

Charles university
Faculty of Physical Education and Sport

Department of Physiotherapy

Rehabilitation after Anterior Cruciate Ligament
Reconstruction

Bachelor Thesis

Author:
Michele Gualco

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Supervisor:
Mgr. Ilona Kučerová

Instructor:
Bc. Gabriela Svobodová

Declaration:

I hereby declare that this bachelor thesis was entirely written by myself based on the Clinical Work Placement which took place in Centrum Léčby Pohybového Aparátu, from the 21st of January until the 1st of February. All the information taken for the purpose of writing this bachelor thesis have been listed at the end of it.

I declare that no invasive methods were used during the therapy period and that the patient was fully aware of the procedures and techniques we were following.

Prague,2019

Michele Gualco

Acknowledgments

With this bachelor thesis I would like to express all my gratitude my parents and family for always supporting me during these three year in Prague. I would like to personally show my appreciation to my teachers which led me during the Bachelor program and gave me an education to be at the level I am right now.

A special thank goes to my supervisor Mgr. Ilona Kučerová for setting me in the right direction during the writing of my Bachelor thesis and to always be available for any clarification.

I'd like to show thankfulness to all my colleagues and friends with whom we created a special group which kept being together for these three fantastic years. A special thank goes to my supervisor Bc. Gabriela Svobodová for leading me during my practice and letting me work autonomously.

Abstract:

Title: Case study of physiotherapeutic treatment about a patient after Anterior Cruciate Ligament reconstruction.

Thesis aim: the thesis is divided into two different parts, theoretical part and practical part. In the former an overview about the anatomy, biomechanics and kinesiology of the knee is shown. In the latter we go through the practical application of my knowledge in order to treat and cure the patient after ACL reconstruction. Initial and final examination of the patient are described as well as the therapy applied and its effects.

Method: the rehabilitation plan included 6 therapy sessions where I was working autonomously with my patient along with the help of my supervisor Bch. Gabriela Svobodová. I was applying practically the knowledge I was taught during these three years on my patient. Techniques which were used included joint play, muscle length, muscle strength, examination of fascia and scar, tone palpation and neurological examination. For active exercises we used the help of specific tool such as Posturomed platform, over-ball, gym-ball, Bosu unstable surface, medicine ball and Theraband. These exercises were slip into isotonic and isometric exercises.

Result: following 8 therapy sessions the patient could feel the improvement on his own lower extremities as well objective the gains were visible to me. His overall ROM of his right increased as well as his muscle strength and tone. Muscle coordination improved and joint stability was the field were the patient improved the most.

Keywords: ACL reconstruction, range of motion, knee, physiotherapy, surgery.

Abstrakt:

Název: případová studie fyzioterapeutické léčby pacienta po rekonstrukci předního vazního vazů.

Cíl práce: práce je rozdělena do dvou částí, teoretické a praktické. V předchozím je uveden přehled o anatomii, biomechanice a kineziologii kolena. V posledně uvedeném článku prochází praktická aplikace mých znalostí za účelem léčby a vyléčení pacienta po rekonstrukci ACL. Popíše se úvodní a závěrečné vyšetření pacienta a aplikovaná terapie a její účinky.

Metoda: rehabilitační plán zahrnoval 6 terapeutických sezení, kde jsem s pacientem pracoval samostatně a za pomoci svého vedoucího Bcha. Gabriela Svobodová. Prakticky jsem aplikoval znalosti, které jsem učil během těchto tří let na mém pacientovi. Použité techniky zahrnovaly hru kloubu, délku svalů, svalovou sílu, vyšetření fascie a jizvy, palpaci tónu a neurologické vyšetření. Pro aktivní cvičení jsme použili pomoc konkrétního nástroje, jako je platforma Posturomed, over-ball, gym-ball, nestabilní povrch Bosu, medicinbal a Theraband. Tato cvičení byla sklouznuta do izotonických a izometrických cvičení.

Výsledek: po 8 terapeutických sezeních mohl pacient pociťovat zlepšení na svých dolních končetinách, což bylo také objektivní, čeho jsem viděl. Jeho celková ROM jeho prava se zvýšila, stejně jako jeho svalová síla a tón. Zlepšení koordinace svalů a zlepšení stability kloubů bylo lepší, když se pacient zlepšil.

Klíčová slova: rekonstrukce ACL, rozsah pohybu, koleno, fyzioterapie, chirurgie.

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1. Preface

My thesis work placement took place in place in Centrum Léčby Pohybového Aparátu, from the 21st of January until the 1st of February. The total amount of worked hours was 80 divided into 10 days of work. The goal of the work placement was to test my knowledge after three years of studies. In CLPA I was assigned a patient with right ACL Autograft reconstruction.

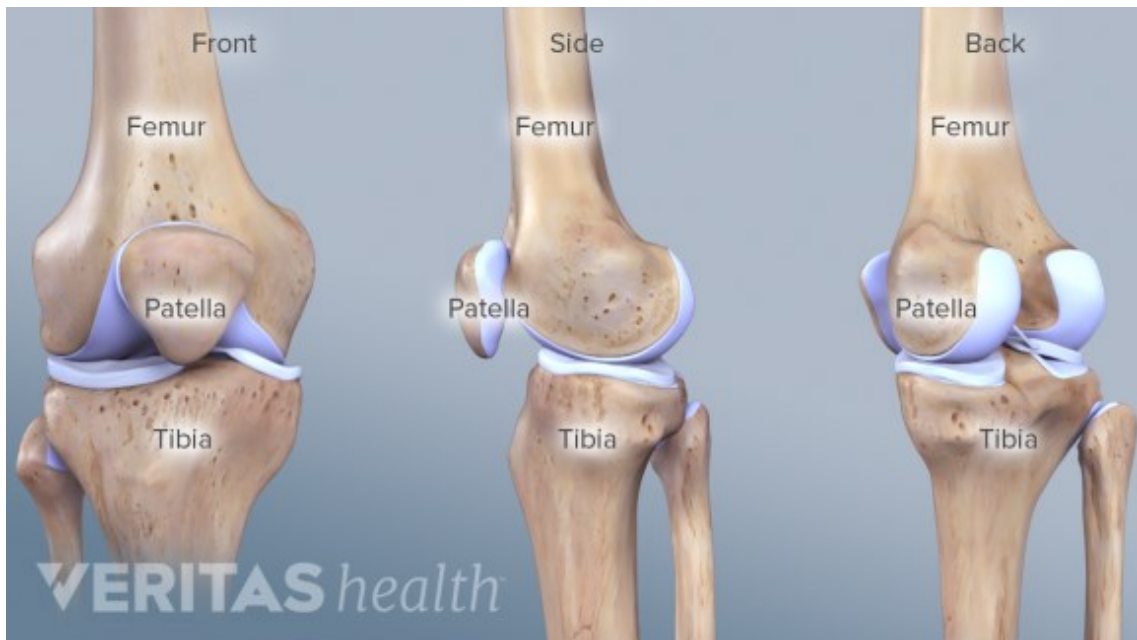
In the thesis I provided a full and detailed description of the theoretical part of the knee such as its biomechanics, anatomy and kinesiology which is the general part. Moreover, the practical part of therapy is described as applied knowledge. Here I described the methods and techniques I was applying, and which exercises the patient was asked to do, this is the special part.

The conclusion of the study contains personal thoughts about the experience I had in CLPA as well as personal opinion of the approach my supervisor asked me to have with my patient.

2. General part

2.1 Anatomy of the knee joint:

The knee joint is the largest and most complicated joint in the human body. In the joint we can find three different articulating bones which are the femur (thigh bone), which is the strongest and longest bone in our skeletal system, the tibia (shin bone) and patella which forms the knee cap. Each surface of these three bones is covered by cartilage, a tough connective tissue. The knee is a hinge joint which supports most of the body weight of human beings, therefore is one of the strongest and most important joints of the human body. The ball of the joint is composed by the femoral condyles. The joint socket is formed by the upper end of the shin bone (Kolář, 2013). The patella is the third articulating bone. The incongruity of the sharp and curved femoral condyles and the almost flat tibial condyles is evened out by the menisci. In the knee joint we have two different menisci, the medial menisci which is oval and more open in shape and the lateral menisci which is smaller in size with a circular contour. (1,2,3,16).



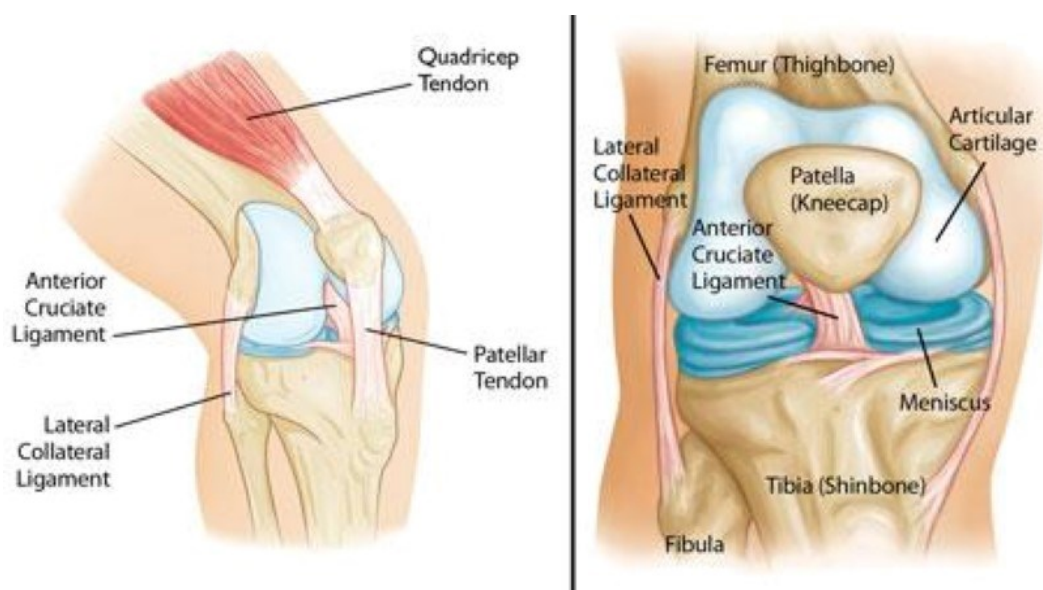
Picture 1: anatomy on the knee joint

2.2 Bones and articulating surfaces of the knee joint:

The bones that give structure to the knee are three, the femur, patella and tibia and are characterized by their large and irregular shape. At the distal end of femur we can find the two condyles, medial and lateral which articulates with the proximal end of tibia. The femur condyles are lined with the articular cartilage. The tibia is considered as a long bone which proximally articulates with the femur at the tibial plateau which are called the tibiofemoral joints. The patella is considered as a sesamoid joint (a bone embedded in a tendon) situated in the quadriceps tendon and it articulates with the femur at the patellofemoral joint.

The knee comprises three joints: the tibiofemoral joint, the patellofemoral joint and the tibiofibular joint. The tibiofemoral joint is the largest joint in the human body as it's the primary weight bearing joint. The knee can be considered a hinge joint which allows a large flexion and extension but limited rotations and minimal abduction and adduction. The menisci help to stabilize the joint by improving weight bearing distribution and increasing the contact area between the tibia and femur. They also serve as shock absorber when landing.

We find the articulating cartilage at the end of each bone which forms the knee joint. It is a thin, tough yet elastic layer of cartilage which allows the end surface of the bones so slide on one another smoothly. As the menisci it acts like shock absorber and helps to increase the stability in the knee joint. (2,6,11,15).



Picture 2: bones and articulating cartilage of the knee joint

2.3 Joint capsule:

The joint capsule, also called synovial membrane, is composed by a fibrous layer in the external part, which is called fibrous capsule made of tough ligament tissue and an internal synovial membrane. The fluid which we find inside the membrane helps the knee joint to keep a good lubrication between the articulating surfaces. The fibrous external layer is connected to the upper part of the femur. Moreover, in the inferior part the fibrous layer connects to the margin of the tibia, the so called tibia plateau. (6).

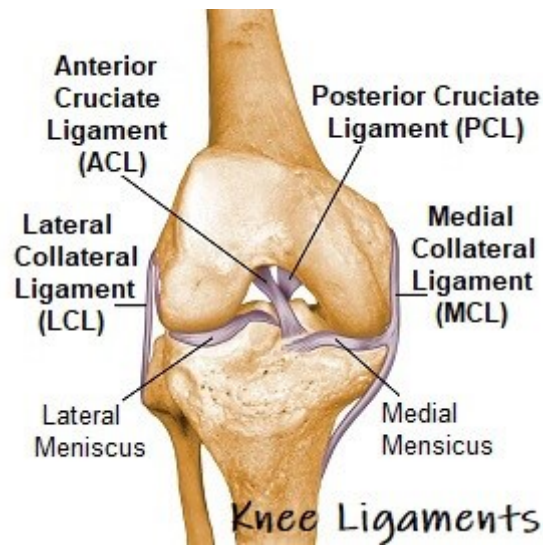
2.4 Ligaments of the knee

We can find two major ligaments on both sides of the knee joint. They are the lateral collateral ligament and the medial collateral ligament. These two ligaments keep the knee alignment with the femur and avoid the joint to move side to side. More specifically the lateral collateral ligament avoids the knee joint to move into abduction, so to produce varus knee. On the other hand, the medial collateral ligament does not let the knee to drop medially into adduction so to cause valgus knee. Another vital function of the two collateral ligaments is to generate a stabilizing force at the knee joint which keeps it in the right alignment. Their function along with the anterior and posterior cruciate ligaments guides the skeletal structure of the knee as the joint moves into flexion and extension.

