CHARLES UNIVERSITY

FACULTY OF PHYSICAL EDUCATION AND SPORTS

Physiotherapy Department

Case study of physiotherapeutic treatment of a patient after Total Knee Replacement

Bachelor's thesis

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Declaration

I declare that the thesis is done on my own. Sources used for all theoretical information are listed in the bibliography section of the thesis. Therapeutic methods and examinations are based on knowledge I gained from FTVS, Charles University in Prague.

I would like to add that practical part was done without any invasive methods and under agreement with the patient

In Prague, May 2021 Wonjun Lee

Acknowledgement

I would like to thank Bc. Lenka Dadkovicova for her kindness during the work placement at Malazinky Rehabilitation Clinic. I would like to express appreciation to Ph.Dr. Tereza Novakova, Ph.D. for her patience and encouragement to guide me through the process. Lastly, I would like to show my sincere gratitude to my patient A. S. for the most delightful cooperation.

Abstract

Title: Case study of physiotherapy treatment of a patient after total knee replacement.

Aim of thesis: The thesis put its purpose in understanding anatomy, kinesiology, and biomechanics of physiological human knee. It, further, covers theoretical information of osteoarthritis and total knee replacement. Finally, the thesis aims to put together theoretical knowledge and physiotherapeutic methods to explore rehabilitation procedure of a patient after total knee replacement.

Methods: All methods used for the thesis are noninvasive. All theoretical and practical knowledge used for the thesis are gained from the study at the Faculty of Sports and Physical Education, Charles University. The use of each method was discussed and supervised with a physical therapist at Malvazinky Rehabilitation Clinic, where the work placement was held.

Result: The applied physiotherapeutic methods in relation to the patient's short-term rehabilitation plans were effective in improving functions of the operated knee.

Keywords: total knee replacement, osteoarthritis, stability, .knee joint.

Abstrakt

Název: Kazuistika fyzioterapeutické péče o pacienta po úplné náhradě kolenního kloubu

Cílem práce je porozumět anatomii, kineziologii a biomechanice fyziologického lidského kolene. Dále jsou zde pokryty teoretické základy osteoartritidy a úplné náhrady kolennho kloubu. Práce pak spojuje te oretické poznatky a znalosti fyzioterapeutických metod k určení možné rehabilitační procedury pro pacienta po úplné náhradě kolenního kloubu. Veškeré metody použité v rámcy této práce jsou neinvazivní a všechny teoretické a praktické poznatky využité k jejímu vypracování byly získány během studia na Fakultě sportu a tělesné výchovy Univerzity Karlovy. Použití všech metod bylo vedeno a diskutováno s fyzioterapeutem z Rehabilitační kliniky Malvazinky, kde probíhala pracovní stáž.

Výsledek: Fyzioterapeutické metody aplikované v rámci pacientova krátkodobého rehabilitačního plánu byly efektivní ve zlepšení funkcí operovaného kolene.

Klíčová slova: úplná náhrada kolenního kloubu, osteoartritida, stabilita, kolenní kloub.

CONTENTS

1 PREFACE

Bipedal locomotion is one of the most defining functions of human being. Humans have evolved to achieve the most economic expenditure of energy during locomotion. It requires ideal centration of joints controlled by deep postural muscles, as well as, phasic muscles that power the joints to move the body in any speed and direction intended.

Individual pattern of locomotion, gait, can be altered and affected by numerous reasons. One of the most common reasons is gonarthrosis, a non-inflammatory degenerative knee joint disease. Discomfort at knee joints develops as cartilaginous tissues start to break down due to aging (Chaitow and DeLany, 2011).

Total knee athroplasty (TKA) is the most common procedure/surgery to replace the function of an affected knee joint with an artificial joint. It enables to reduce pain and discomfort and to increase range of motion in the knee joints. Nevertheless, many patients develop antalgic gait pattern and altered motor function during gait after several years after the surgeries. Incorrect gait pattern in long-tern can eventually bring degeneration in the non-operated contra-lateral joint (Vaienti et al., 2017).

Increasing number of adults with TKA shows the need of appropriate rehabilitation programs dedicated to restore the function of knee joints. Ultimately, as gait is an indispensable activity in everyday life, preparation for correct gait pattern and exercise of correct gait pattern should be the final goal of rehabilitation (Vaienti et al., 2017).

Therefore, intervention of physiotherapeutic methods is critical. It improves postural control, proprioception, and overall condition of soft tissues. That is all essential for achievement of correct gait pattern after TKA surgeries.

The goal of this thesis is to explore theoretical knowledge of total knee replacement and to apply physiotherapeutic methods it in the practical field. The work placement was held in Malvazinky Rehabilitation Clinic in Prague from the 11th of January to the 5th of February 2021.

2 GENERAL PART

2.1 Knee joint anatomy

The knee joint is the largest synovial joint in human body and plays an important role during gait. It is a complex synovial joint consisted of tobiofemoral and patelofemoral joints. It is located intermediately in the lower limb and allows movement between three bones, the femur, tibia, and patella to produce flexion and extension as a hinge joint (Chaitow and DeLany, 2011; Drake et al., 2020; Gupton et al., 2021; Lumley et al., 2018;).

The articulations are stabilized by four main ligaments of the knee, anterior cruciate (ACL), posterior cruciate (PCL), medial collateral (MCL), and lateral collateral (LCL) (Chaitow and DeLany, 2011; Gupton et al., 2021; Sobotta et al., 2020).

Fibro-cartilaginous menisci located between articulations of tibiofemoral joint act as shock absorbers. During movement synovial membranes and sacks, bursas, provide lubrication to reduce friction between articulations (Chaitow and DeLany, 2011; Gupton et al 2021).

2.1.1 Joint articulation

The knee joint consists of three bones, femur, tibia and patella. Two joints emerge as the three bones articulate. They are tibiofemoral and patellofemoral joints.

As the name suggests, the tibiofemoral joint is composed of tibia and femur. The slightly larger medial and smaller lateral condyles of femur, located distally to femur, sit on the tibial plateaus that are located superiorly to the tibia. Both articulating components (medial and lateral condyles) of femur are convex in frontal and sagittal plane presenting, somewhat, spherical shape (Chaitow and DeLany, 2011; Drake et al., 2020).

On the other hand, at the articulating surfaces, medial and lateral tibial plateaus are biconcave, oval, and concave on frontal and sagittal plane respectively. The shape of condyles that accommodate the femoral condyles plays a great role in stability of the knee during static loadings (Chaitow and DeLany, 2011).

The most important components In terms of load-bearing at the articulation of tibia and femur are menisci. They are fibro-cartilaginous C-shaped cartilages. Each is attached at the medial and lateral tibial plateaus. The bigger medial meniscus and smaller lateral meniscus are interconnected anteriorly by transverse ligament of knee. Menisci prevent direct articulation of femur and tibia and act as shock absorbers (Drake et al., 2020; Sobotta et al., 2011).

The patellofemoral joint articulates patella and femur. The posterior surface of patella sits on the trochlear surface on the distal anterior femur. Medial facet accommodates medial condyle of femur and lateral facet accommodates lateral condyle of femur (Chaitow and DeLany, 2011).

2.1.2 Knee joint capsule

The knee joint as a synovial joint, has a joint capsule around the margins of articulations. The capsule is consisted of two membrane, the internal synovial membrane and external fibrous membrane.

Attachments of synovial membrane are found on the joint surface, at the interspace between articular cartilage and bone, to cover up the articular cavity. In the case of the knee joint, synovial membrane is present at the distal epiphysis of femur and proximal epiphysis of tibia and secretes synovial fluid to lubricate the tibiofemoral and patellofemoral articulations. In addition, there are sacs of synovial membrane, bursas that are found outside joints (Gupton et al 2021).

Fibrous membrane is composed of dense connective tissue and surrounds the joint to stabilize it. Varying from locations, fibrous membrane thickens to form ligaments for specific stabilization goals. At the knee joint, additional extra-capsular ligaments are found which reinforces stabilization (Chaitow and DeLany, 2011; Lumley et al., 2018; Sobotta et al., 2011).

2.1.2.1 Synovial membrane

At the knee joint, synovial membrane is attached around the articular surfaces and superior and inferior outer margins of menisci. There are up to 30 bursas around the knee joint. The synovium superiorly expands above patella as suprapatellar bursa between femur and quadriceps muscles. The smaller expansion of synovium is posterolaterally as subpopliteal recess between lateral meniscus and tendon of popliteal muscle. These two bursas communicate with the synovial membrane as expansions (Drake et al., 2020; Lumley et al., 2018).

2.1.2.1 Fibrous membrane

Fibrous membrane blends in with extensions of tendons or ligaments to provide firm stability to the knee joint. Ligaments of the knee can be differentiated into two, extra-capsular and intra-capsular, depending on the attachment location.

Extra-capsular ligaments of the knee are patellar ligament, MCL, LCL, medial and lateral patellar retinacula, oblique popliteal ligament, arcuate popliteal ligament, and anterolateral ligament. Of these 8 ligaments, patellar ligament, MCL, and LCL is to be focused (Lumley et al., 2018; Sobotta et al., 2011).

Patellar ligmanet is an inferior extension of quadriceps femoris tendon. It attaches above the apex of patella and below to the tibial tuberosity (Lumley et al., 2018).

There are two collateral ligaments arising from the posterior aspect of medial femoral condyle; one attaching to the tibia, MCL and the other attaching to the fibula, LCL. Both are considered extra-capsular, however, only MCL attaches firmly to medial meniscus (Phisitkul et al., 2006). According to Maeseneer et al., 2000 there are three layers of the medial compartment of the knee consisting of three layers; deep crural fasciae (layer 1), the superficial portion of MCL (layer 2), and the capsule (layer 3). The superficial portion of MCL has vertical fibers to prevent valgus stress at the knee at the second layer. At the third layer, the capsule, separated from the second layer by bursa, meniscofemoral and meniscotibial extensions of the deep portion of the MCL was attached to the medial meniscus (DeMaseneer et al., 2000; Phisitkul et al., 2006).

Intra-capsular ligaments include ACL and PCL. The two cruciate ligaments are located in the intercondylar area of the knee connecting femur and tibia. They are termed "cruciate" as the two ligaments cross each other. The ACL descends from the inner surface of lateral condyle of femur to anterior part of intercondylar area of the tibia. The PCL descends from the inner wall of medial condyle of femur to posterior part of intercondylar area of the tibia (Drake et al., 2020; Sobotta et al., 2011).

