CHARLES UNIVERSITY IN PRAGUE

Faculty of Physical Education and Sport

Diploma

Osama Hamed Aljeheny, March 2016

CHARLES UNIVERSITY IN PRAGUE

FACULTY OF PHYSICAL EDUCATION AND SPORT

Department of physiotherapy

Case Study of Physiotherapy Treatment of Patient after Distortion of the Right Knee

BACHELOR DEGREE PROGRAM IN PHYSIOTHERAPY

Author Osama Hamed Aljeheny

Supervisor PhDr. Ivana Vláčilová Ph.D.

March 2016, Prague

ABSTRACT

Title of the thesis: Case Study of Physiotherapy Treatment of Patient after Distortion of the Right Knee

Author: Osama Hamed Aljeheny

Work placement: Centrum léčby pohybového aparátu Mediterra

Summary

In the bachelor thesis, which was written by myself, it is divided in two parts, general part and case study. The general part describes anatomy of knee joint, its bones, muscles, ligaments, nerves and blood supply and surgical and non-surgical approaches of therapy of the knee joint after this injury.

Information about kinesiological and biomechanical point of view were discussed as well. In the practical part I analyzed procedures I have done with the patient, all examinations, conclusions, therapies and results.

Last part of the bachelor thesis contains list of literature used in the bachelor thesis, it contains list of figures and tables used in the thesis, abbreviations and the ethics committee.

Key words: knee joint, physiotherapy treatment, knee distortion, knee exercises, knee ligaments

ABSTRAKT

Název: Případová studie fyzioterapeutické péče o pacienta po distorzi pravého kolene

Autor: Osama Hamed Aljeheny

Pracoviště: Centrum léčby pohybového aparátu Mediterra

Souhrn

Tuto bakalářskou práci, kterou jsem napsal sám, jsem rozdělil do dvou částí - obecná část a případová studie. Obecná část popisuje anatomii kolenního kloubu (kosti, svaly, ligamenta, nervy a krevní zásobení kolenního kloubu), chirurgickou a konzervativní léčbu kolene po jeho zranění.

Dále byla diskutována i kineziologie a biomechanika. V praktické části práce je popsána práce s pacientem (všechna vyšetření, závěry, terapie a její výsledek).

Závěrečná část práce obsahuje seznam literatury použité v této bakalářské práci, seznam obrázků, tabulek, zkratek a také souhlas etické komise.

DECLARATION

I declare that the bachelor thesis was written by me and under supervising of PhDr. Ivana Vláčilová Ph.D. This is an original research, which refers to practice with patient after distortion of the right knee, under supervising of Mgr.Zahir Elali, the practice took a place at Centrum léčby pohybového aparátu (CLPA) Mediterra.

I confirm that all written information, examinations, and therapeutic treatments, which are presented in the bachelor thesis, were performed based on my own knowledge that I got from professors of Charles University Faculty of Physical Education and Sport and supervisors in the hospitals. Information in the bachelor thesis were sourced from the list of literature, which is placed below at the end of this thesis.

Finally I confirm that there were no invasive methods used during my practice and that patient was fully aware of examinations and therapies at any time.

ACKNOWLEDGMENT

At this space I would like to thank to all my professors, who taught me for the three years of my studying at Faculty of Physical Education and Sport. Many thanks to PhDr. Ivana Vláčilová Ph.D. for her help and support during my study and for her supervising of my bachelor theses. Special thanks belong to my supervisor in CLPA Mediterra Mgr.Zahir Elali who helped me with the practice of the bachelor theses.

DEDICATION

I would like to dedicate this bachelor thesis to my parents because I would not be at this place without their help and support. And I would not forget my professors who helped me along my study of physiotherapy during the last three years. And at last I would like to thank the supervisors at the hospitals I visited during my practice and also everybody who helped me during my study.

1. INTRODUCTION

Since several activities place life-threatening stress on the knee, it remains one of the greatest traumatized joints within the physical activity populace. The knee is usually considered a hinge joint as its two main movements are extension and flexion. Nevertheless, since the torsion of the tibia is an important component of knee movement, the knee is not an actual hinge joint. The knee joint's stability depends mostly on the ligaments, the muscles, and the joint capsule surrounding the joint. The knee is designed principally to offer stability in weight posture and mobility in locomotion; nevertheless, it is particularly unstable medially and laterally.

Although several knee injuries are rare, they are serious injuries that frequently lead to the loss of the active and passive knee stabilizers plus frequently being linked with the compromise of neurovascular structures. Treating these injuries is contentious, and results following surgery are usually poor (Zhang, 2010). Once sustaining injuries to manifold ligaments, the knee is said to be at a biomechanical weakness which poses a rehabilitative and reconstructive difficulty to even the highest experienced orthopedic surgeons. Surgeons conducting reconstructions in patients with these injuries have to possess a comprehensive understanding of the Knees' normal anatomical view and biomechanics to enhance the timing of the surgery, tunnel preparation, surgical approach and anatomic implants of grafts. This chapter highlights the biomechanics and the atomy of cruciate ligaments and their surgical insinuations (Finerman & Noyes, 2013). The form and structure of the posterior and anterior cruciate ligaments, structural properties of cruciate ligament and graft replacements, a pattern of injury, functional biomechanics and interaction between the cruciate ligament, and the surgical implications associated with anatomic reconstruction of the posterior and anterior cruciate are all reviewed exhaustively.

2. KNEE'S ANATOMY

2.1.Bones

In relation to Pedowitz and Akeson (2013) classifications, bones knee joints complex comprise of the tibia, patella, femur, and fibula. The femur's distal ending extends and forms the medial condyles and convex lateral that are designed to communicate via patella along with the tibia. The medial condyles' articular facade is elongated from anterior to posterior than the surface of the laterals condyles (Yeager, 2010). Anteriorly, the two condyles create a hollowed femoral trochlea, or grove, to receive the patellas. A proximal ending of the tibial plateau, the tibia, articulates with the femur's condyle. On the flat tibial plateau are two shallow concavities, which articulate with their individual condyles and separated by a thepopliteal notch. Dividing these concavities, or articular facets, roughed area in which the cruciate ligament is fixed and from which a procedure commonly referred as the tibial spine rises (Chaudhari, 2013).

2.2.Patella

It is the biggest sesamoid bone inside the humanoid body. It is sited inside the tendon femoris muscle divided into a lateral facet and three medial facets that articulate with the femur (Figure 1). The patella's lateral feature of is broader than the medial feature. The patella articulates between the concavities formed by femoral condyle. Tracking in this groove relies on the pull of patellar tendon and quadriceps muscle, the patella's shape, and the femoral condyles' depth (Bianchi, 2012).

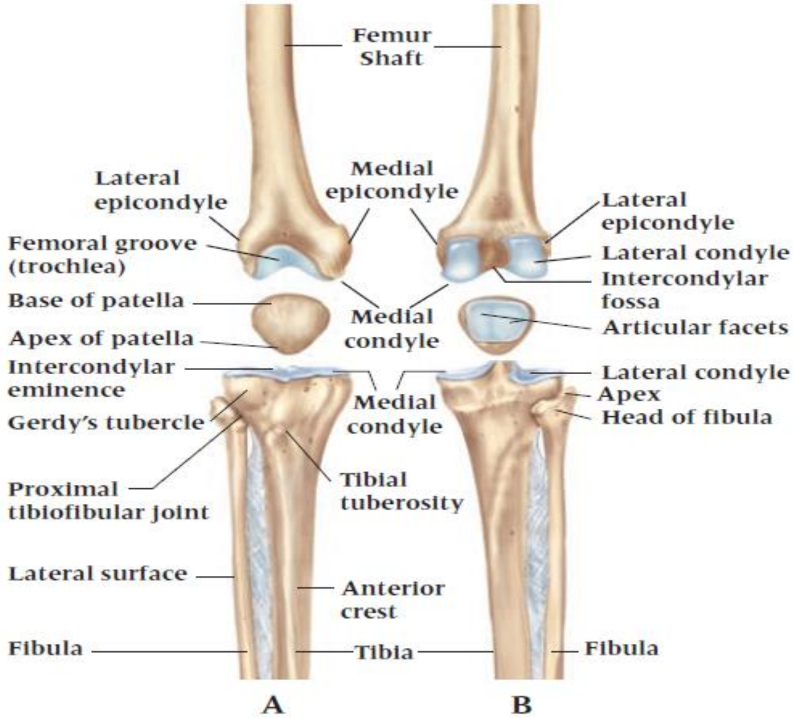

Figure 1: The knee joint bones. A is anterior poor blood supply view. B is posterior view (Bianchi, 2012, p. 231)

Articulations

The knee-joint complex comprises of 4 articulations between the femur and the patella, femur and the tibia, the tibia and the fibula, and the femur and fibula (Jenkins & Hollinshead, 2012).

Menisci

The menisci (Figure 2A) are two semilunar (oval) fibrocartilages that hollow out the articular facets of the tibia, mitigate any stress subjected over the knees intersection, and sustain spacing between the tibial plateau and femoral condyles. The stability of the menisci is much identical that of the intervertebral disk. The menisci distribute one-half of the contact force within the medial section and even higher proportion of the contact load inside most lateral sections. The menisci aid stabilizes the knee, particularly the medial meniscus, in case the knee is flexed at 90 degrees (Jakob & Hassler, 2013).

2.3. Ligaments

2.3.1. Medial Meniscus

It is a C-shaped brocartilage, the edge of which is mounted rigidly to the joint capsules via the coronary ligaments and medial articular facet of the tibia. In is moreover attached to the fibers of the semi-membranous muscle posteriorly (Greenfield, 2011).

2.3.2. Lateral Meniscus

It is more of O-shaped and is mounted on lateral articular facets on the superior facet of the tibia. The lateral meniscus similarly attaches loosely to the popliteal tendon and the lateral articular capsule. The ligaments of the Wrisberg are the lateral meniscus's compartment that points upward, adjacent to the attachment of the posterior cruciate ligaments. The crosswise ligaments join the frontal parts of the menisci (medial and lateral) (Yeager, 2010).

2.3.3. Meniscal Blood Supply

Blood is circulated in every meniscus through the media genicular artery. Every meniscus may be split into three circumferential regions, such as the red-red zone, which is the peripheral or exterior, one-third and characterizes a better supply; and white-white on the one-third interior zone is avascular (Figure 2B) (Fotopoulos, 2015).

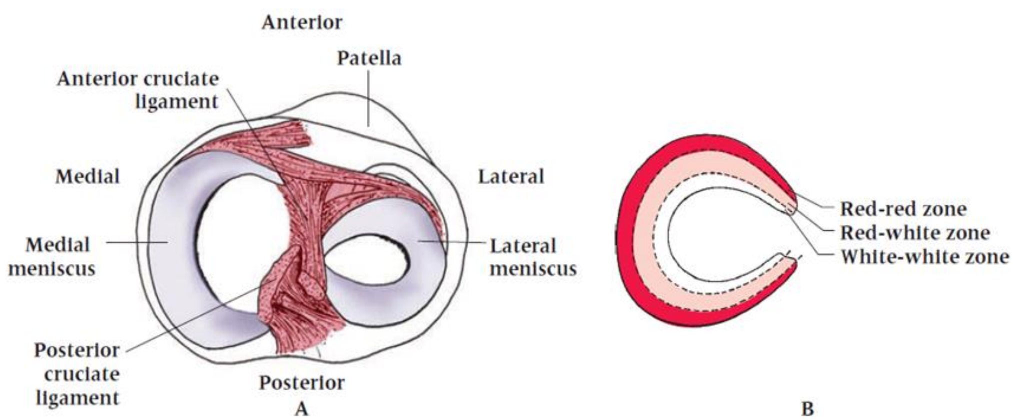

Figure 2: A, Menisci and blood supply of the knees. B is 3-vascular zones (Yeager, 2010, p. 81)

2.3.4. Stabilizing Ligaments

The knee's main stabilizing ligaments include the cruciate ligaments, the capsular ligaments, and the collateral ligaments (Figure 3).

2.3.5. Cruciate Ligaments

It accounts for a significant amount of knee steadiness. They comprise two ligamentous bands that transverse each other in the knee's joint capsule. The anterior capsule ligament attaches beneath and in frontal of the tibia, then passing backward. It attaches laterally to the lateral condyles' interior surface. The posterior cruciate ligament, the resilient of the two, transverses from the posterior of the tibia in a forward, upward, and medial bearing and mounts to the lateral surface's medial condyles anterior part (Cantrell, 2013).

Anterior Cruciate Ligament - It incorporates three twisted bands such as the intermediate, posterolateral, and anteromedial bands. The anterior ligaments inhibit the femur from shifting posteriorly during weight exertion and restrict anterior translation of the tibia within the non-weight bearing. It likewise stabilizes against extreme inner tortion and act as a secondary limitation for varus or valgus stress with collateral ligament impairment. When the knee is completely stretched, the posterolateral part of the cruciate tightens. In flexion, the posterolateral fibers slacken, and the anteromedial fiber tightens. The anterior cruciate ligament functions in combination with the thigh muscles, particularly the hamstring muscle group, to make the knees joints stable (Marshall, 2011).

2.3.6. Posterior Cruciate Ligament

Some section of the posterior cruciate ligament is stretched all through the full range of motion. The posterior cruciate ligaments resist the interior torsion of the tibia, inhibits knee's hyperextension, constraints the femur's anterior translation during weight posture, and constraints posterior translation of the tibia during non-weight bearing (Heerwaarden, 2013).

2.3.7. Capsular and Collateral Ligaments

Further knee stabilization is offered by the lateral and capsular ligaments. Apart from providing stability, they likewise direct motion in the right path. Even though they move in synchrony, they are split into lateral and medial complexes.

2.3.8. Medial Collateral Ligament

The superficial loca of the tibial (medial) collateral ligament is isolated from the deeper capsular ligament over the joint line. It mounts above the joint line over the medial epicondyle and beneath the tibia, just beneath the connection of the pesanserinus (Bianchi, 2012). The posterior façade of the ligament curves into the deeper semi-membranous muscle and posterior capsular ligament. Fibers of the semi-membranous muscles cross the capsule and attach to the medial meniscus's posterior aspects, towing it backward during knee flexion. A number of its fibers are taut via extension and flexion. Its primary function is to shield the knee from valgus and outside rotating forces. The medial collateral ligaments were understood to be the main knees stabilizer within a valgus position when integrated with rotation. It is identified that other structures, like the anterior cruciate ligaments, play an equivalent or better part in the function (Finerman et al., 2013).

2.3.9. Deep Medial Capsular Ligaments

It is disintegrated into three sections, which include posterior, medial and anterior capsular ligaments. The anterior capsular ligaments join with the medial meniscus along with the extensor system via the coronary ligaments. It tightens during knee flexion and loosens during knee extension. The medial capsular ligament principal uses are to connect the medial meniscus to the femur and enable the tibia to son the meniscus inferiorly. The posterior capsule ligament is occasionally called the posterior oblique ligament and connects to the posterior medial facet of the meniscus and overlaps with the semimembranous muscle (Johnson, 2012).

