CHARLES UNIVERSITY, PRAGUE

FACULTY OF PHYSICAL EDUCATION AND SPORT

Case study of a patient with rheumatoid arthritis followed by knee replacement

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Abstract

Title: Case study of a patient with rheumatoid arthritis followed by knee replacement

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Thesis Aim: Study case of patient after fourteen (14) days of operation. Patient did a total knee replacement because of Rheumatoid Arthritis. In my thesis I will present the process of therapy and rehabilitation of the patient. I will also show the results after nine (9) therapeutic sessions.

In this Thesis there are two (2) parts:

a) The first part will describe a general aspect of anatomy of knee joint and also the functional unit of it with its adjacent muscles which are applied to joint.

b) The second part will describe the case study of the patient, the therapy plan that was applied and also the progress of patient after the treatment.

Key Words: Arthritis, knee, knee replacement operation

Dates of practice: 07/02/2011 - 18/02/2011

Location of practice: Revmatologický ústav, Na slupi 450/4, 128 50 Praha-Nové Město, Praha 2

Declaration

This thesis is a presentation of my original research work. Wherever contributions of others are involved, every effort is made to indicate this clearly, with due reference to the literature, and acknowledgement of collaborative research and discussions.

The work was done under the guidance of Mgr Spiritova Maja., at the Revmatologicky ustav, Na Slupi 4, 128 50 Praha 2

The work was done under the guidance of Professor.

Acknowledgement

Until this moment of my life many peopled help me and I will always appreciate what they did for me.

First of all I would like to thank my family for all the times they have been there for me, helping me from the first moment or by pushing me to the limit for me to see how is the real life.

I want to thank all the professors that I had in Charles University of Prague. They do great work and they share their knowledge with pleasure with the students.

Fokas A. Fotakis

Dedicate

I would like to dedicate my work to my role models Fokas Papanikitas and Antonis Fotakis who help me to improve my personality and create my ethical status. Finally I want to dedicate it to my friend that left too early from our sides George

Contents:

1. Knee anatomy

A thorough knowledge of the complex anatomy and biomechanical function of the structures of the knee is essential to make accurate clinical diagnoses and decisions regarding the treatment of the multiple-ligament-injured knee. The knee is a modified hinge joint that must allow flexion and rotation, yet provide complete stability and control under a great range of loading conditions. The knee consists of two joints: the femorotibial joint and the patellofemoral joint. The bony architecture of the femur, tibia, and patella contribute to the stability of the knee joint, along with static and dynamic restraints of the ligaments, capsule, and musculature crossing the joint. [1]The architecture of the bones dictates, to a certain extent, the allowed motion of the joint. Muscles of the knee joint:

i. Muscle Quadriceps femoris: is a group of muscles that consists of 4 muscles. Rectus femoris, Vastus lateralis, Vastus intermedius and Vastus medialis. Quadriceps is one of the larger muscles in the human body. It covers the largest area of the anterior part of thigh. Also considers as the main muscle that strengthen the knee. [1]
ii. Muscle Hamstrings: is a group of muscles that consists of 3 muscles. Biceps femoris, semitendinosus and semimembranosus. Biceps femoris is a large and strong muscle and consists of 2 heads, long and short. The other part of hamstring consists of semitendinosus, a muscle that originates from the back of pelvis and crossing the back of knee joint. Semitendinosus is the 3rd muscle of hamstrings with the insertion to the pes anserinus. [1]

iii. Muscle Plantaris: is a small muscle with short body and long tendon. Its main function is to act with gastrocnemius. There a lot of reports that refers to Plantaris as a great center of receptors of proprioception. Also because of its minor functional role it is used very often as a graft for reconstructive surgery. [1]
iv. Muscle Popliteus: is a thin and small part on the posterior side of knee joint. Its main function is to flex the knee. It is also activated during the standing

phase when the knee is extended or "locked", there the function changes and rotates the femur lateraly and "unlocks" the knee so flexion can be done. [1]

v. Muscle Triceps surae: is a group of muscles consists of gastrocnemius and soleus muscles. Gastrocnemius has 2 heads and they are more prominent in lateral and medial part of the calf. Because of the muscle fibers topography (mainly vertical), the muscle function acts for knee and ankle joint. Soleus is a powerful muscle that can be palpate on each side of gastrocnemius during plantar flexion of the ankle joint. Soleus also considered as an antigravity muscle that contacts alternately with extensor muscle of the leg in order to maintain balance. [1]

1.1 Femorotibial Joint

The femorotibial joint is the largest joint in the body, and is comprised of two condyloid articulations. The medial and lateral femoral condyles articulate with the corresponding tibial plateaus. Intervening medial and lateral menisci serve to enhance the conformity of the joint, as well as to assist the rotation of the knee. [2]

Simplistically, the femoral condyles are cam-shaped in lateral profile. The medial condyle has a larger radius of curvature than the lateral, and extends distal to the lateral on the anteroposterior (AP) projection. The lateral condyle extends anterior to the medial on the lateral projection, and can be identified by its terminal sulcus and groove for the popliteus insertion3. The proximal tibia is separated by the intercondylar eminence into an oval, concave medial plateau, and a circular, convex lateral plateau. The medial and lateral compartments are asymmetrical, particularly anteriorly4. The lateral condyle of the femur is smaller than the medial, both in the AP and proximodistal directions. This contributes to the valgus and AP alignment of the knee. These shapes allow the medial femur to rotate on the tibia through three axes, and the medial femur to translate, to a limited extent, in the AP direction. Laterally, the femur can freely translate in the AP direction, but can rotate around a transverse axis only near extension. The 3-degree lateral inclination of the tibial plateau in relation to the joint line, and 9° posterior slope, creates an overall valgus and posterior-inferior alignment of between 10° to 12° in most knees. [1,5]

1.2 Patellofemoral Joint

The patellofemoral articulation is a sellar joint between the patella and femoral trochlea. This joint is important to knee stability primarily through its role in the extensor mechanism. The patella increases the mechanical advantage of the extensor muscles by transmitting the extensor force across the knee at a greater distance from the axis of rotation. [2] This increased moment arm reduces the quadriceps force required to extend the knee by 15% to 30%. The contribution of the patella to increasing the moment arm of the quadriceps varies over the range of motion. At full flexion, the lever arm of the quadriceps is increased approximately 10%, and this increases to 30% by 45° from full extension, and then once again decreases as the knee passes to terminal extension. [1]The stability of the patella in the trochlear groove is a combination of bony, ligamentous, and muscular restrains. The patella responds to a set of 3 forces: the pull of the quadriceps, hamstrings, and a net compressive force on the patellofemoral surfaces. In addition, several soft tissue constraints contribute to the tracking of the patella within the trochlear groove. The constraints include the medial patellofemoral ligament, medial patellomeniscal ligament, medial patellotibial ligament, medial retinaculum, and lateral retinaculum.

Each compartment (femorotibial joint and patellofemoral joint) has its own structural identity. The osseous portions of the knee are the femur, tibia, patella, and fibula. The distal end of the femur has a medial and a lateral condyle, each of which has a distinct shape that corresponds to the shape of the tibial plateau. The shape of these condyles is important in the movement of the tibia on the femur. The proximal end of the tibia flares to create a plateau with medial and lateral sections divided by the tibial spine. [6]The menisci deepen the contour of these plateaus to provide a good "seat" for the corresponding femoral condyles. This added depth is extremely important because the lateral femoral condyle and lateral tibial plateau are both somewhat convex.

Figure 1: Osseous anatomy of the knee

1.3 Extensor Mechanism

The extensor, or quadriceps femoris, mechanism consists in part of six muscles (the rectus femoris, the vastus intermedius, the vastus lateralis, the vastus medialis longus, the vastus medialis obliquus, and the articularis genu), one tendon (the quadriceps femoris), and the patellar ligament (often referred to as the patellar tendon). The patella (the largest sesamoid in the body) is a critical component of the extensor mechanism: its location allows greater mechanical advantage for the extension of the knee. The direction of pull exerted on the patella by the muscles provides for a great amount of dynamic stability of the patella. The articulating surface of the patella consists of five areas. The extensor mechanism includes still other structures. The fat pad lies beneath the patellar tendon as it runs from the inferior patellar pole to the tibial tubercle. The patellofemoral and the patellotibial ligaments, thickenings in the extensor retinaculum that covers the anterior portion of the knee, stabilize the patella. The prepatellar bursa lies between the skin and the anterior surface of the patella. The infrapatellar bursa lies deep to the patellar tendon but in front of the infrapatellar fat pad. These two bursae are subject to inflammation caused by trauma (primarily to the prepatellar) and by overuse (infrapatellar). Other bursae are present about the anterior, medial, and lateral portions of the knee. [7]The synovial membrane of the knee develops from three separate pouches. Seams from this fusion are present in the synovial membrane. These seams are are termed plicae and are somewhat inconstant in nature. [8] The plica usually courses medially beneath the extensor mechanism and runs distally along the medial patella border across the medial femoral condyle, finally attaching to the fat pad. Because the synovial membrane of the knee is large, in fact the largest synovial membrane in the body, it obtains needed support from the articularis genu during movements of the knee.

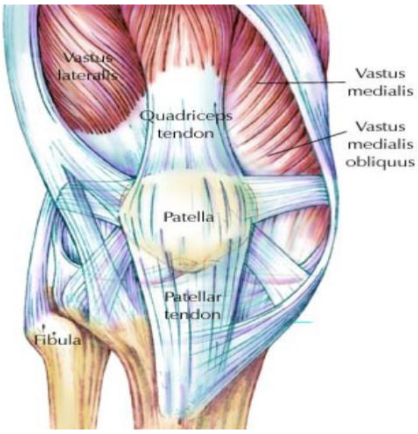

Figure 2: Muscles of the extensor mechanism

1.4 Medial compartment

The medial compartment of the knee is supported by a portion of the extensor retinaculum. Other muscles of the thigh aid in dynamic stability of the knee. Ligamentous stability of the knee involves several planes of motion. Dynamic stabilization is of the utmost importance when dealing with individuals who have knee instability. The pes anserinus group (sartorius, gracilis, and semitendinosus muscles) crosses the posterior medial area of the joint and attaches to the anterior medial part of the tibia at the level of the tibial tubercle. The adductor magnus muscle attaches to the femoral condyle at the adductor tubercle. The semimembranosus muscle with its five branches is an important medial stabilizer of the knee. Fibers from these branches support the posterior capsule and the posteromedial capsule and attach to the medial meniscus as well as to the tibia. The muscular attachment to the medial meniscus pulls the meniscus posteriorly from the joint as the knee flexes. The medial meniscus is intimately attached to the capsular ligaments at its periphery. Thus these capsular ligaments are divided into the meniscofemoral and meniscotibial ligaments. These capsular ligaments lie deep to the tibial collateral ligament, which originates at the medial femoral epicondyle and courses distally and attaches beneath the pes anserinus group on the tibia. [9] The medial capsular ligaments are longitudinally divided into three groups. The anterior third is seen anteromedially.

The middle third provides stability through its thickened structures. The posterior third is often referred to as the posterior oblique ligament and is important in controlling anteromedial rotatory instability.

