Charles University

Faculty of Physical Education and Sports

Physiotherapy Department

Physiotherapy Rehabilitation After Total Hip Replacement

Bachelor Thesis

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Abstract

Title: Physiotherapy Rehabilitation After Total Hip Replacement.

Thesis aim: Application of comprehensive theoretical findings of the hip joint, coxarthrosis, and training of practical knowledge related to total hip replacement diagnosis and following physiotherapeutic rehabilitation care.

Clinical findings: A 59 years old male patient after total hip replacement surgery with swollen upper thigh, reduced ROM at left hip joint for abduction and extension and at the left knee joint in flexion and decreased muscle strength in the left lower extremity but overall no serious complications.

Summary: The thesis includes two main sections. The first section is theoretical, consisting of a brief overview of hip joint anatomy, biomechanics, kinesiology besides coxarthrosis as disease and its prevention, total hip replacement surgery clinical view also its approaches, and rehabilitation protocol for total hip replacement including all surgical care phases. The second section consists of a description related to the patient case study, which contains a detailed initial kinesiological examination, therapies that were applied, final kinesiological examination, and the outcome of applied therapies.

Keywords: Coxarthrosis, Osteoarthritis, Total hip replacement, Hip arthroplasty, Rehabilitation, Physiotherapy

Abstrakt

Název: Rehabilitace fyzioterapie po totální náhradě kyčle.

Cíl disertační práce: Aplikace komplexních teoretických poznatků o kyčelním kloubu, koxartróze a procvičení praktických znalostí souvisejících s diagnostikou totální artroplastiky kyčelního kloubu a následnou fyzioterapeutickou rehabilitační péčí.

Klinické nálezy: 59letý muž po operaci totální náhrady kyčle s oteklou nohou, sníženou ROM v levém kyčelním kloubu pro únos a extenzi a v levém kolenním kloubu při flexi a sníženou svalovou silou v levé dolní končetině, ale celkově bez závažných komplikací.

Shrnutí: Diplomová práce zahrnuje dvě hlavní části. První část je teoretická, sestává ze stručného přehledu anatomie kyčelního kloubu, biomechaniky, kineziologie kromě koxartrózy jako nemoci a její prevence, klinického pohledu na chirurgický zákrok náhrady kyčelního kloubu i jeho přístupů a rehabilitačního protokolu pro totální kyčel výměna včetně všech fází chirurgické péče. Druhá část sestává z popisu souvisejícího s případovou studií pacienta, který obsahuje podrobné počáteční kineziologické vyšetření, použité terapie, závěrečné kineziologické vyšetření a výsledek aplikovaných terapií.

Klíčová slova: Koxartróza, Osteoartróza, Totální náhrada kyčelního kloubu, Artroplastika kyčelního kloubu,, Rehabilitace, Fyzioterapie

Declaration

I declare that this thesis has been composed solely by myself, and it hasn't been submitted in a whole or in part in any previous application for a degree, except where states otherwise by citation or acknowledgments. I asserts that all the existing examinations and therapeutic procedures were based on my knowledge that I acquired during my studies in UK FTVS.

I declare that no invasive methods were used, and the patient was aware and informed about all the performed procedures.

Maie Alabed

Prague, 2021

Acknowledgment

Foremost, I would like to express my sincere gratitude to my supervisor Mgr. Michaela Stupková for the continuous support and guidance throughout writing this dissertation.

I would like to extend my sincere thanks to all my professors at UK FTVS in Prague for the knowledge and support they provided throughout my studies.

Finally, I have to thank my father for his love, support throughout my life

And for giving me an opportunity to study at Charles University in Prague.

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1 Introduction

The thesis aims for a better understanding of rehabilitation care provided by a physiotherapist after total hip replacement and summarized illustration of anatomy of the hip joint and hip osteoarthritis. The contents of my thesis are divided into two main parts, with the first being (The general part) and the second main part is (The special part).

The General Part contains anatomical explanation of the hip joint and its biomechanics. Brief chapter concerning hip osteoarthritis, total hip replacement common surgical approaches, and rehabilitation procedures for patients before and after total hip replacement.

The Special Part comprises a particularised case study based on the clinical placement which was carried out at Centrum léčby pohybového aparátu (CLPA) in Prague, Czech Republic, during the period 11th January 2021 to 5th February 2021 of a patient after a total hip replacement due to coxarthrosis and he is receiving rehabilitation care. The case study includes the complete medical history of the patient and an initial kinesiological analysis which was performed on the patient followed by establishing rehabilitation short-term goals and long-term goals. Detailed therapy progress and therapy procedure have been documented as part of the case study. Subsequently, as all the therapy sessions were completed, a final kinesiological examination was done to evaluate the effects of the applied therapy on the patient.

I was educated on all the performed physiotherapy procedures during the work placement during my bachelor's studies in physiotherapy at the Faculty of Physical Education and Sport of Charles University, Prague, Czech Republic. No invasive methods were employed.

2 General Part

2.1 Anatomy of hip joint

The hip joint is a ball and socket synovial joint that consists of the articulation between the head of the femur and the acetabulum of the pelvis. It meets the four characteristics of a synovial or diarthrodial joint: it has a joint cavity; joint surfaces are covered with articular cartilage; it has a synovial membrane producing synovial fluid, and it is surrounded by a ligamentous capsule with its inherent stability dictated primarily by its osseous components/articulations [1]. The primary function of the hip joint is to provide dynamic support to the weight of the trunk while facilitating force and load transmission from the axial skeleton to the lower extremities, allowing for ambulatory and mobility functions. Allows for movement in three major axes, all of which are perpendicular to one another. The center of the entire axis is located at the femoral head. The transverse axis permits flexion and extension movement. The longitudinal axis, or vertically along the thigh, allows for internal and external rotation. The sagittal axis, or forward to backward, allows for abduction and adduction movements [2].

2.1.1 Osteology

The cup-shaped acetabulum is formed by contributions from the ilium (approximately 40% of the acetabulum), ischium (40%), and the pubis (20%) [3]. These three bones are separated by the triradiate cartilage, in the skeletally immature a fusion of triradiate cartilage starts to occur around the age of 14 – 16 years and is complete usually by the age of 23 [4]. The actual articular surface appears lunate shaped when viewed observing into the acetabulum. The central inferior acetabular fossa which is a fat-filled space that accommodates a synovial covered fat pad and also contain the acetabular attachment of the ligamentum teres Fig. (1). Attached to the rim of the acetabulum is the fibrocartilaginous labrum which has less of a contribution to joint stability compared to the glenoid labrum in the shoulder. It has an important role in distribution of forces around the joint and physiological joint development [5, 9]. It has been also suggested that it plays a role in helping exert a negative pressure effect within the hip joint by restricting the movement of synovial fluid to the peripheral compartment of the hip [6,11]. The femoral head is covered with corresponding articular cartilage regardless the ability of the acetabular brim to accommodate the full range of motion. The covered region forms approximately 60 to 70%.

The fovea capitis is the uncovered part on the central area of the femoral head for the femoral insertion of the ligamentum teres that contains an important blood supply but does not contribute in joint stability [6].

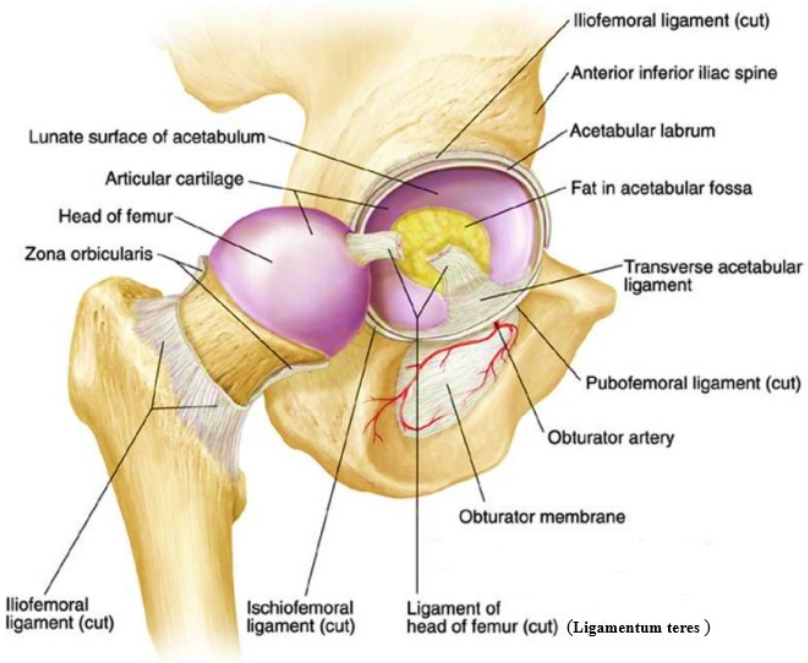

Figure 1 The articulating surfaces of the hip joint – pelvic acetabulum and head of the femur.

The head of the femur is attached to the femoral shaft by the femoral neck, that differ in length depending on body size. In the normal adult, the neck-shaft angle is usually 125±5°, coxa valga is the condition when this value exceeds 130° and when the inclination is less than 120° the condition is coxa vara . This feature is important for facilitating freedom of joint motion when the femoral shaft is laterally displaced from the pelvis. The lever arms used to generate motion by the abductor muscles will either be inadequate or too large if there is significant deviation in angle outward this distinctive range. The neck-shaft angle decreases progressively as a result of remodeling of bone in response to stress patterns changing from 150° after birth to 125° in the adult [7]. The femoral neck rotated slightly anterior to the coronal plane in the normal person. Femoral anteversion is referred to as medial rotation, anteversion angle is measured as the angle between a mediolateral line through the knee and a line through the femoral head and shaft. For femoral anteversion the common range is from 15° to 20° [8].

2.1.2 Ligaments and Capsular Anatomy

The joint capsule is firm. While the ball and deep socket configuration gives naturally the hip great stability ,and the capsular ligaments (iliofemoral, ischiofemoral, and pubofemoral) serve a fundamental role in balancing functional mobility and joint stability Fig(2).

The iliofemoral ligament is anteriorly to the hip in the form of an inverted 'Y.'. It extends from proximal attachment to the ilium to insert along the intertrochanteric line. It keeps the pelvis from tilting posteriorly in upright stance and limiting adduction of the extended lower limb because the iliofemoral ligament is taut in extension and relaxed in flexion. Being the strongest ligament in the body, with a tensile strength greater than 350N [10].

The pubofemoral ligament is located inferiorly and posteriorly blending into its medial edge to the iliofemoral ligament. It spans from its proximal attachment at the obturator crest and superior pubic ramus to the intertrochanteric fossa. The pubofemoral ligament mergers with the inferior band of fibers of the iliofemoral ligament at the attachment site on the lesser trochanter, distally at the femoral attachment. It shows laxity when the hip is in an adducted position and maximal tautness in abduction [11].

The ischiofemoral ligament posteriorly concludes the main ligamentous constraints from its ischial attachment medially, it inserts medially to the base of the greater trochanter and laterally on superolateral aspect of the femoral neck. Due to the length and tautness of ischiofemoral ligament fibers with motion at the hip joint , the ligament has been suggested to restrict internal rotation in hip joint [11].The ligamentum teres has minimal contribution in the stability of the hip and in traumatic dislocations it can be torn but some propose that it enacts in joint nutrition [12].

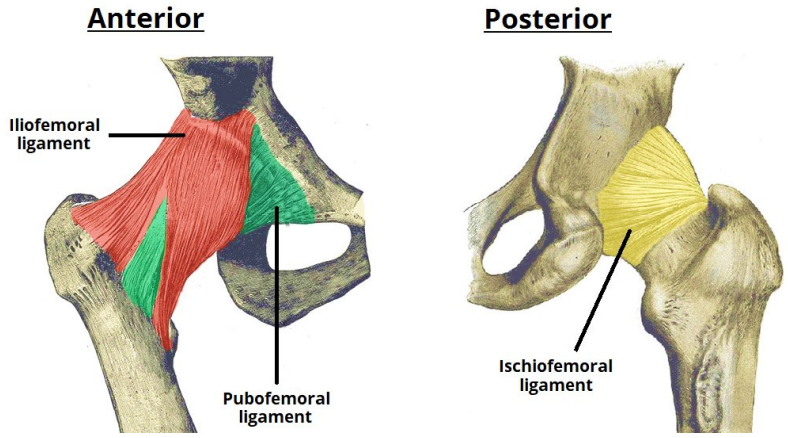

Figure 2 The extracapsular ligaments of the hip joint; iliofemoral, pubofemoral and ischiofemoral ligaments [15].