2.2 Kinesiology and biomechanics of the knee joint

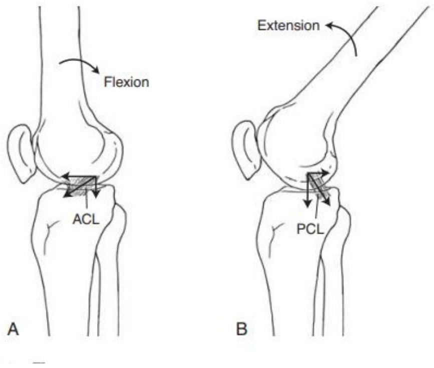
Human body utilizes biomechanical properties of soft tissues to execute a variety of activities in everyday life. The intensity of activities varies from as basic as static to dynamic. For execution of activities with different intensities, stability is always the key component. The body has a life-long task of maintaining upright posture of axial system against different loads coming from constantly changing center of gravity during activities. Without a firm stability system comprised of joints, muscles, and CNS control, executing any action will be a great risk to injuries (Masouros et al., 2010).

2.2.1 Movements of bony structures at the knee joint

Two movements occur at the knee joint. They are flexion and extension and medial and lateral rotations. The flexion and extension or rotation in sagittal plane is voluntary and the main movement of the knee. On the other hand, rotation about a longitudinal axis of the knee joint is the secondary movement to flexion and extension. The medial and lateral rotations at the knee can be voluntary when the knee is flexed and involuntary during the last courses of flexion and extension. Therefore it is a secondary movement of the knee as the movement is associated with flexion and extension involuntarily (Chaitow and DeLany, 2011; Masouros et al., 2010).

The primary movement in the TF joint is thought to be flexion and extension. For the knee being a hinge joint, the femur rolls on tibia or tibia on femur in closed and open chain respectively (Kapandji, 1987). However, the movement occurring at the articulation is more complex than just a pure rotation. The maximal flexion of the knee joint is 140 degrees actively and 160 degrees passively (Chaitow and DeLany, 2011). If it was to rely only on rolling, the femoral condyles will eventually go over the articular surface and cause dislocation, for femoral condyles being larger in size than tibial plateau (Kapandji, 1987).

To ensure a full flexion without dislocation, the femur slides forward on the tibia shortly after rolling backward. Sliding and cruciate ligaments are greatly associated. As the femur continues to roll backward during flexion, the taut ACL pulls femur anteriorly. During the course of flexion, menisci play a role in preventing direct contact of femur and tibia as the structure deform posteriorly. In the same sense, during extension, PCL pulls femur posteriorly as the femur rolls anteriorly on the tibia. Hence, a full range of rotation of the knee in sagittal plane without risks of dislocation is possible with simultaneous rolling and sliding (Kapandji, 1987; Levangie and Norkin, 2005; Ombregt, 2013).



A. rolling and sliding of the femur associated with ACL during flexion. B. rolling and sliding of femur associated with PCL during extension

Figure 1) rolling and sliding of femur and tibia (Levangie and Norkin, 2005)

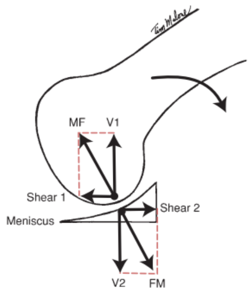


Figure 2) Posterior deformation of menisci during flexion (Levangie and Norkin, 2005)

In detail, participation of rolling and sliding depends on the measure of flexion as tautness of the cruciate ligament starts to be interrupted. Sliding of lateral femoral condyle begins after 10 to 15 degrees of flexion and for the medial condyle starts after 20 degrees of flexion (Kapandji, 1987; Levangie and Norkin, 2005; Ombregt, 2013). The fact that initiation of sliding of lateral condyle requires less flexion is most likely because of the attachment place of ACL. Kapandji (1987) explored that 15 to 20 degrees of initial rolling corresponds to range of motion of flexion and extension of the knee during normal gait. This can be interpreted as there is no stress force acting on cruciate ligaments during gait.

In addition to rolling and sliding of the joint, internal and external rotations of tibia against femur along longitudinal axis are the secondary movement (Chaitow and DeLany, 2011). This secondary motion of the knee depends on incongruence of articulation and laxity of soft tissues holding the joint. Therefore, the knee joint's extent of laxity and congruence differ by the measure of its primary movement (Masouros et al., 2010). In full knee extension, where ligaments and menisci are firm in position and intercondylar notch accommodates tibial tubercles, only minimal rotations are possible. However, during flexion, where laxity of ligaments occurs and the intercondylar notch no longer accommodates tibial tubercles, the joint is free to move laterally and medially. One can have a combined full range of active medial/lateral rotations of 35 degrees when the knee is flexed at 90 degrees (Levangie and Norkin, 2005).

As the axial rotation is a secondary movement to flexion and extension of the knee, there is always an involuntary rotation to sides automatically. This is especially obvious in the beginning of flexion and at the end of extension. The results of the automatic rotations are most visibly expressed in the foot. The foot is laterally rotated when standing upright and medially rotated when seated with flexed knee (Kapandji, 1987).

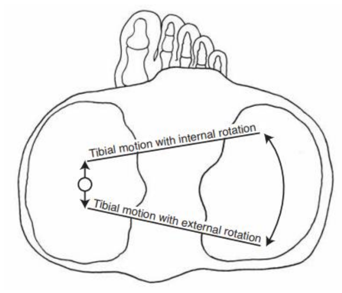


Figure 3) directions of tibial rotation (Levangie and Norkin, 2005)

As it is said, the medial femoral condyle is longer than the lateral and so medial condyle rolls and slides a longer distance than the lateral. In open chain (tibia rolling and sliding on femur or fixed femur), during the end course of extension, say at 5 degrees of flexion, there is no more articular surface area for the lateral tibial condyle to roll and slide anteriorly. The lateral tibial condyle has halted its movement. However, the larger medial tibial condyle is still on its way to full extension. As the medial tibial condyle continues to roll and slide anteriorly on the femur, it rotates the entire tibia laterally. Similarly, in closed chain (femur rolling and sliding on tibia or fixed tibia), the medial femoral condyle will continue to rotate medially inducing lateral rotation of tibia. This associated lateral rotation of tibia with extension is often referred to as screw-home mechanism or locking mechanism of the knee (Kapandji, 1987; Levangie and Norkin, 2005; Ombregt 2013).

2.2.2 Muscular functions at the knee joint

Muscles around the knee joint are responsible for phasic and static activities. During phasic activities, active muscular contractions enable movements of extension and flexion at the knee joint that are prerequisite to gait. While for static activities, muscles at the knee allow active stabilization of the joint (Masouros, 2010).

Muscles responsible for the extension of the knee are placed on the anterior compartment of the thigh. The main extensors are composed of three one-joint muscles, mm.vastii and one two-joint muscle, m. rectus femoris. All four extensors of the knee join together at quadriceps femoris tendon. The tendon is further extended as patellar ligament and attaches at the patella and below tibial tuberosity. The role of patella is to increase the lever arm for quadriceps muscles to promote efficient use of energy while fully extending the knee to 0 degrees (Chaitow and DeLany, 2011). Before stance phase (60%) of gait cycle, a full extension is in action to heel strike. Throughout stance phase and especially in single-limb stance, the knee joint is fully extended and the antagonist muscles co-activate to stabilize the joint (Kirtley, 2006). To help active stabilization function of muscles, the “screw home” locking mechanism comes and provides static and passive stability (Chaitow and DeLany, 2011). Add to that, however, a full extension without any deviation is critical for genuine locking mechanism. Faulty extension causes the vertical line of action of the ground reaction force to pass away from the weight-bearing structures of the knee. For example, if the action of the ground reaction force passes posterior to the knee joint, which is a common phenomenon when knee is slightly flexed, increased activation of quadriceps femoris muscles are required for stability thus breaks the balance of co-activation (Chaitow and DeLany, 2011; Masouros, 2010).

Muscles of the posterior compartment of the thigh are responsible for flexion of the knee. Seven muscles (the hamstrings, sartorius, gracilis, popliteus and gastrocnemius) serve to flex the knee and are all two-joint muscles, except for biceps femoris short head and popliteus muscle. When flexors are activated, the extensors are inhibited to promote efficient activity of the flexors and vice versa. Following Sherington’s law, antagonist muscles are inhibited when agonist activates. This process is also call reciprocal inhibition and it allows efficiency during phasic movements including gait (Chaitow and DeLany, 2011).

It was mentioned above that during single-limb support in gait cycle, coordinated activities of the antagonist muscles of the knee joint (active holding of a body segment) together with true locking mechanism (tautness in joint) that has correct vertical alignment of ground reaction force as a prerequisite should be satisfied to maintain stabilized static posture.

Kolar (2013) implied that physiological CNS development allows quality establishment of co-activation between spinal extensors and its antagonists. He also puts that hip flexion is not achievable without stabilization of spinal extensors and pelvis; the origins of the hip flexors. Thus, it is assumable that tightness of knee joint, which is of our focus, is expected from the stability between the spinal extensors its antagonists as altered hip muscles break tightness of hip joint; the origins of one extensor and 6 flexors of the knee (Kolar et al., 2013; Masouros, 2010).

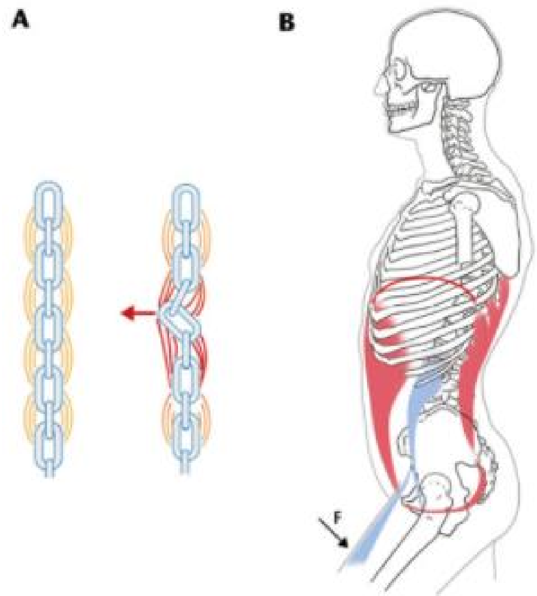


Figure 4) (A) alignment/centration of joints; (B) Deep stabilization system (Kolar, 2013)

Additionally, he states that gravitational force does not need to point directly to the the surface, or base support during ambulation. However, deviation of vectors of gravitational force during stance phase will lead the soft tissues to find ways to balance the body by twisting or exerting more muscle force. Therefore, even if the muscles and ligaments will find way to balance over a non-optimal base support, for example wearing of wrong shoes for a long period or prevalence of altered proprioception of base of support, the stability is violated. The harmonized activation between antagonist muscles, firmness in joint segments cannot exist by breaking all principles of active, static, and passive stability system (Kolar et al., 2013; Masouros, 2010).