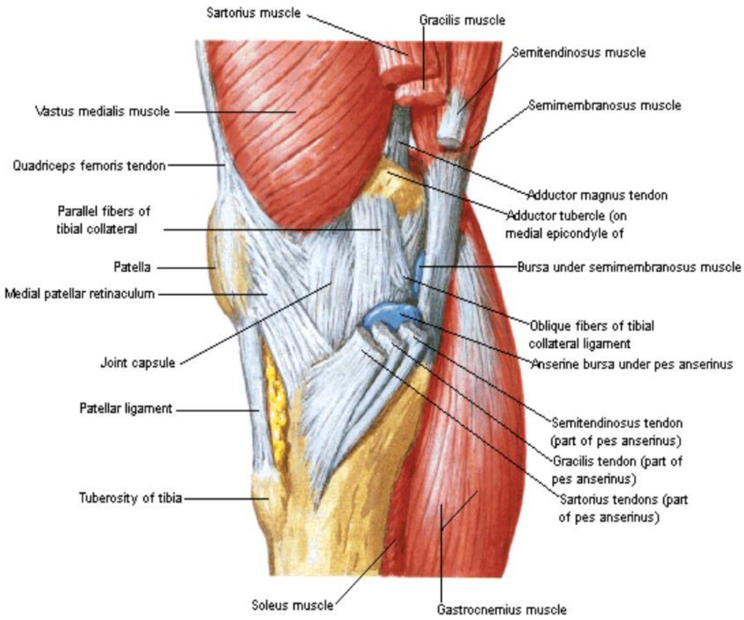

Figure 3: Medial view of the knee. The muscles of the medial compartment are indicated

The posterior cruciate ligament is also included in the medial compartment. It is often referred to as the "main stabilizer" of the knee and is composed of posteromedial and anteromedial bundles. The tension within each bundle varies as the knee moves from flexion to extension. The posterior cruciate ligament tightens as the tibia internally rotates on the femur. Its origin is on the intercondylar surface of the medial femoral condyle and its insertion is on the fovea of the tibia. [10]

1.5 Lateral compartment

Lateral compartment structures of the knee are somewhat analogous to the medial compartment structures. Muscular support is provided by the iliotibial band and iliotibial tract (these structures are divided by their orientation according to the intermuscular septum). These structures attach anterolaterally into Gerdy's tubercle. The popliteus muscle originates on the lateral femoral condyle and inserts on the posterior, medial edge of the tibia. Its insertion forms an important structure as it reinforces the posterior third of the lateral capsular ligament.

The fibular collateral ligament overlies the lateral capsular ligaments. The lateral capsular ligaments attach to the lateral meniscus in much the same way that ligaments attach to the medial meniscus. These lateral ligaments are divided into the meniscofemoral and meniscotibial sections of the lateral capsule. The anterior third of the lateral capsule provides little static support. The middle third of the lateral capsular ligaments is responsible for providing support against anterolateral rotatory instability. The posterior lateral third of the lateral compartment is supported by the arcuate complex. The complex is composed of the fibular collateral ligament, the popliteus tendon, the posterior third of the capsular ligament, and the arcuate ligament. [9] Also included in the lateral compartment is the anterior cruciate ligament. One of its three bundles is the anteromedial bundle, originating posteriorly and superiorly on the medial surface of the lateral femoral condyle and inserting on the medial aspect of the intercondylar eminence of the tibia. More anteriorly and distally is the posterolateral bundle on the medial surface of the lateral femoral condyle, which inserts lateral to the midline of the intercondylar eminence. The intermediate bundle is between these two bundles. [10] The tension on the bundles is altered as the knee moves from flexion to extension. It has become apparent that it is an important stabilizer of the knee. Its structure allows for several different areas of stability and whether to repair it after injury is controversial.

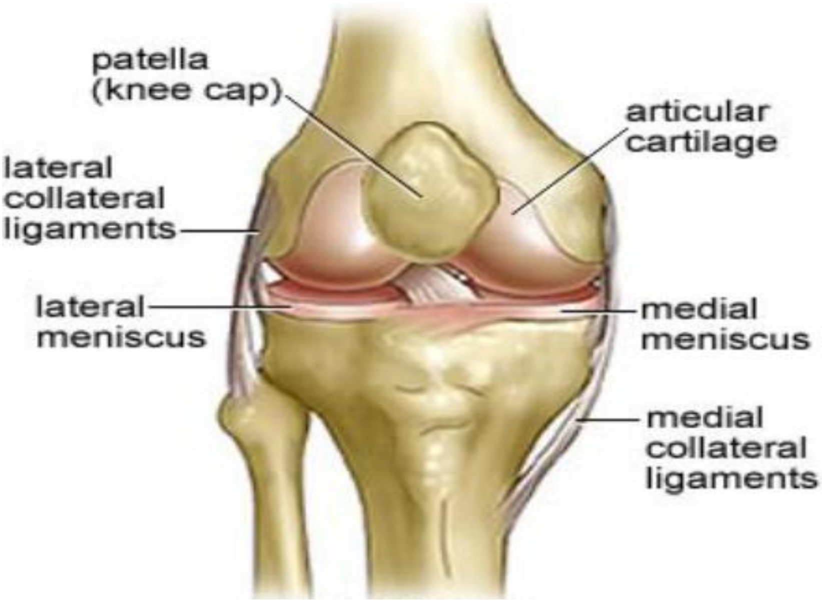

Figure 4: The lateral knee compartment

2. Knee Biomechanics and Kinesiology

2.1 Anterior Cruciate Ligament (ACL)

The anterior cruciate ligament (ACL) is characterized by its complex structure which is considered to reflect its important contribution to knee-joint function. Originally referred to as a crucial ligament because of the cruciate, or crossed, arrangement of the anterior and posterior ligaments within the knee, the irony of the ACL being crucial to the well-being of the knee joint has more recently been demonstrated. It is a keystone to controlled, fluid, and stable flexion and rotation of the normal knee. The ACL is a primary restraint to anterior translation of the tibia on the femur, and a secondary restraint to internal rotation, varus, valgus, and hyperextension. [11,21] The ACL does not resist posterior drawer. [13,19,20,22,23]

Sectioning the ACL produces a significant increase in anterior knee instability. The greatest amount of anterior translation after isolated ACL sectioning occurs between 150 and 450. [19, 22, 24] During the clinical examination, the most effective position to conduct an anterior instability test is at 30° of flexion. [19] The ACL reaches ultimate stress at approximately 15% strain, and gross failure is expected to occur when strain exceeds 15% to 30% or displacement of about 1 cm. Levy23 subjected knees to a 100N anterior force. Intact knees demonstrated, on average, 3.4 mm anterior translation at full extension, and maximum, 4.7 mm at 30° flexion. After isolated sectioning of the ACL, maximum anterior displacement at 30° was 18.1 mm. In a similar study, Fukubayashi[19] found that isolated sectioning of the ACL produced a greater than 2-fold increase in anterior displacement of the tibia, compared with the intact knee, when loaded in an anterior direction. As the flexion angle increased, the displacement decreased; however, sectioning did result in increased laxity at all angles. Later sectioning of the PCL did not alter translation in the anterior direction.

Utilizing the stiffness method, Butler[13] ranked the ligamentous restraints to anterior-posterior motion in the human knee when displacement was fixed at 5 mm. The ACL provided 85% to 87% of the restraining force to anterior translation at 30° and 90° of knee flexion, when rotation was eliminated. Takeda[16] utilized a 5° of freedom kinematic linkage system, which allowed rotation, to investigate the contribution of the ACL to resistance against anterior drawer. The ACL restraint dropped to 74% to 83% of the total, indicating that constrained motion altered the normal function of the structures tested.

2.2 Posterior Cruciate Ligament (PCL)

The average length of the PCL is 38 mm, and the average width is 13 mm. [12] The ligament is enclosed within synovium and is, therefore, extra-articular in an anatomic sense. [25,26] The overall position of the ligament in the joint is located near the longitudinal axis of rotation, just medial to the center of the knee. It is directed vertically in the frontal plane, and angles forward 30° to 56° in the sagittal plane, depending on the degree of knee flexion. The PCL assumes a more vertical orientation in extension, and a more horizontal position in flexion. [25,26] The femoral attachment of the PCL is to the lateral surface of the medial condyle. The attachment is in the form of a segment of a circle, and horizontal in its general direction, with the knee extended. The upper boundary is horizontal, and the lower boundary convex, and parallel to the lower articular margin of the condyle. The tibial attachment of the PCL is into a depression between the two plateaus, approximately 1 cm distal to the articular surface of the tibia, and extends distally several millimeters onto the posterior surface of the tibia. Fibers attach to the tibia in a medial to lateral direction.

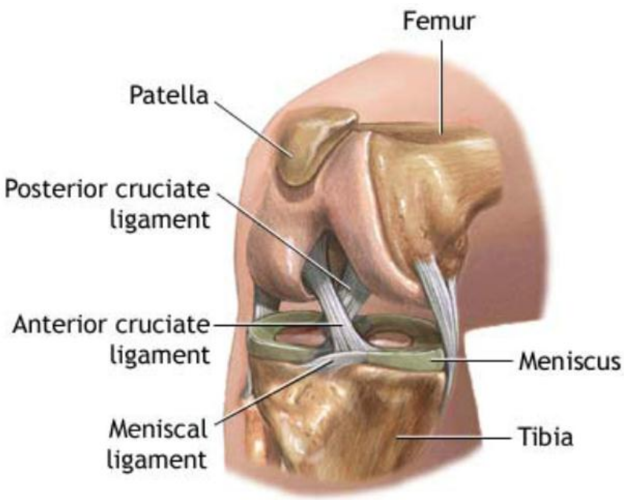

Figure 5: Knee representation. The anterior cruciate ligament and the posterior cruciate ligament are highlighted.

The PCL is a primary restraint to posterior translation of the tibia on the femur, and a secondary restraint to varus-valgus and external rotation. [12, 13, 19, 24, 27] The PCL is the only isolated ligament to provide primary restraint to posterior translation at all angles of flexion. The PCL does not resist anterior drawer. [13,19,22,23] Utilizing the stiffness method, Butler ranked the ligamentous restraints to anterior-posterior motion in the human knee when displacement was fixed at 5 mm. The PCL provided 90% to 95% of the total restraining force to posterior translation at 30° and 90° of knee flexion. No other structure contributed more than 2% to the total restraint. Therefore, abnormal posterior tibial translation cannot occur without injury to the PCL. Grood[27] utilized the flexibility method in a study that allowed 6° of freedom to determine the effect of sectioning the PCL and posterolateral structures (lateral collateral ligament, popliteus, and arcuate complex) on knee motion from 0° to 90°. Isolated sectioning of the PCL resulted in an increase in posterior translation, and this increased as the knee was flexed, to a maximum at 90°. These results reflect the increasing slackness in the remaining secondary restraints to posterior translation as the knee flexes. Conversely, if the knee demonstrated a similar increase in posterior translation at both 30° and 90°, this suggested that the medial and lateral extra-articular ligaments may have lost some of their functional capacity.

After sectioning the PCL, the resulting secondary external rotation disappears. Therefore, it is apparent that this ligament plays a vital role in the natural rotation of the tibia during AP motion. The PCL causes coupled external rotation during posterior translation. In other words, the PCL constitutes a primary mechanism controlling and producing external rotation during posterior translation. [19] The central location of the PCL makes it the center for rotational instability patterns of the knee. [26, 29]

2.3 The menisci and meniscofemoral ligaments

The medial and lateral compartments of the knee each has an intervening meniscus located between the femur and tibia. Grossly, the menisci are peripherally thick and convex, and centrally taper to a thin free margin. The meniscal surfaces conform to the femoral and tibial contours. The medial meniscus is semicircular and approximately 3.5 cm in length. The posterior horn is wider than the anterior horn.

