPA	Centrum léčby pohybového aparátu s.r.o.
E	extension
ER	external rotation
F	flexion
FNKV	Fakultní nemocnice Královské Vinohrady
Homol.	Nemocnice Na Homolce
IKDC	International Knee Documentation Committee
IP	interphalangeal
IR	internal rotation
LCL	lateral colateral ligament
LE	lower extremity
LEE	lower extremities
LLE	left lower extremity
Malvaz.	Rehabilitační klinika Malvazinky
MCL	medial collateral ligament
Motol	Fakultní nemocnice v Motole
MT	metatarsal
MTP	metatarsal phalangeal
n.	nerve
OKC	open kinetic chain
PCL	posterior cruciate ligament
PIR	post isometric relaxation
PLB	posterolateral bundle
PNF	post neuromuscular facilitation
RLE	right lower extremity
ROM	range of motion
STT	soft tissue techniques
UVN	Ústřední vojenská nemocnice

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Photo documentation of therapy in Special Part

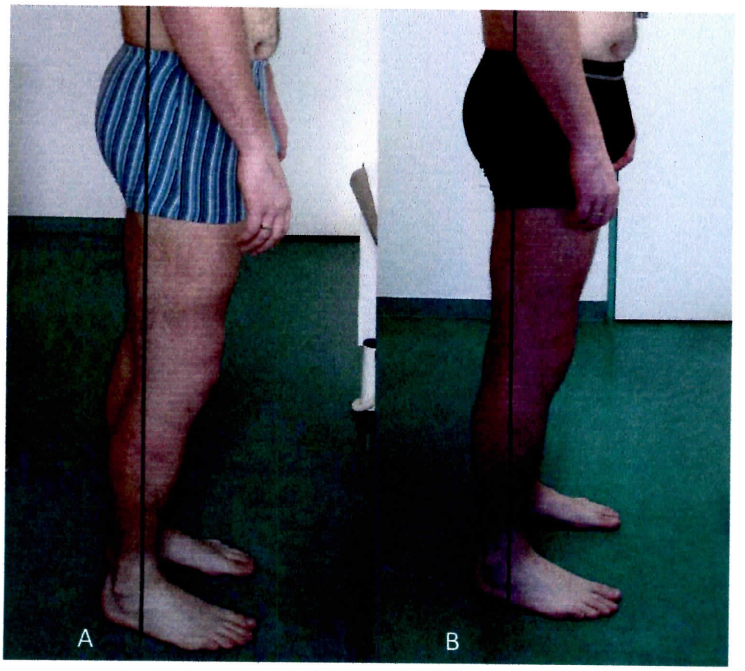

Figure I Side view of the right lower extremity (A) before and (B) after therapy

A

B

Figure II Anterior view of knee joint (A) before and (B) after therapy

A

B

Figure III View of the scar (A) before and (B) after therapy

Figure IV Sensomotoric training on posturomed on one lower extremity

Figure V Sensomotoric training on multiple label platforms

Figure VI Sensomotoric training on flat rope - walking forward

Figure VII Sensomotoric training on flat rope - walking sideways

Figure VIII Sensomotoric training on trampoline - side weight bearing

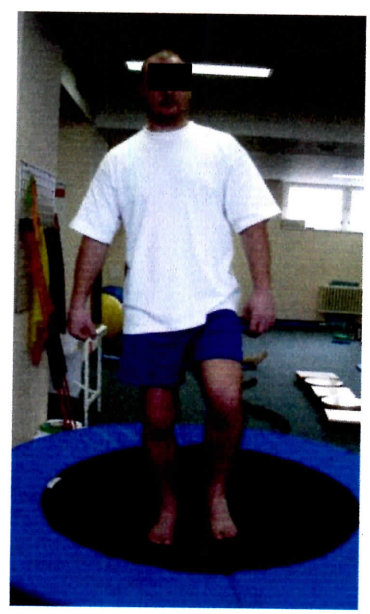

Figure IX Sensomotoric training on trampoline - stance on one lower extremity

2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

Your Full Name_____

Today's Date: _____/_____/_____ (Day / Month / Year)

Date of Injury: _____/_____/_____ (Day / Month / Year)

SYMPTOMS*:

*Grade symptoms at the highest activity level at which you think you could function without significant symptoms, even if you are not actually performing activities at this level.