2.1.3 Neurovascular Anatomy

Hilton's law of innervation states, "The same trunks of nerves whose branches supply the groups of muscles moving a joint, furnish also a distribution of nerves to the skin over the insertion of the same muscles, and the interior of the joint receives its nerves from the same source." It is concurred that innervations to the hip joint are provided by the nerves which cross the joint and supply the hip joint musculature. The anterior region of the hip joint capsule is innervated by the femoral and obturator nerves, the femoral nerve contributing specifically to the anterior and anterolateral capsular regions [14]. The anteromedial aspects of the hip joint is innervated by the anterior and posterior divisions of the obturator nerve, and it has been observed to contribute branches to this region of the capsule. The posterior elements of the joint capsule receive innervation from the superior gluteal nerve, the nerve to the quadratus femoris, and direct branches from the sciatic nerve [13,14]. Also, the superior gluteal nerve accompanying, the inferior gluteal nerve supply both gluteus medius and minimus while running in a posterior to anterior direction between them. This consists of the ascending branch of the first perforating artery, branches of the medial and lateral circumflex femoral arteries, and the descending branch of the inferior gluteal artery which originates from the lumbosacral plexus also and exits the pelvis under the inguinal ligament near to the ASIS [14]. Along the intertrochanteric line the lateral circumflex femoral artery runs after arising from the deep femoral artery.Fig.3 [15]

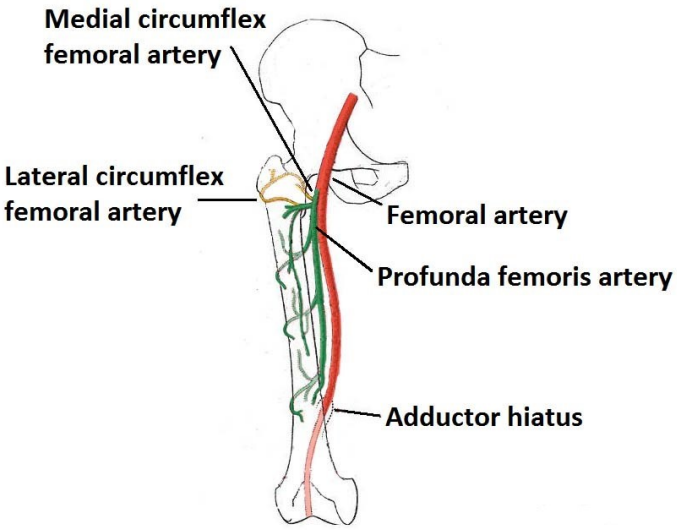

Figure 3 The medial and lateral circumflex femoral arteries are the major blood supply to the hip [15].

2.1.4 Muscular Anatomy

The configuration of the hip allows rotational motions in all directions, requiring many controlling muscles arising from a wide surface area to provide adequate stability. The 22 muscles acting on the hip joint contribute to provide the forces required for movement of the and also contribute in hip stability [16].

Action	Muscle	Origin	Insertion	Innervation
Flexion	Iliopsoas (iliacus, psoas major, psoas minor)	T12-L5 transverse processes, iliac crest, and sacrum	Lesser trochanter	Femoral nerve
	Rectus femoris	AIIS and anterosuperior acetabulum	Superior patella	Femoral nerve (L2-L4)
	Tensor fascia latae	ASIS and iliac crest	Iliotibial tract	Superior gluteal nerve (L4, L5)
	Sartorius	ASIS	Anteromedial tibial plateau	Femoral nerve (L2, L3)
Extension	Gluteus maximus	Outer cortex of ilium, posterior sacrum and coccyx	Posterior iliotibial tract and gluteal tuberosity	Inferior gluteal nerve (L5, S1, S2)
	Biceps femoris	Ischial tuberosity	Fibular head and posterolateral tibial plateau	Tibial branch of sciatic nerve (L5, S1, S2)
	Semimembranosus	Ischial tuberosity	Posteromedial tibial plateau	Tibial branch of sciatic nerve (L5, S1, S2)
	Semitendinosus	Ischial tuberosity	Anteromedial tibial plateau	Tibial branch of sciatic nerve (L5, S1, S2)
Abduction	Gluteus medius	Anterior gluteal line	Lateral surface of greater trochanter	Superior gluteal nerve (L4, L5, S1)
	Gluteus minimus	Outer cortex of ilium	Anterior surface of greater trochanter	Superior gluteal nerve (L5, S1)
	Tensor fascia latae	ASIS and iliac crest	Iliotibial tract	Superior gluteal nerve (L4, L5)

Adduction	Adductor magnus	Inferior pubic ramus, ischial tuberosity	Gluteal tuberosity and adductor tubercle of medial femur	Obturator nerve (L2, L3) and sciatic nerve (L2-L4)
	Adductor longus	Body of pubis	Middle third of linea aspera	Obturator nerve (L2-L4)
	Adductor brevis	Inferior ramus and body of pubis	Proximal linea aspera and pectineal line	Obturator nerve (L2-L4)
Internal Rotation	Gluteus medius	Anterior gluteal line	Lateral surface of greater trochanter	Superior gluteal nerve (L4, L5, S1)
	Gluteus minimus	Outer cortex of ilium	Anterior surface of grater trochanter	Superior gluteal nerve (L5, S1)
	Tensor fascia latae	ASIS and iliac crest	Iliotibial tract	Superior gluteal nerve (L4, L5)
External Rotation	Obturator internus	Inner surface of obturator membrane	Medial greater trochanter	Nerve to obturator internus (L5, S1)
	Obturator externus	Outer surface of obturator membrane, pubic ramus, and ischium	Trochanteric fossa	Obturator nerve (L3, L4)
	Superior gemellus	Ischial spine	Posterior greater trochanter	Nerve to obturator internus (L5, S1)
	Inferior gemellus	Ischial tuberosity	Posterior greater trochanter	Nerve to quadratus femoris
	Piriformis	Anterior surface of the sacrum and sacrotuberous ligament	Posterosuperior greater trochanter	Ventral rami of S1 and S2
	Quadratus femoris	Lateral border of ischial tuberosity	Quadrate tubercle	Nerve to quadratus femoris

Table 1 : Muscles of the hip joint: their origin, insertion, and innervation [16].

2.2 Biomechanics of hip joint

Biomechanics of the hip joint includes solid biomechanics, kinematics, and kinetics. Solid mechanics describes the mechanical properties of living organisms, including the transmission of forces and tribology between joint surfaces. Kinematics mainly describes the movement, coordination, and control of the musculoskeletal system. Kinetics defines the progression of living organisms and their condition of force to understand the joint stability, coordination, fracture healing, gait, and other changes [17].

2.2.1 Solid biomechanics

The ball-and-socket configuration of the hip joint is the main assurance for its inherent stability. In daily activities, the hip joint is influenced by compressive stress, tensile stress, shear stress, moment, and friction. Once it's loaded, the force on the sacrum transmits through the hip joint to the femoral neck and then to the lower limb. Attributable to the neck shaft angle, the route of resultant force on femoral neck is not in line with femoral neck axis, causes the compressive stress to be always greater than the tensile stress. The hip joint capsule is thick and can prevent the dislocation of the hip joint during excessive activity. The three ligaments on the capsule form a complex ligament system to maintain hip stability , as iliofemoral ligament, limits hip hyperextension and internal rotation while pubofemoral ligament limits the hip abduction and external rotation and ischiofemoral ligament when the hip flexes it limits the internal rotation and adduction [17].

2.2.2 Kinematics

The hip joint is capable to perform multiaxial movement placed around the femoral head in three axes perpendicular to each other .The line connecting the centers of the bilateral femoral heads is horizontal axis, the movement around is the flexion and extension; the line through the anterior–posterior direction of the femoral head is sagittal axis, the movement around is adduction and abduction. The line connecting the center of the hip and knee joint is the mechanical axis, or rotation axis, the movement around is an internal and external rotation. The highest movement of the normal hip joint is on the sagittal axis, with 0–140 ° flexion and 0–15 °extension. The other ranges of motions are 0–45 ° abduction and 0–30 ° adduction, 0–45 ° external rotation, and 0–50 ° internal rotation when the hip flexes. All of hip joint movements are restricted by bony structures and joint capsules [18].

2.2.2.1 Femoral-on-pelvic osteokinematics

- Rotation of the Femur in the Sagittal Plane

Full hip flexion loosens the three main capsular ligaments but stretches the inferior capsule and muscles (ex. gluteus maximus). Hip flexion is typically limited to 70° to 80° , when the knee is fully extended due to the increased tension in the hamstring muscles. Significant variability can be projected in this movement as a consequence of high intersubjective flexibility in hamstring muscle [44].

The hip extends normally about 20° beyond the neutral position. The passive tension all over the capsular ligaments increases while full hip extension especially the hip flexor muscles and the iliofemoral ligament. Passive tension in the stretched rectus femoris, which spans across both the hip and the knee, reduces hip extension to about the neutral position while the knee is fully flexed during hip extension [44].

- Rotation of the Femur in the Frontal Plane

The hip abducts typically about 40°, It can be restricted primarily by the pubofemoral ligament and the adductor muscles. The hip adducts beyond the neutral position about 25°. In addition to interfering with the contralateral extremity, passive tension in stretched hip abductor muscles, iliotibial tract, and superior fibers of the ischiofemoral ligament limit full adduction [18][46].

- Rotation of the Femur in the Horizontal Plane

The degree of internal and external rotation of the hip is different among subjects. On average, the hip internally rotates from the neutral position about 35°. when the hip is extended, maximal internal rotation stretches the external rotator muscles, such as piriformis muscle, and some parts of the ischiofemoral ligament [45].

The extended hip externally rotates on average about 45°. Extreme tightness in the lateral fiber bundle of the iliofemoral ligament will lead to limitation in external rotation. Moreover, excessive tension in any internal rotator muscle can limit external rotation [44].

2.2.2.2 Pelvic -on- femoral osteokinematics

- Pelvic Rotation in the Sagittal Plane: Anterior and Posterior Pelvic Tilting

Hip flexion arises during an anterior pelvic tilt. The direction of the tilt is based on the direction of rotation of a point on the iliac crest, either anterior or posterior. The anterior tilt of the pelvis occurs around the mediallateral axis of rotation through both femoral heads. The tendency of the supralumbar trunk to follow the forward rotation of the pelvis is related to the

increase of lumbar lordosis. Whereas, the normal adult when sitting with 90° of hip flexion can achieve about 30° of additional pelvic-on-femoral hip flexion before its restricted by a fully extended lumbar spine. the iliofemoral ligament notably loosens during full anterior tilt of the pelvis as most the ligaments of the hip. Clear tightness in hip extensor muscles such as hamstrings could limit the excesses of anterior pelvic tilt [46].

The more elongated hamstrings are more about to resist an anterior pelvic tilt during standing (with knees fully extended), but the sum of resistance is usually insignificant unless the muscle is physiologically impaired and produce excessive resistance to elongation[46].

The hips can be extended about 10° to 20° from the 90° sitting position through a posterior tilt of the pelvis. During sitting, short-arc pelvic rotation would increase the length (and consequently tension) minimally in the iliofemoral ligament and rectus femoris muscle. As the pelvis posteriorly tilts the lumbar spine flattens or flexes [46].

- Pelvic Rotation in the Frontal Plane

Pelvic-on-femoral rotation in the frontal and horizontal planes is better described supposing a person is standing on one limb. The weight-bearing limb is mentioned as the support hip. By raising the iliac crest on the side of the non-support occurs abduction of the support hip. The lumbar spine should curve in the opposite direction of the rotating pelvis, if the supralumbar trunk remains nearly stationary. Within the lumbar area, to the side of abducting hip, a slight lateral convexity occurs [44].

Pelvic-on-femoral hip abduction is limited to about 30°, due to the natural limitation of lateral bending in the lumbar spine. Pelvic-on-femoral hip abduction can be limited due to the marked tightness in hip adductor muscles or the pubofemoral ligament. In case of a marked adductor contracture, the iliac crest on the nonsupport side of the hip remains lower than the iliac crest of the support hip, which could interfere with walking [46].

Adduction of the support hip happens by a lowering of the iliac crest on the side of the non-support hip. This movement results in a slight lateral concavity on the side of the adducted hip within the lumbar region. A hypomobile lumbar spine and/or decreased extensibility in the iliotibial tract or hip abductor muscles, such as the gluteus medius, tensor fasciae latae, or piriformis, may restrict or affect performing this motion [46].

- Pelvic Rotation in the Horizontal Plane

Pelvic-on-femoral rotation occurs in the horizontal plane about a longitudinal axis of rotation. Internal rotation of the support hip occurs when the iliac crest on the side of the non-support hip rotates anteriorly in the horizontal plane. On the contrary during external rotation, , the iliac crest on the side of the non-support hip rotates posteriorly in the horizontal plane. The lumbar spine must rotate (or minimally twist) in the opposite direction of the rotating pelvis only if the pelvis is rotating beneath a relatively fixed trunk [46] [47].

The minimal range of axial rotation normally permitted in the lumbar spine notably limit the full demonstration of horizontal plane rotation of the support hip. The complete potential of pelvic-on-femoral rotation necessitates that the lumbar spine and trunk follow the rotation of the pelvis , a movement plan which is more consistent with ipsidirectional lumbopelvic rhythm [47].