The intermeniscal ligament, located approximately 8 mm anterior to the ACt, serves as the primary attachment site for the anterior horn of the medial meniscus in approximately one quarter of cases. [30,31] The lateral meniscus is almost circular in gross morphology, and covers a larger portion of the tibial plateau than the medial meniscus. Two meniscofemoral ligaments attach the lateral meniscus to the medial femoral condyle. The anterior meniscofemoral ligament (ligament of Humphrey) is less than one third the diameter of the PCL, and arises from the posterior horn of the lateral meniscus. The posterior meniscofemoral ligament (ligament of Wrisberg) is as large as half the diameter of the PCL, and also arises from the posterior horn of the lateral meniscus. It passes obliquely behind the PCL, and inserts on the medial femoral condyle, along with the posterior PCL fibers. [32,33]

With knee flexion form 0° to 120°, the menisci move posteriorly. Rotation of the knee also affects meniscal motion. Posterior motion of the medial meniscus is guided by the deep medial collateral ligament (MCL) and semimembranosus, whereas anterior translation is caused by the push of the anterior femoral condyle. The medial meniscus lacks the controlled mobility of the lateral meniscus. [33] The posterior oblique fibers of the deep MCL limit motion in rotation and, therefore, the medial meniscus is at increased risk of tear. [30] The lateral meniscus is stabilized, and motion guided, by the popliteus tendon, popliteomeniscal ligaments, popliteofibular ligament, meniscofemoral ligaments, and lateral capsule. [33, 35] The medial meniscus provides greater restraint to anterior translation than does the lateral meniscus, by acting as a buttress. This can be demonstrated by evaluation of the meniscus-deficient knee. A biomechanical study by Levy[23] of humancadaver knees compared intact knees to knees subjected to isolated medial meniscectomy, isolated ACL sectioning, or combined ACL sectioning and medial meniscectomy.

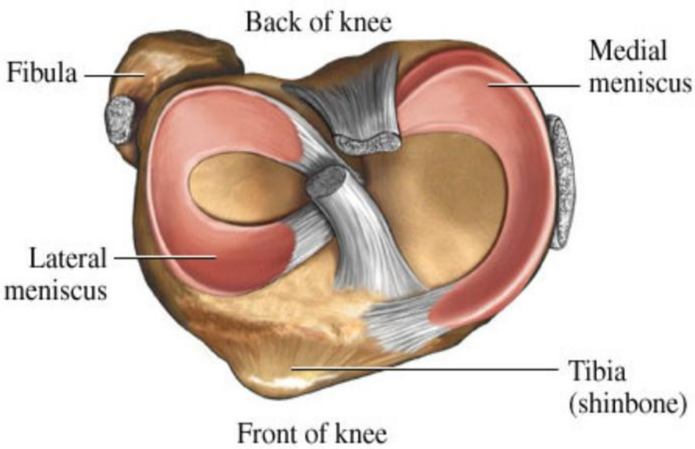

Figure 6: Superior view of the right knee. The meniscus is shown

Compared with intact knees, isolated medial meniscectomy did not significantly alter anterior-posterior displacement, nor coupled internal rotation. ACL-deficient knees demonstrate increased anterior translation when subjected to an anteriorly directed force, and this translation increased significantly with combined meniscectomy at all angles of flexion. Shoemaker[20] evaluated the role of the meniscus in anterior-posterior stability under loaded conditions in the ACL-deficient knee. After ACL sectioning, the resistance provided by the menisci to an anteriorly directed force increased with increasing axial load (57% at 925N axial load). The higher the applied joint load, the greater the meniscal compression, and thus the greater the resistance to anterior force. The contribution from the lateral meniscus was minimal. The loaded menisci helped resist anterior translation in ACL deficient knees; however, they were easily overcome at relatively low anteriorly directed forces of 200N.

In addition to their role in joint stability, the menisci serve additional functional roles, including load bearing and shock absorption. The menisci transmit large loads across the joint, and their contact areas change with different degrees of knee flexion and rotation. Up to 50% of compressive load is transmitted through the menisci in extension, and 85% at 90° of flexion. Removal of a portion of the meniscus results in decreased contact area between the femur and tibia. Medial meniscectomy decreases the contact area by up to 70%. Resection of as little as 15% to 34% of the meniscus results in increased contact pressure by more than 350%. The resulting increased peak stresses and pressure concentrations lead to progressive degenerative changes closely resembling naturally occurring histologic, biochemical, and biomechanical changes of osteoarthritis. The degree of change is proportional to the extent of meniscectomy. [30,36]

2.4 Medial structures of the knee

The supporting structures of the medial side of the knee can be divided into three discrete layers. [1,37] The most superficial layer, layer I, is the deep or crural fascia. This fascia is the first plane encountered deep to the subcutaneous tissue, and extends from the patella to the midline of the popliteal fossa. Anteriorly, this layer blends with layer II in a vertical line, 1 to 2 cm anterior to the anterior edge of the superficial MCL37. Layer II contains the superficial MCL, and is clearly defined by the parallel anterior fibers of this ligament. Layer III is the true joint capsule. The lines of attachment of the capsule follow the joint margins, except anteriorly, where it extends cephalad to form the suprapatellar pouch.

2.4.1 Medial collateral ligament (MCL)

The MCL is composed of a superficial portion and a deep portion. [14] The superficial MCL originates on the medial epicondyle, and runs downward as a broad triangular band approximately 11 cm to its tibial insertion, deep to the gracilis and semitendinosus tendons. [1,15,37] The superficial MCL can be further subdivided into anterior and posterior portions. The anterior margin lies free except at its attachment sites to the tibia and femur, and is separated from the medial meniscus and deep capsular ligament by a bursa, where as the posterior margin passes obliquely backwards to an insertion in the medial meniscus. The deep portion of the MCL also can be divided into two subdivisions, the meniscofemoral and meniscotibial ligaments, defined by their respective insertions. [38]

The MCL is an important restraint to valgus rotation and a check against external rotation and straight medial and lateral translation of the tibia. Warren[38] demonstrated that, regardless the order of ligament sectioning, the superficial portion of the MCL contributed greatest to stability. Sectioning the superficial portion of the ligament, while leaving the remainder intact, resulted in joint space opening under valgus load, over the entire range of motion. In addition, external rotation doubled in extension and progressed to a 3-fold increase by 90°. Sectioning the deep ligament and posterior capsule produced almost no change in the behavior of the specimen under stress if the superficial fibers were intact. The role of the MCL increases with increasing flexion, as the posterior capsular structures become slack. The increase in valgus laxity after sectioning the MCL is greater in a more flexed position, and largest at 30°, with up to 5.5mm of joint-space opening. This measurement points out that a complete injury to the MCL may occur with even subtle laxity, and a large increase in joint laxity likely involves additional structures. [39]

2.4.2 Medial patellofemoral ligament

More recently, the medial patellofemoral ligament is recognized as a major restraint to lateral displacement of the distal knee-extensor mechanism. For this reason, it deserves separate mention. The proximal fibers of the ligament proceed anteriorly toward the vastus medialis obliquus, fanning out proximally to insert on the undersurface of the vastus medialis obliquus and the aponeurotic fibers of the vastus intermedius. The distal fibers insert anteriorly on the superomedial patella, extending inferiorly from the medial process. [40,41]

Conlan[41] utilized the stiffness method to evaluate the medial soft-tissue restraints of the extensor mechanism in 25 fresh-frozen knee specimens performed in extension. The major stabilizer preventing lateral displacement of the patella was the medial patellofemoral ligament, followed, in decreasing order, by the medial patellomeniscal ligament, the medial retinaculum, and the medial patellotibial ligament. The contribution to restraint from the medial patellofemoral ligament was 23% to 80%, with an average 53% of the total restraint.

2.5 Lateral structures of the knee

As it was discussed before the lateral compartment of the knee is divided into three sections. [42] The anterior one third of the lateral compartment includes the capsular ligament, which extends posteriorly from the lateral border of the patella to the illotibial band.

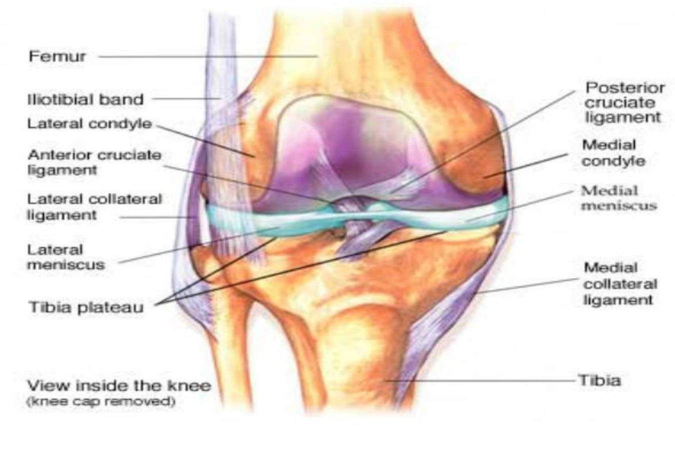

Figure 7: Simultaneous view of various medial and lateral structures of the knee. The medial collateral ligament, the iliotibial band and the lateral collateral ligament are noted among others.

The middle one third is composed of the more superficial iliotibial (IT) band and a deeper capsular Iigament. This section extends posteriorly to the lateral collateral ligament (LCL). The middle third capsular ligament attaches proximally to the lateral epicondyle of the femur, and distally to the tibial joint margin. The remaining posterior one third is termed the posterolateral corner. This region contributes significantly to the stability of the lateral knee through the intricate arrangement of many structures. It is precisely this complexity that has resulted in so much study and controversy.

2.5.1 Iliotibial band

The IT tract is an important stabilizer of the lateral compartment, and is instrumental in preventing varus opening of the knee. [43,44] In full extension, the IT tract may act as an extensor as well as static stabilizer. As the knee flexes, the IT band tightens and moves posteriorly. The biceps fascial communication aids in maintaining tension over the range of motion. The IT tract, therefore, exerts a posteriorly directed and external rotation force on the lateral tibia. The tract is tightest at 10° to 30° of flexion and, therefore, may be most vulnerable to injury at this position. [34,45] Beyond 40°, the tract becomes a flexor of the knee. [46] During extension, the IT tract moves anteriorly, and is thus spared in most cases of varus stress and posterolateral injury.

2.5.2 Lateral collateral ligament (LCL)

The LCL arises in a fan-like fashion in a fovea immediately posterior to the lateral epicondyle at an average 3.7 mm posterior to the apex of the epicondylar ridge. It is located between the superior fovea for the lateral gastrocnemius and the more distal popliteus. [3,43] The LCL is superficial to the tendon of the popliteus. The average length of the ligament is reported from 59.2 to 71 mm[3,47,48] and has a minimum diameter at its midpoint, where it is elliptical in shape. The average AP diameter is 3.4 mm, and the average medial to lateral dimension is 2.3mm.

Because the LCL is located posterior to the axis of flexion-extension rotation, and the radius of curvature of the lateral condyle decreases during flexion, it is tightest in extension and progressively relaxes with flexion beyond 300. [3,39,44,47,49] Additionally, posterior translation of the femorotibial contact point and coupled internal rotation of the tibia with flexion contribute to the change in tension in the

LCL. The LCL appears to remain taut from 0° to 30° and, therefore, is most important in resisting varus instability over this range. Tensioning a graft in no more than 30° of flexion, close to neutral rotation, is recommended. [3]

The LCL is a primary restraint to varus at all positions of flexion[34, 39, 44, 47, 50] and a secondary restraint to external rotation and posterior translation. [50]The LCL resists approximately 55% of applied varus load at full extension. Sectioning of the popliteofibular ligament with an intact LCL results in no significant increase in varus rotation from 0° to 30°, because the LCL is a primary restraint to varus. Yet an increase in varus is seen from 60° to 90° due to the slackening of the LCL with flexion.