Nonetheless, it is beyond the scope of this thesis to explain the detailed relationship between CNS development and muscle balance acting on the joint centration.

2.3 Knee osteoarthritis

Osteoarthritis is the most common form of arthritis occurring in synovial joints. It is a degenerative joint disease due to chronic overloading. Traditionally, the definition of osteoarthritis was thought to be a non-inflammatory degenerative disease. However, recently, it is a term that defines a chronic condition where degeneration and inflammation of one or more joints occur simultaneously. Osteoarthritis is divided into two types; primary (idiopathic) and secondary (Hsu and Siwiec, 2021; Jones and Doherty, 2005; Kolar et al., 2013).

In joints affected by osteoarthritis, cartilage loss is universally recognized. In radiographic findings, narrowing of the articular space is evident. The cause of cartilage loss identifies the type of osteoarthritis. Besides the idiopathic primary osteoarthritis, the secondary causes of osteoarthritis include anatomical, traumatic, metabolic, and inflammatory changes in affected joints. Cartilage loss brings great pain and disability and usually progresses slowly, but varies individually (Hsu and Siwiec, 2021; Jones and Doherty, 2005; Kolar et al., 2013).

Alongside cartilage loss, stiffening (osteophytes and sclerosis) of subchondral bone, osteopenia of bone, thickening of capsule and synovium accompanied by modest inflammation, and weakness of muscles are found in the affected joints (Jones and Doherty, 2005; Kappor and Mahomed, 2015).

Knee is the most commonly affected joints by osteoarthritis. It is also known as gonarthrosis. Other joints affected include hip, shoulder, spine, ankle and hand. Prevalence of Osteoarthritis is 12-15 % of the population, affecting both genders. With elderly over 70 years of age, the prevalence is more than 80% (Heidari, 2011; Michael et al., 2010).

Treatments of knee osteoarthritis are non-surgical and surgical. Non-surgical treatments include conservative methods and pharmacotherapy. If they are not successful, options for surgeries are corrective osteotomies, unicompartmental knee arthroplasty, and total knee arthroplasty (Jones and Doherty, 2005; Kolar et al., 2013).

2.3.1 Risk factors

Osteoarthritis, as a degenerative joint disease due to chronic overloading, accumulation of load-bearing over time can cause a permanent change in joints. Prevalence of osteoarthritis over the age of 40 shows a dramatic rise. The incidence of knee osteoarthritis is higher among women (Heidari, 2011; Kolar et al., 2013; Michael et al., 2010).

Knee, in particular, is a weight-bearing joint. Obesity delivers increased weight at the joint and eventually can alter the alignment of the knee either in valgus or varus. Similarly, alignment of the joint can be disrupted by trauma, occupation, and sport (Jones and Doherty, 2005; Kapoor and Mahomed, 2015; Kolar et al., 2013).

Furthermore, proprioception is another important factor associated with osteoarthritis. According to Jones and Doherty (2005), muscle weakness reduces proprioception of the adjacent synovial joint. They suggest that with reduced proprioception the knee, there is an increased sway when standing with eyes closed, increased risk of falls, and abnormal gait pattern.

2.3.2 Etiology and general pathological features

Knee osteoarthritis is due to chronic overloading and is classified as either primary or secondary. The hyaline cartilage is the main target of the degeneration. The loss of cartilage is focal in early stages then spreads widely to the entire cartilage to eventually disturb entire function of the affected joint (Jones and Doherty, 2005; Kapoor and Mahomed, 2015).

Primary knee osteoarthritis is idiopathic. There is no particular reason explaining the disruption of metabolism or equilibrium among components building healthy articular cartilage (Kolar et al., 2013). Causes of the secondary knee osteoarthritis are trauma, congenital malformation, malposition (varus/valgus), distinct metabolic changes, inflammatory diseases, and joint instability due to ligamentous laxity and weakness in periarticular muscles (Heidari, 2011; Jones and Doherty, 2005; Kapoor and Mahomed, 2015; Kolar et al., 2013; Michael et al., 2010).

At the onset of the osteoarthritis, the earliest changes are seen in the articular cartilages. The cartilage undergoes catabolic process leading to thinning (narrowing of articular surface), thus exposing subchondral bone. Exposure of subchondral bone without lubrication promotes sclerosis (thickening) of bone and formation of osteophytes. Furthermore, holes or cysts on bones may be formed following osteonecrosis. This gives the joint stiffness and limited range of motion. In the later course of the degeneration, the free fragments of cartilage or bone are released in synovial fluid and may be taken up by synoviocytes and cause inflammation (Jones and Doherty, 2005; Kapoor and Mahomed, 2015; Kolar et al., 2013; Ling and Bathon, n.d.).

2.3.3 Clinical symptoms

The knee is composed of three articular surfaces; medial and lateral tibiofemoral joints, and the patellofemoral joint (Chaitow and DeLany, 2011). Local inflammatory changes can manifest in any or all of the three articulations by osteoarthritis (Jones and Doherty, 2005).

As the knee is a large and superficial joint, sings of osteoarthritis can be easily seen with aspections (Jones and Doherty, 2005). Subjective symptoms are pain in the knee. A lot of patients visit physicians with chief complaints of knee pain. The pain primarily comes from inflammatory changes in the knee. The knee pain is very individual and worsens gradually. It is often difficult to assess the pain only from imaging methods. The pain worsens with prolonged activity or with inactivity. Activities transmitting large amount of loads such as bending the knee on stairs, for example, cause pain. Patients usually feel stiffness in the knee and always present swelling in the knee. The condition gets better with anti-inflammatory drugs, rest and application of cold on the affected knee (Heidari, 2011; Jones and Doherty, 2005; Kapoor and Mahomed, 2015; Kolar et al., 2013; Michael et al., 2010).

2.3.4 Imaging methods

Radiographic examination (X-rays) is used to confirm the diagnosis of osteoarthritis. There are other imaging methods such as magnetic resonance image (MRI) and ultrasound examinations. But they are not necessary for diagnostics and used for research purposes (Peter et al., 2014).

Radiographic examinations are taken in standing positions. Anterior and posterior and lateral sides of the affected joint are examined. Radiographic changes in affected joints are; narrowing of the joint spaces, sclerosis and density of subchondral bones, osteophytes or cyst formations (Jones and Dohery, 2005; Kapoor and Mahomed, 2015). Several grading methods are there for assessing the degree of osteoarthritis, but the most widely used is Kellgren and Lawrance (Peter et al., 2014).

The grading system proposed by Kellgren and Lawrance looks at the degree of cartilage loss, presence of osteophytes and cysts, the degree of sclerosis of subchondral bones. The classification has 5 grades, from grade 0 to 4 (Peter et al., 2014; Rock et al., n.d.).

Table 1) Kellgren and Lawrance system for classification of osteoarthritis

Grade 0 (none)	Definite absence of radiographic changes of osteoarthritis
Grade 1 (doubtful)	Possible joint space narrowing osteophytes formation
Grade 2 (minimal)	Osteophytes are seen, possible joint space narrowing
Grade 3 (moderate)	Multiple osteophytes, definite joint space narrowing, sclerosis of subchondral bones, and possible deformity of bones
Grade 4 (severe)	Large osteophytes marked joint space narrowing, severe sclerosis and definite deformity of bones

2.3.5 Diagnosis

The diagnosis is made based on patient's medical history, physical examination, and radiographic examinations (Jones and Doherty, 2005; Kapoor and Mahomed, 2015; Michael et al., 2010).

The medical history of patient with osteoarthritis usually focuses on the joint pain. The onset, location, duration, radiation and characteristics of the specific joint pain play a key role in diagnostics. Furthermore, swelling and stiffness of the joint are useful information (Jones and Doherty, 2005; Kapoor and Mahomed, 2015).

General physical examinations should take place to find other potential pathologies in the musculoskeletal system. Specifically in knee osteoarthritis, the gait examination and alignment of the knee are important for the diagnostics. Range of motion should be assessed for flexion deformities. Stability should also be examined to assess ligament deformities. Palpation of the knee can localize the area of tenderness (Michael et al, 2010).

Finally, radiographic imaging gives specific location and the severity of the osteoarthritis. Narrowing of joint spaces and other symptoms that are not visible with naked eyes are assessed via radiographic examinations for accurate diagnosis (Jones and Doherty, 2005).

2.3.6 Treatment

The treatment plan for osteoarthritis should be made according to the individuality of the disease. There are a wide variety of treatments depending on the severity of the disability, but education comes first for the management of the disability (Jones and Doherty, 2005). There are nonsurgical and nonpharmacological treatments available for earlier stages of the disease. On the other hand, pharmacological and surgical treatments are planned for patients with moderate to severe osteoarthritis (Jones and Doherty, 2005; Kapoor and Mahomed, 2015).

2.3.7 Education

Besides help from health care professionals, patients with adequate knowledge of the management of disability highly influence the quality of life after the treatment. The patients encounter a pool of information about knee osteoarthritis and total knee replacement surgery. It is fairly easy to find relevant, but non-professional information from their friends, family, and internet, which can be sometimes misleading. Therefore, the education of the disease should be based on credible sources and has to be appropriate to the educational level of the patients (Jones and Doherty, 2005).

In malvazinky rehabiliatation clinic, where this thesis is based on, all of the patients with total knee replacement were given excellent education. Handouts with information of osteoarthritis and total knee replacement surgery were given. As well as, information of management after the surgery including exercise programs, gait with crutches, and principles of management for three months after the surgery.

2.3.8 Conservative treatments

The goals of conservative treatment measures for osteoarthritis are to improve quality of life and mobility, reducing pain, and delaying progression of the disease without involvement of surgery and pharmaceuticals (Kapoor and Mahomed, 2015).

