

Charles University
Faculty of Physical Education and Sports
Physiotherapy Department

Case Study of a Patient after ACL reconstruction
Bachelor Thesis

Supervisor :

Mgr. Helena Vomáčková

Author :

Huda Alhomod

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Abstracts

Title: Case study of patient after ACL reconstruction

Goals: follow the complications that found after examinations and therapy that based on according to it to eliminate it then observing the condition after all if there is improvement or deterioration, also showing the theoretical part about ACL and what is related about its injury.

Methods: Thesis have two main parts which are the theoretical part that describe the ACL injury and ACL reconstruction, the other part is according to my knowledge which based on my studies in FTVS I did the examinations that patient need to understand the patient clinical picture then putting the therapy plan and treat according to the complications or deformities that found during the examinations, all based on FTVS studies. Patient will follow the therapy sessions schedule then evaluation of the changes in the end with the conclusion.

Results: satisfying improvements after 8 sessions therapy that improve the knee joint stability with improvement of muscle strength, symmetry of the muscle tone, release the joint play, eliminate the pain that patient complain of, improve the ROM of knee also improve the confidence of knee joint this leads to correct gait pattern which patient need most and achieved.

Keywords: ACL, Session, Knee joint, Examination, Injury, Operation, Hamstrings

Declaration

I declare that my work of thesis was written by myself based on my studies knowledge in FTVS of Charles University in Prague and the literatures which listed in this work. Also based on the clinical work placment in Centrum Léčby Pohybového Aparátu under the guidance of my supervisor there Bc.Gabriela Svobodová.

I also declare that no invasive methods were used during the clinical practice and that the patient was fully aware of the procedures at any given time.

Huda Alhomod

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1. Introduction

This thesis is about a case study of after ACL reconstruction operation and focused on rehabilitation and diagnosis. This thesis is divided into two parts which are the general part that describes information in general about ACL injury and its reconstruction such as its classification, diagnosis, etiology, mechanism, ACL anatomy including the anatomy of the knee joint and more. The second part is the special part that describes the complications the patient has and goals for these complications also its treatment in order with description of it, in the final this thesis shows the effect of the therapy that was given.

This thesis work took place in Centrum Léčby Pohybového Aparátu in the outpatient department in Prague, from 13 January 2020 till 7 February 2020.

2. General part

2.1 Anatomy

Knee joint consist of two main joint parts which is femorotibial joint that bears most of the body weight and second part is patellofemoral joint that limit friction transfer over the knee of forces generated by contraction of quadriceps femoris muscle ,and both parts allow knee joint to move in sagittal plane, transverse plane and frontal plane ,this gives six degree of freedom range of motion including flexion, extension ,internal and external rotation ,varus and valgus stress.

Bones that create knee joint articulation are femur, tibia, patella and fibula. In the distal end of the femur has medial and lateral condyle which both have specific shape that corresponds to the shape of tibial plateau, shape of the condyles is important for tibial movements related to the femur. And The proximal end of the tibia flares to create a plateau with medial and lateral sections divided by the tibial spine, this plateau have menisci which deepen in the contour of it that provide like a seat of medial and lateral condyle of the femur this depth is important because the lateral femoral condyle and lateral tibial plateau are both somewhat convex. (9 , 12)

2.1.1 Cartilage

Menisci is cartilage and there is medial and lateral fibrocartilaginous menisci are positioned between the medial and lateral femoral condyles also tibia which respond to changes of the shape of articular surfaces during activity. Menisci function works as a seat on the tibial condyles for the corresponding femoral condyles. There is also other cartilage part which is articular cartilage or called anterior cartilage that covers both the femoral and tibial condyles and provides a frictionless surface gives free joint movement. They also act as shock absorbers for the body load and dynamic movements. (11 , 3 , 9 , 4 , 12)

2.1.2 Ligaments

There is four ligaments in the knee joint which very important for the knee joint stability they are lateral and medial ligament, anterior and posterior cruciate ligament. There function is not only stability to the joint they also work in joint proprioception through their cutaneous receptors. ACL primarily resists anterior and rotational displacement of the tibia relative to the femur, while the PCL prevents posterior displacement of tibia, MCL runs from femur to tibia medially it gives

stability to the medial aspect of the knee and preventing excessive valgus stress during external rotation of the knee, LCL runs from the femur to the fibula to stabilize the lateral aspect of the knee, preventing excessive varus stress. Both collateral ligaments become tight during extension and loose during flexion.

ACL is a dense connective tissue it has two bundles which are the posterolateral bundle (PL) and the anteromedial bundle (AM) in a cross-sectional area, they are named according to their tibial insertion, both bundles originate on the posteromedial side of femoral condyle and insert anteriorly to the intercondylar tibial eminence, because of their positions ACL is responsible for resisting anterior tibial load and rotational load. The bundle length of AM is 33mm and for PL is 18mm, average width of ACL is 11mm and cross-sectional area average is between 36 and 47 mm². Within ACL there are mechanoreceptors which are Ruffini corpuscles, Pacinian corpuscles, Golgi-like organs, and free nerve ends. (11, 3, 9, 4, 12)

2.1.3 Bursae

It is a fluid-filled structure of synovial fluid that is located in the large joints (shoulder, knee, hip, elbow) specifically located between the skin and tendon or between tendon and bone to facilitate its movements over the joint. The main function of a bursae is frictionless between adjacent moving structures. For the knee joint there are three main bursae which are:

- prepatellar bursae is located between the patella and the overlying subcutaneous tissue
- suprapatellar bursae is located between the quadriceps tendon and the femur
- infrapatellar bursae have two types they are superficial infrapatellar bursae which is located between the tibial tubercle and the overlying skin, and the deep infrapatellar bursae which is located between the posterior aspect of the patellar tendon and the tibia

These bursae are anatomically close to the patella but there are other bursae not anatomically close to patella which are pes anserine bursa, the iliotibial bursa, the tibial and fibular collateral ligament bursae and the gastrocnemius-semimembranosus bursa. But all they cooperate to the knee joint. (25)

2.1.4 Muscles anatomy

Table 1 Muscles anatomy of the knee joint (26)

Muscles	Origin	Insertion	Nerve	Action on knee
Semitendinosus	tuberosity of the ischium	Medial surface of tibia (proximal)	Tibial division of sciatic nerve (L5-S2)	Flexes knee and medially rotates tibia on femur
Semimembranosus	tuberosity of the ischium	Medial condyle of tibia (posteromedial)	Tibial division of sciatic nerve (L5-S2)	Flexes knee and medially rotates tibia on femur
Biceps femoris	tuberosity of the ischium, the linea aspera	Fibula, lateral condyle of the tibia	Sciatic nerve (L5-S2)	Flexes knee and laterally rotate tibia on femur
Gastrocnemius	Medial and lateral condyle of femur (posterior part), capsule of the knee joint	Calcaneus (posterior)	Tibial nerve (S1-S2)	Flexes knee
Gracilis	Inferior symphysis pubis	Medial surface of tibia	Obturator nerve (L2-L3)	Flexes knee and medially rotates tibia on femur
Sartorius	Anterosuperior iliac spine	Medial surface of tibia (proximal)	Femoral nerve (L2-L3)	Flexes knee and medially rotates tibia on femur
Plantaris	Distal lateral supracondylar line of the femur	Calcaneus (posterior)	Tibial nerve (S1-S2)	Flexes knee

Popliteus	Anterior groove on the lateral condyle of the femur	the soleal line on tibia	Tibial nerve (L4-S1)	Medially rotate tibia on femur and flexes knee
Rectus femoris	anteroinferior iliac spine, groove above rim of acetabulum	Proximal border of the patella and tuberosity of the tibia	Femoral nerve (L2-L4)	Extend knee
Vastus lateralis	Proximal part of intertrochanteric line, anterior and inferior borders of greater trochanter, lateral lip of the gluteal tuberosity, linea aspera	Proximal border of the patella and tuberosity of the tibia	Femoral nerve (L2-L4)	Extend knee
Vastus intermedius	Anterior and lateral femur (proximal), linea aspera, and lateral intermuscular septum	Proximal border of the patella and tuberosity of the tibia	Femoral nerve (L2-L4)	Extend knee
Vastus medialis	Distal half of the intertrochanteric line, medial linea aspera, proximal medial supracondylar line, medial intermuscular septum	Proximal border of the patella and tuberosity of the tibia	Femoral nerve (L2-L4)	Extend knee

Tensor fascia lata	Anterosuperior iliac spine	Into the iliotibial tract	Superior gluteal nerve (L4-S1)	Extend knee
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2.2 Classification

2.2.1 Classification of ACL injury

ACL injury happen by two types which are contact and noncontact accident. ACL injury happen by contact accident it means during excessive load in ACL the knee joint hit aggressively the ground or something stiff which causing the injury of ACL and injury happen by noncontact accident it means during excessive load in ACL with frequent changing direction of tibia, rotational maneuvers or lateral bending of knee into valgus position with knee extended and rotated tibia, also jumping causes ACL injury. Most of ACL injury in patients happen by direct contact accidents about one third of patients and they often have hyperextension or valgus stress on the injured knee. (11 , 13)

2.2.2 Classification of ACL operation

Operation of ACL injury can be by replacing it either by graft selection from tendons around the knee and this is usual and most common operation, or by allografts and this is very rare even though it have lower risk of post-operative pain and quicker patient recovery but also have higher risk of transmission of infectious diseases, or by synthetic grafts it is also very rare because of negative previous experiences or because of its poor results even though it have less rehabilitation time then other types of operations. Graft selection have three types which are quadriceps tendon (QT) graft, and most common tow hamstring tendon (HT) graft, bone-patellar tendon-bone (BPTB) graft both have 95% of knee stability and 3% of failure each of these three types have advantages and disadvantages. (11 , 14)

2.2.3 Quadriceps tendon (QT) graft

Comparing to other types of grafts a quadriceps tendon graft is not a good choice for surgeons because there is lack of trials with long- term follow-up it means it can be not safe and clinically not efficient in the long term. This type of graft have less pain in anterior of knee after operation, the graft is taken from rectus femoris this

leads to quadriceps femoris weakness but it have the same stability of patellar tendon graft. (6)

2.2.4 Hamstring tendon (HT) graft

It is one of the most common graft operation for ACL injury, 4-strand hamstring tendon graft is taken from gracile and semitendinosus muscles, this operation have greater cross sectional area and greater tensile strength about three times then ACL, complications after this operation like pain or infection are less then after patellar tendon graft operation. Disadvantages of this operation type are having longer time of healing and graft integration because absence of bone plugs in the ends of the graft, this operation leads to hamstring weakness which leads to lack of stabilizing which these muscles exerts because hamstrings and ACL together they work us reflex arc which contribute in proprioceptive control, there is possibility of having lizard tail phenomenon which is a regrowth of tendon in place of semitendinosus several months after operation. (11 , 14)

2.2.5 Bone-patellar tendon-bone (BPTB) graft

It is also most common and widely used than any other operation type because of greater and initial strength and stiffness, shorter integration time due to presence of bone plugs in the ends of grift, tensile strength is four times greater than ACL it means ACL reconstructions with BPTB graft were significantly more stable than those using HT graft this leads to more fixation structure proprieties. Because it have more stability it will have less aggressively rehabilitation method, But this type of operation have more complications and higher risks after operation then other types, risks like patellar fractures, weakening of the quadriceps muscles, patellar tendon rupture and patellar tendonitis. Also it have long term complications like anterior knee pain, loss of extension and possibility of infection at the surgical site. (11 ,14)

2.3 Biomechanical

During flexion of the knee joint in 30% (60-90 degree) a great force transmit to AM bundle but during full extension a great force transmit to PL bundle also with flexion of 15%, also in rotatory motion a higher load transmit to both bundles, in less degree of flexion there will be no difference in stress between AM and PL bundles unless in greater flexion the AM bundle have higher situ force than PL bundle. In

anterior tibial load position the PL bundle will handle more force while AM bundle situ force will remain constant even with changing in flexion angle.

As it mentioned a great force transmit to PL bundle during full extension and injury of ACL mostly happen during full extension of knee, it consider the PL bundle is more important for overall biomechanical stability of the knee because of higher situ force in the PL bundle during full extension.