2.5.3 Posterolateral corner

The complexity of the posterolateral corner stems largely from the variable presence of many of the component structures. The structures in this region provide both dynamic and static stability to the knee. The dynamic structures include the iliotibial band, the lateral head of the gastrocnemius, biceps femoris, and popliteus. These components are invariably present. Static structures are much more variable in presentation, and include the lateral collateral ligament, fabellofibular ligament, short lateral ligament, popliteofibular ligament, arcuate ligament, posterolateral capsule, posterior horn of the lateral meniscus, and lateral coronary ligament.

Taken as a whole, the structures crossing the posterolateral corner of the knee provide resistance to tibial external rotation, varus rotation, and posterior tibial translation. [24,26,34,44,45,47,50] Various sectioning studies provide insight into the interaction among the ligaments of this region. Combined sectioning of the posterolateral structures, with an intact PCL, result in maximum increased external rotation, varus rotation, and posterior translation at 30°. At low flexion angles, the bulk of the PCL is lax. When the PCL is sectioned along with these structures, posterior translation, varus, and external rotation further increase at all angles.

2.5.4 Popliteus and popliteofibular ligament

The popliteus complex consists of both a dynamic component (popliteus musculotendinous unit) and a static component (popliteofibular ligament, popliteotibial fascicle, and popliteomeniscal fascicle). [45] The popliteus muscle originates from the posteromedial surface of the proximal 10 to 12 cm of the tibial metaphysic. [51] The direct expansion of the semimembranosus blends into the popliteus muscle fascia. The medial part of the popliteus muscle inserts into the posterior horn of the lateral meniscus and capsule via the superior popliteomeniscal fascicle. The lateral part of the muscle joins the arcuate ligament superficially, as well as deep connecting fibers from the fibula, to form the musculotendinous junction. [35]

The popliteus complex acts as a dynamic internal rotator of the tibia and as a static restraint to posterior tibial translation, varus rotation, and primary and combined external rotation of the tibia on the femur. [26,34,44,45,47,50] The popliteus appears to function both statically and dynamically to prevent external rotation, rather than merely acting as an active internal rotator of the tibia. It is the only major structure positioned at an oblique angle in the posterolateral corner of the knee, and thus is well suited to prevent tibial external rotation during flexion from 20° to 130°, as well as varus from 00 to 900. When compared with other components of the deep-ligament complex, sectioning of the popliteus results in significant increases in external rotation at 90° of flexion. [24] The tendon appears to be composed of two fiber bundles. The anterior fibers become tense in flexion, and the posterior fibers tense in extension. This phenomenon is exaggerated by the addition of external rotation. [52, 54]

2.5.5 Summary of Muscle Action on basic movement

Action Muscle

Extension Quadriceps group

- ✓ Rectus femoris
- ✓ Vastus medialis
- ✓ Vastus intermedialis
- ✓ Vastus lateralis

Flexion Hamstring group

- ✓ Semimembranosus
- ✓ Semitendinosus
- ✓ Biceps femoris
- ✓ Popliteus

3. Rheumatoid Arthritis

Musculoskeletal diseases are becoming more prevalent due to increased life expectancy and an ageing population. Rheumatoid arthritis (RA) is a chronic autoimmune, inflammatory disease that causes joint swelling, pain, and bone and cartilage destruction leading to functional disability and reduced quality of life. [55,56] It is the most common inflammatory arthritis affecting approximately 1% of the population. Rheumatoid arthritis (RA) is a symmetric polyarticular arthritis that primarily affects the small diarthrodial joints of the hands and feet. In addition to inflammation in the synovium, which is the joint lining, the aggressive front of tissue called pannus invades and destroys local articular structures. [57]

3.1 Biological Mechanism of Rheumatoid Arthritis

The cause of this autoimmune disease remains obscure, but greater understanding of the underlying mechanisms has facilitated the development of new drugs and revolutionized treatment. [58] Specific CD4+ T cells are involved in the induction of the immune response in rheumatoid arthritis, most likely as a response to an unknown exogenous or endogenous antigen. The CD4+ T cells, B cells and macrophages infiltrate the synovium and sometimes organize into discrete lymphoid aggregates with germinal centres. Hyperplasia of the intimal lining results from a marked increase in macrophage-like and fibroblast-like synoviocytes. Consequently, recruited monocytes, macrophages, and fibroblasts produce cytokines such as tumor necrosis factor a (TNFa) and interleukin-1 within the synovial cavity. [59] These cytokines are central to a damaging cascade, ultimately triggering the production of matrix metalloproteinases and osteoclasts, which digest the extracellular matrix and destroy the articular structures and result in irreversible damage to soft tissues and bones.

A multi-stage model might help integrate the various concepts, although it is important to note that significant temporal overlap can occur. [60] Activation of innate immunity probably occurs early in RA and can serve as a key pathogenic mechanism that initiates synovial inflammation. TLR agonists, including proteoglycans and bacterial DNA, have been detected in rheumatoid synovium61. Engagement of Fc

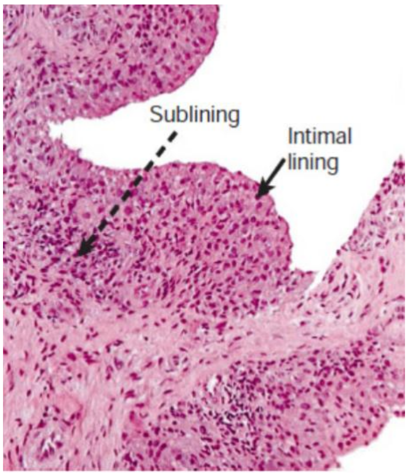

Figure 8: Synovial histology in rheumatoid arthritis. A photomicrograph (magnification 2200) shows the redundant folds of the synovial lining and intense infiltration with inflammatory cells in RA.

The intimal lining layer (solid arrow) is hyperplastic, with multiple layers of cells compared with a normal lining that is one or two cell layers deep. The sublining region (dashed arrow) is marked by accumulation of mononuclear cells such as CD4+ T cells, macrophages and B cells receptors by autoantibodies, like rheumatoid factor and anti-cyclic citrullinated peptide antibodies, represents an alternative mechanism. Synovial dendritic cells activated by TLR ligands can migrate to lymph nodes where primed T cells can be biased towards the TH1 phenotype and, through chemokine receptors like CCR5, home to inflamed synovial tissue. Production of cytokines and expression of adhesion molecules after activation of innate immunity in the joint can permit the continued ingress of immune cells. [57]

A proposed model implicating multiple pathogenic mechanisms in RA. According to this model, a step-wise progression can begin with the activation of innate immunity by stimulating dendritic cells, macrophages, fibroblasts and mast cells. After immune cells migrate into the synovium, an opportunity for adaptive immune responses arises in individuals with the appropriate genetic background. While antigen presentation can occur in the synovium, extra-articular sites can also participate if dendritic cells migrate to lymph nodes and bias T cells to a TH1 phenotype. In the destructive phase of disease, osteoclast activation mediates abundant bone resorption under the influence of RANKL, while synoviocytes can invade cartilage. These processes are not necessarily mutually exclusive. Activation of innate and adaptive immunity can also occur in a parallel fashion (denoted by bidirectional arrows), perhaps contributing to the patterns of disease flares and remissions. DC, dendritic cell; CCP, cyclic citrullinated peptide; FLS, fibroblast-like synoviocyte; MΦ, macrophage.

This early stage might occur commonly in humans but is typically self-limited. In the appropriate conditions, such as the presence of the correct HLA-DR alleles or perhaps cytokine promoter polymorphisms, lymphocytes could accumulate into the transiently inflamed synovium. Under these circumstances, the loss of tolerance related to the effect of HLA-DR background or the T-cell repertoire might contribute to autoreactivity to newly exposed articular antigens. [62,65] Ultimately, long-standing disease could lead to a destructive phase that some investigators believe can run an independent course. This hypothesis does not presuppose a specific ‘rheumatoid antigen’. Instead, a variety of antigens can be targets and lead to both T-cell activation and B-cell maturation. Hence, the progression of disease might require a combination of stochastic events (activation of innate immunity), pre-determined events (genetic background), and adaptive immune responses directed against autologous antigens. It is also possible that recurrent activation of innate immunity or overlap with other elements of this model could participate to varying degrees during the course of disease and contribute to patterns of flare and remission.

3.2 Diagnosis of Rheumatoid Arthritis

The initial priority with rheumatoid arthritis is to make the diagnosis and referral early in onset. Diagnosis can be very difficult in the early stages, with patients complaining of non-specific, vague, systemic symptoms, little active synovitis. [66] The measurement of rheumatoid factor with a blood test and the quantity of anti-cyclic citrullinated peptide (CCP) antibodies in people with suspected RA are the only diagnostic tests available. An x-ray of the hands and feet in people with persistent synovitis in these joints could also be helpful in diagnosing RA. The possible risk factors of this disease contain not only causes such as genetic predisposition and abnormalities but also environmental factors such as viruses or bacteria that could cause the immune system to attack joint tissue. Someone is considered to suffer from RA when four out of the following seven criteria are present [67]

- ✓ Pain and swelling in at least three joint areas
- ✓ Symmetrical presentation
- ✓ Early morning joint stiffness for more than 1 hour
- ✓ Involvement of metacarpophalangeal joints or proximal interphalangeal joints or wrists
- ✓ Subcutaneous nodules
- ✓ Positive rheumatoid factor
- ✓ Radiological evidence of erosions

3.3 Treatment of Rheumatoid Arthritis

The diagnosis of RA still evokes a picture of a patient crippled with bilateral, symmetric deformities of hands and feet in the mind of most doctors. Less than 15 years ago, RA was regarded as a chronic destructive disease leading to joint deformities and severe functional decline with work disability reported in 60% of patients after 10 years. [68] As a systemic disorder, it has also been linked to multiple organ system complications and increased mortality, predominantly due to accelerated cardiovascular disease. Fortunately, over the last two decades, significant advances in the treatment and management of RA have been made and are changing the way we perceive RA. New treatment strategies have shown their ability to slow disease progression. New biologic agents that have been shown to be able to arrest joint damage are now available.

Simple symptoms like pain and stiffness are frequently managed with nonsteroidal anti-inflammatory drugs (NSAIDs), aspirin, or acetaminophen. These drugs, although well-known through media and common usage, do nothing to control the actual disease process, which may continue unabated even though the patient feels better. [69] Steroids like prednisone or methylprednisolone (Medrol) are extremely effective in controlling symptoms, but do little to control the joint damage of RA, and can have serious side effects. Steroids can be used in the short term to control serious, disabling symptoms, but should always be given in the context of using other medications to try and suppress the disease process. There should always be a plan ready to discontinue steroids. [70]

Currently, early institution of a DMARD (Disease Modifying Antirheumatic Drugs) is the cornerstone of the treatment. A DMARD should be started in every patient once the diagnosis has been confirmed. Methotrexate is the most commonly used DMARD and is generally used first. Sulphasalazine and leflunomide are considered the best alternatives. Hydroxycholroquine is also often used in combination therapy but rarely used alone in RA because of a lower response rate. Other conventional DMARDs include azathioprine, cyclosporine, and gold salts. [71]

Biologics represent the latest family of agents available to treat RA. Thanks to molecular biology, a better understanding of the pathophysiology of RA has led to the development of these new drugs that act on the different inflammatory pathways involved in the disease process. They include tumor necrosis factor (TNF) blocking agents, rituximab, abatacept, and tocilizumab. Agents that block TNF-alpha have been shown to be extremely effective; TNF is a cytokine that plays a central role in the inflammatory process in RA72. These include etanercept, infliximab, and adalimumab. They can provide rapid control of inflammation and have proven long-term efficacy in terms of clinical outcome and structural damage both in early and established disease. Rituximab acts by depleting B cells and has proven efficacy in patients with RA who have failed to respond to DMARDs and anti-TNF agents. It is licensed for patients having failed anti-TNF agents and is given in association with MTX. Abatacept is a fusion protein that binds CD80/86 and inhibits T cell activation. Used in combination with MTX, it provides improvement of the disease activity and less radiographic damage both in MTX and anti-TNF inadequate responders. Tocilizumab is a humanized anti-interleukin-6 receptor monoclonal antibody. Given as a monthly intravenous infusion in association with MTX, it has been reported to reduce disease activity and improve quality of life, including fatigue. It is currently being investigated in phase III trials.