Eliminating any risk factor can delay the progression of the disease. As the knee is weight-bearing joint, weight loss by changing of life style and eating habits can reduce stress delivered to the ill joint. Sports such as water-based exercises are recommended. They are effective in strengthening muscles around the knee joint without transferring large mechanical forces to the joint (Jones and Doherty, 2005; Kapoor and Mahomed, 2015; Michael et al., 2014).

Individualized strengthening exercise programs upon patient assessment are important as well. Strengthening muscles to overcome the imbalance of the muscles can lead to centration of joint and appropriate distribution of the load expressed on the joint. Enhanced muscle strength and proprioception can greatly prevent risks such as falls (Jones and Doherty, 2005; Libenson, 2007).

Orthotics may be used to correct the misalignment or reduce stress at the joint. Laterally or medially wedged insoles can be used for medially and laterally localized osteoarthritis respectively. Neoprene sleeves or knee braces can correct malalignment and improve pain and function of the joint. Also, thick, soft and shock-absorbing soles may contribute to reducing stress expressed on the joint during gait. A walking stick or crutches can also be used to unload painful joint (Michael et al., 2010).

Lastly, physiotherapeutic measures such as distraction of the joint with osteoarthritis according to Lewit (2010), muscle strengthening exercises, stretching and relaxing exercises according to Lewit (2010), soft tissue techniques according to Lewit (2010), and cryotherapy are effective.

2.3.9 Pharmacotherapy

Acetaminophen, also known as paracetamol and non-steroidal anti-inflammatory drugs (NSAIDs) are used as first-line pharmacological treatments for osteoarthritis. These drugs are only symptomatic which help reduce symptoms such as pain, but not cure the disease (Anandacoomarasamy and March, 2010; Jones and Doherty, 2005: Zhang et al., 2019). NSAIDs are proved to be more effective in terms of pain relief compared to paracemtamol, simple analgesics. Thus, NSAIDs are preferred over paracetamol. However, both paracetamol and NSAIDs bring adverse effects such as gastrointestinal toxicity and renal risks (Anandacoomarasamy and March, 2010; Yu and Hunter, 2015; Zhang et al., 2019). Narcotic analgesics such as opioids are alternative symptomatic drugs administered to patients for whom first-line drugs are ineffective or contraindicated. Narcotic drugs are effective in relieving moderate to severe pain, but not recommended for a long-term use (Jones and Doherty, 2005; Zhang et al., 2019).

NSAIDs can be locally applied in the form of ointment on the targeted joint. It produces fewer side effects and greater efficacy compared to when administered orally. Another means of local application of drugs, intra-articular injections of hyaluronic acid and corticosteroids, are effective in acute stages of osteoarthritis. It is most effective for the treatment of accumulation of fluids in joint, joint effusion, and inflammation. Sterile condition for punctures or injections is to prevent infections that can lead to septic arthritis (Anandacoomarasamy and March, 2010; Yu and Hunter, 2015; Zhang et al., 2019).

Chondroitin and glucosamine sulfate are believed to reduce pain and increase joint function. They are responsible for regulating homeostasis of cartilage matrix. Their significance in pain management still remains controversial (Zhang et al., 2019). However, in long-term use of such drugs can adverse the catabolic process of the cartilage. Such drugs are called SYSADOA (symptomatic slow acting drugs for osteoarthritis). Their mechanism is not yet fully explained, but it is believed that they have effects including biomechanical properties changes in cartilage (e.g. elasticity), inhibition of inflammation, and nociceptor blockade (Dougados, 2006). Current medication researches focus on the modification of the anabolic/catabolic status of the joint cartilage to treat the disease (Zhang et al., 2019).

2.3.10 Surgical treatment

When conservative treatment fails, surgical intervention is considered. Several surgical treatment options are available and they differ individually depending on clinical features (Jones and Doherty, 2005). Surgical indication is not selected solely on radiographic findings, but based on symptoms, stage of osteoarthritis, patient's age and level of physical activity, and overall health conditions(Jones and Doherty, 2005; Kapoor and Mahomed, 2015).

In the course of knee osteoarthritis, range of motion in the knee is limited due to cartilage degradation. If the goal of surgery is to promote smooth movement of knee joint, arthroscopic procedures are indicated. Depending on the type of intra-articular pathologies, different strategies are selected (Kapoor and Mahomed, 2015). Arthroscopic lavage is used to flush out the free particles of the damaged cartilage. Arthroscopic debridement is used to resect damaged cartilage to make the joint surfaces smooth. Menisectomy is to remove all or a part of damaged meniscus. Chondroplasty is an alternative arthroscopic intervention to trim out loose or damaged cartilage to smoothen articular surfaces (Palmer et al., 2019; Rönn et al., 2011).

When the knee joint is suffering from excessive load medially or laterally, modification of load is necessary and it is done by realigning the articular bones (Kapoor and Mahomed, 2015). Osteotomy is a surgical process to re-align the articular surface of the knee. Cutting the distal femur or proximal tibia and reshaping them will promote desired alignment for proper loading of the joint (Palmer et al., 2019; Rönn et al., 2011).

If all the above are not successful, the surgical option remaining is knee replacement. It involves replacing the damaged joint surfaces with artificial implant (Kapoor and Mahomed, 2015). Depending on the locality of the disease, the site of replacement can be all (total knee replacement) or selected (unicompartmental knee replacement). The bones are resected to accommodate artificial implants (Palmer et al., 2019; Rönn et al., 2011; Varacallo et al., 2021).

2.4 Total Knee Replacement

Total knee replacement is a surgery that replaces the surface of articulation at the knee with artificial implants. The implants of total knee replacement can replace three compartments of the knee joint; distal femur, proximal tibia, and patella. They are composed of metal alloys, ceramics, or synthetic plastics (Hirschmann and Becker, 2015; Kapoor and Mahomed, 2015; Varacallo et al., 2021). Total knee replacement is usually indicated to patients with end-stage osteoarthritis. The main goals are to improve pain management and disability of the knee joint by artificial knee joint with physiologic alignments (Hitschmann and Becker, 2015; Kapoor and Mahomed, 2015; Varacallo et al., 2021). The patient's level of activity, comorbidities, severity of osteoarthritis, type of implants, and the cost are thoroughly discussed between the surgeon and the patient before replacement surgery (Kapoor and Mahomed, 2015; Varacallo et al., 2021).

Implant types vary specifically by the stability given by anterior and posterior cruciate ligaments (Varacallo et al., 2021). Available options are; bicruciate-retaining, cruciate-retaining, and posterior-stabilized designs. The bicruciate-retaining implant type keep both anterior and posterior cruciate ligaments. The cruciate-retaining type keeps PCL, but removes ACL. The posterior-stabilized type removes both the cruciate ligaments and replaces the function of PCL. Among the three, the latter is the most commonly used type. Fixed and mobile bearing design is another type of prosthesis used. Its high congruency compared to other introduced types allows a reduced shear force to the bones. However, its efficacy is doubtful as it provides less stability and may lead to soft tissue impingements. (Hirschmann and Becker, 2015; Varacallo et al., 2021)

2.4.1 Indication

Total knee replacement is selected for patients with end-stage of osteoarthritis. In the end-stage of osteoarthritis, the joint itself is the cause of severe pain and disability. The advantage is in realigning the axis of the knee joint for efficient load delivery (Varacallo et al., 2021).

2.4.2 Contraindication

The total knee replacement is contraindicated for patients with local or remote infection or bacteremia. Patients with severe vascular dysfunctions are also contraindicated (Varacallo et al., 2021).

2.4.3 Complications

Although total knee replacement surgery is reliable and successful in improving pain management and function of the knee joint, complications do exist. There are up to 1 in 5 patients who are not satisfied with the outcome of the surgery (Varacallo et al., 2021).

Poorly controlled nutritional state, obesity, diabetes mellitus, or tobacco use may lead to wound complications. They range from superficial to deep surgical infections. The infections can be devastating and have to be irrigated through arthroscopic lavage and debridement. Another possible post-operative infection is periprosthetic joint infection. However, the incidence is as low as 1% to 2% (Varacallo et al., 2021).

Material wear became greatly uncommon due to improvements in the properties of implants. However, it can lead to implant (or aseptic) loosening deformation, and fractures of periprosthesis. Patients with loose implants suffer from pain during weight-bearing activities (Hirschann and Becker, 2015; Varacallo et al., 2021).

Other complications include malpositioning or instability of the prosthesis, stiffness, peroneal nerve palsy, metal hypersensitivity (Hirschmann and Becker, 2015; Varacallo, 2021).

2.4.4 Pre-operative management

Several changes at home and life style and getting health problems treated prior to the surgery can make recovery easier. The followings are recommended. Rearranging necessary items for everyday life close to waist and shoulder level and reducing houseole hazards such as taping electrical cords will prevent risks of falls. Reducing abuses such as use of alcohol and cigarettes and maintain proper nutritional intake will decrease chances of complications. Getting dental works done will reduce risks of infections. Use of medications should be discussed with a doctor prior to the surgery (Bozic, 2018).

2.4.5 Post-operative management

A successful surgery will sufficiently alleviate pain right after. An individualized rehabilitation plan will be recommended by the surgeon according to the outcome of surgery and patient's level of fitness.

Physical therapy is intervened in the process of rehabilitation. The goal of physical therapy is to reduce swelling, train muscles acting on the knee joint without overloading it, reduce and correct any movement pathologies, and to improve the healing of the soft tissue (scar care) (Kolar et al., 2013).

In the early stage of the rehabilitation the patient learns how to move (repositioning) in bed. Rotating or overloading the knee joint is to be avoided. Breathing exercises are initiated to increase level of fitness. Management of soft tissue (skin, scar, and fasciae) around the knee joint starts with reducing the swelling. Ice packs are locally put on the site of swelling two to three times per day for 10 to 20 minutes to reduce it. Balling over the soft tissue and stretching fasciae around the knee joint is beneficial as well. Scar should be mobilized to ensure correct healing of it (Kolar et al., 2013).

The patient can stand up after two or three days. Isometric exercises of quadriceps and active exercises in the foot and toes are initiated. During isometric exercises of quadriceps, focus is on the extension at the knee, flexion and extension of the knee joint in the alignment. The exercises can be done twice per day with 5 to 10 repetitions, but the intensity may differ individually. Walking with assistive devices such as French crutches is trained with a physical therapist. Passive movement of the knee joint is practiced using CPM devices (Kolar et al., 2013).