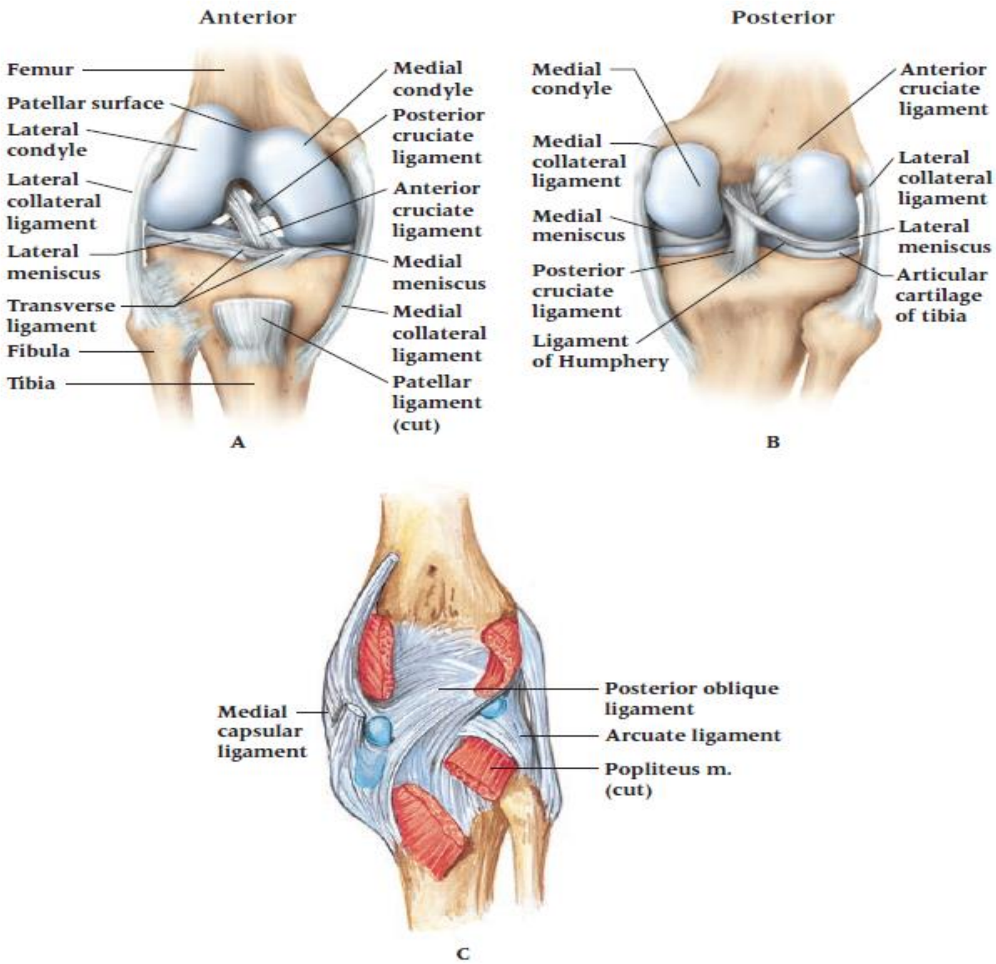

Figure 3: The knee ligaments. A, is anterior view. B is Posterior view. C is Capsular ligament, posterior view (Fotopoulos, 2015, p. 127)

2.4.Lateral Collateral Ligament and Associated Structures

It is around the fibrous cord that is approximately the size of a pencil. It is joined to the head of the fibula, and to the femur’s lateral epicondyle. The lateral collateral ligaments are tough during knees extensions but loosened during flexion. The arcuate ligaments are formed by a thickening of the posterior articular capsules (Zhang, 2010). Its posterior feature attachés to the posterior horn and the lateral meniscus’s popliteal muscle. Additional structures that stabilize the knees laterally include the biceps femoris, iliotibial band, and popliteus muscle. The iliotibial band, a tendon of the gluteus medius and tensor fasciae latae, connects to the tibial tubercle and femur’s lateral epicondyle. It becomes tense during both flexion and extension. The popliteus muscle stabilizes the knees during flexion, and while contracting, protects the lateral meniscus via pulling it posteriorly. The bicep femoris muscle similarly stabilizes the knee laterally through implanting into the fibular head, capsule, and iliotibial band (Kurosawa, 2013).

2.5.Joint Capsule

The articular exteriors are entirely enclosed by the biggest joint capsule within the body. Anteriorly, the joint capsules extend upward below the patella to create the suprapatellar pouch. The inferior portion comprises the infrapatellar bursa and the infrapatellar fat pad. Medially, a thickened portion of the capsule makes the medial collateral ligament’s deep part. Posteriorly, the capsule creates two pouches that envelop the tibial plateau and also femorals condyles. The capsule thickens laterally to create the arcuate ligament and medially to create the posterior oblique ligament (Figure 3C). The joint capsule is split into four parts namely posteromedial, anteromedial, posterolateral, and anterolateral (Finerman et al., 2013).

All these “corners” of the capsule are protected by other anatomical structures. The posterolateral corner is supported by the biceps femoris, the iliotibial band, the popliteus, the arcuate ligament, and the lateral collateral ligament (LCL). The medial collateral ligament (MCL), the semimembranosus, the pesanserinus tendons, and the posterior oblique ligament protect the remedial corner. Synovial membranes line the joint capsule interior surface, excluding posteriorly, in whereby it passes in frontal of the cruciate, enabling them extrasynovial (Figure 4).

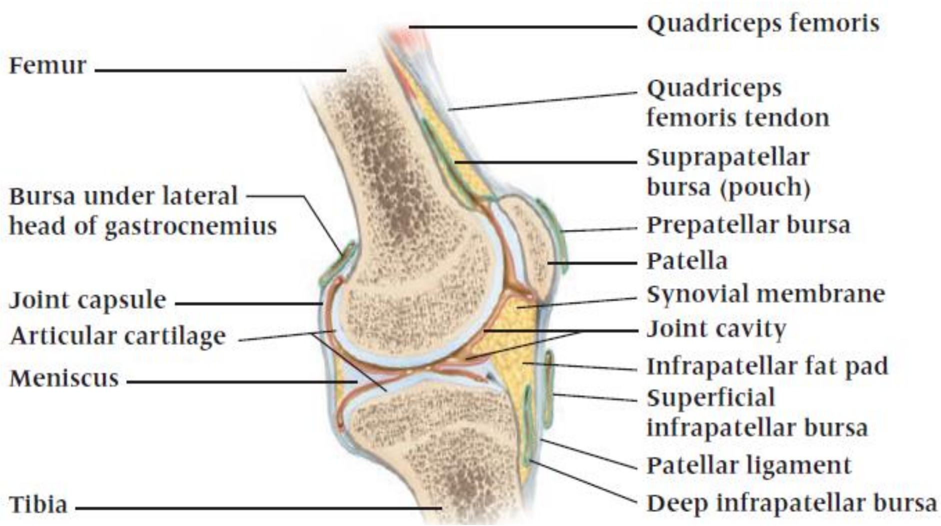

Figure 4: Sagittal knee cross-section, illustrating the position of synovial and bursae membranes (as cited in Greenfield, 2011, p. 246)

2.6.Knee Musculature

For the knees to operate suitably, several muscles have to collaborate in a complex way (Sick & Burguet, 2012). Below is a list of knee activities and the muscles that induce them:

- Knee flexion is performed by the semimembranosus, semitendinosus, biceps femoris, popliteus, gracilis, gastrocnemius, plantaris, and sartorius muscles.
- Knee extension is accomplished by the quadriceps muscles of the thigh, comprising of three vasti, for instance, vastus lateralis, vastus medialis, rectus femoris, and vastus intermedius (Sick & Burguet, 2012).
- Internal rotation is executed by the popliteal, semimembranosus, gracilis, sartorius, and semitendinosus muscles. Torsion of the tibia is restricted and can happen only when the knees is in a flexion position.
- The biceps femoris regulate the exterior torsion of the tibia. The bony structure also generates external tibial rotation when the knee moves into extension.
- On the literal side, the iliotibial band principally serves as a dynamic lateral stabilizer.

2.7.Bursae

A bursa consists of pieces of synovial tissue divided by a thin layer of fluid. The responsibility of a bursa is to decrease the friction between anatomical alignments. Bursae are found between bone and muscle, bone and tendon, alignment and tendons, and many others. As many as 2–dozen bursae have been recognized around the knees joints. The infrapatellar, suprapatellar, prepatellar, pretibial, and gastrocnemius bursae are perchance the leading frequently injured around the knees joints (Figure 4).

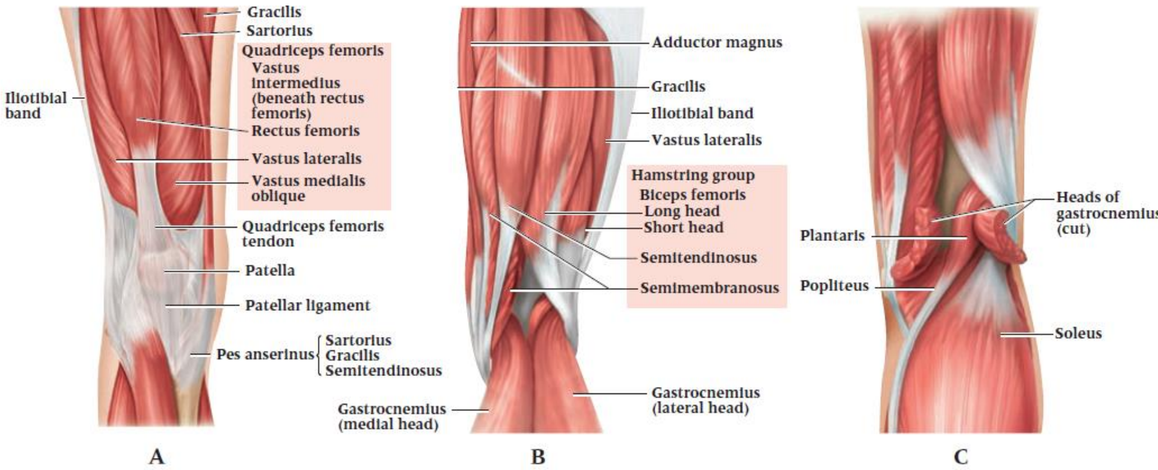

Figure 5: Knee muscles. A is anterior view. B is posterior view. C, is deep posterior view (Trippel, 2014, p. 208)

2.8.Fat Pads

There are numerous fat pads about the knees. Infrapatellar fat pad remains the largest. It cats as a protection to the knee façade and isolates patellar tendon againt the joint capsules. Other dominant fat pads within the knee incorporate the posterior and anterior suprapatellar, and the popliteal. Specific fat pads fill the synovial capsule (Figure 4) (Pedowitz & Akeson, 2013).

2.9.Nerve Supply

The tibial nerves innervate several gastrocnemius and the hamstrings. The mutual peroneal nerves innervate the short head of the bicep femoris and later courses via the popliteal fossa and spirals around the proximal head of the fibula. Since the peroneal nerve is visible at the fibula's head, contusion of the nerve may contribute distal sensory and motor shortfalls. The femoral nerves innervate the sartorius and the quadriceps muscles (Figure 6).

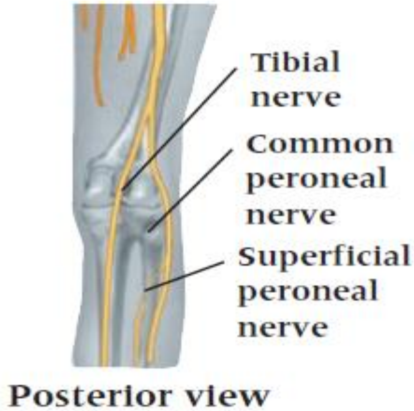

Figure 6: Nerve supply to the knee (Chaudhari, 2013 p. 312)

2.10. Blood Supply

The major blood supply to the knee instigates from popliteal arteries that stem from the femoral artery. From the popliteal arteries, four branches serve the knee, which includes medials and laterals inferior genicular, and medials and laterals superior genicular arteries (Figure 7, A and B). Blood flows through the tiny saphenous vein into the popliteal vein and afterward to the femoral veins (Figure 7C).

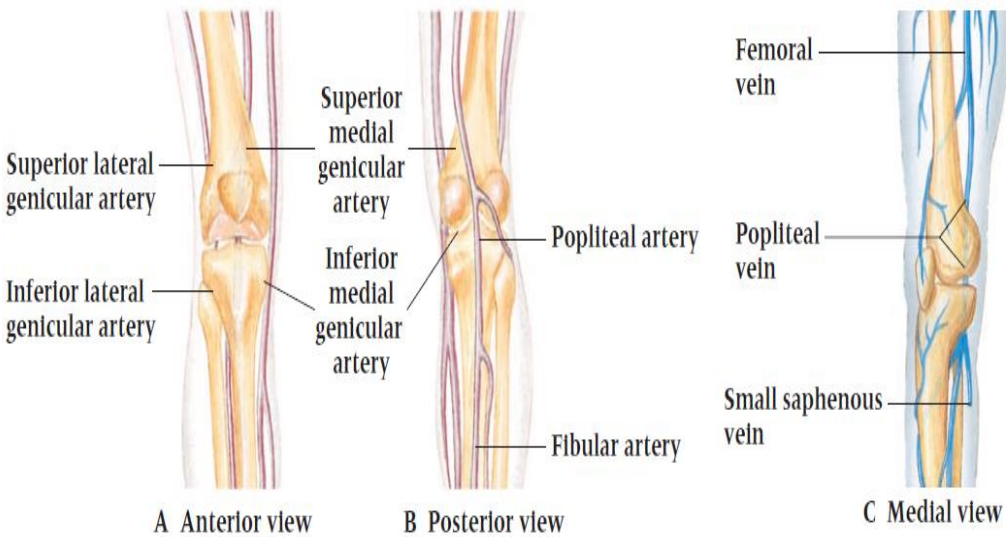

Figure 7: The knees Blood supply. A, is anterior arteries. B is posterior arteries. C, venous supply (Heerwaarden, 2013, p. 98)

2.11. Functional Anatomy

Motion between the femur and tibia entails the physiological movements of extensions, flexion, and torsion besides arthrokinematic mobility as well as gliding and rolling. As the tibia stretches on the femur, the tibia rolls and glides anteriorly. If the femur is stretching on the tibia, gliding takes place in an anterior direction, while rolling happens posteriorly.

Axial torsion of tibia proportional to the femur is an essential constituent of knees movement. As the knee lengthens, the tibia outwardly rotates. The torsion takes place since the medial femoral condyle is bigger than the lateral condyles. Therefore, during weight bearing, the tibia the tibia has to rotate exteriorly to attain full extension. The torsional constituent provides a great compact to knee stability in complete extension. In the case of weight bearing, the popliteus muscle has to contract and externally alternate to the femur to unlock the knees for flexion to occur (Greenfield, 2011).

The capsular ligaments are extended during full extension and rather a slacker during flexion. This is especially true of laterals collateral ligament; nevertheless, medial collateral ligaments parts relax while flexion arises. Relaxation of the other superficial collateral ligament lets rotation take place. On the other hand, the deeper capsular ligaments tighten to stop the excessive turning of the tibia (Sick et al., 2012).

During the final 15-degrees of stretching, the tibia outwardly rotates, and the anterior cruciate ligaments relax. In the full stretch, the posteriolateral section of the anterior cruciate ligament is extended, and it relaxes during flexion. While femurs glide on the tibia, the posterior cruciate ligaments become tight and inhibit additional gliding. Overall, the anterior cruciate ligaments prevent extreme internal torsion, stabilize knees in full extension, and inhibit hyperextension. The posterior cruciate ligaments prevent excessive inner torsion of the tibia, constraints the femur’s anterior translation on the attached tibia, and constraints posterior translation of the tibia within the non-weight bearing (Stenström, 2010).

