“Rehabilitation after Fracture of the Diaphysis of Femur”

Bachelor Thesis

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FTVS

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Abstract

''Rehabilitation after Fracture of the Diaphysis of Femur''

''Rehabilitace po fraktuře distální diafýzy femuru''

Postoperative study case of patient after surgery extraction of screws and intramedullary rod were placed for fixation of the shaft of femur after fracture. In this Thesis I will try to explain the nature of the injury, the medical and physiotherapeutic approach as well as the rehabilitation plan and therapy that followed.

Current Thesis is divided in two parts; first part describes a general aspect of the anatomy of femur as bone but also as functional unit with its adjacent joints and the muscles which apply to it. The mechanism of fractures of femur and the medical and physiotherapeutic approach. The second part of the Thesis describes the case study of the patient and the rehabilitation plan that was performed as well a comparison of the patient's condition before and after the treatment.

Dates of practice 11.1.2010 – 22.1.2010

Location of practice Ústřední vojenská nemocnice Praha 1200/1, 162 00 Praha 6

Declaration

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

The work was done under the guidance of Martina Puchmeltrova Bc., at the Ústřední vojenská nemocnice Praha 1200/1, 162 00 Praha 6

The work was done under the guidance of Professor Miroslava Jalovcova Mgr.

Acknowledgment

First and foremost I offer my sincerest gratitude to my supervisor, Miroslava Jalovcova Mgr. , who has supported me throughout my thesis with her patience and knowledge whilst allowing me the room to work in my own way. I attribute the level of my Bachelor degree to her encouragement and effort and without her, this thesis, too, would not have been completed or written. One simply could not wish for a better or friendlier supervisor.

I am deeply grateful to my supervisor, Martina Puchmeltrova Bc., Member of the Department of Physical Therapy, in UVN hospital, Praha Czech Republic, for her detailed and constructive comments, and for her important support throughout this work.

Charilaos C. Karaliotas

Dedicate

I would like to dedicate my work to my family for the continuous support to my efforts and to my teachers I had through the whole my academic journey the last years in Prague, UK FTVS.

Special thanks and appreciation to Mrs. Miroslava Jalovcova for her guideness to my work and Mrs. Martina Puchmeltrova for her extra time she spend on me, during the clinical practice and my few extra visits in her outpatient in UVN hospital.

Without their guidance and help this thesis would be an impossible work to accomplish

Contents

1. Introduction

The following text describes the work on a patient after car accident that he suffered double fracture of his right femur and his rehabilitation after the extraction surgery and removal of the screws. Its purpose is to evaluate the progress of the patient in response to the proposed rehabilitation plan and description of the procedures that have been applied to him .The rehabilitation took place in UVN hospital during my clinical practice course in Prague between 11/1/2010 and 22/1/2010. I had personally to visit the outpatient where my patient visited few times in advance in order to have a more spherical opinion about his improvement.

In order to give the reader of this text better understanding of the goal of the rehabilitation there is a reference to the basics of anatomy, physiology ,kinesiology and the surgical treatment of the patient as the basis of the rehabilitation that is about to follow.

2. General part

This part of the study explains the anatomy physiology kinesiology and management of the affected areas of the following study case.

2.1 Anatomy of femur bone

The femur as a bone is, the longest and strongest in the skeleton, it has a just about entirely cylindrical shape in its greater part. In the upright posture it is not vertical, being divided above from its associate by a significant interval, which corresponds to the wideness of the pelvis, but inclining steadily downward and inward, so as to approach its associate in the direction of its lower part, for the purpose of bringing the knee-joint near the line of gravity of the body.(18) The level of this tendency is different in each person, and is greater in the female than in the male, on account of the greater width of the pelvis. The femur, like other long bones, is separable into a body or shaft and two extremities, distal and proximal.

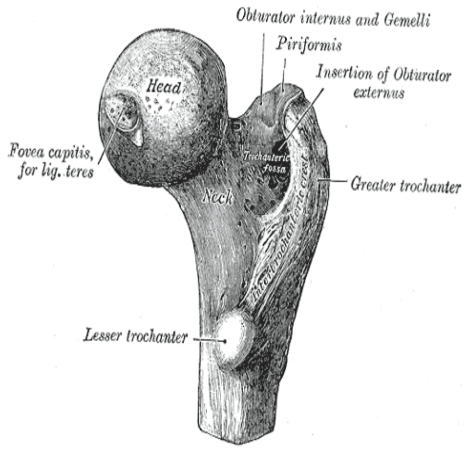


Figure1 Proximal part of femur(3)

2.2 Proximal part of femur

The upper part of femur presents us the following characteristics for study, a head, a neck a greater and a Lesser Trochanter.