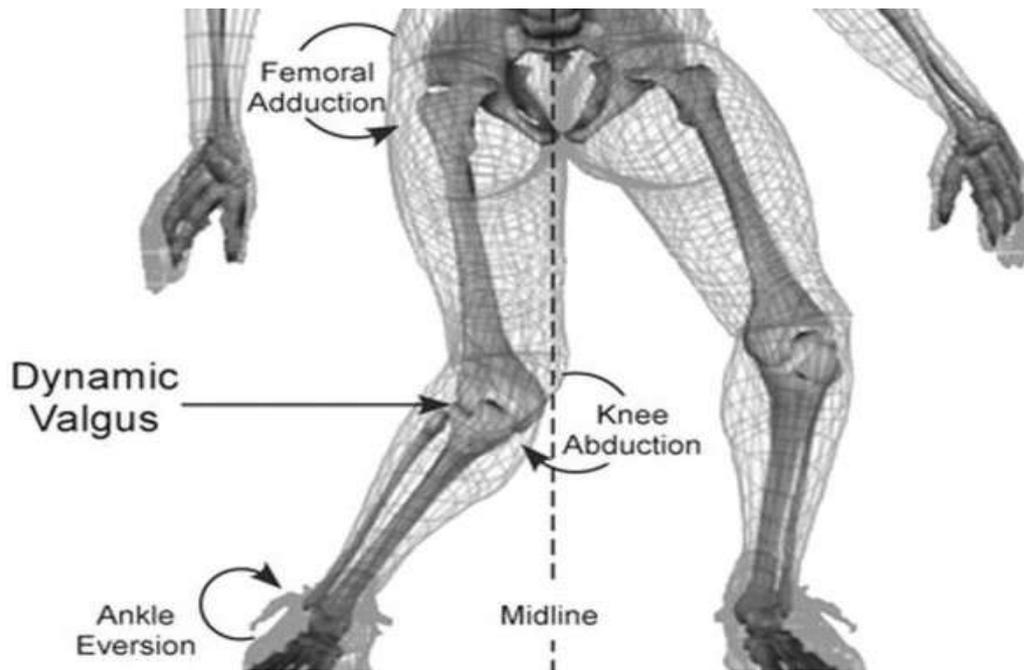
Surgical techniques restore the function of both bundles because if the reconstruction to AM bundle only it will not restore full knee function and stability also is the same to PL bundle, both bundles contribute together in loading transfer across the knee joint.

In general, biomechanically ACL keep the stability between femur and tibia it inhibit the anterior shifting of the tibia and resist the rotational load of tibia, also the load into flexion and extension of the knee joint. (15 , 3 , 11)

2.4 Mechanism of the injury

Changing position quick into valgus or varus which is lateral or medial bending of the knee with knee extended and tibia is rotated (rotational maneuvers), this position it increase stress in ACL leads to injury possible due to poor control of dynamic knee stability may coming from muscle imbalance that involve weak hip extension, abduction, and external rotation. These risk positions happen in sidestepping and crossover cutting maneuvers also during deceleration of the lower extremity. These positions or situations are happen as non-contact injury of ACL and it takes 70% of ACL injuries and contact injuries of ACL takes 30%, in contact injuries of ACL usually there is a history of hyperextension of the knee which lead to excessive load in ACL.

In full extension position of the knee the quadriceps muscles increase in contraction leads in increase of ACL tensile force and hamstrings muscles are often contract minimally, during hip extension and body weight on the heel it lead to excessive forward shifting of femur on tibia, which cause ACL injury. (1 , 13 , 4)



Picture 1 Common mechanism of ACL injury (Hewett , 2005)

2.5 Etiology

ACL injury is higher in female than male, in female they have the risk of 3.96 of ACL injury compared to male in sports (soccer, basketball and rugby specially). The state of quadriceps muscles is related to ACL state which means as much the quadriceps muscles is strong as much the ACL strong it will be, but it is unclear that increase of quadriceps muscles size and strength related to increase of ACL size, quadriceps muscles are larger in male athletes than female athletes which can be related to higher risk of ACL injury in female than male.

The main reason of ACL injury is biomechanical reason which is increasing of the load in ACL causing by increase of varus/valgus of knee joint and tibia internal/external rotation movements, these movements or positions usually happen during sports it means the intensity of play is a factor of ACL injuries with a three to five times greater of risk. There is other factors during plying sports increase the risk of ACL injury, these factor split into two extrinsic factors and intrinsic factors. (1 , 11)

2.5.1 Extrinsic factors

- Playing field or ground (uneven field, wet or muddy conditions)
- Level of playing (higher level give higher risk)
- Playing style (more aggressive increase the risk)

- Shoe surface (for example long cleats may provide too much traction)
- Weather (rain, extreme cold increase risk of accident)

2.5.2 Intrinsic factors

- Body size and limb girth
- Body flexibility, strength and reaction time
- Foot morphology
- Hormonal changes (increased laxity at ovulatory and postovulatory phase)
- Increased quadriceps angle (it is the angle between quadriceps force and patellar tendon cranially, can be related to increase the load in valgus/varus position, it is greater than 14 degrees in men and greater than 17 degrees in women)
- Leg dominance (differences in strength, flexibility, and coordination between right and left leg)
- Ligamentous laxity
- Quadriceps dominance (more quadriceps strength and decreased hamstring strength)
- Small ACL size

Also including previous injury of ACL and age (more active lifestyle) increase the risk of ACL injury. (1)

2.6 Diagnosis

Diagnosis of ACL injury can be either by medical imaging or by physical examinations

- Medical imaging : most common medical imaging is magnetic resonance imaging (MRI) which can visualized both bundles anteromedial and posterolateral bundle also it have 86% of sensitivity and 95% of specificity of detecting ACL injury this is why it is more favorable then other methods, other imaging can be by computer tomography (CT), x-ray and arthroscopy. (11 , 4)
- Physical examinations: there is three specific tests and most common one and usually assessed by Lachman test it is also most effective because it have 85% of sensitivity and 94% of specificity for ACL injury, other two tests are pivot shift test and anterior drawer test both have 62% of sensitivity. These physical tests better be done soon after the injury as soon as possible before swelling, pain or

muscle guarding occurs as pathologic reactions to the injury because it effect the evaluations of the tests, doctors usually wait till the swelling decreased. (1 , 3)

2.6.1 Lachman test

Excessive motion test . Patient relax in supine position and knee flexed in 20-30 degree, the examiner fixate distal thigh with one hand and other hand place it on calf proximal tibia at the level of joint line, then pull the tibia forward with avoiding rotation, in normal results there will be steady limiting and abnormal result is shifting or anterior translation of the tibia relative to the femur. The anterior translation of 1 mm to 5 mm is defined as grade I of laxity, 6 mm to 10 mm as grade II, and greater than 10 mm or without a displacement limit as grade III. Compare it with other leg most happen and reflex resistance like pain with uncontrolled force applied should kept in mind during the test. (3 , 8)



Picture 2 Lachman test (Lam , 2009)

2.6.2 Pivot shift test

This test specifically assess the function of ACL which is as major secondary restraint to internal rotation when the joint is near full extension and as a minor secondary restraint to external rotation and varus–valgus angulation. To perform the test first apply valgus torque and internal rotation of the tibia, test start with knee in full extension then gently flexed the knee to 40 degree, if result is positive there will be forward subluxation of tibia during sudden change in direction but if result is negative there will be potential limitation, comparing it with other side. (3)



Picture 3 Pivot shift test (Lam , 2009)

2.6.3 Anterior drawer test

Patient is relax in supine position, the hip is flexed in 45 degree and knee flexed in 90 degree, examiner stabilize the foot by sitting on it then with both hands hold the proximal tibia (fingers on the calf muscle) to preform gently anterior force shifting of tibia, in normal result there will be potential limiting but in abnormal result there will be antero-posterior displacement of tibia with more than 6mm displacement with soft end point consider as ACL injury, compare it to the other side. (3 , 8)

2.7 Character of the injury

Patient will heard or felt popping sound then immediate extreme pain and the swelling occurs for four hours in the injured knee, there will be feeling of instability and limit the ability to work with knee function, patient may describe it as double fist sign with is fists facing each other and rotating in grinding motion, this feeling it comes from the bones femur and tibia, patient can walk after the injury but there may be no possibility to fully extend the knee. (1)

2.8 Physiotherapy

After ACL reconstruction operation there will be deterioration of proprioceptive system it leads of losing balance and afferent information necessary for muscle function, by sensorimotor training it improve the proprioception and

stability which is the most important therapy because it is more effect then strengthening training in restoring neuromuscular function after ACL injury.

Strengthening training to treat complications of post operation associated with muscle imbalance specially for hamstrings, quadriceps, adductors and abductors, it is also to improve the stability of the affected limb and to prevent from injury in healthy limb.

Relaxation methods as post-isometric relaxation it release hyper tense that coming as pathologic reaction of the muscles after post operation which limit the ROM of joints it can be used also for lengthening muscles.

Limitation in knee joint ROM after operation as pathologic changes can be from stiffness of knee and patella joint or from hypertonic muscles specially rectus femoris or from shortening of muscles around the knee joint and this limitation can release or decrease by joint play mobilization method for stiffness of joints, stretching exercise for shortened muscles and relaxation techniques to release hyper tense and restore knee position after wearing the brace of leg in long time.

Joint play mobilization of knee and neighboring joints according to Lewit it prevent from secondary changes and prepare the proprioceptors for training. Also soft tissues techniques it increase healing process specially for the scar tissues.

Recommended therapy modalities for ACL injury in general are magnetotherapy with above 10Hz of frequency in 20min and 10 repetitions minimum for total in hollow applicator, and ultrasound also with Continuous wave in 0,1-2 W/cm² of intensity and 1-2MHz as thermal effect for 5min and repetitions 10 times for 3 weeks, both are for stimulating metabolism which is the most important to increase healing, also by using cryotherapy such as ice packs to stope the pain which patient complain of. (16 , 10)

3. Special part (Case study)

3.1 Methodology

The clinical work of this thesis was from 13 January 2019 till 7 February 2020 in out-patient department of Centrum Léčby Pohybového Aparátu (CLPA) in Prague, the examinations and treatments done in the gym specifically with supervision of Bc. Gabriela Svobodová

Case study is about a female diagnosed with ACL reconstruction after operation, patient come for eight sessions, twice a week. Examinations took in the first day then in the last day of thesis therapy sessions.

This thesis is approved by the Ethics Committee of the Faculty of Physical Education and Sport of Charles University under registration number 059/2020.

3.2 Anamnesis

Examined person: A.T

Gender: Female

Year: 1979

Age: 41

Diagnosis: post- operative phase of ACL reconstruction operation in the left knee since 12 Dec 2019

Objective:

Height: 162 cm

Weight: 55 kg

BMI: 21 kg/m² (Normal weight)

Somatotype: endomorph

Assistive devices: Non

Subjective:

Chief complain: hard stiffness and limitation in the left knee, sharp pain specially in morning spread in most of the left leg but especially in the lateral side of the knee and it increase during more activation.

History: since 2018 January patient did her accident during skiing sport by jumping and falling down on left knee, after diagnosed with left knee ACL full rupture the doctor make her choose between doing the surgery or trying to work out by strengthening leg muscles that can cooperate in knee stability and condition she decide not to do the surgery and work out but patient couldn't make it and because of annoying pain decide to do the surgery on 12.12.2019, patient stay in the hospital for 3 days then seeing her doctor was on 6.1.2020 then patient decide to do the therapy sessions on 14.1.2020, because of Christmas and new year holiday it takes long period to take the therapy sessions.

During surgery it was with full anesthesia, patient wear splint in the left knee which make it in semi flexion she take it off during therapy only in hospital after operation but wearing the splint was for 1 month, patient used crutches from the first day till 17 days.

Type of surgery: bone tendon bone (BTB), patella tendon graft

Characteristic of pain: is sharp and spread on all over the left leg ,increase in the morning and during increase activation, it comes from time to time but patient use ice packs to decrease it.

Family anamnesis: Non

Occupational anamnesis: patient work in Chinese medicine

Social anamnesis: patient married living with her husband and have no children

Functional anamnesis: limitation in left knee flexion with 90 degree only which cause inability to perform daily activities and struggle during gait pattern, external and internal rotation of hip with knee flexed is forbidden till 6 moth since operation but rotation of whole leg with knee extended can happen.

Cognition: Good

Communication: Good

Assistive devices: Non ,patient stops using crutches and splint after seeing the doctor on 6.1.2020

Physical activities and hobbies: yoga every day, walking and skiing

Allergy: Non

Medication: Non

Injury anamnesis: Non

Gynecological Anamnesis: Non

Post medical or surgical history: Non

Diet: patient not on diet

Abuses: Non

Prior rehabilitation: (in CLPA)

Rehabilitation after operation in hospital for 3 days

- In the 1st day with lying in bed and small ball under the left knee ask the patient to press against the ball into knee extension (as isometric contraction to

strength rectus femoris and AROM into knee extension) also training patient to use crutches

- In the 2nd day every 2-3 hours for 20min training PROM by CPM machine starting with 30 degree of knee flexion then upgrade to 60 degree then upgrade to 90 degree
- In the 3rd day training on stairs

Statement from the patient’s medical documentation:

Unknown was not provided

Rehabilitation indications:

- Increase ROM of left knee into flexion
- Strength left leg muscles
- Correct the gait pattern
- Stretch shortened muscles
- Increase stability and stimulate the proprioceptors
- Eliminate pain
- Treat the scar

3.3 Initial kinesiology examinations

3.3.1 Static Postural examination

Anterior view

Table 2 Initial Static Postural examination anterior view

the base of support	Both feet enclosed within a 30 degree angle, it have a shape of trapezoid
Arches of foot	Lateral arch of both feet are more in contact with floor more than medial arch
the position and shape of the toes	physiological
shape and position of the knee joints	Left knee in semi flexion compared to right knee
Patella position	Left patella is slightly shifted laterally compared to the right

configuration of m. tibialis anterior	Physiological and symmetrical compared of both sides
shape of the thigh muscles (the quadriceps femoris)	There is moderate swelling in the insertion of the left muscles and it is less volume compared to right muscles
position of the pelvis	Left pelvic is depressed
symmetry of the muscle tone of abdominal muscles	Symmetrical
Position of umbilicus	Physiologic
position and symmetry of the chest	Symmetrical and Physiologic
position of the shoulder girdle	Right shoulder is elevated compared with left
position of the upper limbs	Both sides elbow are in slight flexion almost extended
position of the head	Physiologic