In full flexion, about 140 degrees, the variation of knee mobility is restricted by the excessively shortened situation of the hamstring muscles, the bulk of hamstring muscles, and quadriceps muscles extensibility. In this situation, femorals condyles rest on their equivalent menisci at a point that allows a slight degree of internal rotation.

Consistent with Stannard and Cook (2013) assessment, the patella helps the knee during extension by expanding quadriceps muscles lever arms. It transmits the compressive stresses on the femur through widening contact area between the femur and patellar tendons. It similarly shields the patellar tendon against friction. In full extension, the patella lies somewhat proximal and lateral to the trochlea or femoral groove. At 20 degrees of knee flexion, tibial rotation occurs, and the patella moves into the trochlea. Patella remains most prominent at 30-degrees. Also at 30-degrees and above, the patella moves deeper into the femoral groove. At 90 degrees, the patella yet again becomes situated laterally. When knees flexion is 135-degrees, the patella has moved laterally above the femoral groove (Yeager, 2010).

3. THE KNEE WITHIN THE KINETIC CHAIN

The knee is directly affected by forces and motion arising and being transmitted from the ankle, foot, and lower leg. As a result, the knee has to transmit forces to pelvis, thigh, spine, and hip. The tissue must absorb anomalous forces that cannot be transmitted. When the foot interacts with the ground, a locked kinetic chain occurs. In a locked kinetic chain, forces should either be absorbed in a more distal joint or be transmitted to proximal segments. The incapability of this closed system to disperse these forces characteristically causes a breakdown in some portion of the system. The knees joints are prone to vulnerable to injury originating from the absorption of these forces (Pedowitz et al., 2013).

4. BIOMECHANICAL OF THE CRUCIATE

4.1. Biomechanics and Kinematic of the Knees Joints

The aim of the joints is to permit for the motion of the bony parts surrounding the joint whereas resisting the loads against gravity inflicted by these movements. Biomechanics can be defined as the science of the act of forces on the living being. The complex collaboration of patella, femur, and tibia enables knees joints to resist extreme forces during normal stages of ambulation (Marshall, 2011). Kinematics can define as the study of body movement without concern for the contributor of that motion. Six planes of motion are present for the knee, such as medial/lateral translation, anterior/posterior translation, flexion/extension, cephalad/caudad translation, varus/valgus angulation, and internal/external torsion as has been outlined above. The knees joints has to provide a normal degree of motion without losing stability during static actions like standing to more dynamic activities like running, walking, pivoting, jogging, and descending or ascending stairs. These goals are accomplished by the interplay of the osseous anatomy, ligaments, articular surface, menisci, and surrounding musculature around the knee. Modifications of any of these elements can change the knee joint biomechanics, largely increasing loads and operational demands positioned on the rest of the structures. Understanding the normal interplays of these structures is important before trying any reconstructive operations (Kurosawa, 2013).

4.2.Passive Motion of the Knees

According to Trippel (2014) evaluation, the prime motion of the knees is extension and flexion. The knee junction totals from 0 to 135^o of flexion in the sagittal surface. The passive movement of the knees linkages is dictated by the articular surfaces structure and the adjacent soft-tissue capsule ligament. Due to the distal between the lateral and medial femoral condyles, mobility between 20^o of flexion and full extension is accompanied by gently sloping of the laterals femoral condyle posteriorly greater than the medial femoral condyle. This enables the tibia and femur to unlock from full extension and ensue with no assistance from any dynamic muscle participation. Following 20^o of flexion, knee joint passive flexion happens by a sliding motion, with comparative tibial mobility on the femur (Pedowitz et al., 2013).

4.3.The Functional Biomechanics of the Ligament

Among the knees ligament, the cruciate is the most essential in offering passive limit to the posterior/anterior knee motions. If a single or both cruciate are interrupted, the biomechanics during ambulatory practices can be interrupted. The knee interaction between the collateral ligaments, cruciate ligaments and other dynamic and static stabilizer is complicated, and appreciation for the meniscal, osseous, tendinous, articular, and other soft-tissue components causes the entire knee motion and stability is vital (Cantrell, 2013).

4.4.Biomechanical of the Anterior Cruciate Ligament

The principal function anterior cruciate ligament (ACL) is to prevent anterior translation of the tibia. It serves as a secondary stabilizer against valgus angulation at the knee and interior torsion of the tibia. In full extension, the ACL uptakes 75% of the anterior translation weight and 85% between 30-90^o flexion. Loss of ALC results in reduced magnitude of this coupled rotation in an unstable knee and during flexion. Numerous researches have been executed to discover the biomechanical aspects of ACL. Nevertheless, uniform analysis on strain rates and alignment is improbable. A number of recent studies have showed that the anterior bundles (both lateral and medial) have higher maximal strain and stress than the posterior bundles. The tensile strength of

ACL is about 2,2 N though it is changed with age and repetitive loads. When the magnitude of the anterior drawers force rises, the in situ force of the ALC similarly rises (Bianchi, 2012).

4.5.Biomechanics of Posterior Cruciate Ligament

The main task of the posterior cruciate ligaments (PCL) is to withstand posterior translation of the tibia on the femur at any bearing of the knees flexion. It is a secondary stabilizer against exterior rotation of the tibia and extreme valgus or varus angulation of the knees. The anterolateral band is rigid in flexion and is extremely important in withstanding posterior distortion of the tibia in 70^o to 90^o of flexion. The posteromedial section is taut in extension; therefore, it withstands posterior distortion of the tibia in this position. Whereas the PCL is the major limit to the posterior translation of the tibia, this ro9le is largely enhanced by other atomies. The recent cadaveric research has reported that extreme posterior translation of the tibia needs damage to one or more structures as well as the PCL (Johnson, 2012).

Isolated PCL ruptures can contribute a mild increase in external torsion at about 90^o knees flexion. That is to say, they do not significantly alter the valgus/varus angulation or tibial rotation, however, because of the tight extracapsular ligaments and tissues. With both posterolateral corner and PCL rupture, there is a noticeable increase in external tibia torsion to the absence of reinforcing restraints. It has been established that the anterolateral component characterized a greater tensile and stiffness strength than the meniscofemoral ligaments and the posteromedial bundle. Moreover, it has been established that at a different degree of knee flexion, variance in situ forces occurred. At 0^o, the PCL characterized a total tensile strength of 6.1 N, whereas, at 90^o, it characterized a tensile strength of approximately 112.3 N. The posteromedial bundle reached a maximum force of 67.9 N at 90^o of the knees flexion, whereas the anterolateral bundle attained a maximum force of 478 N at 60^o. Knowledge of these associations is crucial in the reconstructive surgery to make sure that the grafts are tensioned appropriately (Chaudhari, 2013).

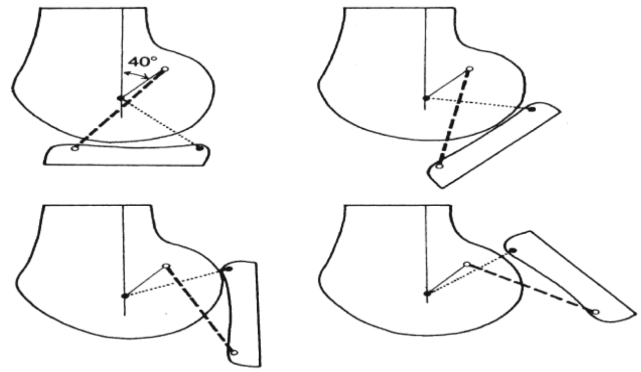

Figure 8: The four-bar cruciate link system (Kurosawa, 2013, p. 134)

As well as to its well-known function in the sagittal plane, the PCL affects knee motion in the anterior plane. This happens because the PCL attaches onto the medial femoral condyle's lateral facet of and is aligned indirectly. This alignment of the PCL assists in the articular unevenness between the lateral and medial femoral condyles and allows sufficient tensioning of the PCL in the course of the laterals femoral condyle rolling posteriorly in initial flexion. The popliteus muscle helps the PCL in withstanding posterior tibial translation and improving stability. In PCL-deficient knees, the popliteus muscle decreased posterior translation of the tibia by about 36% (Fotopoulos, 2015).

4.6.The Interaction of the Cruciate Ligament

The complex interplay between PCL and ACL at different degrees of extension and flexion aids account for the knee joint dynamic balance. The tension and stretch of the PCL and ACL alter during extension and flexion because of their asymmetric insertion positions. In full extension, the ACL is tight, whereas the PCL is relatively loose. When an individual stands up with his knees in hyperextension, the joint is partially stable, with little requirement for muscular support. When the knees flex, the posterolateral section of the ACL turns to lax, whereas the PCL remains taut, particularly the anterolateral bundle. Stability is delicate between 0-50^{o} of flexion because neither cruciate ligament is tremendously tight. The alteration in the orientation of the PCL and ACL fibers during knee flexion permits for dynamic stability within the sagittal surface. With augmenting flexion, the ACL shifts from an upright position to a more horizontal alignment with respect to the joint line. The PCL's alignment is opposite to the ACL's during extension and flexion (Pedowitz et al., 2013).

Thus, as the knee attains a higher degree of flexion, the PCL changes to more important in inhibiting damage to the joint. This interaction between PCL and ACL is often known as the four-bar cruciate link system. The connection of these ligaments illustrates that the epicenter of joint rotation moves posteriorly in the company of the knees flexion. This enables for both the femur rolling and sliding movements in the course of flexion and prevents the femurs from rolling off the tibial plateau at excesses of flexion. In the varied phase of the bearing cycle, the force vector surrounding the knee is the sagittal plane alteration. The mechanical loads throughout the knees intersection are modified by variations in foot position besides by the type and intensity of ambulatory action (Kean, 2012).

In normal ambulation, a joint responsive force of 2 to 5 times the body mass is generated; this force is approximately 24-times the body mass during running period. Dynamic muscle forces aid to stabilize these functional weights and joint responsive forces, specifically as knee flexes and the load-bearing axis moves from a site anterior to the knees linkage to a single posterior. If a muscular, ligamentous, and bony injury happens that interrupts this weak balance of forces, the joint is ineffective at resisting these loads, quickening the knees waning process (Marshall, 2011).

According to Muscolino (2014) insinuation, the dynamic activities of the adjoining muscles are controlled by the cruciate ligaments during knee extension and flexion. The quadriceps muscles, via the patella tendon, eventually join onto the anterior tibia, and, thus, the tibia is translated anteriorly by way of the exterior mechanism and constrained by way of the pull of the ACL. The biomechanical benefit is capitalized on when the axis of knee rotation is vertical to the joint line. When anterior translation takes place on the sagittal surface during ambulation, the epicenter of torsion is altered as with ACL deficiency, and the resulting escalation of forces across the knee linkage exerts increased stress following the secondary limitations. The moment arm of the knees extensor device is reduced, leading to an increase in muscle forces needed to maintain stability all over the knee linkage. This causes an increase in joint responsive forces and, finally, injured or stressed reinforcing structures. Within ACL-deficient knees, increased stress is exerted on the secondary restraints of anterior translations, encompassing the menisci and the adjacent soft-tissue capsule. In case, the quadriceps become atrophied once ACL raptures, the extensor pull on the tibia decreases, lessening the stresses exerted on the secondary stabilizer (Heerwaarden, 2013).

The screw-home method again indicates the essential the dynamic of muscle in knee movement. As the lateral femoral condyles move posteriorly during early flexion, the extensor apparatus's moment arm increases. This provides a mechanical advantage to the knees during running and stair climbing, when there is a maximum demand on the knee joints (Jakob et al., 2013).

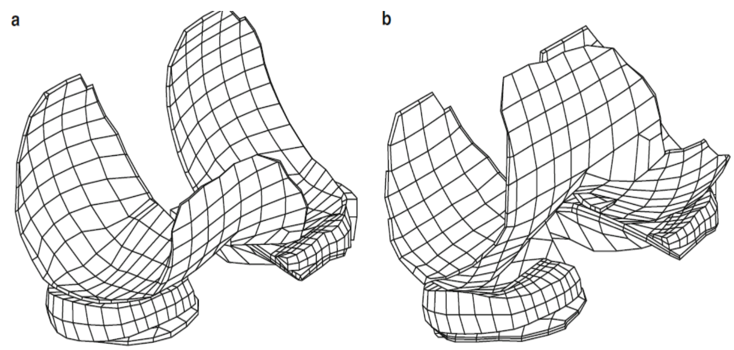

Figure 9: Knee illustration of the in 0o (left) and 30o (right) of flexion showing femoral rotation associated with the tibia in early flexion (Muscolino, 2014, p. 124)

5. DIAGNOSIS AND MANAGEMENT OF KNEE DISTORTIONS

Analysis by Greenfield (2011) explicate that acute knee distortion is a rare diagnosis in the orthopedics, with a high rate of related injuries and possible limb-threatening problems. The reported occurrence is 0.02% of musculoskeletal shock, even though this is likely an underrating due to an unidentified number of spontaneous decreases briefly after injury. Reports of permanent instability and suffering are common after a diagnosis of knee distortion. Though management principles have evolved over the last two decades, optimal therapy of these injuries is still controversial. Few high-level substantiation studies are obtainable to aid guide management. The low occurrence and varied nature of the injury enable randomized controlled experiments challenging to facilitate. An elementary knowledge of the topic, with special attention to physical evaluation and first management, will let the treating doctor to manage patient's knees distortion properly, with a possibly decreased risk of complications (Lee, 2013).

5.1. Classification

The knee distortion classification is mainly centered on the direction the tibia distorts comparative to the femur. This leads to diverse categories including posterior, anterior, medial, lateral, or rotatory. The posterior –medial, anterior-medial, and lateral distortion can be classified as “rotatory” dislocation. Other parameters to be taken into consideration comprise whether the knee is totally dislocated or subluxated, the injury is open or closed, there is neurovascular involvement, and the low-energy or high-energy trauma. Also, one ought to be acutely mindful of the fact that a total distortion can spontaneously moderate, and triple-ligament knee damage constitutes a forthright distortion (Bianchi, 2012).

Reports differ, but anterior and posterior distortion seems to be the most frequent direction of distortion. There is 70% occurrence rate of posterior, 5% rotatory, and 25% anterior distortions. Rotatory distortion incidence is less frequent, but the posterolateral distortion appears to be the most frequent combination. This specific pattern can be complex due to the medial femoral condyle turning button-hollowed via the anteromedial joint capsule. Additionally, the MCL invaginates into the joints space, preventing reduction. This button-hollowing lead to a skin furrow along the medial joint line as the subcutaneous tissue connections to the joint capsule pull the skin into the joint. Efforts at a reduction in this situation make the skin furrow more marked (Pedowitz et al., 2013).

The real incidence of various directional displacements is not essential as properly diagnosing the direction of the damage, and how it associates to the possible neurovascular damage. Posterior dislocations or hyperextension injuries, due to the tethered popliteal vein and artery, can encounter the highest incidence of related vascular injury; nevertheless, any displacement, if the original distortion is severe enough, will cause impairment to the popliteal artery. The normal peroneal nerve is less endangered since it has a higher excursion rate than the popliteal vessels, although it remains susceptible in case a verus force is subjected to the knee. Posterolateral distortion is linked with a high incidence of damage to the common peroneal nerve (Pedowitz et al., 2013).

Open knee dislodgements are not common. The reported occurrence is range from 19-35% of all dislodgements. An open knee distortion, generally, carries an inferior prognosis of the serious harm to the soft-tissues envelopes. Consequently, an open injury can need a staged reconstruction, or an open ligament reconstruction, as arthroscopically assisted methods cannot work in the acute environment with these open wounds (Jenkins et al., 2012).