1. What is the highest level of activity that you can perform without significant knee pain?

   4 ❑ Very strenuous activities like jumping or pivoting as in basketball or soccer
   3 ❑ Strenuous activities like heavy physical work, skiing or tennis
   2 ❑ Moderate activities like moderate physical work, running or jogging
   1 ❑ Light activities like walking, housework or yard work
   0 ❑ Unable to perform any of the above activities due to knee pain

2. During the past 4 weeks, or since your injury, how often have you had pain?

	10	9	8	7	6	5	4	3	2	1	0	
Never	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	Constant

3. If you have pain, how severe is it?

	10	9	8	7	6	5	4	3	2	1	0	
No pain	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	❑	Worst pain imaginable

4. During the past 4 weeks, or since your injury, how stiff or swollen was your knee?

   4 ❑ Not at all
   3 ❑ Mildly
   2 ❑ Moderately
   1 ❑ Very
   0 ❑ Extremely

5. What is the highest level of activity you can perform without significant swelling in your knee?

   4 ❑ Very strenuous activities like jumping or pivoting as in basketball or soccer
   3 ❑ Strenuous activities like heavy physical work, skiing or tennis
   2 ❑ Moderate activities like moderate physical work, running or jogging
   1 ❑ Light activities like walking, housework, or yard work
   0 ❑ Unable to perform any of the above activities due to knee swelling

6. During the past 4 weeks, or since your injury, did your knee lock or catch?

   0 ❑ Yes 1 ❑ No

7. What is the highest level of activity you can perform without significant giving way in your knee?

   4 ❑ Very strenuous activities like jumping or pivoting as in basketball or soccer
   3 ❑ Strenuous activities like heavy physical work, skiing or tennis
   2 ❑ Moderate activities like moderate physical work, running or jogging
   1 ❑ Light activities like walking, housework or yard work
   0 ❑ Unable to perform any of the above activities due to giving way of the knee

SPORTS ACTIVITIES:

8. What is the highest level of activity you can participate in on a regular basis?

   4❑ Very strenuous activities like jumping or pivoting as in basketball or soccer
   3❑ Strenuous activities like heavy physical work, skiing or tennis
   2❑ Moderate activities like moderate physical work, running or jogging
   1❑ Light activities like walking, housework or yard work
   0❑ Unable to perform any of the above activities due to knee

9. How does your knee affect your ability to:

		Not difficult at all	Minimally difficult	Moderately Difficult	Extremely difficult	Unable to do
a.	Go up stairs	4❑	3❑	2❑	1❑	0❑
b.	Go down stairs	4❑	3❑	2❑	1❑	0❑
c.	Kneel on the front of your knee	4❑	3❑	2❑	1❑	0❑
d.	Squat	4❑	3❑	2❑	1❑	0❑
e.	Sit with your knee bent	4❑	3❑	2❑	1❑	0❑
f.	Rise from a chair	4❑	3❑	2❑	1❑	0❑
g.	Run straight ahead	4❑	3❑	2❑	1❑	0❑
h.	Jump and land on your involved leg	4❑	3❑	2❑	1❑	0❑
i.	Stop and start quickly	4❑	3❑	2❑	1❑	0❑

FUNCTION:

10. How would you rate the function of your knee on a scale of 0 to 10 with 10 being normal, excellent function and 0 being the inability to perform any of your usual daily activities which may include sports?

FUNCTION PRIOR TO YOUR KNEE INJURY:

Couldn't perform daily activities 0 ❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5 ❑ 6 ❑ 7 ❑ 8 ❑ 9 ❑ 10 ❑ No limitation in daily activities

CURRENT FUNCTION OF YOUR KNEE:

Cannot perform daily activities 0 ❑ 1 ❑ 2 ❑ 3 ❑ 4 ❑ 5 ❑ 6 ❑ 7 ❑ 8 ❑ 9 ❑ 10 ❑ No limitation in daily activities

2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

Jmeno: [redacted]

Datum: 27 / 01 / 09 před operaci

SYMPTOMY:

1. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat bez značne bolesti v kolene?

   4☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
   3☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
   2☒ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
   1☐ Nenaročne fyzicke aktivity např. chozeni, domaci prace
   0☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli bolesti v kolene

2. Jak často jste mel bolest v kolene posledni tyden / po urazu?

	10	9	8	7	6	5	4	3	2	1	0	
Nikdy	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	Porad

3. Jestli mate bolest, jak je to bolestlivy?

	10	9	8	7	6	5	4	3	2	1	0	
Žadna	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐	Nejhurši

4. Nakolik tuhe nebo otekle mel jste koleno posledni tyden / po urazu?

   4☐ Vubec ne
   3☐ Trochu
   2☒ Mirne
   1☐ Moc
   0☐ Velmi mocne

5. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat bez značneho otekani kolena?