The cruciate ligaments act together to prevent excessive posterior and anterior translation of the tibia on the femur. As their name expresses these two ligaments are cross-shaped, more specifically they cross within the intercondylar notch of the femur. Both ligaments are covered by a synovial lining which keeps their physiological hydration. Both are thick and tough, feature which underlines their importance in the stability of the knee joint. The ACL connects the anterior intercondylar are to the medial surface of the lateral condyle of femur. Its main functions is to limit knee extension, medial rotation and to avoid forward translation of tibia on the femur.

The posterior cruciate ligament arises from the posterior eminence of tibia and inserts to the lateral surface of medial condyle of femur. It is the strongest of the two, as a matter of fact PCL injury is less likely to happen. Its biomechanical function is to

prevent an anterior roll of the femur away from the tibial plateau. A major feature of PCL is to prevent hyperextension of the knee. (2,3,6,15,19).



Picture 3: ligaments of the knee joint, anterior view

2.5 Movements of the knee joint:

Flexion and extension are considered as the two main movements happening in the knee joint. The normal alignment of the knee is considered to be at zero degrees of flexion (Kolář, 2013). When the physiological alignment is achieved the knee locks because of the position of the femur on the tibia. This position is best suitable for weight bearing. During the motion which brings the joint from flexion to extension a certain volume of medial rotation is noticeable. Instead, when the knee goes from extension to flexion the joint unlocks thanks to the activation of the popliteus which, this time, rotates laterally the femur of the tibia.

Slight rotation of the knee joint is happening due to the different length of the medial and lateral condyle of femur. The former, in fact, is almost 4cm longer than the latter. As described before the medial rotation of the femur on the tibia allows the knee to lock and achieve full extension. (1,3).

2.6 Main muscles of the knee joint:

The stability and motion of the knee joint depends on the activity of the muscles which are working on the frontal or dorsal part of the joint. Here is a list of the main muscles on both sides.

Anterior group of muscles:

Quadriceps femoris:

Rectus femoris:

Origin: anterior inferior iliac spine and ilium

Vastus medialis:

Origin: intertrochanteric line, medial lip of linea aspera of femur

Vastus intermedius:

Origin: anterior and later surface of body of femur

Vastus lateralis:

Origin: greater trochanter, lateral lip of line aspera of femur

Insertion of quadriceps femoris: base of patella and tibial tuberosity via patellar ligament

Action: the quadriceps extends the knee joint, the rectus femoris partially flexes the hip joint

Nerve supply: femoral nerve

Sartorius:

Origin: anterior superior iliac spine

Insertion: superior part of medial surface of tibia

Action: abducts, laterally rotates and flexes thigh; flexes knee joint

Nerve supply: femoral nerve

Posterior group of muscles:

Semimembranosus:

Origin: ischial tuberosity

Insertion: posterior part of medial condyle of tibia

Action: flexes the knee; extends the thigh

Nerve supply: sciatic nerve

Semitendinosus:

Origin: ischial tuberosity

Insertion: superior part of medial surface of tibia

Action: flexes the knee; extends the thigh

Nerve supply: sciatic nerve

Biceps femoris:

Origin: long head: ischial tuberosity; short head: lateral supracondylar line of femur

Insertion: lateral side of head of fibula

Action: flexes and laterally rotates the leg; extends the hip

Nerve supply: sciatic nerve

Popliteus:

Origin: lateral aspect of lateral condyle of femur; lateral meniscus

Insertion: posterior tibia; posterior soleal line

Action: flexes knee and unlocks it by medially rotating the femur on tibia

Nerve supply: tibial nerve

Gastrocnemius:

Origin: lateral head: lateral aspect of lateral condyle of femur; medial head: medial condyle of femur

Insertion: posterior aspect of calcaneus via calcaneal tendon

Action: ankle plantar-flexion; assists knee flexion

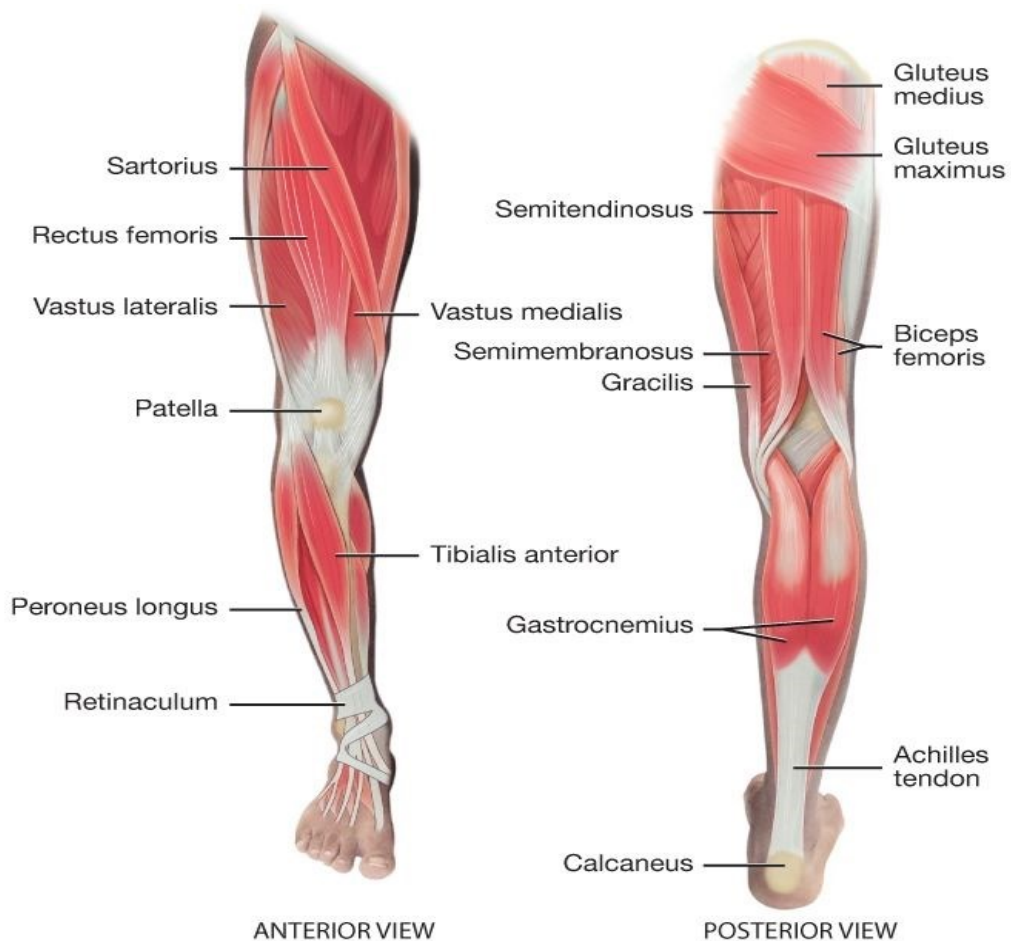
Gracilis:

Origin: body of anterior ramus of pubis

Insertion: superior part of medial surface of tibia

Action: adducts thigh; flexes and medially rotates the leg

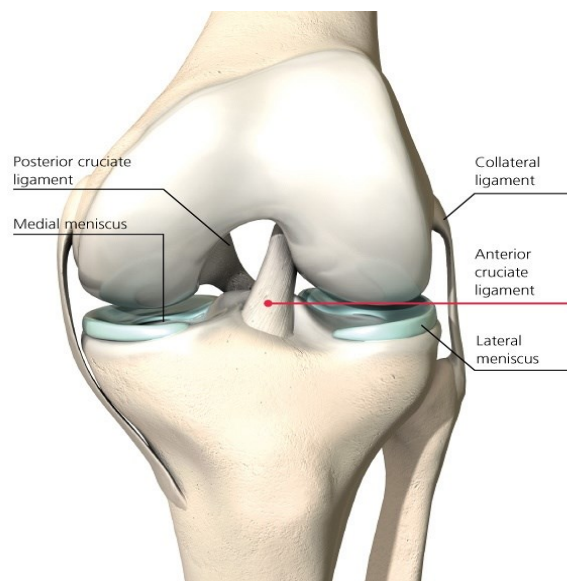
Nerve supply: obturator nerve (4,5).



Picture 4: muscles of the lower limbs

2.7 Menisci:

In the knee joint we can find a pair of menisci, medial and lateral. They are crescentic plates of fibrocartilage situated on the top of tibia next to the femur. The key role is to act as shock absorber. The two menisci work like a gasket which is able to transmit the load to the femur and tibia which protects the articular cartilage and the end of the bones from possible fractures and excessive forces. The load transmission ability is possible thanks to the fact that the two menisci increase the contact area between femur and tibia. Another vital function is to provide low friction between the tibio-femoral joint in order to avoid any possible direct shear damaging friction between the two bones. (9)

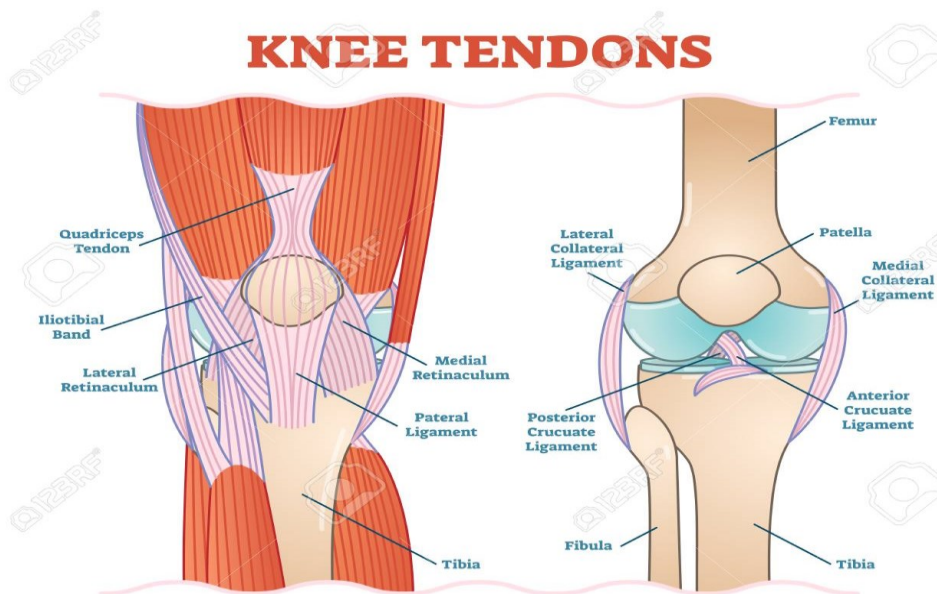


Picture 5: frontal view of menisci

2.8 Tendons:

Tendons play a really important role in the transmission of contractile forces as well as connecting the muscles to the bones. They act as storage and recovery of elastic energy during locomotion. Their stiffness allows the knee joint to be in the correct and physiological alignment and to produce the best and most efficient movement.

The biggest tendon of the knee is the patellar tendon which connects the distal part of the femur to the patella. It's called quadriceps tendon since it connects the quadriceps muscle to the knee cap. This tendon helps to maintain the patella in its physiological position. The posterior-thigh muscles have their own tendons which attach to the posterior part of the fibula and tibia. (10).



Picture 6: knee tendons, frontal view

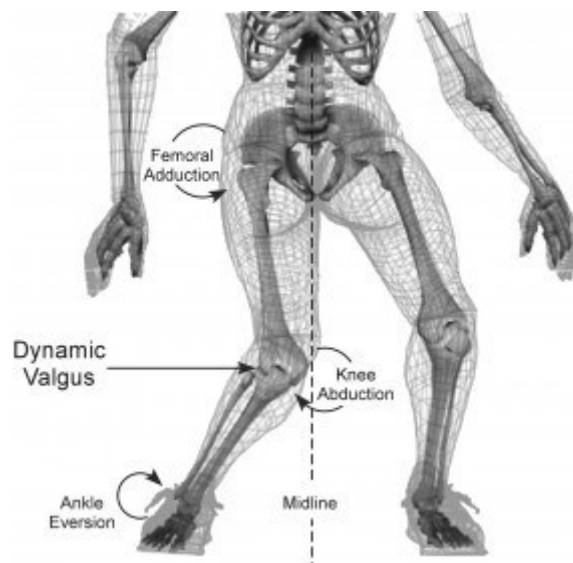
2.9 Biomechanics of the ACL:

The main and primary function of the anterior cruciate ligament is to prevent forward translation of the tibia relative to the femur. Another important function is to prevent knee hyperextension. The ACL provides crucial stability of the knee joint since the affective contact between tibia and femur is so tiny. The tension and orientation of the ACL change as the knee flexes or extends. During flexion of the knee we can notice that the fibres of the ACL increase in tension and stretch. This mechanical change allows the knee to increase its stability and limits the anterior translation of tibia on femur. The ACL average length is between 25mm to 35mm. Along with the other 5 ligaments which are found in the joint the ACL acts as joint stabilizer. (2,8,13).

2.10 Mechanism of ACL rupture:

Sprains are the most common injury that can happen to the ligaments surrounding the knee joint. The ACL and PCL are the most likely to suffer such an injury. Injury to these ligaments usually occurs during sport activities such as football, basketball and soccer where a sudden torsion of the knee may happen and cause the cruciate ligament to rupture. Both contact and noncontact mechanism can cause the sprain of the ACL. In the contact mechanism finds the foot to be firmly on the ground and a lateral rotation to happen while a valgus-directed force is applied on the knee from the latera side of it with the knee slightly flexed.