Differentiating between high- and low-energy injuries is essential. Low-energy injuries, often connected with sports injuries, have a reduced incidence of related vascular injury. High-energy injuries, linked with motor vehicle crashes or falls from an elevation, tend to have augmented prevalence of vascular compromise. With reduced pulses in a wounded limb and the history of a high-velocity or high energy injury, one ought to acquire vascular studies immediately (Zhang, 2010).

5.2.Mechanism of Injuries

The mechanism of the injury of two most frequent knee distortions patterns, posterior and anterior, are considerably well discussed. There is some query as to whether the PCL or the ACL fails initially with hyperextension, though in clinical results, both posterior and anterior cruciate ligament fails with displacement. A posterior-directed force exerted to the proximal tibias if the knee is flexed to 90^o is alleged to produce a posterior distortion, what is known as “dash-board” injury. Lateral and medial distortions arise from valgus/varus stresses inflicted to the knee. A combination of hyperextension/blow with valgus/varus stress to proximal tibia will potentially give rise to one of the rotatory distortions.

5.3.Associated Injuries

As stressed by Lee (2013), numerous anatomic structures are at danger in the distorted knee. The knee’s four primary ligaments along with the lateral corners and posterior medial may be compromised. Nerve and vascular injuries are regular. There can also be associated bony lesions; such as distal femur condylar or frank tibial plateau fractures, avulsion breakages of the PCL or ACL, or femoral shaft or ipsilateral tibial breakages.

There is confirmation in the literature that an actual distortion cannot lead to the complete rapture of three out of four primary ligaments; nevertheless, this appears to be exclusion instead of the rule. Many investigators have identified that actual knee distortion habitually causes rapture of a minimum 3 from the 4 primary ligaments. With frank knee distortion, cautious ligament analysis is required to completely diagnose the degree of the damage (Wilkinson, (2014).

The occurrence of vascular compromise in knee displacements has been approximated to be 32%. When constrained to posterior or anterior dislocation, the occurrence can be increased by 50%. Latest studies prove the important incidence of arterial injuries, echoing the demand for careful vascular examination. The popliteal artery is also called “end artery” to the legs, with least collateral circulation via the genicular arteries. Consequently, the popliteal vein account for the majority of the venous discharge from the knee. If either anatomy is compromised to the point of protracted impairment, ischemia and ultimate amputation are usually the outcomes.

Two mechanisms have been discussed for damage to the popliteal artery: once include a stretching mechanism, observed with hyperextension, pending the vessel ruptures. This can ensue secondary to the tethered condition of the artery positioned at the adductor hiatus and the inlet via the gastrocnemius-soleus component. This kind of injury should be expected with anterior distortion. Posterior dislodgments can result in direct contusion of the vessels by the posterior plateau, causing damage. Under no condition should the compromised vascular state be associated with arterial spasm; in this condition, there is normally intimal injury and future thrombosis formation. Initial evaluation can be common; however, thrombus formation may occur hours or days later, and previous studies have realized delayed thrombus formation. Also, bicruciate ligament ruptures showing a decreased dislocated knee could have a high incidence of arterial damage as a frank distortion (Lee, 2013).

Potential vein damage takes place much less often, or as minimum historically had not been observed. Regardless of this, venous occlusion should similarly be identified and adequately treated. Factually, whether to repair venous injury is looked contentious. Ligating the popliteal vein, regular practice during Vietnam War, caused severe phlebitis, edema, and chronic stasis alterations. The venous restoration was believed to contribute to pulmonary embolism and thrombophlebitis. Today, if the obstruction to outflow is discovered, surgical repair of the popliteal vein is necessary (Finerman et al., 2013).

Injury to either tibial nerve or peroneal nerve has been reported with an incidence rate of approximately 20% to 30%. The nervous anatomies around the knee are not as rigidly attached to the popliteal vessels; this is possibly accounted for the lower occurrence of injury in comparison with surrounding vascular structures. The mechanism of damage is often the stretch. The peroneal nerves appear to be more regularly engaged than the tibial nerve, certainly due to its anatomic site. With any varus knees weighing, the peroneal is positioned under tension. Posterior distortion contributed most of the nerve injuries. Provided the reality that knee displacement is often contributed by violent trauma, related fractures are frequent; the incidence can be as great as 60%, Tibial plateau ligament and fractures avulsion fracture from the proximal-distal or tibia-femur are frequent. Acknowledgment of these injuries is similarly vital since extra bony involvement has insinuations on the absolute treatment.

Related distal femur ruptures and proximal tibial ruptures treated with intramedullary nailing make bone shaft dislocation for PCL and ACL reconstruction problematic. With violent trauma, any avulsion or fracture imaginable can take place with a distorted knee, but there is a report that lateral and medial distortions are related to some elevated frequency of bony minor lesions. Fracture distortions signify a different entity within the range of pure knee displacement to tibial plateau ruptures. Pure knee displacement necessitates only soft tissue reconstruction to acquire balance; tibial plateau raptures need purely bony stabilization. Fracture knee distortions commonly involve both ligamentous and bony reconstruction. A permanent result of fracture-distortion damages to the knee linkage is someplace between pure distortions or tibial plateau fractures, with tibial plateau fractures doing better and distortion the worst (Cantrell, 2013).

6. FIRST EVALUATION AND MANAGEMENT

6.1. General Considerations

Evident deformity can exist during the initial evaluation. However, in a poly-trauma, patients who are sedated and intubated, the injury can escape initial examination. Contusions or abrasions about the knee, laxity, or gross crepitus can allude to injury in an or else normal looking knee (Heerwaarden, 2013). This significance of instant recognition of the knees distortion or fracture-distortion lay not with the treatment variability, but the recognition of possible vascular injury and potential vascular compromise. The neurovascular condition must be evaluated on both lower limits. Neurologic assessment can be tough in poly-trauma patients, and is not as significant initially as is the series neurologic assessment. Vascular evaluation is more important since ischemia lasting greater than 8 hours normally lead to amputation. In the decreased knee, a white could limb, which is noticeable on the physical evaluation and represents arterial damage, needed an instant arteriogram. Nevertheless, Doppler signals, normal pulses, and capillary refill do not exclude an arterial damage. Thrombosis can occur hours to days after, calling for serial evaluation. If there is any query of perfusion limb, an arteriogram is necessary.

6.2. Imaging Studies

Before any manipulation, lateral and anteroposterior radiographs of the interrupted constraint are completed. This is vital to verify the direction of distortion and any related fractures and helps in planning the attenuation of maneuver. With the existence of cyanosis, pallor, weak capillary refill, pallor, and reduced peripheral following decrease, arteriography must be taken into consideration. Venography can be warranted if the clinical images display sufficient limb perfusion but blockade of outflow. Following the acute treatment of the distorted knee, magnetic resonance imaging can be carried out subacutely to validate and assist in strategizing the reconstruction of affected ligamentous structures (Pedowitz et al., 2013).

6.3.Reduction

According to Fotopoulos (2015) studies, unrestrained distorted knee establishes an orthopedic emergency, and reduction must be made as soon as possible, rather in the emergency ward. Prior to manipulation, adequate anteroposterior and lateral radiographic examination is conducted. This permits for identification of the direction of distortion, any related fractures, and aids in planning the direction movement. In the separated knee distortion, conscious sedation or intravenous morphine is often needed. Slow longitudinal traction is inflicted to the leg from ankle, and a proximal tibia is repositioned in the suitable direction to effect moderation. Once decreased, the radiographic analysis is applied to confirm tibiofemoral congruency, as well as repeated neurovascular evaluation. The limb is then put in either knee extension immobilizer or a long leg split. It is imperious to perform radiographic examination following placement in the brace or splint, as posterior subluxations of the tibia on the femur is normal. A "bump" comprising a pad or towel behind the gastrocnemius-soleus composite can help in maintaining reduction.

The “dimple sign” demonstrates a posterolateral distortion, and closed reduction might not be prosperous. The medial femoral condyle infiltrates the medial joint, contributing interposition of soft tissue within the joint, necessitating open reduction (Jenkins et al., 2012).

6.4.Physical Examination

Physical examination properties of the PCL/ACL/PLC injured knee incorporate abnormal posterior and anterior translation at equally 25^{o} and 90^{o} of the knees flexion that is typically higher than 15 mm. The tibial step-off is missing at 90^{o}, and the posterior drawer test is two or more, indicating higher than 10 mm of pathologic posterior tibial distortion. The pivot-shift and Lachman test phenomenon are positive, presenting ACL disruption, and there could be knee hyperextension. Three types of posterolateral instability, A, B, and C, have been identified and described.

Posterolateral imbalance (PLI) in the multiple-ligament Wounded Knee consists, at least, 10^{o} of enhanced tibial external rotation in comparison with the typical knee at 30^{o}-90^{o} of flexion, and adjustable degree of varus imbalance relying on the injured anatomic structures. Posterolateral unsteadiness PLI type A has augmented external torsion only, relative to damage to the popliteus tendon, and popliteofibula ligaments only. PLI type B indicates with increased external alternation, and slight varus of about 5 mm augmented lateral joint opening to varus stress at 30-degrees knee flexion. This takes place after harm to the popliteus tendon, popliteofibular ligament, and decline of the fibular collateral ligaments. PLI type C indicates with augmented tibial exterior rotation and varus imbalance of 10 mm more than the normal knee examined at 30^{o} flexion with varus stress. This takes place after damage to the popliteus tendon, popliteofibular ligament, lateral capsular avulsion, fibular collateral ligament, as well as cruciate ligament disruption.

The MCL is verified with valgus stress between 0^{o}-30^{o} flexion to evaluate the superficial MCL, the posterior medial capsule, and the posterior oblique ligament. Extensor mechanism stability is evaluated by medials and laterals patellar glide to examine the veracity of the laterals and medial retinaculum.

6.5. Vascular Injuries

As indicated by Johnson (2012) studies, a complete spectrum of vascular injuries can be experienced. The overall clinical pictures can fluctuate from an uncomplicated, bicruciate ligament damage, with a potential internal injury with a normal physical evaluation to a poly-trauma patient, having intra-abnormal bleeding, a closed head injury, and distorted knee with vascular complication. Severe injuries treated first. The orthopaedic surgeon must be aware of the of the overall limb ischemia time. If the suspicious arterial damage is observed, a vascular consult is obtained straightaway. The reduction is conducted to confirm if this restores blood circulation to the limb. When the overall ischemia time nears 6 hours, there is an urgency to reinstate circulation to the lower end. An intraoperative angiogram during vascular examination and shutting might be needed at the expense of a first-rate preoperative angiogram (Stenström, 2010). Mechanism of damage also needs to be considered. A high-energy injury could be more suspicious of vascular damage, and one can opt to obtain arteriograms in spite of a normal vascular test.

When an isolated displaced knee with suspected arterial injury arises, arteriography is performed as the normal availability of pulses does not exclude vascular mutilation. Any suspicion necessitates a vascular operation consultation. When the limb is appropriately perfused, and all indices are well, one can opt to forego a formal arteriogram in care there are recurrent neurovascular examinations to the lower extremity. In spite of the historical preference to receive an arteriogram in the existence of knee distortion as screening model, it has been demonstrated that arteriography after considerable blunt pain to the lower extremity with typical vascular check exhibit a low yield ratio for discovering surgical vascular lesion. Popliteal vein damage is also likely. When the clinical picture is required, a venogram could be supportive.

6.6. Absolute Surgical Indications

A situation of vascular injury and irreducibility warrants instant surgical intervention. Four-partition fasciotomy of the limb is taken into account when ischemia time is higher than 5 hours. The incapability to sustain reduction similarly obligates early ligamentous reconstruction or external skeletal fixation to stabilize the knee to prevent potential repeated vascular compromise. Open displacements and open fracture-displacements warrant immediate clinical debridement to disinfect the wound. An exterior fixator can be a rational alternative in the situation of open distortion with large soft-tissue impairment or open fracture distortion. In this scenario, access to soft-tissue would be sustained for surgical debridement (Pedowitz et al., 2013).

7. DEFINITIVE SURGICAL MANAGEMENT

7.1. Historical Management

Knee distortions were originally managed using a cylinder cast for many months. Early reports indicate meaningful results for nonoperatively treated knee displacements. However, there was the recommendation that surgically stabilized distortioned knees would be quite better in the long-standing. A recent finding compared surgically stabilized knee with conservative therapy and resolved that the conservative therapy was similar to surgical intervention. Despite the same results, the conservatively treated knee was grossly compared with surgically stabilized knee. The survey was reflective from 1963-1988 and the distinctive surgical treatment in this period was in many cases open direct reconstruction of the ligaments. The same results were arrived at by comparing four conservatively treated knees using 16-direct suture reconstruction of torn ligaments. Likewise, examined early (in 5 days of damage) direct reconstruction (with or without increment) of torn ligament parts in 13 out of 17 patients. They resolved that better outcomes were attained with early versus after direct repair of the torn ligament. This research backs surgical treatment of the distortioned knees and presents the idea of benefit from ligamentous stabilized knee (Stannard et al., 2013).

In the past decade, the method of arthroscopically assisted PCL/ACL repair has become common. Numerous advancements have enabled these techniques successful such as better sterilization, procurement, and storage of allograft tissue, better graft fixation techniques, improved arthroscopic surgical instrumentation method, and improved knowledge of knees ligamentous biomechanics and anatomy. Few reports of integrated PCL/ACL repair are accessible in the literature though surgical repair seems to afford identical outcomes, if not better, than the direct reconstruction of ligaments (Marshall, 2011).

7.2.Sports Injury Clinic Experience

There is the 38-percent incidence of PCL tears in acute knee wounds; with 45% of these PCL wounded knees being linked PCL/ACL tears. Careful evaluation and treatment of vascular wounds are critical in these acute multiple-ligaments. There is an 11% occurrence of vascular injury related to these acute multiple-ligaments injured knees. Most preferred to technique to link PCL/ACL repair with the transtibial method, with capsular/collateral ligament surgery as specified. Not all incidences are agreeable to the arthroscopic technique, and the surgical physician must examine each case independently (Pedowitz et al., 2013).

7.3.Surgical timing

Surgical timing is reliant on the vascular situation, skin condition, reduction stability, open versus closed knees injury, systematic injury, articular and meniscus surface injuries, other orthopaedic damages, and capsular/collateral ligaments concerned. Particular PCL/ACL/MCL damages are treated through bracing of the MCL succeeded by arthroscopic combined PCL/ACL repair in 46 weeks after recovery of the MCL. Other cases could warrant medial structures reconstruction and have to be examined individually.

Combined PCL/ACL/posterolateral damages are addressed timely as safe as conceivable. ACL/PCL/posterolateral reconstruction-repair carried out between 2-3 weeks following injury enables closing of capsular tissues to allow an arthroscopic intervention, and still allows primary reconstruction of damaged posterolateral structures. Open multiple-ligament knee distortions may need staged procedures. The capsular/collateral structures are reconstructed after methodical debridement and irrigation and combined PCL/ACL repair performed at a later date once wound healing has occurred. Care must be considered in all cases of postponed reconstruction to guarantee the attenuation of tibiofemoral joint by lateral radiograph and serial anteroposterior.

The surgical timing procedures highlighted above must be taken into account in the context of each patient. Some patients having multiple-ligament knee damages are seriously wounded multiple-trauma patients with multisystem wounds. Modifiers to the best timing protocols highlighted earlier encompass the reduction stability, the vascular state of the involved extremity, open or close injury, skin condition, and other systemic and orthopaedic injuries. These extra considerations can contribute the knee ligament surgery to be done earlier or later than expected (Kean, 2012).