2.2.3 Kinetics of hip joint

The static loading of the hip joint has been frequently approximated with a reorganised, two-dimensional analysis performed within the frontal plane. Once the body weight is being held on both legs, the centre of gravity is focused between the two hips, and the force is exerted evenly on both hips. Under these loading conditions, the body weight minus the weight of both legs is evenly supported on the femoral heads, and the resultant vectors are vertical [19].

The actual centre of gravity in a single leg stance moves distally and away from the supporting leg since the non-supporting leg is being calculated as part of the body mass acting upon the weight-bearing hip. The muscles that resist this movement embraces the upper fibres of gluteus maximus, tensor fascia lata, piriformis, hamstrings, obturator internus, gluteus medius and minimus participate to maintain balance by improving stability at the knee and hip joints. The magnitude of the forces for single leg stance is three times bodyweight but it varies crucially on the lever arm ratio between the body weight moment arm and the abductor muscle moment arm. Therefore, increasing the lever arm ratio likewise increases the abductor muscle force mandatory for gait and subsequently the force on the head of the femur [20].

Forces acting on the hip joint will be significantly reduced by using a cane [21]. Standing up using a cane for support, does not eliminate the requirement of standing with the center of mass (COM) with the specificity of it being vertically aligned with the base of support. One should have the ability to maintain an upright posture when using a cane held in the hand of the non-stance side, and the COM kept over the wide base of support. The stance hip would be in alignment in a more direct way over the stance foot, and compared to while standing without a cane the moment arm of the ground reaction force (GRF) would be shorter [22]. The momentum caused by pull of the abductor muscles and the cane support produce a moment with the same magnitude but opposite to that generated by the effective body weight, besides the cane use on the non-stance side reduces the required force from the abductor muscles to around 50% of body weight [22]. The joint reaction forces can be reduced by 50%, when about 15% of the body weight is applied to the cane [21]. However holding a cane on the affected side for patients after hip replacement surgery would not reduce the gravitational torque of the upper body around the stance hip. Consequently, the pain reduction would be minimal around the hip implant in this position [23].

Holding the cane in a hand on the side of stance, the base of support might shift more laterally in the direction of the stance side and might become even more further from the hip

joint than the case where no cane is used. All of which might cause the individual to lean yet more laterally with the purpose of maintaining the vertical alignment which ensures that the COM is still over the base of support. The lean of the trunk would reduce the weight of HATL (Head, Arms, Trunk, and the opposite Lower extremity) which affects the adductor moment and the required pull moment of the abductor muscles may be reduced. Nevertheless, it requires more activity in the other body parts muscles, and leads to an increase in the load on the knee joints , the lumbar spine joints and other neighboring joints [22].

2.3 Hip Joint Osteoarthritis

Hip osteoarthritis, also knows as 'Coxarthrosis' is manifested as degeneration of the tissues of the hip joint, including hyaline cartilage, fibrocartilage, bone, and synovium. The hip is the second most commonly affected joint after the knee [24].

2.3.1 Epidemiology

Worldwide, osteoarthritis (OA) is estimated to be the fourth leading cause of disability, it's the precipitating diagnosis for more than 90% of the increasing number of total hip joint replacement operations being undertaken worldwide [25]. Dagenais et al. conducted a systematic review of the prevalence of radiological primary radiographic primary hip osteoarthritis [26]. The study was reviewed in many locations and the mean prevalence by location was much lower in Asia (1.4%) and Africa (2.8%) than it is in Europe (7.2%) and North America (10.1%). The prevalence of hip OA was lower in women (6.9%) than in men (8.5%). Prevalence of hip OA correlating sturdily and raising gradually with age and reached 14% in the 85-or-above age group [26].

2.3.2 Etiology and risk factors

OA is characterized by loss of structural integrity of cartilage lining the articular surface. Senescence of the chondrocytes within the matrix is evident within osteoarthritic cartilage and increases with age. A combination of decreased matrix synthesis, increased matrix degradation, and wear and tear of the weight bearing joints leads to irreparable destruction of the articular cartilage. Destructive processes lead to swelling, decreased shock absorbing properties (compliance), softening, fracturing, fibrillation, ulceration and ultimately erosion of the cartilage with exposure of the subchondral bone [27].

As the disease process, forces are transmitted to the subchondral bone leading to increased bone turnover with sclerosis and the formation of cysts and osteophytes. The bone overlying the cysts or areas of avascular necrosis might collapse causing flattening of the femoral head. This is associated with significant pain of sudden onset resulting in decreased use of the limb, loss of muscle bulk and strength around the joint allowing abnormal biomechanical forces through the joint and surrounding soft tissues and thus disrupting the joint organ as a whole [29]. The known causes of hip osteoarthritis include primary inflammatory arthritis, such as rheumatoid arthritis and ankylosing spondylitis; acromegaly and various other metabolic diseases; and anatomical deformities of the joint resulting from developmental disorders, such as congenital hip dysplasia, Perthes disease, and slipped capital

epiphysis [30]. However, some risk factors are modifiable (e.g., body mass, training patterns, lifestyle, hip positioning and loading) [30].

General risk factors include age, sex, and genetics [28]. Genes have been identified that are associated with both cartilage thickness and hip shape [29]. These genes are expressed in developing limb buds and in developing cartilage as well as being expressed in response to increased biomechanical loads. Thus, the genes associated with hip OA could affect either the hip shape or the cartilage microstructure [29].

2.3.3 Signs and symptoms

Patients with hip osteoarthritis classically develop pain over months to years rather than acutely. The pain is described at first as intermittent an achy groin pain, which gets worse at the end of the day, and/or within some related activity (predominantly when walking or climbing stairs). In all disease stages rest and night pain may feature, but as the disease progresses, the severity increases. hip osteoarthritis cases may be considered "severe" if symptoms are considerable obstruction to mobility and independence [31]. Muscle spasm found around the hip joint can promotes the joint deformity to set in. The limb could be shortened, and the thigh could be adducted, and. Typical examination findings for OA includes groin tenderness and decreased or painful movements [30]. The most sensitive single indicator of hip osteoarthritis is limitation of internal rotation [32].

2.3.4 Diagnosis and classification

Osteoarthritis can be classified into two categories primary osteoarthritis which is idiopathic and secondary osteoarthritis which is caused by an underlying disorder such as joint trauma, Wilson's disease, hemochromatosis, gout, and neuropathic arthropathies [49]. Hip OA frequently diagnosed upon clinical appearance, however imaging examinations can be suitable to both confirm a diagnosis and to monitor the disease progression. When confirmed the clinician performs a focused clinical examination of the affected hip. The examination contains an inspection and leg length assessment followed by comparison between the affected and opposite side, an evaluation of joint fixed position denoting deformity, and a gait assessment. To assess for tenderness or injuries, palpation of regional bony prominences and tendons. A neurovascular assessment of both lower limbs and range of motion of the affected hip joint should be performed with a comparison to the contralateral side [50].

In 1963, Kellgren described four grades for the radiologic assessment of hip OA based on the degree of joint space narrowing, osteophyte formation, arthritic changes affecting the bone margins, and gross deformity as the following [24] :

- Grade 1- (Doubtful OA) with possible joint space narrowing medially and subtle osteophyte formation around the femoral head.
- Grade 2 – (Mild OA) with definite joint space narrowing inferiorly with definite osteophyte formation and slight subchondral sclerosis.
- Grade 3 - (Moderate OA) with marked narrowing of the joint space, small osteophytes, some sclerosis and cyst formation, and deformity of the femoral head and acetabulum.
- Grade 4 – (Obliterated) joint space with features seen in grades 1 to 3, large osteophytes, and gross deformity of the femoral head and acetabulum.

Numerous other radiographic classification systems exist such as Croft's grade, minimal joint space, and the Tönnis classification [48]. A blood test usually confirms the diagnosis and to shows other inflammatory conditions such as rheumatoid arthritis. Among the most common laboratory examinations that are ordered when testing for hip OA includes complete blood count, erythrocyte sedimentation rate, C-reactive protein, rheumatoid factor, and cyclic citrullinated peptide antibody tests. Patients with marked radiographic changes may not essentially show severe associating clinical symptoms and vice versa [49].

2.3.5 Treatment

Hip joint OA extend over periods of a patient's life, patients with OA are expected to be treated with a number of different pharmaceutical and nonpharmaceutical interventions, often in combination [51].

- Nonpharmacologic treatments [52][51]
  - An exercise program that does not comprise high-impact activities frequently is advocated and is associated with pain reduction. Aquatic exercises improve function as well. Exercises that strengthen and stretch the muscles around the hip can support the hip joint and ease hip strain. Certain activities and exercise that can aggravate the hip joint should be recognized and avoided Activities that require twisting and bending at the hip such as

golf or high impact such as jogging which should be substituted with activities that put on less stress on the hip joint such as gentle yoga, cycling, or swimming. Manipulation and stretching should be considered as adjuncts to core treatments, particularly for hip OA.

- Physical therapy is the backbone of treatment in mild and early hip OA it is aimed for strengthening hip muscles and maintaining joint mobility. Physical therapy may provide little or no benefit, if provided during the later stages of hip OA.
- Transcutaneous electrical nerve stimulation is considered as an adjunct to core treatments for pain relief for patients with hip OA.
- Temperature extremes hot and cold treatments sometimes are effective pain relief modalities. Heat treatments enhance circulation and soothe stiff joints and tired muscles. Cold treatments slow circulation, reduce swelling, and alleviate acute pain. A patient may need to experiment and/or alternate use of heat and cold therapies to determine which is most effective.
- Proper Footwear and Bracing/Joint Supports/Insoles Patients should be educated about appropriate footwear that features shock absorbing properties to address lower limb.
- Assistive Devices including walking sticks, tap turners, canes, and other devices should be considered as adjuncts to core treatments for people with OA who have specific problems with activities of daily living.
- Patient education can help to incorporate multiple approaches into hip OA treatment and minimize risk factors.

➢ Pharmacologic Treatments [52]

- Acetaminophen is typically recommended as a first-line medication for OA. However, the role of acetaminophen for short-term relief of hip OA pain remains equivocal.
- Topical Nonsteroidal anti-inflammatory drugs (NSAIDs) may be considered as an adjunct therapy for pain in addition to core treatments. Acetaminophen and topical NSAIDs should be considered ahead of oral NSAIDs, cyclooxygenase 2 inhibitors, or opioids.

- Intra-Articular Injections corticosteroids; hyaluronic acids; and, relatively recently, platelet-rich plasma injections, are the most common modalities to treat pain associated with hip OA.

- Surgical Treatments [52]
    - Hip Arthroscopy primarily performed during early OA stages, provides temporary relief and is associated with a high conversion rate to THA (9.5%-50%).
    - Total Hip Arthroplasty surgical modality for patients with intractable pain, for those who have failed nonsurgical treatment, and with severe functional impairment.

2.4 Total hip arthroplasty

2.4.1 Indications and contraindications

Total hip arthroplasty (THA) designated for patients who have failed conservative treatment options for a deteriorated hip joint [37]. THA is primarily indicated for the patients who continue to have persistent, debilitating pain, a significant decrease in the activities of daily living, and some radiographic evidence (X-ray) of joint damage. The surgery relieves the pain and functional disability experienced by patients with moderate to severe arthritis of the hip, improving their quality of life [41].

THA contraindications include local hip infection or sepsis, ongoing systemic infection or bacteria and severe cases of vascular dysfunction [41].

2.4.2 Common surgical approaches

2.4.2.1 Anterior approach

The patient positioned supine on a specialized traction table. Both feet are firmly secured to boots attached to lever arms that permit positioning of each lower extremity. The surgical incision begins 2–4 cm lateral to the anterior superior iliac spine of the pelvis. It is then carried distally and laterally for about 8–12 cm at 20° from the sagittal plane of the patient toward the lateral aspect of the patient's ipsilateral knee. The fascia overlying the tensor fascia latae (TFL) is incised, and a plane is then developed between the TFL and sartorius. The surgeon will then encounter the interval between the rectus femoris and gluteus medius. Hip retractor displaces the rectus femoris medially and the gluteus medius laterally to expose the anterior joint capsule of the hip [37]. Advocates of this approach consider its advantages to be the muscle-sparing nature of its internervous intervals, earlier restoration of gait kinematics and low dislocation rates [38].

2.4.2.2 Lateral approach

The patient is placed in the lateral decubitus position. A longitudinal incision is made extending 3–5 cm proximal and about 5–8 cm distal to the tip of the greater trochanter. The gluteus medius and vastus lateralis are split during the process and the abductor hip abductor mechanism is compromised [37]. This approach provides adequate exposure of both the proximal femur and acetabulum[37]. It has the benefit of providing an extensile exposure to the femur as required. A very low dislocation rate has also been reported in clinical follow-up [39].