Over time, the intensity of active exercises can be increased and the patient trains ascending and descending on stairs with assistive devices. After stitches are removed, the patient can be put in prone and a variety of exercises of different muscles can be done. Continuous exercises will reduce smooth joint play of the knee and tighten muscles around the knee. The joint play can be improved by mobilizing blocked joints and tight muscles can be relaxed or stretched using PIR (post isometric relaxation) and contraction-relaxation technique of PNF (proprioceptive neuromuscular facilitation). Improving proprioception in the distal lower extremity is one of the most important late rehabilitation goals. Proper proprioception in the planta of the foot will promote correct alignment and thus prevent falls and overloading (Adler et al., 2014; Liebenson, 2007; Kolar et al., 2013).

Detailed physiotherapeutic techniques used to achieve rehabilitation goals for patients after total knee replacement are as follows:

- Cryotherapy: this therapy is effective in reducing swelling. It can be done by locally applying ice packs on the areas of swelling for 10 to 20 minutes 2 to 3 times a day.
- Static breathing gymnastics (Kolar et al., 2013): it is the basic practical component of respiratory rehabilitation and increases one's level of fitness by promoting efficient breathing. It is mostly done in sitting or supine and the patient's breathing pattern is never forcefully altered.
- Shifting the deep fasciae: Lewit (2010) emphasizes that fascia stretching is the most important of all soft tissue manipulation techniques he describes. Additionally Ming (2008) puts traumas to fascia such as surgery, leads to adhesion formation that causes tightness of fascia. Fascia envelops all soft tissues including nerves, muscles, blood vessels, organs, and bones. Thus, for patients with their knees replaced, restoring mobility of fascia according to Lewit's (2010) manual techniques is a crucial preparatory step before manipulation of other soft tissues that are enveloped within fascia. For releasing tight fascia around the knee, rotating soft-tissue about a longitunial axis and wringing at the barrier is beneficial.
- Joint mobilization: blocked joints could cause a reduced range of motion. In the knee joint, patella and fibular head are typically blocked. According to Lewit (2010), blocked fibular head is significantly related to trigger points in biceps femoris. This will lead to postural imbalance by disturbing correct fixation of the pelvis.
- Muscle strengthening: active exercises including flexion and extension at the knee and abduction and adduction of lower limb strengthen muscles

around the knee. The intensity may differ individually. Open and closed kinetic chain exercises can be performed depending on the patient's level of fitness and outcomes of the surgery.

- Open kinetic chain exercise program (OKC): it is a less intensive exercise program as load is eliminated. It promotes isolated muscle strengthening of the target joint. However, the movement is different to how muscles are used in daily activities. It is suggested that OKC produces maximum shear forces to the new joint and minimum co-contraction of muscles (Abbas and Daher, 2017).
- Closed kinetic chain exercise program (CKC): it is rather a more aggressive exercise program compared to the OKC. Therefore, patient's level of fitness and outcomes of surgery should be carefully assessed for CKC. It is great for increasing stability of the new joint as co-contraction of adjacent muscles is maximized. Its benefits are greater than compared to OKC in terms of stabilization, functionality of muscles, and muscle strengthening (Abbas and Daher, 2017).
- Muscle relaxing: post-isometric relaxation (Lewit, 2010), reciprocal inhibition (Lewit, 2010), and contraction-relaxation technique of PNF can be used to relax hypertonic muscles (Adler, 2014). Relaxing hypertonic muscles improve quality of locomotor system aiming at alleviating muscle imbalance.
- Muscles stretching: it allows restoration of length of shortened muscles. Quality of locomotor system including range of motion is improved.
- Sensorimotor stimulation (SMS): sensorimotor stimulation exercises such as small foot exercise improve muscle coordination, motor regulation, and activation of muscles. The improvement leads to treatment of any muscle imbalance, postural control, and gait. Any interrupting factors to proprioception such as dysfunctions of skin, fascia, muscles, and joints should be eliminated before SMS. SMS begins with the most distal part of the lower limbs and gradually continues to the head, neck, and shoulder (Liebenson, 2007).
- Gait re-education: gait is one of the most important daily activities. Re-

education of gait attempts to show how to use assistive devices such as crutches correctly and to eliminate any movement pathology such as asymmetric or antalgic gait pattern after surgery (Kolar, 2013).

3 SPECIAL PART

3.1 METHODOLOGY

The practical part of this thesis was conducted in Malvazinky rehabilitation clinic, Prague, Czech Republic. The work placement was from the 11^{th} of January to the 5^{th} of February, four hours a day for four consecutive weeks.

The subject patient was assigned on the 13^{th} of January and therapeutic procedures were provided to him under supervision of a physical therapist until the 2^{nd} of February. The patient was aware of the purpose of the thesis by reading and signing the informed consent provided by the ethical committee of FTVS, Charles University. The ethical approval and a sample of informed consent can be found in the supplements section 6.4 and 6.5.

The patient was diagnosed with gonarthrosis of the right knee and undergone a total knee replacement surgery on the 6^{th} of January. Every session of physical therapy was for 25 minutes. Therapeutic methods applied to the patient include physical examination, manual methods, active physical exercises, stretching of soft tissues, relaxing of muscles of the affected lower leg, and breathing exercises.

3.2 ANAMNESIS

Examined person: A.S.

Year of birth: 1943

Diagnosis: After Total knee replacement following gonarthrosis of the right knee

Past medical history:

- Right inguinal herniation in 2001
- Left total hip replacement in August 2018

Prior rehabilitation

- Following total hip replacement in 2018.

Occupational: retired electromechanic

Allergy: none

Abuse: ex-smoker for 30 years, 500ml beer a day

3.3 INITIAL KINESIOLOGICAL EXAMINATION

13.1.2021

Table 2) Initial circumference measurements

	Left	Right
Knee joint	40cm	47cm
Vastus medialis	43cm	50cm
Quadriceps	46cm	53cm

Table 3) Initial range of motion of the knee

	Left	Right
Active	S: 0-0-115	S: 0-5-60
Passive	S:5-0-120	S:0-5-70

Table 4) Initial aspection of the knee

	Left	Right
Color of skin		Not red
Sign of infection (abnormal redness, pus, or swelling)		None
Position		The knee is slightly flexed.
Size and shape		Larger due to inflammation.

		The skin is stretched.
Temperature		Warmer
Scar		Stapled

Superficial sensation on the knee:

- Light touch on both lower extremities was done.
- Reduced sensation mainly around the scar on the place of knee replacement was reported.
- Normal sensation of the left knee was reported.

Table 5) Initial muscle length test

	Left	Right
Hamstrings (according to Kendall)	70 degrees	50 degrees
Hip flexors (according to supervisor – with tested leg out of the bed, patient in supine)	Shortness in the two joint muscles.	Shortness in the two joint muscles
Triceps surae (according to Janda) - Gastrocnemius (fully extended knee) - Soleus (slightly flexed knee)	Grade 0 for both gastrocnemius and soleus	Grade 1 for both gastrocnemius and soleus
Pectoralis minor (according to Kendall)	Grade 2	Grade 2

Table 6) Initial muscle strength test

	Left	Right
Quadriceps femoris	Grade 5	Grade 3
Hip adductors	Grade 5	Grade 3
Tensor fasciae latae	Grade 5	Grade 4
Hip abductors	Grade 5	Grade 4
Gastronemius	Grade 5	Grade 4
Iliopsoas	Grade 4	Grade 3+
Gluteus maximus*	Grade 4	Grade 3

*Gluteus maximus was tested in prone on the 21st of January, after staples were removed

Table 7) Initial palpation of tonus

	Left	Right
Vastus medialis	Normal	Hypotonic
Rectus femoris	Hypertonic	Hypertonic
Hamstring (supine with leg rasied up and the heel rested on overball)*	Normal	Lightly hypertonic (m. biceps femoris)
Iliacus	Slightly hypertonic	Hypertonic
Gluteus maximus**	Normal	Hypotonic

*patient has staples on the operated knee; it was advised not to test in prone position.

**Gluteus maximus was tested on the 21st of January, after the staples were removed.

Table 8) Initial joint play examination (Lewit, 2010)

	Left	Right
Head of fibula	Restrictions in ventral and dorsal directions	Restriction with hard barrier in ventral and dorsal

		directions
Patella	Restriction in cadual direction	Restrictions in cadual and cranial directions.

Pelvic examination

- Pelvic obliquity (deviates to the left/higher on the left)
- Anteversion
- Rotated to the left
- Left anterior superior iliac spine lower
- Left posterior superior iliac spine higher

Gait examination

- Patient is with French crutches
- 20% to 30% of load is allowed on the right leg.
- Non weight-bearing 3-point gait; when walking with crutches, the patient places both crutches in front firstly and then puts affected limb in the line of crutches without stepping. Finally the non-operated leg follows to step forward.
- Antalgic gait pattern
- Rhythm of each strike not identical
- Reduced strike length in the right knee
- Smaller extension and flexion in the right hip

- Trunk leaning forward

- Width of the base of support not wide.

Table 9) Initial Fascia shifting examination

Fasciae around the knee joint	Free	Restricted towards the scar from laterally and medially
Fasciae of the thight	Free	The upper thigh is freer than compared to the lower part of the thight where the stapled scar begins.
Fasciae of the calf	Free	Very restricted in the anterior part, especially in the area where the scar finishes upper part of the lower leg.

Breathing patterns

- Ribs are in inspiratory position (both ribs are flaring out, however the flare is larger in the left rib)

- Patient breathes with chest, the involvement of abdomen while breathing is very small.

- Furthermore, diastasis was observed during inhalation, leading to necessity of tests following deep stabilization system.

Assessment of deep stabilization system according to Kolar (2013)*

- Diaphragm test:
  - Ability to symmetrically resist against palpation under the lower ribs laterally
  - Ability to keep the ribs caudally
  - Ability to expand intercostal spaces
- Trunk flexion test:
  - Extent of involvement of abdominal muscles activity during neck flexion and trunk flexion.
  - Ability to hold chest caudally during neck flexion
  - Note any sign of arching of lateral abdominal muscles and diastasis
- Extension test:
  - Ability to balance activation of the spinal extensors
  - Ability to keep pelvis in position
  - Ability to hold the lateral abdominals
- Hip flexion test:
  - Ability to make counter resistance on the inguinal cavity.
  - Ability to keep pelvis in position
  - Balanced activation of abdominal muscles

*The assessment was done on day 9 after realizing there was insufficient control of trunk with evidence of patient's breathing pattern, flared ribs, and diastasis.