Gene therapy holds great promise for the treatment of rheumatoid arthritis (RA). Gene therapy is defined as an introduction of nucleic acids into a host cell for therapeutic purposes; the option may be the overexpression of therapeutic gene or an underexpression of a target gene highly expressed in disease (small interfering RNA). The proof of principle in animal models of arthritis has shown convincingly that gene therapy can be an advantageous strategy in the treatment of RA. [73]

Muscle weakness, restricted range of motion (ROM) of joints and reduced physical function are common signs in patients with rheumatoid arthritis (RA). Exercise therapy could act supplementary to pharmaceutical treatment in reducing pain and disability by improving aerobic fitness, muscle strength, and the stability and ROM of joints74. A Cochrane review of Randomized Controlled Trials (RCTs) using dynamic exercise therapy to treat RA suggested that dynamic exercise therapy is effective at increasing aerobic capacity and muscle strength[75] and RCTs published after the latest update of this review agree on the conclusions. No detrimental effects on disease activity and pain were observed. Short-term strength training can be used successfully in the treatment of patients with active or chronic RA, providing an increase in knee extension strength without increase in pain or disease activity. [76,77]

The mean increase in knee extension strength after 5-weeks exercise period in patients with stable RA was 33%77. This exercise program consisted of ten exercise sessions and comprised relatively simple, progressive muscle strength, balance and co-ordination exercises. In order to increase muscle strength different types (isometric or dynamic, concentric or eccentric) of muscle actions should be used in different stages of training. [78,79]Aerobic exercises in water or with bicycle ergometer training can also lead to the increased strength level.

The evidence on the long-term results of dynamic exercise therapy in patients with RA is based on a number of longlasting interventions. [80, 83] In his nonrandomized controlled long-term follow-up study among patients with RA, Nordemar found that the subjects in the training group had a much better disease outcome with reference to changes as shown by x-rays, clinical evaluation and some physiological parameters compared with control patients. Functional capacity as measured by the Health Assessment Questionnaire (HAQ) improved in both the exercise group and the control group doing ROM exercises, but after 24-month training period the improvement was greater in strength-training group compared with ROM exercise group. A supervised long-term high-intensity exercise programme improved functional ability and physical capacity more than usual care among RA patients. [83] The median radiographic damage of the large joints did not increase in either group, but the mean difference in change between the groups showed a tendency to greater increase in damage in the exercise group compared with the usual care group.

4. Rheumatoid arthritis and the knee

The start of the disease is usually insidious but can be episodic or acute. Rheumatoid arthritis usually presents as a polyarthritis affecting small joints or small and large joints. Early disease is characterised by pain and other cardinal signs of inflammation (heat, swelling, functional loss, and possible erythema over the joints) but not by damage and deformity. If the disease remains active and uncontrolled the inflammation will usually spread to additional joints and gradual irreversible tissue damage will occur, causing deformity and instability of joints. [84] The most serious long term disability is associated with damage to the larger weight bearing joints. Inflammation of other synovial structures is common, and a similar process may occur in tendon sheaths, progressing to serious dysfunction and rupture. Palpable thickening or nodularity of tendons is common. Effusion of the knee may produce a popliteal (Baker's) cyst. This may rupture to cause diffuse pain and swelling in the calf that mimics deep vein thrombosis.

Although many patients with arthritis can be treated by conservative modalities, such as weight reduction, modification of lifestyle, drug therapy, physiotherapy and occupational therapy, surgery, including joint replacement surgery, is available and often necessary for arthritis and other joint conditions. Joint replacement was initially introduced to treat hip and knee arthritis, and has been used much more extensively in these joints than in others. The severity of the joint damage is the main reason in deciding on surgery. Knee joint damage can be assessed in three main ways: in terms of pain severity, the degree of functional impairment, or by radiographic (or other imaging) methods that determine the degree of structural anomaly. [85] Other patient-related variables such as motivation, age, obesity, and co-morbidity and environmental factors (socio-economic status) could also contribute in surgical decision making.

4.1 Total Knee Replacement (TKR)

Total Knee Arthroplasty (TKA) has been proven to be one of the most successful surgical interventions for reducing pain and enhancing physical function in RA patients, and primary TKA is the most frequently performed orthopedic intervention in RA patients. [86, 88] Procedural variations can be factors that affect the operative outcomes. Recently, a variety of novel surgical-techniques have been introduced into orthopedic surgery, including minimally invasive surgery (MIS)[89, 90] and computer-assisted surgery.[91, 92]

Cemented TKA is the current gold standard with consistent long-term (10 to 14 year) survival rates of 94–98%.[93, 94] Although a few designs of cementless TKA have demonstrated good long-term success, the majority of cementless implants have not been able to reliably result in bone ingrowth.[95] Long-term survival rates and functional abilities are comparable in cruciate-retaining and cruciate-substituting (posterior stabilized) prostheses.[96] To improve patient satisfaction and function, implants have been modified to permit an increased arc of flexion that may approach 150 degrees of knee flexion.[97] The results of several randomized controlled trials (RCTs) investigating the role of this type of implant in improving functional performance are forthcoming.

Whether or not to resurface the patella during primary TKA has long been a debate within the orthopaedic community. A recently published RCT demonstrated no differences in knee pain or patient satisfaction between those with and without patellar resurfacing.[98] Recent literature syntheses and efforts at meta-analysis suggest that resurfacing the patella likely improves outcomes and long-term, patellar pain-free function.[99, 101] Despite the advances in TKA technology, polyethylene wear and component loosening are major mechanisms of prosthetic failure.[102] Therefore, there remains the need to enhance fixation and reduce wear to optimize long-term survival. The trabecular metal technology used in cementless THA also serves a role in enhancing fixation in cementless TKA.[103] Tibial base plates made of tantalum are now available and are porous with high shear strength and low stiffness. In addition, efforts are currently underway to explore the merits of hydroxyapatite and other osteoinductive or osteoconductive materials to augment bone ingrowth and adherence to TKA prostheses. The knee arthroplasty component with the lowest wear debris production in routine use appears to be a cobaltchromium alloy femur articulating against a standard, polyethylene tibial surface. The role of ceramic-on-polyethylene designs is being explored, and a zirconium oxide–coated femoral implant is currently available for use against polyethylene tibial surfaces. Knee simulator stud ies suggest wear reduction by as much as 85% with this type of bearing.[104] Similar to THA, the use of cross-linked polyethylene in TKA reduces polyethylene wear; however, studies are needed to establish the long-term

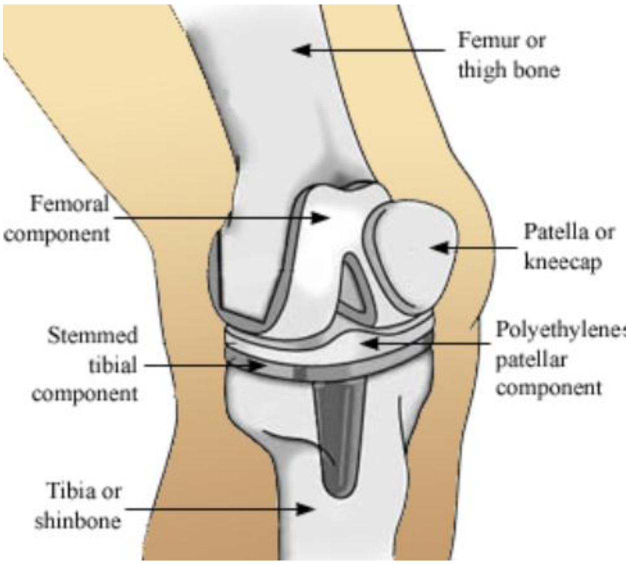

Figure 11:Total knee replacement. Various TKRs are are shown.

effectiveness of this technology. [105,106] Additional efforts to reduce polyethylene stresses and wear debris include the use of the rotating platform or mobile-bearing knee implants. Most manufacturers now produce second-generation rotating platform implants; however, there are few studies with more than 10 years of followup data. [107,108]

Minimally invasive TKA is rapidly gaining the attention of the orthopedic community. Limited, early published results suggest better range of motion, less blood loss, and a shorter length of stay with minimally invasive TKA as compared with standard TKA. [109] Long-term results for these minimally invasive techniques are not available. Although TKA is currently the so-called gold standard for knee joint replacement, unicompartmental arthroplasty has re-emerged as a suitable option for advanced medial compartment osteoarthritis with outcomes comparable with those for TKA. [110] The procedure is generally performed using a minimally invasive approach and leads to a more rapid recovery, minimal bone loss, less pain, and early discharge as compared with TKA. The 10-15 year survival rates for unicompartmental knee arthroplasty are high, and range from 95 to 98%.[111, 113]

4.2 Types of Knee Prostheses

The prostheses were initially categorized into two distinct types: the condylar replacements where the joint surfaces alone were replaced and the hinge-type prostheses. [114]

4.2.1 Condylar replacements

This group can be further subdivided into designs which mimic the anatomical configuration of the normal knee, thus simulating normal motion (unicondylar, duocondylar, UCI, St. Georg, and Marmor), and prostheses of constant radius which do not copy the normal geometry (Gunston, polycentric, and geometric).

4.2.1.1 Unicondylar

This is an anatomically designed replacement for either the medial or the lateral femoral tibial articulation. It is designed to allow 120 degrees of flexion. The Vitallium femoral component is curved in both the coronal and sagittal planes. In the anteroposterior plane thecurvature has a larger radius anteriorly than posteriorly thus mimicking the normal femoral condyle. The curvature in the coronal plane also simulates the normal curvature in the region of the intercondylar notch. Because of this design, right and left prostheses are provided. Fixation is by a central pin and a small anterior flange. The tibial component, of high-density polyethylene, has a medial prominence and matches the curve of the femoral cornponent in the coronal plane; it is flat in the sagittal plane.

4.2.1.2 Duocondylar

The femoral component of the duocondylar prosthesis is similar in shape to that of the unicondylar model except that there is no anterior flange and instead the halves are connected by an anterior cross bar which is countersunk during insertion. The two separate tibial components are identical to those used for the unicondylar prosthesis and are aligned for insertion with a jig. The cruciate ligaments have to be preserved when this prosthesis is used. Flexion of 120 degrees is allowed.

4.2.1.3 Geometric

The prosthesis is non-anatomical in that the curvature of the femoral component is of constant radius. The plastic tibial component is in one piece, with two halves connected by an anterior bar. It has an articular curvature designed to mate with the femoral component. This curvature provides greater inherent stability than the duocondylar prosthesis. Fixation to the tibia is enhanced by three flanges. The prosthesis is designed to allow a 90-degree arc of motion. The cruciate ligaments are preserved.

4.2.2 Hinge-type prostheses

In the hinge-type prosthesis the ligaments are sacrificed and the stability is provided by the design of prosthesis itself. Hinges may have a fixed axis with a constant center of rotation (Walldius, Shiers, and Guepar) or be of more complex design allowing a variable axis of mo tion or rotation (stabilocondylar, Herbert, and Lyons rotational prosthesis)

4.2.2.1 Guepar

The Guepar is a Vitallium hinge prosthesis (improved over the Young model) which is fully constrained, providing motion in a fixed axis without rotation. The axle is placed posteriorly in a rough approximation of the axis of rotation of the normal knee. The intramedullary stems are approximately ten centimeters long. The femoral stem is inclined to provide 7 degrees of valgus alignment, a patellar surface is provided, and a Silastic buffer lessens the impact in full extension. The femoral and tibial components are articulated after insertion with an axle which is secured by spreading flanges on the lateral side by means of a special c-clamp. There is no limit to flexion imposed by the prosthesis.

