CHARLES UNIVERSITY IN PRAGUE

FACULTY OF PHYSICAL EDUCATION AND SPORT

DEPARTMENT OF PHYSIOTHERAPY

BACHELOR DEGREE OF PHYSIOTHERAPY

BACHELOR THESIS

CASE STUDY OF PHYSIOTHERAPEUTIC TREATMENT OF A PATIENT AFTER RECONSTRUCTION OF ANTERIOR CRUCIATE LIGAMENT

Author: **RafaelAlexandros Vasiliou**

Supervisor: **Mgr. Ivana Vláčilová**

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Abstract

Title: Case study of diagnosis of anterior cruciate ligament reconstruction

Author: RafaelAlexandros Vasiliou

In this Bachelor Thesis I analyzed the anatomy of the knee joint including bones, ligaments, muscles and nerves, kinesiology and biomechanics, ACL rupture and its mechanism. I also included some chapters which are related to the ACL rupture like risk factors, prevention and rehabilitation.

During the clinical work placement I applied individual therapy to my patient for eight times during two weeks including individual exercise program to the gym. The therapeutic plan was based according to my findings during the first day of meeting when I performed the initial kinesiologic examination. Detailed description of the initial kinesiologic examination and day to day therapy are included in the special part of this Bachelor Thesis.

After eight therapy sessions the result was positive with the objective findings to confirm it. The strength of the muscles of the right lower extremity of the patient was improved and the range of motion of the right knee which is the most important was also improved for 20 degrees. More details about the final kinesiologic examination and results are also included in the special part of this Bachelor Thesis.

KEY WORDS: Anterior Cruciate Ligament, balance exercises, m.quadriceps femoris, m.vastus medialis, Range of Motion, Proprioceptive Neuromuscular Facilitation, Post Isometric Relaxation.

Abstrakt

Název: Kazuistika fyzioterapeutické péče o pacienta po rekonstrukci předního zkříženého vazu

Autor: RafaelAlexandros Vasiliou

V této bakalářské práci uvádím anatomii kolenního kloubu včetně popisu kostí, ligament, svalů a nervů. Uvádím i kinesiologii, biomechaniku a popis mechanismu vzniku ruptury ACL. V kapitolách vztahujících se k problematice ruptury ACL popisuji i rizikové faktory, prevenci a rehabilitaci.

Během klinické praxe jsem v době dvou týdnu aplikoval 8x individuální terapii včetně cvičebního programu v tělocvičně. Fyzioterapeutický plán byl sestaven na podkladě vstupního kineziologického vyšetření, které bylo provedeno v první den seznámení s pacientem. Detailní popis tohoto vyšetření a jednotlivých terapeutických jednotek je uveden ve speciální části této bakalářské práce.

Po osmé terapii bylo dosaženo pozitivního objektivního výsledku. Svaly pravé dolní končetiny byly posíleny a o 20 stupňů se zlepšil i rozsah pohybu pravého kolenního kloubu. Více informací z výstupního kineziologického vyšetření a výsledky jsou popsány opět ve speciální části této bakalářské práce.

Klíčová slova: přední zkřížený vaz, balanční cvičení, m.quadriceps femoris, m.vastus medialis, rozsah pohybu, proprioceptivní neuromuskulární facilitace, postizometrické relaxace

Acknowledgement

I would like to thank all my teachers who helped me a lot and for the knowledge I gained from them during my studies in the Faculty of Physical Education and Sport in Prague.

Special thanks to my supervisor Mgr. Ivana Vláčilová who helped me by giving me instructions and advice for the development of my Bachelor Thesis.

I also want to express my thanks to my supervisor PhDr. Mahr – Edwin to the C.L.P.A. (Centrum léčby pohybového aparátu) where my clinical practice took place for the special knowledge I gained from him.

I would also like to thank my patient who was very understandable and cooperative with me during the two weeks of my clinical practice.

Finally, many thanks to my family and my girlfriend who were supporting and encouraging me during my whole studies in Czech Republic.

Declaration

I declare that this Bachelor Thesis has been based on my own individual work. The clinical work placement took place at the C.L.P.A. (Centrum léčby pohybového aparátu) from 05.01.2015 until 16.01.2015. During my clinical practice I was supervised by PhDr. Mahr – Edwin and by Mgr. Ivana Vláčilová from the department of physiotherapy of Faculty of Physical Education and Sport in Prague. I was responsible for a patient with diagnosis of reconstruction of anterior cruciate ligament of the right knee. All examinations I used and treatment methods I applied are based on my knowledge I gained during my studies. All the information I used for the development of my Bachelor Thesis has been taken from a list of literature which is included at the end of this project.

RafaelAlexandros Vasiliou
April 2015, Prague

Contents

1. PREFACE

Anterior cruciate ligament often occurs during sports. This type of injury is common in football, basketball, skiing and other sports with lot of stop-and-go movements, jumping or weaving. Without treatment, the injured ACL is less able to control the knee movements and keep it stable and almost every time abnormal changes are presented.

My Bachelor Thesis is divided in two parts. In the first part apart from the anatomy including bones, ligaments, muscles and innervation, kinesiology and biomechanics of the knee joint which are important to be understandable for the reader, I also included special chapters explaining the mechanism of the ACL injury, specific examination of the knee joint and anterior instability, the risk factors of the ACL injury, the changes during walking after operation, the prevention and rehabilitation after an operation. These topics and some others are explained during the first part.

The second and the most important part of my Bachelor Thesis includes concretely the therapeutic plan which I followed to a patient after reconstruction of anterior cruciate ligament and also specific results after the final kinesiologic examination.

The reader of this Bachelor Thesis should be able to understand the general principles of ACL injury and the importance of an effective therapeutic approach during the short rehabilitation plan.

2. GENERAL PART

2.1. Anatomy of the knee joint

The knee is a major weight – bearing joint and it is located between two of the body's longest bones. These two facts make the knee highly susceptible to soft injury due to shear and torsion loads. The knee is a uniaxial and synovial joint. It consists of two articulations [5], [24]. One is between the femur and tibia and one between the femur and patella which permits flexion and extension as well as slight internal and external rotation [27]. The joint is bathed in synovial fluid which is contained inside the synovial membrane called the joint capsule. It plays an important role in movement related to carrying the body weight in horizontal (walking and running) and vertical (jumping) directions. Around the knee joint are present the ligaments which offer stability by limiting movements together with several menisci and bursae and protect the articular capsule (Fig.1) [5],[12].

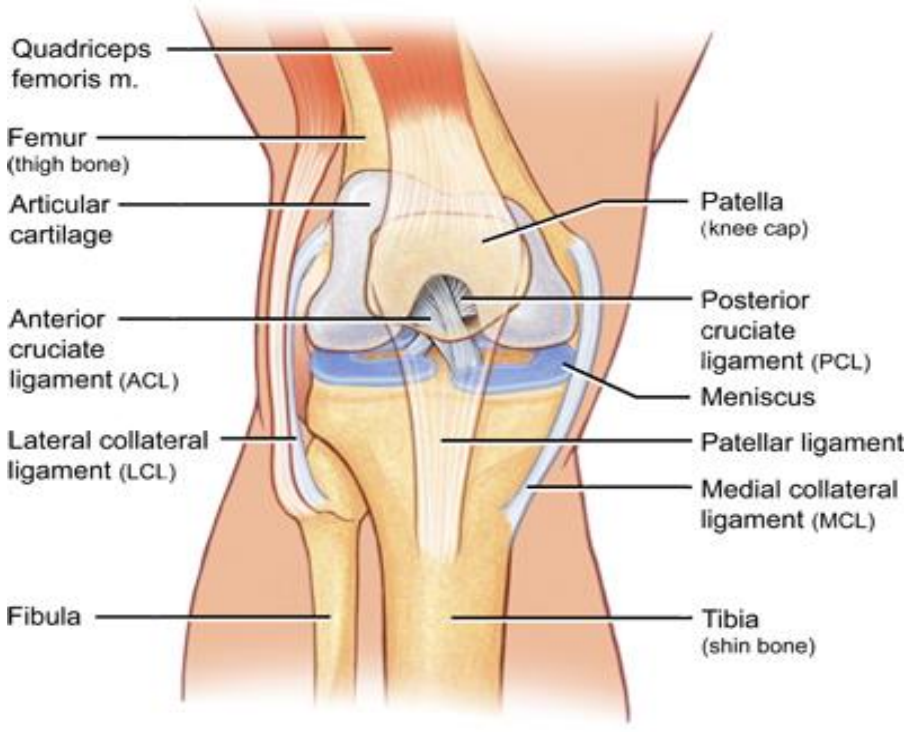

Figure 1: Anatomy of the knee joint [1]

2.1.1. Bones of the knee joint

The knee joint is a large synovial joint including three articulations within the joint capsule. The articulating bones include the femur, tibia and patella. Their joint surfaces are covered by cartilage [1].The first articulation is between the medial femoral and the medial tibial condyles. Then the articulation between the lateral femoral and lateral tibial condyles and last the articulation between the patella and the femur (medial and lateral tibiofemoral joints and patellofemoral joint) [4], [28].

2.1.2. Patella

The patella is the knee cap and a nearly triangular – shaped bone fixed within the quadriceps tendon. It is the largest sesamoid bone in the body. It covers and protects the anterior articular surface of the knee joint. In a relaxed standing position, the upper part of the patella lies just proximal to the knee joint line. The subcutaneous anterior surface of the patella is convex in all directions. The base of patella has irregular surface due to the attachment of the quadriceps tendon. The posterior articular surface of the patella is covered with articular cartilage up to 4 to 5 mm thick. This surface contacts the intercondylar groove of the femur, forming the patellofemoral joint. The thick cartilage helps to disperse the large compression forces that cross the joint. Patella is attached to the tendon of muscle quadriceps which contracts to extend and straighten the knee joint. The m.vastus intermedius is attached to the base of patella. The m.vastus lateralis and m.vastus medialis are attached to the lateral and medial boarders of patella respectively [11], [25].

2.1.3. Menisci

The medial and lateral menisci are crescent – shaped fibrocartilaginous discs located within the knee joint between the tibia and femur (Fig.2) [25].The external edge of each meniscus is attached to the tibia and the adjacent capsule by the coronary ligaments. The coronary ligaments are relatively loose, thereby allowing the menisci, especially the lateral, to turn around freely during movement. A slender transverse ligament connects the two menisci anteriorly. The anterior and posterior aspects of each meniscus are often referred to as the anterior and posterior horns of the meniscus. The menisci act to spread the weight of the body and to reduce the friction during movement. Shock absorption is another function of meniscus [12], [21].

The blood supply reaches the outer 10-33% of each meniscus and enabling inflammation, repair and remodeling [4].

2.1.4. Joint capsule

The joint capsule is composed of a fibrous membrane and a synovial membrane.

The synovial membrane is a soft tissue found between the articular capsule and the joint cavity of the knee joint. A number of bursae are located in and around the capsule to reduce friction during knee movements [14].

The fibrous membrane is thin but strong. It is formed as a united bundle around the femoral and tibial parts of the knee joint. The patella is enveloped by the capsule at the anterior aspect of the knee and in this way forms a functional unit [4], [16].

2.1.5. Ligaments of the knee joint

Capsular ligament

Like all synovial joints, the knee joint has a capsular ligament. The capsular ligament is unlike others because it consists of portions of other ligaments and fibrous expansions of other structures that cross the knee joint and become part of the capsule.

Medial collateral and lateral collateral ligament

These two ligaments provide stability to both sides of the joint. They are very important to prevent lateral motions (abduction and adduction) of the joint and make it a uniaxial, which flexes and extends in the sagittal plane.

The medial collateral ligament runs from the medial condyle of the femur to the medial condyle of tibia, with some deep fibers attaching to the medial meniscus (Fig.2).

The lateral collateral ligament runs from the lateral condyle of the femur to the head of fibula (Fig.2). It does not have fibers attaching to the lateral meniscus [4], [21].

Anterior and posterior cruciate ligaments

Both ligaments are located in the middle of the knee joint and actually cross each other as they pass through the middle of the knee joint (Fig.2). Both ligaments limit the forward and backward sliding of the femur on the tibia during knee flexion and extension.

The anterior cruciate ligament runs from just anterior to the intercondylar eminence of the tibia to the posterior medial surface of the lateral condyle of the femur. The main function of the ligament is to prevent displacement of the tibia off the distal end of the femur. It also prevents the hyperextension of the knee.

The posterior cruciate ligament runs from just posterior to the intercondylar eminence of the tibia to the anterior portion of the medial surface of the medial condyle of the femur. Its main function is to prevent posterior displacement of the tibia off the distal end of femur [4], [21], [27].

Other ligaments

Three more ligaments are found on the posterior aspect of the knee joint. These are the oblique popliteal ligament, the arcuate ligament and the ligament of Wrisberg.

On the anterior side of the knee, between the apex of the patella and the tibial tuberosity the patellar ligament is also present.

The coronary ligament which is actually a portion of the capsular ligament is connecting the outer edges of the menisci to the proximal end of the tibia.

The transverse ligament runs between the anterior horns of the medial and lateral menisci [21], [27].

Figure 2: Ligaments and meniscus of the knee joint [2]

2.1.6. Muscles and innervation of the knee joint

The knee is not a particularly stable joint, considering the form and arrangement of its bony structures. A great degree of stability of the knee join depends on the coordinated contraction of the muscles which are in the area of the knee. The muscles crossing the knee joint can easily be divided into these crossing the joint anteriorly and these posteriorly [2], [12].

The anterior group of muscles is (Fig.3), (Fig.4):

Sartorius

Origin: Anterosuperior iliac spine and superior half of the notch just distal to the spine.

Insertion: Proximal part of the medial surface of the tibia near the anterior border.

Action: Flexes, laterally rotates and abducts the hip joint. Flexes and assists in medial rotation of the knee joint.

Nerve: Femoral, L2, 3, (4).

Quadriceps femoris

Origin of rectus femoris

Straight head: from anteroinferior iliac spine

Reflected head: from groove above rim of acetabulum

Origin of vastus lateralis

Proximal part of intertrochanteric line, anterior and inferior borders of greater trochanter, lateral lip of the gluteal tuberosity, proximal half of lateral lip of linea aspera, and lateral intermuscular septum.

Origin of vastus intermedius

Anterior and lateral surfaces of the proximal 2/3 of the body of the femur, distal half of the linea aspera, and lateral intermuscular septum.

Origin of vastus medialis

Distal half of the intertrochanteric line, medial lip of the linea aspera, proximal part of the medial supracondylar line, tendons of the adductor longus and adductor magnus and medial intermuscular septum.

Insertion: Proximal border of the patella and through the patellar ligament to the tuberosity of the tibia.

Action: The quadriceps extends the knee joint, and the rectus femoris portion flexes the hip joint.

Nerve: Femoral, L2, 3, 4.

Genu articularis

This muscle, deep beneath the vastus intermedius originates on the anterior surface of the femur just proximal to the condyles and inserts, not on the bone, but on the synovial membrane of the knee joint. As the knee moves into extension, this muscle contracts,

pulling the articular capsule of the knee proximally to prevent the synovial membrane from becoming impinged between the femur, the patella and the tibia.

Nerve: Branch of the nerve to the vastus intermedius [2], [21].

The posterior group of muscles is (Fig.3), (Fig.4):

Biceps femoris

Origin of long head: Distal part of the sacrotuberous ligament and posterior part of the tuberosity of the ischium.

Origin of short head: Lateral lip of the linea aspera, proximal 2/3 of the supracondylar line, and lateral intermuscular septum.