Lateral view (of both sides R/L)

Table 3 Initial Static Postural examination lateral view

shape and position of the ankle joints	Physiological without planter or dorsal flexion
shape and contour of the shin	physiological
position of the knee joints	Right knee joint in slight hyper extension but left knee joint in semi flexion
contour of the thigh muscles	Volume of the right thigh muscles is bigger then left thigh muscles
contour of the calf muscles	Volume of the right calf muscles is bigger then left calf muscles
position of the pelvis	Slightly increased in anteversion
position and curvature of the spine	Slight increase of kyphotic in thoracic spine and lordosis of lumber spine

shape of the abdominal muscles	prominence of belly
position of the shoulder girdle	Protracted of both sides
position of the head	Slightly protracted

Posterior view

Table 4 Initial Static Postural examination posterior view

the base of support	Both feet enclosed within a 30 degree angle, it have a shape of trapezoid
shape and contours of the heels	physiological
shape and position of the ankle joints	Physiological without pronation or supination
shape and thickness of the Achilles tendon	Symmetrical of both sides and physiologic
contour of the calf muscles (medial and lateral part)	Volume of the right calf muscles is bigger then left calf muscles
shape and position of the knee joints	Left knee joint in semi flexion and right knee in hyper extension
popliteal line	Left line is lower than right slightly
contour of the thigh muscles - especially the adductors	Left thigh muscles is less volume then right but there is swelling in insertion part only
subgluteal line	Symmetrical of both sides
gluteal muscles	Physiologic and symmetric
position of pelvis	Left pelvic is depressed
paravertebral muscles	Physiological shape and prominence
curvature of the spine in the frontal plane	Physiologic and symmetric in lateral and medial side
position of the scapula	Slightly in external rotation more in both sides
position of the shoulder girdle	It is protracted and right shoulder is elevated then left

position of the upper limb	Slight flexion in both sides elbows but almost extended
position and contour of the nuchal muscles	Physiologic
position of the head	Protracted but no lateral tilt

3.3.2 Dynamic spine examination

Forward flexion: there is no limitation during the movement patient can touch the ground with fingers but the body lean back ward slightly during it, curve of spine is physiologic and symmetrical laterally ,there is prominence of Th-L spine junction and lumber spine, during the move patient feel pain spreading over the right leg from right buttock to posterior part of the thigh and stop there but there is no pain during return to upright position.

Lateral flexion L/R: there is no limitation during movement and no pain ,but there is prominence of Th-L spine junction.

Backward flexion: there is no limitation and no pain ,curve is physiologic and lateral symmetry ,but there is prominence of the lumber spine .

3.3.3 Specific testing of posture

Tow scale standing: right side is 28 and left side is 27, the difference is only 1kg (not bigger than 15% of body weight about 3kg)

Véle test: grade 1/normal

Romberg test I., II and III: negative

Single leg stand test: left leg standing with moderate shaking but without pain , right leg standing with slight shaking but without pain also

Trendelenburg: negative

3.3.4 Pelvis palpation

- height and symmetry of cristae iliacae: left is lower than right slightly
- height and symmetry of posterior superior iliac spine: left slightly lower than right

- height and symmetry of anterior superior iliac spine: left slightly lower than right
- pelvis position: there is slight lateral tilt of the left side only ,without pelvic rotation or torsion

3.3.5 Gait analysis

Patient walk without assistive device, periodic walking in normal steps length and speed, but there is no flexion of the left knee during walking which make patient to elevate left hip slightly and swing the left leg forward with slight flexion of left hip to move body forward, right feet movements it is optimal, while there is absent of heel-off and toe-off in the left feet movement, trunk movements is limited also head but position of head and shoulder are protracted slightly, arms swing slightly almost no movement but it is rhythmical moves, patient stable during walking and not need any support, pelvis swing rhythmically but lateral tilt it increase in the right, abdominal muscles and back muscles activate physiologically during walking, patient feel pain in knee joint laterally after repetitions of walking.

During gait modifications the results are :

- walking with upstretched arms patient was stable and had no problem to do it correct
- walking on tiptoe patient was stable and able to do it without pain
- walking on heels patient was not able to do it because of feeling pain
- walking on the narrow basis patient able to do it but with shaking
- walking on soft surfaces patient able to do it with good stability
- walking with eyes closed patient able to do it with good stability
- walking backwards patient able to do it with good stability but there is feeling of pain in left knee joint laterally

3.3.6 Goniometry measurements of joint ROM (according to Janda, SFTR format) on LE

Table 5 Initial goniometry measurements of joint ROM

	Right leg		Left leg	
	Passive ROM	Active ROM	Passive ROM	Active ROM
Hip joint	S 30-0-105	S 25-0-90	S 30-0-95	S 20-0-90

	F 85-0-20 R 40-0-30	F 80-0-20 R 30-0-25	F 85-0-20 CI	F 80-0-20 CI
Knee joint	S 10-0-139	S 10-0-130	S 5-0-90	S 5-0-90
Ankle joint	S 15-0-50 R 20-0-40	S 15-0-45 R 20-0-40	S 15-0-50 S 20-0-35	S 10-0-45 R 20-0-35

3.3.7 Anthropometric measurements on LE

Table 6 Initial anthropometric measurements

	Right leg	Left leg
Anatomical length of lower extremity	84 cm	79.5 cm
Functional length of lower extremity	83 cm	78.5 cm
Length of thigh	44 cm	42 cm
Length of middle leg	39 cm	41 cm
Length of foot	23 cm	23 cm
Circumference of thigh 15cm above knee cap	51.5 cm	49 cm
Circumference of thigh 10cm above knee cap	47 cm	46 cm
Circumference of the knee joint	37 cm	38 cm
Circumference of the calf	35 cm	34 cm
Circumference of the ankle	25 cm	25 cm
Circumference of the foot	23 cm	23 cm

3.3.8 Muscle length tests (according to Janda) on LE

Table 7 Initial muscle length test

	Right leg	Left leg
Two joint planter flexors (m.gastrocnemius- m.plantaris)	Grade 0	Grade 0
One joint planter flexor (m.soleus - m.popliteus)	Grade 0	Grade 0

Tow joint hip flexors	Grade 0	Grade 2
One joint hip flexors	Grade 0	Grade 0
Tow joint hip adductors	Grade 0	Grade 0
One joint hip adductors	Grade 0	Grade 0
Hamstrings	Grade 0	Grade 0

3.3.9 Muscle strength tests (according to Kendal) on LE

Table 8 Initial muscle strength test

	Right leg	Left leg
Iliopsoas	Grade 4	Grade 3
Gluteus maximus	Grade 5	Grade 3
Gluteus medius	Grade 4 +	Grade 4
Gluteus minimus	Grade 4 +	Grade 4
Lateral hamstring	Grade 5	Grade 5
Medial hamstrings	Grade 5	Grade 5
Popliteus	Grade 5	Grade 3
Tensor fascia latae	Grade 5	Grade 5
Sartorius	Grade 5	Grade 5
Hip Adductors	Grade 4	Grade 4
Gastrocnemius + Plantaris	Grade 5	Grade 3
soleus	Grade 5	Grade 4
Quadriceps femoris	Grade 5	Grade 3 +
External rotators	Grade 5	Grade 3
Tibialis anterior	Grade 5	Grade 5
Tibialis posterior	Grade 5	Grade 5
Peroneus longus	Grade 5	Grade 5
Peroneus brevis	Grade 5	Grade 5

3.3.10 Muscle tone palpation on LE

Table 9 Initial muscle tone palpation

Right leg	Left leg
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	Origin	belly	Insertion	origin	belly	insertion
Iliopsoas	Normal tone			Normal tone		
Gluteus maximus	normal	hypotone	normal	normal	hypotone	normal
Gluteus medius	Normal tone			Normal tone		
Gluteus minimus	Normal tone			Normal tone		
Tensor fascia latae	Normal tone			Normal tone		
piriformis	Normal tone			normal	hypertone	normal
Biceps femoris	Hypertone			Hypertone		
Semitendinosus	Normal tone			normal	hypertone	hypertone
Semimembranosus	Normal tone			normal	hypertone	hypertone
Sartorius	Normal tone			normal	normal	hypotone
Hip Adductors	Normal tone			normal	normal	normal
Gastrocnemius	Normal tone			hypotone	hypotone	normal
soleus	Normal tone			Normal tone		
Rectus femoris	normal	Hypertone	normal	normal	normal	hypotone
Vastus lateralis	Normal tone			normal	normal	hypotone
Vastus medialis	Normal tone			normal	normal	hypotone

3.3.11 Joint play examination (according to Lewit) on LE

Table 10 Initial joint play examination

	Right leg	Left leg
Patella	No restriction	Restricted caudal and lateral direction with hard barrier and cranial with moderate barrier
Tibiofemoral	No restriction	CI
Head of fibula	No restriction	Restricted in anterior direction with hard barrier
Talocrural joint	No restriction	No restriction
Subtalar joint	No restriction	No restriction
Chopart joint	No restriction	No restriction

Lisfranc joint	No restriction	No restriction
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3.3.12 Movement stereotype (according to Janda) on LE

Table 11 Initial movement stereotype examination

	Right leg	Left leg
Hip extension	Slight hip rotation to the right side from beginning without anterior tilt of pelvic	Marked hip rotation to the right side from the beginning but no anterior tilt of pelvic
Hip abduction	The movement is combined with slight flexion of the leg with stable trunk and pelvic	The movement is combined with slight flexion of the leg with stable trunk and pelvic

3.3.13 Neurologic examination (superficial sensation)

Table 12 Initial neurologic examination

Segments dermatomes	Right leg	Left leg
L1 segment	Normal sensation	Normal sensation
L2 segment	Normal sensation	Normal sensation
L3 segment	Normal sensation	Normal sensation
L4 segment	Normal sensation	Normal sensation
L5 segment	Normal sensation	Patient have normal sensation but when reach lateral side of knee joint sensation is decreased
S1 segment	Normal sensation	Normal sensation
S2 segment	Normal sensation	Normal sensation

Note: less sensation when reach the scar

3.3.14 Scar examination (aspection + palpation)

The length of the scar is 7cm long located in the anterior aspect of the knee joint of left leg in the midline proximately between caudal part of patella and head of tibia, stitches wasn't observed and not painful when being touched , swelling is in the insertion of gracilis, sartorius and quadriceps femoris as arch shape above patella it increase medially more than laterally and redness is very slight along the scar only, no inflammation signs and no pathologic aspect in other parts of whole left leg.

During palpation of cutis and subcutis tissues there is stiffness along and around the scar it increase medially then laterally and caudally then cranially hard barrier is felt ,without pain and temperature is physiologic.

3.3.15 Fascia examination (according to Lewit)

Table 13 Initial fascia examination

	Right leg	Left leg
Upper leg	Anterior: elastic no restriction is felt in lateral and medial direction Posterior: slight barrier is felt lateral and medial direction	Anterior :elastic no restriction is felt in lateral and medial direction Posterior :hard barrier is felt lateral and medial direction
Lower leg	Both posterior and anterior: elastic no restriction is felt in lateral and medial direction	Anterior: slight barrier is felt only in the head of tibia level laterally Posterior: elastic no restriction is felt in lateral and medial direction
Achilles tendon	elastic no restriction is felt in lateral and medial direction	elastic no restriction is felt in lateral and medial direction

3.3.16 Initial kinesiology examinations conclusion

According to the exams results the main problem in the patient is limitation of left knee flexion with 90 degree ROM and have lack of using knee function this lead to muscle weakness and stiffness of knee joint as it shows in the results .As during the gait there is lack of using left knee which leads patient to elevate left hip and swing the leg to move body forward but patient can correct it if instructed and because of swinging of the leg there is not enough or complete heel strike move this leads to left gluteus maximus muscle weakness with grade 3, as well as other muscles have weakness because of pain feeling during the test in the lateral side of left knee joint and as pathologic changes that comes after operation these muscles in patient are left Iliopsoas with grade 3, left Popliteus with grade 3, left Gastrocnemius and Plantaris with grade 3, left Quadriceps femoris with 3+ ,left External rotators with grade 3 other muscles with grade 4 left soleus, left and right Hip Adductors, Gluteus minimus and Gluteus medius with grade 4+ on right and 4 on left. Due to some weakness in the left leg patient could not be stable during single leg test, instability increase in left leg compared to right leg.

Most pathologic changes that comes direct after operation is change in muscle tonicity and patient have hypotone in right and left belly of gluteus maximus, left insertion of sartorius, left origin and belly of gastrocnemius, left insertion of all rectus femoris, vastus lateralis and vastus medialis muscle and because of hypotonicity of these muscles patient have less circumferences of left leg then right leg in thigh and calf, the difference is between 1cm – 2cm and left knee circumference is bigger than right because of hypotonicity of quadriceps femoris insertions and swelling, the difference is 1cm. Patient also have hypertone in left belly of piriformis, right and left all parts of biceps femoris, left belly and insertion of Semitendinosus and Semimembranosus, right belly of rectus femoris, hypertonicity in hamstrings can be a reason of not reaching full ROM in hip flexion patient can reach 90 degree in left and right while it should be 125 degree ,as well restriction of posterior upper left leg fascia can be also a reason of this limitation. Patient have limitation also in hip external rotation with 30 degree and in internal rotation with 25 degree, but there is hypermobility in hip abduction with 80 degree and it come by playing yoga almost every day as patient mention it.