7.4.Graft Selection

The suitable graft material is strong, gives safe fixation, is simple to pass, readily obtainable, and has low donor-site movement. The available alternatives in America are allograft and autograft sources. The most preferred graft for PCL includes the Achilles tendon allograft due to its broad cross-sectional area and strength, an easy passage with safe fixation, and lack of donor mobility. Also, bone allograft, bone patellar tendons or Achilles tendon allograft are preferred for ACL repair. For a posterolateral corner, the preferred graft material is split biceps tendon transfer, allograft tissue, or free autograft (semitendinosus) when biceps tendon cannot be obtained (Pedowitz et al., 2013).

Cases necessitating MCL and posteromedial corner operation could have reconstruction, primary repair, or a combination of both. Open favored approach for MCL and posteromedial reconstruction involves a posteromedial capsular shift with allograft or autograft supplementation as required (Moreno, 2012).

7.5.Surgical Approach

The principal surgical approach includes a single-stage arthroscopic combined PCL/ACL reconstruction with the transtibial method with capsular/collateral ligament procedure as presented. The posterolateral corner is reconstructed and then amplified with an allograft tissue, semitendinosus free gap, split biceps tendon transfer, or biceps tendon transfer. An acute medial injury, not amenable responsive to brace treatment go through the posteromedial capsular shift, primary repair, or allograft reconstruction as specified. The surgery surgeon should be prepared to adapt to an open procedure or a dry arthroscopic procedure in case fluid extravasation becomes an issue (Manske, 2015).

7.6.Graft Tensioning and Fixation

The PCL is the first to be reconstructed followed by ACL, and then the medial ligament complex and posterolateral complex follows. Tension is exerted on the PCL graft distally with the Arthrotek knee ligaments tensioning instrument along with the tension set for 20 lb (Figure 15). This reinstates the anatomic tibial step-off.

Figure 10: The mechanical graft knee ligament tensioning instrument (Tortora et al., 2014, p. 499)

The mechanical graft knee ligament tensioning instrument is employed to accurately tension ACL and PCL grafts. In PCL reconstruction, the tensioning instrument is inserted to the tibial ending of the graft and the torque wrench ratchet set to 20 lb. This reinstates the anatomic tibial step-off (Tortora et al., 2014).

The operated knee is cycled via a complete range of movement 25-times to enable pretensioning and positioning of the graft. The knee is position in 70^{o} of flexion, and concluding fixation is accomplished with the ACL graft using a bioabsorbable interference screw and spikey ligament washer and a screw stoppage fixations. Tensioning the ACL graft of the knees flexion allows surgeons to maintain the knee's neutral location of by checking the tibial step-off at the period of final graft in 70º fixations. The MCL restoration is tensioned with the knees at 30º of flexions with the leg within the fugure-of-4 bearing. (Moreno, 2012).

Table 1: Tensile strength comparison (Cantrell, 2013, p. 366)

Material	**Maximum load (N)**
Antrior cruciate ligament	2,0
Posterios cruciate ligament	4,0
Bone-patellar tendon-bone (10 mm)	2,9
Semitendinosus and gracilis (2-strand)	1,9
Semitendinosus and gracilis (4-strand)	2,8

8. PHYSIOTHERAPY

Physiotherapists are experienced in the prescription of exercises. They will offer you specified exercises to improve your flexibility, strength, posture and balance as designated by a detailed examination. Thus, your program will be individualized to make sure the best probable result for your knee, especially for ligament treatment. Physiotherapists also employ other treatment methods for knee pain resulting from distortion. These may incorporate tissue massage and joint mobilizing, knee taping, education and advice on how well to manage knee injury condition (Cantrell, 2013).

8.1. Examples of Physiotherapies

8.1.1. Mobility Exercises

Mobility exercises are conducted immediately pain will enable with the aim of regaining or maintaining complete joint mobility (Fotopoulos, 2015).

Plan for mobility exercises

Table 2: Plan for mobility exercises (Moreno, 2012, p. 120)

Mobility Exercises per days			
	sets	Reps	Time in seconds per set
Heel slides	3	2-4	30 sec/se
Flexion Extension Exercise	3	10-20	60 sec/set

8.1.2. Heel slides

To carry out this gentle knee range workout, the athlete lies on a hard surface or on their back. The heel is gradually moved upwards the buttocks, as much as this is comfortable (Wilkinson, (2014). Sock may be worn to make sure that foot slides. Once a minute, advance movement can be possible. A strap or a towel wrapped about the ankle may be used to aid though this must not be forced during the early stages in case there is a lot of pain (Yeager, 2010). Do 2-4 reps several times during the day.

Figure 11: Heel slides (Manske, 2015, p. 625)

8.1.3. Flexion Extension Exercise

The exercise is tremendously crucial to improve the movement of injured knee though it will also assist to maintain the hamstrings and quadriceps during early phases of rehabilitation. It can similarly help to lessen swelling around the knee.

Try to bend your knee as much as you can easily. This may be done while sitting, lying or standing on your front. Aim three sets of 10 to 20 repetitions as pain tolerates. Progress this workout to holding the in position at the ending of likely range, both in extension and flexion. This will help in strengthening muscles (Bianchi, 2012).

Figure 12: Flexion Extension Exercise (as cited in Johnson, 2012, p. 313)

8.1.4. Strengthening Exercises

Table 3: Strengthening Exercises (Manske, 2015, p. 633)

Strengthening Exercises			
	sets	Repetitions	Time in seconds per set
Static squad contractions	3	2-4	30 sec/se
Hip Abduction	3	10-20	60 sec/set
Half Squats	3	10-20	30 sec/set
Squat with Swiss Ball	3	10	60 sec/set
Lunges	2	10	60 sec/set
Bridge exercises	3	8-13	30 sec/set
Leg press	3	6	60 sec/set
Calf Raises	3	2-20	60 sec/set
Leg Curl	3	10-20	30 sec/set

These should start immediately as pain allows starting with static or somatic shrinkages/contractions. Follow your trainer or physiotherapist rehabilitation program. Do not do it if it hurts. Knee strengthening ought to be done 1-3 times for each week given they do not increase or cause pain. Idyllically they ought not to be carried out on successive days, to enable muscle recovery. The exercises may be advanced by slowly augmenting the repetitions numeral of sets and resistance of the exercises so long as they do not increase or cause pain (Fotopoulos, 2015).

8.2.Static squad contractions

This exercise can be commenced the moment pain will allow and can be performed every day. Contract the quadriceps muscles at the anterior of the thigh. Hold for ten sec. Relax and rest for 3 sec., repeat 10-20 times. You can also exercise with foam or rolled up towel under a tree as shown below. Contraction will contribute the foot to take off the floor while the knee strengthens (Cantrell, 2013).

Figure 13: Static squad contractions (Moreno, 2012, p. 148)

8.3.Hip Abduction

Stand on the unhurt leg only and move the injured leg out of the sideways as much as possible. Gradually bring it back toward the center. Ensure you have something to grip. Use ankle weights or resistance band for increase strain. Aim for three sets of 10-12 reps (Yeager, 2010).

Figure 14: Hip Abduction (as cited in Johnson, 2012, p. 356)

8.4.Half Squats

Sand using feet wider than shoulder width, back straight. Then, squat down half way to about 45^o or horizontal and resume standing. Target three sets of 10-20 repetitions while in rehabilitation. Continue with this workout by increasing weight, adding the depth of squat to 90^o or close to horizontal thighs or single leg squats (Bianchi, 2012).

Figure 15: Half Squats (Kean, 2012, p. 210)

8.5.Squat with Swiss Ball

Start this workout while standing with your shoulder and feet width spaced out. Your feet should face forward and a Swiss ball positioned between your lower back and a wall. Gradually do a squat. Maintain the back straight. Your knees must be consistent with your medium toes and must not move forward beyond your toes. Do 3 sets of 10 repetitions given you do not feel pain (Wilkinson, 2014).

Figure 16: Squat with Swiss Ball (Kean, 2012, p. 277)

8.6.Lunges

They are a slightly simpler version of squat and are some cases referred as split squats. Begin with a broad posture. Bend the back knee towards the ground, but do not allow it touch. Maintain you're back upright all through and do not let the frontal knee move frontward pas the toes. Begin with 2 sets of 10 reps, with the harmed leg forward in the back. Slowly increase to three sets of fifteen. To make it tougher, you may add either a dumbbell per hand of a barbell on the shoulder (Fotopoulos, 2015).

Figure 17: Lunges (Moreno, 2012, p. 165)

8.7.Bridge exercises

The sportsperson lies on the back, knees twisted/bent and pushes hips upwards to work hamstrings and gluteual muscle. Use all the feet over the floor pushing up to start with. Hold the place shortly and then lower. Commence with 3 sets of 8 reps increasing to 3 of 13 reps, afterward continue the exercise to single leg bridges (Yeager, 2010).

Single leg bridges are done typically making sure press the gluteal muscles to keep a straight line interval from the shoulder on the floor to the knees at the climax of the workout.

Figure 18: Bridge exercises (as cited in Johnson, 2012, p. 416)

8.8.Leg press

Posture yourself on a seat. The feet hip should be apart over the platform. There should be roughly 90^{o} angle at knee. You may adjust the seat correspondingly. Push using the legs to strengthen your knees. Do not close the knees but leave a slight bend/curve. Gradually bend the knees back towards the initial position, but do not let the weights in the pile to touch. This sustains tension on the muscle (Cantrell, 2013).

Figure 19: Leg press (Manske, 2015, p. 648)

8.9.Calf Raises

Feet shoulder width should be set width apart and adjacent when as you stand. Hold something for balance. Raise your heels high off the ground. During the initial stages of the workout, this has to be performed simultaneously. Gradually lower back to the ground. Aim 2 to 3 sets of 15 – 20 reps. Afterward this workout may be progressed through to one leg calf raises/lifting (Fotopoulos, 2015).

Figure 20: Calf Raises (as cited in Johnson, 2012, p. 506)

8.10. Leg Curl

Lie on your anterior and bend one knee up together with resistance band or resistance ankle and lightly lower. Do not forget to position your hips firmly on the ground or bench and do not let them to lift. Your aim should be 3 sets of 10-20 reps firstly and as power enhances, continue by adding resistance to attain 3 sets of 8-10 failure (Yeager, 2010).

Figure 21: Leg curl (Kean, 2012, p. 280)

8.11. Proprioception exercises

These entail balance and co-ordination that is frequently impaired with knee hurt.

Table 4: Proprioception exercises (Pedowitz et al., 2013, p. 158)

Proprioception exercises			
	sets	Repetitions	Time in seconds per set
Balance board exercise	4	6	60 sec/se

8.12. Balance board exercise

Wobble board is most largely used in recovery of ankle damages like ankle sprains, even though they ought to be utilized for lower led and knees injuries (Wilkinson, (2014).

8.13. Plan for sprain exercise

As soon as probable, and for 72hrs, injuries, apply the RICE method

Table 5: Plan for sprain exercise (Pedowitz et al., 2013, p. 191)

RICE METHOD within 72 hours	
Rest	Take it easy and only move within your limit of pain
Ice	Immediately, and for 20 min every 2 hours, place ice or a frozen cream pack draped in a damp towel. This aids to stop pain, bleeding and diminishes secondary tissue harm.
Compression	Steadily bandage the knees and add 5 cm below and above the joint to control swelling.
Elevation	raise your leg above the level of your heart to diminish inflammation

Figure 22: Balance board exercise (as cited in Johnson, 2012, p. 753)

8.14. Functional Exercises

They tend to be complex sports particular workouts which close the **cavity** between standard restoration and reverting to complete sports playing and training. Specific exercises are reliance on the kind of sport take and you must look for professional guidance from a physiotherapist (Wilkinson, 2014).

Table 6: Functional Exercises (Moreno, 2012, p. 215)

Functional Exercises			
	sets	Repetitions	Time in seconds per set
Plyometric exercise	4	8	120 sec/se

8.15. Plyometric exercise

Plyometric exercise is a kind of strengthening exercise, involving hopping, jumping, and hopping movements which improve strength in the muscles. Strength/power is employed to facilitate develop this for many athletes (Fotopoulos, 2015).

Figure 23: Plyometric exercise (Kean, 2012, p. 301)

9. NON-SURGICAL THERAPY

9.1. Heat/Cold therapies

Use heat cold or heat on joints can provide temporary pain relief and stiffness. Often, packs aid to diminish swelling and inflammation, and can be helpful for flare-ups. Heat also helps in increasing circulation and relaxing muscles (Bianchi, 2012).

9.2. Assistive Devices

You may protect your knee with cane or other walking aids to protect you from placing excessive stress over them. Shoes inserts known as orthotics are designed to align, support and enhance your foot function. As a result, they can reduce the pressure on your knee (Wilkinson, (2014).

9.3.Balancing

Diverse forms of braces can aid you lessen knee pain and boost mobility and function. A “support” braces resist the overall load on your knee, whereas “unloader” withstand the weight sideway, in case one side on the knees got injured (Fotopoulos, 2015).

9.4.Avoidance

Specific activities to shun comprise impact-loading sports like downhill skiing, jogging, high-impact aerobics; excessive stair climbing; physical activities engaging impact-stresses or twisting, quick stop-start motion; excessive kneeling and betting; pushing or lifting heavy object; sitting on low chairs and surfaces. You can also try resting for some time (Yeager, 2010).

9.5.Mental heath

Conversing about how you feel with friends and family members, performing mental exercises like staying positive and medication, and joining support groups can help you manage knee pain.

9.6.Injections

At times hyaluronic acid, a product produced in natural, healthy joints, can be utilized to give ease or relief knee pains. Anesthetics also can be injected suing a corticosteroid anti-inflammatory prescription to distressed knee pain at bay (Fotopoulos, 2015).

9.7.Technical Hints

The posteromedial secure incision protects the neurovascular anatomies, confirms precise tibial tunnel positioning and permits more expeditious accomplishment of surgical operation. The single-incision ACL reconstruction method inhibits lateral convex congestion and eradicates multiple through-and-through drill openings in the distal femur that diminishes stress riser impact. It is vital to know the –tibial directions and to maintain 1 cm bridge between ACL and PCL tibial tunnels. This will minimize the likelihood of fracture. It is advantageous to utilize back-up and primary fixation. Back-up fixation is attained with spiked ligament washer and a screw while primary fixation is with resorbable interference screws.

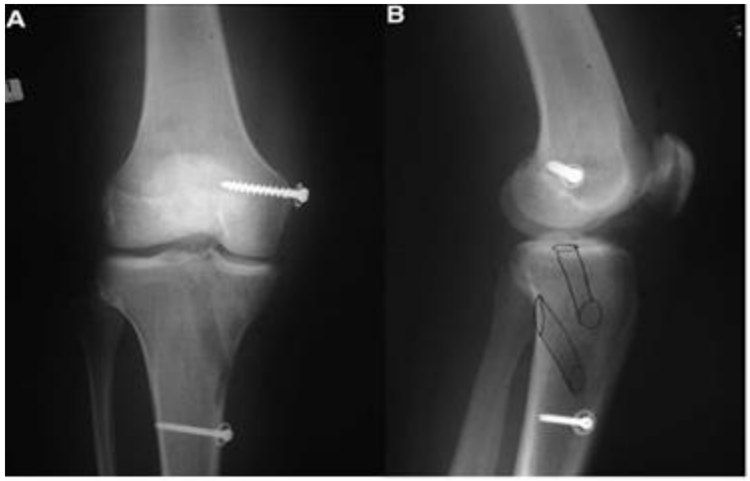

Figure 24: Anteroposterior and lateral radiographs once combined ACL/PCL are reconstructed (Manske, 2015, p. 666)

The sequence of tensioning includes the PCL, posterior lateral corner, the ACL, and the MCL respectively. Reinstatement of the normal tibia step-off in 70^{o} of flexion provides the greatest reproducible technique of setting the neutral site of the tibia-femoral correlation.