Most likely the ACL sprain happens with noncontact mechanism (70%). The latter may be started by a sudden deceleration, change of direction or by an awkward landing on the almost full extended knee. This kind of injury may cause a side injury such as knee transient dislocation which may cause tear of other soft tissue in the knee joint. Video analysis of the injury show three key factors linked to the ACL rupture: valgus collapse of the knee joint, high activation of the knee extensors and massive external rotation of the knee joint. Hyperextension of the knee can be considered as another factor of ACL sprain. (3,5,4,2).

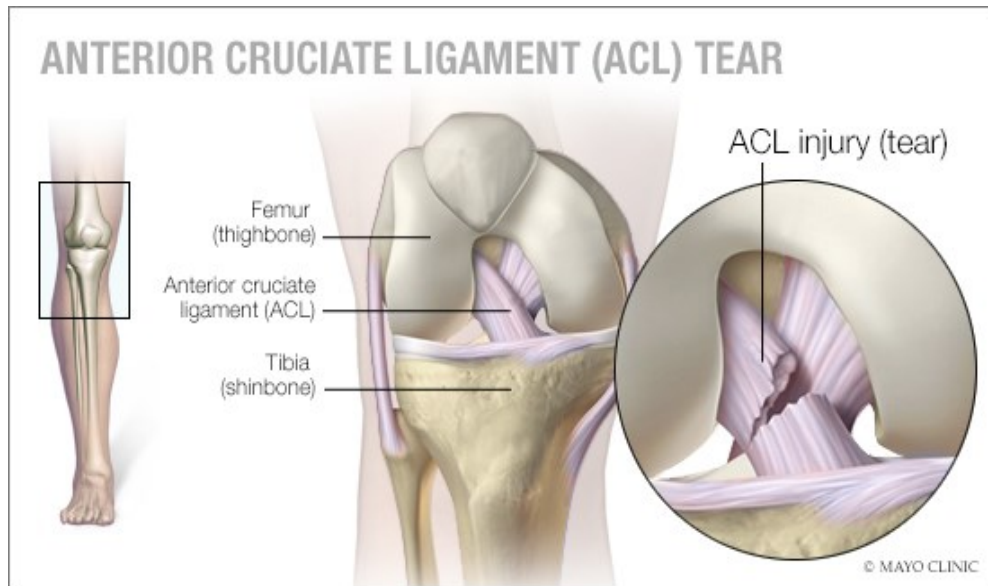


Picture 7: mechanism of ACL rupture

2.11 Clinical state after ACL sprain:

The rupture of the ACL will cause the knee to decrease in term of stability especially during athletic physical exercises such as running. The injury could be only partial with a minor damage of the ligament of total with complete rupture of the ACL. Most injuries involve the complete rupture of the ligament. Symptom may be the following:

- Immediate pain and loss of the full ROM of the affected knee.
- The athlete may declare that he heard a pop right before the pain arose.
- Inability to bear weight on the injured leg.
- Swelling of the knee.
- Feeling of weakness and instability of the injured knee. (2,12).



Picture 8: ACL rupture

2.12 Diagnosis of a ruptured ACL:

The diagnosis can be assessed as follows:

Through imaging machines:

- Computed tomography (TC)
- Magnetic Resonance Imaging (MRI)
- X rays

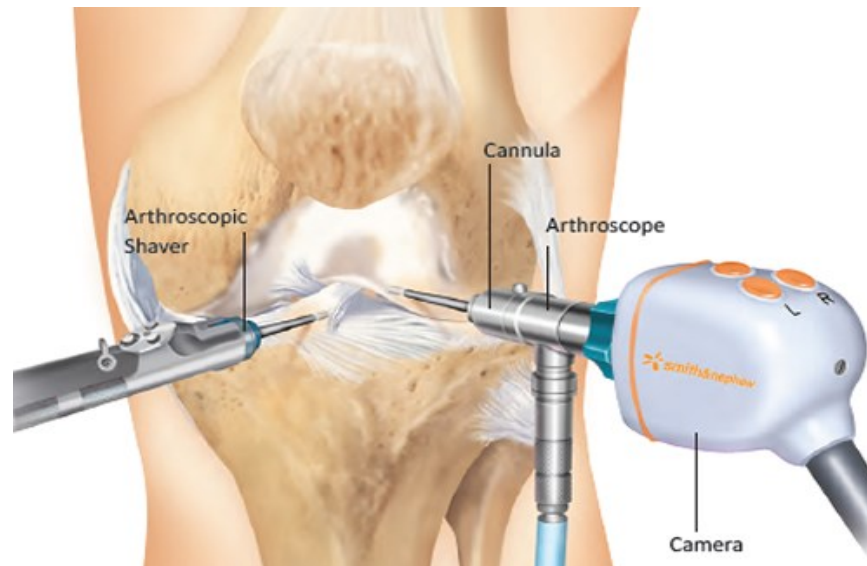
Through arthroscopy.

Trough manual orthopaedics assessment methods.

2.13 Arthroscopy:

Knee arthroscopy is a surgical procedure which allows doctors to diagnose and to have a clear view of the knee joint without making a big incision of the skin and soft tissues so a big scar. During the surgery the specialized surgeon will insert a small camera, called arthroscope, into your knee through the small incision he made previously. The camera displays live images of the knee on a video monitor which is followed by the surgeon to orientate his movements inside the knee joint. Thanks to this the surgeon can

handle the miniaturized surgical instruments to fix any further problem. There are many cons of knee arthroscopy. Because the incision the surgeon will make are so small the operated knee will have less stiffness, usually the patient will feel less pain and usually shortens the time for recovery according to the surgical treatment provided. (13,14,15,20).

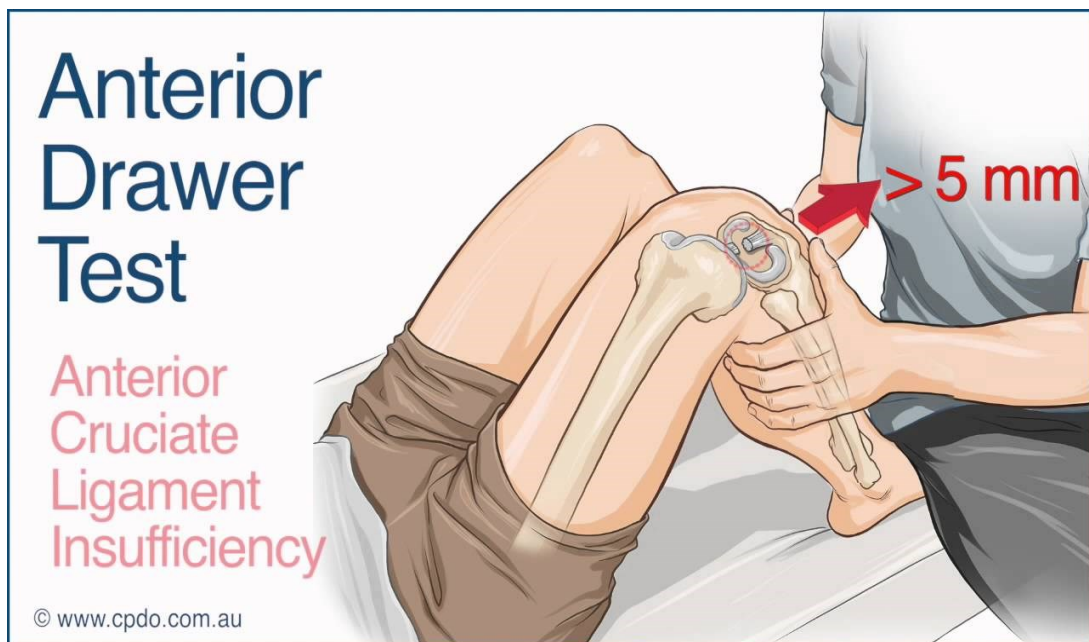


Picture 9: arthroscopy of the knee joint

2.14 Manual orthopaedics assessment methods:

2.14.1 Anterior drawer test:

The test diagnoses the anterior shift of tibia on femur. The test is performed with 90 degrees of knee flexion and neutral position of tibia in terms of rotation. The patient lies supine with the foot of the examined leg flat on the table. From this position the examiner place both of his hands on the proximal part of the tibia anteriorly. Once grasped the tibia the examiner pulls the leg towards himself (anterior drawer test) or pushes the leg towards the patient (posterior drawer test). If the tibial mobility is considered more than normal the test result will be positive. (1,2).



Picture 10: Anterior drawer test

2.14.2 Lachman's test:

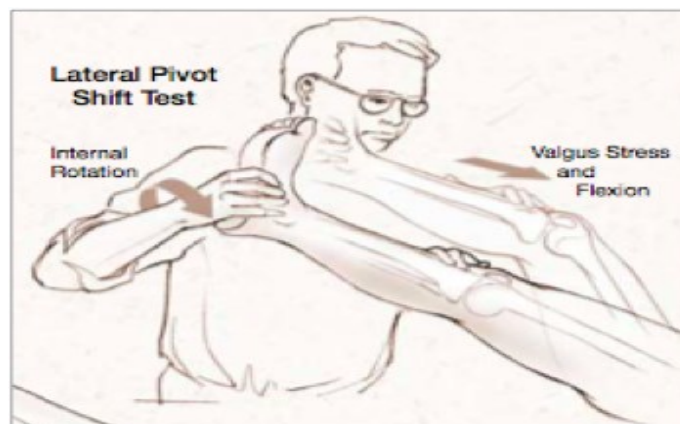
Lachman's test is another medical test used to assess the possible rupture of the ACL of the knee. The patient is examined in supine position. The examiner grasps the patient leg from both above and under the knee with 15° of flexion approximately. From this position the examiner shifts the proximal part of tibia in a ventral direction against the femoral condyle. If the ACL will be ruptured, we will notice a drawer phenomenon. The Lachman's test is recognized as one of the most reliable tests for ACL. (1,2).



Picture 11: Lachman's test for ACL

2.14.3 Pivot shift test:

Another effective medical test for ACL rupture assessment is the Pivot test. For this test the patient lies supine. The examiner grasps the foot of the possibly affected leg. With the other hand he provides knee extension. At this point tibia internal rotation and abduction are performed. The result will be positive if the examiner will notice an anterior subluxation of the later part of the tibia. (1,2).



Picture 12: Pivot test for ACL rupture

3 Special part (Case Study)

3.1 Methodology

My clinical work placement was performed at Centrum Léčby Pohybového Aparátu, (CLPA). I was attending daily from the 21st of January until the 1st of February. The total worked hours were 80 with 8 hours being performed each and every day of the work placement.

CLPA is an in-patient and out-patient clinic which is offering a wide variety of treatment to patients with different diagnosis and injuries. The clinic is equipped with a room for hydrotherapy, one for magnetotherapy and one fully equipped gym. In it I was able to work with a wide variety of machines and equipment such as Posturomed balance board, Bosu balance boards, gym balls, medicine balls, different intensity Thera Bands, treadmill, stationary bicycle, stepper and leg extensor and flexor machine.

My supervisor during the practice was Gabriela Svobodová, Cert. Bc. I first met my patient on the 22nd of January and immediately performed my initial examination on him. I started the therapy session on the 23rd of January, through January the 31st for a total of 8 therapy sessions with my patient. On the 1st of February I took notes for my final examination with him as our programmed therapies came to an end.

Each therapy session my patient and I had lasted 1 hour. In addition to the therapy my patient was having both hydrotherapy and magnetotherapy 3 times each week. I was not responsible for this as he was carefully followed by other physiotherapists.

For my therapy I mainly focused on regaining the muscles strength that my patient lost after a long rest period due to his right knee ACL rupture. I performed my therapy mainly in the fully equipped gym by the use of softball, gym ball, Theraband, medicine ball, Bosu balance boards and a stationary bike.

In order to take detailed data for my kinesiological examination I used a goniometer and a measuring tape. The patient was fully aware of the procedure we were following and he was informed about the exercises we were doing each and every session.

3.2 Anamnesis

Examined person, gender: J.P. Male

Year of birth: 1985

Diagnosis: by the end of April he had injury to his right knee while playing basketball. During June he had arthroscopic surgery to his right knee due to the pain that arose while playing basketball. After the surgery he started rehabilitation for 4 months but he realized that no gain was achieved as he constantly felt pain while walking up the stairs. He later talked to another doctor who told him to do a magnetic resonance. By the end of October he did it and it showed that the right ACL was ruptured. Surgery of his right ACL followed on the 19th of December. He had the Autograft approach for the reconstruction of his right ACL.

History: the patient first came to CLPA on January the 14th after undergoing his right knee ACL reconstruction surgery on December the 19th. When I first met him it was the 22nd of January and he already had 5 therapy sessions in CLPA. Moreover he was doing therapy sessions at home as his girlfriend is a physiotherapist. The injury happened by the end of April during a basketball game.

Anamnesis, past medical history: dislocation of his right shoulder in 2008 while playing basketball, fracture of his right clavicle in 2014 due to a bike crash, broke his right wrist in 2003 while playing basketball.

Present status: the patient feels pain in the morning, it increases during the day and it reaches its peak by night. He feels muscles soreness during the evening due to muscle weakness of his lower extremities. The pain is localized on the back of the right knee and on the later side of it. He has discomfort on his right hip due to a wrong gait stereotype.

A) Objective:

Height: 188cm

Weight: 85kg

BMI: 24

Glasses: he uses no glasses

Communication: physiological

Cognition: physiological

Dominant limb: right

Assistive devices: no use of any

B) Subjective:

Chief complaint: pain localized in the dorsal part of the right knee, pain while flexing the knee due to its limited ROM.