Patient have marked shortness in left tow joint hip flexors which can be also related to the limitation of left knee joint flexion with 90 degree passively and actively, also restriction with hard barrier of left patella (caudal and lateral direction) and left head of fibula (anterior direction) can cooperate with this limitation of knee flexion.

During the postural examination found that patient left knee it is in semi flexion it caused by wearing the splint which keep the leg in semi flexion for 1 month after operation, because of this position of left knee it let the left pelvis level to be slightly lower then right pelvis, also it makes the left leg anatomical and functional length lower then right leg about 4.5cm difference. Also during postural examination found slight right shoulder elevation and protraction of both sides of shoulder and head, slight kyphosis of thoracic spine and slight lordosis of lumber spine, scapula slightly in external rotation which can be related to the protraction of shoulders as a reason, right knee slightly in hyper extension this position can increase the risk of ACL rupture according to the mechanism of the load.

In dynamic spine examinations it shows that patient have prominence in the thoracic lumber junction where there can be a stiffness as sign but can not make sure because joint play examination of spine was not done.

Patient hip extension stereotype is pathologic in both sides because there is hip rotation during the move from the beginning caused by overactivation of contralateral lumber erectors it increase in left leg more than right ,but in hip abduction stereotype it is also pathologic because there is slight flexion of leg during the move in both sides caused by over activation of tensor facia latae muscle not shortness of it because it was negative result during muscle shortness test.

It is normal to find stiffness in cutis and subcutis tissues around the scar of after operation as it felt in the patient, it increase medially more. There is also fascia stiffness in the head of tibia level anterior lateral, in this same place there is decrease of sensation as it found during superficial sensation test.

3.4 Physiotherapy plan

3.4.1 Short-term therapy plan

- Decrease swelling around the left knee and feeling of pain

- Relax hypertonic muscles which are left and right hamstrings and left piriformis
- Release stiffness of soft tissues around the scar also posterior fascia of both upper legs and anterior lateral tibia head level of left leg
- Reduce stiffness of left patella and head of fibula
- Increase ROM of left knee into flexion also hip flexion of both legs
- Lengthening rectus femoris of left leg
- Strengthening left leg weak muscles which are quadriceps femoris, gluteus maximus, gastrocnemius
- Correct left pelvic level
- Improve both legs muscles function which can cooperate in left knee and body stability also weight balance in both legs.
- Correct the gait pattern and emphasis the patient to use the left knee correctly.
- Improve stability of both legs by improve the sensorimotoric system
- Awareness of knee function

3.4.2 Long-term therapy plan

- Reach full ROM of left knee flexion and hip flexion of both legs
- Eliminate swelling and pain of left knee
- Release stiffness of left patella and head of fibula
- Correct position of left knee and hip
- Reach normal tonicity in both legs
- Maintain strength of left leg muscles
- Scar healed
- Restore patient confidence in left knee
- Maintain corrected gait pattern
- Improve ADL

3.4.3 Proposed therapy

- AROM exercise to increase left knee flexion ROM
- PIR according to Lewit to relax hypertonic hamstrings muscle of both legs
- Acupuncture to relax hypertonic left piriformis muscle

- Gait training to correct it and be aware of knee function
- STT according to Lewit to reduce stiffness around scar and stiff fascia of both legs
- STT with soft ball to reduce swelling around left knee specially caudal and medial
- Mobilization of joint play according to Lewit to release left patella and fibula
- Stretching exercise for left rectus femoris to increase left knee
- Stretching left hamstrings to correct position of left knee and to release hypertone
- Strengthening exercise of left leg muscles quadriceps femoris, gluteus maximus, gastrocnemius to increase their strength and stabilize the knee joint also increase stability or balance and improve left leg function
- Strengthening left hip abductors and adductors to cooperate in knee stability and body balance or stability
- Sensomotric exercises to increase stability and balance, balance weight bearing and increase left knee joint stability.

3.5 Therapy progress

Note: therapy proposal is written with applied therapy

1st session

Date: 14.1.2020

Duration: 45 min

Subjective: patient operation was in 12.12.2019 and this is the first session after it, patient play yoga today morning for 30min for stretching and control breathing and complain from strong pain comes from gluteal maximus region to the thigh posteriorly and stops in left knee laterally.

Objective: initial kinesiology examinations preformed today in the beginning, patient was a bit tiring after it

Goal of today session:

- Reduce swelling above patella medially and laterally as arch
- Release stiff soft tissues around the scar

- Release stiff fascia left and right posterior fascia of both upper legs and anterior lateral tibia head level of left leg
- Release joint play of left patella and head of fibula
- Relax hypertonic muscles left and right hamstrings and left piriformis
- Stretch left rectus femoris muscle
- Increase ROM of left knee into flexion
- Correct gait pattern

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling specially caudal and medial of knee joint by rolling the ball with slight pressure starting from caudal to cranial, also STT for scar according to Lewit is used along the scar medial and lateral directions, patient in supine with roll pillow under the left knee, applied for 7min
- fascia STT according to Lewit to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 7min.
- mobilization according to Lewit for patella into caudal and lateral direction specially and head of fibula into anterior direction
- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, with 3 repeats.
- Because it is impossible to use PIR method to relax left piriformis as the movement is contraindicated instead of it acupuncture is used applied by my supervisor.
- to stretch rectus femoris muscle passive stretching is used then using PIR can cooperate with stretching, patient in prone position with flexed left knee as much as possible, holding under the ankle and stretch gently without pain if barrier is reached hold it in same level for 20 seconds then release and relax 20 seconds, repeating it 3 times

- Using AROM to increase ROM in left knee, patient in prone position, fixating femur and holding under the ankle to perform the movement, repeating it 10 times.
- Patient instructed to correct the gait by walking forward, backward and sideward with hip and knee flexion 90 degree this way emphasized using the left knee into flexion also to improve leg muscles function and improve stability, then walking on tip toes to improve strength of foot and lower leg muscles and stability, patient do it for each direction 10 times.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, repeat it 3 times in 4 repeats a day.
- Using ice packs in place where patient feel pain in anterior lateral of left knee joint near the scar, cover it with towel to avoid burning then putting it for 5-10 min, temperature approximately -6°C , repetition a day depends on the level of pain feeling.
- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.

Therapy evaluation:

Subjective: patient feel tired as it is the first session, moderate pain is felt in anterior lateral side of left knee joint during the therapy but the ability to do the therapy complete was good.

Objective: today therapy is less than it should be because patient feel a bit tiring before starting, during passive stretch of rectus femoris engaging to new barrier was not felt ,and stiffness of patella was very hard in the beginning with strong pain but it decrease after repetitions, during PIR of hamstrings patient felt strong pain of tension but it decrease after 3rd repeat, other therapies went well and with improve.

2nd session

Date: 16.1.2019

Duration: 40min

Subjective: patient also play yoga today for 30min for stretching and control breathing before the session, she still feel the same pain that comes from gluteal maximus region to the thigh posteriorly and stops in left knee laterally but as patient said it increase during flexion of trunk, patient don't feel any change from last session, she try to do the self-therapy but not well.

Objective: ROM of left knee flexion still 90 degree, hard stiffness still in patella and head of fibula but soft tissues around the scar slightly released, no decrease of semi flexion position of left knee and fascia of posterior upper leg still stiff.

Goal of today session:

- Release stiff soft tissues around the scar
- Reduce swelling above patella medially and laterally as arch
- Release stiff fascia left and right posterior facia of both upper legs and anterior lateral tibia head level of left leg
- Release joint play of left patella and head of fibula
- Correct gait pattern
- Sensomotric training and awareness of knee function
- Weight bearing balance training
- Increase ROM of left knee and both sides hip into flexion
- Strengthening of gluteus maximus, hamstrings, adductors and abductors of both legs against resistance
- Stretch left rectus femoris muscle and both sides hamstrings
- Relax hypertonic muscles left and right hamstrings and left piriformis

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling specially caudal and medial of knee joint by rolling the ball with slight pressure starting from caudal to cranial, also scar STT according to Lewit is used along the scar medial and lateral directions, patient in supine with roll pillow under the left knee, applied for 7min

- fascia STT according to Lewit to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 5min.
- mobilization according to Lewit for patella into caudal and lateral direction specially and head of fibula into anterior direction.
- Patient instructed to correct the gait by walking forward, backward and sideward with hip and knee flexion 90 degree this way emphasized using the left knee into flexion also to improve leg muscles function and improve stability, then walking on tip toes to improve strength of foot and lower leg muscles and stability, patient do it for each direction 10 times.
- For sensomotric training, after teaching the patient the short foot formation then to stimulate foot proprioceptors patient will step on plate of rocks few steps for 10 seconds then perform on posturomed a half step for both legs with correct posture (like stick on the back and try to let parts of posture to reach the stick in one line) and contract of abdominal muscle core this it will be on all sensomotric trainings, then with half step on posturomed patient try to shake it and stop it few times, after this patient will walk through the posturomed forward, backward and sideward with correct gait, all of these trainings the repetitions is for 10 times.
- For weight bearing balance patient will sit on the big ball then getting up from it but not complete maintain knee flexion less than 90 degree and trunk flexion with correct posture and contraction of abdominal muscle core, foot are in same line stay in this position for 5 seconds and repeat it for 10 times, this exercise is also for strengthening legs muscles specially rectus femoris, hamstrings, gluteus maximus.
- Using AROM to increase ROM in left knee, patient in prone position, fixating femur and ask patient to flex the knee maximum, repeating it 10 times, also by sitting on the big ball with correct posture and ask the patient to step forward until the ball reach buttock only then step backward until ball reach whole upper leg, repeat it 10 times for one round. It also increase stability

- For strengthening patient in supine with knee flexed placing the small ball between the knees and elastic band rolling on both knees together then ask the patient to press against the ball (to strength adductors) then against the band (to strength abductors) to preform isometric contraction, to strength rectus femoris patient in the same position but small ball is under patient heel then pressing against the ball after repetitions patient with the same position will raise buttock as much as possible to strength gluteus maximus and hamstrings, each exercise have 10 repeats and for both legs
- to stretch rectus femoris muscle passive stretching is used then using PIR can cooperate with stretching, patient in prone position with flexed left knee as much as possible, holding under the ankle and stretch gently without pain if barrier is reached hold it in same level for 20 seconds then release and relax 20 seconds, repeating it 3 times, it is also the same therapy for hamstrings by flexion of hip with knee extended (I put the leg on my shoulder and clasp my hands on the thigh to improve left knee extension) for both legs.
- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, with 3 repeats.
- Because it is impossible to use PIR method to relax left piriformis as the movement is contraindicated instead of it acupuncture is used applied by my supervisor.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using belt tight it under the ankle with extended knee bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring repeat it 3 times in 4 repetition a day
- Using ice packs in place where patient feel pain in anterior lateral of left knee joint near the scar, cover it with towel to avoid burning then putting it for 5-10 min, repetition a day depends on the level of pain feeling.

- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.
- Isometric contraction to strength gluteus maximus, rectus femoris and hip abductors and adductors as it explained in the therapy session

Therapy evaluation:

Subjective: same pain is felt it is moderate in the anterior lateral side of left knee joint during the therapy but the ability to do the therapy complete was good, patient was tired after strengthening exercises but satisfied

Objective: during passive stretch of rectus femoris engaging to new barrier was felt after 3rd repeat but it was very slight and patient feel uncomfortable with it because of stiffness pain in the left knee joint, the same like 1st session the stiffness of patella was very hard in the beginning with strong pain but it decrease after repetitions, relaxation of hamstrings it improved by engaging new barrier and less tension feeling, other therapies went well and with improve.

3rd session

Date: 21.1.2019

Duration: 40min

Subjective: patient played yoga before the session in 30min for stretching and control breathing, there is less feeling of pain which comes from gluteal maximus region to the thigh posteriorly, patient is not having enough attention to do the self-therapy as instructed.

Objective: ROM of left knee flexion still 90 degree, hard stiffness still in patella but head of fibula it was better, soft tissues around the scar is less stiff but it increase medially then laterally, swelling is still the same

Goal of today session:

- Reduce swelling above patella medially and laterally as arch
- Release stiff soft tissues around the scar
- Release stiff fascia left and right posterior fascia of both upper legs and anterior lateral tibia head level of left leg

- Release joint play of left patella and head of fibula
- Correct gait pattern
- Sensomotric training and awareness of knee function
- Weight bearing balance training
- Improve stability
- Increase ROM of left knee and both sides hip into flexion
- Strengthening of gluteus maximus, hamstrings, adductors and abductors of both legs against resistance
- Stretch left rectus femoris muscle and both sides hamstrings
- Relax hypertonic muscles left and right hamstrings and left piriformis

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling specially caudal and medial of knee joint by rolling the ball with slight pressure starting from caudal to cranial, also scar STT according to Lewit is used along the scar medial and lateral directions, patient in supine with roll pillow under the left knee, applied for 7min
- fascia STT according to Lewit to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 5min.
- mobilization according to Lewit for patella into caudal and lateral direction specially and head of fibula into anterior direction
- Patient instructed to correct the gait by walking forward, backward and sideward with hip and knee flexion 90 degree this way emphasized using the left knee into flexion also to improve leg muscles function and improve stability, then walking on tip toes to improve strength of foot and lower leg muscles and stability, patient do it for each direction 10 times.
- For sensomotric training, after teaching the patient the short foot formation then to stimulate foot proprioceptors patient will step on plate of rocks few steps for 10 seconds then perform on posturomed a half step for both legs with correct posture and contract of abdominal muscle core, then with half step on

posturomed patient try to shake it and stop it few times, after this patient will walk through the posturomed forward, backward and sideward with correct gait, then walking through the balance boards with knee and hip flexion 90 degree, all of these trainings the repetitions is for 10 times.