2.4.2.3 Posterior approach

The patient is placed in the lateral decubitus position. The skin incision begins 5 cm distal to the greater trochanter, centred on the femoral diaphysis. The incision continues proximal to the greater trochanter. At that point, it curves toward the posterior superior iliac spine for 6cm.The surgeon then incises the fascia latae overlying the gluteus maximus and bluntly splits the muscle down to the short external rotator [37]. This approach provides adequate visualization of both the acetabulum and femur during both reconstructive procedures. The approach spares the abductor muscles during surgical exposure of the acetabulum and femur. It also has the benefit of providing an extensile exposure to the femur and acetabulum as required [40].

2.4.3 Complications

THA following complications includes dislocation (posterior approach dislocations frequently higher compared to other surgical approaches), abductor muscle weakness (Common after lateral approach), nerve injury, intra-operative fractures, haemorrhage, venous thromboembolism, fat embolism, and pulmonary embolism, discrepancy of leg length, and pain [42].

2.5 Rehabilitation before and after total hip replacement

2.5.1 Pre-operative rehabilitation

The pre-operative phase includes comprehensive examination of the patient which should be done before preceding to any rehabilitation plan. The examination should include a kinesiological examination, goniometric measurement, and a standardized evaluation of the everyday life quality [43], and it focuses on the following :

- Correct muscle imbalance in the hip area and decrease contractures.
- Modification of breathing pattern.
- Gait training with decreased weightbearing on the affected extremity while using walking aids.
- Self-care training with uninvolved limb.
- Enhancement of overall fitness.
- Patient instruction regarding early post-operative phase (verticalization).
- Pain management

Also, the patient should be informed about the hip precautions (contraindicated motions) after THA for the prevention of hip dislocation, and THA using the posterolateral approach contraindicated movements are no hip flexion over 90° degrees, no hip adduction past the midline of the body, and no hip internal rotation. The anterolateral approach contraindicated movements are identical as for after the posterolateral approach, but also hip external rotation as precaution [33].

2.5.2 Post-operative rehabilitation

At an early post-operative stage, the physiotherapist should assess the neuromuscular and respiratory system of the patient. The assessment includes the following components [43]:

- Localized observation (swelling, redness, atrophy and asymmetry of musculature, joint misalignment, etc.).
- Assessment of pain (intensity, location, etc.).
- Palpation (tenderness, increased warmth,muscle tone, etc.).
- Anthropometric measurement of lengths and circumferences of both legs
- Assessment of sensation in dermatomes.
- Examination of ROM using a goniometer.
- Muscle strength testing on both legs around the hips and other distal joints .
- Muscle length testing (hamstrings, hip adductors, etc.).
- Gait and dynamic posture.

- Assessment of ADL, self-care, and independence of the patient (dressing up, bed mobility, hygiene, etc.).

In this phase, thromboembolic prevention is the main focus [43]. Compression stocking are worn right after the surgery to prevent blood clots, and the prevention can be achieved with the ankle pump exercise, in which the patient actively performs maximum dorsal flexion and plantar flexion of the ankles repetitively or vascular gymnastics. Repositioning of the patient and maintain the operated extremity in a safe position for the operated hip joint. A cushion should be put between knees to prevent rotation and adduction past midline. On the first post-operative day verticalization is allowed if the patient is in a normally good condition. Physical therapy, for the reduction of post-operative pain and edema around the surgical area cryotherapy with (ice packs, crushed ice, etc.) can be initiated shortly after the surgery [43]. For the prevention of post-operative pulmonary complications respiratory physiotherapy is indicated. Muscle strength exercising with isometric or active-assisted concentric contraction of muscles such as the quadriceps femoris, hip abductors, and gluteal muscles. In order to increase muscle contraction and improve the musculature and control of the lower extremities [43]. The weight-bearing resumption is up to the decision of the surgeon. On the second post-operative day usually begin bed mobility training, transfer training, and gait training if the patient condition allows [43].

Starting from 3rd post-operative day until discharge, hip abduction and extension exercises in the prone position should begin, and daily repositioning is essential for the prevention of muscle contractures [43]. The therapist should confirm that the patient is sustaining the post-operative precautions. Training the upper extremities should start in order to conserve or improve muscle strength and correct muscle imbalance. As the stitches are removed the scar therapy should be initiated to prevent the development of scar contractures and adhesions. The patient should also become independent with transfers and with gait using assistive devices, ability to demonstrate 3-point gait with relief of loading of the operated leg and train stairs climbing after the first week of operation [43]. the patient should be taught to do some home exercises and the therapist should ensure that the patient is able to do the exercise program independently before being discharged from the hospital [43]. The involved extremity can be fully loaded usually after 3-6 months of the surgery and in this phase sensory-motor training for improvement of posture and balance can be introduced.

3 Case study

3.1 Methodology

The clinical work placement for writing this dissertation took place in the orthopedic department of Centrum Léčby Pohybového Aparátu in Prague, Czech Republic, from the 11th of January 2021 till the 5th of February 2021. All the therapy procedures which I applied to the patient were performed under the supervision of Bc. Tereza Lavingerova.

The case study has one male participant aged 59 years and diagnosed with M16.0 Coxarthrosis sin grade 4. The patient underwent total hip replacement surgery after all the conservative therapies failed. The total amount of applied sessions were 8.

This thesis project was approved by the Ethics Committee of the Faculty of Physical Education and Sport of Charles University under the registration number 073/2021, and the patient was alerted and aware of my position as a student, and his agreement to participate in the therapy is for the aim of fulfilling my bachelor's thesis.

3.2 Anamnesis

Date 19-1-2021

Examined person: M.J

Gender: Male

Date of birth: 06-05-1961

Diagnosis according to ICD-10 :

- M16.0 Coxarthrosis sin.

- Z96.6 Presence of artificial hip joint. Total hip arthroplasty sin.

3.2.1 Present Status

Objective

Height: 185cm

Weight: 84kg

BMI: 24.5 Kg/m2.

Somatotype: Ectomorph

Cognition: physiological

Assistive devices: 2 French crutches, Glasses for reading.

The patient is oriented, cooperative, eloquent, and apyretic with normal breathing intensity. Compression socks covering both lower extremities from metatarsals to mid-thigh, with no signs of hematoma. Stitches are present and it's covered with adhesive sterile wound dressing. Slight edema around the operation site.

Subjective

Chief complaint: Pain around the surgical wound and decreased mobility in the left hip.

STP: The patient is after TEP of the left side with anterolateral approach. The surgery was done in CLPA on the 12th of January after being diagnosed with grade 4 coxarthrosis. The stiches planned to be removed on the 25th of January. At the moment the patient is complaining from decreased mobility and decreased muscle strength accompanied with pain grade 3-4 on

visual analog scale during the performance of active movements in the left hip . He is able to eat , dress up and go to the toilet with help of the two crutches.

3.2.2 Occupational Anamnesis:

Retired electrician who used to work in big factories to fix engines.

3.2.3 Medical Anamnesis:

Chronic asthma

3.2.4 Pharmacological Anamnesis :

Airflusan 25mg 1-0-1.

3.2.5 Surgery Anamnesis :

None.

3.2.6 Family Anamnesis :

The mother has Hypertension and diabetes mellitus type II.

The father had rheumatoid arthritis and coxarthrosis.

3.2.7 Social Anamnesis :

The patient lives with his wife and son.

3.2.8 Functional Anamnesis :

-The patient is able to perform all ADL, stand and walk with assistance of crutches.

-The patient prior to the surgery, used to play sports three times a week.

-He Lives on the 1st floor with 30 stairs.

-Sleeping hours are not affected after the surgery but, he cannot sleep on the side of operated hip due to the pain, and must have the pillow between legs during sleep to avoid adduction across the mid line.

-The patient mustn’t flex the hip over 90°, perform hip adduction cross the midline of the body nor external rotation due to the hip operation.

3.2.9 Allergy Anamnesis :

None

3.2.10 Hobbies :

Climbing, golf and handball.

3.2.11 Abuses:

Non smoker, alcohol occasionally.

3.2.12 Previous rehabilitation:

None.

3.2.13 Indication of rehabilitation:

- Prevention of postoperative complications.
- Prevention of musculoskeletal changes.
- Pain relief.
- Verticalization.
- Scar care.
- Improve muscle strength.
- Maintain mobility of the joints.
- Educate the contraindicated movements.
- Gait and stairs training.
- Use of assistive devices (crutches) training.
- Maintain range of motion in physiological ranges.

3.3 Initial kinesiological analysis

Date:19-1-2021

3.3.1 Postural Examination (Static)

“The patient is standing and supporting more on the right side using two forearm crutches “

- Posterior view:

  The patient has slight narrow base of support, with both feet externally rotated. The patient is bearing most of his weight on the medial side of right foot. He has general hypotrophy of calf muscles, thigh muscles and gluteal muscles on the left side compared to the right side, with flexed knee joint on the left side. The shoulder gridle is slightly elevated, protracted and the scapula is abducted with internal rotation of inferior angle, while the head is in protracted.

- Side view :

  The left knee and hip is in semiflexion position. Increased lumbar lordosis with prominence of spinous process from L2/L4 and slightly increased thoracic kyphosis. Trunk in slight rotation towards the left side. shoulders and head in slight protraction position.

- Anterior view :

  Both feet are in external rotation position, and the toes are slightly pressed to the floor. The patient is bearing weight more on the right side resulted in slight flexion of the left knee joint. The shoulders are elevated, protracted and the head is in a protraction position.

3.3.2 Gait Examination

The patient is using 2 forearm crutches during walking to decrease the weight-bearing on the operated leg as he is allowed to load it only 70%. The width of support is normal not wide nor narrow, asymmetrical rhythm during the gait as he tends to move the right leg first quickly and drag the left leg on the floor , The speed of his gait is relatively fast with short stride length . The patient has covered all phases of the gait

except loading response phase as he tends to avoid loading of the left leg which has slight flexion position of knee and hip and decreased extension of the left hip. The whole trunk was steady deprived of unwanted movements but the patient has a tendency to watch his steps resulted in slight kyphotic posture with protraction and flexion of the head and elevation of shoulders.

Typology of gait according to Janda: Distal gait pattern.

3.3.3 Pelvis Palpation :

The iliac crest, anterior superior iliac spine (ASIS), and posterior superior iliac spine (PSIS) were all higher on the right side.

Pelvis position:: The pelvis is in anteversion position with a lateral tilt to the left side.

3.3.4 Breathing Stereotype :

The patient has abdominal breathing in sitting and standing while in supine position mostly he was using upper chest. the breathing frequency was 13 breath per minute. and no prominent activity of accessory muscles. the trunk was stable in all positions.

3.3.5 Vele Test:

-Grade 1 (Both sides)

3.3.6 Anthropometric measurements (Measured using a Linen Measuring Tape)

Measured	**Left**	**Right**
Anatomical length	97 cm	98 cm
Functional length	101 cm	102 cm
Thigh length	55 cm	56 cm
Calf length	45 cm	45 cm

Table 2: Lengths of the lower extremities-Anthropometric measurements-Initial kinesiological analysis

Measured	**Left**	**Right**
The circumference of the thigh	**15 cm above the patella**	
	44 cm	46 cm

	10 cm above the patella	
	40 cm	42 cm
The circumference of the knee joint	37 cm	37 cm
The circumference of the calf	36 cm	37 cm
The circumference of the ankle	32 cm	33 cm
Circumference Foot	28 cm	28 cm

Table 3: Circumferences of the lower extremities- Anthropometric measurements-Initial kinesiological analysis

3.3.7 Measurement of range of motion (SFTR format, goniometry according to Janda)

- Adduction, internal rotation, and external rotation of the left hip joint were not measured as its contraindication .

	AROM		PROM	
	Left	Right	Left	Right
Hip Joint	S 5-0-55	S 10-0-90	S 10-0-70	S 10 -0-100
	F 15-0-CI	F 35-0-10	F 30-0-CI	F 45-0-15
	R CI-0-CI	R 35-0-30	R CI -0-CI	R 40 -0-35
Knee Joint	S 0-0-100	S 0-0-120	S 0-0-105	S 0-0-130
Ankle joint	S 10-0-30	S 10 -0-40	S 10-0-35	S 10-0-45
	R 15-0-30	R 15-0-30	R 15-0-30	R 20-0-35

CI=Contraindication .

Table 4: Measurement of range of motion—Initial kinesiological analysis

3.3.8 Muscle length test (according to Janda)

Hip flexors, hip abductors and piriformis muscles weren't tested because the testing positions for these muscles require the patient to have his hip joint in a position that is contraindicated by the surgeon.

Muscle	Left	Right
Triceps Surae	1	0
Hip Adductor	1	0
Hamstring	1	1

Table 5: Muscle length test- Initial kinesiological analysis

3.3.9 Manual muscle strength testing (according to Kendall)

- The testing position for the left hip adductor and hip flexor muscles described by Kendall methodology is contraindicated by the surgeon for the patient . Therefore the testing position was modified to match the patient abilities .

- For testing left hip adductor muscles the patient is in supine position having wedge pillow between thighs to prevent adduction , with the help of the therapist the patient places his leg in abduction , and then asked to return back the leg while the therapist applies resistance

- For testing left hip flexor muscles the patient was in supine position with his knee at the edge of the table and then asked to flex his hip slightly and hold from the position.