Personal anamnesis: the patient first had pain in his right knee by the end of April 2018 while playing basketball. After the first onset of the pain he underwent arthroscopic surgery of the affected knee but no damage was to be found. After 4 months of gainless therapy the pain persisted so he decided to visit another doctor who found his right ACL was ruptured. Surgery followed on December the 19th.

Past medical history: he dislocated his right shoulder in 2008 while playing basketball, broke his right clavicle in 2014 due to a bike crash, broke his right wrist in 2003 while playing basketball.

Medications, pharmacological anamnesis: none

Allergies anamnesis: no allergies

Abuses: no abuses of alcohol or cigarettes

Diet: the patient follows a high protein diet

Functional anamnesis: the patient is a manager, he wakes up every morning at 8AM, he goes to work by car and walks for about 2 hours every day. He lives girlfriend so they share the household activities. He sleeps for 6-7 hours each day he sits for about 5-6 hours a day. He has a 4 months old child.

Family anamnesis: his younger brother and parents did not suffer from any specific disease.

Social anamnesis: he lives in a flat with his girlfriend and child. They live at the 6th floor of the building, he takes the elevator to reach his apartment.

Occupational anamnesis: he's a manager, he travels a lot to the United States of America for job reasons.

Sport, hobbies: he used to play basketball before injury took him out of the court, he runs and performs crossfit.

Prior rehabilitation:

After the arthroscopic surgery to his right knee the patient followed a 4 months therapy progress before having his right ACL reconstructed. During these 4 months he mainly focused on regaining the full ROM of his right knee and increase muscle strength of knee flexors and extensors as well as the muscles of the hip. Scar therapy and exercises to increase the balance were part of the therapy program as well as lymphatic drainage techniques. Correction of his gait was part of the therapy as well as he changed the way he was walking due to the pain he felt on his right knee. During these 4 months his knee did not respond well to the therapies as the pain remained the same with just a minimum gain in the ROM and muscle strength. Due to his right shoulder dislocation he had to follow a rehabilitation for one month. He focused on increasing the rotator cuff muscles strength as well as the strength of the muscles surrounding the shoulder joint. Before starting exercising he had his right shoulder immobilized for 2 weeks.

Indication for rehabilitation:

The doctor recommended the patient to have therapy once a day with the following instructions:

- Scar therapy
- Strengthening of extensors and flexors of the right knee
- Strengthening of gluteal muscles
- Strengthening of the hip flexors
- Increase ROM of the affected knee, both flexion and extension
- Decrease muscle tone of hypertonic muscles
- Correct the gait pattern
- Increase core muscle strength
- Increase core stability

3.3 Initial kinesiological examination:

3.3.1 Postural examination:

Posterior view:

- The base of support is somehow narrow
- Shape of the heels: symmetrical
- Shape and position of the ankle joint: symmetrical
- Achilles tendon: thickness and shape are symmetrical
- Contour of the calf muscles: right calf is clearly smaller
- Position of the knee joint: left knee more extended
- Popliteal lines: symmetrical
- Contour of thigh muscles: hypotrophy of right muscles
- Subgluteal line: left is more prominent
- Gluteal muscles: left is more prominent
- Position of the pelvis: even
- Position of the scapula: right scapula is more dorsally prominent
- Position of the shoulder: left shoulder is higher
- Position of the head: physiological position

Anterior view:

- Base of support: narrower than physiological
- Arches: slightly medially collapsed, both symmetrical
- Weight distribution: slightly medially
- Shape and position of the knee: both patella face slightly medially
- Contour of calf muscles: hypotrophy of right calf muscles
- Shape of the thigh muscles: hypotrophy of right quadriceps muscle
- Position of the pelvis: even
- Symmetry of abdominal muscles: symmetric, left and right part
- Position of umbilicus: physiological
- Position of collarbones: left supraclavicular hole is deeper than the right one
- Position of the shoulder girdle: left shoulder is higher than the right one
- Position of the head: symmetrical

Right lateral view:

- Weight distribution: slightly to the medial part of the foot
- Shape of ankle joint: physiological
- Position of the knee joint: the knee is not fully extended
- Position of the pelvis: anterior tilted
- Shape of the spine: physiological curves of the spine with slight increase of lumbar lordosis
- Position of the shoulder: protracted
- Position of the head: protracted

Left lateral view:

- Weight distribution: slightly to the medial part of the foot
- Shape of ankle joint: physiological
- Position of the knee joint: physiological
- Position of the pelvis: anterior tilted
- Shape of the spine: physiological curves of the spine with slight increase of lumbar lordosis
- Position of the shoulder: elevation of the shoulder as well as protraction
- Position of the head: protracted

Conclusion of postural examination: the patient can't fully extend his right knee due to limitation. Both feet arches are slightly collapsed medially as they weight distribution follows their shape to the medial aspect of both feet. The muscles of the right calf are less developed than the one on the left side, the same situation is visible in the right thigh and gluteus due to atrophy. The left shoulder is higher than the right one are more protracted.

3.3.2 Palpation of pelvis:

- Anterior superior iliac spines: same level
- Posterior superior iliac spines: same level
- Iliac crests: same level

Conclusion: the ASIS are lower than the PSIS as a result that the pelvis is slightly in a position of anteversion. There are no signs of rotation of it.

3.3.3 Breathing stereotype:

- Standing position: involves the lower abdominal wall
- Sitting position: involves lower thoracic part
- Lying position: lower abdominal

Conclusion of breathing stereotype: the patient involves the lower abdominal wall while he's in a standing and lying position. When he sits his lower thoracic cage is mostly involved. The motion is symmetrical as both sides of the thoracic cage expand symmetrically. The same symmetric motion can be noticed in the lower abdominal wall.

3.3.4 Specific testing of posture:

- Two scale standing: right: 42 left: 43
- Romberg test: I, II, III: all negative
- Single leg stance test: right: slight correction left: slight correction
- Trendelenburg sign: right: drop of the pelvis left: physiological
- Velè test: negative

Conclusion of specific testing of posture: the patient has a great weight distribution as it is almost even. The biggest deficit can be seen in the Trendelenburg test on the right side as the pelvis clearly drops. While performing it we can see that the lumbar spine bends to the right side. While standing on the right leg the corrections he makes are minimal but still noticeable. The same situation repeats on the left leg.

3.3.5 Modification of standing:

- Standing on tiptoes: able
- Standing on heels: able

Conclusion: the patient can perform both tasks with no complications.

3.3.6 Anthropometric measurements:

Table 1-anthropometric measurements:

Measurement of:		
Height in standing:	188 cm	
Height in sitting:	93cm	
Arm spam:	188cm	
	Right leg:	Left leg:
Anatomical:	98cm	96cm
Functional:	88cm	88cm
Length of thigh:	46cm	46cm
Length of calf:	46cm	47cm
Foot:	26cm	26.5cm
Circumference of thigh:		
15 cm above knee cap:	46cm	53cm
10 cm above knee cap:	41.5cm	40.5cm
Circumference of the knee:	41.5cm	39.5cm
Circumference of the calves:	38cm	39cm
Circumference of the ankle:	26cm	27cm
Circumference of the foot:	26cm	25.5cm

Conclusion of anthropometric measurements: as shown by the results we can find discrepancies between the two examined lower limbs. The circumference of the right thigh is clearly smaller if compared to the left one. The right knee circumference is slightly bigger as some oedema is still present in the soft tissue.

3.3.7 Gait examination:

The patient walks without any help or assistive device. The weight distribution happens mainly on the medial aspect of the feet as both arches are slightly collapsed medially. The heel phase is merely visible due to weakness of ankle flexors. The right knee does not flex as much as the left knee due to limited ROM. Extension of the right knee follows the same fashion as the knee never fully extends. Right hip circumduction is visible as a side effect of lack of right knee flexion. The motion of the spine is fluent, moreover he's able to keep an erected posture while walking. The rhythm of the gait is not harmonic as he still spends more time of his left leg. The stride length is good but not exactly rhythmical. The motion of upper extremities is fluent, it follows rhythmically the one of lower extremities. The activation of abdominal muscles is physiological, I notice a protracted position of both shoulders and slight elevation of the left one. He feels slight discomfort in his right hip due to repetitive circumduction while walking.

3.3.8 Modification of gait:

- Walking on narrow basis: able, good stability
- Walking on soft surfaces: able, good stability
- Walk with eyes closed: able, good stability
- Walk backwards: able, good stability, no flexion of the right knee
- Walk on tiptoes: able, good stability
- Walk on heels: able, good stability
- Walk in squatting: able, right knee can't flex as much as left knee

Conclusion of modification of gait: the patient is able to perform every task with no pain. While walking in squatting position his right knee can't reach maximum flexion so the motion happens with both knees flexed at about 80°.

3.3.9 Measurement of ROM, goniometry:

Table 2-measurement of ROM, goniometry

Motion:	Right side: Active/ Passive	Left side: Active/ Passive
Ankle PF:	50°/ 45°	50°/ 45°
Ankle DF:	20°/ 25°	20°/ 25°
Ankle inversion:	40°/ 40°	40°/ 45°
Ankle eversion:	20°/ 25°	20°/ 25°
Knee flexion:	100°/ 105°	140°/ 145°
Knee extension:	5°/ 0°	0°/ 0°
Hip IR:	30°/ 40°	35°/ 35°
Hip ER:	40°/ 50°	40°/ 50°
Hip ADD:	30°/ 30°	30°/ 30°
Hip ABD:	50°/ 50°	50°/50°
Hip flexion:	110°/ 120°	115°/ 130°
Hip extension:	20°/ 30°	20°/30°

Conclusion of goniometry: the patient was able to perform all the required movements with no pain except when providing right knee flexion which caused him a bit of discomfort. The results show a limited ROM of the right knee into flexion and a limited extension of the same knee. Hip IR and ER are slightly limited as well. The rest of the results are physiological.

3.3.10 Muscle length test (According to Kendall and Janda):

Table 3-muscle length test (According to Kendall and Janda)

Muscle:	Right:	Left:	Kendall/ Janda
Gastrocnemius:	G-0	G-0	Acc. Janda
Soleus:	G-0	G-0	Acc. Janda
Hip flexors:			
One joint muscle:	Slight shortness	No shortness	Acc. Kendall
Two joint muscles:	Slight shortness	No shortness	Acc. Kendall
Hip adductors:	G-0	G-0	Acc. Janda
Hamstring:	G-0	G-0	Acc. Janda
Paravertebral muscles:	G-2		
Piriformis:	G-0	G-0	Acc. Janda

Conclusion of muscle length test: both one joint and two joint hip muscles are shorted on his right leg. While performing the test for the two joint flexors on the left leg the patient had problem to fully bend his right knee due to pain. The test for hamstring was slightly modified on his right leg as he had to flex his knee by 5 degrees. The paravertebral muscles are clearly shorted as the distance between knees and forehead was more than 20cm.

3.3.11 Muscle tone palpation (According to Lewit):

Table 4-muscle tone palpation (According to Lewit)

Muscle:	Right:	Left:
Iliacus:	Hypotonic	Normal tone
Hamstring:	Hypotonic	Normal tone
Piriformis:	Normal tone	Normal tone
Adductors:	Normal tone	Normal tone
Gluteal muscles:	Hypotonic	Normal tone
Rectus femoris:	Hypotonic	Hypertonic
Tensor fasciae latae:	Hypotonic	Normal tone
Gastrocnemius:	Hypotonic	Hypertonic
Soleus:	Hypotonic	Hypertonic

Conclusion of muscle tone palpation: the results show that almost every muscle of the right lower extremity is hypotonic. Piriformis and hip adductors of the right lower limb have a normal tone. On the left lower limb we can state that calf muscles and rectus femoris are hypertonic.

3.3.12 Muscle strength test of lower extremities (According to Kendall):

Table 5-muscle strength test of lower extremities (According to Kendall)

Muscle:	Right:	Left:
Gluteus maximus:	Grade 4	Grade 5
Iliopsoas:	Grade 4	Grade 5
Sartorius:	Grade 4+	Grade 5
Tensor fasciae latae:	Grade 4	Grade 5
Quadriceps femoris:	Grade 4-	Grade 5
Hip flexors as a group:	Grade 4-	Grade 5
Hip adductors:	Grade 4	Grade 5
Gluteus minimus:	Grade 4-	Grade 5
Glutes medius:	Grade 4-	Grade 5
Lateral rotators:	Grade 4-	Grade 5
Medial rotators:	Grade 4	Grade 5
Lateral hamstring:	Grade 4-	Grade 5
Medial hamstring:	Grade 4-	Grade 5
Popliteus:	Grade 4-	Grade 5
Ankle plantar flexors:	Grade 4+	Grade 5
Soleus:	Grade 4+	Grade 5
Peroneus longus:	Grade 4+	Grade 5
Peroneus brevis:	Grade 4+	Grade 5
Tibial anterior:	Grade 4+	Grade 5
Tibialis posterior:	Grade 4+	Grade 5

Conclusion of muscle strength test: the results show that there was no found of any major weakness of the right leg muscles. However, the condition of the right lower extremity is lower if compared to the left leg. Pain was felt while testing popliteus and medial rotators of the hip. Same for the testing of quadriceps femoris.