- For weight bearing balance patient will sit on the big ball then getting up from it but not complete maintain knee flexion less than 90 degree and trunk flexion with correct posture and contraction of abdominal muscle core, foot are in same line stay in this position for 5 seconds and repeat it for 10 times, this exercise is also for strengthening legs muscles specially rectus femoris, hamstrings, gluteus maximus.
- Using AROM to increase ROM in left knee, patient in prone position, fixating femur and ask patient to flex the knee maximum, repeating it 10 times, also by sitting on the big ball with correct posture and ask the patient to step forward until the ball reach buttock only then step backward until ball reach whole upper leg, repeat it 10 times for one round. It also increase stability
- For strengthening patient in supine with knee flexed placing the small ball between the knees and elastic band rolling on both knees together then ask the patient to press against the ball (to strength adductors) then against the band (to strength abductors) to preform isometric contraction, to strength rectus femoris patient in the same position but small ball is under patient heel then pressing against the ball after repetitions patient with the same position will raise buttock as much as possible to strength gluteus maximus and hamstrings, each exercise have 10 repeats and for both legs
- to stretch rectus femoris muscle passive stretching is used, passive stretching of rectus femoris muscle by using band putting it tight under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the bend toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using the bend tight it under the ankle with extended knee (patient can put hand on the thigh anteriorly to decrease semi flexion of the knee) bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring patient fix the pelvic by holding it by hand to avoid pelvic rotation ,repeating it 3 times

- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, and to stretch rectus femoris, with 3 repeats.
- Because it is impossible to use PIR method to relax left piriformis as the movement is contraindicated instead of it acupuncture is used applied by my supervisor.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using belt tight it under the ankle with extended knee bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring repeat it 3 times in 4 repetition a day
- Using ice packs in place where patient feel pain in anterior lateral of left knee joint near the scar, cover it with towel to avoid burning then putting it for 5-10 min, repetition a day depends on the level of pain feeling.
- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.
- Isometric contraction to strength gluteus maximus, rectus femoris and hip abductors and adductors as it explained in the therapy session

Therapy evaluation:

Subjective: patient feel less pain during therapy then before

Objective: patient still feel moderate uncomfortable during rectus femoris stretching but with PIR it is better for the patient, I can feel slight engaging to new barrier, stiffness in patella it released after repetitions also head of fibula it improved more, during walking on the balance boards patient loss balance and step outside the board but after repetitions there is improving, during strengthening exercises after 7th repeat patient feel tired but trying to do it slow then, other therapies went well and with improve.

4th session

Date: 23.1.2019

Duration: 40min

Subjective: patient not feeling pain anymore in the gluteus maximus region, there is feeling of confident in left knee

Objective: ROM of left knee flexion still limit with 90 degree, stiffness still in patella, there is release in soft tissues around the scar more than before, balance during single leg stance is improved, stiffness of fascia in the hamstrings region is decreased

Goal of today session:

- Reduce swelling above patella medially and laterally as arch
- Release stiff soft tissues around the scar
- Release stiff fascia left and right posterior fascia of both upper legs and anterior lateral tibia head level of left leg
- Mobilize left patella and head of fibula
- Correct gait pattern
- Sensomotric and balance training
- Weight bearing balance training
- Improve stability
- Increase ROM of left knee and both sides hip into flexion
- Strengthening with weight of gluteus maximus, hamstrings, adductors and abductors of both legs
- Stretch left rectus femoris muscle and both sides hamstrings
- Reduce semi flexion position of left knee
- Relax hypertonic muscles left and right hamstrings

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling specially caudal and medial of knee joint by rolling the ball with slight pressure starting from caudal to cranial, also scar STT according to Lewit is used along the scar medial and lateral directions, patient in supine with roll pillow under the left knee, applied for 7min
- fascia STT according Lewit to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in

hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 5min.

- mobilization according to Lewit for patella into caudal and lateral direction specially and head of fibula into anterior direction
- Patient instructed to correct the gait by walking forward, backward and sideward with hip and knee flexion 90 degree this way emphasized using the left knee into flexion also to improve leg muscles function and improve stability, then walking on tip toes to improve strength of foot and lower leg muscles and stability, patient do it for each direction 10 times.
- For sensomotric training, after teaching the patient the short foot formation then to stimulate foot proprioceptors patient will step on plate of rocks few steps for 10 seconds then preform on posturomed a half step for both legs with correct posture and contract of abdominal muscle core, then with both legs and knee slightly flexed on posturomed patient try to shake it and stop it few times, after this patient will walk through the posturomed forward, backward and sideward with correct gait, then walking through the balance boards with knee and hip flexion 90 degree, all of these trainings the repetitions is for 10 times.
- Training of stability and weight bearing balance by bosu, steeping on in with both legs apart and knee slight flexed with correct posture and contract abdominal core ask patient to put the weight in front feeling it in toes then put weight in the back feeling it in heels without moving parts of body but whole body can lean and maintain balance also the same thing but to sides without pelvic elevation only knee flexed can change, then preforming single leg stance for both legs
- For strengthening, with weight 1kg on left leg above the ankle patient in side lying to preform hip abduction to strength hip abductors, patient in supine to preform extension of knee by putting the small ball under the knee then extend it laterally then medially to strength all parts of quadriceps femoris, last one with patient in prone position flex the knee to strength hamstrings then raise the leg up with knee flexed to strength gluteus maximus, each exercise have 10 repeats only for left leg

- Patient during strengthening exercise for hamstrings there is performing AROM in the same time for knee flexion
- to stretch rectus femoris muscle passive stretching is used, passive stretching of rectus femoris muscle by using band putting it tight under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the band toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using the band tight it under the ankle with extended knee (patient can put hand on the thigh anteriorly to decrease semi flexion of the knee) bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring patient fix the pelvis by holding it by hand to avoid pelvic rotation ,repeating it 3 times
- To correct semi flexion position of left knee and stretch hamstrings, patient in prone position close to the edge of the table bringing the left leg to fall over the edge, putting the small ball under the knee in the level of table edge then reach barrier by putting pressure above the ankle when it reached hold it for 20 seconds then relax for 20 seconds, then PIR can cooperate with stretching in the same position.
- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, and to stretch rectus femoris, with 3 repeats.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using belt tight it under the ankle with extended knee bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring repeat it 3 times in 4 repetition a day
- Using ice packs in place where patient feel pain in anterior lateral of left knee joint near the scar, cover it with towel to avoid burning then putting it for 5-10 min, repetition a day depends on the level of pain feeling.

- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.
- Gait training it explained in the therapy session

Therapy evaluation:

Subjective: patient satisfied from the therapy, getting used to it without feeling of tiredness in the end of session, feeling discomfort or little pain in the lateral side of knee it comes in some parts of the therapy

Objective: fascia is softer then it was before patient still feel moderate uncomfortable during rectus femoris stretching but with PIR it is better for the patient, I can feel slight engaging to new barrier, stiffness in patella it released after repetitions also head of fibula it improved more, during walking on the balance boards patient loss balance and step outside the board but after repetitions there is improving, during strengthening exercises after 7th repeat patient feel tired but trying to do it slow then, other therapies went well and with improve.

5th session

Date: 28.1.2019

Duration: 40min

Subjective: patient feel exciting to try more difficult exercises, she do not feel any pain or complications

Objective: there is reducing in swelling is noticeable laterally, stiffness in patella still the same but it improved cranially, there is more confident during walking in correct gait pattern, semi flexion of the left knee still the same.

Goal of today session:

- Aerobic training
- Reduce swelling above the patella medially to laterally as an arch
- Release stiff soft tissues around the scar
- Release stiff fascia left and right posterior facia of both upper legs and anterior lateral tibia head level of left leg
- Release joint play of left patella and head of fibula
- Sensomotric and balance training

- Weight bearing balance training
- Improve stability
- Increase ROM of left knee and both sides hip into flexion
- Strengthening with weight of gluteus maximus, hamstrings, adductors, abductors and quadriceps femoris of both legs
- Stretch left rectus femoris muscle and both sides hamstrings
- Reduce semi flexion position of left knee
- Relax hypertonic muscles left and right hamstrings

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling by rolling the ball with slight pressure starting from caudal to cranial, STT for the scar according to Lewit is used along the scar medial and lateral directions, patient in supine with roll pillow under the left knee, applied for 7min
- fascia STT to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 5min.
- mobilization according to Lewit for patella into caudal and lateral direction specially and head of fibula into anterior direction
- Aerobic exercises to increase AROM of left knee and strength the left leg muscles also stimulate or prepare the proprioceptors, by using the walker machine for 5 min in different directions in straight walking, side walking and back walking, speed is 1.7 km/h. After it using the stepper machine also for 5 min, 104 watt, 45 spm. After it using exercise bike machine also for 5 min, 22 W, 0.47 km, 43 rpm.
- For sensomotric training, after teaching the patient the short foot formation then to stimulate foot proprioceptors patient will step on plate of rocks few steps for 10 seconds then preform on posturomed a half step for both legs with correct posture and contract of abdominal muscle core, then with both legs and knee slightly flexed on posturomed patient try to shake it and stop it few

times, after this patient will walk through the posturomed forward, backward and sideward with correct gait, then walking through the balance boards with knee and hip flexion 90 degree and taking the small ball in the same time throw it up and catch it then pass it under the flexed knee and over the hip for one time on each step, all of these trainings the repetitions is for 10 times.

- Training of stability and weight bearing balance by bosu, steeping on in with both legs apart and knee slight flexed with correct posture and contract abdominal core ask patient to put the weight in front feeling it in toes then put weight in the back feeling it in heels without moving parts of body but whole body can lean and maintain balance also the same thing but to sides without pelvic elevation only knee flexed can change, then performing single leg stance for both legs.
- For strengthening, with weight 2kg for left leg only above the ankle patient in side lying to perform on left leg hip abduction and adduction to strength hip abductors and adductors, then patient in supine to perform extension of knee by putting the small ball under the knee then extend it laterally then medially to strength all parts of quadriceps femoris, last one with patient in prone position flex the knee to strength hamstrings then raise the leg up with knee flexed to strength gluteus maximus, then by using the big ball patient putting it in the wall and patient back lean on it with erected posture and knee flexed 90 degree and feet apart but in a line with knee placing the small ball between the knees to press against it in the same time ask the patient to go up with the big ball behind back and go down again to starting position to strength quadriceps femoris, hamstrings, gluteus maximus and adductors, each exercise have 10 repeats.
- Patient during strengthening exercise for hamstrings there is performing AROM in the same time
- to stretch rectus femoris muscle passive stretching is used, passive stretching of rectus femoris muscle by using band putting it tight under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the bend toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using the bend tight it under the ankle with extended knee (patient can put hand on the

thigh anteriorly to decrease semi flexion of the knee) bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring patient fix the pelvic by holding it by hand to avoid pelvic rotation ,repeating it 3 times

- To correct semi flexion position of left knee and stretch hamstrings, patient in prone position close to the edge of the table bringing the left leg to fall over the edge, putting the small ball under the knee in the level of table edge then reach barrier by putting pressure above the ankle when it reached hold it for 20 seconds then relax for 20 seconds, then PIR can cooperate with stretching in the same position.
- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, and to stretch rectus femoris, with 3 repeats.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using belt tight it under the ankle with extended knee bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring repeat it 3 times in 4 repetition a day
- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.
- Gait training as it explained in the first therapy sessions
- Self-strengthening exercises by AROM without weights on the leg for adductors and abductors in side lying of the patient performing abduction with adduction of left leg, hamstrings and gluteus in prone position performing extension of the left leg or in supine position with knee flexed trying to lift the pelvic as much as possible, quadriceps femoris in supine positions performing flexion of the knee with placing small ball under the knee, repetition 10 times one a day

Therapy evaluation:

Subjective: this time patient feel the difficulty of the exercises more than last sessions but she is good with it and she believe it is better for her.

Objective: strengthening exercise with big ball it was difficult for the patient she try to stop few times but she motivated to complete 10 repeats, also she loose her balance in the balance board with throwing the small ball but after repetitions she can use to it. There is strong limitation felt when doing PIR of rectus femoris feeling that three repetitions it is not enough. Stiffness of the joints play it decrease.

6th session

Date: 30.1.2019

Duration: 40min

Subjective: patient is not feeling any pain, there is feeling of confident in left knee more

Objective: ROM of left knee flexion still limit with 90 degree, stiffness still in patella, there is release in soft tissues around the scar more than before, stiffness of fascia in the hamstrings region still but it decreased more than before.