Insertion: Lateral side of the head of fibula, lateral condyle of the tibia, deep fascia on the lateral side of the leg.

Action: The long and short heads of the biceps femoris flex and laterally rotate the knee joint. In addition, the long head extends and assists in lateral rotation of the hip joint.

Nerve to long head: Sciatic (tibial branch), L5, S1, 2, 3.

Nerve to short head: Sciatic (peroneal branch), L5, S1, 2.

Semitendinosus

Origin: Tuberosity of the ischium by the tendon common with the long head of the biceps femoris.

Insertion: Proximal part of the medial surface of the body of the tibia and deep fascia of the leg.

Action: Flexes and medially rotates the knee joint. Extends and assists in medial rotation of the hip joint.

Nerve: Sciatic (tibial branch), L4, 5, S1, 2.

Semimembranosus

Origin: Tuberosity of the ischium, proximal and lateral to the biceps femoris and the semitendinosus.

Insertion: Posteromedial aspect of the medial condyle of the tibia.

Action: Flexes and medially rotates the knee joint. Extends and assists in medial rotation of the hip joint.

Nerve: Sciatic (tibial branch), L4, 5, S1, 2.

Gracilis

Origin: Inferior half of the symphysis pubis and medial margin of the inferior ramus of the pubic bone.

Insertion: Medial surface of the body of the tibia, distal to the condyle, proximal to the insertion of the semitendinosus, and lateral to the insertion of the Sartorius.

Action: Adduct the hip joint, flexes and medially rotates the knee joint.

Nerve: Obturator, L2, 3, 4.

Popliteus

Origin: Anterior part of the groove on the lateral condyle of the femur and oblique popliteal ligament of the knee joint.

Insertion: Triangular area proximal to the soleal line on the posterior surface of the tibia and fascia covering the muscle.

Action: In non-weight bearing the popliteus medially rotates the tibia on the femur and flexes the knee joint. In weight bearing, it laterally rotates the femur on the tibia and flexes the knee joint. This muscle helps to reinforce the posterior ligaments of the knee joint.

Nerve: Tibial, L4, 5, S1.

Gastrocnemius

Origin of medial head: Proximal and posterior part of the medial condyle and adjacent part of the femur, capsule of the knee joint.

Origin of lateral head: Lateral condyle and posterior surface of the femur, capsule of the knee joint.

Action: Flexes the ankle joint and assists in flexion of the knee joint.

Nerve: Tibial, S1, 2.

Plantaris

Origin: Distal part of the lateral supracondylar line of the femur adjacent part of its popliteal surface and oblique popliteal ligament of knee joint.

Insertion: Posterior part of the calcaneus.

Action: Flexes the ankle joint and assists in flexion of the knee joint.

Nerve: Tibial, L4, 5, S1, (2).

Iliotibial band

It's a combination of gluteus maximus and tensor fascia latae tendons of insertion. It flexes and extends the knee joint, depending on the angle of the knee joint at any particular moment [2], [12], [21].

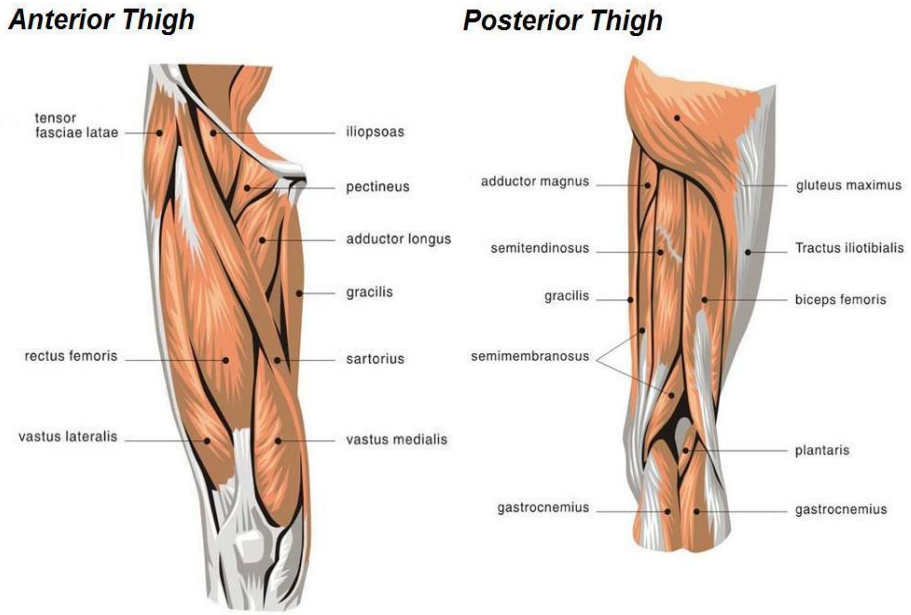

Figure 3: Muscles of the thigh in anterior and posterior view [3]

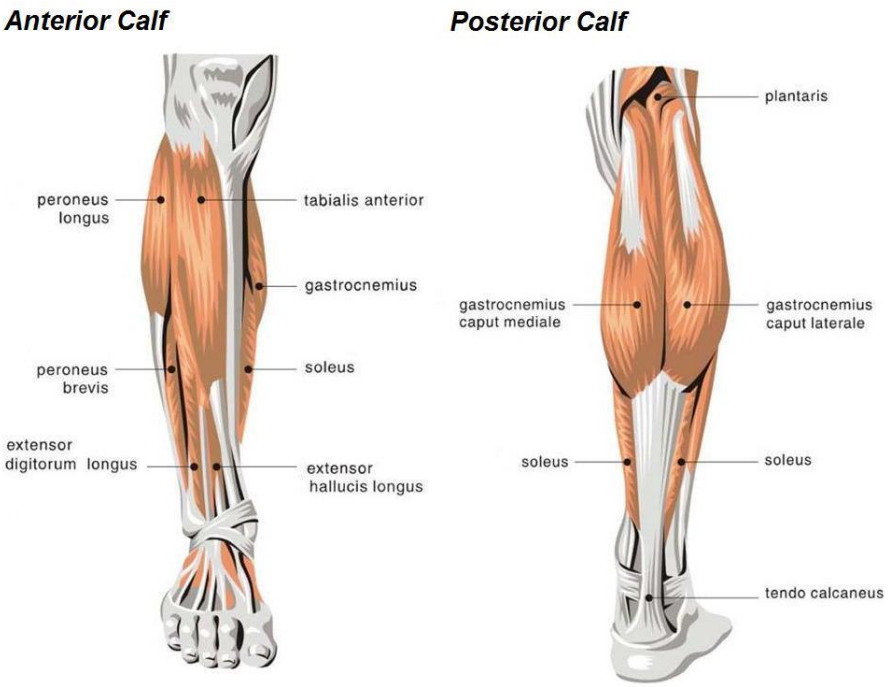

Figure 4: Muscles of the lower leg in anterior and posterior view [4]

2.1.7. Nerve supply of joints

The same nerves supplying the muscles that have a joint also send out branches that supply the skin over the muscle attachments at the joint itself. One joint may be supplied by the branches of several nerves. Many sensory nerve fibers of these nerves terminate as nerve endings in the fibrous capsules, ligaments and synovial membranes of the joints. Sensory nerve fibers relay information about the joint activity to the spinal cord and brain. After this information is processed in the spinal cord and brain it contributes to the information conveyed by motor fibers of these nerves to the muscles controlling the movements of the joints [28].

2.1.8. Vascular supply and lymph supply of the knee joint

Vascular supply to the knee joint is predominantly through descending and genicular branches from the femoral, popliteal and lateral circumflex femoral arteries in the thigh and the circumflex fibular artery and recurrent branches from the anterior tibial artery in the leg. These vessels form an anastomotic network around the knee joint.

When ligaments and tendons are severed or seriously damaged, they heal slowly but in due course very well, and with the proper surgical treatment they can become as strong as they were before [27], [28].

The repair is associated with the generation of fibroblasts and a good capillary blood supply. Both of them grow into the damaged region. The fibroblasts become oriented parallel to the long axis of the ligament or tendon, and form new collagenous fibers. In addition near the blood vessels located around a joint, there are many lymphatic vessels that form a network [27].

2.2. Kinesiology and Biomechanics of the knee joint

Motion of the knee joint occurs in two planes, allowing flexion and extension in the sagittal plane, and internal and external rotation in the horizontal plane (Fig.5). The strong functional association within the joints of the lower limb is reflected by the fact that most muscles that cross the knee also cross either the hip or ankle joint [25].The normal alignment of the knee joint is considered to be at zero degrees of flexion. With a position of zero flexion, the ligaments which are located to the sides are taut and all ligamentous structures which are located to the posterior side of the joint, femur, menisci and tibia are in a firm contact. This position is known as “locked knee”. Consequently the joint surfaces become larger and more stable in extension.

Medial rotation and full extension tighten all the associated ligaments. This is another component of the locking mechanism during extension [1], [27]. The body's center of gravity which is positioned along a vertical line that passes anteriorly to the knee joint is also a component which keeps the knee extended during standing. In the knee joint, independed rotations (internal and external) are possible when the joint is "unlocked". The rotations occur mainly in the menisco-tibial articulation with simultaneous translation of the menisci.

Because the knee joint is positioned between the two longest bony levers of the body (the femur and the tibia), the potential for torque development at the joint is large. It is also a major weight-bearing joint. The knee has important biomechanical factors. Many of them are expressed during walking and running. For example, during the swing phase of walking, the knee flexes to shorten the functional length of the lower limb. Otherwise, the foot would not easily contact the ground. Then during the stance phase, the knee remains slightly flexed. In this way it allows conservation of energy and the transmission of forces through the lower limb [1], [25].

Running requires a large range of motion of the knee joint, especially in the sagittal plane. During rapidly changing of directions while running requires additional freedom of movement in the horizontal plane as well.

The stability of the knee joint is based primarily on its soft tissue constrains rather than on its bony configuration. With the foot firmly in contact with the ground, these soft tissues are often subjected to large forces, from muscles and external forces. Injury of ligaments and cartilage are two common consequences of the large functional demands placed on the knee [4], [25].

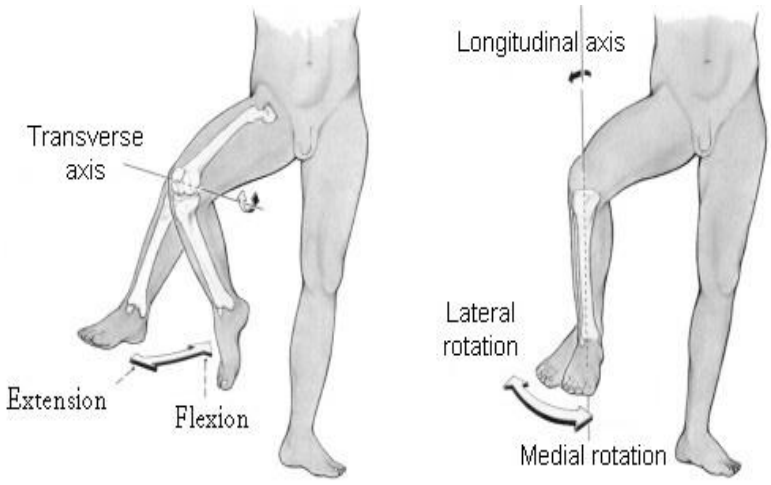

Figure 5: Movements of the knee joint in transverse and longitudinal axis [5]

2.3. Movements of the knee joint

The only two movements the knee joint is capable to provide are flexion and extension. However, because of the sizes and shapes of the femoral condyles and the soft tissue configurations, when the knee flexes and extends, the lower leg (tibia and fibula) are able to provide rotation. When the knee extends, the leg rotates externally. When the knee flexes, the leg rotates internally. As the knee joint "locks" into extension and "unlocks" when moving into flexion, the rotation of the leg is difficult to see when weight is not being borne by the leg [8], [9], [21].

According to Kendall full range of motion of the knee in direction of flexion is 140 degrees and normal extension is 0 degrees [2].

2.4. Instability of the knee joint

Joint stability is created by ligaments (the primary or static stabilizers) and muscles (the dynamic stabilizers) [15]. Four ligaments provide static stability to the knee. The most commonly injured knee ligaments are the medial collateral ligament and the anterior cruciate ligament [19].

Knee instability is usually the result of ACL injury that has not been surgically repaired. If ACL deficient athlete continues to participate in sport, the knee may be subjected to new injuries. Because the anterior cruciate ligament is absent, other ligaments have to assume the load and become overdistened and the athlete may develop either posterolateral instability or medial instability [26].

These combined instabilities often make it difficult or impossible for the affected athlete to participate again in sports and to load again the knee with weight [23], [26].

2.5. Sports injuries - Ligament injuries

Sports injuries can be divided into soft-tissue injuries (cartilage injuries, muscle injuries, tendon injuries and ligament injuries) and skeletal injuries (fractures). The various types of tissue have distinctly different biomechanical properties and their ability to adapt to training also varies [5], [26].

Ligament injuries

Unlike tendons, which are subject to both acute and overuse injuries, ligaments are usually injured as the result of acute trauma. The typical injury mechanism involves sudden overloading, stretching the ligament while the joint is in an extreme position on

one side of the joint when a blow is sustained from the opposite side during weight bearing.

Ruptures may occur in the mid-substance of the ligament-bone junction. Sometimes avulsion fractures also occur, when the ligament pulls a piece of the bone off with it [4], [22].

Ligament injuries are usually classified as a mild (grade 1), moderate (grade 2), or severe (grade 3) (Fig.6). Mild injuries are characterized by structural damage on the microscopic level with slight local tenderness. Partial tears are classified as moderate injuries and usually result in visible swelling and notable tenderness but tends not to affect joint stability. Severe injuries result in a complete rupture of the ligament, with significant swelling and instability [4], [13].

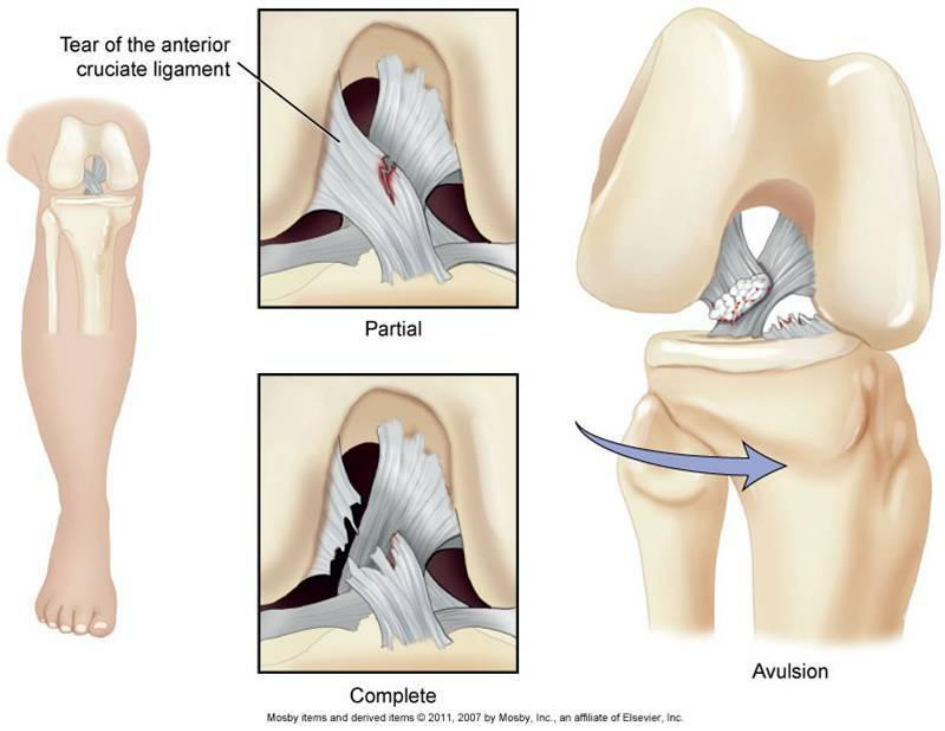

Figure 6: Avulsion, partial and complete tear of the ACL [6]

2.5.1. Anterior cruciate ligament rupture

Rupture of the anterior cruciate ligament (Fig.7) occurs more often in females than in males, from adolescents to older adults. ACL tears can occur as the result of contact or non-contact injuries [13].