3.3.2 Conclusion of the initial Kinesiological examination

Patient is 7 days after the surgery. There are no signs of infection or thromboembolism. However, only minimal weight bearing is allowed by the doctor.

As the measurements of circumference indicate, swelling around the knee joint is present due to injury of the soft tissue. No redness is present, however, it is warm. Swelling and pain of the knee lead to inadequate activity of knee flexors and extensors. During gait, inadequate activity of unilateral lower extremity decreases time spent on stance phase and enhances swing phase of the painful leg (Ogrodzka and Niedwiedzki, 2012).

As shown in the length test, hamstrings are shortened. Short hamstrings will limit extension in the knee as the short hamstrings will keep the knee joint in flexion. If the hamstring will be left shortened or flexed for longer time, the quadriceps, knee extensors, will elongate or inhibit. Eventually, there will be a loss balance between these two agonist and antagonist muscle groups. Prolonged imbalance of the two muscles without activity to recover the balance will lead to a dysfunction of co-activation between them (Kolar et al., 2013). Closed chain exercises are great for improving co-activation of antagonist muscles and proprioception, but weight bearing is allowed only minimally (Abbas and Daher, 2017). Following the acute condition of the patient, gaining general strength in the lower extremities by open chain exercises will prepare for co-activation trainings.

Reduction of mobility in the knee joint could also prohibit activity of the hip joint muscles. Reduced knee extension/flexion due to pain is compensated by larger movement of hip flexors, which is responsible for swing phase, to make up for the lost strike due to reduced stance phase, which in long term inhibits hip extensors (Ogrodzka and Niedwiedzki, 2012). The hypotonic m. gluteus maximus and hypertonic/shortened iliopsoas may be due to inactivity and imabalance between muscle groups.

Prolonged use of crutches lead to shortening of pectoralis minor muscles

3.4 SHORT TERM AND LONG TERM PHYSIOTHERAPY PLAN

3.4.1 Short term rehabilitation plan

- The acute problem is the injury to the soft tissue and the mobility in the knee.
- Reduce pain and inflammation in the operated knee (ice pack 3 times a day, 10 mins per application)
- Relax hypertonic muscles using PIR
- Stretch shortened muscles using PIR with stretching and stretching techniques
- Increase mobility of the knee (passive and active trainings)
- Activation of hypotonic muscles
- Strengthening of the weaker muscles
- 3 point gait training
- gait training on stairs with crutches
- mobilization of restricted muscles
- stretching and release of restricted fasciae

3.4.2 Long term rehabilitation plan

- Joint mobilization of the ankle and foot
- Improve proprioception of feet
- 2 point gait training
- Improve stability of the operated knee

- Strengthening exercises
- Self-therapy on the scar (education of scar care)
- Stretching of the shortened muscles
- Relaxation of the hypertonic muscles (self-PIR)
- Achieve deep stabilization by correction of breathing stereotype.

3.5 THERAPY PROGRESS

Day 1

13.1.2021

Stp. Subj.: The patient is tired but ready to cooperate and help with the thesis.

Stp. Obj.: The patient uses French crutches (3 point gait) to move around the clinic. He is rather slow. He uses elevator to move from his room (1st floor) to the therapy room (2nd floor). He needs higher chair in his room to avoid large flexion in the operated knee.

Procedure: Initial kinesiologic examination.

Result

- subjective: He was tired and expressed mild pain throughout the examinations. The patient, however, tolerated well until the end of the examination and cooperated.
- Objective: 30 minutes were given, but it was not enough time for managing a full initial kinesiologic examination; roughly 10 minutes were taken for us to introduce ourselves to each other and for him to come into the room and lie down on the table.

Day 2

14.1.2021

Stp. Subj.: the patient is feeling better than the day before. He has complained how soft the bed is

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: kinesiological examinations, improve mobility of the knee fasciae and joint

Propsed therapy: kinesiological examinations, cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles

Procedure: (1) kinesiological examinations (muscle length test of bilateral hamstrings and triceps suarae); (2) application of ice pack; (3) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (4) 10 x hold isometric contractions for 5 seconds in m. quadriceps femoris (overball under knee - open chain), hamstrings (overball under heel - closed chain), gluteual muscles (squeezing buttocks together - open chain), 10 x isotonic contractions: m. triceps surae, m.tibilais anterior (dorsi/plantar flexion in the air - open chain), hamstrings, m.rectus femoris (rolling overball with feet - closed chain); (5) CPM (continuous passive motion) device for 25 minutes at 79 degrees of flexion

Results of the therapy:

- Objective: mobilization of soft tissue around the cranial part of the scar is less restricted than the distal part, the strengthening exercises were done in a slow rhythm and without pain, rolling overball with feet (rolling up; 60 degress of knee flexion, rolling down; 5 degrees of knee flexion), terminal extension in the knee is not possible; 5 degrees of flexion remains

- Subjective: patient performed active strengthening exercises without problem.

Day 3

15.1.2021

Stp. Subj.: patient has not slept very well and feels the air is dry for him at the hospital

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: kinesiological examinations, improve mobility of the knee fasciae and joint

Propsed therapy: kinesiological examinations, cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, and relax hypertonic muscles

Procedure: (1) kinesiological examinations (muscle length test of bilateral iliopsoas and tonus palpation of iliacus advised by supervisor); (2) application of ice pack; (3) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (4) 10 x hold isometric contractions for 5 seconds in m. quadriceps femoris, hamstrings, gluteual muscles, and adductors, 10 x isotonic contractions of m. triceps surae, m.tibilais anterior, hamstrings + m.rectus femoris, abductors + adductors; (5) gravity induced relaxation of the left m. iliopsoas (position advised by supervisor – patient lies close to the edge of table and lets the leg out of the table); (6) CPM (continuous passive motion) device for 25 minutes at 82 degrees of flexion

Results of the therapy:

- Objective: the restriction of fasciae cranial to the scar is less than the distal part, during abduction exercise, patient flexed the hip (after putting a plastic bag under heels, flexion disappeared), every knee flexion during strengthening exercises were at 60 degrees, terminal extension in the knee is with 5 degrees of flexion, relaxation of m. iliopsoas was successful

- Subjective: patient well tolerated the therapeutic unit

Day 4

18.1.2021

Stp. Subj.: the patient is feeling better than the day before.

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: kinesiological examinations, improve mobility of the knee fasciae and joint

Propsed therapy: kinesiological examinations, cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, and relax hamstring

Procedure: (1) kinesiological examinations (joint play of fibular head, tonus palpation of hamstrings); (2) application of ice pack; (3) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (4) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris, and abductors + adductors; (5) relaxation of hamstings (PNF – hold and relax technique in supine); (6) joint mobilization of fibular head; (7) CPM (continuous passive motion) device for 25 minutes at 85 degrees of flexion

Results of the therapy:

- Objective: the restriction of fasciae cranial to the scar is less than the distal part, outcome of strengthening exercises was the same as previous day, restricted joint play of fibular head, increased flexion after relaxation of hamstrings

- Subjective: patient well tolerated the therapeutic unit, join mobilization of fibular head was somewhat painful

Day 5

19.1.2021

Stp. Subj.: the patient is feeling better than the day before.

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: kinesiological examinations, improve mobility of the knee fasciae and joint

Propsed therapy: kinesiological examinations, cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, and relax hamstring

Procedure: (1) kinesiological examinations (joint play of both patella and fibular head); (2) application of ice pack; (3) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (4) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris, and abductors + adductors; (5) relaxation of biceps femoris (PIR); (6) joint mobilization of fibular head and patella; (7) CPM (continuous passive motion) device for 25 minutes at 87 degrees of flexion

Results of the therapy:

- Objective: improved movement of fasciae around the scar, no significant change during strengthening exercises, , increased flexion after relaxation of m. biceps femoris, notable restriction of both patellas in caudal direction, decreased barrier during fibular head mobilization in both directions

- Subjective: joint mobilization of fibular head was less painful

Day 6

20.1.2021

Stp. Subj.: the patient is feeling better than the day before. The patient is excited to remove the staples on the site of operation in the afternoon after the therapy.

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: improve mobility of the knee fasciae and joint

Propsed therapy: cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, relax hamstring, and increase proprioception of feet

Procedure: (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m. rectus femoris, and abductors + adductors; (4) sensory motor stimulation of feet (small foot exercise – passive and passive assisted); (5) CPM (continuous passive motion) device for 25 minutes at 87 degrees of flexion

Results of the therapy:

- Objective: improvement on the soft tissue mobilization and strengthening exercises, small foot exercise instructions in Czech language were made easier with my supervisor, activation of arch in both feet is weak

- Subjective: patient was confused with small foot exercise only in the beginning

Day 7

21.1.2021

Stp. Subj.: the patient is feeling better than the day before. The patient is happy due to removal of staples on the knee, as he experienced increased mobility in the knee on the CPM device.

Stup. Obj.: the patient is cooperative and in a good mood. A bandage is covered on the operated site after the removal of staples.

Goal of today's therapeutic unit:, improve mobility of the knee fasciae and joint

Propsed therapy: cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, relax hypertonic muscles, and increase proprioception of feet

Procedure: (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris, and abductors + adductors; (4) sensory motor stimulation of feet (small foot exercise – passive and passive assisted); (5) relaxation of biceps femoris (PIR); (6) CPM (continuous passive motion) device for 25 minutes at 90 degrees of flexion

Results of the therapy:

- Objective: improvement on the soft tissue mobilization and strengthening exercises, better joint play in the fibular head after relaxation of biceps femoris, activation of arches of both feet remains poor during small foot exercise

- Subjective: patient does not want small foot exercise

Day 8

22.1.2021

Stp. Subj.: the patient is feeling better than the day before.

Stup. Obj.: the patient is cooperative and in a good mood. A bandage on the operated site is removed and the patient is now able to lie on stomach and exercise.