   4☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
   3☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
   2☐ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
   1☒ Nenaročne fyzicke aktivity např. chozeni, domaci prace
   0☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli otekani v kolene

6. Mel jste zablokovano koleno posledni tyden/po urazu?

   0☐Ano 1☒Ne

7. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat bez značne nestability kolena?
   4☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
   3☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
   2☐ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
   1☒ Nenaročne fyzicke aktivity např. chozeni, domaci prace
   0☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli nestabilte v kolene

SPORTOVNI AKTIVITY:

8. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat pravidelne?

4☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
3☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
2☐ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
1☒ Nenaročne fyzicke aktivity např. chozeni, domaci prace
0☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli kolenu

9. Jak koleno ovlinuje Vašu schopnost:

		Vubec neni složite	Trochu složite	Mirne složite	Moc složite	Neschopen
a.	Jit po schodech nahoru	4☒	3☐	2☐	1☐	0☐
b.	Jit po schodech dolu	4☒	3☐	2☐	1☐	0☐
c.	Kleknout si	4☒	3☐	2☐	1☐	0☐
d.	Drepnout si	4☐	3☐	2☒	1☐	0☐
e.	Sedet s pokrčenymi koleny	4☒	3☐	2☐	1☐	0☐
f.	Vstavat ze židle	4☒	3☐	2☐	1☐	0☐
g.	Behat	4☐	3☐	2☐	1☐	0☒
h.	Skoknout a dopadnout na poškozenou nohu	4☐	3☐	2☐	1☒	0☐
i.	Rychle začinat a zastavovat (pohyb)	4☐	3☐	2☐	1☒	0☐

FUNKCE:

10. Jak byste ohodnotil funkčnost Vašeho kolena na stupnici od 0 do 10, když 10 je vyborna funkčnost a 0 je neshopnost vykonavat obvykle aktivity (a sport).

FUNKČNOST KOLENA PŘED URAZEM:

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☒

BEŽNA FUNKČNOST KOLENA:

0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☒ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

2000 IKDC SUBJECTIVE KNEE EVALUATION FORM

Jmeno: [redacted]

Datum: 19 / 02 / 09

SYMPTOMY:

1. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat bez značne bolesti v kolene?

   4. ☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
   3. ☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
   2. ☒ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
   1. ☐ Nenaročne fyzicke aktivity např. chozeni, domaci prace
   0. ☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli bolesti v kolene

2. Jak často jste mel bolest v kolene posledni tyden / po urazu?

	10	9	8	7	6	5	4	3	2	1	0	
Nikdy	☐	☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	Porad

3. Jestli mate bolest, jak je to bolestlivy?

	10	9	8	7	6	5	4	3	2	1	0	
Žadna	☐	☐	☒	☐	☐	☐	☐	☐	☐	☐	☐	Nejhurši

4. Nakolik tuhe nebo otekle mel jste koleno posledni tyden / po urazu?

   4. ☐ Vubec ne
   3. ☒ Trochu
   2. ☐ Mirne
   1. ☐ Moc
   0. ☐ Velmi mocne

5. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat bez značneho otekani kolena?

   4. ☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
   3. ☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
   2. ☒ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
   1. ☐ Nenaročne fyzicke aktivity např. chozeni, domaci prace
   0. ☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli otekani v kolene

6. Mel jste zablokovano koleno posledni tyden/po urazu?

   0. ☐ Ano 1. ☒ Ne

7. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat bez značne nestability kolena?

   4. ☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
   3. ☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
   2. ☒ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
   1. ☐ Nenaročne fyzicke aktivity např. chozeni, domaci prace
   0. ☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli nestabilte v kolene

SPORTOVNI AKTIVITY:

8. Jakou nejvyšši uroven fyzicky aktivity mužete vykonavat pravidelne?

4☐ Velmy naročne fyzicke aktivity např. skakani, basketbol a futbol
3☐ Naročne fyzicke aktivity např. naročna fyzicka prace, lyžovani, tenis
2☒ Mirne naročne fyzicke aktivity např. mirna fyzicka prace, behani
1☐ Nenaročne fyzicke aktivity např. chozeni, domaci prace
0☐ Neschopny vykonavat žadne vyše uvedene aktivity kvuli kolenu