Non-contact injuries to the knee are responsible for most ACL tears. Pivoting and cutting sports (soccer and basketball) are the most common scenarios for non-contact ACL injuries. Approximately 70% of ACL injuries are non-contact, with most of these being sustained when the femur is rotated on the planted leg with the knee close to full extension during cutting, landing or stopping. The most direct contact injuries occur in American football. ACL tears can be associated with meniscal tears or collateral ligament injuries. Although different mechanisms can place the ACL at risk, the individual is often rotated on a planted foot with the knee in flexion and the m.quadriceps femoris activating strongly [4], [6], [19].

The patient will often report hearing or feeling a “pop”. The patient will also describe a sense of knee instability, especially with twisting activities such a changing direction when walking or running. An occasional sense of hyperextension of the knee is also common. Tenderness often occurs at the lateral joint line [7], [19].

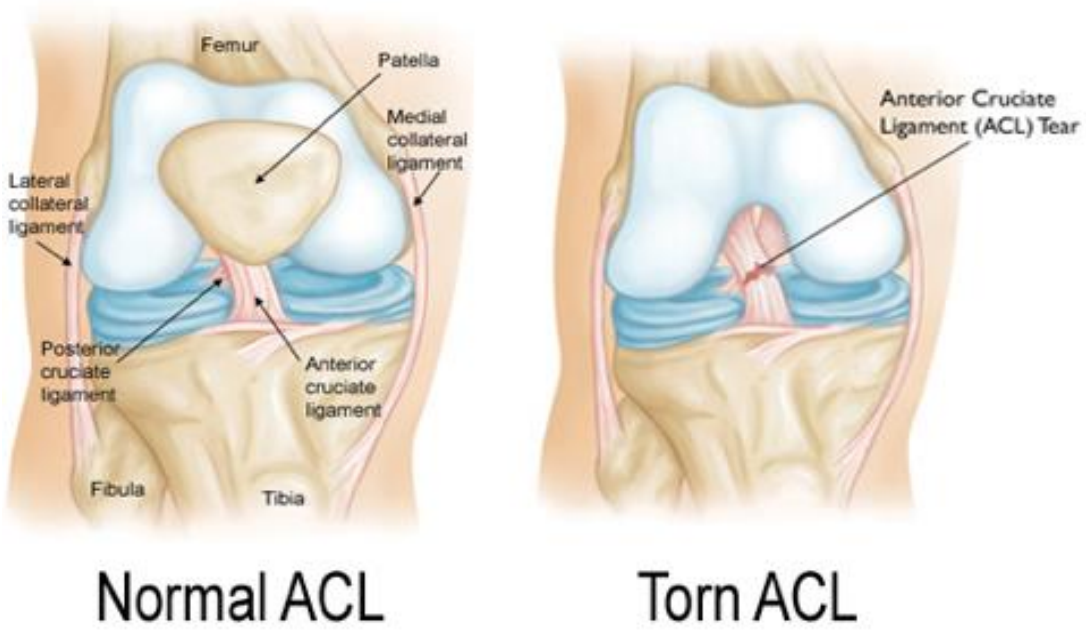

Figure 7: Normal ACL and torn ACL [7]

2.5.2. Epidemiology for ACL ruptures

Anterior Cruciate ligament rupture is one of the most common knee injuries. In the United States of America, a number of 100.000 to 200.000 of these injuries are reported every year. This makes them the most common ligament injury in the country. This number is increasing in both the general population and athletes. Football players comprise the greatest number of ACL injuries (53% of the total) and skiers and gymnasts are also at a high risk. For the past twenty years, surgical techniques for ACL reconstruction and post-operative rehabilitation have become highly developed, which enables the patients to return to sports activities at the pre-operative levels. However, a long time is still needed for full recovery and improving the condition as it was before the injury. Injury prevention has received attention in the past years [37].

2.5.3. Mechanism of ACL ruptures

Injury often occurs in combination with other soft tissue injuries in the knee joint.

- Lateral knee impact (forced external rotation and valgus strain) causing ACL, MCL and medial capsular damage.
- Medial knee impact (forced internal rotation (Fig.8) and varus strain) causing ACL, LCL and posterolateral capsule damage.
- Hyperextension or hyperflexion impacts causing combined ACL and PCL damage +/- knee dislocation.
- Avulsion of the tibial insertion site is common in younger athletes [22].

Using a standardized questionnaire which applied in the United States of America, 89 athletes (100 knees) were interviewed about the events surrounding their ACL injury. A noncontact mechanism was reported in 71 (72%) knees and a contact injury in 28 (28%) knees, one patient was unsure if there was any contact. Most of the injuries were sustained at foot strike with the knee close to full extension. Noncontact mechanisms were classified as sudden deceleration prior to a change of direction or landing motion, while contact injuries occurred as a result of valgus collapse of the knee. Hamstring flexibility parameters declare a statistically higher level of laxity in the injured athletes in comparison with a matched group of 28 controls [22], [32].

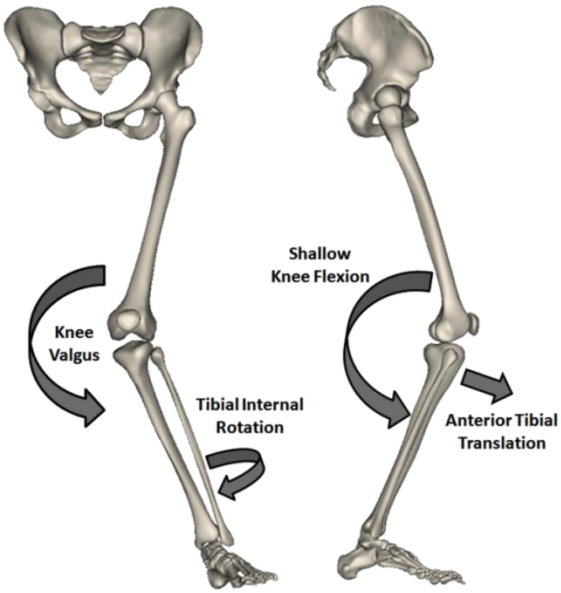

Figure 8: Mechanism of ACL injury [8]

2.5.4. Risk factors of ACL injury

Analysis of the risk factors for ACL injury suggests that it occurs three to five times more frequently among women than among men in comparable sports [26]. Several theories have been advanced to explain this gender difference in injury incidence including:

- Narrowed cruciate ligaments in females
- Narrowed intercondylar notches in addition to other anatomical differences
- Hormonal effects on ligaments
- Poorer neuromuscular control among women
- Reduced strength
- Inappropriate stopping and landing techniques
- Friction in the athlete's shoes
- Surface [26], [33], [34]

2.5.5. Prevention of the ACL injury

Most ACL injuries occur when attempting a fake or in a landing situation.

For prevention it is good to teach the players to land on two legs instead of one. In this way there is a reduction of the forces affecting the knee and reducing the load on the ACL.

It is also suggested that athletes should practice faking and landing with the knees bended for reducing the maximum force that transmitted to the ACL.

Another important factor for athletes to prevent ACL injuries is to follow an individual program emphasizing to neuromuscular training of the knee using strengthening exercises of muscles which surround the knee and also balance and sensomotoric exercises [26], [35], [36].

2.6. Biomechanical changes during level walking following ACL reconstruction surgery

The effect of anterior cruciate ligament reconstruction on joint kinematic and kinetic patterns during gait is receiving increased research attention.

Some studies have shown that abnormal gait patterns are common following ACL reconstruction surgery.

It has been suggested that abnormal gait patterns might have implications for the long term development of pathologic knee conditions. For example recent studies have shown that between 40% and 50% of patients who had undergone ACL reconstruction surgery had knee rotational changes that were greater than 5 degrees during level walking. A rotational shift of this magnitude has been suggested to be sufficient to cause the acceleration of articular cartilage degeneration. An increased external knee adduction movement has also recently been reported following ACL reconstruction surgery which may be a potential mechanism for the development of osteoarthritis [4], [31].

2.7. Alterations in joint kinematics during walking after ACL reconstruction surgery

The anterior cruciate ligament plays an important role in the control of knee stability by not only controlling anterior tibial translation but also varus movement and axial rotation. Rupture of the ACL can therefore significantly affect the knee joint stability and result in the application of abnormal load bearing patterns on the articular surfaces. Actually, there have been numerous studies which have observed abnormal knee movement patterns in patients following ACL rupture. It has further been suggested, that such abnormal knee movements associated with ACL rupture could be a cause of cartilage degeneration and the eventual development of knee joint osteoarthritis. ACL reconstruction is a commonly performed procedure to restore knee joint stability and function but its effectiveness in preventing osteoarthritis is questionable. Several studies have demonstrated relatively high incidences of osteoarthritis after ACL reconstruction. This may in part be explained by the finding that the movement of the ACL reconstructed knee remains abnormal when compared to the contralateral side or to healthy control knees during a variety of static and dynamic activities. One factor which may contribute to the altered movement patterns after ACL reconstruction is that most contemporary ACL reconstruction surgeries have primarily focused on restoring anterior–posterior translation whereas the native ACL not only controls anterior–posterior translation but also internal–external rotation [4], [17], [29].

Activities that have a repetitive, cyclic nature have been suggested to be relevant to study in populations at risk for the development of knee osteoarthritis. Overground walking is one such activity [29], [30].

2.8. Examination by the physiotherapist

History usually includes sport played, mechanism of injury, symptoms and relieving factors, location and type of pain and chronicity. All the information related to the injury which can be helpful for the therapy and its effectiveness should be included. As physiotherapists we are always interested in any health problems which patient may face and we should collect information about the whole body of the patient.

The physical examination should be gently initiated. The non-injured knee should be examined first to compare later with the affected knee. A standard systemized examination with recording of all findings is essential. Performing and recording normal test results are just as valuable as noting abnormal findings. The initial physical

examination should include an overview of anthropometric measurements. Body height and weight, overall muscular mass and tone should be recorded. The measurements of the leg are very important, especially above patella, over the knee and also of the lower leg. In this way we determine the condition of muscles of the affected leg of course in comparison with the healthy leg. We also identify if swelling is present on the knee area and if area around the knee is prominent.

The level of injury and disability can be assessed by observing stance and gait, walking normally or with a limb or using crutches. It should also be examined the alignment of the whole body in standing position and observe the differences in each side of the patient.

Examination of the patient in the relaxed, sitting or lying position can produce very different results from those obtained with the patient in standing position. We should conclude in our notes any abnormal findings. A comprehensive understanding of anatomy is essential of any physical therapist. In the clinical situation the therapist uses the sense of touch, known as palpation, to assess what is occurring below the skin and what musculoskeletal structures are involved in an injury. When palpating an area of the body, the therapist is feeling for areas of pain and tenderness and areas of restriction.

Active and passive movements of the knee joint are also tested to see the restriction of motion again with comparison with the healthy knee. Extremely important for the physiotherapist is to perform to patient some functional tests to evaluate and determine the knee joint instability or laxity. Restriction in a joint produces reflex changes, mainly in the segment concerned, affecting the cutaneous and subcutaneous tissue and muscles. So it is surely important to know if there is restriction in any joint which can affect the patient's movements. The purpose of assessment of muscle length test is to determine whether the range of motion occurring in the joint is normal, limited or excessive by the intrinsic joint structures or by the muscles crossing the joint. Muscles have an important role in supporting and moving the skeletal structures. A muscle has to be short enough to provide stability of a joint and long enough to allow normal mobility. In muscle testing, weakness must be distinguished from restriction of range of motion. Frequently, a muscle cannot complete the normal range of motion. It may be that the muscle is too weak to complete the movement, or it may be that the range of motion is restricted because of the shortness of the muscles or the shortness of the ligaments [3], [10], [22].

2.8.1. Specific examination of the knee joint

Before any examination it is important to record some important information related to the injury. The history should include information about the presenting complain, the signs and symptoms, and the patient's lifestyle. This history may give a significant indication to the type of injury and the likely findings on clinical examination. For example if the patient was kicked around the medial aspect of the knee, a valgus deformity injury to the tibial collateral ligament might be suspected.

The examination should include assessment in the erect position and on the treatment table and also walking. The affected side must be compared with the unaffected side. There are many tests and techniques for examining the knee joint. In the next chapters there is the description of the tests for anterior instability [27].

2.8.1.1. Lachman's test

The patient lies on the treatment table in supine position and the examiner places one hand around the distal femur, the other around the proximal tibia and elevates the knee producing 20 degrees of flexion. The patient's heel rests on the table. The examiner's thumb must be on the tibial tuberosity. The hand on the tibia applies a brisk anteriorly directed force. If the movement of the tibia on the femur comes to a sudden stop it is a firm endpoint. If it does not come to a sudden stop the endpoint is described as soft and is associated with a tear of the anterior cruciate ligament [1], [27].

2.8.1.2. Anterior drawer test

A positive anterior drawer test is when the proximal head of the patient's tibia can be pulled anteriorly on the femur. The patient lies supine on the treatment table. The knee is flexed in 90 degrees and the heel and sole of the foot are placed on the table. The examiner sits gently on the patient's foot, which has been placed in a neutral position. The index fingers are used to check that the hamstrings are relaxed while the other fingers encircle the upper end of the tibia and push the tibia. If the tibia moves forward, the anterior cruciate ligament is torn. Other peripheral structures, such as the medial meniscus or meniscotibial ligaments, must also be damaged to elicit this sign [27].

2.8.1.3. Pivot shift test

There are many variations of this test. The patient's foot is wedged between the examiner's body and elbow. The examiner places one hand flat under the tibia pushing it forwards with the knee in extension. The other hand is placed against the patient's thigh pushing it the other way. The lower limb is taken into slight abduction by the examiner's elbow with the examiner's body acting as a fulcrum to produce the valgus. The examiner maintains the anterior tibial translation and the valgus and initiates flexion of the patient's knee. At about 20-30 degrees the pivot shift will occur as the lateral tibial plateau reduces. This test demonstrates damage to the posterolateral corner of the knee joint and the anterior cruciate ligament [1], [27].

2.8.1.4. Assessment of other structures of the knee

- Assessment of the tibial collateral ligament can be performed by placing a valgus stress on the knee.
- Assessment of lateral and posterolateral knee structures requires more complex clinical testing.

<u>The knee will also be assessed for:</u>

- Joint line tenderness
- Patellofemoral movement and instability
- Presence of an effusion
- Muscle injury
- Popliteal fossa masses [27]

2.8.1.5. Further investigations

After the clinical examination has been carried out, further investigations usually include pain radiography and may be magnetic resonance imaging, which allows the radiologist to assess the menisci, cruciate ligaments, collateral ligaments, bony and cartilage surfaces, and the soft tissues.

Arthroscopy may be carried out and damage to any internal structures repaired or trimmed. An arthroscope is a small telescope that is placed into the knee joint through the anterolateral or anteromedial aspect of the knee joint. The joint is filled with a saline solution and the telescope is manipulated around the knee joint to assess the cruciate ligaments, menisci, and cartilaginous surfaces [1], [27].