Goal of today session:

- Reduce swelling above the patella medially to laterally as an arch
- Release stiff soft tissues around the scar
- Release stiff fascia left and right posterior fascia of both upper legs and anterior lateral tibia head level of left leg
- Release joint play of left patella and head of fibula
- Aerobic training
- Sensomotric and balance training
- Weight bearing balance training
- Improve stability
- Increase ROM of left knee and both sides hip into flexion
- Strengthening with weight of gluteus maximus, hamstrings, adductors, abductors and quadriceps femoris of both legs
- Stretch left rectus femoris muscle and both sides hamstrings
- Reduce semi flexion position of left knee

- Relax hypertonic muscles left and right hamstrings

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling by rolling the ball with slight pressure starting from caudal to cranial, STT for the scar according to Lewit is used along the scar medial and lateral directions, patient in supine with roll pillow under the left knee, applied for 7min
- fascia STT to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 5min.
- mobilization according to Lewit for patella into caudal and lateral direction specially and head of fibula into anterior direction
- Aerobic exercises to increase AROM of left knee and strength the left leg muscles also stimulate or prepare the proprioceptors, by using the walker machine for 5 min in different directions in straight walking, side walking and back walking, speed is 1.7 km/h. After it using the stepper machine also for 5 min, 104 watt, 45 spm. After it using exercise bike machine also for 5 min, 22 W, 0.47 km, 43 rpm.
- For sensomotric training, after teaching the patient the short foot formation then to stimulate foot proprioceptors patient will step on plate of rocks few steps for 10 seconds then perform on posturomed a half step for both legs with correct posture and contract of abdominal muscle core, then with both legs and knee slightly flexed on posturomed patient try to shake it and stop it few times, after this patient will walk through the posturomed forward, backward and sideward with correct gait, then walking through the balance boards with knee and hip flexion 90 degree and taking the small ball in the same time throw it up and catch it then pass it under the flexed knee and over the hip for one time of each step, all of these trainings the repetitions is for 10 times.
- Training of stability and weight bearing balance by bosu, stepping on in with both legs apart and knee slight flexed with correct posture and contract

abdominal core ask patient to put the weight in front feeling it in toes then put weight in the back feeling it in heels without moving parts of body but whole body can lean and maintain balance also the same thing but to sides without pelvic elevation only knee flexed can change, then performing single leg stance for both legs, after then training by mini trampoline with the same concept with bosu by standing on it with feet apart and slight flexion of knee and correct posture without flexion of trunk, then ask the patient to try to shake the trampoline and stope it without moving parts of the body and keeping the weight on foot, or moving to sides and stope it without elevation of hip, or moving back and front and stope without moving any part of the body only putting weight front and back. After then training on narrow basis by using balance rope walking on it with trying keeping the balance.

- For strengthening, with weight 2kg on left leg above the ankle patient in side lying to perform on left leg hip abduction and adduction to strength hip abductors and adductors, then by using the big ball patient putting it in the wall and patient back lean on it with erected posture and knee flexed 90 degree and feet apart but in a line with knee placing the small ball between the knees to press against it in the same time ask the patient to go up with the big ball behind back and go down again to starting position to strength quadriceps femoris, hamstrings, gluteus maximus and adductors. After then exercising by using knee flexion machine for hamstrings and knee extension machine for quadriceps femoris with 10kg, each exercise have 10 repeats
- Patient during strengthening exercise for hamstrings there is performing AROM in the same time
- to stretch rectus femoris muscle passive stretching is used, passive stretching of rectus femoris muscle by using band putting it tight under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the bend toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using the bend tight it under the ankle with extended knee (patient can put hand on the thigh anteriorly to decrease semi flexion of the knee) bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch

lateral hamstring patient fix the pelvic by holding it by hand to avoid pelvic rotation ,repeating it 3 times

- To correct semi flexion position of left knee and stretch hamstrings, patient in prone position close to the edge of the table bringing the left leg to fall over the edge, putting the small ball under the knee in the level of table edge then reach barrier by putting pressure above the ankle when it reached hold it for 20 seconds then relax for 20 seconds, then PIR can cooperate with stretching in the same position.
- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, and to stretch rectus femoris, with 3 repeats.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using belt tight it under the ankle with extended knee bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring repeat it 3 times in 4 repetition a day
- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.
- Gait training as it explained in the first therapy sessions
- Self-strengthening exercises by AROM without weights on the leg for adductors and abductors in side lying of the patient performing abduction with adduction of left leg, hamstrings and gluteus in prone position performing extension of the left leg or in supine position with knee flexed trying to lift the pelvic as much as possible, quadriceps femoris in supine positions performing flexion of the knee with placing small ball under the knee, repetition 10 times one a day

Therapy evaluation:

Subjective: patient satisfied from the therapy, getting used to it without feeling of tiredness in the end of session, she feel uncomfortable and little exhausting when she reach 7th repeat of the strength exercise but she can continue to 10 repeat.

Objective: I can feel more release of scar tissues then before reach to moderate barrier, patient still feel moderate uncomfortable during rectus femoris stretching, but can feel slight engaging to new barrier, during walking on the balance boards patient loss balance and step outside the board but after repetitions there is improving it is the same on balance rope, in strengthening on the machine of knee extension there was shaking of the leg but without pain or complications but patient feel uncomfortable when sitting on it because of the position of the knee but after repetition patient was good.

7th session

Date: 4.2.2019

Duration: 40min

Subjective: patient was excited for the exercises physically and psychologically without any complains on her left knee

Objective: patient apply kinesiology tape on her left knee for stabilization, ROM of left knee flexion improve to 95 degree, stiffness in patella it is only caudal lateral, there is improvement in release scar stiffness, patient is stable in the left leg when standing in single leg, swelling it decrease laterally only, stiffness in fascia hamstrings region still the same.

Goal of today session:

- Reduce swelling above the patella medially to laterally as an arch
- Release stiff soft tissues around the scar
- Release stiff fascia left and right posterior fascia of both upper legs and anterior lateral tibia head level of left leg
- Release joint play of left patella and head of fibula
- Aerobic training
- Sensomotric and balance training
- Weight bearing balance training
- Improve stability
- Increase ROM of left knee and both sides hip into flexion
- Strengthening with weight of gluteus maximus, hamstrings, adductors, abductors and quadriceps femoris of both legs

- Stretch left rectus femoris muscle and both sides hamstrings
- Reduce semi flexion position of left knee
- Relax hypertonic muscles left and right hamstrings

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling by rolling the ball with slight pressure starting from caudal to cranial, STT for the scar according to Lewit is used along the scar medial and lateral directions, patient in supine with roll pillow under the left knee, applied for 7min
- fascia STT to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 5min.
- mobilization according to Lewit for patella into caudal and lateral direction specially and head of fibula into anterior direction
- Aerobic exercises to increase AROM of left knee and strength the left leg muscles also stimulate or prepare the proprioceptors, by using the walker machine for 5 min in different directions in straight walking, side walking and back walking, speed is 1.7 km/h. After it using the stepper machine also for 5 min, 104 watt, 45 spm. After it using exercise bike machine also for 5 min, 22 W, 0.47 km, 43 rpm.
- For sensomotric training, after teaching the patient the short foot formation then to stimulate foot proprioceptors patient will step on plate of rocks few steps for 10 seconds then perform on posturomed a half step for both legs with correct posture and contract of abdominal muscle core, then with both legs and knee slightly flexed on posturomed patient try to shake it and stop it few times, after this patient will walk through the posturomed forward, backward and sideward with correct gait, then walking through the balance boards with knee and hip flexion 90 degree and taking the small ball in the same time throw it up and catch it then pass it under the flexed knee and over the hip for one time of each step, all of these trainings the repetitions is for 10 times.

- Training of stability and weight bearing balance by bosu, steeping on in with both legs apart and knee slight flexed with correct posture and contract abdominal core ask patient to put the weight in front feeling it in toes then put weight in the back feeling it in heels without moving parts of body but whole body can lean and maintain balance also the same thing but to sides without pelvic elevation only knee flexed can change, then performing single leg stance for both legs, after then training by mini trampoline with the same concept with bosu by standing on it with feet apart and slight flexion of knee and correct posture without flexion of trunk, then ask the patient to try to shake the trampoline and stop it without moving parts of the body and keeping the weight on foot, or moving to sides and stop it without elevation of hip, or moving back and front and stop without moving any part of the body only putting weight front and back. After then training on narrow basis by using balance rope walking on it with trying keeping the balance.
- For strengthening, with weight 2kg on left leg above the ankle patient in side lying to perform on left leg hip abduction and adduction to strength hip abductors and adductors, then by using the big ball patient putting it in the wall and patient back lean on it with erected posture and knee flexed 90 degree and feet apart but in a line with knee placing the small ball between the knees to press against it in the same time ask the patient to go up with the big ball behind back and go down again to starting position to strength quadriceps femoris, hamstrings, gluteus maximus and adductors. After then exercising by using knee flexion machine for hamstrings and knee extension machine for quadriceps femoris with 10kg, each exercise have 10 repeats
- Patient during strengthening exercise for hamstrings there is performing AROM in the same time
- to stretch rectus femoris muscle passive stretching is used, passive stretching of rectus femoris muscle by using band putting it tight under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the bend toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using the bend tight it under the ankle with extended knee (patient can put hand on the thigh anteriorly to decrease semi flexion of the knee) bring the leg toward the

trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring patient fix the pelvic by holding it by hand to avoid pelvic rotation ,repeating it 3 times

- To correct semi flexion position of left knee and stretch hamstrings, patient in prone position close to the edge of the table bringing the left leg to fall over the edge, putting the small ball under the knee in the level of table edge then reach barrier by putting pressure above the ankle when it reached hold it for 20 seconds then relax for 20 seconds, then PIR can cooperate with stretching in the same position.
- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, and to stretch rectus femoris, with 3 repeats.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using belt tight it under the ankle with extended knee bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring repeat it 3 times in 4 repetition a day
- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.
- Gait training as it explained in the first therapy sessions
- Self-strengthening exercises by AROM without weights on the leg for adductors and abductors in side lying of the patient performing abduction with adduction of left leg, hamstrings and gluteus in prone position performing extension of the left leg or in supine position with knee flexed trying to lift the pelvic as much as possible, quadriceps femoris in supine positions performing flexion of the knee with placing small ball under the knee, repetition 10 times one a day

Therapy evaluation:

Subjective: patient feel exhausted when using mini trampoline but she is satisfying with the therapy.

Objective: head of fibula it release and the stiffness cranially of patella it release also, patient leg is shaking during strength exercise on knee extension machine but without pain or any complications,

8th session

Date: 5.2.2019

Duration: 1h (20min for final examinations + 40min therapy)

Subjective: patient fall over last night she slip from her left leg when going down stairs but she fall on her buttocks, she did not feel pain after it, patient was walking more confidently then before.

Objective: final kinesiology examination was done today, stiffness in the hamstrings region is still, stiffness of scar is only medially and patella it released cranially only, head of fibula it release, ROM in knee flexion still 95 degree, increasing of left thigh volume can be noticed.

Goal of today session:

- Reduce swelling above the patella medially to laterally as an arch
- Release stiff soft tissues around the scar
- Release stiff fascia left and right posterior facia of both upper legs and anterior lateral tibia head level of left leg
- Release joint play of left patella and head of fibula
- Aerobic training
- Sensomotric and balance training
- Weight bearing balance training
- Improve stability
- Increase ROM of left knee and both sides hip into flexion
- Strengthening with weight of gluteus maximus, hamstrings, adductors, abductors and quadriceps femoris of both legs
- Stretch left rectus femoris muscle and both sides hamstrings
- Reduce semi flexion position of left knee
- Relax hypertonic muscles left and right hamstrings

Procedure of therapy applied:

- STT by soft ball is used around the scar and around left knee joint to reduce swelling by rolling the ball with slight pressure starting from caudal to cranial, STT for the scar according to Lewit is used along the scar medial directions, patient in supine with roll pillow under the left knee, applied for 7min
- fascia STT to release stiffness of fascia on left and right upper leg posteriorly, patient in prone position, applying the therapy in hamstrings region in left and right leg in both directions lateral and medial, also applied STT on the anterior lateral of tibia head level of left leg with patient in supine and roll pillow under the knee, applied for 5min.
- mobilization according to Lewit for patella into caudal and lateral direction
- Aerobic exercises to increase AROM of left knee and strength the left leg muscles also stimulate or prepare the proprioceptors, by using the walker machine for 5 min in different directions in straight walking, side walking and back walking, speed is 1.7 km/h. After it using the stepper machine also for 5 min, 104 watt, 45 spm. After it using exercise bike machine also for 5 min, 22 W, 0.47 km, 43 rpm.
- For sensomotric training, after teaching the patient the short foot formation then to stimulate foot proprioceptors patient will step on plate of rocks few steps for 10 seconds then perform on posturomed a half step for both legs with correct posture and contract of abdominal muscle core, then with both legs and knee slightly flexed on posturomed patient try to shake it and stop it few times, after this patient will walk through the posturomed forward, backward and sideward with correct gait, then walking through the balance boards with knee and hip flexion 90 degree and taking the small ball in the same time throw it up and catch it then pass it under the flexed knee and over the hip for one time of each step, all of these trainings the repetitions is for 10 times.
- Training of stability and weight bearing balance by bosu, steeping on in with both legs apart and knee slight flexed with correct posture and contract abdominal core ask patient to put the weight in front feeling it in toes then put weight in the back feeling it in heels without moving parts of body but whole body can lean and maintain balance also the same thing but to sides without pelvic elevation only knee flexed can change, then performing single leg stance for both legs, after then training by mini trampoline with the same

concept with bosu by standing on it with feet apart and slight flexion of knee and correct posture without flexion of trunk, then ask the patient to try to shake the trampoline and stope it without moving parts of the body and keeping the weight on foot, or moving to sides and stope it without elevation of hip, or moving back and front and stope without moving any part of the body only putting weight front and back. After then training on narrow basis by using balance rope walking on it with trying keeping the balance.