10.POSTOPERATIVE REHABILITATION

The knee is kept in full extension for 3-weeks non-weight direction. Advanced range of movement occurs in week 4 through 6. Advanced weight direction takes place at the ending of week 6. Advanced closed-chain kinetic strength exercises continual motion training is done. The brace is suspended after the 10th week. Return to heavy labor and sports happen following 9 months when adequate strength and range movement has resumed (Trippel, 2014).

10.1. Complications

Possible complications in treatment of injured knee consist of failure to identify and treat vascular injuries (both venous and arterial), iatrogenic neurovascular damage during repair, iatrogenic tibial plateau fractures during reconstruction, failure to identify and treat complexes of the instability, knee motion loss, postoperative anterior knee pain, and postoperative medial femoral condyle osteonecrosis.

11.DATA ANALYSIS

Descriptive statistics, comprising means and standard deviation for continual variables and frequency averages for ordinary and nominal level variables were computed. Individual tests were conducted for continual variables, and chi-square tests were performed for many and nominal level variables to identify the importance of variances between patients treated with acute replacement and those treated with chronic replacement (Fotopoulos, 2015).

12.RESULTS

About 31 of 33 patients were availed for examination at a mean of 44-months after the operation. The patients' mean age at surgery was about 28.4 years (range, 16-50 years). 17-patients were injured during sports sessions, 4 in a car accident, 4 in a motorcycle accident, 4 in work-associated accidents, and 2 in a fall. Also, 19 patients went through surgery less than 3-weeks following injury. 12 patients went through surgery more than 3-weeks after injury.

Injury ranges were variable and were recognized by magnetic resonance imaging, a checkup with arthroscopy and the patient under anesthesia. 15 of the 18 patient suffering acute injury underwent reconstruction of both the posterior and anterior cruciate ligament with fresh-frozen allograft. One patient experienced a grade- 2+ wound of the anterior cruciate ligament, which was not replaced, and 2-patients had a grade- 2+ wound of the posterior cruciate ligament, which was not replaced. The remaining cruciate ligament was restored in all 3-patients. One patient encountered a peel-off wound of the posterior cruciate ligaments which was reconstructed primarily plus a wound of the anterior cruciate ligament that was replaced with an allograft (Pedowitz et al., 2013).

Of the 15-patients who were treated, 10 had collective injuries of posterior cruciate, anterior cruciate and medial collateral without lateral injury. 8 of those 10 patients had a medial ligament replacement of grade- 3+ damages and 2 did not go through replacement of a grade- 2+ injury (Simonian & Bach, 2011). 7 of the 19 patients had damages of the posterior cruciate ligament, anterior cruciate ligament, and posterolateral corner. 5 of the 7 went through lateral collateral ligament allograft replacement with the reconstruction of posterolateral corner portions. 1 patient had a reconstruction of an avulsion that incorporated the lateral collateral ligaments, and the biceps femoris anchoring onto the fibular head. 1 patient had an intact posterolateral corner and lateral collateral ligament, though the iliotibial band and anterolateral capsule were avulsed and repaired. The rest of the 2 acutely treated patients were found to have a low-energy knee distortion. 1 of these patients suffered graded- 3+ injuries of the posterior and anterior cruciate ligament but only grade- 1+ damages of lateral collateral and medial collateral ligaments. The remaining patient had the grade- 3+ injuries of the posterior and anterior cruciate ligament and medial collateral ligaments with grade- 1+ injuries of the posterolateral corner which did not warrant surgical intervention (Wilkinson, (2014).

The laxity structures in patients going through delayed procedure were determined with intraoperative physical evaluation at the period of ligament reconstruction. 11 of the 12 patients having chronic injury went through allograft replacement of the posterior and anterior cruciate ligaments (Sick et al., 2012). One 17-year-old patient submitted to primary repair of an avulsion damage of the anterior cruciate ligament and a fresh allograft reinstatement of the posterior cruciate ligaments 1 month following injury. 5 patients who were subjected to chronic treatment encountered injuries of medial collateral ligaments, anterior cruciate, and posterior cruciate. 3 out of 3 patients suffered medial collateral ligaments grade- 3+ laxities necessitating reconstruction. 2 out of the 5 experienced grade- 2+ laxities of the posterior and anterior cruciate ligaments, and medial collateral ligaments were replaced with no medial collateral ligaments repair. 2 patients who underwent chronic procedure had grade- 3+ injuries of posterior and anterior cruciate ligaments and laxity of posterolateral corner (Pedowitz et al., 2013).

13.DISCUSSION

It was found that allograft reconstruction presents a good operational result in most patients. Subjective functional results were tolerable for patients who went through the ligament surgery in the first 3-weeks following injury. The grades on all 3 rating scales applied in examination demonstrate this pattern. Many patients suffered only functional limitations and slight symptoms during activities of day-to-day living. Patients who were placed on surgery in the first 3-weeks following operation tended to have higher subjective grades. Nevertheless, only the variance in the score on sports actions of the outcome of knee review attained significance ($p = 0.04$) (Johnson, 2012).

Objectively, all the chronically and acutely treated patients received a positive range of movement. On evaluation, most knees were stable. Enduring laxity of the posterior cruciate ligaments was very prevalent in chronically treated patients. As well, residual valgus laxity was more common in patients who went through delayed medial collateral ligament reconstruction. These results are in line with those other studies concerning the treatment of dislocated knee (Bianchi, 2012).

Clinically, nevertheless, most patients did not show instability unless they tried strenuous sports or manual labor activities warranting aggressing shifts in pivoting or direction.

14.CONCLUSION

Knee distortions are serious injuries as they can result in disruption of numerous ligaments, neurovascular structures, and surrounding musculature. Acute treatment and diagnosis may be difficult, and the changing techniques that are employed to reconstruct the PCLs and anterior structures may be controversial. These injuries, as a result of surrounding tissue damage and ligamentous disruption, can cause biomechanical hindrances of the knees intersections before or following reconstruction efforts made.

To avoid abnormal angulations and translations in the reconstructed knees, surgeons in charge of repairs in patients having multiple ligament damages must have a complete knowledge of biomechanics and normal anatomy of the entire knee plus the anterior and PCLs. This understanding ought to help optimize the order of ligament reconstructions, the timing of the surgery, the rehabilitation of the neighboring musculature, and the anatomic placement of grafts.

15. CASE STUDY

15.1. Report on Clinical Work

Done by: Osama Aljeheny **Year:** 3rd year **Workplace:** C.L.P.A

Supervisor: PhDr.Ivana Vláčilová Ph.D., Mgr.Zahir Elali

Year of birth: 1967

Examined person: J.K.

16.DIAGNOSIS

Distortion of the right knee joint

17.SUBJECTIVE FEELING OF THE PATIENT

The patient feels slight pain just some times when he tries to perform a full range of motion in the right knee joint in the direction of maximum flexion and extension. The patient feels bad about the weakness he has in his thigh muscles and he feels also decreased knee joint stability.

18.STATUS PRESENS

Height: 180cmWeight: 85kg BMI: 26.2 Blood pressure: 119 over 80 Heart rate: 70

He felt good and no pain when he walked into the room but later the patient had some pain during the therapy session during exercising of isometric training but there was not any special movement that can provoke the pain. The patient was in the 1st day walking without the knee orthosis so he didn't feel stable with walking. The patient used the orthosis for one month.

19.HISTORY OF PROBLEM

The injury happened on 15.12.2015 when the patient was running outdoor. As the patient described while running his right knee was rotated inward suddenly then he lost balance and fell down on the ground with sharp pain in the knee.

Medications: Insulin injection for diabetic patients

Excerpt from patient's health care file: NO

20.SOCIAL ANAMNESIS

He is living in the 3rd floor in house in Prague with elevator.

21.ANAMNESIS

Family History: No special diseases related to the patient injury.

Operations: NO

Injuries: NO

Allergies: Soap

Abuses: Social drinker

Hobbies: Tennis, jogging, football and cycling sometimes

Occupation: Psychiatrist at the state police (sitting most of the time at work almost 5 hours)

Prior rehabilitation: NO**.** The patient used knee brace for one month after this injury.

22.RHB INDICATIONS

- Soft tissue techniques for skin and fascia
- Exercises for limited Range of motion (ROM) of knee joint
- Mobilization for restricted joints of the lower extremity
- PNF technique
- Relaxing hypertonic muscles using Post isometric relaxation (PIR) technique
- Sensomotoric training to improve proprioception level
- Stretching of shorted muscles
- Strengthening and stimulation of weak muscles of lower extremity
- Correct posture and gait

23.INITIAL EXAMINATIONS

23.1. Postural examination (by Kendal)

Posterior view:

- Both lower extremities are in slight internal rotation
- Right knee joint is in semi-flexed position
- Whole spine is in mid line
- Both scapulas are slightly abducted.
- Both upper extremities are in slightly external rotation
- Left shoulder is slightly higher than the right shoulder

Lateral view:

- More loading on heels
- Right knee joint is in semi-flexed position

- Normal curves of whole spine
- Both upper extremities are in slight external rotation

Anterior view:

- Both lower extremities are in slight external rotation
- Right knee is in semi-flexed position
- The navel is at mid line
- Left shoulder is slightly higher than the right shoulder

23.2. Gait examination (by Kendal)

Patient is on the 1st day after using the knee brace (orthosis) which was supporting the right knee.

- Whole body limping to the left side
- He walks more on the lateral aspects of the foot
- There is not full extension in the right knee
- Pain in the 1st metatarsal bone during walking in the right foot
- More loading on the left side
- The patient's gait is symmetrical

23.3. Modification of gait examination:

Walking on tip toes: Patient is able to provide but there is not full extension of his right knee joint.

Walking with squats: Patient is able to provide it. But he felt not so comfortable due to some pain in the right knee.

23.4. Soft tissue examination (by Lewit)

- Skin and connective tissue of lower extremity (shin and calf) is restricted in both directions (medial and lateral) in the right leg.

- Deep facia of the thigh is restricted in both directions (medial and lateral) around the axis of the lower extremity in both legs.

23.5. Pelvis examination (by Kendal)

The position of the pelvic is in slight anterior tilt.

23.6. Special tests

2 scales test: R 43 L 52

Trandelburg's test: The patient was able to perform the test on left side but on the right side the patient was slightly shaking and the pelvic drooped (which indicates weakness in the right hip abductors) and the stability was worse too. So the test was positive in the right side.

Romberg test:

I negative

II negative

III negative

Special tests for stability of knee joint

Anterior drawer test: Negative

Posterior drawer test: Negative

Lachman test: Negative

Anthropometry examination (by Kendal)

Table 7: Anthropometry examination (by Kendal)

Measurement	Right lower extremity	Left lower extremity
Anatomical length	89 cm	89 cm
Functional length	92 cm	92cm
Length of the thigh	49 cm	49 cm
Length of the middle leg	40 cm	40 cm
Length of the foot	26 cm	26 cm
Circumference of thigh Quadriceps	45 cm	46 cm
Vastus Medialis	40 cm	42 cm
Circumference of knee joint	39 cm	37 cm
Circumference of the calf	36 cm	36 cm
Circumference of ankle joint	27 cm	27 cm
Circumference of the foot	25 cm	25 cm

23.7. Palpation examination (by Kendal)

Muscles:

Right lower extremity:

M. Quadriceps (m. rectus femoris): hypotonic

M. Tensor fasciae latae: hypertonic

M. Adductors (m. adductor longus, magnus, brevis): normal tonus

M. Hamstrings: hypertonic

M. Iliopsoas: normal tonus

M. Gastrocnemius: normal tonus

M. Gluteus maximus: normal tonus

M. Piriformis: hypertonic

Left lower extremity:

M. Quadriceps (m. rectus femoris): normal tonus

M. Tensor fasciae latae: hypertonic

M. Adductors (m. adductor longus, magnus, brevis): normal tonus

M. Hamstrings: normal tonus

M. Iliopsoas: normal tonus

M. Gastrocnemius: normal tonus

M. Gluteus maximus: normal tonus

M. Piriformis: normal tonus

23.8. Range of motion examination (by Kendal)

Knee joint:

Table 8: Range of motion examination - Knee joint

	Right side		Left side	
Motion	Active movement (degrees)	Passive movement (degrees)	Active movement (degrees)	Passive movement (degrees)
Extension	-10°	-5°	0°	0°
Flexion	110°	125°	130°	135°

Ankle joint:

Table 9: Ankle joint

	Right side		Left side	
Motion	Active movement (degrees)	Passive movement (degrees)	Active movement (degrees)	Passive movement (degrees)
Plantar Flexion	40°	45°	45°	45°
Dorsiflexion	15°	20°	15°	20°

Hip joint:

Table 10: Hip joint

	Right side		Left side	
Motion	Active movement (degrees)	Passive movement (degrees)	Active movement (degrees)	Passive movement (degrees)
Extension	10°	15°	10°	15°
Flexion	100°	110°	110°	120°
Abduction	40°	45°	40°	45°
Adduction	10°	15°	10°	15°
External rotation	40°	40°	40°	40°
Internal rotation	35°	40°	40°	40°

23.9. Muscle strength examination (by Kendal)

Table 11: Muscle strength examination (by Kendal)

Muscle	Right lower extremity	Left lower extremity
Quadriceps	4-	5
Hamstrings	4-	5
Adductors	5	5
Tensor fasciae latae	4	5
Gastrocnemius	4+	5
Iliopsoas	5	5
Gluteus maximus	4	4
Gluteuse medius	-4	4

23.10. Muscle length examination (by Janda)

Table 12: Muscle length examination (by Janda)

Muscle	Right lower extremity	Left lower extremity
Quadriceps	0	0
Hamstrings	2	2
Adductors	0	0
Tensor fasciae latae	0	0
Gastrocnemius	0	0
Iliopsoas	0	0

23.11. Neurological examination (by Lewit)

Deep sensation test: Sterognosis: it was felt by hands and feet. Graphesthesia: it was applied on both hands and both lower extremities. Both are Negative position sense: it was applied of both lower extremities it was negative in all joints except of the right knee joint the sense was slightly decreased.