2.8.1.6. Magnetic Resonance Imaging

The MRI is an aggregate of techniques that provide information about the structure, biochemistry and function of the brain and other tissues. Due to a high differential ability of the tissue, the MRI allows a good quality of images of the brain, spine and spinal cord structures, vascular supply, concentration of certain chemical substances in tissues, course of nerve fibers and the state of the blood-brain barrier. MRI also helps in diagnosis of degenerative illnesses and infections. Also the condition of joint cartilage, menisci and bone marrow can be assessed [1], [7].

Figure 9: My patient's MRI of the right knee before the operation [9]

2.9. Rehabilitation of the ACL rupture

The goal of function-based rehabilitation programs is the return of the athlete to optimum athletic function. Optimal athletic function is the result of psychological motor activations creating specific biomechanical motions and positions using intact anatomical structures to generate forces and actions. Sport-specific function occurs when the activations, motions and resultant forces are specific and efficient for the needs of the sport [20].

Every sport has metabolic, psychological and biomechanical demands inherent in the way the sport is played, at whatever level or skill or intensity. Every athlete brings a specific musculoskeletal base to interact with the demands. Performance in the sport and injury risk is the results of the interaction [18].

Clinical results of ACL reconstruction are quite good, with very low re-injury rates. The most common complication is some residual anterior knee pain. Strengthening the hip muscles during therapy is extremely important in helping to restore stability in the lower limbs and avoid strain on the reconstructed ligament [13].

2.9.1. Phases of rehabilitation of the ACL rupture

Phase I – (Pre-Operative Phase)

The patient in this phase is introduced to all methods and techniques that they will undergo during post-operative treatment. This will actually encourage the patient with the entire process and strongly motivate them [1].

Phase II – (0-2 weeks post-surgery)

This phase is the most important time period during the whole rehabilitation program. It includes five important parameters:

- Maintain full extension
- Control post-operative edema by rest and elevation of the lower extremities
- Allow surgical incision healing
- Preserve quadriceps activity
- Achieve 90º of knee flexion at the end of this period

Phase III – (3-5 weeks)

During this phase, progression toward greater knee flexion is continued. Soft tissue techniques can be used for decreasing the tension of the surrounding tissues. Scar mobilization can be applied. Active and exercises include stabilization exercises in sitting, standing on the floor with symmetrical bilateral lower extremity weight-bearing, and exercises with balls.

Phase IV – (6-8 weeks)

In this phase, if the recovery of the patient is normal without complications coordination and strengthening exercises can be used on unstable surfaces. Some devices which can be used are rocker boards, exercise sandals, balls and posturomed. Athletes can start running on a treadmill or on a soft surface without speed or directional

changes. Closed chain exercises like mini-squad and leg press can also be used in this phase [1].

Phase V – (from completed week 8)

Every patient completing the outpatient part of rehabilitation is instructed in exercise principles and given a home program. The training has to include coordination exercises and needs to prevent repeated loading in knee flexion greater than 60º. Closed chain exercises are preferred during strength training [1], [7].

3. SPECIAL PART (case study)

3.1. Methodology

My clinical work placement took place in the Centrum léčby pohybového aparátu at Vysočany in Prague. The duration of my practice was from 05.01.2015 until 16.01.15. The daily hours of practice were eight and in summary I performed 80 hours of practice. My clinical work placement was supervised by PhDr. Mahr - Edwin.

My patient had operation of reconstruction of anterior cruciate ligament of the right knee on 19th December 2014 and he was going to stay in the orthopedic department of the hospital for at least two weeks. During the period I was practicing to the hospital I consulted my patient eight times. The first time we met was on 06.01.2015 and the last was on 16.01.2015. All therapies took place in the orthopedic department of the hospital in a specific room applying individual therapies to the patients. During every therapeutic unit my main goal was to improve my patient's range of motion of his right knee into direction of flexion and to improve the strength of the muscles of his right lower extremity. For that reason I applied mainly manual therapy but I used as well special equipment such as soft ball, overball and gymnastic ball. For the examination of my patient's state before, during and after the therapy units I also used some instruments such as:

- Goniometer (for the evaluation of the range of motion of the associated body segments – lower extremities)
- Measurement tape (for the measurement of circumferences and the anthropometric measurements)
- Neurological hammer (for the evaluation of the deep tendon reflexes as a part of the neurologic examination)
- Plumb line (to notice if any abnormalities are present distinguishing two halves of the body)
- Weight scales (to perform the examination of weight bearing)

As a part of my therapy I consider my guidance and correction of the patient during exercising in the gym so I also include some devices such as the posturomed, the extension machine, bicycle, treadmill, stepper machine, extra weight, balance boards, gymnastic ball, bosu, thera-bands and the rope.

The patient was using crutches until the 3rd therapy. From the 4th therapy (12.01.2015) he was able to walk without crutches.

The patient was fully aware that he was part of my Bachelor Thesis. No invasive methods were used and a consent for signed between me and the patient.

My clinical work placement has been approved by the Ethics Board Committee of the Faculty of Physical Education and Sport at Charles University in Prague, under the approval number 016/2015.

3.2. Anamnesis

Examined person: L. J. Male

Date of birth: 1986

Diagnosis: Reconstruction of anterior cruciate ligament of the right knee

Code: Z509

History:

The patient is a goalkeeper in a football team. On 25th May during the morning training before a football match he jumped to catch the ball and he fell down. He heard a strange noise to his right knee. It was very painful and immediately stopped the training. The following day he went to hospital. The doctor recommended him to have a magnetic resonance imaging to see what exactly the problem was. A week later he had the magnetic resonance imaging which showed rapture to the anterior cruciate ligament. On 19th December he had an operation of reconstruction of the anterior cruciate ligament of his right knee in a hospital of Beroun. There, he had three therapies after the operation and then he moved to "Centrum léčby pohybového aparátu Vysočany". Today (06/01/2015) is the 2nd day in this hospital and also the second therapy.

Previous rehabilitation:

In 2005 he had a treatment for his left knee after an injury he had had during a football match. He was feeling his left knee unstable probably due to incorrect function of the anterior cruciate ligament. He had no operation.

In 2010 he had a treatment for a rupture of the m.biceps femoris of the right leg after an injury he had also had during a football match.

Long time ago (not specified when) he had treatment for his right ankle. He was injured during the training and the doctor diagnosed ankle sprain.

Statement from the patient's medical documentation:

He had magnetic resonance imaging for his left knee in 2005.
He had magnetic resonance imaging of his right knee in 2014.

Indication of rehabilitation:

Reduce the swelling on the right knee.
Improve the range of motion of the right knee in direction of flexion.
Strengthen the muscles of the right leg, especially hamstrings, quadriceps femoris and m.triceps surae.
Improve his balance.
Train the walking pattern.

Present state (Status present):

The patient is in a good condition. He does not have any pains on his right knee. He is walking with crutches. Every day, during the morning he has treatment for his right knee, lymphatic drainage and magnetotherapy. Then he goes to the gym to do some stretching and strengthening exercises. Every afternoon he goes to the gym for individual exercising to keep his condition in a good level. On his right knee the swelling is visible and also the hypotrophic m.quadriceps femoris and triceps surae. He has a scar 4 cm long on the medial side of his right knee and also three other smaller scars. The color of his skin is normal. The temperature on the area of his right knee is a little bit higher than normal. He is also very positive for the result of the therapy.
His weight is 85 kg, his height is 192 cm and his BMI is 23.1

Family Anamnesis:

His father has the same problem with anterior cruciate ligament.

Previous operations:

No previous operations. That was the first time.

Medication:

The patient has taken painkillers just after the surgery of reconstruction of anterior cruciate ligament for two days.

Allergies:

He has no allergies.

Abuses:

He is not a smoker. He drinks alcohol occasionally.

Hobbies:

He is interested in history and politics.

Occupational Anamnesis

He has been a professional football player for 10 years.

Social Anamnesis

He lives in a flat on the 4th floor but he does not have to climb the stairs because he uses the elevator.

3.2.1. Doctor's report

Walking with two crutches

Bicycling in the gym without extra weight

Rhythmic stabilization of the right knee

Exercising with balance board to improve the balance

Swimming after the scar is healed

Application of analytic techniques and sensomotoric exercises

Next control will be after five weeks

3.3. Initial kinesiologic examination

3.3.1. Postural Examination

Postural Examination in anterior view

- No valgosity and varosity of the ankle joints
- No valgosity and varosity of the knee joints
- Knee joints are in the same level
- Right patella is medially rotated with the swelling visible
- M.vastus medialis is hypotrophic to the right leg
- Anterior superior iliac spines are symmetrical in transverse plane
- Iliac crests are both in the same level
- Umbilicus is in the center
- Symmetry of both thoracobrachial triangles
- Right clavicle is slightly elevated than the left one
- Right shoulder is slightly higher than the left one
- Head is slightly shifted to his right side

Postural examination in posterior view

- No valgosity and varosity of the ankle joints
- No valgosity and varosity of the knee joints
- M.soleus and m.gastrocnemius (lateral and medial) are hypotrophic to the right leg
- Popliteal lines of both knees are in the same level
- Posterior superior iliac spines are symmetrical in transverse plane
- Hyperextended lumbar spine (lordosis)
- Increased flexion in thoracic spine (kyphosis)
- Slightly extended cervical spine
- Symmetry of both thoracobrachial triangles
- Scapula is slightly elevated in the right side
- Shoulder is slightly higher in the right side
- Head is slightly shifted to the right side

Postural examination in lateral view (right side)

- Whole body is slightly shifted forward
- The plumb line goes slightly anterior to lateral malleolus
- The plumb line goes slightly anterior to axis of knee joint
- Extended right knee
- The plumb line goes slightly posterior to hip joint
- Anterior tilt of pelvis
- Hyperextended lumbar spine till Th12 (lordosis)
- Increased flexion of thoracic spine till C7 (kyphosis)
- Slightly extended cervical spine
- The plumb line goes midway of shoulder joint
- Head in neutral position

Postural examination in lateral view (left side)

- The plumb line goes slightly anterior to lateral malleolus
- The plumb line goes slightly posterior to axis of knee joint
- Hyperextended left knee
- The plumb line goes slightly posterior to hip joint
- Anterior tilt of pelvis
- Hyperextended lumbar spine till Th12 (lordosis)
- Increased flexion of thoracic spine till C7 (kyphosis)
- Slightly extended cervical spine
- The plumb line goes midway of shoulder joint
- Head in neutral position

3.3.2. Foot arch

Normal arch in left foot

Normal arch in right foot

3.3.3. Special Tests

- **Romberg test :**

Romberg I – patient stand with his heels together – Negative
Romberg II – patient stays with feet together – Negative
Romberg III – the patient stand with closed eyes – Negative

- **Trendelenburg test:**

He performed the test only in standing to the healthy leg (left leg) – Negative result
He wasn't able to stand in right leg (because of the operation) without crutches

- **Weight bearing on two scales :**

Left Leg: 48 kg Right Leg: 37 kg

- **Ballottement sign**

To test if there was liquid inside the knee joint I used the ballottement sign. I applied downward pressure towards the foot with one hand, while pushing the patella backwards against the femur with one finger of the opposite hand.
This pressure caused the solid object to lean against my hand so the test was positive.

3.3.4. Anthropometric Measurements

Height of patient:

Standing: 192 cm

Sitting: 90 cm

Table 1: Length of lower extremities

	Left	**Right**
Anatomical	106 cm	106 cm
Functional	1)116 cm (superior anterior iliac spine) 2) 120 cm (umbilicus)	1)116 cm (superior anterior iliac spine) 2)120 cm (umbilicus)
Thigh	58 cm	58 cm
Middle leg	48 cm	48 cm
Foot	23,5 cm	23,5 cm

Table 2: Circumferences of lower extremities

	Left	**Right**
Thigh	47 cm (15cm from patella)	45,5 cm (15cm from patella)
Thigh	44 cm (10 cm from patella)	40 cm (10 cm from patella)
Knee	39,5 cm	43 cm
Calf	36 cm	34,5 cm

3.3.5. Palpation (according to Lewit)

Table 3: Muscle tone examination

Muscle	Left Leg	Right Leg
Gastrocnemius (lateralis)	Normal tone	Hypotonic
Gastrocnemius (medialis)	Normal tone	Hypotonic
Soleus	Normal tone	Hypotonic
Tibialis anterior	Normal tone	Hypotonic
Rectus femoris	Normal tone	Hypotonic
Vastus medialis	Normal tone	Hypotonic
Vastus lateralis	Normal tone	Hypotonic
Tensor Fasciae Latae	Hypertonic	Hypotonic
Biceps femoris	Hypertonic	Hypotonic
Semitendinosus	Hypertonic	Hypotonic
Semimembranosus	Hypertonic	Hypotonic

3.3.6. Soft tissue Examination (according to Lewit)

Hyperalgesic zones

Run with one finger very lightly over the surface of the skin – no friction / no sweat production

Stretching of skin – hard barrier, no elasticity in the area of thigh and around the scar

Stretching of subcutaneous fold – hard barrier, no elasticity in the area of thigh and around the scar

Fasciae stretching – hard barrier, no elasticity in the area of thigh and around the scar

3.3.7. Muscle Strength Tests (according to Kendall)

Table 4: Examination of strength of the muscles of lower extremities

Muscle	Left Leg	Right Leg
Tibialis anterior	Grade 5	Grade 4+
Tibialis posterior	Grade 5	Grade 4
Peroneus longus	Grade 5	Grade 4
Peroneus brevis	Grade 5	Grade 4
Soleus	Grade 5	Grade 3+
Ankle plantar flexors	Grade 5	Grade 4
Popliteus	Grade 5	Grade 4
Semitendinosus / Semimembranosus	Grade 5	Grade 3
Biceps femoris	Grade 5	Grade 3
Quadriceps femoris	Grade 5	Grade 3
Hip flexors	Grade 5	Grade 3
Iliopsoas	Grade 5	Grade 3+
Sartorius	Grade 5	Grade 3+
Tensor Fasciae Latae	Grade 5	Grade 3
Hip adductors	Grade 5	Grade 3
Medial rotators	Grade 5	Grade 3+
Lateral rotators	Grade 5	Grade 3+
Gluteus minimus	Grade 5	Grade 4
Gluteus medius	Grade 5	Grade 4
Gluteus maximus	Grade 5	Grade 4
Abductor halluces	Grade 5	Grade 5
Flexor halluces brevis	Grade 5	Grade 5
Flexor halluces longus	Grade 5	Grade 5
Extensor hallucis brevis	Grade 5	Grade 5
Lumbricales	Grade 5	Grade 5
Dorsal interossei	Grade 5	Grade 5
Flexor digitorum brevis	Grade 5	Grade 5
Flexor digitorum longus	Grade 5	Grade 5
Extensor digitorum longus and brevis	Grade 5	Grade 5
Peroneus tertius	Grade 5	Grade 5

3.3.8. Muscle Length Tests (according to Janda)

Lower extremity:

m.soleus, m.popliteus – Grade 0 (no shortness)

m.gastrocnemius (lateralis and medialis), m.plantaris – Grade 0 (no shortness)

Hip flexors – Grade 0 (no shortness)

Hip adductors - Grade 0 (no shortness)

m.biseps femoris, m.semitendinosus, m.semimebranosus – Grade 1 (moderate shortness)

m.piriformis – Grade 2 (marked shortness)

Upper extremity:

m.levator scapulae – Grade 0 (soft barrier)

m.trapezius (upper part) – Grade 1 (resistance in depression of shoulder)

m.strernocleidomastoid – Shortness (hard barrier)

Note: I performed the muscle length tests in both lower extremities with the same results.