- For strengthening, with weight 2kg on left leg above the ankle patient in side lying to perform on left leg hip abduction and adduction to strength hip abductors and adductors, then by using the big ball patient putting it in the wall and patient back lean on it with erected posture and knee flexed 90 degree and feet apart but in a line with knee placing the small ball between the knees to press against it in the same time ask the patient to go up with the big ball behind back and go down again to starting position to strength quadriceps femoris, hamstrings, gluteus maximus and adductors. After then exercising by using knee flexion machine for hamstrings and knee extension machine for quadriceps femoris with 10kg, each exercise have 10 repeats
- Patient during strengthening exercise for hamstrings there is preforming AROM in the same time
- to stretch rectus femoris muscle passive stretching is used, passive stretching of rectus femoris muscle by using band putting it tight under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the bend toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using the bend tight it under the ankle with extended knee (patient can put hand on the thigh anteriorly to decrease semi flexion of the knee) bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring patient fix the pelvic by holding it by hand to avoid pelvic rotation ,repeating it 3 times
- To correct semi flexion position of left knee and stretch hamstrings, patient in prone position close to the edge of the table bringing the left leg to fall over the edge, putting the small ball under the knee in the level of table edge then reach barrier by putting pressure above the ankle when it reached hold it for 20

seconds then relax for 20 seconds, then PIR can cooperate with stretching in the same position.

- PIR method according to Lewit was used to relax hypertonic hamstrings muscle, and to stretch rectus femoris, with 3 repeats.

Self therapy:

- passive stretching of rectus femoris muscle by using any belt putting it under the ankle and holding it with patient in prone position and maximum flexion of left knee can perform passive stretching by pulling the belt toward the trunk, hold it for 20 seconds then relax for 20 seconds, also stretching hamstrings by using belt tight it under the ankle with extended knee bring the leg toward the trunk laterally to stretch medial hamstring then bring it medially to stretch lateral hamstring repeat it 3 times in 4 repetition a day
- AROM of left knee joint, patient in prone position repeat left knee maximum flexion 10 times for 4 repetitions a day.
- Gait training as it explained in the first therapy sessions
- Self-strengthening exercises by AROM without weights on the leg for adductors and abductors in side lying of the patient performing abduction with adduction of left leg, hamstrings and gluteus in prone position performing extension of the left leg or in supine position with knee flexed trying to lift the pelvic as much as possible, quadriceps femoris in supine positions performing flexion of the knee with placing small ball under the knee, repetition 10 times one a day

Therapy evaluation:

Subjective: patient satisfied with the therapy sessions

Objective: head of fibula it release and the stiffness cranially of patella it release also, scar stiffness it release laterally only, ROM of left knee flexion still 95 degree, a strong limitation if felt when doing PIR of rectus femoris and it is impossible to go farther when doing passive stretching of it because patient will feel strong pain, there is improvement of left thigh muscle volume it can be noticed, feeling of release and stretched when stretching hamstrings in prone position.

3.6 Final kinesiology examinations

3.6.1 Static Postural examination

Anterior view

Table 14 Final Static Postural examination anterior view

the base of support	Both feet enclosed within a 30 degree angle, it have a shape of trapezoid
Arches of foot	Lateral arch of both feet are more in contact with floor more then medial arch
the position and shape of the toes	physiological
shape and position of the knee joints	Left knee slightly in semi flexion almost extended compared to right knee
Patella position	Left patella is slightly shifted laterally compared to the right
configuration of m. tibialis anterior	Physiological and symmetrical compared of both sides
shape of the thigh muscles (the quadriceps femoris)	There is slight swelling in the insertion of the left muscles medially only ,and it is less volume compared to right muscles
position of the pelvis	Left pelvic is slightly depressed
symmetry of the muscle tone of abdominal muscles	Symmetrical
Position of umbilicus	Physiologic
position and symmetry of the chest	Symmetrical and Physiologic
position of the shoulder girdle	Right shoulder is elevated compared with left
position of the upper limbs	Both sides elbow are in slight flexion almost extended
position of the head	Physiologic

Lateral view (both sides R/L)

Table 15 Final Static Postural examination lateral view

shape and position of the ankle joints	Physiological without planter or dorsal flexion
shape and contour of the shin	physiological
position of the knee joints	Right knee joint in slight hyper extension but left knee joint in slight semi flexion almost extended
contour of the thigh muscles	Volume of the right thigh muscles is bigger then left thigh muscles
contour of the calf muscles	Volume is symmetrical
position of the pelvis	Slightly increased in anteversion
position and curvature of the spine	Slight increased of kyphotic in thoracic spine and lordosis of lumber spine
shape of the abdominal muscles	prominence of belly
position of the shoulder girdle	Protracted of both sides
position of the head	Slightly protracted

Posterior view

Table 16 Final Static Postural examination posterior view

the base of support	Both feet enclosed within a 30 degree angle, it have a shape of trapezoid
shape and contours of the heels	physiological
shape and position of the ankle joints	Physiological without pronation or supination
shape and thickness of the Achilles tendon	Symmetrical of both sides and physiologic
contour of the calf muscles (medial and lateral part)	Volume is symmetrical
shape and position of the knee joints	Left knee joint in slight semi flexion almost extended and right knee in hyper extension
popliteal line	Left line is lower then right slightly

contour of the thigh muscles - especially the adductors	Left thigh muscles is less volume than right but there is slight swelling in insertion part medially only
subgluteal line	Symmetrical of both sides
gluteal muscles	Physiologic and symmetric
position of pelvis	Left pelvic is slightly depressed
paravertebral muscles	Physiological shape and prominence
curvature of the spine in the frontal plane	Physiologic and symmetric in lateral and medial side
position of the scapula	Slightly in external rotation more in both sides
position of the shoulder girdle	It is protracted and right shoulder is elevated than left
position of the upper limb	Slight flexion in both sides elbows but almost extended
position and contour of the nuchal muscles	Physiologic
position of the head	Protracted but no lateral tilt

3.6.2 Dynamic spine examination

Forward flexion: there is no limitation during the movement patient can touch the ground with fingers but the body lean back ward slightly during it, curve of spine is physiologic and symmetrical laterally, there is prominence of Th-L spine junction and lumbar spine, during the move patient feel pain spreading over the right leg from right buttock to posterior part of the thigh and stop there but there is no pain during return to upright position.

Lateral flexion L/R: there is no limitation during movement and no pain, but there is prominence of Th-L spine junction.

Backward flexion: there is no limitation and no pain, curve is physiologic and lateral symmetry, but there is prominence of the lumbar spine.

3.6.3 Specific testing of posture

Tow scale standing: right side is 28 and left side is 27, difference it is only 1kg (not bigger than 15% of body weight about 3kg)

Véle test: grade 1/normal

Romberg test I, II and III: negative

Single leg stand test: left leg standing without shaking and without pain, right leg standing without shaking and without pain also

Trendelenburg: negative

3.6.4 Pelvis palpation

- height and symmetry of cristae iliacae: left is lower than right slightly
- height and symmetry of posterior superior iliac spine: left slightly lower than right
- height and symmetry of anterior superior iliac spine: left slightly lower than right
- pelvis position: there is slight lateral tilt (depression) of the left side only, without pelvic rotation or torsion

3.6.5 Gait analysis

patient walk without assistive device, periodic walking in normal steps length and speed. there is flexion of left knee but still not enough during walking because patient not confident in left knee. Patient do complete phases in right and left leg (heel strike – flat foot- heel off- toe off) without complications also in stance phase and swing phase the difference is flexion of left knee is lesser than right knee during mid stance but it does not effect next phases, swinging of hip is optimal and slightly, there is no movement in the trunk and head but position of head and shoulder are protracted slightly, arms swing slightly almost no movement but it is rhythmical moves, patient stable during walking and not need any support, abdominal muscles and back muscles activate physiologically during walking, patient not feeling any pain during walking specially in left knee joint.

During gait modifications the results are:

- walking with upstretched arms patient was stable and had no problem to do it correct

- walking on tiptoe patient was stable and able to do it without pain
- walking on heels patient was stable and able to do it without pain
- walking on the narrow basis patient able to do it but with slight shaking
- walking on soft surfaces patient able to do it with good stability
- walking with eyes closed patient able to do it with good stability
- walking backwards patient able to do it with good stability without pain

3.6.6 Goniometry measurements of joint ROM (according to Janda, SFTR format) on LE

Table 17 Final goniometry measurements of joint ROM

	Right leg		Left leg	
	Passive ROM	Active ROM	Passive ROM	Active ROM
Hip joint	S 30-0-105	S 25-0-90	S 30-0-95	S 20-0-95
	F 85-0-20	F 80-0-20	F 85-0-20	F 80-0-20
	R 40-0-30	R 30-0-25	CI	CI
Knee joint	S 10-0-139	S 10-0-130	S 5-0-95	S 5-0-95
Ankle joint	S 15-0-50	S 15-0-45	S 15-0-50	S 10-0-50
	R 20-0-40	R 20-0-40	S 20-0-35	R 20-0-35

3.6.7 Anthropometric measurements on LE

Table 18 Final anthropometric measurements

	Right leg	Left leg
Anatomical length of lower extremity	84 cm	81.5 cm
Functional length of lower extremity	83 cm	80.5 cm
Length of thigh	44 cm	42 cm
Length of middle leg	39 cm	41 cm
Length of foot	23 cm	23 cm
Circumference of thigh 15cm above knee cap	51.5 cm	50 cm
Circumference of thigh 10cm above knee cap	47 cm	46 cm

Circumference of the knee joint	37 cm	38 cm
Circumference of the calf	35 cm	34 cm
Circumference of the ankle	25 cm	25 cm
Circumference of the foot	23 cm	23 cm

3.6.8 Muscle length tests (according to Janda) on LE

Table 19 Final muscle length test

	Right leg	Left leg
Tow joint planter flexors (m.gastrocnemius- m.plantaris)	Grade 0	Grade 0
One joint planter flexor (m.soleus - m.popliteus)	Grade 0	Grade 0
Tow joint hip flexors	Grade 0	Grade 2
One joint hip flexors	Grade 0	Grade 0
Tow joint hip adductors	Grade 0	Grade 0
One joint hip adductors	Grade 0	Grade 0
Hamstrings	Grade 0	Grade 0

3.6.9 Muscle strength tests (according to Kendal) on LE

Table 20 Final muscle strength test

	Right leg	Left leg
Iliopsoas	Grade 4	Grade 4
Gluteus maximus	Grade 5	Grade 4
Gluteus medius	Grade 4 +	Grade 4+
Gluteus minimus	Grade 4 +	Grade 4+
Lateral hamstring	Grade 5	Grade 5
Medial hamstrings	Grade 5	Grade 5
Popliteus	Grade 5	Grade 5
Tensor fascia latae	Grade 5	Grade 5
Sartorius	Grade 5	Grade 5
Hip Adductors	Grade 4	Grade 4

Gastrocnemius + Plantaris	Grade 5	Grade 4+
soleus	Grade 5	Grade 5
Quadriceps femoris	Grade 5	Grade 4
External rotators	Grade 5	Grade 4
Tibialis anterior	Grade 5	Grade 5
Tibialis posterior	Grade 5	Grade 5
Peroneus longus	Grade 5	Grade 5
Peroneus brevis	Grade 5	Grade 5

3.6.10 Muscle tone palpation on LE

Table 21 Final muscle tone palpation

	Right leg			Left leg		
	Origin	belly	Insertion	origin	belly	insertion
Iliopsoas	Normal tone			Normal tone		
Gluteus maximus	normal	hypotone	normal	normal	hypotone	normal
Gluteus medius	Normal tone			Normal tone		
Gluteus minimus	Normal tone			Normal tone		
Tensor fascia latae	Normal tone			Normal tone		
piriformis	Normal tone			normal	normal	normal
Biceps femoris	Hypertone			Hypertone		
Semitendinosus	Normal tone			normal	normal	hypertone
Semimembranosus	Normal tone			normal	normal	hypertone
Sartorius	Normal tone			normal	normal	hypotone
Hip Adductors	Normal tone			normal	normal	normal
Gastrocnemius	Normal tone			normal	normal	normal
soleus	Normal tone			Normal tone		
Rectus femoris	normal	Hypertone	normal	normal	normal	normal
Vastus lateralis	Normal tone			normal	normal	normal
Vastus medialis	Normal tone			normal	normal	hypotone

3.6.11 Joint play examination (according to lewit) on LE

Table 22 Final joint play examination

	Right leg	Left leg
Patella	No restriction	Restricted caudal and lateral direction with moderate barrier
Tibiofemoral	No restriction	CI
Head of fibula	No restriction	No restriction
Talocrural joint	No restriction	No restriction
Subtalar joint	No restriction	No restriction
Chopart joint	No restriction	No restriction
Lisfranc joint	No restriction	No restriction

3.6.12 Movement stereotype (according to Janda) on LE

Table 23 Final movement stereotype examination

	Right leg	Left leg
Hip extension	Slight hip rotation to the right side from beginning without anterior tilt of pelvic	Marked hip rotation to the right side from the beginning but no anterior tilt of pelvic
Hip abduction	The movement is combined with slight flexion of the leg with stable trunk and pelvic	The movement is combined with slight flexion of the leg with stable trunk and pelvic

3.6.13 Neurologic examination (superficial sensation)

Table 24 Final neurologic examination

Segments dermatomes	Right leg	Left leg
L1 segment	Normal sensation	Normal sensation
L2 segment	Normal sensation	Normal sensation
L3 segment	Normal sensation	Normal sensation
L4 segment	Normal sensation	Normal sensation

L5 segment	Normal sensation	Normal sensation
S1 segment	Normal sensation	Normal sensation
S2 segment	Normal sensation	Normal sensation

Note: less sensation when reach the scar

3.6.14 Scar examination (aspection + palpation)

The length of the scar is 7cm long located in the anterior aspect of the knee joint of left leg in the midline proximately between caudal part of patella and head of tibia, stitches wasn't observed and not painful when being touched, swelling is only medially of the knee above patella in the insertion of gracilis, sartorius and vastus medialis and redness still along the scar only and it is very light , no inflammation signs and no pathologic aspect in other parts of whole left leg.