Goal of today's therapeutic unit:, kinesiological examination, improve mobility of the knee fasciae and joint

Propsed therapy: kinesiological examination, cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, relax hypertonic muscles, and increase proprioception of feet

Procedure: (1) kinesiological examination (Janda's movement stereotype – hip abduction test) (2) application of ice pack; (3) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (4) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (5) hip abduction in side lying position and facilitation of m. gluteus maximus in prone (squeezing the buttocks, but light stimulation is added by scratching with fingers before and in the beginning of the contraction on the attachment points of right m. gluteus maximus, advised by supervisor); (6) CPM (continuous passive motion) device for 25 minutes at 95 degrees of flexion

Results of the therapy:

- Objective: during abduction in side lying position, the patient showed flexion and internal rotation of the hip which is tensor mechanism according to Janda's movement stereotype
- Subjective: abduction in side lying position is difficult for the patient

Day 9

25.1.2021

Stp. Subj.: the patient is feeling better than the day before. The patient feels tightness in the right Sartorius muscle.

Stup. Obj.: the patient is cooperative and in a good mood. Flares of the ribs (especially in the left) and diastasis are noticed while breathing. This indicates the need of examination of deep stabilization system.

Goal of today's therapeutic unit:, kinesiological examination, improve mobility of the knee fasciae and joint

Propsed therapy: kinesiological examination, cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, relax hypertonic muscles, and increase proprioception of feet

Procedure: (1) kinesiological examination (examination of deep stabilization system according to Kolar – extension test, trunk flexion test, and diaphragm test); (2) application of ice pack; (3) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (4) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (5) hip abduction in side lying position and facilitation of hip extensors in prone; (6) CPM (continuous passive motion) device for 25 minutes at 97 degrees of flexion

Results of the therapy:

- Objective:

Table 10) initial examination of deep stabilization system (Kolar, 2013)

Examination of deep stabilization system according to (Kolar, 2013)	Observation
Diaphragm test	Patient is able to make counter pressure symmetrically, but the recruitment of the left is slower Patient is not able to keep the ribs caudally There is a minimal expansion in the intercostal spaces
Trunk flexion test	There is arching of lateral abdominal muscles and diastasis is visible
Extension test	High activation of spinal extensors at

	the thoracolumbar junction Slight anteversion of pelvis is noticed
Hip flexion test	There is good counter resistance at the inguinal region Slight anteversion of pelvis is noted

- Subjective: abduction in side lying position is difficult for the patient

Day 10

26.1.2021

Stp. Subj.: the patient is feeling better than the day before.

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: improve mobility of the knee fasciae and joint and improve deep stabilization system

Propsed therapy: cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, improve deep stabilization system (correction of breathing pattern)

Procedure: (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (4) hip abduction in side lying position and facilitation of hip extensors in prone; (5) correction of breathing pattern (the patient was in 3 months position of an infant in prone with hip and knee at 90 degrees rested on a large gymball, an overball was placed on his abdomen to control inhalation and exhalation, additionally, Kolar's improvement of chest wall dynamics was used to manually hold ribs in expiratory position); (6) CPM (continuous passive motion) device for 25 minutes at 100 degrees of flexion

<u>Results of the therapy:</u>

- Objective: manually pushing the ribs caudally was gentle
- Subjective: patient was confused with when to breathe out and in

Day 11

27.1.2021

Stp. Subj.: the patient is feeling better than the day before. Patient expressed tightness on the medial aspect of the tight down to the medial aspect of the knee

Stup. Obj.: the patient is cooperative and in a good mood

<u>Goal of today's therapeutic unit:</u> improve mobility of the knee fasciae and joint and improve deep stabilization system

<u>Propsed therapy:</u> cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, relaxation of hypertonic muscles, improve deep stabilization system (correction of breathing pattern)

<u>Procedure:</u> (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (4) hip abduction in side lying position and facilitation of hip extensors in prone; (5) correction of breathing pattern (the patient was in 3 months position of an infant in prone with hip and knee at 90 degrees rested on a large gymball, an overball was placed on his abdomen to control inhalation and

exhalation, additionally, Kolar's improvement of chest wall dynamics was used to manually hold ribs in expiratory position); (6) relaxation of adductors and m. Sartorius with PIR (PIR on muscle Sartorius was done under supervision); (7) CPM (continuous passive motion) device for 25 minutes at 102 degrees of flexion

Results of the therapy:

- Objective: The patient well adopted to the newly introduced breathing pattern, but from time to time returns to his own pattern, flexion of the knee in prone is becoming larger, PIR on both hip adductors and Sartorius muscle was performed without pain and any rotation in the knee joint

- Subjective: patient is not very confident during breathing exercise, feels release in the medial aspect of the thigh after relaxing the hip adductors and Sartorius muscle, but feel tightness in the lateral aspect of the thigh immediately.

Day 12

28.1.2021

Stp. Subj.: the patient is feeling better than the day before.

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: improve mobility of the knee fasciae and joint and improve deep stabilization system

Propsed therapy: cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, relaxation of hypertonic muscles, improve deep stabilization system (correction of breathing pattern)

Procedure: (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings +

m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (4) hip abduction in side lying position and facilitation of hip extensors in prone; (5) correction of breathing pattern (the patient was in 3 months position of an infant in prone with hip and knee at 90 degrees rested on a large gymball, an overball was placed on his abdomen to control inhalation and exhalation, additionally, Kolar's improvement of chest wall dynamics was used to manually hold ribs in expiratory position); (6) relaxation of abductors with PIR*; (7) CPM (continuous passive motion) device for 25 minutes at 105 degrees of flexion

*PIR of abductors was slightly modified from lewit, the patient's leg was not completely outside of the table… in this case, there is only minimal relaxation effect on m. quadratus lumborum

Results of the therapy:

- Objective: the hip abduction is getting better, flexion of the knee in prone is becoming larger, PIR on hip abductor was performed without pain
- Subjective: patient feels release in the lateral aspect of the thigh.

Day 13

29.1.2021

Stp. Subj.: the patient is feeling better than the day before. Expressed tightness in the medial aspect of the thigh and quadriceps

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: improve mobility of the knee fasciae and joint and improve deep stabilization system

Propsed therapy: cryotherapy (ice pack), stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, relaxation of hypertonic muscles, improve deep stabilization system (correction of breathing pattern)

Procedure: (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (4) hip abduction in side lying position and facilitation of hip extensors in prone; (5) correction of breathing pattern (the patient was in 3 months position of an infant in prone with hip and knee at 90 degrees rested on a large gymball, an overball was placed on his abdomen to control inhalation and exhalation, additionally, Kolar's improvement of chest wall dynamics was used to manually hold ribs in expiratory position); (6) relaxation of quadriceps with PIR (advised by supervisor); (7) CPM (continuous passive motion) device for 25 minutes at 107 degrees of flexion

Results of the therapy:

- Objective: abdominal breathing present (however, the manual control of ribs in caudal position is needed), flexion of the knee in prone is becoming larger, extension to 0 degrees, PIR on m. quadriceps femoris was performed without pain

- Subjective: patient feels release in the ventral aspect of the thigh.

Day 14

1.2.2021

Stp. Subj.: the patient is feeling better than the day before.

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: improve mobility of the knee fasciae and joint and improve deep stabilization system, introduction for self-relaxation of hypertonic muscles

Propsed therapy: cryotherapy (ice pack), to emphasize the need of drinking at least 2 liters of water a day, stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, relaxation of hypertonic muscles, improve deep stabilization system (correction of breathing pattern)

Procedure: (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (4) hip abduction in side lying position and facilitation of hip extensors in prone; (5) correction of breathing pattern (the patient was in 3 months position of an infant in prone with hip and knee at 90 degrees rested on a large gymball, an overball was placed on his abdomen to control inhalation and exhalation, additionally, Kolar's improvement of chest wall dynamics was used to manually hold ribs in expiratory position); (6) self-relaxation of quadriceps with PIR (advised by supervisor); (7) gait training on stairs with crutches; (8) CPM (continuous passive motion) device for 25 minutes at 110 degrees of flexion

Results of the therapy:

- Objective: the patient already knew gait on stairs with crutch (left hip replacement in 2018)
- Subjective: patient is confident with self-PIR on m. quadriceps femoris.

Day 15

2.2.2021

Stp. Subj.: the patient is feeling better than the day before. Is happy to go home the next day with his daughter.

Stup. Obj.: the patient is cooperative and in a good mood

Goal of today's therapeutic unit: kinesiological examination, to improve mobility of the knee fasciae and joint and improve deep stabilization system, introduction for self-relaxation of hypertonic muscles

Propsed therapy: kinesiological examination (final examination), cryotherapy (ice pack), to make a promise he will drink at least 2 liters of water every day, stretch to release soft tissues, strengthen the weakened muscles, restore pelvic stabilizers, self-relaxation of hypertonic muscles, improve deep stabilization system (correction of breathing pattern)

Procedure: (1) application of ice pack; (2) S and C curve on scar and stretching of fasciae above the knee in longitudinal and vertical directions; (3) 10 x hold isometric contractions of knee flexors and knee extensors, gluteal muscles, and adductors for 5 seconds, 10 x isotonic contractions in plantar/dorsiflexion at the ankle, hamstrings + m.rectus femoris in supine and in side lying position (with a pillow between both knees – open chain), and abductors + adductors; (4) hip abduction in side lying position and facilitation of hip extensors in prone; (5) correction of breathing pattern (the patient was in 3 months position of an infant in prone with hip and knee at 90 degrees rested on a large gymball, an overball was placed on his abdomen to control inhalation and exhalation, additionally, Kolar's improvement of chest wall dynamics was used to manually hold ribs in expiratory position); (6) self-relaxation of quadriceps with PIR (advised by supervisor); (7) gait training on stairs with crutches; (8) CPM (continuous passive motion) device for 25 minutes at 110 degrees of flexion

Results of the therapy:

- Objective: the patient already knew gait on stairs with crutch (left hip replacement in 2018)
- Subjective: patient is confident with self-PIR on m. quadriceps femoris.

Results of the therapy

- Objective: gait training on stairs with crutches were well performed, but for few steps, when going up the stairs, he rushes and takes up the crutches with the unhealthy leg.

- Subjective: patient is sure of self-PIR on m. quadriceps femoris, promises he will wait with crutches until he has landed his unhealthy leg next to the healthy leg when going up the stairs.