3.3.13 Soft tissue and fascia examination (According to Lewit):

- Thigh: no restriction was present in both lower extremities
- Knee: restriction was felt on the operated knee (right). The motion is restricted when I tried to move the fascia medially and laterally, while in caudal end cranial direction the motion is physiological if compared to the one on the left knee
- Calf: no restriction in both lower extremities
- Ankle: no restriction in both legs
- Scar: the scar has no more stitches but there is limitation in all directions. There is no oedema around the scar and the colour itself is good. The old scars from arthroscopic surgeries have regained their full motion in all directions.

3.3.14 Joint play examination (According to Lewit):

Table 6-joint play examination (According to Lewit)

Examined joint:	Right:	Left:
Patella:	Restriction in caudal and cranial direction. No restriction medially and laterally.	No restriction.
Head of fibula:	Restriction in all direction, hard barrier.	No restriction.
Talocrural:	No restriction.	No restriction.
Subtalar:	No restriction.	No restriction.
Talocalcaneonavicular:	No restriction.	No restriction.
Tarsometatarsal (Lisfranc):	No restriction.	No restriction.
Transvers tarsal (Chopart):	No restriction.	No restriction.

Conclusion of joint play examination: restriction was found only when examination 2 specific joint play, such as right patella and right head of fibula. The former has restriction

in caudal and cranial direction. The latter has all the movements restricted plus the end barrier is hard.

3.3.15 Movement stereotype:

Table 7-movement stereotype

Movement:	Right:	Left:
Hip extension:	The activation of muscles is not physiological. Moreover, the movement begins with anteversion of the pelvis.	The motion begins with anteversion of the pelvis, muscles activation is good.
Hip abduction:	Elevation of the pelvis happens first followed by abduction of the hip. Hyperactivation of ipsilateral paravertebral is visible. Muscle activation is not physiological.	The muscles activation is better if compared to the right side. There's no elevation of pelvis and the motion mainly happens at the hip level.

3.3.16 Neurological examination:

Table 8-neurological examination

Dermatome:	Right:	Left:
L1 segment:	Sensation is normal	Sensation is normal
L2 segment:	Sensation is normal	Sensation is normal
L3 segment:	Sensation is normal	Sensation is normal
L4 segment:	Sensation is normal	Sensation is normal
L5 segment:	Sensation is normal	Sensation is normal
S1 segment:	Sensation is normal	Sensation is normal
S2 segment:	Sensation is normal	Sensation is normal

Conclusion of neurological examination: the patient has normal sensation in all the dermatomes of lower extremities except in the lateral part of the knee where the sensation is decreased due to the scar.

Notes: the area around the scar has lost a bit of sensation, this decrease the feeling of possible pain.

3.3.17 Conclusion of initial kinesiological examination:

According to my examination and the results obtained I conclude that the patient is mainly suffering from a loss of knee function, especially caused by muscle weakness which involves the muscles of his right leg. This muscle weakness is caused by the reconstruction of his right ACL and the following resting period. During postural examination I could notice how his right knee never fully extends but stays in a semi-flexed position. Both feet arches are collapsed medially, and a large difference of the lower limb muscles is visible when the two legs are compared. The left shoulder is clearly higher than the right one which scapula is more dorsally prominent. The pelvis is slightly anteriorly tilted with an accent of his lumbar lordosis. During the single leg stance, specifically when standing on his right leg, the patient was not able to keep a perfect balance, instead he had to continuously correct his stance in order to provide the full test. The same situation was visible on his left leg. The biggest deficit can be seen in the Trendelenburg test on the right side as the pelvis clearly drops. While performing it we can see that the lumbar spine bends to the right side. As shown by the anthropometric measurements the biggest noticeable deficit is found in his right leg. Here the results show that both his right thigh and calf muscles are clearly smaller in circumference if compared to the left leg muscles. A small yet noticeable discrepancy is to be found in his right knee circumference which is bigger than the right one due to oedema. The patient is able to walk in every different surface with a bit of struggle while walking backwards due to lack of right knee flexion. As the gait examination shows the patient mainly load his body weight in the medial aspect of his feet. Right hip circumduction helps him to bring his right limb forward during the gait causing the right knee to never fully extend rather staying in a semi-flexed position. The gait is not rhythmical as he spends more time on his left leg. The stride length is good, yet not rhythmic. The motion of upper extremities is physiological and follows the rhythm of lower limbs. ROM examination shows physiological results except for the knee. His right knee flexion is limited by 35°- 40° as well as the extension by 5°. Muscle shortness can be seen in one and two joint hip flexors on his right leg as the posterior thigh never touches the table and the knee slightly extends. Paravertebral muscles are heavily shortened as the distance between knee and forehead is more than 20cm. The overall result of muscle tone shows hypotonicity of right leg muscles. Right piriformis and rectus femoris are hypertonic. Muscle strength test results show that the overall condition of the right leg is lower than the left. However no major

weaknesses were to be found. The soft tissue of the right knee is limited in medial and lateral direction. The scar motion is till limited in all direction although the colour it self is good with no presence of oedema. Joint play examination shows decreased mobility of right patella in cranial and caudal direction. The right head of fibula mobility is restricted in all directions as well. The movement stereotype shows that both hip extension and abduction movements begin with pelvis motion. The muscle activation is not physiological on the right side while the left side shows some improvement. The neurological examination is physiological except the superficial sensation on the lateral side of the right knee which is decreased.

3.4 Short-term and long-term rehabilitation plan:

Short-term rehabilitation plan:

- Increase ROM of the right knee in flexion and extension
- Decrease pain in the right knee
- Increase stability of the right knee
- Increase muscle strength of the right lower limb especially knee flexors and extensors muscles
- Restore joint play where restricted
- Improve proprioception of right lower limb
- Optimize weight bearing of the lower extremities
- Increase muscle endurance for challenging exercises
- Improve mobility of the scar
- Relax hypertonic muscles

Long-term rehabilitation plan:

- Continue to regain muscle strength of the lower extremities as well as knee stability
- Improve patient's confidence of his right knee
- Decrease possibilities of further injuries by increasing dynamic stability of right knee during dynamic exercises
- Restore full ROM of right knee
- Return of the patient to his favourite activities

3.5 Therapy progress:

1st therapeutic unit (22.01.2019)

Goals of today's therapy:

- Soft tissue technique for lymph drainage and scar
- Increase ROM of right knee
- Relaxation of hypertonic muscles
- Stretch hypertonic muscles
- Increase muscle strength of hypotonic muscles

Procedure of today's therapy:

- Soft tissue technique with soft ball on the right lower limb in a cranial direction for lymph drainage (15 repetitions).
- Scar therapy by using soft tissue techniques (S-wave and C-wave).
- Patient is supine with flexed knees and supported trunk of the headrest of the treatment table. Active isometric adduction of lower limbs by placing a soft ball between the knees combined with active isotonic abduction with TheraBand placed around the knees to create resistance. The patient is asked to provide both movements slowly, 10 repetitions for adduction, 10 for abduction.
- PIR for rectus femoris on the right leg. The patient is lying supine with his left leg flexed so to bring it to the chest. The right leg rest on the treatment table with the knee protruding from it. He's asked to extend the knee, hold it, breath in and slowly breath out and let the knee fall back again. Each procedure last 1 minute for a total of 3 repetitions.
- Active extension and flexion of the right knee by placing a soft-ball under his ipsilateral heel. The patient was lying supine with his trunk resting on the headrest of the treatment table with both of his legs extended. He was instructed to do the movement avoiding the knee to drop medially and laterally. Each movement was repeated 10 times.
- Active isometric extension of the right knee by placing a soft-ball under his ipsilateral knee. The patient was in lying supine with his trunk resting on the headrest of the treatment table. 10 repetitions. This exercise was to increase strength of quadriceps femoris muscle.

- PIR for hip abductors on the right leg. Patient is side lying with the leg to be treated (right) upward. His left leg is flexed so to bring it to the chest. The right leg is resting on the treatment table at hip level. From this position the patient is asked to abduct his right leg hold it, breath in, hold it and slowly breath out and let the leg fall back again. Each procedure last 1 minute for a total of 3 repetitions.
- PIR for gastrocnemius on the right calf. The patient is lying supine with both ankles coming out of the treatment table. I applied pressure with my thigh on his right ankle in order to produce dorsi-flexion. With my right hand I stabilize the tibia while with my left hand I stabilize the foot. I ask the patient to increase the pressure on my thigh by actively plantar-flexing his right ankle. From this position he breaths in, hold the breath and position for about 10 seconds, breaths out and relax to increase dorsi-flexion. Each procedure is repeated 3 times.
- Active extension of right hip while lying prone. The patient was asked to produce a movement as pure as possible as hip extension with no involvement of pelvis movement. (10 repetitions).
- Active abduction of right hip while side lying. Again, the movement the patient was asked to produce shouldn't involve the motion of the pelvis. To increase the stability, I've instructed the patient to flex his underneath leg and to rest his trunk on his flexed arm. (10 repetitions).
- Active stretching of hamstring, adductors and abductors of the right leg in supine position with extended knee with the help of a rope. The patient placed the rope around his ipsilateral foot arch and dragged the leg upward midway to stretch the hamstring. Once reached this position he held it for 10 seconds and then went back to starting position. (10 repetitions). For abductors he dragged the leg midway in adduction with extended knee, once reached the position he held it for 10 seconds and then came back to starting position. (10 repetitions). For adductors the same motion is repeated but leg falls to the side in abduction. The same procedure described above is repeated. (10 repetitions).
- Active stretching of right quadriceps femoris in prone position with flexed knee by placing a rope on the ipsilateral foot arch. The patient was actively pulling the rope with his ipsilateral hand to engage the barrier and stretch the muscle. He was instructed to use PIR principle so once he reached the position ha was increasing

pressure in the direction of knee extension, breath in, hold it, breath out and relax so to increase knee flexion. (10 repetitions).

Results of today's therapy unit:

Objective:

- Scar tissue still stiff, motion is restricted in all directions.
- Right knee flexion is limited, evaluated by eyesight.
- Quadriceps femoris is hypotonic.
- Right knee extension doesn't reach the full ROM.
- Overall right leg muscle condition is poor.
- Fascia around the right knee lack of medial and lateral movement.

Subjective:

- Patient feels pain in the right knee if we try to push further in both flexion and extension.
- The patient felt unable to reach full relaxation during therapy to increase knee flexion and extension but by the end of the therapy his relaxation was better so we could stretch the movements a bit further.
- Patient felt weakness during the exercises involving knee flexion and extension.

2nd therapeutic unit (23.01.2019)

Goals of today's therapy:

- Stretching of hypertonic muscles
- Scar therapy
- Soft tissue techniques for lymph drainage and right knee fascia
- Relaxation of hypertonic muscles

Procedure of today's therapy:

- Scar therapy by using soft tissue techniques (S-wave and C-wave).
- Soft tissue technique with soft ball on the right lower limb in a cranial direction for lymph drainage for 5 minutes with the patient lying supine.
- PIR principle for the following right leg muscles by following the methodology described in the previous therapy session:

- Rectus femoris, (3 repetitions)
- Gastrocnemius, (3 repetitions)
- Hip abductors, (3 repetitions)
- Active stretching of hamstring, abductors, adductors and quadriceps femoris of the right leg by following the procedure described in the previous therapeutic session with the help of a rope. (10 repetitions).

Results of today's therapy unit:

Objective:

- Scar tissue begins to release itself.
- Rectus femoris, gastrocnemius and hip abductors were successfully relaxed after PIR principle was applied.
- Active stretching makes the patient feel release in his hypertonic muscles
- Knee flexion and extension are still limited, evaluated by eyesight.

Subjective:

- Patient has slight discomfort on his right hip due to his wrong walking stereotype which involve right hip circumduction.
- The area around the scar has some limitations in both motion and sensation.
- Active stretching makes the patient feel release in his hypertonic muscles

3rd therapy unit (24.01.2019)

Goals of today's therapy:

- Release the scar tissue for better mobility.
- Increase strength and resistance of knee flexors and extensors of the right lower extremity.
- Increase stability of the right knee by training on unstable surfaces.
- Stretching and relaxation techniques for hypertonic and shorted muscles of the right lower leg, especially hamstring, abductors and adductors.
- Increase core strength.

Procedure of today's therapy:

- Scar therapy by using soft tissue techniques (S-wave and C-wave).
- Soft tissue technique with soft ball on the right lower limb in a cranial direction for lymph drainage for 5 minutes with the patient lying supine.
- Stationary bike: 5 minutes cycling against low intensity with low speed. The height of the seat was adjusted so to reach adequate knee flexion and extension.
- Stepper: 5 minutes on the machine which simulates stepping up a ramp of stairs. The intensity was kept low as well as the speed.
- Sensomotoric training:
 - Single leg tandem standing on Bosu balance board. The patient was standing one meter away from the unstable Bosu balance board. From this position he was stepping with one leg on it so to balance himself and to load most of his body weight on that leg. Once reached the position he was asked to keep it for 10 seconds and keep an upright position of his chest. (10 repetitions for each leg).
 - Single leg tandem stance on Posturomed unstable surface. This exercise followed the same instructions as the one described before. (10 repetitions for each leg).
 - Single leg stance on Posturomed unstable surface. Patient was standing on the unstable surface lifting one leg at the time and keeping the position with less corrections as possible for 10 seconds. (10 repetitions for each leg).
 - Walking on unstable surfaces: the path was set with 15 different unstable pads each of them put 30cm from one another. The patient was asked to walk through them and on each station to keep the single leg stance position for 10 seconds with his other leg semi-flexed. Each path was repeated 2 times.
 - Strengthening of hamstring in supine position with a soft ball placed between the flexed knees and feet resting on an oval gym ball. From this position the patient was asked to raise his pelvis slowly up and to keep an equal weight distribution on both of his feet. (10 repetitions for 3 sets).