During palpation of cutis and subcutis tissues there is stiffness along and the scar medially and it increase caudally then cranially moderate barrier is felt ,without pain and temperature is physiologic.

3.6.15 Fascia examination (according to Lewit)

Table 25 Final fascia examination

	Right leg	Left leg
Upper leg	Anterior: elastic no restriction is felt in lateral and medial direction Posterior: slight barrier is felt lateral and medial direction	Anterior :elastic no restriction is felt in lateral and medial direction Posterior :hard barrier is felt lateral and medial direction
Lower leg	Both posterior and anterior: elastic no restriction is felt in lateral and medial direction	Anterior: slight barrier is felt only in the head of tibia level laterally Posterior: elastic no restriction is felt in lateral and medial direction
Achilles tendon	elastic no restriction is felt in lateral and medial	elastic no restriction is felt in lateral and medial

	direction	direction
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3.6.16 Final examination conclusion

There is difference between initial examinations results and final examinations results, some results shows the improvements that should be as a goal and some results remain the same unfortunately but without any deterioration. The improvement is on elimination of the swelling laterally only, semi flexion of left knee is slightly decreased almost to extension but still noticeable this result change the anatomical and functional length to increase 2.5cm difference, there is increasing of left thigh muscles volume after strengthening exercises to reach 1.5cm difference of circumference, strength also increase in left leg iliopsoas, quadriceps femoris and external rotators all to grade 4 and gluteus maximus, gluteus medius, gluteus minimus, gastrocnemius + plantaris all improve to grade 4+ also popliteus and soleus muscles improved to grade 5. Also improvements of muscle tone to reach the symmetry and normal tonicity of left leg piriformis, semitendinosus and semimembranosus change only in belly but the insertion still hypertonic, gastrocnemius, rectus femoris, vastus lateralis. During gait analysis the improvement was on left knee flexion during walking but still not enough, because patient try to flex the hip and knee also during walking there is no elevation of the left hip and swinging of leg during walking, there is no pain in the left knee after repetition of walking, a great improvement of stability during walking on heels and narrow basis without pain also patient able to stand in single leg without shaking. In ROM of left knee flexion increase only 5 degree passively and actively and left planter flexion increase to 50 degree actively also left hip flexion increase 5 degree only passively and actively. Improvement in release stiffness of joint play in left patella cranially only and complete release of left head of fibula. Reaching normal superficial sensation of L5 region. During scar examination lateral scar tissues it completely release.

3.7 Evaluation of the effect of the therapy

3.7.1 Specific testing

Single leg stand test:

Initial: left leg standing with moderate shaking but without pain

Final: left leg standing without shaking and without pain

After sensomotric training for eight sessions there is a good results patient able to keep the stability in left leg.

3.7.2 Gait analysis

Initial: there is no flexion of the left knee during walking which make patient to elevate left hip slightly and swing the left leg forward with slight flexion of left hip to move body forward, there is absent of heel-off and toe-off in the left feet movement, pelvis swing rhythmically but lateral tilt it increase in the right, patient feel pain in knee joint laterally after repetitions of walking, patient was not able to walk on heels and not stable to walk on narrow basis.

Final: there is flexion of left knee but still not enough during walking because patient not confident in left knee. Patient do complete phases in right and left leg (heel strike – flat foot- heel off- toe off) without complications also in stance phase and swing phase the difference is flexion of left knee is lesser then right knee during mid stance but it does not effect next phases, swinging of hip is optimal, patient not feeling any pain during walking specially in left knee joint after repetitions, patient able to walk on heels and narrow basis with very slight shaking.

3.7.3 Goniometry measurements of joint ROM (according to Janda, SFTR format)

Table 26 Comparison of goniometry measurements of joint ROM

	Initial		Final	
	Passive	Active	Passive	Active
Hip joint	S 30-0-95	S 20-0-90	S 30-0-95	S 20-0-95
Knee joint	S 5-0-90	S 5-0-90	S 5-0-95	S 5-0-95
Ankle joint	S 15-0-50	S 10-0-45	S 15-0-50	S 10-0-50

By using PIR according Lewit and stretching quadriceps muscles of the left knee the flexion it increase only 5 degree and it is not enough for 8 sessions, it is the same in left hip flexion it increase 5 degree by PIR and stretching of hamstrings, also planter flexion of ankle it increase 5 degree.

3.7.4 Anthropometric measurements

Table 27 Comparison of anthropometric measurements

	Initial	Final
Anatomical length of lower extremity	79.5 cm	81.5 cm
Functional length of lower extremity	78.5 cm	80.5 cm
Circumference of thigh 15cm above knee cap	49 cm	50 cm

The changing in anatomical and functional length of LE is 2cm different and this is according to decrease of semi flexion position of left knee, circumference of thigh it increase 1cm after strengthening quadriceps muscles.

3.7.5 Muscle strength tests (according to Kendal)

Table 28 Comparison of muscle strength test

	Initial	Final
Iliopsoas	Grade 3	Grade 4
Gluteus maximus	Grade 3	Grade 4
Gluteus medius	Grade 4	Grade 4+
Gluteus minimus	Grade 4	Grade 4+
Popliteus	Grade 3	Grade 5
Gastrocnemius + Plantaris	Grade 3	Grade 4+
soleus	Grade 4	Grade 5
Quadriceps femoris	Grade 3+	Grade 4
External rotators	Grade 3	Grade 4

By strengthening exercises with or without weights there is satisfying in increased grades specially quadriceps femoris, iliopsoas, gluteus maximus, popliteus, Gastrocnemius + Plantaris.

3.7.6 Muscle tone palpation

Table 29 Comparison of muscle tone palpation

	Initial			Final		
	Origin	belly	Insertion	origin	belly	insertion
piriformis	normal	hypertone	normal	Normal tone		

Semitendinosus	normal	hypertone	hypertone	normal	normal	hypertone
Semimembranosus	normal	hypertone	hypertone	normal	normal	hypertone
Gastrocnemius	hypotone	hypotone	normal	normal	normal	normal
Rectus femoris	normal	normal	hypotone	normal	normal	normal
Vastus lateralis	normal	normal	hypotone	normal	normal	normal

PIR according Lewit and stretching exercises help hypertone muscles to relax and have good results but still the same for Semitendinosus and Semimembranosus insertion it need more treatment also acupuncture help piriformis muscle to relax, and strengthening exercises and isometric exercises help hypotone muscles to reach normal tonicity.

3.7.7 Joint play examination (according to Lewit)

Table 30 Comparison of joint play examination

	Initial	Final
Patella	Restricted caudal and lateral direction with hard barrier and cranial with moderate barrier	Restricted caudal and lateral direction with moderate barrier
Head of fibula	Restricted in anterior direction with hard barrier	No restriction

Mobilisation according Lewit for patella and head of fibula had a satisfying results the stiffness is reducing but it still need more sessions of mobilisations for complete reducing.

3.7.8 Neurologic examination (superficial sensation)

Table 31 Comparison of neurologic examination

Segments dermatomes	Initial	Final
L5 segment	Patient have normal sensation but when reach lateral side of knee joint sensation is decreased	Normal sensation

3.7.9 Scar examination (aspection + palpation)

Initial: swelling is in the insertion of gracilis, sartorius and quadriceps femoris as arch shape above patella it increase medially more than laterally. During palpation of cutis and subcutis tissues there is stiffness along and around the scar it increase medially then laterally and caudally then cranially hard barrier is felt.

Final: swelling is only medially of the knee above patella in the insertion of gracilis, sartorius and vastus medialis. During palpation of cutis and subcutis tissues there is stiffness along the scar medially and it increase caudally then cranially moderate barrier is felt.

After using STT according to Lewit and with using the soft ball it result a release of tissues around the scar. The soft ball it reduce the swelling in one side only (lateral of the knee) I believe after later sessions it will eliminate.

3.7.10 Prognosis

after eight sessions of therapy there is a satisfying results in general and improvements, but in another part there is results which are not enough for eight sessions and it need definitely more sessions to improve specially for knee flexion ROM. Patient feel unconfident in her left leg but I believe after she complete her therapy sessions she will reach higher degree of improvements and more satisfying results, because psychologically patient had acceptance to her exercises and she is excited to do group exercises and harder exercises for the later sessions.

3.7.11 Conclusion

After eight sessions with the patient I notice the effect of the therapy and the general change on the patient which was satisfying this give me the chance to improve my knowledge on the therapies I applied on patients, and see how the effect levels is different depending on the patient himself, it can be either faster or slower comparing with other patients who have the same injury. With my patient I almost achieve the short-term goals which been made before therapy, patient was understandable to the exercises been giving and was active.

Under the lead of my supervisor Bc. Gabriela Svobodová, CLPA give me the opportunity to treat patients with different diagnosis and knowing specially the schedule they follow for ACL reconstruction patients.

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5.3 List of abbreviations

ROM - Rang of motion

ACL - Anterior cruciate ligament

PIR - Post isometric relaxation

STT - Soft tissue techniques

ADL - Activity of daily living

PROM - Passive rang of motion

AROM - Active range of motion

SFTR - Sagittal frontal transverse rotational

CLPA - Centrum Léčby Pohybového Aparátu

FTVS - Fakulta telesne vychovy a sportu Univerzity Karlovy

R- Right

L – Left

LE – Lower extremity

5.4 Patient consent form

UNIVERZITA KARLOVA
FAKULTA TĚLESNÉ VÝCHOVY A SPORTU
José Martího 31, 162 52 Praha 6-Vešelavín

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 pacientovi Podpis:

5.5 Application for Approval by UK FTVS Ethics committee

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 patient After ACL reconstruction

Project form: bachelor thesis

Period of realization of the project: January 2020 - February 2020

Applicant: Huda Alhomod, UK FTVS - Physiotherapy department

Main researcher: Huda Alhomod, UK FTVS - Physiotherapy department

Workplace: CLPA (Centrum léčby pohybového aparátu)

Supervisor: doc. PaedDr. Dagmar Pavlů

Project description: case study of physiotherapy treatment of patient after ACL reconstruction, the aim is to follow the complications which therapy is based according to it and to observe the condition after all if there is improvement or deterioration. The type of study is observational cross-sectional study. Methods and informations which collected by questionnaire and observation of specific examinations based on the studies in UK FTVS and all observed by supervisor in the hospital Bc. Gabriela Svobodová

Characteristics of participants in the research: there will be only one female participant in age 40 years old who have a valid health-check, diagnosed with rupture of ACL in the L knee. Movement - ER and IR of knee - will not be included in the project because it is contraindicated.

Ensuring safety within the research: Non-invasive methods are used. Everything that will be done between researcher and participant will be under observation of supervisor Bc. Gabriela Svobodová, all precautions and risk preventions are followed according to the hospital rules and policies with signed documentations. Risks of therapy and methods will not be higher than the commonly anticipated risks for this type of therapy.

Ethical aspects of the research: The collected data will be anonymized within one week after the end of working with the patient. I understand that anonymization means that the text does not use any item of information or combination of items that could lead to the identification of a person. I will be careful not to enable recognition of a person in the text of the thesis, especially within the anamnesis. After the text has been anonymized, any personal data still kept elsewhere will be deleted.

Photographs of the participant will be anonymized within one week after being taken by blurring the face, parts of the body or any characteristics that could lead to identification of the person. After anonymization any non-anonymized photographs will be deleted.

All collected data will be safely stored on a PC safeguarded by a keyword in a locked room, any data in paper form will be kept safely under lock and key in a locked room. The data will be processed, safely retained and published in an anonymous way in the bachelor thesis.

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, 31.1.2020

Applicant's signature:

Approval of UK FTVS Ethics Committee

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

Members: prof. PhDr. Pavel Slepíčka, DrSc.

prof. 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:

059/2020

Date of approval:

4.2.2020

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.

FAKULTA TELESNĚ VÝCHOVY A SPORTU
José Martího 31, 162 52, Praha 6

- 20 -
Stamp of UK FTVS

Signature of the Chair of
UK FTVS Ethics Committee