As the current level of TKR operations is rising year after year the market of knee implants is a flourishing one and a wide range of replacements is now available. [115,116] The majority of the implants replace both condylar surfaces, with or without patellar components and only a small portion is unicompartmental. Most of them offer a choice of cemented or cementless fixation while the others are cemented. Some of them are claimed by the manufacturers to be modular and others have components that can be used with either posterior cruciate ligament sacrifice or posterior cruciate ligament retention. Furthermore, modular stems and wedges can be used. [117] There is option for polyethylene tibial inserts of variable shape conformity, with or without cams. Patellar resurfacing option is also available.

4.3 Surgery Complications

4.3.1 Infection

Reports on complications after total knee arthroplasty account for a large proportion of studies in the literature. They are critical for the appropriate education of surgeons and also for the ongoing optimization of patient care. Jameson [et al.118] reviewed primary and revision knee arthroplasties in the Finnish Arthroplasty Register in order to search for risk factors for infection. They identified 43.149 arthroplasties with a median duration of follow-up of three years and also identified 387 reoperations that were performed because of infection. This yielded a 0.9% rate of reoperation for infection in their study. Factors that were found to be significantly associated with reoperation for infection included male sex, seropositive rheumatoid arthritis, a history of fracture about the knee, revision procedures, and the use of hinged and constrained prostheses. In addition, antibiotic-loaded cement combined with parenteral prophylactic antibiotics was protective against infection, especially for patients undergoing revision procedures. Patients with obesity [119] (body-mass index, >50), diabetes, and younger age were more likely to have a deep infection after arthroplasty. In addition, the authors found that infections had a lower probability of developing in patients managed with bilateral arthroplasty.

The treatment of infection has evolved tremendously as we have defined outcomes after various types of infections and types of treatments. Anderson [120] retrospectively analyzed twenty-five consecutive patients with a chronic deep infection who had a two-stage procedure involving the use of an articulating spacer. The femoral component was removed, sterilized, and reimplanted, and a new polyethylene liner was inserted. Appropriate microbial identification and parenteral antibiotic treatment was accomplished between stages, during which mobilization was encouraged. [121] After a mean duration of follow-up of fifty-four weeks, only one patient had a reinfection and the average range of motion for the group was 30 to 1150. The findings of this study add to those of several previous studies demonstrating that infections at the site of a total knee arthroplasty can be successfully treated with two stage procedure involving the use of an articulating spacer. Surgeons who identify an acute infection with Staphylococcus aureus at the site of a total knee arthroplasty, especially when the infection is methicillin-resistant, should be aware of the low rate of success with debridement and should consider removal of components depending on the patient's specific scenario. [122]

4.3.2 Other complications

Feibel [et al.123] reviewed the records of 1190 patients who had had a total knee arthroplasty with an indwelling femoral nerve catheter. The overall complication rate was 1.5%, with nine femoral nerve palsies, eight major falls, and a 0.2% rate of permanent nerve injury. The authors warned about the complications that may result from the use of continuous femoral nerve catheters. Koo and Choi[124] reviewed the results of nonoperative treatment for fifteen patients who had a complete iatrogenic detachment of the medial collateral ligament at the time of total knee arthroplasty. The authors did not use any specific procedures or repairs, but rather allowed the medial collateral ligament to remain in place to heal after surgery. They also did not recommend a brace or immobilization of any kind after surgery. After a minimum of two years of follow-up, the patients with detachment of the medial collateral ligament had no significant differences in terms of clinical or radiographic outcomes, and the authors recommended nonoperative treatment of iatrogenic medial collateral ligament injuries during total knee arthroplasty. Kusuma [et al.125] retrospectively reviewed the results of 1108 total knee arthroplasties in 314 patients who had a lateral release for improved patellar tracking and 794 patients who did not have a release. At an average of 4.7 years after total knee arthroplasty, there were no differences between the groups with regard to Knee Society scores, complication rates, or range of motion. The authors concluded that lateral release does not compromise the patella and is not associated with an elevated rate of complications after total knee arthroplasty.

Patients who have a postoperative reoperation because of a wound problem have a 5.3% risk of needing a third procedure (component removal, muscle flap coverage, or amputation) and a 6.0% risk of deep infection. In comparison, these rates are 0.6% and 0.8%, respectively, for patients without a postoperative procedure for a wound complication. [126] The importance of obtaining wound-healing after total knee arthroplasty is critical in order to avoid what is often a terrible series of postoperative complications.

4.4 Rehabilitation following Total Knee Replacement (TKR)

Rehabilitation is as essential as the other requirements for the success of TKR. Ideally, the rehabilitation program starts before surgery with a complete analysis of the patient's status. A thorough education of the patient and spouse must be provided, as well as the selection of appropriate postoperative goals. Rehabilitation in the acute care phase focuses on reducing pain, increasing mobility, restoring function, and identifying and preventing immediate postoperative complications. [127] The early postoperative phase also includes patient education on weight-bearing and positioning precautions, as well as an assessment of equipment needs and available resources at home. [88] After the surgical procedure an early rehabilitation program during the hospital stay will help to provide restoration of function and range of motion (ROM), and this must be continued following discharge from the hospital. Although most reports regarding rehabilitation after TKR have focused on the initial phase during the patients' hospitalization, some reports have remarked on the importance of physical therapy (PT) by a competent physical therapist for at least 2 to 4 weeks after the hospital discharge. [128, 132]

A common practice after TKR surgery is the application of the continuous passive motion machice immediately after the surgery at 60°, by increasing 15° per day until 90° is achieved (postoperative day 2). With the help of a physical therapist the patients can work from day one on isometric ankle dorsiflexion and plantar flexion, quadriceps and gluteal sets, as well as ambulation with a walker as tolerated. During the subsequent days, the exercises can progressto straightleg raises, short-arc quadriceps stretching, supine heel slides, passive hamstring stretching, and sitting knee flexion as tolerated. [88] After hospital discharge, the patients are advised to continue with the aforementioned physical therapy program established during the hospitalization. Simultaneously with these therapies, the patients were instructed to perform exercises on their own. Binder [et al.133] reported the results of an RCT of 6 months of physical therapy or home exercise in 90 patients following hip fracture. Extended outpatient therapy improved physical functioning, quality of life, and reduced overall disability.

5. Therapy Plan

Therapy plan is divided into short and long plan. Each therapy plan is divided according to individual need of patient.

Short Plan: The primary goal of short rehabilitation plan is to distinguish issues as pain that bothers directly the patient to return to his daily activities. This part of therapy usually lasts for up to 4 weeks in order to proceed to long rehabilitation plan.

Long Plan: The primary goal of long rehabilitation plan is to restore patient's functional level. The most common issue of long rehabilitation plan is to regain proper muscle activity.

6. Clinical Case Study

Methodology: Clinical case study took place in the Rheumatology Clinic (Revmatologický ústav) in Prague. The practice started at 7.2.2011 until 19.2.2011. During my practice I was able to see my patient 9 times before his discharge from the clinic.

6.1 Anamnesis

Examined Person: J.S

Sex**:** Male

Age**:** 85 years old

Height**:** 179 cm

Weight**:** 70 kg

BMI**:** 21.85

Diagnosis**:** total knee arthroplasty at left side (left knee replaced).ICD10: M170

Present State**:** Patient

6.2 Chief complain

Patient was complaining for pain in the region of the left knee. Pain was constant and from times to times get worsen. The fact that he suffers from rheumatoid arthritis leads him to his physician and he recommends MRI where the damage on his knee joint where found.

6.3 Previous Operations

Patient had prostatectomy at 2006 due to hypertrophy of prostate. At 2009 patient had a knee replacement operation on his right extremity because of rheumatoid arthritis.

6.4 Family Anamnesis

Patient’s father died from myocardial infraction. No rheumatic disease have been recorded in his family.

6.5 Personal Anamnesis

Patient had all the common illness of childhood. On February of 1997 patient diagnosed with ulcer in duodenum. He also suffered from vein insufficiency. Finally he had operation of total knee replacement due to rheumatoid arthritis at 24.1.2011.

6.6 Allergies: No

6.7 Abuses: no alcohol, no smoker

6.8 Social Anamnesis

He lives alone. Right now he is pensioner. His job was building constructor.

6.9 Medications: Xarelto, Eneblin

6.10 Previous Rehabilitation: No

6.11 Statement from hospital documentation:

Subjective: Patient complaints for pain during walking or movement but not during palpation.

Objective: Patient has normal breathing, he has no fever and normal skin hydration. Patient is very cooperative. His pupils are isochoric and has no nystagmus.

Head: Movement with no pain, facial nerve has normal activity.

Neck: Normal carotid pulse

Chest: Symetric, good breathing pattern

Abdomen: Soft, palpation with no pain, no resistance and negative response of percussion examination

Left Leg: bandaged, tender during palpation but without pain. No edema or inflammation and the periphery palpation is normal

Right Leg: Scar moves freely, no edema or inflammation

Left Knee: Tenderness, no inflammation. Range of motion in Flexion: 45 degrees, hypotonic and slight hypotrophy of quadriceps

Subjective part: Patient feels good, he feels slight pain on the knee. He can handle walking with crutches very good.

Objective Part: Scar is under sterilized patch, stitches are in proper position, the whole extremity is bandaged

Conclusion: Because of gonarthrosis on left extremity at 24.1.2011, Warfarin is used preventively.

7. Initial Kinesiological Examination

7.1 Postural Examination

The postural examination was provided from three sides, anterior, lateral and posterior. The equipment that has been used is a plumb line.

Anterior: Patient stands with physiological base with a very slight external rotation of feet. Right knee joint is in physiological extension and left in slight flexion. Hip joint is extended.

Lateral: Patient's ankle joints are both in position of plantar flexion. It looks that on left leg the load is more on the posterior part and the heel. The pelvis is in slight anterior tilt. Head and shoulders are protracted.

Posterior: Patient's Achilles tendons are not facing in parallel direction because of the slight external rotation of the feet. Left knee is flexed and the right in physiological extension. Lumbar spine is in extension, thoracic spine is flat in lower segments and the cervical part of the spine is in flexion.

7.2 Inspection

Patient has physiological colour of skin. There no signs of edema or inflammation on the knee region. There are no signs for deformities but patient is to slim and the left extremity (operated) looks slimmer than right, not in hypotrophy level.

7.3 Breathing Examination

Patient during examination has normal breathing with approximately 16 repetitions per minute. During the examination patient did not face any problem, and uses mainly his upper chest and diaphragm. The movement of upper chest is clear and obvious.

7.4 Palpation

Patient has slightly dehydrated skin although there is no inflammation sign as raised temperature. There is restriction of fascias on the region around operated knee and thigh. Patient also feels weird but no pain was present in the area of head of Fibula. During muscle palpation it was found that whole quadriceps is hyper tonic and hamstrings also. Adductors of hip joint found hypertonus and trigger point found also.

7.5 Pelvis Examination

After measuring the level Anterior Superior Iliac Crest on both sides, there was found that there is no lateral shift. After measuring of position of Anterior Superior Iliac Crest and Posterior Superior Iliac Crest, found that there in anterior tilt of pelvis.