3.3.9. Joint Play Examination (according to Lewit)

Metatarsophalangeal Joints – The joint play is present in both legs in dorsoplantar and laterolateral direction

Tarsometatarsal Joints - The joint play is present in both legs in dorsoplantar direction

Transverse tarsal joints - The joint play is present in both legs in dorsoplantar direction

Subtalar Joint – The joint play is present in both legs in distal and upward direction

Talocrural Joint – The joint play is present in both legs in distal direction

Tibiofibular Joint – The joint play is present in both legs in distal and ventral direction

Knee Joint – The joint play is present in the left leg in laterolateral direction

I performed joint play of the knee joint only to the healthy leg (left leg)

Patella - The joint play is present in left leg in craniocaudal and laterolateral direction. In the operated leg is not present in both directions probably due to the liquid.

Hip Joint - The joint play is present in both legs along the longitudinal axis and in direction of the femoral neck

Sacroiliac Joint – The joint play is present in dorsal direction for the upper part of sacroiliac joint and in ventrocaudal direction for the lower end of the sacroiliac joint

3.3.10. Examination of Movement Patterns (according to Janda)

Hip extension – Normal

(Is examined to analyze one of the most important phases of the gait cycle)

The patient performed the test lying in prone position. During straight leg lifting into extension the sequence of muscles which are activated is m.biceps femoris, m.semitendinosus and m.semimemranosus together, m.gluteus maximus, m.spinal extensors and shoulder girdle muscles.

Hip abduction – Normal

(This test gives information about the quality of the lateral muscular pelvic brace and thus indirectly about the stabilization of the pelvis in walking)

The m.gluteus medius and m.gluteus minimus together with the m.tensor fascia lata act as a prime movers while the m.quadratus lumborum acts as a pelvic stabilizer.

3.3.11. Gait Examination (according to Janda)

The patient was walking with crutches. He had:

- Fast walking speed
- Long and symmetrical steps
- No flat foot
- First contact of the ankle to the ground and last contact on toes
- Hip joints were doing the most motion
- No trunk rotation
- Normal movement of shoulders in direction of flexion and extension

3.3.12. Pelvis examination (according to Lewit)

Iliac crests are both in the same level

Anterior superior iliac spines are in the same level and lower than the posterior superior iliac spines.

3.3.13. R.O.M. Examination (according to Kendall)

Table 5: Range of motion of the hip joint

HIP JOINT				
Movement	**Active Movement**		**Passive Movement**	
	Left side	**Right side**	**Left side**	**Right side**
Flexion	120º	120º	125º	125º
Extension	10º	10º	10º	10º
Abduction	45º	45º	45º	45º
Adduction	10º	10º	10º	10º
External Rotation	25º	30º	35º	40º
Internal Rotation	30º	35º	35º	40º

Table 6: Range of motion of the knee joint

KNEE JOINT				
Movement	**Active Movement**		**Passive Movement**	
	Left side	**Right side**	**Left side**	**Right side**
Flexion	125º	95°	130º	100°
Extension	-	-	-	-

Table 7: Range of motion of the ankle joint

ANKLE JOINT				
Movement	**Active Movement**		**Passive Movement**	
	Left side	**Right side**	**Left side**	**Right side**
Dorsal Flexion	20º	20º	20º	20º
Plantar Flexion	40º	40º	45º	45º
Inversion	30º	30º	30º	30º
Eversion	20º	20º	20º	20º

3.3.14. Examination of deep stabilization system of the trunk (according to Kolář)

Diaphragm Test

The patient is in sitting position with an upright posture of the spine. The chest is in a caudal or expiratory position.

I palpated in the region dorsolateral, underneath the lower ribs and slightly against abdominal muscles. I checked simultaneously the alignment and actions of the lower ribs. I asked the patient to try to push the abdominal cavity and the lower part of chest against my fingers.

During the examination the spine maintains an erect posture. The lower part of the chest is expanding laterally and dorsally and the intercostal spaces are widening.

When the patient was in standing position I asked him to breathe normally and I observed his breathing stereotype.

Then in lying position I also instructed him to breath under my hands in the area of abdominal muscles (localized breathing) to examine his ability to do it.

My patient's breathing stereotype was in a good level but he had to improve it and reach the best possible condition of breathing pattern.

3.3.15. Neurologic Examination

- **Deep tendon reflexes**

I examined the following deep tendon reflexes:

- Patellar L2-4 (of the healthy leg)
- Achilles L5-S2 (of both legs)

Normal response of both reflexes

- **Position Sense**

I grasped the patient's big toe and hold it away from the others toes to avoid friction. I showed the patient "up" and "down" movements. With the patient's eyes closed I asked him to identify the direction I move the toe.

The patient was able to identify the direction I was moving his toe.

I made the same test in both legs with the same result.

- **Sense of touch**

I used my fingers to touch the skin lightly. I asked the patient to respond whenever the touch was felt. I tested the following areas of lower extremity:

Front of both thighs (L2)

Medial and lateral aspect of both calves (L4 and L5)

Little toes (S1)

3.3.16. Conclusion of initial kinesiologic examination:

During my whole initial kinesiology examination I noticed and kept some information which could be helpful for my therapy and for my goals. From posture examination the most important findings were the swelling around his right knee and the hypotrophy of his muscles of the right lower extremity in comparison with the left side. He was able to be in standing position for the examination without crutches but with no full load on the affected leg. When I measured the circumferences of his lower extremities I confirmed the hypotrophy of his m.gastrocnemius lateralis and medialis, m.soleus and m.quadriceps femoris. During palpation examination I found that all muscles of his right leg were hypotonic due to inactivity. The most important muscles which were hypotonic were m.vastus medialis, m.rectus femoris, m.soleus, m.gastroqnemius lateralis and medialis and m.tibialis anterior. The upper part of m.trapezius and m.sternocleidomastoid were shorter than normal in both sides. When I stretched the skin, subcutaneous fold and fascias I found hard barrier with no presence of elasticity. After the examination of strength of his muscles of right and left lower extremities I found that the muscles on the right side were weaker than the left one. The weaker muscles were m.semitendinosus, m.semimebranosus, m.biceps femoris, m.quadriceps femoris, the hip flexors and hip adductors. The swelling on his right knee was visible so I provided the ballottement test to see if there was liquid inside the knee. The test was positive. During joint play examination of his lower extremities I determined that there wasn't present in his right patella probably due to liquid in the knee joint. The most important finding was during the range of motion examination. There was limitation of range of motion of the right knee into direction of flexion. Also the right shoulder was elevated because the patient was not able to give full load on his right leg so his body was slightly shifted on the left side.

3.4. Short-term rehabilitation plan:

As short-term rehabilitation plan I want to decrease the swelling from his right knee and to improve his range of motion of his right knee in direction of flexion using special techniques. Also I want with some specific exercises and training to improve his strength of his whole lower extremity (m.soleus, m.gastrocnemius lateralis and medialis, m.rectus femoris, m.vastus medialis, m.vastus lateralis, m.biceps femoris, m.semitendinosus and semimembranosus, m.tibialis anterior), to improve the elasticity around his scar on his right knee, to relax the muscles upper trapezius and sternocleidomastoid in both sides, to limit the weight bearing and to improve his balance.

3.5. Day to day therapy

1st Day

Date: 06/01/2015

I met the patient at noon, some hours after his second therapy. I did the whole initial kinesiology examination and I collected as much information as possible about his problem. Then, the patient around 12:00 had magnetotherapy and lymphatic drainage. Half an hour later we went to the gym together and I saw what exercises other physiotherapists instructed him to do. I corrected and gave him some more helpful exercises for his situation.

Therapy No: 1

Date: 07/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: The patient told me that he had no pain and he was feeling well.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 100 degrees in direction of flexion. I palpated his m.quadriceps femoris which was hypotonic. I also checked the skin and fascias around his scar and around the thigh and it was stretched without elasticity.

Goal of today's therapy unit:

The main goal of today's therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his m.rectus femoris, m.vastus medialis and m.vastus lateralis.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee because as I found from the initial kinesiologic examination patella was restricted in laterolateral and craniocaudal directions.

Strengthening techniques

Using an overball I instructed the patient to perform some isometric contractions for strengthening of the m.rectus femoris, m.vastus medialis and m.vastus lateralis. I also used the bridging exercise.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors, knee extensors to the right leg and the m.upper trapezious and m.sternocleidomastoid to both sides.

Proprioceptive Neuromuscular Facilitation (PNF)

I used the PNF technique for activation of the muscles of the whole right lower extremity.

Other techniques

I instructed my patient how to walk correctly using the crutches.

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion was slightly better, approximately 105 degrees.

Physical Therapy

Then the patient after my therapy continued with:

Magnetotherapy

Small ring applicator

Effect: Support the tissue trophisity

Type: Pulsed

Low frequency: 100 Hz

Duration: 25 minutes

Note: The patient had magnetotherapy every day with no changeable parameters

Lymphatic drainage

Effect: For minimizing the edema

Pressure: 9 kilopascals

The pressure was starting from the foot with direction towards the thigh with the pressure rising for 30 second and then decreasing for 30 second.

Duration: 25 minutes

Note: The patient had lymphatic drainage for two weeks. Every day the pressure was rising about 0,5 kilopascals.

Exercises in the gym

Every day from 11:15 a.m. until 12:00 o'clock I was going to the gym to show to my patient some exercises that I believe will help him to improve his condition, to improve his balance and strengthen his right lower extremity.

I instructed and showed to my patient the following exercises:

- Bicycling
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercise for m.gastrocnemious (lateralis and medialis)
- Strengthening exercise for m.vastus medialis and for improving the mobility of the knee in direction of flexion and extension
- Strengthening exercise for m.gluteus maximus and m.hamstrings
- Exercise for strengthening of m.hamstrings
- Exercise for improving the whole balance and stability of his right leg
- Exercise for improving the whole balance and stability of his right knee

Therapy No: 2

Date: 08/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: The patient was feeling better than the previous day without pain.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 100 degrees in direction of flexion. I palpated his m.quadriceps femoris which was hypotonic. I also checked the skin and fascias around his scar and around the thigh and it was stretched without elasticity.

Goal of today's therapy unit:

The main goal of today's therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his m.rectus femoris, m.vastus lateralis and vastus medialis. Also using a specific technique I want to relax the m.upper trapezius and m.sternocleidomastoid in both sides.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee because as I found from the initial kinesiologic examination patella was restricted in laterolateral and craniocaudal directions.

Strengthening techniques

The patient with my help performed an exercise for strengthening of hip abductors and adductors, m.tibialis anterior and m.tibialis posterior and finally he performed isometric contractions for the m.rectus femoris.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors to the right leg and the m.upper trapezious and m.sternocleidomastoid to both sides.

Other techniques

The patient performed also another exercise for improving the range of motion of his knee in both directions called heel slides.

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion was the same as before the therapy. The patient was feeling a little bit tired.

Physical Therapy

Magnetotherapy

Lymphatic drainage

Exercises in the gym

- Bicycling
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercise for m.gastrocnemious (lateralis and medialis)
- Strengthening exercise for m.vastus medialis and for improving the mobility of the knee in direction of flexion and extension
- Strengthening exercise for m.gluteus maximus and m.hamstrings
- Exercise for strengthening of m.hamstrings
- Exercise for improving the whole balance and stability of his right leg
- Exercise for improving the whole balance and stability of his right knee

Therapy No: 3

Date: 09/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: The patient was feeling better day by day as he told me.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 105 degrees in direction of flexion. I palpated his m.quadriceps femoris which was hypotonic. I also checked the skin and fascias around his scar and around the thigh and it was stretched without elasticity.

Goal of today's therapy unit:

The main goal of today’s therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his m.rectus femoris, m.vastus lateralis and m.vastus medialis.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee because as I found from the initial kinesiologic examination patella was restricted in laterolateral and craniocaudal directions.

Strengthening techniques

Using an overball I instructed the patient to perform some isometric contractions for strengthening of the m.rectus femoris, m.vastus medialis and m.vastus lateralis. I also used the bridging exercise.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors and knee extensors to the right leg.

Proprioceptive Neuromuscular Facilitation

I used the PNF technique for activation of the muscles of the whole right lower extremity

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion was slightly better than before the therapy, approximately 110 degrees.

Physical Therapy

Magnetotherapy

Lymphatic drainage

Exercises in the gym

- Bicycling
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercise for m.gastrocnemious (lateralis and medialis)
- Strengthening exercise for hip adductors and for improving the mobility of the knee in direction of flexion and extension
- Strengthening exercise for m.gluteus maximus and m.hamstrings
- Exercise for strengthening of m.hamstrings
- Exercise for improving the whole balance and stability of his right leg
- Exercise for improving the whole balance and stability of his right knee

Therapy No: 4

Date: 12/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: The patient told me that he had no pain around the knee and he was feeling better than the previous time. He also told me that during the weekend he exercised a lot in the gym.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 110 degrees in direction of flexion. I palpate his m.quadriceps femoris which was hypotonic. I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with slight elasticity.

Goal of today's therapy unit:

The main goal of today’s therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his m.rectus femoris, his hip adductors, m.vastus medialis, m.tibialis anterior

and posterior and m.hamstrings. Also with a specific technique I want to relax his m.upper trapezius and m.sternocleidomastoid in both sides.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee in laterolateral and craniocaudal directions.

Strengthening techniques

The patient with my help performed an exercise for strengthening of hip adductors, m.tibialis anterior and m.tibialis posterior, m.vastus medialis, m.hamstrings and finally he performed isometric contractions for the m.rectus femoris.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors to the right leg and the m.upper trapezious and m.sternocleidomastoid to both sides.

Proprioceptive Neuromuscular Facilitation

I applied the PNF technique to strengthen my patient's right lower extremity.

Other techniques

The patient also performed another exercise to improve the range of motion of his knee in both directions called heel slides.

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion was the same as it was before the therapy. I also palpated his m.quadriceps femoris. There was hypotonic but in better condition in comparison with previous therapies.

Physical Therapy

Magnetotherapy

Lymphatic drainage

Exercises in the gym

The patient was in better condition. He was able to walk without crutches so I decided to change the program that he was following during exercising in the gym.

The exercises that I showed him were:

- Bicycling
- Walking on treadmill
- Gait training
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercise for m.gluteus maximus and m.hamstrings
- Exercise for strengthening of m.quadriceps femoris
- Bridging exercise
- Balance exercise (1)
- Balance exercise (2)
- Sensomotoric exercise for knee stabilization

Therapy No: 5

Date: 13/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: As the patient informed me he has already felt stronger and he was very positive for the result of the therapy.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 115 degrees in direction of flexion. I palpated his m.quadriceps femoris. They were in better condition than previous times. I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with slight elasticity.

Goal of today's therapy unit:

The main goal of today's therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his m.quadriceps femoris, m.hamstrings, m.vastus lateralis and m.vastus medialis.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee in laterolateral and craniocaudal directions.

Strengthening techniques

Using an overball I instructed the patient to perform some isometric contractions for strengthening of the m.rectus femoris, m.vastus medialis and m.vastus lateralis. He performed an exercise for strengthening of m.hamstrings as I showed him and also the bridging exercise.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors and knee extensors to the right leg.

Proprioceptive Neuromuscular Facilitation

I used the PNF technique for strengthening of the muscles of the whole right lower extremity.

Other techniques

I was instructed by my supervisor in the hospital and I applied lymphatic taping to the area of the thigh and to the area of patella.