9. Jak koleno ovlinuje Vašu schopnost:

		Vubec neni složite	Trochu složite	Mirne složite	Moc složite	Neschopen
a.	Jit po schodech nahoru	4☐	3☒	2☐	1☐	0☐
b.	Jit po schodech dolu	4☐	3☒	2☐	1☐	0☐
c.	Kleknout si	4☐	3☒	2☐	1☐	0☐
d.	Drepnout si	4☐	3☒	2☐	1☐	0☐
e.	Sedet s pokrčenymi koleny	4☒	3☐	2☐	1☐	0☐
f.	Vstavat ze židle	4☒	3☐	2☐	1☐	0☐
g.	Behat	4☐	3☐	2☒	1☐	0☐
h.	Skoknout a dopadnout na poškozenou nohu	4☐	3☐	2☒	1☐	0☐
i.	Rychle začinat a zastavovat (pohyb)	4☐	3☒	2☐	1☐	0☐

FUNKCE:

10. Jak byste ohodnotil funkčnost Vašeho kolena na stupnici od 0 do 10, když 10 je vyborna funkčnost a 0 je neshopnost vykonavat obvykle aktivity (a sport).

FUNKČNOST KOLENA PŘED URAZEM:

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☒

BEŽNA FUNKČNOST KOLENA:

0	1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☒	☐	☐	☐	☐

CHARLES UNIVERSITY IN PRAGUE
FACULTY OF PHYSICAL EDUCATION AND SPORT
José Martího 31, 162 52 Praha 6-Veleslavín
tel. +420 2 2017 1111
http://www.ftvs.cuni.cz/

Application for Ethics Board Review

of the ~~research project, doctoral research, master degree research~~, undergraduate research, involving human subjects

Project title: Case study of patient after surgical reconstruction of the anterior cruciate ligament

Nature of the research project: ~~basic research / applied research (faculty or staff investigators)*~~
~~doctoral / PhD research*~~
~~master degree research~~ / undergraduate research*

* Please delete as appropriate.

Author (chief investigator): Anna Lalaeva
co-investigators:
Supervisor (in case of student research): Kateřina Maršáková

Case study of the physiotherapy of the patient with diagnosis M239
will be processed with supervision of skilled physiotherapeutist in Centrum léčby pohybového aparátu s.r.o.
No invasive method will be used. Personal datas will be not published.
Informed consent (in Czech language, **attached)**

Date: 19.02.2009 Author's signature:

Faculty of Physical Education and Sport, Charles University in Prague
ETHICS BOARD REVIEW

Ethics Board members: Doc. MUDr. Staša Bartůňková, CSc.
Prof. Ing. Václav Bunc, CSc.
Prof. PhDr. Pavel Slepička, DrSc.
Doc. MUDr. Jan Heller, CSc.

The Ethics Board at the Faculty of Physical Education and Sport, Charles University, approved the research project.
Approval number: 0275/2009
Date: 20.2.2009

The Ethics Board at the Faculty of Physical Education and Sport, Charles University, reviewed the submitted research project and **found no contradictions with valid principles**, regulations and international guidelines for biomedical research involving human subjects.

The chief investigator of the project met the necessary requirements for receiving the Ethics Board approval.

Official school stamp — Univerzita Karlova v Praze, Fakulta tělesné výchovy a sportu

Signature, REB Chairman

INFORMOVANÝ SOUHLAS

V souladu se Zákonem o péči o zdraví lidu (§ 23 odst. 2 zákona č.20/1966 Sb.) a Úmluvou o lidských právech a biomedicíně č. 96/2001, Vás žádám o souhlas k vyšetření a následné terapii. Dále Vás žádám o souhlas k nahlížení do Vaší dokumentace osobou získávající způsobilost k výkonu zdravotnického povolání v rámci praktické výuky a s uveřejněním výsledků terapie v rámci bakalářské práce na FTVS UK. Osobní data v této studii nebudou uvedena.

Dnešního dne jsem byl odborným pracovníkem poučen o plánovaném vyšetření a následné terapii. Prohlašuji a svým dále uvedeným vlastnoručním podpisem potvrzuji, že odborný pracovník, který mi poskytl poučení, mi osobně vysvětlil vše, co je obsahem tohoto písemného informovaného souhlasu, a měl jsem možnost klást mu otázky, na které mi řádně odpověděl.
Prohlašuji, že jsem shora uvedenému poučení plně porozuměl a výslovně souhlasím s provedením vyšetření a následnou terapií.
Souhlasím s nahlížením níže jmenované osoby do mé dokumentace a s uveřejněním výsledků terapie v rámci studie.

Datum:.....

Osoba, která provedla poučení:.....

Podpis osoby, která provedla poučení:.....

Vlastnoruční podpis pacienta:.....