Tested Muscle	Right Extremity	Left Extremity
Gluteus Maximus	4+	3
Gluteus medius	4+	3
Gluteus minimus	4+	3
Hip adductors	4+	3
Hip flexors	4+	3
Hamstrings	4+	3+
Quadriceps femoris	4+	3
Triceps Surae	4+	4
Peroneus longus et brevis	4+	4
Tibialis anterior	4+	4
Tibialis posterior	4+	4

Table 6: Muscle strength tesing- Initial kinesiological analysis

3.3.10 Neurological Examination

Deep Tendon Reflexology of Upper & Lower Extremities

Right		Left
Normal	Patellar reflex (L 2 – 4)	Normal
Normal	Ankle jerk (L 5 – S 2)	Normal
Normal	Medio plantar reflex (L5 – S2)	Normal

Table 7: Deep Tendon Reflexology of Upper & Lower Extremities- Neurological Examination- Initial kinesiological analysis

Superficial (exteroceptive) sensation in the lower extremities

Right	Sense	Left
Normal	Tactile sensation	Normal

Table 8: Superficial (exteroceptive) sensation in the lower extremities-Neurological Examination- Initial kinesiological analysis

Superficial (exteroceptive) sensation in the lower extremities

Right	Sense	Left
Normal	Sense of body movement	Normal
Normal	Sense of joint position	Normal

Table 9: Superficial (exteroceptive) sensation in the lower extremities-Neurological Examination- Initial kinesiological analysis

Cortical sensory functions in the lower extremities:

Right	Sense	Left
Normal	Graphesthesia	Normal
Normal	Two point discrimination	Normal
Normal	Touch localization	Normal

Table 10: Cortical sensory functions in the lower extremities-Neurological Examination- Initial kinesiological analysis

3.3.11 Palpation of muscle tone

Muscle	Right	Left
Quadracepis femoris	Normal	Hypotonic
Hamstrings	Normal	Hypotonic
Adductor muscles	Hypertonic	Hypertonic
Abductor muscles	Hypertonic	Hypotonic
Gluteus maximus	Normal	Hypotonic
Triceps surae	Normal	Hypertonic
Rectus abdominis	Hypotonic	
Iliopsoas	Hypertonic	Hypertonic
Piriformis	Hypertonic	Hypertonic
Quadratus lumborum	Normal	Normal

Table 11: Palpation of muscle tone- Initial kinesiological analysis

3.3.12 Joint play examination according Lewit

Examined joint	Right	Left
Head of fibula	Normal	Restricted in ventral direction
Patellofemoral	Normal	Restricted in caudal and lateral direction
Talocrural	Normal	Normal
Subtalar	Restriction in direction of eversion	Restriction in direction of eversion
SI	Restricted	Normal
Transverse tarsal (Chopart)	Normal	Normal
Tarsometatarsal (Lisfranc)	Normal	Restricted
Metatarsophalangeal (MTP)	Normal	Normal
Proximal interphalangeal (PIP)	Normal	Normal
Distal interphalangeal (DIP)	Normal	Normal

Table 12: Joint play examination- Initial kinesiological analysis

3.3.13 Scar examination

The patient has 11 cm long scar which is 8 days old . It is located in the anterolateral part of the left thigh , with stitches and covered with sterile wound dressing. No signs of inflammation nor hematomas , but slight swelling around the scar. Upon palpation around the scar the temperature is warm and increase resistance of the skin .

3.3.14 Fascia examination

Examined fascia	**Right**	**Left**
Upper leg	No restriction in medial or lateral directions .	Restricted mobility in both medial and lateral directions
Lower leg	No restriction in medial or lateral directions .	No restriction in medial or lateral directions .
Achilles tendon	No restriction in medial or lateral directions .	No restriction in medial or lateral directions .

Table 13: Fascia examination- Initial kinesiological analysis

3.3.15 Deep stabilization system examination (Prof. Kolář Approach)

- Extension test: The patient was extensively activating his paravertebral muscles round the lumbar region. Supported on umbilicus. Hyperactivity of the hamstrings.
- Trunk diaphragm test: the diaphragm motion wasn't visibly observable during aspection but the patient could activate the diaphragm against pressure but its not engaging with abdominals and pelvic floor muscles.

3.3.16 Initial kinesiological examination conclusion

The patient is 7 days after hip replacement surgery. The incision is warm with present stitches, visible swelling around the surgical site on the left thigh, and increased resistance of the upper leg fascia around the scar. The left lower extremity cannot bear weight yet as instructed by the surgeon therefore, the patient tends to keep it in flexion position at hip and knee joint accompanied by external rotation of the both feet and flexion of toes as Vele test graded 1 which indicates instability of the foot, while the patient during the gait tends to look toward his steps which caused increase kyphosis of thoracic spine, protracted head, and shoulder. The anterolateral approach of the surgery resulted in decreased strength in gluteus maximus, gluteus medius, gluteus minimus, hip flexors, hip adductors, hamstrings and quadriceps femoris as all the mentioned muscles graded 3 according to Kendall and hypotonicity of quadriceps femoris, hamstrings, gluteus maximus and abductor muscles as a consequence some functions were altered such as inability of the patient to perform full extension in the left leg during walking, decreased active range of motion in abduction, flexion and extension at left hip joint and flexion at left knee joint. On the other hand, it had a consequence on the circumference measurement of the left thigh and calf as there was found a difference of 2 cm less on the left side, regardless the swelling that's only around the surgical wound, which is 35cm above the patella.

The joint restriction was found in the left head of fibula, patellofemoral joint, Lisfranc joint, and subtalar joint on both sides. The overloading of the right side due to the surgery resulted in restriction of sacroiliac joint right side left lateral tilt of the pelvis, and hypertonicity of iliopsoas caused anteversion of the pelvis. All of the mentioned findings are physiological after total hip replacement. Upon palpation of muscle tone examination the patient felt discomfort when quadratus lumborum muscle was palpated on the right side. The patient was using crutches during all the examinations that require the patient to stand.

3.4 Physiotherapy plan

3.4.1 Short term plan

- DVT Prevention
- Pain relief
- Scar therapy
- Reduce swelling around the scar on the left leg .
- Strengthen hip adductors , hip flexors , quadriceps femoris and hamstrings on the left side .
- Improve ROM of left hip joint into flexion, extension and abduction .
- Relaxation of hypertonic muscles (adductors,triceps surae,iliopsoas) on the left side.
- Mobilization of head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .
- Release fascia of upper leg .
- Verticalization training
- Posture correction
- Gait training accompanied with stairs climbing
- Crutches use training

3.4.2 Long term plan

- Eliminate pain
- Improve walking patterns and reduction use of walking aids .
- Restore ROM in LE to physiological .
- Improvement of overall physical condition
- Maintain muscles condition of LE
- Scar care and restore skin mobility
- Ability to perform ADL and return to sports (climbing , golf and handball) .

3.5 Therapy progress

3.5.1 Session 1

Date: 20-01-2021

Duration: 45 minutes

Subjective: The patient is excited and motivated to exercise as his goal is to have the ability of performing all ADL without restrictions and return to his hobbies . At the moment the patient doesn't feel pain .

Objective : The patient is in a good mood and overall condition too , there is slight swelling around the scar on the left hip , decreased ROM , weakness of lower extremity muscles .

Goal of today's therapy unit:

- DVT prevention
- Reduction of swelling of the left thigh.
- Pain relief
- Verticalization training .
- Release fascia of upper leg .
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors , hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors , iliopsoas and triceps surae .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .
- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball . The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.

- To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .
- To strengthen abductors . the patient is in supine position and instructed to abduct his left leg actively to the side and return to the starting position . The exercise was repeated 10 times.
- Strengthening of gluteus maximus muscle using isometric contractions. The patient is in prone position and was instructed to contract his buttock isometrically and exert maximum force of contraction for 5 seconds and then relax. The exercise was repeated 10 times.
- For strengthening hamstrings using overball ,the patient is in prone and he was told to put the ball between his ankles and to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .

- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .

- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.
- Verticalization and mobilization of the patient from supine to sitting to standing with assistance of crutches , he was informed about the contraindicated movements and cushion should be between two legs when resting in bed and getting out of bed in order to maintain a safe position of the left hip joint.

Results of today's therapy unit:

Objective:

PIR method decreased the hypertonicity of muscles, also the strengthening exercises for weak muscles were completed as necessary, there was no restriction subsequently as mobilization of the blocked joints was performed. he was able to demonstrate the self-therapy and understood the instructions for contraindicated movements.

Subjective:

Patient was performing good during therapy session , he was able to perform all exercises but he felt slight pain during performing abduction.

Self-therapy:

- Ankle exercises as in the therapy session.
- Isometric contractions of the gluteus maximus as in the therapy session.

3.5.2 Session 2

Date: 21-01-2021

Duration: 45 minutes

Subjective: The patient is excited to start the session and is feeling better today as the pain during active movements decreased.

Objective: The patient is in a good mood and overall condition too , decreased swelling around the scar on the left hip , slight improvement of ROM , weakness of lower extremity muscles .

Goal of today's therapy unit:

- DVT prevention
- Swelling reduction of the left thigh.
- Pain relief
- Release fascia of upper leg.
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side, sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors, hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors, iliopsoas and triceps surae .
- Stretching of triceps surae muscle, hip adductors on the left side and hamstrings on both sides .
- Gait training and crutches using.

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .
- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball .The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.

- To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .

- To strengthen abductors . the patient is in supine position and instructed to abduct his left leg actively to the side and return to the starting position . The exercise was repeated 10 times.
- Strengthening of gluteus maximus muscle using isometric contractions. The patient is in prone position and was instructed to contract his buttock isometrically and exert maximum force of contraction for 5 seconds and then relax. The exercise was repeated 10 times.
- For strengthening hamstrings using overball ,the patient is in prone and he was told to put the ball between his ankles and to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .

- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.
- By the end of the session, the patient was trained and instructed for the correct gait in the hallway of orthopaedic department in CLPA .

Results of today's therapy unit:

Objective:

The hypertonicity of muscles was decreased by performed PIR, improved ROM of the left knee in flexion and the patient has less tendency to overload right leg .

Subjective:

Patient performed all exercises without pain , he was happy because we walked but he felt exhausted at the end .

Self-therapy:

- Ankle exercises as in the therapy session.
- Isometric contractions of the gluteus maximus as in the therapy session 1.

3.5.3 Session 3

Date: 22-01-2021

Duration: 45 minutes

Subjective: The patient is excited to start the session, the pain during active movements decreased .

Objective : The patient is in a good mood and overall condition too , decreased swelling around the scar on the left hip , weakness of lower extremity muscles .

Goal of today's therapy unit:

- DVT prevention
- Swelling reduction of the left thigh.
- Pain relief
- Release fascia of upper leg .
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors , hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors , iliopsoas and triceps surae .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .
- Gait training .
- Stairs climbing training

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .
- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball. The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.

- To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .
- To strengthen abductors . the patient is in supine position and instructed to abduct his left leg actively to the side and return to the starting position . The exercise was repeated 10 times.
- Strengthening of gluteus maximus muscle using isometric contractions. The patient is in prone position and was instructed to contract his buttock isometrically and exert maximum force of contraction for 5 seconds and then relax. The exercise was repeated 10 times.
- For strengthening hamstrings using overball ,the patient is in prone and he was told to put the ball between his ankles and to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .
- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into

dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.

- By the end of the session ,the patient was trained for the gait in the hallway , and for climbing the stairs he was instructed for correct pattern when climbing up and down after that he practiced it within two floors both ways .

Results of today's therapy unit:

Objective:

The hypertonicity of muscles was decreased by performed PIR, improved ROM of the left hip in abduction ,

Subjective:

Patient performed all exercises without pain and he felt the release after PIR .

Self-therapy:

- Ankle exercises as in the therapy session.
- Isometric contractions of the gluteus maximus as in the therapy session 1.

3.5.4 Session 4

Date: 25-01-2021

Duration: 45 minutes

Subjective: The patient is excited to start the session ,he expresses the pain 0 on VAS .

Objective : The patient is in a good mood and overall condition too and the stiches were removed today .

Goal of today's therapy unit:

- DVT prevention
- Swelling reduction of the left thigh.
- Pain relief
- Scar Examination
- Release fascia of upper leg .
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors , hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors , iliopsoas and triceps surae .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .
- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball. The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.
- To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient

flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .

- To strengthen abductors . the patient is in side lying position and instructed to abduct his left leg actively to the side and return to the starting position with cushion between the knees and the therapist is fixing the iliac crest with one hand . This was repeated for 8 times.
- To strengthen gluteus maximus muscle The patient is in prone position and was instructed to lift his left leg above the mat and keeping it extended at knee and hip joint and bringing it back to the mat . This was repeated 10 times.
- For strengthening hamstrings using overball ,the patient is in prone position and a fitness weight of half kilo was attached around the left ankleand he was instructed to to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .
- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.