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion was approximately 115 degrees in direction of flexion. I also palpated his m.quadriceps femoris. There was in better condition in comparison with the previous days. I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with good elasticity.

Physical Therapy

Magnetotherapy

Lymphatic drainage

Whirlpool

Temperature: 37ºC

Duration: 30 minutes

Exercises in the gym

I followed the same exercising program for the patient like previous day.

The exercises that I showed him were:

- Bicycling
- Walking on treadmill
- Gait training
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercise for m.gluteus maximus and m.hamstrings
- Exercise for strengthening of m.quadriceps femoris
- Bridging exercise
- Balance exercise (1)
- Balance exercise (2)
- Sensomotoric exercise for knee stabilization

Therapy No: 6

Date: 14/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: The patient told me that he was feeling better day by day.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 115 degrees in direction of flexion. I palpated his m.quadriceps femoris. They were in better condition. . I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with good elasticity.

Goal of today's therapy unit:

The main goal of today’s therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his m.rectus femoris, hip adductors, m.hamstrings, m.tibialis anterior and tibialis posterior. I also want to relax the m.upper trapezius and m.sternocleidomastoid in both sides.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee in laterolateral and craniocaudal directions.

Strengthening techniques

The patient with my help performed an exercise for strengthening of hip adductors and abductors, m.tibialis anterior and m.tibialis posterior, m.vastus medialis and m.vastus lateralis, m.hamstrings and finally he performed isometric contractions for the m.rectus femoris.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors to the right leg and the m.upper trapezious and m.sternocleidomastoid to both sides.

Proprioceptive Neuromuscular Facilitation

I applied the PNF technique to strengthen my patient's right lower extremity.

Other techniques

The patient also performed another exercise to improve the range of motion of his knee in both directions called heel slides.

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion was approximately 115 degrees in direction of flexion. I palpated his m.quadriceps femoris.

There was hypotonic but in better condition in comparison with previous days. I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with good elasticity.

Physical Therapy

Magnetotherapy

Lymphatic drainage

Whirlpool

Temperature: 37ºC

Duration: 30 minutes

Exercises in the gym

- Bicycling
- Walking on treadmill
- Gait training
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercise for m.gluteus maximus and m.hamstrings
- Exercise for strengthening of m.quadriceps femoris
- Bridging exercise
- Balance exercise (1)
- Balance exercise (2)
- Sensomotoric exercise for knee stabilization

Therapy No: 7

Date: 15/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: As he told me he was really happy for the progress of the therapy, the improvement of his strength of his muscles and also for the improvement of his range of motion of the knee in direction of flexion.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 120 degrees in direction of flexion. I also palpated his m.quadriceps femoris. The tone was in very good level except the m.vastus medialis which was in a little bit worse condition. I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with good elasticity.

Goal of today's therapy unit:

The main goal of today's therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his m.rectus femoris, m.vastus medialis, m.vastus lateralis and m hamstrings.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee in laterolateral and craniocaudal directions.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors and knee extensors to the right leg and the m.upper trapezious and m.sternocleidomastoid to both sides.

Strengthening techniques

The patient with my help performed an exercise for strengthening of m.hamstrings, isometric contractions of m.vastus medialis and m.rectus femoris and also the bridging exercise.

Proprioceptive Neuromuscular Facilitation

I applied the PNF technique to strengthen my patient's right lower extremity.

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion in direction of flexion was the same as before the therapy, approximately 120 degrees.

Physical Therapy

Magnetotherapy

Lymphatic drainage

Whirlpool

Temperature: 37ºC

Duration: 30 minutes

Exercises in the gym

- Bicycling
- Walking on treadmill
- Exercise for strengthening of lower extremities muscles
- Gait training
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercises for m.tibialis anterior and m.tibialis posterior

- Exercise for strengthening of m.quadriceps femoris
- Exercise for improving the balance (1)
- Exercise for improving the balance (2)
- Exercise for improving the balance (3)
- Exercise for strengthening of the upper legs
- Sensomotoric exercise for knee stabilization

Therapy No: 8

Date: 16/01/2015

Time: 09:00 – 09:40

Status Present before the therapy

Subjective: It was my last day with my patient. He was really happy for the result of my therapy. As he told me he will train himself harder with purpose to return playing football as soon as possible.

Objective: I checked his range of motion of his right knee passively. The range of motion was approximately 120 degrees in direction of flexion. I palpated his m.quadriceps femoris. The tone was in good level except the m.vastus medialis which was in a little bit worse situation. I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with good elasticity.

Goal of today's therapy unit:

The main goal of today's therapy is to increase the range of motion of his right knee into direction of flexion. Then with some specific exercises my goal is to increase the strength of his hip adductors and abductors, m.rectus femoris, m.hamstrings, m.tibialis anterior and posterior. Also I want to relax the m.upper trapezius and m.sternocleidomastoid in both sides.

Procedure:

Soft tissue techniques

I applied soft tissue technique for the scar to reduce the stretching of the skin and to improve the elasticity. Then I used a soft ball to open the lymphatic nodes. I also applied stretching of fascias mostly to the area of thigh.

Stretching techniques

I stretched the m.triceps surae and also the m.hamstrings of the patient's right leg. In this way I activated these muscles and prepared them for later exercises.

Mobilization techniques

I applied patella mobilization to the right knee in laterolateral and craniocaudal directions.

Strengthening techniques

The patient with my help performed an exercise for strengthening of hip abductors and adductors, exercise for m.hamstrings, isometric contractions of m.vastus medialis and m.rectus femoris and also exercise for strengthening of m.tibialis anterior and m.tipialis posterior.

Relaxation techniques

Using the post isometric relaxation (PIR) technique I tried to relax the knee flexors to the right leg and the m.upper trapezious and m.sternocleidomastoid to both sides.

Proprioceptive Neuromuscular Facilitation

I applied the PNF technique to strengthen my patient's right lower extremity.

Other techniques

The patient performed also another exercise for improving the range of motion of his knee in both directions called heel slides.

Effect of the therapy

I checked his range of motion of his right knee passively. The range of motion was approximately 120 degrees in direction of flexion. I palpated his m.quadriceps femoris. The tone was normal except the m.vastus medialis which was a little bit in worsen situation. I also checked the skin and fascias around his scar and around the thigh and I found them slightly stretched with good elasticity.

Physical Therapy

Magnetotherapy

Lymphatic drainage

Whirlpool

Temperature: 37ºC

Duration: 30 minutes

Exercises in the gym

- Bicycling
- Walking on treadmill
- Exercise for strengthening of lower extremities muscles
- Gait training
- Stretching of m.hamstrings
- Stretching of m.triceps surae
- Strengthening exercises for m.tibialis anterior and m.tibialis posterior
- Exercise for strengthening of m.quadriceps femoris
- Exercise for improving the balance (1)
- Exercise for improving the balance (2)
- Exercise for improving the balance (3)
- Exercise for strengthening of the upper legs
- Sensomotoric exercise for knee stabilization

Note: The patient apart from my therapy and the exercises we were doing together to in gym was also going to the gym also every evening to train himself and to keep his condition in good level. For this reason sometimes after evening exercise, the swelling on his right knee was increasing slightly so he had cryotherapy using ice packs for 10 to 15 minutes.

3.5.1. Treatment methods that used during daily therapies

Soft tissue techniques

Scar therapy

I used transverse friction. With my two fingers I made massage to the scar in a direction that is perpendicular to the line of the scar. This technique helps to remodel the scar and ensures that the collagen fibers of the scar are aligned properly.

I also applied very light pressure directly to the scar until feeling the release of the tissue.

Soft tissue techniques using the soft ball

I used the small ball for opening the lymph nodes around the knee joint and also at the area of m.quadriceps femoris.

Stretching of fascias of lower extremity

I stretched the fascia of the right limb to the area of thigh around the longitudinal axis, and also to the area of scar against the underlying layer. I applied the stretching in the region of the lower leg and also to the upper leg.

Stretching techniques

Stretching of m.triceps surae

With the patient in prone position and his knee flexed I put my one hand to fixed the leg just above the ankle and with my other hand around patient's heel I brought his forefoot and toes into dorsiflexion relative to the heel and I kept that position for fifteen seconds to stretch m.soleus. Then with the patient in supine lying position and his knee extended over the table I brought his forefoot and toes into dorsiflexion and I kept that position for fifteen seconds to stretch the m.gastrocnemious (lateralis and medialis).

Stretching of m.hamstrings

With the patient in supine lying position, his knee extended and his hip as more possible flexed I fixed his ipsilateral side of pelvis, I kept that position for fifteen seconds to stretch his m.hamstrings.

Mobilization techniques

Patella mobilization

I mobilize the patella using both hands and moving the patella in a laterolateral and craniocaudal direction.

Strengthening techniques

Isometric contractions of m.rectus femoris

I put an overball below the patient's knee and I asked him with extended knee to press downwards and keep that position for five seconds. I instructed him to repeat it ten times. I performed this exercise to improve the strength of the m.rectus femoris.

Isometric contractions of m.vastus lateralis

Using an overball below the patient's knee I instructed him to rotate the hip 45º medially and to press with extended knee in downward direction and keep that position for approximately ten seconds to contract isometrically. I recommended him to repeat it ten times. I performed this exercise to improve the strength of the m.vastus lateralis.

Isometric contractions of m.vastus medialis

Using an overball below the patient's knee I instructed him to rotate the hip 45º laterally and to press with extended knee in downward direction and keep that position for approximately ten seconds and to contract isometrically. I recommended him to repeat it ten times. I performed this exercise to improve the strength the m.vastus medialis.

Exercise for strengthening of hip abductors and adductors

While the patient was in supine lying position with his knee extended I put my hand to the lateral side of his ankle joint. I asked the patient to resist my pressure towards the opposite direction and hold against pressure for a while.

Then I put my hand to the medial side of his ankle joint and asked him to do the same.

I repeated that exercise for ten times.

Exercise for strengthening of m.tibialis anterior and m.tibialis posterior

The patient was in supine lying position with extended knees. I put my hand to the dorsal aspect of his foot and I instructed him to push in direction of dorsal flexion and inversion against my resistance, to keep that position for a while and then to relax.

Then I put my hand to the plantar aspect of his foot and I instructed him to provide plantar flexion and inversion of the foot against my resistance, to hold that position for a while and then to relax.
I performed that exercise ten times for each muscle.

Exercise for strengthening of m.hamstrings (1)

The patient was in supine lying position. I used a gymnastic ball and I instructed the patient to put both his legs over the ball and to press downwards, to hold that position for five seconds and then to relax.
I recommended him to repeat it for ten times.

Exercise for strengthening of m.hamstrings (2)

The patient was in supine lying position. I used a gymnastic ball and I instructed the patient to put his both legs over the ball. Then I told him to press downwards with one leg while the other one was extended and not touching the ball. I advised him to hold that position for five seconds and then to relax.
I recommended him to repeat it for ten times.

Strengthening exercise for hip adductors and for improving the mobility of the knee in direction of flexion and extension

The patient was lying on the mat with both knees flexed with an overball between his knees. While he was pushing medially I instructed him to extend his right knee. He performed that exercise ten times.

Exercise for strengthening of m.adductors

The patient was in supine lying position with his both knees flexed. I put an overball between his knees and I instructed him to press with both knees in medial direction. Each time he was pressing the overball for five seconds.
I instructed him to perform that exercise ten times.

Bridging exercise

I instructed the patient in supine lying position with both knees flexed and his both hands resting to the sides to try to elevate his pelvis, to keep that position for five seconds and repeat it for ten times.

I used the bridging exercise to improve the strength of my patient's abdominals and also to exercise the deep lying core muscles that support the back.

Relaxation techniques – Exercises for improving the range of motion

Post Isometric Relaxation for the knee flexors

With the patient in prone position and his knee flexed I fixed his ipsilateral side of pelvis with one hand and with other hand fixing above the ankle joint, I instructed him to put minimal resistance in direction of extension of the knee while he was breathing in and then to breath out and relax while I was waiting the knee actively to improve the flexed position.

I performed this technique to improve the mobility and range of motion of the knee in direction of flexion.

Post Isometric Relaxation for the knee extensors

With the patient in prone position and his affected lower leg hanging down from the table I put minimal resistance fixating his leg above the ankle joint in direction of extension and I asked the patient to try to flex his knee, to hold for a while and then to relax. I repeated it ten times.

I used this technique to improve the mobility and the range of motion of his knee in direction of extension.

Post Isometric Relaxation for the upper part of m.trapezius

The patient was in a supine lying position. With one hand I fixated the patient's shoulder from one side and with the other hand I moved his head in direction of side bending to the opposite side until reaching the barrier. Then I asked him to see towards my hand, which was fixating his shoulder while he was breathing in, to hold for a while and then to see towards the opposite side and relax while he was breathing out. I performed this PIR technique in both sides.

Post Isometric Relaxation for the m.sternocleidomastoid

The patient was in a supine lying position. With one hand I fixated the patient's sternum from above and with the other hand I moved his head in direction of extension, lateroflexion and rotation to the opposite side until to reach the barrier. Then I asked

him to see towards my hand, which was fixating his sternum while he was breathing in, to hold for a while and then to see towards the opposite side and relax while he was breathing out. I performed this PIR technique in both sides.

Heel slides

While the patient was in supine lying position with extended knee I used an overball below his heel and I asked him to flex his knee as much as possible while rolling the ball towards his side.

I recommended him to provide it for ten times.

Proprioceptive Neuromuscular Facilitation (PNF) techniques

Proprioceptive Neuromuscular Facilitation for activation of the muscles of the whole right lower extremity

I used the first diagonal flexion pattern especially to affect the m.vastus medialis which was hypotrophic. My ipsilateral hand was on his dorsomedial part of the foot and my contralateral hand was on the anteromedial part of the thigh above the patella. I showed his the correct starting position of the pattern and I instructed him to turn his heel inward, to push the toes up, to bend the knee and push the lower limb up to the hip to opposite side.

I performed this movement five times.

I also used the second diagonal extension pattern because was also helpful for the m.vastus medialis which was hypotrophic. My ipsilateral hand was on the medial part of the planta and my contralateral hand on the posteromedial part of the thigh above the fossa popliteal. I showed his the correct starting position of the pattern and I instructed him to turn his heel inward, to push the toes down and to each other to the big toe, to extend the knee and to push the lower limb down to the second limb. I performed this movement five times.

Proprioceptive Neuromuscular Facilitation for strengthening of the muscles of the right lower extremity

I used the strengthening technique with repetitive contractions for the m.vastus medialis. I performed isotonic contraction of the agonist muscle against resistance in the place I found that the muscle was weak, there I did isometric contraction of all the

components of movement from distal to proximal parts and I gave the last resistance to the weaker component of the movement and then I continued with the isotonic contraction of the agonist muscle with resistance.

Gait training

Gait training

During the first therapy I corrected the patient while he was walking with crutches not to put full load to his right leg but also not to be afraid to use his affected leg during walking.

I instructed him to put the crutches first, then to touch the floor with the heel of his operated leg and then the whole foot and move his healthy leg forward last.

I continued instructing him how to walk on stairs with crutches, upstairs and downstairs. When the patient was going downstairs I was in front of him protecting and instructing him using the crutches. I told him that he had to put the crutches first, then the operated leg and last the healthy leg. When the patient was going upstairs I was behind to protect him. I instructed him to put the healthy leg first, then the operated leg and finally the crutches.

Other techniques

Lymphatic Taping

At the end of my today's therapy I was instructed by my supervisor in the hospital how to apply lymphatic taping to my patient. I applied the tape from the area of m.quadriceps towards the lower leg and also to the patella.