Rhomberg test: I,II,III are Negative

Superficial sensation test: light touch: it was applied on both lower extremities on the inner and outer aspects. The test is Negative

Examination of deep tendon reflexes (by Lewit):

Patellar tendon: 2 normal reflex

Achilles tendon: 2 normal reflex

23.12. Joint Play Examination (by Lewit)

Table 13: Joint Play Examination (by Lewit)

Joint	**Left side**	**Right side**
Sacroiliac	No restriction in all directions	No restriction in all directions
Patella	No restriction in all directions	Restricted in the lateral direction
Head of fibula	No restriction in all directions	No restriction in all directions
Talocrural	No restriction	No restriction
Subtalar	No restriction	No restriction
Chopar't	No restriction	Restricted cranial direction
Lisfranc's	No restriction	Restricted cranial direction
Metatarsophalangeal	No restriction in all directions	No restriction in all directions
Interphalangeal	No restriction in all directions	No restriction in all directions

24.EXAMINATIONS CONCLUSION

From the case of the patient we can see that the patient has pain sometimes when he reaches his maximum ROM of his injured knee, bad stabilization of the knee joint due to decreased level of proprioception in the joint after the injury. Due to the position of the right lower extremity (semi flexed knee) and the restricted joins Chopar't and Lisfranc's the patient has a wrong contact with the foot and the ground which results in a fault gait pattern. One more major problem for the patient at this time there is the swelling around the right knee joint and the restriction of the deep fascia at this area too. The patient has no sensation problems in superficial and deep except of the position sense in the right knee joint. As a result of his injury now the patient suffers from weakness of muscles of right lower extremity (quadriceps, hamstrings and gastrocnemius) with shortness of both hamstrings and some hypertonic muscles (Tensor fasciae latae, Hamstrings).

25.SHORT-TERM PLAN

- Reduce pain (applying hot rolls and PIR)
- Relax hyper tonic muscles (using PIR technique)
- Increase ROM in limited joints (using passive and active ROM training)
- Stretch shorted muscles (using PIR with stretching and stretching techniques)
- Mobilization for restricted joints
- Activation of hypotonic muscles
- Strengthening of weak muscles
- Correct faulty gait with instructions

26.LONG-TERM PLAN

- Keep strengthening exercises for weak muscles
- Improve stability of the knee

- Stretching exercises for shortened muscles
- Relaxing hypertonic muscles
- ADL training
- Improve gait pattern
- Advices to improve posture daily activities

27.PHYSICAL THERAPY TOOLS

- Kinesio-tape for decreasing the swelling and improving stability
- Laser therapy: biostimulation efect for 14 minutes, power 3 W, area 25 cm^2, total energy 2500 J.

28.PHYSICAL THERAPY SESSIONS

Day to day therapy

Date 20.1.2016

Status praesens subjective: the patient feels weakness and limitation in the range of motion and some pain during maximum range of motion.

Status praesens objective: the biggest problems for the patient now is the limited range of motion in the right knee, the swelling and the weakness of the mentioned muscles above. And for sure we still need to work on the gait to improve it and the restricted joints and fascia.

Goal of today's therapy unit

The goal of therapy is to increase range of motion of the right knee joint. Strengthening of right knee extensors and flexors and hip joint abductors. Mobilization of the fascia of the thighs (around the axis of the leg). Mobilization of patella and Chopar't Lisfranc's joints.

Procedure

For mobilization of patella and Chopar't and Lisfranc's joints in cranial direction.

While patient on bed supine with legs extended, we do mobilization of patella which was restricted in lateral direction in right knee, by moving patella by therapist hand to the restriction direction and hold it until release.

For mobilization of Chopar't and Lisfranc's joints, when patient is supine with slightly flexed knees, we reach the barrier in the cranial direction then we apply repetitive movements in the same direction till we feel releas.

PIR techniques for hypertonic muscles according to lewit M. Tensor fasciae latae,M. Hamstrings, M. Iliopsoas and M. Piriformis.

for mobilization of deep fascia of thigh , both side, while patient is in bed, with flexed knees, we move whole thigh by whole hand (around the axis of leg) to one direction which is restricted and wait for release

For increase ROM of knee joints

Patient supine, putting small ball under heel and roll it by doing flexion and extension of knee.

For strengthening knee extensors muscles

at the bed, post isometric contraction, when patient is supine, putting small ball under knee, ask patient to lift foot up (extend knee) and hold for few seconds and then relax

At the gym

Walk on unstable surfaces, and holding small ball and pass it around the body

Standing on bosu, with holding small ball and throw it from hand to hand

Lifting weight

For abductors patient is side lying, weight on leg above ankle, and doing abduction

For hamstring patient is prone, weight on leg above ankle and doing flexion of knee

At the end of training patient do cycling for 10 min with slight resistance.

Laser therapy: biostimulation efect for 14 minutes, power 3 W, area 25 cm^2, total energy 2500 J.

Results

Patient felt good, doing exercises in good form as he already learned from physiotherapist, he had good stability and strength of lower extremities muscles.

Self-therapy

The patient is out-patient, and does not have therapy every day at hospital, but we taught him ROM exercises at bed by rolling small ball under heel while doing flexion and extension of knee and hip, we instruct her also to do isometric contraction of quadriceps by putting small ball under knee and extend the knee. He can also exercise at the home same exercises we have done.

Date 22.1.2016

<u>Status praesens subjective:</u> the patient still feels weakness and limitation in the range of motion and some pain during maximum range of motion.

<u>Status praesens objective:</u> the biggest problems for the patient now still the limited range of motion in the right knee, the swelling and the weakness of the mentioned muscles above. And for sure we still need to work on the gait to improve it and the restricted joints and fascia.

Goal of today's therapy unit

We checked the muscles tone, joint play of patella and Chopar't and Lisfranc's joints, ROM of knee joints. Mobilization for right patella which is restricted in lateral direction, mobilization of deep fascia of thighs, lymph drainage, gait training, strengthening exercises of weak muscles and general relaxation of muscles and soft tissues.

Procedure

For mobilization of patella and Chopar't and Lisfranc's joints.

While patient on bed supine with legs extended, we do mobilization of patella which was restricted in lateral direction in right knee, by moving patella by therapist hand to the restriction direction and hold it until release.

For mobilization of Chopar't and Lisfranc's joints, when patient is supine with slightly flexed knees, we reach the barrier in the cranial direction then we apply repetitive movements in the same direction till we feel releas.

PIR techniques for hypertonic muscles according to lewit M. Tensor fasciae latae,M. Hamstrings, M. Iliopsoas and M. Piriformis

For mobilization of deep fascia of thigh , both side, while patient is in bed, with flexed knees, we move whole thigh by whole hand (around the axis of leg) to one direction which is restricted and wait for release

For increase ROM of knee joints

Patient supine, putting small ball under heel and roll it by doing flexion and extension of knee.

For gait training

Forward walking, with slow walk, and semi flexed knees, contact heel sole tiptoes

Backward walking with slow walk, contact toes sole heels

Side to side walk

Tiptoes walking, contact on tiptoes

Heel walking, contact on heel

For strengthening knee extensors muscles

at the bed, post isometric contraction, when patient is supine, putting small ball under knee, ask patient to lift foot up (extend knee) and hold for few seconds and then relax

Adductors

Putting small ball between knees and squeezing it, while patient supine with flexed knees

Standing on bosu, and throw small ball from hand to hand, while patient is standing with semi flexed knees and hips, and slight external rotation of hip

Knee and hip extensors, bridging

By putting medicine ball under calves and heels, arms at sides, lifting pelvis upward, and hold for few seconds then relax

Abductors, lifting weight

2 kg weight on leg above ankle, patient side lying, doing abduction

Hamstring, lifting weight while patient is prone, 2 kg weight on leg above ankle, doing knee flexion

For lymph drainage, after exercising

Lymph therapy (massage), duration 25 min, pressure 9.5 kpa, program 37

Cycling, for 5 min with slight resistance

Stretching exercises for quadriceps and hamstring

For quadriceps, patient prone, flexed knees, belt around foot and heel, and in patient hand, withdraw foot in direction of flexion of knee and hold it for few seconds then relax

For hamstring, patient is supine, with extended knees, belt around foot and heel, and and patient is holding it by her hand, withdraw the belt toward trunk, while doing flexion of hip and dorsal flexion of foot, hold the belt for few seconds and then relax.

All exercises 3 times 10 repetitions.

Laser therapy: biostimulation efect for 14 minutes, power 3 W, area 25 cm2, total energy 2500 J.

Results

Patient did not have pain or difficulties in exercising, he is doing exercises well, and there is improvement in ROM of right knee, moveable patella and better mobility of Chopar’t and Lisfranc’s joints, improvement in muscle strength of weak muscles.

Self-therapy

Patient can do the same self-therapies was instructed before, he knows it well and can perform it in good form.

Date 25.1.2016

Status praesens subjective: the patient still feels weakness and limitation in the range of motion and some pain during maximum range of motion.

Status praesens objective: the biggest problems for the patient now still the limited range of motion in the right knee, the swelling and the weakness of the mentioned muscles above. And for sure we still need to work on the gait to improve it and the restricted joints and fascia.

Goal of today's therapy

We do evaluation checking for muscle tone of affected muscles, soft tissues of thigh, joint play for restricted joints and ROM of knees. The goal of therapy is increase ROM of the right knee, strengthening of weak muscles (knee extensors) , lymph drainage, gait training, stretching shorten muscles (hamstring)

Procedure

Lymph massage therapy

Lymph therapy (massage), duration 25 min, pressure 11 kpa, program 37

For gait training

Forward walking, with slow walk, and semi flexed knees, contact heel sole tiptoes

Backward walking with slow walk, contact toes sole heels

Side to side walk

Tiptoes walking, contact on tiptoes

Heel walking, contact on heel

PIR techniques for hypertonic muscles according to lewit M. Tensor fasciae latae,M. Hamstrings, M. Iliopsoas and M. Piriformis.

For strengthening exercises

Standing on bosu, and throw small ball from hand to hand, while patient is standing with semi flexed knees and hips, and slight external rotation of hip

Knee and hip extensors, bridging

By putting medicine ball under calves and heels, arms at sides, lifting pelvis upward, and hold for few seconds then relax

Cycling, for 10 min with slight resistance

Stretching exercises for quadriceps and hamstring

For quadriceps, patient prone, flexed knees, belt around foot and heel, and in patient hand, withdraw foot in direction of flexion of knee and hold it for few seconds then relax

for hamstring, patient is supine, with extended knees, belt around foot and heel, and and patient is holding it by his hand, withdraw the belt toward trunk, while doing flexion of hip and dorsal flexion of foot, hold the belt for few seconds and then relax

Laser therapy: biostimulation efect for 14 minutes, power 3 W, area 25 cm^2, total energy 2500 J.

All exercises 3 times 10 repetitions

Results

Patient is feeling good, no pain, no complication, he does exercises well, there is improvement in ROM in knees (F, E), free and moveable patella and Chopar’t and Lisfranc’s joints.

Self-therapy

We instruct patient to continue self-therapy he was instructed before.

Date 26.1.2016

Status praesens subjective: the patient still feels weakness and limitation in the range of motion and some pain during maximum range of motion.

Status praesens objective: the biggest problems for the patient now still the limited range of motion in the right knee, the swelling and the weakness of the mentioned muscles above. And for sure we still need to work on the gait to improve it and the restricted joints and fascia.

Goal of today's therapy

We do evaluation checking for muscle tone, soft tissues (fascia), joint play of patella and head of fibula, ROM knees and hips. The goal of therapy is increase ROM of right knee, strengthening of weak muscles (knee extensors) and hip abductors, gait training, stretching shorten muscles (hamstring).

Procedure

For gait training

Forward walking, with slow walk, and semi flexed knees, contact heel sole tiptoes

Backward walking with slow walk, contact toes sole heels

Side to side walk

Tiptoes walking, contact on tiptoes

Heel walking, contact on heel

Walking on treadmill, for 5 min

Walking on unstable surfaces, holding small ball and throw it from hand to hand

PIR techniques for hypertonic muscles according to lewit M. Tensor fasciae latae,M. Hamstrings, M. Iliopsoas and M. Piriformis.

For strengthening exercises

Standing on bosu, and throw small ball from hand to hand, while patient is standing with semi flexed knees and hips, and slight external rotation of hip

Knee and hip extensors, bridging

By putting medicine ball under calves and heels, arms at sides, lifting pelvis upward, and hold for few seconds then relax

Hip abductors

By placing a weight around the ankle in side laying position and perform abduction in the hip joint.

Cycling, for 10 min with slight resistance

Stretching exercises for quadriceps and hamstring

For quadriceps, patient prone, flexed knees, belt around foot and heel, and in patient hand, withdraw foot in direction of flexion of knee and hold it for few seconds then relax

For hamstring, patient is supine, with extended knees, belt around foot and heel, and patient is holding it by his hand, withdraw the belt toward trunk, while doing flexion of hip and dorsal flexion of foot, hold the belt for few seconds and then relax.

Laser therapy: biostimulation efect for 14 minutes, power 3 W, area 25 cm2, total energy 2500 J.

All exercises 3 times 10 repetitions.

Results

Patient felt fine, no pain or fatigue, doing exercises well, there is improvement in ROM of knee (F, E) free patella and Chopar't and Lisfranc's joints. , free deep fascia of thighs both side.

Self-therapy

Patient continue the same self-therapy was instructed.

Date 27.1.2016

<u>Status praesens subjective:</u> the patient feels better and more confident and stronger with no pain.

<u>Status praesens objective:</u> the paiten is so much better by this time but we still need to work on the same things as before to reach the optimal condition. (Still the limited range of motion in the right knee, the swelling and the weakness of the mentioned muscles above. And for sure we still need to work on the gait to improve it and the restricted joints and fascia).

Goal of today's therapy

We do evaluation checking for muscle tone of affected muscles, soft tissues of thigh, joint play and ROM of right knee. The goal of therapy is increase ROM of right knee, strengthening of weak muscles (knee extensors) and hip abductors and hamstrings, lymph drainage, gait training, stretching shorten muscles (hamstring).

Procedure

Lymph massage therapy

Lymph therapy (massage), duration 25 min, pressure 12.5 kpa, program 37

For gait training

Forward walking, with slow walk, and semi flexed knees, contact heel sole tiptoes

Backward walking with slow walk, contact toes sole heels

Side to side walk

Tiptoes walking, contact on tiptoes

Heel walking, contact on heel

PIR techniques for hypertonic muscles according to lewit M. Tensor fasciae latae,M. Hamstrings, M. Iliopsoas and M. Piriformis.

For strengthening exercises

Standing on bosu, and throw small ball from hand to hand, while patient is standing with semi flexed knees and hips, and slight external rotation of hip

Knee and hip extensors, bridging

By putting medicine ball under calves and heels, arms at sides, lifting pelvis upward, and hold for few seconds then relax

Hip abductors

By placing a weight around the ankle in side laying position and perform abduction in the hip joint.

Jumping on trampoline, for few minutes

Cycling, for 10 min start with resistance

Stretching exercises for quadriceps and hamstring

For quadriceps, patient prone, flexed knees, belt around foot and heel, and in patient hand, withdraw foot in direction of flexion of knee and hold it for few seconds then relax

For hamstring, patient is supine, with extended knees, belt around foot and heel, and patient is holding it by his hand, withdraw the belt toward trunk, while doing flexion of hip and dorsal flexion of foot, hold the belt for few seconds and then relax

Laser therapy: biostimulation efect for 14 minutes, power 3 W, area 25 cm^2, total energy 2500 J.

All exercises 3 times 10 repetitions. Patient is going to gym twice a day doing the same exercises.

Results

Patient felt perfect, no pain or fatigue, doing exercises well, there is improvement in ROM of knee (F, E), free patella and Chopar't and Lisfranc's joints, free deep fascia of thighs both side, muscle strength is improvement.

Self-therapy

Patient can continue the same exercises, and can add jumping on trampoline.

Date 29.1.2016

<u>Status praesens subjective:</u> the patient feels better and more confident and stronger with no pain.

<u>Status praesens objective:</u> the patient is so much better by this time but we still need to work on the same things as before to reach the optimal condition. (Still the limited range of motion in the right knee, the swelling and the weakness of the mentioned muscles above. And for sure we still need to work on the gait to improve it and the restricted joints and fascia).