- Active stretching of hamstring, abductors, adductors and quadriceps femoris of the right leg by following the procedure described in the previous therapeutic session with the help of a rope. (10 repetitions).

Results of today's therapy unit:

Objective:

- Knee flexion and extension remain the same, evaluated by eyesight.
- The scar tissue is softer and it's easy to move it in all directions.
- The stability of his right knee did not increase much.
- He feels better stability in his right leg after he was instructed how to provide the exercises in the correct way.

Subjective:

- The patient was feeling good after this series of active exercise focused to increase his lower extremities strength.
- Patient is highly motivated about this kind of exercises and he's willing to continue work hard.
- Patient feels muscle soreness on his right lower extremity after the sets of exercises.

4th therapy unit (25.01.2019)

Goals of today's therapy:

- Increase muscle strength of right leg muscles.
- Increase strength and resistance of knee flexors and extensors of the right lower extremity.
- Increase of mobility of the right head of fibula in all directions.
- Stretching of hypertonic muscles of right lower extremity.

Procedure of today's therapy:

- Mobilization of right head of fibula in all directions, medial, lateral, cranial and caudal. I've repeated each movement 10 times.
- Mobilization of right patella in all directions. Each movement was repeated 10 times.

- Stationary bike: 5 minutes cycling against medium intensity with medium speed. The height of the seat was adjusted so to reach adequate knee flexion and extension.
- Stepper: 5 minutes on the machine which simulates stepping up a ramp of stairs. Medium intensity and speed.
- Sensomotoric training:
 - Walking on unstable surfaces with 2kg medicine ball in hands: the path was set with 15 different unstable pads each of them put 30cm from one another. The patient was asked to walk through them and on each station to keep the single leg stance position for 10 seconds with his other leg semi-flexed. At this point the patient was passing the medicine ball through his semi-flexed leg and behind his back. Each path was repeated 2 times.
 - Walk on narrow rope with 2kg medicine ball in hands. (6 repetitions of the path).
 - Single leg tandem standing on Bosu balance board with 2kg medicine ball in hands. The patient was standing one meter away from the unstable Bosu balance board. From this position he was stepping with one leg on it so to balance himself and to load most of his body weight on that leg. Once reached the position he was asked to keep it for 10 seconds and to move diagonally the medicine ball with his arms. (10 repetitions for each leg for 3 sets).
 - Single leg tandem stance on Posturomed unstable surface with 2kg medicine ball passes. The patient was stepping with one leg on it so to balance himself and to load most of his body weight on that leg. From this position I was passing him the medicine ball as he was asked to maintain his erected posture while catching it. (3 repetitions for each leg, each time 10 passes).
- Squatting with gym ball behind his back between him and the wall. Squat exercise until 90° of flexion of the knee. (3 sets, 10 repetitions).
- Side squatting with Theraband around the knees to create resistance for abduction. The patient was asked to provide the movement whit his trunk erected, knees

flexed at 80°. One set was composed by him taking 5 steps to the right and back 5 steps to the left. Each set was repeated 4 times.

- Strengthening of hamstring in supine position with a soft ball placed between the flexed knees and feet resting on an oval gym ball. From this position the patient was asked to raise his pelvis slowly up and to keep an equal weight distribution on both of his feet. (10 repetitions for 3 sets).
- Active stretching of hamstring, adductors and abductors of the right leg in supine position with extended knee with the help of a rope. The patient placed the rope around his ipsilateral foot arch and dragged the leg upward midway to stretch the hamstring. Once reached this position he held it for 10 seconds and then went back to starting position. (10 repetitions). For abductors he dragged the leg midway in adduction with extended knee, once reached the position he held it for 10 seconds and then came back to starting position. (10 repetitions). For adductors the same motion is repeated but leg falls to the side in abduction. The same procedure described above is repeated. (10 repetitions).
- Active stretching of right quadriceps femoris in prone position with flexed knee by placing a rope on the ipsilateral foot arch. The patient was actively pulling the rope with his ipsilateral hand to engage the barrier and stretch the muscle. He was instructed to use PIR principle so once he reached the position he was increasing pressure in the direction of knee extension, breath in, hold it, breath out and relax so to increase knee flexion. (10 repetitions).

Results of today's therapy unit:

Objective:

- The mobilization of right head of fibula was successfully increased while the right patella mobility remains limited in medial and later direction.
- The patient has discomfort feeling in his right hip due the wrong gait pattern he's assuming which involves circumduction of the right knee due to lack of right knee flexion.
- Right knee ROM remains the same, evaluated by eyesight.

Subjective:

- His right leg muscles are sore as we worked on them with weight bearing exercises as well as Sensomotoric exercises.
- His right knee stability has slightly increased as he was making less corrections during the single leg stance exercises.
- He feels his right knee is more reliable and stable while walking on unstable surfaces.

5ht therapy unit (28.01.2019)**Goals of today's therapy:**

- Strengthening of right knee flexors and extensors as well as gluteal muscles.
- Increase stability of the right knee through Sensomotoric training.
- Increase mobility of the scar.
- Relaxation and stretching of knee flexors, extensors, adductors and abductors.
- Increase mobility of right head of fibula in all directions.

Procedure of today's therapy:

- Mobilization of right hip joint in the direction of femoral neck with the patient lying supine. Traction was applied along the axis of the head of femur. PIR principle was combined. (5 repetitions).
- Soft tissue technique with soft ball on the right lower limb in a cranial direction for lymph drainage (15 repetitions).
- Scar therapy by using soft tissue techniques (S-wave and C-wave).
- Stationary bike for 5 minutes, medium intensity combined with medium-high speed.
- Stepper: 5 minutes on the machine which simulates stepping up a ramp of stairs. Medium-high intensity, speed was increased as well.
- Strengthening of hamstring by using TRX suspension training system. The patient was lying supine, he placed both of his heels on the end-hook part of the TRX cables to support them about 40cm from the ground with extended knee. From this position he was asked to raise his pelvis from the ground about 20cm and flex one leg at a time so to bring it towards the chest then coming back to the starting

position with elevated pelvis. Each of the three sets included 5 leg flexions on each side.

- Squatting with gym ball behind his back between him and the wall. Squat exercise until 90° of flexion of the knee combined with 3kg medicine in hands. (3 sets, 10 repetitions).
- Sensomotoric training:
 - Single leg tandem standing on Bosu balance board with 2kg medicine ball in hands. The patient was standing one meter away from the unstable Bosu balance board. From this position he was stepping with one leg on it so to balance himself and to load most of his body weight on that leg. Once he reached the position, he was asked to keep it for 10 seconds and to move diagonally the medicine ball with his arms. (10 repetitions for each leg for 3 sets).
- Side squatting with Theraband around the knees to create resistance for abduction. The patient was asked to provide the movement with his trunk erected, knees flexed at 80°. One set was composed by him taking 5 steps to the right and back 5 steps to the left. Each set was repeated 4 times.
- Strengthening of calf muscles. Patient was supporting his body on the bar in front of him and standing with one foot on a step so to increase dorsiflexion on the ankle. From this position he was providing active plantarflexion so to raise his body and activating the calf muscles. (3 sets, 10 repetitions for each leg).

Results of today's therapy unit:

Objective:

- Right hip was successfully relaxed after the traction was applied.
- ROM of the knee increased, passively I could reach 118° of flexion with no pain.
- Stability of the right knee increased as he's correcting less his posture during Sensomotoric exercises which became more difficult and demanding.
- The scar mobility is increasing in each direction.

Subjective:

- He has no pain in the right knee even if discomfort in the right hip is still present.
- Patient felt good about the therapy applied even if today he struggled more due to muscle weakness. This may be caused by the walk he had during the weekend which overused his muscles.

6th therapy unit (29.01.2019)**Goals of today's therapy:**

- Increase strength and endurance of muscles of lower extremities, especially knee flexors and extensors.
- Increase mobility of the scar tissue in all directions.
- Increase stability and strength of core muscles.
- Stretching of hamstring, adductors and abductors.

Procedure of today's therapy:

- Soft tissue technique with soft ball on the right lower limb in a cranial direction for lymph drainage (15 repetitions).
- Scar therapy by using soft tissue techniques (S-wave and C-wave).
- PIR for right quadriceps femoris in prone position. I was passively flexing the knee to engage the barrier, from this position the patient was asked to resist me in the direction of knee extension. Once the barrier was reached, he was asked to keep the position for 10 seconds, breath in deeply, hold it, breath out and let the knee flex more. (3 repetitions).
- Stationary bike for 5 minutes, medium intensity combined with medium-high speed.
- Stepper: 5 minutes on the machine which simulates stepping up a ramp of stairs. Medium-high intensity, speed was increased as well.
- Strengthening of hamstring by using TRX suspension training system. The patient was lying supine, he placed both of his heels on the end-hook part of the TRX cables to support them about 40cm from the ground with extended knee. From this position he was asked to raise his pelvis from the ground about 20cm and flex

one leg at a time so to bring it towards the chest then coming back to the starting position with elevated pelvis. Each of the three sets included 5 leg flexions on each side.

- Plank exercise for core muscles. Patient was in plank position for 40 seconds. (3 repetitions).
- Side plank exercise to increase core stability. Side plank position held for 40 seconds on both sides. (3 repetitions each side).
- Leg curl machine for hamstrings. Active flexion of the right knee to increase muscle strength of hamstrings. (3 sets for 10 repetitions with 10kg).
- Leg extensions machine. Active right knee extension to increase muscle strength of knee extensors muscles. (3 sets for 10 repetitions with 10kg).
- Stretching for hamstring, adductors, abductors and quadriceps femoris of the right leg with the help of a rope. Each technique was described in the previous therapy sessions.

Results of today's therapy unit:

Objective:

- Right knee extensors are still weak as during the leg extension exercises the whole muscle group was shaking.
- Core stability and strength is good as the patient was able to keep the plank position with small corrections.
- Scar tissue movement keep increasing even if superficial sensation is not physiological yet.
- Right knee flexions increase as was measured to 120°.

Subjective:

- The patient was disappointed at the leg extension machine as his right knee extensors were shaking while providing the exercise.
- He feels discomfort in his right hip due to circumduction while walking.
- His right leg muscles are sore as we worked on them with isotonic exercises on the machines.

7th therapy unit (30.01.2019)

Goals of today's therapy:

- Decrease discomfort feeling in the right hip.
- Increase mobility of right head of fibula.
- Increase strength and endurance of muscles of lower extremities, especially knee flexors and extensors.
- Increase stability of the right knee with Sensomotoric exercises.

Procedure of today's therapy:

- Mobilization of right hip joint in the direction of femoral neck with the patient lying supine. Traction was applied along the axis of the head of femur. PIR principle was combined. (5 repetitions).
- Mobilization of right head of fibula in all directions, medial, lateral, cranial and caudal. I've repeated each movement 10 times.
- Mobilization of right patella in all directions. Each movement was repeated 10 times.
- Stationary bike for 5 minutes, 80% intensity combined with medium-high speed.
- Squatting with gym ball behind his back between him and the wall. Squat exercise until 90° of flexion of the knee combined with 4kg medicine in hands after each squat the patient was asked to raise the medicine ball over his head to activate core muscles. (3 sets, 10 repetitions).
- Stepper: 5 minutes on the machine which simulates stepping up a ramp of stairs. Medium-high intensity, speed was increased as well.
- Single leg tandem standing on Bosu balance board with 2kg medicine ball in hands. The patient was standing one meter away from the unstable Bosu balance board. From this position he was stepping with one leg on it so to balance himself and to load most of his body weight on that leg. Once reached the position he was asked to keep it for 10 seconds and to move diagonally the medicine ball with his arms. (10 repetitions for each leg for 3 sets).
- Leg curl machine for hamstrings. Active flexion of the right knee to increase muscle strength of hamstrings. (3 sets for 10 repetitions with 10kg).
- Leg extensions machine. Active right knee extension to increase muscle strength of knee extensors muscles. (3 sets for 10 repetitions with 10kg).

- Strengthening of hamstring by using TRX suspension training system. The patient was lying supine, he placed both of his heels on the end-hook part of the TRX cables to support them about 40cm from the ground with extended knee. From this position he was asked to raise his pelvis from the ground about 20cm and flex one leg at a time so to bring it towards the chest then coming back to the starting position with elevated pelvis. Each of the three sets included 5 leg flexions on each side.
- Strengthening of hamstring in supine position with a soft ball placed between the flexed knees and feet resting on an oval gym ball. From this position the patient was asked to raise his pelvis slowly up and to keep an equal weight distribution on both of his feet. (10 repetitions for 3 sets).
- Active stretching of hamstring, abductors, adductors and quadriceps femoris of the right leg by following the procedure described in the previous therapeutic sessions with the help of a rope. (10 repetitions for each muscle).

Results of today's therapy unit:

Objective:

- Right knee extensors had a better respond to the leg extension machine as this time the movement was provided with just minimal shaking.
- Stability of the right knee is better, less corrections were made during the Sensomotoric exercises.
- Patient had a better resistance during the exercises.
- During the squat exercises the patient increased the flexion of both knee by 10°.

Subjective:

- Patient was motivated by seeing the improvement of the quality of the exercises he was asked to do, especially the leg extension machine.
- He had a abetter feeling in his right knee especially about his stability.
- His feeling of discomfort decreased as the traction technique was successfully applied.