3.5.2. Exercises used in the gym improving patient's condition

Warming-up and stretching exercises

Bicycling

The patient had ten minutes bicycling with low intensity without extra weight with main purpose the warming up and also the improvement of the mobility of the knee flexion and extension.

Stretching of m.hamstrings

The patient was sitting on the mat with extended knees and I instructed him to flex his trunk and try to touch his toes with his fingers and stay in that position for ten seconds.

Stretching of m.triceps surae

I instructed him to stand opposite the wall, put his palms on the wall and then extend his hip and keep that position for ten seconds. An important thing for the patient was to remember to touch with his plantar aspect of the foot of the extended leg to the ground and think about three points of the foot as I showed him.

Walking on treadmill

I recommended my patient to start walking on treadmill for five minutes with low intensity, symmetrical steps and to concentrate to do the biggest motion of walking on the knees. My target was to improve the mobility of the knee joint and also to re-educate my patient to walk correctly.

Strengthening exercises

Strengthening exercise for m.gastrocnemious (medialis and lateralis)

While the patient was facing the wall with feet together he was standing on tip toes for ten seconds and then he was relaxed. He performed that exercise twenty times for each of the three sets.

Strengthening exercise for hip adductors and for improving the mobility of the knee in direction of flexion and extension

The patient was lying on the mat with both knees flexed with an overball between his knees. While he was pushing medially I instructed him to extend his right knee. He performed that exercise ten times for each of the three sets.

Strengthening exercise for m.gluteus maximus and m.hamstrings

With the patient in prone position and extra kilos (2,5 kg) around his ankle I instructed him to extend his hip with extended knee fifteen times for each of the three sets.

Exercise for strengthening of m.hamstrings

With the patient in supine lying position with both legs over a gymnastic ball and hands resting to the sides I instructed him to press with one leg downwards while his other leg was extended. He was holding that position for five seconds and he performed it for fifteen times for each of the three sets.

Exercise for strengthening of m.quadriceps femoris

The patient used the extension machine for strengthening of the m.quadriceps femoris while he was sitting on the machine and providing extension of the knee lifting 2, 5 kilos.

He did the exercise for ten repetitions for three sets.

Exercise for strengthening of lower extremities muscles

I used the stair stepper machine to target muscles in the buttocks, hips, calves and thighs. The patient did this exercise for three to five minutes.

Exercise for strengthening of the upper legs

The patient was standing with his back against a wall and placed a gymnastic ball between his back and the wall and placing his feet in front of him. He was bending his knees, sliding his back down the wall until his knees were at 90 degree angles. His thighs should remain parallel. He was holding for 15 to 30 seconds, and then stands up.

He repeated the exercise for five times for each of the three sets.

Bridging exercise

I instructed the patient in supine lying position with both legs over a gymnastic ball and his both hands resting to the sides to try to elevate his pelvis, to keep that position for five seconds and repeat it for ten times for each of three sets.

I used the bridging exercise to improve the strength of my patient's abdominals and also to exercise the deep lying core muscles that support the back.

Exercises for improving the stability and balance

Exercise for improving the whole balance and stability of his right leg

The patient was sitting over the gymnastic ball with upright posture and both feet touching the ground. I instructed him to extend his left leg and try to stay in the same position while I was behind him to prevent falling.

Exercise for improving the whole balance and stability of his right knee

I instructed the patient to stand over the bosu with both legs with my support and to try to provide plantar and dorsal flexion of the ankle while he was pressing the bosu downwards.

Balance exercise (1)

With the patient sitting on a gymnastic ball with correct upright posture and both feet support to the ground I asked him to elevate one of his legs and try to stay in that position for few seconds.

He performed the same movement for fifteen times.

Balance exercise (2)

With the patient sitting on a gymnastic ball with correct upright posture and both feet support to the ground I asked him to try to keep the same position while I was standing behind him and using my hands to push him slightly in all directions, forward, to sides and backward.

We did that exercise for six minutes with rest period of thirty seconds every two minutes.

Sensomotoric exercise for knee stabilization

With the patient standing in front of the posturomed which is equipment for sensomotoric exercises and me to his side to support him if it was necessary the patient provided stepping forward with one leg on that machine and then movement backwards. Then he stepped on it from the side and then movement again in starting position.

Exercise for improving the balance (1)

I instructed the patient to walk on a series of balance boards. Of course I was next to him to support his during walking.

Exercise for improving the balance (2)

The patient was stepping forward to the bosu, first with the healthy leg and then step to the bosu with the affected leg. Then he stepped to the floor with the healthy leg. Then he changed the pattern. He stepped to the bosu, first with the unhealthy leg and then step to the bosu with the healthy leg. Then he stepped to the floor with the affected leg.

After this exercise we continued with an exercise using again the bosu. The patient was standing on the bosu with the healthy leg and then with the affected leg for few seconds while he was trying do not lose his balance. He was also trying to perform plantar and dorsal flexion of his ankle joint while he was standing. I was next to him to support him if he wasn't able to keep his balance.

Exercise for improving the balance (3)

He was walking on a rope with my support for five minutes with periods of 30 second of resting.

Sensomotoric exercise for knee stabilization

With the patient standing in front of the posturomed which is equipment for sensomotoric exercises and me to his side to support him if it was necessary the patient provided stepping forward with one leg on that machine and then movement backwards. Then he stepped on it from the side and then movement again in starting position.

I also instructed him to step with the affected leg on the posturomed, to concentrate to the three points of the foot and then to shake slightly his lower leg in all directions, forward, backward and to the sides.

He performed these exercises in ten minutes. Five minutes for each exercise.

Gait training

Gait training

It was the first time that my patient was trying to walk without crutches. I showed him the correct walking pattern. I also instructed him to hold crutches with his hand in case he feels unable to keep his balance.

Then I instructed him to walk for some meters on tip toes and on heels.

The duration of gait training was ten minutes.

3.6. Final kinesiologic examination:

I performed the final kinesiology examination six hours after the therapy and two hours after being relaxed from the gym.

3.6.1. Postural Examination

Postural Examination in anterior view

- No valgosity and varosity of the ankle joints
- No valgosity and varosity of the knee joints
- Knee joints are in the same level
- Right patella is slightly medially rotated
- Anterior superior iliac spines are symmetrical in transverse plane
- Iliac crests are both in the same level
- Umbilicus is in the center
- Symmetry of both thoracobrachial triangles
- Both clavicles are in the same level
- Both shoulders are in the same level
- Head is slightly shifted to his right side

Postural examination in posterior view

- No valgosity and varosity of the ankle joints
- No valgosity and varosity of the knee joints
- Popliteal lines of both knees are in the same level
- Posterior superior iliac spines are symmetrical in transverse plane
- Hyperextended lumbar spine (lordosis)
- Increased flexion in thoracic spine (kyphosis)
- Slightly extended cervical spine
- Symmetry of both thoracobrachial triangles
- Both scapulas are in the same level
- Both shoulders are in the same level
- Head is slightly shifted to the right side

Postural examination in lateral view (right side)

- The plumb line goes slightly anterior to lateral malleolus
- The plumb line goes slightly anterior to axis of knee joint
- Slightly extended right knee
- The plumb line goes slightly posterior to hip joint
- Anterior tilt of pelvis
- Hyperextended lumbar spine till Th12 (lordosis)
- Increased flexion of thoracic spine till C7 (kyphosis)
- Slightly extended cervical spine
- The plumb line goes midway of shoulder joint
- Head in neutral position

Postural examination in lateral view (left side)

- The plumb line goes slightly anterior to lateral malleolus
- The plumb line goes slightly posterior to axis of knee joint
- Left knee slightly extended
- The plumb line goes slightly posterior to hip joint
- Anterior tilt of pelvis
- Hyperextended lumbar spine till Th12 (lordosis)
- Increased flexion of thoracic spine till C7 (kyphosis)
- Slightly extended cervical spine
- The plumb line goes midway of shoulder joint
- Head in neutral position

3.6.2. Foot arch

Normal arch in left foot

Normal arch in right foot

3.6.3. Special Tests

- **Romberg test :**

Romberg I – patient stand with his heels together – Negative
Romberg II – patient stays with feet together – Negative
Romberg III – the patient stand with closed eyes – Negative

- **Trendelenburg test:**

Standing on the left leg - Negative result
Standing on the leg knee - Negative result

- **Weight baring on two scales :**

Left Leg: 44 kg Right Leg: 41 kg

- **Ballottement sign:**

Negative result

3.6.4. Anthropometric Measurements

Height of the patient

Standing: 192 cm

Sitting: 90 cm

Table 8: Length of lower extremities

	Left	**Right**
Anatomical	106 cm	106 cm
Functional	1)116 cm(superior anterior iliac spine) 2)120 cm (umbilicus)	1)116 cm(superior anterior iliac spine) 2)120 cm (umbilicus)
Thigh	58 cm	58 cm
Middle leg	48 cm	48 cm
Foot	23,5 cm	23,5 cm

Table 9: Circumferences of lower extremities

	Left	**Right**
Thigh	48 cm (15 cm from patella)	46,5 cm (15 cm from patella)
Thigh	45 cm (10 cm from patella)	43 cm (10 cm from patella)
Knee	40 cm	41,5 cm
Calf	36,5 cm	36,5 cm

3.6.5. Palpation (Soft tissue Examination) according to Lewit

Table 10: Muscle tone examination

Muscle	Left Leg	Right Leg
Gastrocnemius (lateralis)	Normal tone	Normal tone
Gastrocnemius (medialis)	Normal tone	Normal tone
Soleus	Normal tone	Normal tone
Tibialis anterior	Normal tone	Normal tone
Rectus femoris	Normal tone	Normal tone
Vastus medialis	Normal tone	Normal tone
Vastus lateralis	Normal tone	Normal tone
Tensor Fasciae Latae	Hypertonic	Normal tone
Biceps femoris	Hypertonic	Normal tone
Semitendinosus	Hypertonic	Normal tone
Semimembranosus	Hypertonic	Normal tone

3.6.6. Soft tissue Examination (according to Lewit)

Hyperalgesic zones

Run with one finger very lightly over the surface of the skin – no friction / no sweat production

Stretching of skin – normal barrier to the area of thigh and around the scar with good elasticity

Stretching of subcutaneous fold – normal barrier to the area of thigh and around the scar

Fasciae stretching – normal barrier to the area of thigh and around the scar

3.6.7. Muscle Strength Tests (according to Kendall)

Table 11: Examination of strength of the muscles of lower extremities

Muscle	Left Leg	Right Leg
Tibialis anterior	Grade 5	Grade 5
Tibialis posterior	Grade 5	Grade 5
Peroneus longus	Grade 5	Grade 5
Peroneus brevis	Grade 5	Grade 5
Soleus	Grade 5	Grade 4+
Ankle plantar flexors	Grade 5	Grade 5
Popliteus	Grade 5	Grade 5
Semitendinosus / Semimembranosus	Grade 5	Grade 4+
Biceps femoris	Grade 5	Grade 4+
Quadriceps femoris	Grade 5	Grade 4+
Hip flexors	Grade 5	Grade 4+
Iliopsoas	Grade 5	Grade 4
Sartorius	Grade 5	Grade 4
Tensor Fasciae Latae	Grade 5	Grade 4+
Hip adductors	Grade 5	Grade 4
Medial rotators	Grade 5	Grade 4
Lateral rotators	Grade 5	Grade 4+
Gluteus minimus	Grade 5	Grade 5
Gluteus medius	Grade 5	Grade 5
Gluteus maximus	Grade 5	Grade 5
Abductor halluces	Grade 5	Grade 5
Flexor halluces brevis	Grade 5	Grade 5
Flexor halluces longus	Grade 5	Grade 5
Extensor hallucis brevis	Grade 5	Grade 5
Lumbricales	Grade 5	Grade 5
Dorsal interossei	Grade 5	Grade 5
Flexor digitorum brevis	Grade 5	Grade 5
Flexor digitorum longus	Grade 5	Grade 5
Extensor digitorum longus and brevis	Grade 5	Grade 5
Peroneus tertius	Grade 5	Grade 5

3.6.8. Muscle Length Tests (according to Janda)

Lower extremity

m.soleus, m.popliteus – Grade 0 (no shortness)

m.gastrocnemius (lateralis and medialis), m.plantaris – Grade 0 (no shortness)

Hip flexors – Grade 0 (no shortness)

Hip adductors - Grade 0 (no shortness)

m.hamstrings – Grade 1 (moderate shortness)

m.piriformis – Grade 2 (marked shortness)

Upper extremity:

m.levator scapulae – Grade 0 (soft barrier)

m.trapezius (upper part) – Grade 0 (soft barrier)

m.strernocleidomastoid – Normal (soft barrier)

Note: I performed the muscle length tests in both lower extremities with the same results.

3.6.9. Joint Play Examination (according to Lewit)

Metatarsophalangeal Joints – The joint play is present in both legs in dorsoplantar and laterolateral direction

Tarsometatarsal Joints - The joint play is present in both legs in dorsoplantar direction

Transverse tarsal joints - The joint play is present in both legs in dorsoplantar direction

Subtalar Joint – The joint play is present in both legs in distal and upward direction

Talocrural Joint – The joint play is present in both legs in distal direction

Tibiofibular Joint – The joint play is present in both legs in distal and ventral direction

Knee Joint – The joint play is present in the left leg in laterolateral direction

I performed joint play of the knee joint only to the healthy leg (left leg)

Patella - The joint play is present in both legs in craniocaudal and laterolateral direction

Hip Joint - The joint play is present in both legs along the longitudinal axis and in direction of the femoral neck

Sacroiliac Joint – The joint play is present in dorsal direction for the upper part of sacroiliac joint and in ventrocaudal direction for the lower end of the sacroiliac joint

3.6.10. Examination of Movement Patterns (according to Janda)

Hip extension – Normal

(Is examined to analyze one of the most important phases of the gait cycle)

The patient performed the test lying in prone position. During straight leg lifting into extension the sequence of muscles which are activated is m.biceps femoris, m.semitendinosus and m.semimembranosus together, m.gluteus maximus, m.spinal extensors and shoulder girdle muscles.

Hip abduction – Normal

(This test gives information about the quality of the lateral muscular pelvic brace and thus indirectly about the stabilization of the pelvis in walking)

The m.gluteus medius and m.gluteus minimus together with the m.tensor fascia lata act as a prime movers while the m.quadratus lumborum acts as a pelvic stabilizer.

3.6.11. Gait Examination (according to Janda)

- Fast walking speed
- Long and symmetrical steps
- No flat foot
- First contact of the ankle to the ground and last contact on toes
- Hip joints were doing the most motion. There was also motion in both knees
- No trunk rotation
- Normal movement of shoulders in direction of flexion and extension

3.6.12. Pelvis examination (according to Lewit)

Iliac crests are both in the same level

Anterior superior iliac spines are in the same level and lower than the posterior superior iliac spines.

3.6.13. R.O.M. Examination (according to Kendall)

Table 12: Range of motion of the hip joint

HIP JOINT				
Movement	**Active Movement**		**Passive movement**	
	Left side	**Right side**	**Left side**	**Right side**
Flexion	120º	120º	125º	125º
Extension	10º	10º	10º	10º
Abduction	45º	45º	45º	45º
Adduction	10º	10º	10º	10º
External Rotation	25º	30º	35º	40º
Internal Rotation	30º	35º	35º	40º

Table 13: Range of motion of the knee joint

KNEE JOINT				
Movement	**Active Movement**		**Passive Movement**	
	Left side	**Right side**	**Left side**	**Right side**
Flexion	125 º	115º	130º	120º
Extension	-	-	-	-

Table 14: Range of motion of the ankle joint

ANKLE JOINT				
Movement	**Active Movement**		**Passive Movement**	
	Left side	**Right side**	**Left side**	**Right side**
Dorsal Flexion	20 º	20 º	20 º	20 º
Plantar Flexion	40 º	40 º	45 º	45 º
Inversion	30 º	30 º	30 º	30 º
Eversion	20 º	20 º	20 º	20 º

3.6.14. Examination of deep stabilization system of the trunk (according to Kolář)

Diaphragm Test

The patient is in sitting position with an upright posture of the spine. The chest is in a caudal or expiratory position.