3.6 FINAL KINESIOLOGICAL EXAMINATION

Postural examination

- Posterior view
  - Base of support not wide nor narrow
  - Right foot is only slightly more forward than the left
  - Contour of calves not visible due to bandages
  - Higher popliteal line on the left
  - Higher tonus on the left thigh
  - Gluteal line is higher on the left
  - Pelvis shifted to the left (higher on the left)
  - Higher tonus of left spinal extensors (thoracolumbar region more significant)
  - Lower inferior scaulpar angle on the right
  - Shoulder is elevated on the right
  - Torso is turned/rotated to the left
  - Head is turned to the left
- Lateral view (left)

- Base of support is slightly more on the toes and lateral arch rather than on the heel
- Knee is only slightly flexed
- Hip is slightly flexed
- Pelvic anteversion
- Elbow is slightly flexed
- Shoulder is protracted
- Head is protracted

■ Anterior view

- Base of support not wide nor narrow
- Right foot is only slightly placed more forward
- Left foot deviates more laterally
- Left knee is higher
- Pelvis shifts to the left and
- Left side of the pelvis more protracted (as in turned to the left)
- Left rib visibly protracted compared to the right
- Right nipple higher
- Right shoulder higher
- Clavicle symmetrical

- Head is turned to the left

■ Lateral view (right)

- Base of support is more on the toes than on the heel and lateral arch
- Knee is flexed
- Hip is flexed
- Pelvic anteversion
- Abdominal muscle on the left is contracted(?/held inside, as in concave)
- Shoulder is protracted
- Head is protracted

Table 11) Final circumference measurements

	Left	Right
Knee joint	40cm	45cm
Vastus medialis	43cm	47cm
Quadriceps	46cm	49cm

Table 12) Final range of motion of the knee

	Left	Right
Active	S: 0-0-120	S: 0-0-95
Passive	S:5-0-125	S:0-0-100

Table 13) Final aspection of the knee

	Left	Right

Color of skin		Not red
Sign of infection (abnormal redness, pus, or swelling)		None
Position		The knee is slightly flexed.
Size and shape		Swelling has decreased
Temperature		Decreased
Scar		Stitches removed

Superficial sensation on the knee

- Light touch on both lower extremities was done.
- Sensation around the scar on the place of knee replacement has improved.
- Normal sensation of the left knee was reported.

Scar examination

- Restriction of the soft tissue around the scar has decreased especially on the cranial part.
- The movement in the cranial part of the scar is free.
- The movement in the distal part of the scar is slightly restricted.

Table 14) Final muscle length test

	Left	Right
Hamstrings (according to kendall)	80 degrees	80 degrees
Hip flexors (according to supervisor – with tested leg out of the bed, patient in	Slight shortness in the two joint muscles.	Slight shortness in the two joint muscles

supine)		
Triceps surae (according to janda) - Gastrocnemius (fully extended knee) - Soleus (slightly flexed knee)	Grade 0 for both gastrocnemius and soleus	Grade 0 for both gastrocnemius and soleus
Pectoralis minor (according to Kendall)	Grade 2	Grade 2

Table 15) Final muscle strength test according to Janda

	Left	Right
Quadriceps femoris	Grade 5	Grade 4
Hip adductors	Grade 5	Grade 4
Tensor fasciae latae	Grade 5	Grade 4
Hip abductors	Grade 5	Grade 4
Gastronemius	Grade 5	Grade 4
Iliopsoas	Grade 4	Grade 4
Gluteus maximus	Grade 4	Grade 4

Table 16) Final palpation of tonus

	Left	Right
Vastus medialis	Normal	Slightly hypotonic
Rectus femoris	Normal	Normal
Hamstring (supine with leg rasied up and the heel rested on overball)	Normal	Normal
Iliacus	Slightly hypertonic	Normal
Gluteus maximus	Normal	Slightly hypotonic

Pelvic examination

- Pelvic obliquity (deviates to the left/higher on the left)
- Anteversion
- Rotated to the left
- Left anterior superior iliac spine lower
- Left posterior superior iliac spine higher

Gait examination

- 3 point gait with French crutches; 50% of weight-bearing was permitted in the operated leg
- Slight antalgic gait pattern
- Rhythm of each strike fairly identical
- Improved strike length in the right knee
- Visibly increased extension and flexion in the right hip
- Trunk is still leaning forward

Table 17) Final fascia shifting examination (Lewit, 2010)

Fasciae around the knee joint	Free	Moderately free
Fasciae of the thight	Free	Free
Fasciae of the calf	Free	Moderately fee

Breathing patterns

- Ribs are in moderate inspiratory position
- The involvement of abdomen while breathing is satisfactory.

3.7 EVALUATION OF THE EFFECT OF THE THERAPY

The patient has taken all the therapeutic sessions aimed at improving function of knee joint after total knee replacement without any complication or pain. The patient cooperated well and followed all instructions without complaining expect for proprioception training (small foot exercise).

Factors limiting the range of motion in the knee joint including swelling, scar, and tight fasciae and muscles were successfully improved. The patient showed an increase in both active and passive flexion of the knee. Extension as well improved to reach 0 degrees.

General strength and length of muscles improved. Notable increase in the length was at the right hamstring, where flexion at the hip joint reached 80 degrees from 50.

Breathing exercises were very effective in correcting the pattern to abdominal breathing. However, pushing the ribs down during breathing exercises in an attempt to fix rib flare was not successful to treat the left rib flare.

4 CONCLUCSION

The subject patient was diagnosed with gonarthrosis and was treated with total knee replacement. The patient's rehabilitation program for 15 days and it was a success in improving function of the new joint and the muscles around the knee joint. The patient was dependent to some extent. However, at the end of the therapeutic sessions, he was able to move independently in bed, corridor, and in the stairs with crutches. It was evident that independent life back at home was possible before leaving the care.

This study case has enabled full use of knowledge gained during 4 years of study of physiotherapy. I would like to thank supervisor at Malvazinky Rehabilitation Clinic for helping and leading me throughout the work placement.

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6 SUPPLEMENTS

6.2 List of Figures

6.3 List of tables

6.4 Ethical approval

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

Application for Approval by UK FTVS Ethics Committee

of a research project, thesis, dissertation or seminar work involving human subjects

The title of a project: Case study of physiotherapy treatment of a patient with total knee replacement

Project form: bachelor thesis

Period of realization of the project: January 2021 – February 2021

Applicant: Wonjun Lee, department of physiotherapy, UK FTVS

Main researcher: Wonjun Lee, department of physiotherapy, UK FTVS

Workplace: Rehabilitacni klinika Malvazinky

Supervisor: PhDr. Tereza Novakova, PhD.

Project description: This project is a case study of a patient after a total knee replacement at inpatient department at a rehabilitation clinic. The aim of this project is to evaluate the researcher's use of theoretical knowledge regarding human knee anatomy, kinesiology, diseases, and relevant physiotherapeutic treatment methods during clinical practices to help achieve full function of the artificial knee joint of the patient. Observations/inspections and recordings of improvement in general condition of the replaced knee joint including the range of motion, level of swelling, pain, scar formation, gait, and etc. will be carried out for this study.
Characteristics of participants in the research: One patient, 78 years old, diagnosis of gonarthrosis.
Ensuring safety within the research: Non-invasive methods are used under supervised cooperation with an experienced physiotherapist at the rehabilitation clinic Malvazinky to minimize risks of planned therapeutic methods. Risks of therapy and methods will not be higher than the commonly anticipated risks for this type of therapy.
Ethical aspects of the research: The collected data will be anonymized within one week after the end of working with the patient. I understand that anonymization means that the text does not use any item of information or combination of items that could lead to the identification of a person. I will be careful not to enable recognition of a person in the text of the thesis, especially within the anamnesis. After the text has been anonymized, any personal data still kept elsewhere will be deleted.
Photographs of the participant will be anonymized within one week after being taken by blurring the face, parts of the body or any characteristics that could lead to identification of the person. After anonymization any non-anonymized photographs will be deleted.
All collected data will be safely stored on a PC safeguarded by a keyword in a locked room, any data in paper form will be kept safely under lock and key in a locked room. The data will be processed, safely retained and published in an anonymous way in the bachelor thesis.
I shall ensure to the maximum extent possible that the research data will not be misused.
Informed Consent: attached

It is the duty of **all participants of the research team** to protect life, health, dignity, integrity, the right to self-determination, privacy and protection of the personal data of all research subjects, and to undertake all possible precautions. Responsibility for the protection of all research subjects lies on the researcher(s) and not on the research subjects themselves, even if they gave their consent to participation in the research. All participants of the research team must take into consideration ethical, legal and regulative norms and standards of research involving human subjects applicable not only in the Czech Republic but also internationally.
I confirm that this project description corresponds to the plan of the project and, in case of any change, especially of the methods used in the project, I will inform the UK FTVS Ethics Committee, which may require a re-submission of the application form.
In Prague, 13.1.2021 Applicant's signature:

Approval of UK FTVS Ethics Committee

The Committee: Chair: doc. PhDr. Irena Parry Martínková, Ph.D.
Members: prof. PhDr. Pavel Slepička, DrSc.
prof. MUDr. Jan Heller, CSc.
PhDr. Pavel Hráský, Ph.D.
Mgr. Eva Prokešová, Ph.D.
Mgr. Tomáš Ruda, Ph.D.
MUDr. Simona Majorová

The research project was approved by UK FTVS Ethics Committee under the registration number: 048/2021

Date of approval: 16.1.2021

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

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

Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6
-70-

Stamp of UK FTVS

Signature of the Chair of
UK FTVS Ethics Committee

6.5 Sample informed consent form

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

INFORMOVANÝ SOUHLAS

Vážená paní, vážený pane,

v souladu se Všeobecnou deklarací lidských práv, nařízením Evropské Unie č. 2016/679 a zákonem č. 110/2019 Sb. – o zpracování osobních údajů, Helsinskou deklarací, přijatou 18. Světovým zdravotnickým shromážděním v roce 1964 ve znění pozdějších změn (Fortaleza, Brazílie, 2013) a dalšími obecně závaznými právními předpisy Vás žádám o souhlas s prezentováním a uveřejněním výsledků vyšetření a průběhu terapie prováděné v rámci praxe na ………………………………………………, kde Vás příslušně kvalifikovaná osoba seznámila s Vaším vyšetřením a následnou terapií. Výsledky Vašeho vyšetření a průběh Vaší terapie bude publikován v rámci bakalářské práce na UK FTVS, s názvem ……………………

Cílem této bakalářské práce je ……………………………………………………………………………………………

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

Jméno a příjmení řešitele ……………………………………………………………… Podpis:……………………

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

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

Místo, datum ………………

Jméno a příjmení pacienta ……………………………………… Podpis pacienta: ……………………………

Jméno a příjmení zákonného zástupce ………………………………………

Vztah zákonného zástupce k pacientovi ……………………………… Podpis: ……………………………