8th therapy unit (31.01.2019)

Goals of today's therapy

- Stimulate right lower limb lymphatic drainage by the mean of soft ball.
- Increase mobility of scar tissue.
- Increase strength and resistance of right lower limb by the mean of active analytic exercises.
- Increase overall stability of the right knee.
- Free mobility of right patella and head of fibula.

Procedure of today's therapy:

- Soft tissue technique with soft ball on the right lower limb in a cranial direction for lymph drainage (15 repetitions).
- Scar therapy by using soft tissue techniques (S-wave and C-wave).
- Mobilization of right head of fibula in all directions, medial, lateral, cranial and caudal. I've repeated each movement 10 times.
- Mobilization of right patella in all directions. Each movement was repeated 10 times.
- PIR for right quadriceps femoris in prone position. I was passively flexing the knee to engage the barrier, from this position the patient was asked to resist me in the direction of knee extension. Once the barrier was reached he was asked to keep the position for 10 seconds, breath in deeply, hold it, breath out and let the knee flex more. (3 repetitions).
- Stationary bike for 5 minutes, 80% intensity combined with medium-high speed.
- Stepper: 5 minutes on the machine which simulates stepping up a ramp of stairs. Medium-high intensity, speed was increased as well.
- Leg extensions machine. Active right knee extension to increase muscle strength of knee extensors muscles. (3 sets for 10 repetitions with 10kg).
- Sensomotoric exercises:
 - Single leg tandem standing on Bosu balance board with 2kg medicine ball passes. The patient was standing one meter away from the unstable Bosu balance board. From this position he was stepping with one leg on it so to balance himself and to load most of his body weight on that leg. Once

reached the position he was asked to accept 5 passes, then to go back to the starting position. (10 repetitions for each leg for 3 sets).

- Walk on narrow rope with 3kg medicine ball in hands. The rope was about 2 meters long. At each step the patient was asked to move the medicine ball diagonally in both directions to increase core muscles activation. (6 repetitions of the path).
- Walking on unstable surfaces with 3kg medicine ball in hands: the path was set with 15 different unstable pads each of them put 30cm from one another. The patient was asked to walk through them and on each station to keep the single leg stance position for 10 seconds with his other leg semi-flexed. At this point the patient was passing the medicine ball through his semi-flexed leg and behind his back. Each path was repeated 2 times.
- Side squatting with Theraband around the knees to create resistance for abduction. The patient was asked to provide the movement with his trunk erected, knees flexed at 80°. One set was composed by him taking 5 steps to the right and back 5 steps to the left. Each set was repeated 4 times.
- Active stretching of hamstring, abductors, adductors and quadriceps femoris of the right leg by following the procedure described in the previous therapeutic sessions with the help of a rope. (10 repetitions for each muscle).

Results of today's therapy unit:

Objective:

- Right knee stability is better. During the Sensomotoric training less corrections were made to keep a correct and erected posture.
- Right lower limb knee flexors and extensors are still weak as the analytic exercises were demanding for the Patient.
- Core stability and strength is good as the patient was able to keep an erected position with small corrections during the Sensomotoric exercises.

Subjective:

- The patient felt muscle fatigue half way through the therapy session due to the amount of analytic exercises we've been doing during the week. To complete the whole set was more demanding than the other days.
- He has a better feeling of his right knee extensors as the quality of exercises was better than before.
- He has slight pain in the posterior aspect of his right knee.

3.6 Final kinesiological examination

3.6.1 Postural examination:

Posterior view:

- The base of support is somehow narrow
- Shape of the heels: symmetrical
- Shape and position of the ankle joint: symmetrical
- Achilles tendon: thickness and shape are symmetrical
- Contour of the calf muscles: right calf is smaller
- Position of the knee joint: symmetrical
- Popliteal lines: symmetrical
- Contour of thigh muscles: right muscles are less prominent
- Subgluteal line: symmetrical
- Gluteal muscles: symmetrical
- Position of the pelvis: even
- Position of the scapula: right scapula is more dorsally prominent
- Position of the shoulder: left shoulder is higher
- Position of the head: physiological position

Anterior view:

- Base of support: narrower than physiological
- Arches: slightly medially collapsed, both symmetrical
- Weight distribution: slightly medially
- Shape and position of the knee: both patella face slightly medially
- Contour of calf muscles: right calf muscles are smaller in size
- Shape of the thigh muscles: right quadriceps muscles are smaller in size
- Position of the pelvis: even
- Symmetry of abdominal muscles: symmetric, left and right part
- Position of umbilicus: physiological
- Position of collarbones: left supraclavicular hole is deeper than the right one
- Position of the shoulder girdle: left shoulder is higher than the right one
- Position of the head: symmetrical

Right lateral view:

- Weight distribution: slightly to the medial part of the foot
- Shape of ankle joint: physiological
- Position of the knee joint: the knee is fully extended
- Position of the pelvis: anterior tilted
- Shape of the spine: physiological curves of the spine with slight increase of lumbar lordosis
- Position of the shoulder: protracted
- Position of the head: protracted

Left lateral view:

- Weight distribution: slightly to the medial part of the foot
- Shape of ankle joint: physiological
- Position of the knee joint: physiological
- Position of the pelvis: anterior tilted
- Shape of the spine: physiological curves of the spine with slight increase of lumbar lordosis
- Position of the shoulder: elevation of the shoulder as well as protraction
- Position of the head: protracted

Conclusion of postural examination: both feet arches are slightly collapsed medially as they weight distribution follows their shape to the medial aspect of both feet. Muscle atrophy of the right lower limb is visible if compared to the left. Both knees are now fully extended. The left shoulder is higher than the right one are more protracted.

3.6.2 Palpation of pelvis:

- Anterior superior iliac spines: same level
- Posterior superior iliac spines: same level
- Iliac crests: same level

Conclusion: the ASIS are lower than the PSIS as a result that the pelvis is slightly in a position of anteversion. There are no signs of rotation of it.

3.6.3 Breathing stereotype:

- Standing position: involves the lower abdominal wall
- Sitting position: involves lower thoracic part
- Lying position: lower abdominal

Conclusion of breathing stereotype: the patient involves the lower abdominal wall while he's in a standing and lying position. When he sits his lower thoracic cage is mostly involved. The motion is symmetrical as both sides of the thoracic cage expand symmetrically.

3.6.4 Specific testing of posture:

- Two scale standing: right: 42 left: 43
- Romberg test: I, II, III: all negative
- Single leg stance test: right: slight correction left: slight correction
- Trendelenburg sign: right: slight drop of the pelvis left: physiological
- Velè test: negative

Conclusion of specific testing of posture: the patient has a great weight distribution as it is almost even. A deficit can be seen in the Trendelenburg sign on the right side due to a small drop of the pelvis. While standing on the right leg the corrections he makes are minimal but still noticeable. The same situation repeats on the left leg.

3.6.5 Modification of standing:

- Standing on tiptoes: able
- Standing on heels: able

Conclusion: the patient can perform both tasks with no complications.

3.6.6 Anthropometric measurements:

Table 9-anthropometric measurements

Measurement of:		
Height in standing:	188 cm	
Height in sitting:	93cm	
Arm spam:	188cm	
	Right leg:	Left leg:
Anatomical:	98cm	96cm
Functional:	88cm	88cm
Length of thigh:	46cm	46cm
Length of calf:	46cm	47cm
Foot:	26cm	26.5cm
Circumference of thigh:		
15 cm above knee cap:	47cm	53cm
10 cm above knee cap:	42cm	42.5cm
Circumference of the knee:	41cm	39cm
Circumference of the calves:	38cm	39cm
Circumference of the ankle:	26cm	27cm
Circumference of the foot:	26cm	25.5cm

Conclusion of anthropometric measurements: as shown by the results we can find discrepancies between the two examined lower limbs. The circumference of the right thigh, 15cm from the knee cap, remains smaller in size if compared to the left one. The right knee circumference is slightly bigger as some oedema is still present in the soft tissue.

3.6.7 Gait examination:

The patient walks without any help or assistive device. The weight distribution happens mainly on the medial aspect of the feet as both arches are slightly collapsed medially. Now the heel phase on the right leg is more visible as we strengthened the muscles of the right calf. Right hip circumduction is still visible as his gait stereotype involves it. The motion of the spine is fluent, moreover he's able to keep an erected posture while walking. The rhythm of the gait is now almost harmonic as the time spent on both legs is basically the same. The stride length is good and rhythmical. The motion of upper extremities is fluent. The activation of abdominal muscles is physiological, I notice a protracted position of both shoulders and slight elevation of the left one.

3.6.8 Modification of gait:

- Walking on narrow basis: able, good stability
- Walking on soft surfaces: able, good stability
- Walk with eyes closed: able, good stability
- Walk backwards: able, good stability,
- Walk on tiptoes: able, good stability
- Walk on heels: able, good stability
- Walk in squatting: able, test provided with 80° of knee flexion

Conclusion of modification of gait: the patient is able to perform every task with no pain.

3.6.9 Measurement of ROM, goniometry:

Table 10- measurement of ROM, goniometry

Motion:	Right side: Active/ Passive	Left side: Active/ Passive
Ankle PF:	50°/ 45°	50°/ 45°
Ankle DF:	20°/ 25°	20°/ 25°
Ankle inversion:	40°/ 40°	40°/ 45°
Ankle eversion:	20°/ 25°	20°/ 25°
Knee flexion:	115°/ 125°	140°/ 145°
Knee extension:	0°/ 0°	0°/ 0°
Hip IR:	30°/ 40°	35°/ 35°
Hip ER:	40°/ 50°	40°/ 50°
Hip ADD:	30°/ 30°	30°/ 30°
Hip ABD:	50°/ 50°	50°/50°
Hip flexion:	110°/ 120°	115°/ 130°
Hip extension:	20°/ 30°	20°/30°

Conclusion of goniometry: the patient was able to perform all the required movements with no pain except when providing right knee flexion which caused him a bit of discomfort. The results show a limited flexion of the right which has improved remarkably from the first examination. Right knee extension now reached a physiological result with 0°. Hip IR and ER are slightly limited as well.

3.6.10 Muscle length test (According to Kendall and Janda):

Table 11-muscle length test (According to Kendall and Janda):

Muscle:	Right:	Left:	Kendall/ Janda
Gastrocnemius:	G-0	G-O	Acc. Janda
Soleus:	G-0	G-0	Acc. Janda
Hip flexors:			
One joint muscle:	Slight shortness	No shortness	Acc. Kendall
Two joint muscles:	Slight shortness	No shortness	Acc. Kendall
Hip adductors:	G-0	G-0	Acc. Janda
Hamstring:	G-0	G-0	Acc. Janda
Paravertebral muscles:	G-1		
Piriformis:	G-0	G-0	Acc. Janda

Conclusion of muscle length test: both one joint and two joint hip muscles are slightly shorted on his right leg. Compared to the first examination the shortness has decrease remarkably thanks to the stretching that was applied daily. The paravertebral muscles are clearly shorted as the distance between knees and forehead was more than 15cm.

3.6.11 Muscle tone palpation (According to Lewit):

Table 12-muscle tone palpation (According to Lewit)

Muscle:	Right:	Left:
Iliacus:	Hypotonic	Normal tone
Hamstring:	Normal tone	Normal tone
Piriformis:	Normal tone	Normal tone
Adductors:	Normal tone	Normal tone
Gluteal muscles:	Normal tone	Normal tone
Rectus femoris:	Normal tone	Hypertonic
Tensor fasciae latae:	Normal tone	Normal tone
Gastrocnemius:	Normal tone	Hypertonic
Soleus:	Normal tone	Hypertonic

Conclusion of muscle tone palpation: all the muscles with initial hypotonicity have improved. Now their trophic state is better as the result of efficiency of the therapeutic program.

3.6.12 Muscle strength test of lower extremities (According to Kendall):

Table 13-muscle strength test of lower extremities (According to Kendall)

Muscle:	Right:	Left:
Gluteus maximus:	Grade 4+	Grade 5
Iliopsoas:	Grade 4+	Grade 5
Sartorius:	Grade 4+	Grade 5
Tensor fasciae latae:	Grade 4	Grade 5
Quadriceps femoris:	Grade 4+	Grade 5
Hip flexors as a group:	Grade 4+	Grade 5
Hip adductors:	Grade 4+	Grade 5
Gluteus minimus:	Grade 4+	Grade 5
Glutes medius:	Grade 4+	Grade 5
Lateral rotators:	Grade 4+	Grade 5
Medial rotators:	Grade 4+	Grade 5
Lateral hamstring:	Grade 4+	Grade 5
Medial hamstring:	Grade 4+	Grade 5
Popliteus:	Grade 4+	Grade 5
Ankle plantar flexors:	Grade 5	Grade 5
Soleus:	Grade 5	Grade 5
Peroneus longus:	Grade 5	Grade 5
Peroneus brevis:	Grade 5	Grade 5
Tibial anterior:	Grade 5	Grade 5
Tibialis posterior:	Grade 5	Grade 5

Conclusion of muscle strength test: the results show that there was no found of any major weakness of the right leg muscles. Muscle strength has improved for all the muscles of the right lower extremity. Now minor muscle weakness is to be found in the tensor fasciae latae with a grade of 4.

3.6.13 Soft tissue and fascia examination (According to Lewit):

- Thigh: no restriction was present in both lower extremities
- Knee: during the previous examination restriction was felt in the right knee especially in medial and lateral direction. Now the motion has increased to almost physiological result. In caudal end cranial direction, the motion is physiological.
- Calf: no restriction in both lower extremities
- Ankle: no restriction in both legs
- Scar: the scar gained a lot of movement in all directions thanks to the daily therapy applied on it.