I palpated in the region dorsolateral, underneath the lower ribs and slightly against abdominal muscles. I checked simultaneously the alignment and actions of the lower ribs. I asked the patient to try to push the abdominal cavity and the lower part of chest against my fingers.

During the examination the spine maintains an erect posture. The lower part of the chest is expanding laterally and dorsally and the intercostal spaces are widening.

When the patient was in standing position I asked him to breathe normally and I observed his breathing stereotype.

Then in lying position I also instructed him to breath under my hands in the area of abdominal muscles (localized breathing) to examine his ability to do it.

My patient's breathing stereotype was in a very good level.

3.6.15. Neurologic Examination

- **Deep tendon reflexes**

I examined the following deep tendon reflexes:

- Patellar L2-4 (of the healthy leg)
- Achilles L5-S2 (of both legs)

Normal response of both reflexes

- **Position Sense**

I grasped the patient's big toe and hold it away from the others toes to avoid friction. I showed the patient "up" and "down" movements. With the patient's eyes closed I asked him to identify the direction I move the toe.

The patient was able to identify the direction I was moving his toe.

I made the same test in both legs with the same result.

- **Sense of touch**

I used my fingers to touch the skin lightly. I ask the patient to respond whenever the touch is felt. I tested the following areas of lower extremity:
Front of both thighs (L2)
Medial and lateral aspect of both calves (L4 and L5)
Little toes (S1)

3.7. Conclusion of the final examination and evaluation of the effect of the therapy

After eight therapies I provided the final kinesiologic examination to my patient to determine if my therapy program which I followed was effective. The patient was very cooperative with me and he helped me a lot to achieve the best result at the end of my therapies.

According to my final kinesiologic examination that I provided I noted very important changes in comparison with my initial kinesiologic examination before starting my therapy sessions.

During postural examination the swelling inside the knee was not visible and the condition of muscles of the right lower extremity was improved. The position of the right clavicle, shoulder and scapula was corrected and was in the same level with the left side. As I mentioned before the condition of muscles of the right lower extremity was in higher levels. The differences were visible without the need of measurements, especially in the group of muscles of quadriceps femoris, hamstrings and triceps surae.

The improvement of the tone was also confirmed when I palpated the above muscles and also during the examination of measurements of circumferences.

At the beginning the circumference 15 cm above patella to the right side was 45,5 cm and after therapies and exercising were 46,5 cm. The circumference 10 cm above patella at the beginning was 40 cm and after was 43cm. The condition of calf muscles was also improved in both legs. The circumference of m.soleus, m.gastrocnemius (lateralis and medialis) at the beginning to the left leg was 36 cm and to the right 34,5 and we had improvement to the left side 0.5 cm and to the right leg 2 cm. The circumference over the knee joint was decreased to the right leg about 1,5 cm because the swelling was also decreased.

The strength of all the muscles of the lower extremity was also improved and I confirmed it during the muscle strength test examination.

Romberg test was again negative like during the initial kinesiologic examination. The patient was able to provide the Trendelenburg test with both legs with negative result. The Ballottement sign was also negative.

Skin and fascias around the scar and the area of the thigh were improved with good elasticity. The length of the upper part of m.trapezius and the m.sternocleidomastoid in both sides of the patient was improved as I found soft barrier during the final examination.

The joint play was present in all joints of the lower extremities including the right patella where there was blockage in craniocaudal and laterolateral directions before my therapies.

The patient was able to walk without crutches and to put full load to his operated leg. He was afraid a lot at the beginning when he first tried to walk without crutches but day by day he was feeling better and more comfortable.

I also checked my patient's deep stabilization system and the results were better than the beginning due to some specific exercises I instructed him to perform especially during the gym.

The last and most important finding during the final kinesiologic examination was the improvement of the range of motion of his right knee in direction of flexion. When I started my first therapy the range of motion was 95 degrees with providing flexion of the knee actively and 100º passively. During the final examination I noted improvement of 20 degrees actively and also passively.

3.7.1. Prognosis

My last therapy session (16.01.2015) was also the last therapy for my patient in the hospital. The doctor was very satisfied with the result of my therapies and informed the patient that he was able to leave hospital.

I consider my therapy effective and the rehabilitation progress successful enough. My patient did not face any problems during my therapies as he was always informing me after each therapy session. He looked forward to returning to sports activities. He was very cooperative as well. He was exercising every day and that was also helpful for the good result of the therapy. He was in a very good condition and happy for that.

There was improvement to his strength of his right lower extremity and also improvement of the mobility of his right knee in direction of flexion.

He was going to continue a strengthening program including exercises for the improvement of balance. I instructed him to continue using the exercises I showed him and also give his knee enough time to restore full mobility and strength step by step and not to overuse it during exercising because in this way he may lead his knee to other injuries.

3.8. Long-term rehabilitation plan:

As long-term rehabilitation plan I want to maintain and improve if necessary results from short rehabilitation plan. As a result the patient will not face any problems during his daily activities and he will be in good condition and able to play football again.

4. CONCLUSION

Hopefully the result of the therapy program which I followed during those two weeks in the Centrum léčby pohybového aparátu Vysočany for my patient after reconstruction of the anterior cruciate ligament was positive and I am satisfied for that.

The patient was very cooperative with me from the first time I met him. He trusted me and he was listening carefully to my instructions during the therapy sessions. He wanted to return to sports activities as soon as possible so he was also exercising during his free time to improve his condition. Day by day he was able to see the positive changes and he was always positive for the result of my therapies.

After eight therapies, with the excellent cooperation of the patient, I achieved my goals. There was improvement of the range of motion of his right knee into direction of flexion, his weak muscles were strengthened and he started to improve his stability. Due to these results the patient was very satisfied with me.

5. BIBLIOGRAPHY (List of literature)

Books

1. Kolář P. et al. (2013). *Clinical Rehabilitation*. Czech Republic: Rehabilitation Prague School. ISBN: 978-80-905438-0-5
2. Kendall F.P. et al. (2005). *Muscles Testing and function with posture and pain* (5th ed.). Philadelphia: Lippincott Williams & Wilkins. ISBN: 1-4511-0431-6
3. Lewit K. (2010). *Manipulative Therapy*: Musculoskeletal Medicine. Czech Republic: Churchill Livingstone Elsevier. ISBN: 9-780-7020-3056-7
4. Enoka R. M. (2008). *Neuromechanics of Human Movement* (4th ed.). United States: Human Kinetics. ISBN: 0-7360-6679-9
5. Bartlett R. (1999). Sp*orts Biomechanics: Reducing injury and improving performance.* United States: Routledge. ISBN: 0-419-18440-6
6. Hong Y. (2002). *International Research in sports biomechanics*. London: Routledge. ISBN: 0-415-26230-5
7. Fontera W.R., Silver J.K., Rizzo T.D. (2008). *Essentials of Physical Medicine and Rehabilitation* (2nd ed.). Philadelphia: Saunders Elsevier. ISBN: 978-1-4160-4007-1
8. Hamil J., Knutzen K.M. (2009). *Biomechanical Basic of Human Movement* (3rded.). Philadelphia: Lippincott Williams & Wilkins. ISBN: 0-7817-9128-6
9. Calais Germain B. (2007). *Anatomy of Movement*. United States: Eastland Press. ISBN: 9780-0-939616-57-2
10. Pagliarulo M.A. (2012). *Introduction to Physical Therapy* (4th ed.). New York: Churchill Livingstone Elsevier. ISBN: 978-0-323-07395-0
11. Lindsay D.T, (1996). *Functional human anatomy*. United States: Mosby – Year Book. ISBN: 0-8016-6471-3
12. Lippert L.S. (2000). *Clinical Kinesiology for Physical Therapist Assistants* (3rd ed.). Philadelphia: F.A. Davis Company. ISBN: 0-8036-0453-X
13. Gotlin R.S. (2008). *Sports Injuries Guidebook*. United States: Human Kinetics. ISBN: 0-7360-6339-5
14. Winkel D., Matthijs O., Phelps V. (1997). *Diagnosis and treatment of the lower extremities*. United States: Aspen Publishers. ISBN: 0-8342-0902-0
15. Hutson M.A. (1996). *Sports injuries: Recognition and management* (2nd son). Oxford University Press. ISBN: 0-19-262676

16. Levangle P.K., Norkin C.C. (2001). *Joint structure and foundation: a comprehensive analysis* (3rd ed.). Philadelphia: F. A. Davis Company. ISBN: 0-8036- 0710-5
17. Nigg B.M., Herzog W. (2007). *Biomechanics of the Musculo-skeletal system* (3rded.). Canada. WILEY. ISBN:978-0-470-01767-8
18. Manske R. (2006). *Postsurgical Orthopedic Sports Rehabilitation: knee and shoulder*. United States: Churchill Living stone. ISBN: 0-323-02702-4
19. Braddom R. L. (2006). *Physical Medicine and Rehabilitation* (3rd ed.). Philadelphia: Churchill Livingstone Elsevier. ISBN: 1-416-0261-X
20. Frontera W. R. (2003). *Rehabilitation of sports injuries: scientific basis*. United States: Blackwell Publishing Science Ltd. ISBN: 0-632-05813-7
21. Behnke R.S. (2001). *Kinetic Anatomy*. United States: Human Kinetics. ISBN: 0-7360-0016-X
22. Eustace S., Johnston C., O'Neill P., O'Byrne J. (2007). *Sports injuries, examination, imaging and management*. United Kingdom: Churchill Livingstone Elsevier. ISBN: 0-443-10203-1
23. Donatelli R. (2007). *Sports – specific Rehabilitation*. United States: Churchill Livingstone Elsevier. ISBN: 0-443-06642-6
24. Bartlett R., Bussey M. (2012). *Sports Biomechanics* (2nd ed.). United States: Routledge. ISBN: 978-0-415-55837-2
25. Neuman D. (2002). *Kinesiology of the musculoskeletal system* (2nd ed.). United States: Churchill Livingstone Elsevier. ISBN: 0-3230-3989-8
26. Bahr R., Maehlum S. (2004). *Clinical Guide to sports injuries*. United States: Human Kinetics. ISBN: 0-7360-4117-6
27. Drake R.L., Vogl W., Mitchell A.W.M. (2005). *Gray's Anatomy for students*. Philadelphia: Churchill Livingstone Elsevier. ISBN: 0-8089-2306-4
28. Carola R., Harley J.P., Noback C.R. (1990). *Human Anatomy and Physiology*. United States: McCRA –HILL PUBLISHING COMPANY. ISBN: 0-07-557937-5

Electronic Journals

29. Webster K.E., Feller J.A. (2011). Alterations in joint kinematics during walking following hamstring and patellar tendon anterior cruciate ligament reconstruction surgery. *Journal of Clinical Biomechanics*, 26, 175-180. Retrieved 12 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/20950901
30. Hall M., Stevermer C.A., Gillette J.C. (2012). Gait analysis post anterior cruciate ligament reconstruction: Knee osteoarthritis perspective. *Journal of Gait and Posture*, 36, 56-60. Retrieved 14 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22310303
31. Webster K.E., Feller J.A., Wittwer J.E. (2012). Longitudinal changes in knee joint biomechanics during level walking following anterior cruciate ligament reconstruction surgery. *Journal of Gait and Posture*, 36, 167-171. Retrieved 15 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/22469773
32. Boden B.P., Dean G.S., Feagin J.A., Garrett W.E. (2000). Mechanisms of anterior cruciate ligament injury. *Journal of orthopedics*, 23, 573-578. Retrieved 15 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10875418
33. Griffin L.Y., Agel J., Albohm M.J. et al. (2000). Noncontact anterior cruciate ligament injuries: risk factors and prevention strategies. *Journal of American Academy of orthopedic surgeons*, 8, 141-150. Retrieved 17 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/10874221
34. Kramer L.C., Denegar C.R., Buckley W.E., Hertel J. (2007). Factors associated with anterior cruciate ligament injury: history in female athletes. *Journal of Sports Medicine and Physical Fitness*, 47, 446-454. Retrieved 17 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/18091686

35. Hewett T.E., Myer G.D., Ford K.R. (2001). Prevention of anterior cruciate ligament injuries. *Journal of Current Women's Health Reports*, 3, 218-224. Retrieved 19 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/12112973
36. Alentorn-Geli E., Myer G.D., Silvers H.J., Samitier G., Romero D., Lázaro-Haro C., Cugat R. (2009). Prevention of non-contact anterior cruciate ligament injuries in soccer players. Part 1: Mechanisms of injury and underlying risk factors. Official *Journal of the ESSKA*, 7,705-729. Retrieved 19 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/19452139
37. Pahnabi G., Akbari M., Ansari N., Mardani M., Ahmadi M., Rostami M. (2014). Comparison of the postural control between football players following ACL reconstruction and healthy subjects. *Journal of medicine*, 28, 101. Retrieved 20 March, 2015, from PubMed Central database. Available from: http://www.ncbi.nlm.nih.gov/pubmed/25664302

6. SUPPLEMENTS

6.1. List of figures

6.2. List of tables

6.3. Abbreviations

L: Lumbar root

S: Sacral root

Th: Thoracic

C: Cervical

No: Number

ROM: Range of Motion

BMI: Body Mass Index

Fig: Figure

Kg: Kilogram

Hz: Hertz

º: degrees

PIR: Post Isometric Relaxation

PNF: Proprioceptive Neuromuscular Facilitation

ACL: Anterior Cruciate Ligament

PCL: Posterior Cruciate Ligament

LCL: Lateral Collateral Ligament

MCL: Medial Collateral Ligament

MRI: Magnetic Resonance Imaging

cm: centimeter

m: muscle

ºC: degree Celsius

6.4. Approval by the Ethics Committee

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

Undergraduate research

Project title: Case study of a patient with diagnosis of anterior cruciate ligament rupture

Nature of the research project: Bachelor's thesis

Author (chief investigator): RaphaelAlexandros Vasiliou

Supervisor (in case of student research): Mgr. Ivana Vláčilová

Research project description: Case Study of physiotherapy treatment of a patient with the diagnosis of Anterior cruciate ligament rapture will be conducted under the expert supervision of an experienced physiotherapist to the orthopedic department of Centrum léčby pohybového aparátu Vysočany.
Guaranteed safety to be judged by experts: No invasive methods will be used. Personal data obtained during the investigation will not be published.
Ethical aspects of the research: special rationale for research involving children, pregnant and nursing women, mentally disabled, prisoners and persons in underdeveloped communities (see the Ethics Board Code, Faculty of Physical Education and Sport, Charles University, and International Ethical Guidelines 5, 6, 7, 8 and 11)
Informed consent (attached)

Date: 26.1.2015 Author's signature:

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

Ethics Board members: 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: 016/2015

Date: 27. 1. 2015

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.

UNIVERZITA KARLOVA v Praze
Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6
1

Official school stamp

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 byla odborným pracovníkem poučena 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 měla jsem možnost klást mu otázky, na které mi řádně odpověděl.

Prohlašuji, že jsem shora uvedenému poučení plně porozuměla 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 /tky:…….