- The patient has removed the stitches today , the wound is slightly red , the temperature is higher around it and slight swelling .

Results of today's therapy unit:

Objective:

Improved muscle length of hamstrings on both sides and triceps surae on the left .

Subjective:

The patient feels more strong and confident compared to previous days .

Self-therapy:

- Ankle exercises as in the therapy session.
- Isometric contractions of the gluteus maximus as in the therapy session 1.

3.5.5 Session 5

Date: 26-01-2021

Duration: 45 minutes

Subjective: The patient is excited to start the session ,he expresses the pain 0 on VAS .

Objective : The patient is in a good mood and overall condition too .

Goal of today's therapy unit:

- DVT prevention
- Swelling reduction of the left thigh.
- Pain relief
- Scar therapy
- Release fascia of upper leg .
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors , hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors , iliopsoas and triceps surae .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .
- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball. The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.

- Scar massage was applied with slight pressure around all the scar massaging it to S and C shape and holding for each point 5 seconds . The overall time is for this procedure is 5 minutes .

- To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .
- To strengthen abductors . the patient is in side lying position and instructed to abduct his left leg actively to the side and return to the starting position with cushion between the knees and the therapist is fixing the iliac crest with one hand . This was repeated for 8 times.
- To strengthen gluteus maximus muscle The patient is in prone position and was instructed to lift his left leg above the mat and keeping it extended at knee and hip joint and bringing it back to the mat . This was repeated 10 times.
- For strengthening hamstrings using overball ,the patient is in prone position and a fitness weight of half kilo was attached around the left ankleand he was instructed to to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .
- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into

dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.

Results of today's therapy unit:

Objective:

Improved muscle length of hamstrings on both sides and triceps surae on the left .

Subjective:

The patient feels more strong and confident compared to previous days .

Self-therapy:

- Ankle exercises as in the therapy session.
- Isometric contractions of the gluteus maximus as in the therapy session 1.

3.5.6 Session 6

Date: 27-01-2021

Duration: 45 minutes

Subjective: The patient is excited to start the session and he is willing to train the stairs today .

Objective : Improved ROM of abduction in the left hip joint,the swelling is almost diminished.

Goal of today's therapy unit:

- DVT prevention
- Swelling reduction of the left thigh.
- Pain relief
- Scar therapy
- Release fascia of upper leg .
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors , hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors , iliopsoas and triceps surae .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .
- Gait training .
- Stairs climbing training

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .
- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball. The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.

- Scar massage was applied with slight pressure around all the scar massaging it to S and C shape and holding for each point 5 seconds . The overall time is for this procedure is 5 minutes .
- To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .
- To strengthen abductors . the patient is in side lying position and instructed to abduct his left leg actively to the side and return to the starting position with cushion between the knees and the therapist is fixing the iliac crest with one hand . This was repeated for 8 times.
- To strengthen gluteus maximus muscle The patient is in prone position and was instructed to lift his left leg above the mat and keeping it extended at knee and hip joint and bringing it back to the mat . This was repeated 10 times.
- For strengthening hamstrings using overball ,the patient is in prone position and a fitness weight of half kilo was attached around the left ankleand he was instructed to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction

on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .

- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.
- By the end of the session ,the patient was trained for the gait in the hallway , and for climbing the stairs he was instructed for correct pattern when climbing up and down after that he practiced it within two floors both ways .

Results of today's therapy unit:

Objective:

The patient gait pattern and posture has improved .

Subjective:

The patient states that his overall condition is significantly improving .

Self-therapy:

- Ankle exercises as in the therapy session.
- Isometric contractions of the gluteus maximus as in the therapy session 1.

3.5.7 Session 7

Date: 28-01-2021

Duration: 45 minutes

Subjective: The patient is excited to start the session .

Objective : Improved ROM of abduction in the left hip joint,the swelling is almost diminished.

Goal of today's therapy unit:

- DVT prevention
- Swelling reduction of the left thigh.
- Pain relief
- Scar therapy
- Release fascia of upper leg .
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors , hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors , iliopsoas and triceps surae .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .
- Gait training .
- Stairs climbing training

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .
- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball. The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.

- Scar massage was applied with slight pressure around all the scar massaging it to S and C shape and holding for each point 5 seconds . The overall time is for this procedure is 5 minutes .
- To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .
- To strengthen abductors . the patient is in side lying position and instructed to abduct his left leg actively to the side and return to the starting position with cushion between the knees and the therapist is fixing the iliac crest with one hand . This was repeated for 8 times.
- To strengthen gluteus maximus muscle The patient is in prone position and was instructed to lift his left leg above the mat and keeping it extended at knee and hip joint and bringing it back to the mat . This was repeated 10 times.
- For strengthening hamstrings using overball ,the patient is in prone position and a fitness weight of half kilo was attached around the left ankleand he was instructed to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction

on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .

- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.
- By the end of the session ,the patient was trained for the gait in the hallway , and for climbing the stairs he was instructed for correct pattern when climbing up and down after that he practiced it within two floors both ways .

Results of today's therapy unit:

Objective:

The patient gait pattern and posture has improved .

Subjective:

The patient states that his overall condition is significantly improving .

Self-therapy:

- Ankle exercises as in the therapy session.
- Isometric contractions of the gluteus maximus as in the therapy session 1.

3.5.8 Session 8

Date: 29-01-2021

Duration: 45 minutes

Subjective: The patient is excited to go back home , he is feeling good and has no complications.

Objective : it's the last session, notable improvement of ROM and muscle strength in the left lower extremity

Goal of today's therapy unit:

- DVT prevention
- Swelling reduction of the left thigh.
- Pain relief
- Scar therapy
- Release fascia of upper leg .
- Increasing the ROM of the left hip into flexion, abduction and extension
- Mobilization of head of fibula, patellofemoral joint, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides
- Strengthening of hip adductors , hip abductors ,hip flexors , quadriceps femoris , gluteus maximus and hamstrings on the left side .
- Relaxation of hip abductors, adductors , iliopsoas and triceps surae .
- Stretching of triceps surae muscle , hip adductors on the left side and hamstrings on both sides .
- Gait training .
- Stairs climbing training

Procedure:

- For prevention of DVT , the patient performed ankle movement exercises. In supine position, the patient was told to perform dorsiflexion, plantarflexion ,eversion and inversion actively for both of his ankles approximately 5 minutes .

- STT was applied on the left thigh to reduce swelling around the scar. The patient is in supine position , gentle massage around the surgical wound was performed using a foam ball. The massage was done by rolling the ball straight lines in caudocranial direction and in a circular motion for 10 minutes.

- Scar massage was applied with slight pressure around all the scar massaging it to S and C shape and holding for each point 5 seconds . The overall time is for this procedure is 5 minutes .

  - To strengthen quadriceps femoris and improve ROM the patient was in supine position with overball under his knee and he was instructed to press his knee on the ball slightly lift the leg above the mat as it contracts , for strengthening of flexors the patient had overball under his ankles and was instructed to flex his leg ,as for strengthening adductors the patient flexed knee joint of both legs , placed overall ball between knees and asked to squeeze the ball and relax . each exercise was repeated 10 times .
- To strengthen abductors . the patient is in side lying position and instructed to abduct his left leg actively to the side and return to the starting position with cushion between the knees and the therapist is fixing the iliac crest with one hand . This was repeated for 8 times.
- To strengthen gluteus maximus muscle The patient is in supine position and was instructed to bend both, knees in full flexion and feet flat on the bed and close to the buttock. Then the patient lifts hip off the bed towards the ceiling and contract glutes muscles and then rest back on the bed .This was repeated 6 times.
- For strengthening hamstrings using overball ,the patient is in prone position and a fitness weight of half kilo was attached around the left ankleand he was instructed to perform active flexion in the knee joint. As reaching the maximal ROM , he slowly returns his feet on the table .This was repeated 8 times.
- Joint play mobilization according to the principles of Lewit were applied to mobilize the left head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides in direction on eversion .
- To relax hypertone muscles. Principle of PIR according to Lewit was applied for hip adductors , iliopsoas , and triceps surae, but special modifications were made to meet the patient's actual condition and his ability to cooperate . The procedure was repeated 3 times for each individual muscle.
- Joint play mobilization according to the principles of Lewit were applied to mobilize head of fibula in ventral direction , patellofemoral joint in caudal direction, Lisfranc joint on the left side , sacroiliac joint on the right side and subtalar joint on both sides .
- Passive stretching is used to stretch shortened muscles and increase ROM in the left hip joint. For stretching the hip adductors and increase of range of motion into abduction

on both sides, the patient is supine . It was stretched by performing abduction with extended leg. It was repeated for 4 times , each repetition 30 seconds .

- For stretching of gastrocnemius, patient is in supine position with feet at the edge of treatment table , with one hand I grabbed the patient's foot and brings it into dorsiflexion at ankle joint until I feel the resistance and hold for 20 seconds and then 10 seconds of relaxation was allowed. This was repeated 10 times. For stretching hamstring similar procedure was used.
- By the end of the session ,the patient was trained for the gait in the hallway , and for climbing the stairs he was instructed for correct pattern when climbing up and down after that he practiced it within two floors both ways .

Results of today's therapy unit:

Objective:

After PIR hypertonic muscles condition was improved, patient doesn't feel tension around hip joint or pain during exercises. Scar therapy didn't cause pain, after joint mobilization there was no more restriction found, the patient gait pattern and posture has improved .

Subjective:

The patient is happy to be home tomorrow, he will continue exercising everyday as instructed and he is willing to take off the crutches and return to normal life .

Self-therapy:

- Ankle exercises as in the therapy session.
- Bridging exercise as in the therapy session .
- Exercising with the overball as demonstrated in therapy session.
- Stretching left hamstrings with stretch rope as instructed in therapy session .

3.6 Final kinesiological analysis

Date:29-01-2021

3.6.1 Postural Examination (Static)

"The patient is standing and supporting on 2 forearm crutches "

- Posterior view:

The patient has normal base of support , feet are positioned width apart and slight external rotation . Weight bearing appear to be even on right side however left side is not fully loaded and symmetrical muscle trophy of calf muscles, thigh muscles and gluteal muscles on both sides . Minimal elevation of the right hip. The trunk is in optimal position without any rotations .The shoulder gridle is slightly elevated protracted and the scapula is abducted with internal rotation of inferior angle on both sides and the head is in protracted .

- Side view :

The left knee in semiflexion position . Increased lumbar lordosis and slightly increased thoracic kyphosis. The trunk is not rotated ,shoulders and head in protraction position .

- Anterior view :

Both feet are in external rotation position and the toes are slightly pressed to the floor. The patient is bearing additional weight on the right side resulted in semiflexion of the left knee joint .The shoulders are elevated , protracted and the head is in protraction position .

3.6.2 Gait Examination

The patient is using 2 forearm crutches during walking to decrease the weight bearing on operated leg . the width of support is normal not wide nor narrow , symmetrical rhythm during the gait .The speed of his gait is normal with normal stride length . The patient has covered all phases of the gait except loading response phase as he doesn't fully load the left leg which has resulted in minimal semiflexion position of knee, and extension of the left hip is not performed in the full range of motion but improved . The whole trunk was steady deprived of unwanted movements but the patient has to be informed constantly to up right the trunk. Protraction and flexion of the head and elevation of shoulders .

Typology of gait according to Janda: Distal gait pattern.

3.6.3 Pelvis Palpation:

The iliac crest, anterior superior iliac spine (ASIS), and posterior superior iliac spine (PSIS) were all higher on the right side.

Pelvis position: The pelvis is in anteversion position with a lateral tilt to the left side.

3.6.4 Breathing Stereotype:

The patient has abdominal breathing in sitting and standing while in supine position mostly he was using upper chest. the breathing frequency was 13 breath per minute. and no prominent activity of accessory muscles. the trunk was stable in all positions.

3.6.5 Vele Test:

-Grade 1 (Both sides)

3.6.6 Anthropometric measurements (Measured using a Linen Measuring Tape)

Measured	**Left**	**Right**
Anatomical length	97 cm	98 cm
Functional length	101 cm	102 cm
Thigh length	55 cm	56 cm
Calf length	45 cm	45 cm

Table 14: Lengths of the lower extremities-Anthropometric measurements-Final kinesiological analysis

Measured	**Left**	**Right**
The circumference of the thigh	**15 cm above the patella**	
	46 cm	46 cm
	10 cm above the patella	
	42 cm	42 cm
The circumference of the knee joint	37 cm	37 cm
The circumference of the calf	37 cm	37 cm
The circumference of the ankle	32 cm	33 cm
Circumference Foot	28 cm	28 cm

Table 15: Circumferences of the lower extremities- Anthropometric measurements-Final kinesiological analysis

3.6.7 Measurement of range of motion (SFTR format, goniometry according to Janda)

- Adduction, internal rotation, and external rotation of the left hip joint were not measured as its contraindication .