3.6.14 Joint play examination (According to Lewit):

Table 14: joint play examination (According to Lewit)

Examined joint:	Right:	Left:
Patella:	No restriction.	No restriction.
Head of fibula:	No restriction.	No restriction.
Talocrural:	No restriction.	No restriction.
Subtalar:	No restriction.	No restriction.
Talocalcaneonavicular:	No restriction.	No restriction.
Tarsometatarsal (Lisfranc):	No restriction.	No restriction.
Transvers tarsal (Chopart):	No restriction.	No restriction.

Conclusion of joint play examination: results show the efficiency of the therapy. Both right patella and head of fibula motion are now physiological.

3.6.15 Movement stereotype:

Table 15-movement stereotype

Movement:	Right:	Left:
Hip extension:	Good activation of muscles. The movement begins with anterior movement of the pelvis.	The motion begins with anteversion of the pelvis, muscles activation is good.
Hip abduction:	Elevation of the pelvis happens first followed by abduction of the hip. Hyperactivation of ipsilateral paravertebral is visible. Good muscle activation.	Great muscle activation. There's no elevation of pelvis and the motion mainly happens at the hip level.

3.6.16 Neurological examination:

Table 16-neurological examination

Dermatome:	Right:	Left:
L1 segment:	Sensation is normal	Sensation is normal
L2 segment:	Sensation is normal	Sensation is normal
L3 segment:	Sensation is normal	Sensation is normal
L4 segment:	Sensation is normal	Sensation is normal
L5 segment:	Sensation is normal	Sensation is normal
S1 segment:	Sensation is normal	Sensation is normal
S2 segment:	Sensation is normal	Sensation is normal

Conclusion of neurological examination: the patient has normal sensation in all the dermatomes of lower extremities except in the lateral part of the knee where the sensation is decreased due to the scar.

Notes: the area around the scar has lost a bit of sensation.

3.6.17 Conclusion of final kinesiological examination:

As shown by the postural examination the patient was able to reach a better posture while standing, especially by increasing the extension of the right knee to a physiological 0°. His left shoulder was still more elevated than the right one but we couldn't focus on this as our main goal was to restore overall condition of the right leg. The patient's operated right knee now has full extension, however, there is still a deficit in flexion where goniometry shows a maximum of 120° passively. The gait pattern has got better in terms of rhythm and stance length. Now the whole motion is more harmonic with better rhythm, however, right hip circumduction is still a deficit as we were not able to fix it during the therapeutic unit. We can still notice a deficit in the circumference of the thigh and calf muscles where the right musculature is still smaller in size than the left one. Right knee circumference is still greater due to the presence of oedema in the joint. Stability is the field where the patient increased the most. Not he's more aware of his right knee reliability and he loads all his body weight on it with no problem at all. Muscle shortness of one joint and two joint hip flexors decreased thanks the daily stretching routine he was following. Trophic of those muscles which were hypo trophic now increased to a better condition. All muscles now have a physiological condition according to palpation. PIR technique delated abnormal muscle tone and restored full ROM. Ever since the initial kinesiological examination no great deficit was found about the muscle strength of the operated leg. After the therapy sessions the overall condition increased to an almost physiological result. Every muscles score is now 4+ (Acc. to Kendall). Soft tissue of the right knee had a great movement increasement in all directions as now the result is physiological. Joint play of right patella and head of fibula was restored thank to mobilization techniques which were applied almost every therapy session. Movement stereotype of right hip extension and abduction, which initially demonstrated pathological sign now were restored to a physiological patter thank to a better muscle coordination and activation achieved by the analytic exercises of lower extremities. The neurological examination showed the same results as no deficit was found.

3.7 Evaluation of the effect of the therapy:

After 8 therapeutic units the improvement of the patient from a therapeutic point of view was remarkable. The therapy applied did not cause any problem to the patient, however, muscle fatigue was felt due to muscle weakness. Every field had a positive final result. Muscle strength increase of the right leg was remarkable as all the examined muscles improved. Stability was a big factor. For the last 4 therapeutic sessions the patient was able to keep a correct and erected posture with small corrections while providing challenging exercises on the unstable surfaces. The tone of muscles was another important factor as the physiological state was achieved.

Anthropometric measurements:

Table 17-anthropometric measurements changes

Measurement of:		
	Right leg initial:	Right leg final:
Circumference of thigh:		
15 cm above knee cap:	46cm	47cm
10 cm above knee cap:	41.5cm	42cm
Circumference of the knee:	41.5cm	41cm
Circumference of the calves:	38cm	38cm

Measurement of ROM, goniometry:

Table 18-ROM changes

Motion:	Right side: Active/ Passive initial	Right side: Active/ Passive final
Knee flexion:	100°/ 105°	115°/125°
Knee extension:	5°/ 0°	0°/ 0°

Muscle length test (According to Kendall and Janda):

Table 19-muscle length test changes (According to Kendall and Janda):

Muscle:	Right initial:	Right fi	Kendall/ Janda
Hip flexors:			
One joint muscle:	Slight shortness	No shortness	Acc. Kendall
Two joint muscles:	Slight shortness	No shortness	Acc. Kendall

Muscle strength test of lower extremities (According to Kendall):

Table 20-muscle strength test changes of lower extremities (According to Kendall)

Muscle:	Right initial:	Right final:
Gluteus maximus:	Grade 4	Grade 4+
Quadriceps femoris:	Grade 4-	Grade 4+
Hip flexors as a group:	Grade 4-	Grade 4+
Hip adductors:	Grade 4	Grade 4+
Gluteus minimus:	Grade 4-	Grade 4+
Glutes medius:	Grade 4-	Grade 4+
Lateral hamstring:	Grade 4-	Grade 4+
Medial hamstring:	Grade 4-	Grade 4+

Joint play examination (According to Lewit):

Table 21-joint play examination changes (According to Lewit)

Examined joint:	Right initial:	Right final:
Patella:	Restriction in caudal and cranial direction. No restriction medially and laterally.	No restriction.
Head of fibula:	Restriction in all direction, hard barrier.	No restriction.

3.7.1 Prognosis:

The prognosis for the patient will be definitely positive and full of satisfying results. Since the very first therapy unit his improvement was constant and solid. Psychologically the patient is more aware of his right knee's potential and improvement which will help him in the future and in the upcoming therapy.

In the following therapy phase the patient will be asked for more demanding exercises. This will lead him to be back to his sport activity with more safety and better muscle endurance. One key point of the prognosis will be to estimate the future tasks according to the current state of the patient.

I truly believe that the patient will be more and more motivated as he will achieve better results week after week. He will be able to successfully face the following therapy phase with a great attitude and motivation. The stability of the right knee will increase and the risk of possible future injuries will decrease.

4 Conclusion:

After 2 weeks at CLPA I was really satisfied about the system they follow and the lead of my supervisor. Mrs. Gabriela trusted in me and made me work face to face autonomously. I was able to practice my knowledge and at the same time to receive feedbacks from the therapy chief.

I was really satisfied to see the objective results of therapy day after day. My patient was really open minded and ready to put effort in every exercises he was asked to provide. Thanks to his good initial physical condition I was able to set up a plan of active exercises and to elaborate how to increase the difficulty step by step. Every two sessions it was clear what was improved and what was needed to be improved. I really have to thank the patient for his understanding and enthusiasm about the way we approached the therapy.

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6.3 List of abbreviations:

ABD: abduction

ADD: adduction

ACL: anterior cruciate ligament

ER: external rotation

IR: internal rotation

E: extension

F: flexion

DF: dorsiflexion

PL: plantarflexion

ROM: range of motion

6.4 Model inform consent:

INFORMOVANÝ SOUHLAS

Vážená paní, vážený pane,

v souladu se Všeobecnou deklarací lidských práv, zákonem č. 101/2000 Sb., o ochraně osobních údajů a o změně některých zákonů, ve znění pozdějších předpisů, Helsinskou deklarací, přijatou 18. Světovým zdravotnickým shromážděním v roce 1964 ve znění pozdějších změn (Fortaleza, Brazílie, 2013) a dalšími obecně závaznými právními předpisy Vás žádám o souhlas s prezentováním a uveřejněním výsledků vyšetření a průběhu terapie prováděné v rámci praxe na, kde Vás příslušně kvalifikovaná osoba seznámila s Vaším vyšetřením a následnou terapií. Výsledky Vašeho vyšetření a průběh Vaší terapie bude publikován v rámci bakalářské práce na UK FTVS, s názvem

Získané údaje, fotodokumentace, průběh a výsledky terapie budou uveřejněny v bakalářské práci v anonymizované podobě. Osobní data nebudou uvedena a budou uchována v anonymní podobě. V maximální možné míře zabezpečím, aby získaná data nebyla zneužita.

Jméno a příjmení řešitele..... Podpis:.....

Jméno a příjmení osoby, která provedla poučení..... Podpis:.....

Prohlašuji a svým níže uvedeným vlastnoručním podpisem potvrzuji, že dobrovolně souhlasím s prezentováním a uveřejněním výsledků vyšetření a průběhu terapie ve výše uvedené bakalářské práci, a že mi osoba, která provedla poučení, osobně vše podrobně vysvětlila, a že jsem měl(a) možnost si řádně a v dostatečném čase zvážit všechny relevantní informace, zeptat se na vše podstatné a že jsem dostal(a) jasné a srozumitelné odpovědi na své dotazy. Byl(a) jsem poučen(a) o právu odmítnout prezentování a uveřejnění výsledků vyšetření a průběhu terapie v bakalářské práci nebo svůj souhlas kdykoli odvolat bez represí, a to písemně zasláním Etické komisi UK FTVS, která bude následně informovat řešitele. Místo, datum

Jméno a příjmení pacienta.....Podpis pacienta:

Jméno a příjmení zákonného zástupce

Vztah zákonného zástupce k pacientoviPodpis:

6.5 Ethics Committee Agreement:

CHARLES UNIVERSITY
FACULTY OF PHYSICAL EDUCATION AND SPORT
José Martího 31, 162 52 Prague 6-Vešelavín

Application for Approval by UK FTVS Ethics Committee of a research project, thesis, dissertation or seminar work involving human subjects

The title of a project: Case study of physiotherapeutic treatment about a patient after Anterior Cruciate Ligament reconstruction.

Project form: Bachelor Thesis

Period of realization of the project: January 2019

Applicant: Michele Gualco, UK FTVS, Physiotherapy department

Main researcher: Michele Gualco, UK FTVS, Physiotherapy department

Workplace: CLPA

Supervisor: Mgr. Ilona Kučerová

Project description: This case study Bachelor Thesis involve the rehabilitation of a patient after Anterior cruciate ligament reconstruction. The goal of the case study is to first examine the patient's initial state after the surgery, before becoming the physiotherapeutic treatment. The examination is developed using specific questionnaires, observations and physiotherapeutic examinations. After our 2 weeks physiotherapeutic path has come to an end the patient will again be examined mainly by observation, questionnaires and specific physiotherapeutic examinations. Changes about his physical state will also be examined to asses the effectiveness of the therapy applied.

Characteristics of participants in the research: Male patient, aged 34. The patient comes daily to CLPA to follow his therapy program which will last 2 weeks. The patient has already had therapeutic sessions due to different injuries he suffered in the past.

Ensuring safety within the research: The risk for the patient will be minimized as he will be followed in every and each therapy session by a team of skilful and qualified physiotherapists. No invasive procedures will be used during the research. The patient was instructed to notify us if any unbearable pain was felt during the session so to stop immediately. Risks of therapy and methods will not be higher than the commonly anticipated risks for this type of therapy.

Ethical aspects of the research: All the information gathered during the research won't be anyhow disclosed and will only be used for the Bachelor thesis. No photos nor videos will be taken during the examination to assure the patient maximum anonymity. The gained data will be processed and safely retained in an anonymised form and published in a bachelor thesis, possibly also in journals, monographs, and presented at conferences, possibly also used in further research at UK FTVS. After the anonymization the personal data will be deleted. I shall ensure to the maximum extent possible that the research data will not be misused.

Informed Consent: attached

It is the duty of all participants of the research team to protect life, health, dignity, integrity, the right to self-determination, privacy and protection of the personal data of all research subjects, and to undertake all possible precautions. Responsibility for the protection of all research subjects lies on the researcher(s) and not on the research subjects themselves, even if they gave their consent to participation in the research. All participants of the research team must take into consideration ethical, legal and regulative norms and standards of research involving human subjects applicable not only in the Czech Republic but also internationally.

I confirm that this project description corresponds to the plan of the project and, in case of any change, especially of the methods used in the project, I will inform the UK FTVS Ethics Committee, which may require a re-submission of the application form.

In Prague, 25.01.2019

Applicant's signature:

Approval of UK FTVS Ethics Committee

The Committee: Chair: doc. PhDr. Irena Parry Martínková, Ph.D.

Members: prof. PhDr. Pavel Slepíčka, DrSc.

doc. MUDr. Jan Heller, CSc.

PhDr. Pavel Hráský, Ph.D.

Mgr. Eva Prokešová, Ph.D.

MUDr. Simona Majorová

The research project was approved by UK FTVS Ethics Committee under the registration number: 052/2019

Date of approval: 29.1.2019

UK FTVS Ethics Committee reviewed the submitted research project and **found no contradictions** with valid principles, regulations and international guidelines for carrying out research involving human subjects.

The applicant has met the necessary requirements for receiving approval of UK FTVS Ethics Committee.

UNIVERZITA KARLOVA
Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6
Stamp of UK FTVS

Signature of the Chair of
UK FTVS Ethics Committee

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