7.6 Anthropometric measurement

7.6.1 Anthropometric Evaluation

measurement	***details***	***right extremity (cm)***	***left extremity (cm)***
anatomical length	from trochanter major to lateral malleolus	84,5	83,5
functional length	from anterior superior iliac spine to medial malleolus	94	93
functional length	from umbilicus to medial malleolus	99	99
thigh	from trochanter major to knee joint	45	44
middle leg	from knee joint to lateral malleolus	46	46
foot	from heel to longest toe	25,5	25,5

Table 1

7.6.2 Circumference Evaluation

mesurement	***right extremity (cm)***	***left extremity (cm)***
thigh (10 cm cranial to patella)	41	41
patella	42	42
calf	30	30

Table 2

7.7 Gait Examination

Patient is walking with crutches of french style. After the doctor's orders patient is not allowed to load the operated leg over 15% of the weight. After that I observe that patient uses limited flexion of the healthy knee. The rotation of the trunk is restricted. There is also elevation and protraction of shoulders. Head is also protracted.

7.8 Range of Motion Measurement

All measurements are done according to techniques of Kendall.

Movement ***Unit-*** ***Degree***	***left hip***		***right hip***	
	passive movement	***active movement***	***passive movement***	***active movement***
flexion	100	95	115	105
extension	15	5	0	0
external rotation	14	10	15	12
internal rotation	15	12	18	15
adduction	10	10	10	10
abduction	20	15	25	25

Table 3

Movement ***Unit-*** ***Degree***	***left knee***		***right knee***	
	passive movement	***active movement***	***passive movement***	***active movement***
flexion	90	65	115	112
extensio	5	-10	0	0

Table 4

Movement ***Unit-Degree***	***left ankle***		***right ankle***	
	passive movement	***active movement***	***passive movement***	***active movement***
dorsal flexion	20	20	20	20
plantar flexion	45	40	45	40
inversion	40	40	40	40
eversion	20	20	20	20

Table 5

7.9Muscle Length Test

All measurements are done according to techniques of prof.Janda

muscle	***left extremity***	***right extremity***
quadriceps	grade 2	grade 0
hamstrings	grade 1	grade 1
adductors	grade 2	grade 0
iliopsoas	grade 0	grade 0

Table 6

7.10 Muscle Strength Evaluation

Muscle strength tests are done by the use of Janda Techniques.

muscle	***left extremity***	***right extremity***
quadriceps	2^+	4^+
hamstrings	3	4
adductors	3	4
triceps	4	4^+
iliopsoas	4	4

Table 7

7.11 Joint Play Examination

Patient was examined in tibio-fibular joint and all joints of the foot on left extremity. Examination of head of Fibula in ventral and dorsal shows restriction in both directions but more in dorsal. Also during the examination of Navicular found restriction in plantar direction.

7.12 Neurological Examination

Reflex Test	***Left Extremity***	***Right Extremity***
patellar reflex	2	2
medioplantar	2	2
achilles tendon	2	2

Table 8

7.12.1 Superficial Sensation Test

With the pin of neurological hummer and gentle contact, dermatomes L1,L2,L3,L4,L5 and S1 were followed and there was no problem with the sensation as the feeling was the same on both extremities. The same test done again with the tip of the finger and the results where the same.

7.13 Examination Conclusion

After all the examination and test, we can say that patient has functional problem on the operated leg, especially muscles around the area of knee joint. Quadriceps is weak and also in hyper tonic state. Hamstrings and adductors are in hyper tonic state but their strength level is satisfied. On adductors was found a trigger point that causes pain sometimes during the movement of hip adduction. Finally there was restriction on the movement of the head of Fibula and Navicular. The range of motion of knee in direction of flexion and extension found restricted. The muscle imbalance plays the most important role in this situation and of course the fact that patient is after an operation of joint replacement.

7.14 Short and Long Rehabilitation Plan

7.14.1 Short Rehabilitation Plan

Release fascia's restriction on the region of thigh

Decrease tonus of Rectus Femoris with use of PIR

Decrease tonus of hamstrings with use of PIR

Decrease tonus and treat trigger point in the region of adductors with use of PIR

Mobilization of head of Fibula and Navicular

7.14.2 Long Rehabilitation Plan

Strengthening exercises to improve muscle condition

Increase of ROM at first on the knee joint and some small improvement in hip joint

Education of patient for correct posture and proper weight sharing on both extremities

Education for activities of daily living in order to provide all important information for activities that patient might face difficulties.

7.15 Instruments used in Rehabilitation program

For the rehabilitation program we use some instruments. Use of Powerball for strengthening exercises. Use of device Continues Passive Movement to increase range of motion.

8. Visit Sessions

8.1 Session 1 *Date: 7.2.2011*

Subjective Report: Patient's basic complain is about a stretch feeling in the medial side of the thigh on the operated lower extremity. According to patient's complains this feeling comes up during walking especially when there is load on the operated leg. Finally patient is talking all the time about weakness of his whole extremity and believes that the reason is 3 days of rest after the surgery.

Assessment: Fascias of the thigh region are restricted. Hypertonic Rectus Femoris and adductors of the hip joint. Increase range of motion of the knee in the movement of flexion. Also there is weakness in Rectus Femoris and adductors so strengthening exercises will needed. Trigger point on thigh, in the medial side. Restriction in movement of head of Fibula in dorsal direction and Navicular on foot region, on plantar and dorsal direction.

Today's Plan: Increase the elasticity of thigh's fascias. Increase the range of motion of knee in the movement of flexion. Decrease muscle tone on Rectus Femoris and adductors. Strengthening exercises for Rectus Femoris and adductors of hip joint. Treatment for trigger point that found on adductors. Mobilization of head of Fibula and Navicular in order to decrease the restriction.

Today's Procedure:

I. Soft tissue technique application on the fascias of thigh .
II. Stretching exercises for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region
V. Isometric exercises with powerball for quadriceps and elevation of pelvis for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device CPM for the 30 minutes with settings on F:90 degrees and E:5 degrees

Results: The elasticity of the fascia has been slight increased. Adductors are slightly respond to PIR and stretching exercises, while Rectus Femoris shows better reaction. Still looks that there is a lot of work needed in order to reach a proper level. Trigger point is slightly released while stretching exercises and PIR help a lot on that issue. Mobilization of the head of Fibula had good result, on the other hand mobilization of Navicular was not so effective.

Prognosis: Patient is very cooperative and the prognosis looks good for the near future.

8.2 Session 2 *Date: 8.2.2011*

Subjective Report : The basic complain about the stretch feeling still exists. Pain in the medial part of thigh is better localized today. Patient still feels slight weak.

Assessment: Fascias of the thigh region are restricted. Trigger point in the region of adductors. . Increase range of motion of the knee in the movement of flexion. Hupertonisity of Rectus Femoris and adductors of hip joint. Strengthen exercises for Rectus Femoris and adductors of hip joint. Restriction in movement of head of Fibula and Navicular.

Today's Plan: Increase the mobility of fascias of thigh. . Increase range of motion of the knee in the movement of flexion. Treatment for trigger point. Stretch and relaxation of Rectus Femoris and adductors. Strengthening exercises for Rectus Femoris and adductors of hip joint. Mobilization of the head of Fibula and Navicular.

Today's Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler's fold formation
II. Stretching exercise for adductors and Rectus Femoris

III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region
V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device CPM for the 30 minutes with settings on F:90 degrees and E:5 degrees

Results: The mobility of the fascia's is increased and the therapy looks much more effective. The trigger point is not yet released but relief of the patient has been accomplished. Rectus Femoris and adductors are still in hypertonisity although isometric exercises has been provided easier. The head of Fibula has increase mobility, and Navicular starts to respond to mobilization. Patient feels tired but much more relieved, especially because of the trigger point treatment in combination with stretching exercises.

Prognosis: Good and promises more for the future.

8.3 Session 3 *Date: 9.2.2011*

Subjective Report: Patient does not feel very well today. He feels pain today on the operated knee and he is not in a good mood generally. Although he feels better his operated leg considering previews days.

Assesment: Release of thigh's fascias. Decrease of muscle tone on Rectus Femoris and adductors of hip joint. Increase range of motion of the knee in the movement of flexion. Strengthen exercises for Rectus Femoris and adductors for hip joint. Treatment for trigger point on the region of adductors. Mobilization of Navicular and head of Fibula.

Today's Plan: Increase the mobility of fascias of thigh. Increase range of motion of the knee in the movement of flexion. Treatment for trigger point. Stretch and relaxation of Rectus Femoris and adductors. Strengthening exercises for Rectus Femoris and adductors of hip joint. Increase mobility of the head of Fibula and Navicular.

Today's Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler's fold formation
II. Stretching exercise for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region
V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device of CPM for 30 minutes with settings on F:95 degrees and E:5 degrees

Result: Patient today feels very relieved. Fascias of the thigh respond to therapy much more than previews days. Adductors starts to decrease their muscle tone but Rectus Femoris is still in hypertonic condition. Patient has some difficulties with isometric exercises because of this stretching feeling he had, but it is quite normal in consideration with the state of the quadriceps muscle after the surgery. Mobilization is effective today both Fibula and Navicular has start to gain mobility.

Prognosis: Good

8.4 Session 4 *Date: 10.2.2011*

Subjective Report: Patient feels partial relieved but he is tired. He started to believe that therapy has results and state that he is going to try more.

Assessment: Release of thigh's fascias. Decrease of muscle tone for Rectus Femoris and adductors of hip joint. Strengthen exercises for Rectus Femoris and adductors of hip joint. Increase range of motion of the knee in the movement of flexion. Treatment for trigger point on the region of thigh in the medial side. Mobilization of Navicular and head of Fibula.

Today's Plan: Increase the mobility of fascias on the thigh region. Treatment of trigger point on the medial side of the thigh. Increase range of motion of the knee in the movement of flexion. Stretching exercises of Rectus Femoris and adductors. Relaxation of Rectus Femoris and adductors. Increase mobility of head of Fibula and Navicular**.**

Today's Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler's fold formation
II. Stretching exercise for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region
V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device of CPM for 30 minutes with settings on F:95 degrees and E:5 degrees

Result: Fascias has started to gain their physiological mobility as it was quite flexible from the beginning of the therapy session. Adductors has decrease their tonus and the deference is almost visible in passive movement of adduction of hip joint. Rectus

Femoris is still very stiff and it is painful during stretching Head of Fibula and Navicular have gain a lot of their physiological mobility.

Prognosis: Good

8.5 Session 5 *Date: 11.2.2011*

Subjective report: Patient looks very well today. He look full of energy. He still complains for some pain on his thigh but he is very optimistic about the therapy session.

Assessment: Release of thigh's fascias. Decrease of muscle tone on Rectus Femoris and adductors of hip joint. Increase range of motion of the knee in the movement of flexion. Strengthen exercises for Rectus Femoris and adductors for hip joint. Treatment for trigger point on the region of adductors. Mobilization of Navicular and head of Fibula.

Today's Plan: Increase mobility of fascias on the region of the thigh. Increase the range of motion of the operated knee in the movement of flexion. Treatment for trigger point. Decrease muscle tone of Rectus Femoris and adductors of hip joint. Strengthen Rectus Femoris. Strengthening exercises for Rectus Femoris and adductors of hip joint. Increase mobility of Navicular and head of Fibula.

Today's Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler's fold formation
II. Stretching exercise for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region

V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device of CPM for 30 minutes with settings on F:100 degrees and E:0 degrees

Results: Thigh's fascias are released and their mobility is close to physiological. Range of motion on CPM is increased as the stretching exercises have been effective for Rectus Femoris and adductors of hip joint, also muscle tone has gradually decreased on both muscles. Joint mobilization has been effective too as head of Fibula and Navicular respond to the therapy.