	AROM		PROM	
	Left	Right	Left	Right
Hip Joint	S 10-0-70	S 10-0-90	S 15-0-75	S 10 -0-100
	F 25-0-CI	F 35-0-10	F 35-0-CI	F 45-0-15
	R CI-0-CI	R 35-0-30	R CI -0-CI	R 40 -0-35
Knee Joint	S 0-0-120	S 0-0-120	S 0-0-125	S 0-0-130
Ankle joint	S 10-0-30	S 10 -0-40	S 10-0-35	S 10-0-45
	R 15-0-30	R 15-0-30	R 15-0-30	R 20-0-35

CI=Contraindication .

Table 16: : Measurement of range of motion—Final kinesiological analysis

3.6.8 Muscle length test (according to Janda)

Hip flexors, hip abductors and piriformis muscles weren't tested because the testing positions for these muscles require the patient to have his hip joint in a position that is contraindicated by the surgeon.

Muscle	Left	Right
Triceps Surae	0	0
Hip Adductor	0	0
Hamstring	1	0

Table 17: Muscle length test- Final kinesiological analysis

3.6.9 Manual muscle strength testing (according to Kendall)

- The testing position for the left hip adductor and hip flexor muscles described by Kendall methodology is contraindicated by the surgeon for the patient . Therefore the testing position was modified to match the patient abilities .
- For testing left hip adductor muscles the patient is in supine position having wedge pillow between thighs to prevent adduction , with the help of the therapist the patient places his leg in abduction , and then asked to return back the leg while the therapist applies resistance
- For testing left hip flexor muscles the patient was in supine position with his knee at the edge of the table and then asked to flex his hip slightly and hold from the position.

Tested Muscle	Right Extremity	Left Extremity
Gluteus Maximus	4+	4
Gluteus medius	4+	4
Gluteus minimus	4+	4
Hip adductors	4+	4

Hip flexors	4+	4
Hamstrings	4+	4+
Quadriceps femoris	4+	4
Triceps Surae	4+	4+
Peroneus longus et brevis	4+	4
Tibialis anterior	4+	4
Tibialis posterior	4+	4

Table 18: Muscle strength tesing- Final kinesiological analysis

3.6.10 Neurological Examination

Deep Tendon Reflexology of Upper & Lower Extremities

Right		Left
Normal	Patellar reflex (L 2 – 4)	Normal
Normal	Ankle jerk (L 5 – S 2)	Normal
Normal	Medio plantar reflex (L5 – S2)	Normal

Table 19: Deep Tendon Reflexology of Upper & Lower Extremities- Neurological Examination- Final kinesiological analysis

Superficial (exteroceptive) sensation in the lower extremities

Right	Sense	Left
Normal	Tactile sensation	Normal

Table 20: Superficial (exteroceptive) sensation in the lower extremities-Neurological Examination- Final kinesiological analysis

Superficial (exteroceptive) sensation in the lower extremities

Right	Sense	Left
Normal	Sense of body movement	Normal
Normal	Sense of joint position	Normal

Table 21: Superficial (exteroceptive) sensation in the lower extremities-Neurological Examination- Final l kinesiological analysis

Cortical sensory functions in the lower extremities:

Right	Sense	Left
Normal	Graphesthesia	Normal
Normal	Two point discrimination	Normal
Normal	Touch localization	Normal

Table 22: Cortical sensory functions in the lower extremities-Neurological Examination- Final kinesiological analysis

3.6.11 Palpation of muscle tone

Muscle	**Right**	**Left**
Quadracepis femoris	Normal	Normal
Hamstrings	Normal	Normal
Adductor muscles	Hypertonic	Normal
Abductor muscles	Hypertonic	Normal
Gluteus maximus	Normal	Hypotonic
Triceps surae	Normal	Normal
Rectus abdominis	Hypotonic	
Iliopsoas	Hypertonic	Hypertonic
Piriformis	Hypertonic	Hypertonic

Quadratus lumborum	Normal	Normal

Table 23: Palpation of muscle tone- Final kinesiological analysis

3.6.12 Joint play examination according Lewit

Examined joint	Right	Left
Head of fibula	Normal	Normal
Patellofemoral	Normal	Restricted in lateral direction
Talocrural	Normal	Normal
Subtalar	Normal	Restriction in direction of eversion
SI	Normal	Normal
Transverse tarsal (Chopart)	Normal	Normal
Tarsometatarsal (Lisfranc)	Normal	Normal
Metatarsophalangeal (MTP)	Normal	Normal
Proximal interphalangeal (PIP)	Normal	Normal
Distal interphalangeal (DIP)	Normal	Normal

Table 24: Joint play examination- Final kinesiological analysis

3.6.13 Scar examination

The scar is 10 cm long , It is located in the anterolateral part of the left thigh . The stitches and the sterile wound dressing are removed . No signs of inflammation nor hematomas , and the swelling around the scar is decreased more like diminished , upon palpation around the scar the temperature is same as other parts , slightly increase resistance of the skin only around the scar and the sensation is intact .

3.6.14 Fascia examination

Examined fascia	Right	Left
Upper leg	No restriction in medial or lateral directions .	No restriction in medial or lateral directions .
Lower leg	No restriction in medial or lateral directions .	No restriction in medial or lateral directions .
Achilles tendon	No restriction in medial or lateral directions .	No restriction in medial or lateral directions .

Table 25: Fascia examination- Final kinesiological analysis

3.6.15 Deep stabilization system examination (Prof. Kolář Approach)

- Extension test: The patient was extensively activating his paravertebral muscles round the lumbar region. Supported on umbilicus. Hyperactivity of the hamstrings.

- Trunk diaphragm test: the diaphragm motion wasn't visibly observable during aspection but the patient could activate the diaphragm against pressure but its not engaging with abdominals and pelvic floor muscles.

3.6.16 Final Kinesiological examination conclusion

The patient is 18 days after hip replacement surgery with reporting grade 0 on VAS. The stitches, sterile wound dressing are removed, and no more edema is present around the scar but slightly increased resistance of the skin around. As the patient is instructed not to load fully the left operated extremity, therefore, he still tends to keep the left knee joint in semiflexion position, which result in right side pelvis elevation. and alteration of stability which was confirmed by grade 1 of Vele test on both sides . the muscle strength of gluteus maximus, gluteus medius, gluteus minimus, hip flexors, hip adductors, hamstrings, and quadriceps femoris of all the mentioned left sided muscles significantly improved as it was graded 4 according to Kendall it had a positive consequence on growing muscle volume as the circumference difference decreased to 0cm. All mentioned along with decreased tonus of hypertonic muscles, affected the active range of motion to increase in the hip joint into abduction, flexion, and extension and the left knee joint in flexion . The typology of the gait according to Janda is distal gait pattern, the patient is using 2 forearm crutches for support. He has symmetrical rhythm, normal speed but without fully loading the left side and tendency to watch his steps which increase the thoracic kyphosis and head protraction. The joint mobility in the left patellofemoral joint, head of fibula, right subtalar joint, sacroiliac joint, and Lisfranc joint is not restricted. The patient's condition is physiologically excellent as expected to be in the postoperative phase, but he still has to continue the self-therapy exercises for improvement of shortness of left hamstrings, range of motion in hip joint into flexion, extension, and abduction and complete the planned rehabilitation plan to improve the achieved results from the performed therapy session.

3.7 Evaluation of therapy effect

The patient overall condition has significantly improved. Pain level decreased to 0 on VAS , he has removed the stitches .The swelling around the scar is gone ,and he is able to walk for longer distance without any pain .Passive stretching was effective to decrease shortness in adductors and triceps surae which influenced the range of motion to increase in the left hip flexion , extension and abduction . Strengthen exercises which was provided in the sessions has improved the strength of glutei muscles , hip adductors , hip flexors , hamstrings , quadriceps femoris and triceps surae . PIR technique was helpful to decrease the tonus in adductors and triceps surae .

The session applied weren't enough to achieve all the goals which allows the patient to go back to normal life and return to his hobbies therefore he is excited to join the group exercising and to complete the rehabilitation plan which should be focused on specific improvements such as range of motion in hip joint into flexion , extension and abduction and improve the gait pattern, decrease shortness in hamstrings and correctness of the posture. If the patient would still have pressed toes sensory motor stimulation should be performed.

During all the sessions the patient was cooperative , instructed , always smiling and finally satisfied with all achieved results .

3.7.1 Anthropometric measurements

Measured (Left side)	**Initial examination**	**Final examination**
The circumference of the thigh	**15 cm above the patella**	
	44 cm	46 cm
	10 cm above the patella	
	40 cm	42 cm
The circumference of the calf	36 cm	37 cm

Table 26 Anthropometric measurements- Evaluation of therapy effect

3.7.2 Measurement of range of motion

	AROM		PROM	
Hip Joint (left side)	Initial Examiation	Final Examination	Initial Examiation	Final Examination
	S 5-0-55	S 10-0-70	S 10-0-70	S 15-0-75
	F 15-0-CI	F 25-0-CI	F 30-0-CI	F 35-0-CI
Knee Joint (left side)	S 0-0-100	S 0-0-120	S 0-0-120	S 0-0-125

Table 27 Measurement of range of motion- Evaluation of therapy effect

3.7.3 Muscle length test

Tested Muscle	Left		Right	
	Initial examination	Final examination	Initial examination	Final examination
Triceps Surae	1	0	0	0
Hip Adductor	1	0	0	0
Hamstring	1	1	1	0

Table 28 Muscle length test - Evaluation of therapy effect

3.7.4 Muscle strength test

Muscle	Left side	
	Initial examination	Final examination
Gluteus maximus	3	4
Gluteus medius	3	4
Gluteus minimus	3	4
Hip adductors	3	4
Hip flexors	3	4
Hamstrings	3+	4+
Quadriceps femoris	3	4

Table 29 Muscle strength test- Evaluation of therapy effect

3.7.5 Palpation of muscle tone

Muscle	Left side	
	Initial examination	Final examination
Quadriceps femoris	Hypotonic	Normal
Hamstrings	Hypotonic	Normal
Adductor muscles	Hypertonic	Normal
Abductor muscles	Hypotonic	Normal
Gluteus maximus	Hypotonic	Hypotonic
Triceps surae	Hypertonic	Normal

Table 30 Palpation of muscle tone - Evaluation of therapy effect

3.7.6 Joint play

	Right		Left	
	Initial Examination	Final Examination	Initial Examination	Final Examination
Head of fibula	Normal	Normal	Restricted in ventral direction	Normal
Patellofemoral joint	Normal	Normal	Restricted in caudal and lateral direction	Restricted in lateral direction
Subtalar	Restricted in direction of eversion	Normal	Restricted in direction of eversion	Restricted in direction of eversion
SI	Restricted	Normal	Normal	Normal
Tarsometatarsal (Lisfranc)	Normal	Normal	Restricted	Normal

Table 31Joint play - Evaluation of therapy effect

3.7.7 Scar

Initial Examination	Final Examination
The scar is 11 cm long scar, with stitches and covered with sterile wound dressing . No	The scar is 10 cm long ,

signs of inflammation nor hematomas , but slight swelling around the scar , upon palpation around the scar the temperature is warm and increase resistance of the skin .	The stitches and the sterile wound dressing are removed . No signs of inflammation nor hematomas , and the swelling around the scar is decreased more like diminished , upon palpation around the scar the temperature is same as other parts , slightly increase resistance of the skin only around the scar and the sensation is intact .

Table 32 Scar - Evaluation of therapy effect

3.7.8 Fascia

Examined fascia (Left side)	Initial Examination	Final Examination
Upper leg	Restricted mobility in both medial and lateral directions	No restriction in medial or lateral directions .

Table 33 Fascia- Evaluation of therapy effect

3.7.9 Gait

Initial Examination	Final Examination
Asymmetrical rhythm	Symmetrical rhythm
Fast pace gait	decreased
Short stride length	Normal
Lack hip extension	Increased
Avoiding to contact the left foot with the floor .	Ability to minimally load the left foot .
Inability to use the crutches in correct way	Understood and able to demonstrate 3 point gait and stair climbing with crutches .
Trunk in hyperkyphosis	Ability to keep the trunk straighten up for a while

Table 34 Gait- Evaluation of therapy effect

3.7.10 Pain level

Initial Examination	Final Examination
4 on VAS	0 on VAS

Table 35 Pain level- Evaluation of therapy effect

4 Conclusion

Writing this bachelor thesis has improved my knowledge in a better understanding of hip osteoarthritis, its treatment and also total hip replacement pre-operative care and post-operative care . I am grateful for taking the clinical placement where I had the chance to express my knowledge .The aim of this thesis has been achieved as the physical state of my patient has improved after all the therapy sessions. I am absolutely delighted to see this progress and it has been inspiring and educational experience for me.

Finally, I would like to thank all my professors , instructors, and patients for all support, cooperation, and patience they presented.