Goal of today's therapy

We do evaluation checking for muscle tone of affected muscles, soft tissues of thigh, joint play and ROM of knees. The goal of therapy is increase ROM of right knees, strengthening of weak muscles (knee extensors, hip extensors) and hamstrings and hip abductors, lymph drainage, gait training, stretching shorten muscles (hamstring).

Procedure

For gait training

Forward walking, with slow walk, and semi flexed knees, contact heel sole tiptoes

Backward walking with slow walk, contact toes sole heels

Side to side walk

Tiptoes walking, contact on tiptoes

Heel walking, contact on heel

PIR techniques for hypertonic muscles according to lewit M. Tensor fasciae latae,M. Hamstrings, M. Iliopsoas and M. Piriformis.

For strengthening exercises

Standing on bosu, and throw small ball from hand to hand, while patient is standing with semi flexed knees and hips, and slight external rotation of hip.

Hip abductors

By placing a weight around the ankle in side laying position and perform abduction in the hip joint.

Knee and hip extensors, bridging

By putting medicine ball under calves and heels, arms at sides, lifting pelvis upward, hold for few Seconds then relax.

First time to do extension of knee with weight (machine), 1.5 kg (3 times 8 repetitions)

First time to do extension of hip with weight (machine), 1, 5 kg (3 times 8 repetitions)

Jumping on trampoline, for few minutes

Cycling, for 10 min with resistance

Stretching exercises for quadriceps and hamstring

For quadriceps, patient prone, flexed knees, belt around foot and heel, and in patient hand, withdraw foot in direction of flexion of knee and hold it for few seconds then relax

for hamstring, patient is supine, with extended knees, belt around foot and heel, and and patient is holding it by his hand, withdraw the belt toward trunk, while doing flexion of hip and dorsal flexion of foot, hold the belt for few seconds and then relax

Lymph massage therapy, after exercising

Lymph therapy (massage), duration 25 min, pressure 17 kpa, program 37

Laser therapy: biostimulation efect for 14 minutes, power 3 W, area 25 cm^2, total energy 2500 J.

All exercises 3 times 10 repetitions.

Results

We can see notable improvement in ROM of knee (F, E) improvement strength of weak muscles (quadriceps, hamstring) and hip abductors, moveable patella and Chopar't and Lisfranc's joints, moveable deep fascia of thigh.

Self-therapy

Patient felt great, we instruct him to continue past self-therapy.

29.FINAL KINESIOLOGIC EXAMINATION

29.1. Postural examination (by Kendal)

Posterior view:

- Both lower extremities are in slight internal rotation
- Right knee joint is in slightly semi-flexed position
- Whole spine is in mid line
- Both scapulas are slightly abducted.
- Both upper extremities are in slightly external rotation
- Left shoulder is slightly higher than the right shoulder

Lateral view:

- More loading on heels
- Right knee joint is in semi-flexed position
- Normal curves of whole spine
- Both upper extremities are in slight external rotation

Anterior view:

- Both lower extremities are in slight external rotation
- Right knee is in slightly semi-flexed position
- The navel is at mid line
- Left shoulder is slightly higher than the right shoulder

Gait examination (by Kendal)

Patient is on the 1st day after using the knee brace (orthosis) which was supporting the right knee.

- Whole body slightly limping to the left side
- He walks slightly more on the lateral aspects of the foot
- There is almost full extension in the right knee
- The pain in the 1st metatarsal bone during walking in the right foot is disappeared
- The patient's gait is symmetrical

29.2. Modification of gait examination:

Walking on tip toes: Patient is able to provide but there is not full extension of his right knee joint.

Walking with squats: Patient is able to provide it.

29.3. Soft tissue examination (by Lewit):

- Skin and connective tissue of lower extremity (shin and calf) is not restricted in both directions (medial and lateral) in the right leg.
- Deep facia of the thighs is not restricted in both directions (medial and lateral) around the axis of the lower extremity in both legs.

29.4. Pelvis examination (by Kendal)

The position of the pelvic is in slight anterior tilt.

Special tests:

2 scales test: R 45 L 50

Trandelburg's test: The patient was able to perform the test on left and right side with no problems. So the test was negative in both side.

29.5. Romberg test:

I negative

II negative

III negative

Special tests for stability of knee joint:

Anterior drawer test: Negative

Posterior drawer test: Negative

Lachman test: Negative

29.6. Anthropometry examination (by Kendal)

Table 14: Anthropometry examination (by Kendal)

Measurement	Right lower extremity	Left lower extremity
Anatomical length	89 cm	89 cm
Functional length	92 cm	92cm
Length of the thigh	49 cm	49 cm
Length of the middle leg	40 cm	40 cm
Length of the foot	26 cm	26 cm
Circumference of thigh Quadriceps	45 cm	46 cm
Vastus Medialis	40 cm	42 cm
Circumference of knee joint	37 cm	37 cm
Circumference of the calf	36 cm	36 cm
Circumference of ankle joint	27 cm	27 cm
Circumference of the foot	25 cm	25 cm

29.7. Palpation examination (by Kendal)

Muscles:

Right lower extremity:

M. Quadriceps (m. rectus femoris): normal tone

M. Tensor fasciae latae: normal tone

M. Adductors (m. adductor longus, magnus, brevis): normal tonus

M. Hamstrings: hypertonic

M. Iliopsoas: normal tonus

M. Gastrocnemius: normal tonus

M. Gluteus maximus: normal tonus

M. Piriformis: hypertonic

Left lower extremity:

M. Quadriceps (m. rectus femoris): normal tonus

M. Tensor fasciae latae: normal tone

M. Adductors (m. adductor longus, magnus, brevis): normal tonus

M. Hamstrings: normal tonus

M. Iliopsoas: normal tonus

M. Gastrocnemius: normal tonus

M. Gluteus maximus: normal tonus

M. Piriformis: normal tonus

29.8. Range of motion examination (by Kendal)

Knee joint:

Table 15: Knee joint

	Right side		Left side	
Motion	Active movement (degrees)	Passive movement (degrees)	Active movement (degrees)	Passive movement (degrees)
Extension	-5°	0°	0°	0°
Flexion	125°	130°	130°	135°

Ankle joint:

Table 16: Ankle joint

	Right side		Left side	
Motion	Active movement (degrees)	Passive movement (degrees)	Active movement (degrees)	Passive movement (degrees)
Plantar Flexion	40°	45°	45°	45°
Dorsiflexion	15°	20°	15°	20°

Hip joint:

Table 17: Hip joint

	Right side		Left side	
Motion	Active movement (degrees)	Passive movement (degrees)	Active movement (degrees)	Passive movement (degrees)
Extension	10°	15°	10°	15°
Flexion	100°	110°	110°	120°
Abduction	40°	45°	40°	45°
Adduction	10°	15°	10°	15°
External rotation	40°	40°	40°	40°
Internal rotation	35°	40°	40°	40°

29.9. Muscle strength examination (by Kendal)

Table 18: Muscle strength examination (by Kendal)

Muscle	Right lower extremity	Left lower extremity
Quadriceps	5	5
Hamstrings	5	5
Adductors	5	5
Tensor fasciae latae	4+	5
Gastrocnemius	4+	5
Iliopsoas	5	5
Gluteus maximus	4	4
Gluteuse medius	4+	4+

29.10. Muscle length examination (by Janda)

Table 19: Muscle length examination (by Janda)

Muscle	Right lower extremity	Left lower extremity
Quadriceps	0	0
Hamstrings	1	1
Adductors	0	0
Tensor fasciae latae	0	0
Gastrocnemius	0	0
Iliopsoas	0	0

29.11. Neurological examination (by Lewit)

Deep sensation test: Sterognosis: it was felt by hands and feet. Graphesthesia: it was applied on both hands and both lower extremities. Both are Negative position sense: it was applied of both lower extremities it was negative in all joints.

Rhomberg test: I,II,III are Negative

Superficial sensation test: light touch: it was applied on both lower extremities on the inner and outer aspects. The test is Negative

Examination of deep tendon reflexes (by Lewit):

Patellar tendon: 2 normal reflex

Achilles tendon: 2 normal reflex

29.12. Joint Play Examination (by Lewit)

Table 20: Joint Play Examination (by Lewit)

Joint	**Left side**	**Right side**
Sacroiliac	No restriction in all directions	No restriction in all directions
Patella	No restriction in all directions	No restricted in all directions
Head of fibula	No restriction in all directions	No restriction in all directions
Talocrural	No restriction	No restriction
Subtalar	No restriction	No restriction
Chopar't	No restriction	No restricted
Lisfranc's	No restriction	No restricted
Metatarsophalangeal	No restriction in all directions	No restriction in all directions
Interphalangeal	No restriction in all directions	No restriction in all directions

30.THERAPY EFFECT EVALUATION, PROGNOSIS

After all the therapy sessions we had with patient. We strongly notice the next, increasing in range of motion in the right knee joint flexion 125° and extension -5° in the active movement. But passively we can see its better flexion 130° and extension 0°. The swelling around the knee cap is much better, now it is 37 cm in circumference. Increasing in strength of quadriceps and hamstrings on the right leg (grade 5 by Kendall). No more restriction of joint play in patella, Chopar't and Lisfranc's joints. Restriction of connective tissues and fascia on the thighs and legs is gone. Gait of patient was slightly better as it was described above. Change of loading on both extremities was improved and now the difference between both legs is 5 kg in the two scales test. The proprioception on the right knee was improved too. At last the hypertonic muscles were relaxed after PIR techniques.

The overall condition of the patient is very good and we expect him to be normal soon and this good results is referred to the good fitness level of the patient before the injury.

31.REFERENCES

Bianchi, A. B. (2012, June 12). A Sagittal Plane Model of the Knees and Cruciate Ligaments With Application of a Sensitivity Analysis. Retrieved March 03, 2016, from http://biomechanical.asmedigitalcollection.asme.org/article.aspx?articleid=1400415

Cantrell, K. B. (2013, September 8). Biomechanical evaluation of augmented and nonaugmented primary repair. Retrieved March 03, 2016, from http://link.springer.com/article/10.1007/s00264-013-2098-8/fulltext.html

Chaudhari, A. M. (2013). *Development and application of biomechanical methods to study non-contact injuries of the anterior cruciate ligament*.

Pedowitz, R. A., & Akeson, W. H. (2013). *Daniel's knee injuries: Ligament and cartilage: Structure, function, injury, and repair*. Philadelphia: Lippincott Williams & Wilkins.

Finerman, G., & Noyes, F. R. (2013). *Biology and biomechanics of the traumatized synovial joint: The knee as a model*. Rosemont, IL: American Academy of Orthopaedic Surgeons.

Fotopoulos, W. (2015). *Posterior dislocation of the flexed knees: A biomechanical study of progressive ligament injuries, especially of the anterior cruciate ligament*.

Greenfield, B. H. (2011). *Rehabilitation of the knees: A problem-solving approach*. Philadelphia: F.A. Davis.

Heerwaarden, R. V. (2013). *Effects of pretension in reconstructions of the anterior cruciate ligament: Clinical, biomechanical and computer model analyses*. S.l.: S.n.

Jakob, R., & Hassler, H. (2013). *Observations on rotatory instability of the laterals compartment of the knees: Experimental studies on the functional anatomy and the pathomechanism of the true and the reversed pivot shift sign*. Copenhagen: Munksgaard.

Jenkins, D. B., & Hollinshead, W. H. (2012). *Hollinshead's functional anatomy of the limbs and back*. Philadelphia: Saunders.

Johnson, S. G. (2012). *System behavior of cranial cruciate reconstruction autografts commonly used in the canine stifle: A thesis*. College Station, TX: Texas A & M University.

Kean, C. O. (2012). *Effects of high tibial osteotomy and resistance training on neuromuscular and biomechanical function of patients with varus gonarthrosis*. Ottawa: Library and Archives Canada = Bibliothèque et Archives Canada.

Kurosawa, H. (2013). Conservative Repair for Acute Anterior Cruciate Ligament Injury. *Reconstruction of the Knees Joints,* 28-35. Retrieved March 3, 2016.

Lee, T. Q. (2013). Biomechanical Effects of Kneeling With Posterior Cruciate Retaining and Posterior Cruciate Substituting Total Knee Arthroplasty. *ASME 2009 4th Frontiers in Biomedical Devices*.

Manske, R. C. (2015). *Postsurgical orthopedic sports rehabilitation: Knee & shoulder*. St. Louis, MO: Mosby.

Marshall, C. (2011). *Biomechanical characteristics of the healthy and ACL-reconstructed female knee*.

Moreno, A. (2012). *Influence of a dexterity training protocol on biomechanical parameters of the knees joints among adolescent female basketball players*.

Muscolino, J. E. (2014). *Kinesiology: The skeletal system and muscle function*. St. Louis, MO: Mosby Elsevier.

Pedowitz, R. A., & Akeson, W. H. (2013). *Daniel's knee injuries: Ligament and cartilage: Structure, function, injury, and repair*. Philadelphia: Lippincott Williams & Wilkins.

Sick, H., & Burguet, J. (2012). *Imaging anatomy of the knee region: Anatomy-CT-NMR, frontal slices, sagittal slices, horizontal slices*. München: J.F. Bergmann.

Simonian, P. T., & Bach, B. R. (2011). *Sports medicine of the knee: Surgical approaches*. New York: Thieme.

Stannard, J. P., & Cook, J. L. (2013). *Articular cartilage injury of the knee: Basic science to surgical repair*. New York: Thieme.

Stenström, R. (2010). *Arthrography of the knees joints in children. Roentgenologic anatomy, diagnosis and the use of multiple discriminant analysis*. Stockholm.

Tortora, G. J., & Nielsen, M. (2014). *A brief atlas of the skeleton, surface anatomy, and selected medical images*. Hoboken, NJ: John Wiley & Sons.

Trippel, S. B. (2014). Articular Cartilage Injury and Repair. *Traumatic Disorders of the Knees,* 19-36. Retrieved March 3, 2016.

Wilkinson, R. R. (2014, June 10). Biomechanics of ACL. Retrieved March 03, 2016, from http://www.wheelessonline.com/ortho/biomechanics_of_acl

Winslow, V. L. (2014). *Classic human anatomy: The artist's guide to form, function, and movement*. New York: Watson-Guptill.

Yeager, C. R. (2010). *Anterior cruciate ligament (ACL): Causes of injury, adverse effects, and treatment options*. New York: Nova Science.

Zhang, Y. (2010). Biomechanical Analysis of Anterior Cruciate Ligament Elongations. *2010 4th International Conference on Bioinformatics and Biomedical Engineering*. Retrieved March 3, 2016.

LIST OF ATTACHMENTS

Attachment No. 3: List of Tables

Attachment No. 4: List of Figures

Attachment No. 5: List of Abbreviations

CLPA - Centrum léčby pohybového aparátu

LCL - Lateral collateral ligament

MCL - Medial collateral ligament

ACL - Anterior cruciate ligament

PCL - Posterior cruciate ligaments

ROM - Range of motion

PIR - Post isometric relaxation

m. – muscle

PNF – Proprioceptive neuromuscular facilitation

PLI - Posterolateral imbalance

F – Flexion

E – Extension

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

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[1] Centrum léčby pohybového aparátu Mediterra, 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[2] Case Study Patient with Diagnosis after Distortion of the Right Knee

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: Osama Aljeheny Podpis:........................

Jméno a příjmení osoby, která provedla poučení[3]................................. 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[4] ....….

Vztah zákonného zástupce k pacientovi .... Podpis: ....