Prognosis: Good

8.6 Session 6 *Date: 14.2.2011*

Subjective report: Patient feels tired today. During the weekend he felt pain during the day that's why he didn't walk a lot. He said that he feels again this stiffness on his operated leg. The stiches has been removed from the operated knee during the weekend and he had a strange feeling on the area.

Assessment: Release of thigh's fascias and decrease restriction of knee's scar. Decrease of muscle tone on Rectus Femoris and adductors of hip joint. Increase range of motion of the knee in the movement of flexion. Strengthen exercises for Rectus Femoris and adductors for hip joint. Treatment for trigger point on the region of adductors. Mobilization of Navicular and head of Fibula.

Today's Plan: Increase mobility of fascias on the region of the thigh and on the scar on the operated region of the knee. Increase the range of motion of the operated knee in the movement of flexion. Treatment for trigger point. Decrease muscle tone of Rectus Femoris and adductors of hip joint. Strengthen Rectus Femoris. Strengthening exercises for Rectus Femoris and adductors of hip joint. Increase mobility of Navicular and head of Fibula.

Today’s Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler’s fold formation. Soft tissue on the scar.
II. Stretching exercise for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region
V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device of CPM for 30 minutes with settings on F:95 degrees and E:0 degrees

Results: Fascias was a bit restricted again but it was very easy to come in last level of mobility. Knee’s scar is restricted. Also adductors start to respond with more stiffness at beginning of the therapy but finally was better. Rectus Femoris is still stiff but stretching through exercises we handle to increase the range of motion in flexion movement. Finally it was preferred not to keep raising the settings of CPM on flexion because of the today’s complained so the passive movement in flexion was decreased by 5 degrees.

Prognosis: Good

8.7 Session 7 *Date: 15.2.2011*

Subjective Report: Patient today feels better than the last therapy. He said that he was rest and he is ready to continue therapy.

Assessment: Release of thigh's fascias and decrease restriction of knee's scar. Decrease of muscle tone on Rectus Femoris and adductors of hip joint. Increase range of motion of the knee in the movement of flexion. Strengthen exercises for Rectus Femoris and adductors for hip joint. Treatment for trigger point on the region of adductors. Mobilization of Navicular and head of Fibula.

Today's Plan: Increase mobility of fascias on the region of the thigh and the mobility of the scar on the operated knee. Increase the range of motion of the operated knee in the movement of flexion. Treatment for trigger point. Decrease muscle tone of Rectus Femoris and adductors of hip joint. Strengthen Rectus Femoris. Strengthening exercises for Rectus Femoris and adductors of hip joint. Increase mobility of Navicular and head of Fibula.

Today's Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler's fold formation. Soft tissue on the scar.
II. Stretching exercise for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region
V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device of CPM for 30 minutes with settings on F:100 degrees and E:0 degree

Results: The therapy today was the most effective during the whole time of sessions. Fascias are released. Patient feels only some pain on Rectus Femoris. Adductors has been relaxed and the tone has been significant decreased. Also trigger point's treatment is very effective as the pain is almost gone and the patient feels no more this strange feeling he was complaining before.

Prognosis: Very good

8.8 Session 8 *Date: 16.2.2011*

Subjective Report: Patient feels very well. He confess that he is walking ability is increased and his muscle condition is probably better because of his ability to walk more during his free time without the feeling of fatigue**.**

Assessment: Release of thigh's fascias and decrease restriction of knee's scar. Decrease of muscle tone on Rectus Femoris and adductors of hip joint. Increase range of motion of the knee in the movement of flexion. Strengthen exercises for Rectus Femoris and adductors for hip joint. Treatment for trigger point on the region of adductors. Mobilization of Navicular and head of Fibula.

Today's Plan: Increase mobility of fascias on the region of the thigh and the mobility of the scar on the operated knee. Increase the range of motion of the operated knee in the movement of flexion. Treatment for trigger point. Decrease muscle tone of Rectus Femoris and adductors of hip joint. Strengthen Rectus Femoris. Strengthening exercises for Rectus Femoris and adductors of hip joint. Increase mobility of Navicular and head of Fibula.

Today's Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler's fold formation. Soft tissue on the scar.
II. Stretching exercise for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle

IV. Treatment of trigger point on adductor region
V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device of CPM for 30 minutes with settings on F:110 degrees and E:0 degrees

Result: Fascias of the thigh region have reached a very good level. The scar of the operated knee has gain some of the flexibility on both edges (cranial and caudal) but the middle part remains restricted. Rectus Femoris is better condition as the pain that causes is decreased and the strengthen exercises have been very effective. Adductors of the hip joint have improved in strengthen and length level as the muscle tone is decreased in a level that patient does not feel any of this annoying feeling. The mobility of Navicular and head of Fibula is very close to physiological. Because of the state of the patient it was decided to increase the flexion angle on the CPM device and the patient was able to handle with no problem.

Prognosis: Very good

8.9 Session 9 Date: 17.2.2011

Subjective Report: Patient feels no pain today. The feeling of stiffness on the knee joint has already decreased and he is very optimistic for the future. Today he is living the hospital as his therapy program considered to be done.

Assessment: Release of thigh's fascias and decrease restriction of knee's scar. Decrease of muscle tone on Rectus Femoris and adductors of hip joint. Increase range of motion of the knee in the movement of flexion. Strengthen exercises for Rectus Femoris and adductors for hip joint. Treatment for trigger point on the region of adductors. Mobilization of Navicular and head of Fibula.

Today's Plan: Increase mobility of fascias on the region of the thigh and the mobility of the scar on the operated knee. Increase the range of motion of the operated knee in the movement of flexion. Treatment for trigger point. Decrease muscle tone of Rectus

Femoris and adductors of hip joint. Strengthen Rectus Femoris. Strengthening exercises for Rectus Femoris and adductors of hip joint. Increase mobility of Navicular and head of Fibula.

Today’s Procedure:

I. Soft tissue technique application on the fascias of thigh with application of Kibler’s fold formation. Soft tissue on the scar.
II. Stretching exercise for adductors and Rectus Femoris
III. PIR for adductors, hamstrings and Rectus Femoris 3x times for each muscle
IV. Treatment of trigger point on adductor region
V. Isometric exercises with use of powerball for quadriceps and pelvis elevation for activation of pelvic muscles
VI. Mobilization of the head of Fibula and Navicular
VII. Application of device of CPM for 30 minutes with settings on F:115 degrees and E:0 degree

Result: Patient has complete todays program without any problem or pain. Rectus Femoris and adductors are in very good condition. The trigger point is treated as it almost gone and it causes no pain any more. Fascias of the thigh has physiological mobility but the scar of knee is not fully treated, especially the middle part as the two edges (cranial and caudal) have gain their mobility. Head of Fibula and Navicular bone have also increase their mobility to the physiological level.

9. Final Kinesiological Examination

9.1 Postural Examination

The postural examination was provided from three sides, anterior, lateral and posterior. The equipment that has been used is a plumb line.

Anterior: Patient stands with physiological base with a very slight external rotation of feet. Right knee joint is in physiological extension and left in slight flexion. Hip joint is slightly extended on the right side.

Lateral: Patient's left ankle joint is in position of slight plantar flexion. It looks that on left leg the load is more on the posterior part and the heel. The pelvis is in slight anterior tilt. Head and shoulders are protracted. . Lumbar spine is in extension, thoracic spine is flat in lower segments and the cervical part of the spine is in flexion.

Posterior: Patient's Achilles tendons are not facing in parallel direction because of the slight external rotation of the feet. Left knee is slightly flexed and the right in physiological extension

9.2 Palpation

At first palpation was provided in superficial level. The results are very good compared with the initial examination. Especially on the scar of the left knee, the two edges of the scar (cranial and caudal) are almost released and in physiological mobility. The middle part of the scar has still some restriction, although the progress of the therapy concerning with the time was very good. On the level of fascias of the thigh, therapy was more effective as the result is excellent. The restriction of the fascias has been decreased and the mobility at this time is physiological. Trigger point on the region of the medial part of thigh (adductors of hip joint) has been treated and there is no pain anymore.

9.3 Gait Re-evaluation

Patient continues to walk with the help of crutches. During the final examination the patient was able to move with better stability on the healthy leg. There was improvement in the position of the operated leg also and it was obvious after observation of the standing phase. The foot of the left extremity was able to carry the 30% of patient's weight with stability in its neutral position.

9.4Anthropometric Re-evaluation

measurement	***details***	***right extremity (cm)***	***left extremity (cm)***
anatomical length	from trochanter major to lateral malleolus	84,5	83,5
functional length	from anterior superior iliac spine to medial malleolus	94	93
functional length	from umbilicus to medial malleolus	99	99
thigh	from trochanter major to knee joint	45	44
middle leg	from knee joint to lateral malleolus	46	46
foot	from heel to longest toe	25,5	25,5

Table 9

9.4.1 Circumference Re-evaluation

mesurement	***right extremity (cm)***	***left extremity (cm)***
thigh (10 cm cranial to patella)	40	41
patella	40	42
calf	32	31

Table 10

9.5 Range of Motion Re-evaluation

All measurements are done according to techniques of Kendall.

Movement	***left hip***		***right hip***	
Unit-Degrees	***passive movement***	***active movement***	***passive movement***	***active movement***
flexion	110	98	115	105
extension	10	10	0	0
external rotation	15	11	15	12
internal rotation	18	15	18	15
adduction	10	10	10	10
abduction	25	24	25	25

Table 11

Movement ***Unit-*** ***Degrees***	***left knee***		***right knee***	
	passive movement	***active movement***	***passive movement***	***active movement***
flexion	115	100	115	112
extensio	0	0	0	0

Table 12

Movement ***Unit-*** ***Degree***	***left ankle***		***right ankle***	
	passive movement	***active movement***	***passive movement***	***active movement***
dorsal flexion	20	20	20	20
plantar flexion	45	40	45	40
inversion	40	40	40	40
eversion	20	20	20	20

Table 13

9.6 Muscle Strength Re-evaluation

Muscle strength tests are done by the use of Janda Techniques.

muscle	***left extremity***	***right extremity***
quadriceps femoris	4	4^+
hamstrings	4	4
adductors	4	4
triceps	4	4^+
iliopsoas	4	4

Table 14

9.7 Muscle Length Re-evaluation

Muscle length test are done by the use of Janda Techniques.

muscle	***left extremity***	***right extremity***
quadriceps	grade 2	grade 1
hamstrings	grade 1	grade 1
adductors	grade 1	grade 1
iliopsoas	grade 1	grade 1

Table 15

9.8 Conclusion of Final examination

At first patient have done a great effort in order to succeed his final condition. During this short therapy time he managed to mark an improvement in all levels. Right now the patient has almost reached the proper range of motion in knee joint for standardized cases of knee replacement. After hard work the muscle condition is in the best level that can reach in that hospitalization time. Finally the most important is that patient feels no pain any more, that's why he is able to follow his daily activities with no difficulties.

Prognosis: is very good. He is able to keep the present level of wellness and even improve it with the only condition to keep working on his exercises daily.

Patient's Progress: was remarkable in two levels, range of motion and muscle condition. Patient manages to improve the range of motion 40 degrees in only 9 therapies. Muscle condition is also improved in a great level if we consider all the difficulties we face from the first time. Patient improved his muscle tone of m.Quadriceps femoris, hamstrings and the adductors of hip joint. At the same time and after great effort the muscle strength was increased in a level that patient starts to walk and move without any problem.

9.9 Discharge of Patient

Patient after reaching a good condition in functional and structural level for his daily activities is discharged. Although he has to continue exercising in order to keep improving his muscle and joint condition and reach an equal level of his both extremities.

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Tables