5 Bibliography

1. Drake, R. L., Vogl, W., Mitchell, A. W., & Gray, H. (2010). Grays anatomy for students.2nd ed. Philadelphia, PA: Churchill Livingstone/Elsevier.
2. Hansen, J.T. (2019). Netter's Clinical Anatomy. 4th ed. Philadelphia: Elsevier. ISBN 978-0-323-53188-7
3. Kapandji, A.I. (2011). The Physiology of the Joints. 5th ed. Vol. 2. Edinburgh: Churchill Livingstone.ISBN 978 0 7020-3942-3.
4. Kouyoumdjian, P., Coulomb, R., Sanchez, T., & Asencio, G. (2012). Clinical evaluation of hip joint rotation range of motion in adults. Orthopaedics & Traumatology: Surgery & Research, 98(1), 17–23. doi: 10.1016/j.otsr.2011.08.015
5. Moore, K.L., A.F. Dalley et al. (2014).Clinically Oriented Anatomy. 7th ed. Baltimore: Wolters Kluwer Health. ISBN 978-1-4511-1945-9.
6. Hall, S. J. (2011). Basic biomechanics (6th ed.). New York, NY: McGraw-Hill Education.
7. Kajzer, J., Tanaka, E., & Yamada, H. (2014). Human biomechanics and injury prevention.
8. Jeffers, J. R. T., & Beaulé, P. E. (2019). Hip Joint Capsular Anatomy, Mechanics, and Surgical Management. The Journal of Bone and Joint Surgery, 101(23), 2141–2151. doi:10.2106/jbjs.19.00346
9. Wagner, F. V., Negrão, J. R., Campos, J., Ward, S. R., Haghighi, P., Trudell, D. J., & Resnick, D. (2012). Capsular Ligaments of the Hip: Anatomic, Histologic, and Positional Study in Cadaveric Specimens with MR Arthrography. Radiology, 263(1), 189–198. doi:10.1148/radiol.12111320
10. Schuenke, M., Schulte, E., Schumacher, U. (2006). THIEME Atlas of Anatomy. In: Ross L, Lamperti E, Eds. General Anatomy of the Musculoskeletal System. New York.
11. Ito, H., Song, Y. Lindsey, DP., Safran, M. (2009). The proximal hip joint capsule and the zona orbicularis contribute to hip joint stability in distraction. J Orthop Res. 2009;27:989–95.
12. Ferguson, S., Bryant, J. Ganz, R.(2003). Investigation of the acetabular labral seal in hip joint mechanics. J Biomech . 36(2): 171-8
13. Thorp, L. E. (2014). Hip Anatomy. Hip Arthroscopy and Hip Joint Preservation Surgery, 1–17. doi:10.1007/978-1-4614-7321-3_113-1

14. Shane Tubbs, R., Carmichael, S. W., & Spinner, R. J. (2013). Hilton's law revisited. Clinical Anatomy, 27(4), 548–555. doi:10.1002/ca.22348
15. Oliver, J. (2019). The hip joint. Retrieved April 11, 2021, from https://teachmeanatomy.info/lower-limb/joints/hip-joint/
16. Hudák, R. et. al.(2016). Memorix Anatomy.1st ed. Prague:Triton. ISBN 978-80-7387-950-1
17. Zhang, C. (Ed.). (2021). Hip Surgery. doi:10.1007/978-981-15-9331-4
18. Malloy, P. J., & Nho, S. J. (2014). Clinical Biomechanics of the Hip Joint. Hip Arthroscopy and Hip Joint Preservation Surgery, 17–32. doi:10.1007/978-1-4614-6965-0_2
19. Fetto, J. F. (2019). A Dynamic Model of Hip Joint Biomechanics: The Contribution of Soft Tissues. Advances in Orthopedics, 2019, 1–7. doi:10.1155/2019/5804642
20. Sorbie, C., Zdero, R., & Bryant, J. T. (2004). Normal and Prosthesic Hip Biomechanics. Biomechanics and Biomaterials in Orthopedics, 528–549. doi:10.1007/978-1-4471-3774-0_47
21. Iyer, K.(2017).The Adult Hip and Its Disorders. The Hip Joint. Singapore: Pan Stanford. ISBN 978-981-4745-14-7
22. Oatis,C.(2017). Kinesiology: The Mechanics and Pathomechanics of Human Movement. 3rd ed. Philadelphia: Wolters Kluwer. ISBN 9781451191561
23. Knudson, D.(2007).Fundamentals of Biomechanics. 2nd ed. New York: Springer. ISBN 978-0-387-49311-4
24. Lespasio, M.(2018). Hip Osteoarthritis. The Permanente Journal . doi:10.7812/tpp/17-084
25. Fransen, M., Bridgett, L., March, L., Hoy, D., Penserga, E., & Brooks, P. (2011). The epidemiology of osteoarthritis in Asia. International Journal of Rheumatic Diseases, 14(2), 113–121. doi:10.1111/j.1756-185x.2011.01608.x
26. Dagenais, S., et Wai.,K.(2009).Systematic Review of the Prevalence of Radiographic Primary Hip Osteoarthritis. Clinical Orthopaedics and Related Research. vol. 467, iss. 3, pp. 623-637.
27. Martin, A. Buckwalter, A. (2003). The role of chondrocyte senescence in the pathogenesis of osteoarthritis and in limiting cartilage repair. J Bone Joint Surg .85-A Suppl 2:106-10
28. Pola, E, et al. (2005). Interleukin-6 gene polymorphism and risk of osteoarthritis of the hip: a case-control study. Osteoarthritis Cartilage; 13:1025-8

29. Nho, S. J., Leunig, M., Larson, C. M., Bedi, A., & Kelly, B. T. (Eds.). (2015). Hip Arthroscopy and Hip Joint Preservation Surgery. doi:10.1007/978-1-4614-6965-0
30. Bierma,Z.et al.(2002). Joint space narrowing and relationship with symptoms and signs in adults consulting for hip pain in primary care. J Rheumatol;29:1713-8.pmid:12180735.
31. Birrell, F. et al.(2001).PCR Hip Study Group.Predicting radiographic hip osteoarthritis from range of movement. Rheumatology (Oxford);40:506-12. doi:10.1093/rheumatology/40.5.506 pmid:11371658.
32. Edwards, J. J., Khanna, M., Jordan, K. P., Jordan, J. L., Bedson, J., & Dziedzic, K. S. (2013). Quality indicators for the primary care of osteoarthritis: a systematic review. Annals of the Rheumatic Diseases, 74(3), 490–498. doi:10.1136/annrheumdis-2013-203913
33. Gray, P. et al. (2013). Total Hip Arthroplasty. Rehabilitation for the Postsurgical Orthopedic Patient. 3rd ed. St. Louis: Mosby. ISBN 978-0-323-07747-7.
34. Trudelle-Jackson, E., Emerson, R., & Smith, S. (2002). Outcomes of Total Hip Arthroplasty: A Study of Patients One Year Postsurgery. Journal of Orthopaedic & Sports Physical Therapy, 32(6), 260–267. doi:10.2519/jospt.2002.32.6.260
35. Yusuf, E. (2016). Pharmacologic and Non-Pharmacologic Treatment of Osteoarthritis. Current Treatment Options in Rheumatology, 2(2), 111–125. doi:10.1007/s40674-016-0042
36. Rannou, F., & Poiraudeau, S. (2010). Non-pharmacological approaches for the treatment of osteoarthritis. Best Practice & Research Clinical Rheumatology, 24(1), 93–106. doi:10.1016
37. Petis, S., Howard, J., Lanting, B., & Vasarhelyi, E. (2015). Surgical approach in primary total hip arthroplasty: anatomy, technique and clinical outcomes. Canadian Journal of Surgery, 58(2), 128–139. doi:10.1503/cjs.007214
38. Mayr, E. et al. (2009). A prospective randomized assessment of earlier functional recovery in THA patients treated by minimally invasive direct anterior approach: a gait analysis study. Clin Biomech (Bristol, Avon) .24:812-8
39. Kwon, M. et al. (2006). Does surgical approach affect total hip arthroplasty dislocation rates? Clin Orthop Relat. Res; 447:34-8
40. Hoppenfeld, S. DeBoer P. Buckley, R. (2009). Surgical exposures in orthopaedics: the anatomic approach. Philidelphia, PA: Lippincott Williams and Wilkins.

41. Murray D.(2000). Surgery and joint replacement for joint disease. Acta Orthop Scand Suppl .281:17–20.
42. Hwang, S. K. (2014). Experience of Complications of Hip Arthroplasty. Hip & Pelvis, 26(4), 207. doi:10.5371/hp.2014.26.4.207
43. Kolář, P., & Andelova, V. (2013). Clinical rehabilitation. Prague: Rehabilitation Prague School.
44. Roach, K. E., & Miles, T. P. (2009). Normal Hip and Knee Active Range of Motion: The Relationship to Age. Physical Therapy, 71(9), 656–665. doi:10.1093/ptj/71.9.656
45. Hewitt, J. D., Glisson, R. R., Guilak, F., & Vail, T. P. (2002). The mechanical properties of the human hip capsule ligaments. The Journal of Arthroplasty, 17(1), 82–89. doi:10.1054/arth.2002.27674
46. Neumann, D. A. (2010). Kinesiology of the Hip: A Focus on Muscular Actions. Journal of Orthopaedic & Sports Physical Therapy, 40(2), 82–94. doi:10.2519/jospt.2010.3025
47. Bowman, K. F., Fox, J., & Sekiya, J. K. (2010). A Clinically Relevant Review of Hip Biomechanics. Arthroscopy: The Journal of Arthroscopic & Related Surgery, 26(8), 1118–1129. doi:10.1016/j.arthro.2010.01.027
48. A. Sheridan, G., & P. Cashman, J. (2019). Osteoarthritis of the Hip Joint. Hip Surgeries. doi:10.5772/intechopen.82030
49. Wood, A. M., Brock, T. M., Heil, K., Holmes, R., & Weusten, A. (2013). A Review on the Management of Hip and Knee Osteoarthritis. International Journal of Chronic Diseases, 2013, 1–10. doi:10.1155/2013/845015
50. Bombelli, R. (1983). Classification of Osteoarthritis of the Hip. Osteoarthritis of the Hip, 89–108. doi:10.1007/978-3-642-96691-0_4
51. Bennell, K. (2013). Physiotherapy management of hip osteoarthritis. Journal of Physiotherapy, 59(3), 145–157. doi:10.1016/s1836-9553(13)70179-6
52. Altman, R. D., April, K. T., Benkhalti, M., Guyatt, G., McGowan, J., Tugwell, P. (2012). American College of Rheumatology 2012 recommendations for the use of nonpharmacologic and pharmacologic therapies in osteoarthritis of the hand, hip, and knee. Arthritis Care & Research, 64(4), 465–474. doi:10.1002/acr.21596

6 Supplement

6.1 List of pictures

6.2 List of tables

6.3 List of abbreviations

ADL = Activity of daily living

AROM = Active range of motion

ASIS = Anterior superior iliac spine

AIIS = Anterior inferior iliac spine

BMI= Body mass index

COM = Center of mass

GRF = Ground reaction force

HATL = Head, arms, trunk, and the opposite lower extremity

ICD-10 = International Statistical Classification of Diseases and Related Health Problems 10th edition

L1/2/3/4/5 = 1st/2nd/3rd/4th/5th lumbar nerve

LE = Lower extremity

NSAID = Non-steroidal anti-inflammatory drug

OA = Osteoarthritis

PIR = Post-isometric relaxation

PROM = Passive range of motion

PSIS = Posterior superior iliac spine

ROM = Range of motion

S.F.T.R = Sagittal-Frontal-Transverse-Rotation

STP = Status post

STT = Soft tissue techniques

THA = Total hip arthroplasty

THR = Total hip replacement

VAS = Visual analogue scale

xxx = Not tested

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 Rehabilitation After Total Hip Replacement

Project form: Bachelor's Thesis

Period of realization of the project: January,2021- February 2021

Applicant: Maie Alabed, Department Of Physiotherapy, UK FTVS

Main researcher Maie Alabed, Department Of Physiotherapy, UK FTVS

Workplace: Centrum léčby pohybového aparátu (CLPA) , Sokolovská 810/304, 190 00 Praha 9, Czechia

Supervisor: Mgr.Michaela Stupková

Project description: Case study of a patient after left side total hip replacement with implementation of physical therapy procedures and evaluation of the results for the applied physiotherapy rehabilitation plan which is based on detailed kinesiological examination . Consisting also theoretical part from relevant literature which will demonstrate explanation regarding the hip joint , hip replacement and coxarthrosis .
Characteristics of participants in the research: Only one patient will participate in this case study, he is a male, aged 59 and after total hip replacement of the left side .
Ensuring safety within the research: The research is taking a place in Orthopaedics department of CLPA , it will follow the precautions and risk prevention according to the centre rules , policies and signed documents. Non invasive methods is used and all the applied therapies, discussions and instructions is done under the supervision of Bc.Tereza Langerová. 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,19/01/2021 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.
doc. 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: 043/2021
Date of approval: 22.4.2021

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.

UNIVERZITA KARLOVA
Fakulta tělesné výchovy a sportu
José Martího 31, 162 52, Praha 6
– 20 –

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: .....