Figure 2 Angle of femur at 120 degrees (18)

The head of femur bone (Caput Femoris), is spherical and forms a hemisphere, is directed upward, inward and a little forward, the greater part of its convexity being above and in front. Its surface is smooth and sheltered with cartilage except an ovoid depression, the fovea Capitis Femoris, which is located just below and behind the centre of the head of femur, and gives attachment to the ligament teres. The neck of femur (Column femoris), is a flattened pyramidal process of bone, connecting the head with the body, and forming with the later a wide angle opening inward. The angle is widest in infancy, and becomes lessened during growth, so that at puberty it shapes a gentle curve from the axis of the body of the bone. In the adult, the neck forms an angle of about 125° with the body, but this varies in opposite ratio to the development of the pelvis and the figure. In the female, in outcome of the increased width of the pelvis, the neck of the femur forms more nearly a right angle with the body than it does in the male. The angle decreases during the period of growth, but after full growth has been attained it does not usually undergo any change, even in old age; it varies significantly in different persons of the same age. It is smaller in short than in long bones, and when the pelvis is wide. In addition to projecting upward and inward from the body of the femur, the neck also projects to some extent forward, the amount of this forward projection is extremely variable, but on an average is from 12° to 14°.(18)(3)

The Trochanters are prominent processes which manage to pull the muscles that rotate the thigh on its axis. They are two in number, the Greater and the Lesser Trochanter. The Greater Trochanter is a large, irregular, four-sided figure eminence, situated at the junction of the neck with the upper part of the body. The lateral surface, is marked by a diagonal impression, and serves for the insertion of the tendon of the Gluteus Medius. Above the impression is a triangular surface, sometimes rough for part of the tendon of the same muscle, sometimes smooth for the interposition of a bursa between the tendon and the bone. Below and behind the diagonal impression is a smooth, triangular surface, over which the tendon of the Gluteus Maximus plays, a bursa being interposed. The Lesser Trochanter is a conical eminence, which varies in size in different subjects, it projects from the lower and back part of the base of the neck. From its apex three well-marked borders extend; two of these are above—a medial continuous with the lower border of the neck, a lateral with the Intertrochanteric Crest the inferior border is continuous with the middle division of the Linea Aspera. The summit of the Trochanter is rough, and gives insertion to the tendon of the Psoas Major.(18)(3)

2.3 Distal part of femur

The lower extremity is to some extent cuboid in form but its horizontal diameter is greater than its anterior posterior, it consists of two diamond shape eminences known as the condyles. In front, the condyles are but a little prominent, and are divided from one another by a smooth shallow articular depression named the patellar surface, and the space between them forms a deep mark, the intercondyloid fossa.

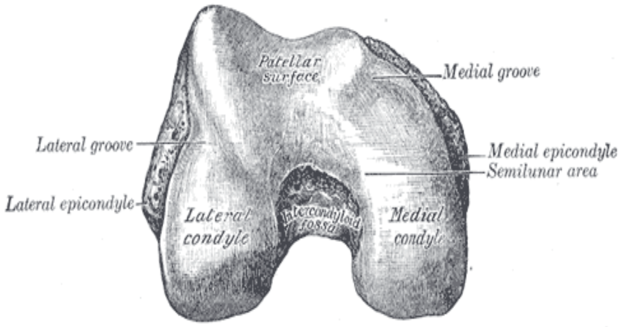


Figure 3 Distal part of femur viewed from bellow (3)

The lateral condyle is the more prominent and is the wider both in its anterior posterior and transverse diameters, the medial condyle is the longer and, when the femur is held with its body upright, projects to a lower level. When, , the femur is in its normal oblique position the lower surfaces of the two condyles lie almost in the same horizontal plane. The condyles are not quite parallel with one another; the long axis of the lateral is almost frankly anterior posterior, but that of the medial goes backward and inward. Their opposed surfaces are small, rough, and concave, and form the walls of the intercondyloid fossa.

This fossa is restricted above by an edge, the intercondyloid line, and below by the central part of the posterior boundary of the patellar surface. Each condyle is characterized by an elevation, the epicondyle. The medial epicondyle is a large convex eminence to which the tibial collateral ligament of the knee-joint is attached. At its upper part is the adductor tubercle, already referred to, and behind it is a rough impression which gives origin to the medial head of the Gastrocnemius. The lateral epicondyle, smaller and less prominent than the medial, gives attachment to the fibular collateral ligament of the knee-joint. (18)(3)

2.4 Anatomy of the shaft of femur

The body or shaft (Corpus Femoris).The body, almost cylindrical in form, is a little wider on top of than in the center, broadest and to some extent flattened from before backward below. It is slightly arched, so as to be convex in front, and concave behind, where it is strengthened by a prominent longitudinal ridge, the Linea Aspera. It presents for examination three borders, separating three surfaces. Of the borders, one, the linea aspera, is posterior; one is medial, and the other, lateral. Above, the linea aspera is prolonged by three ridges.

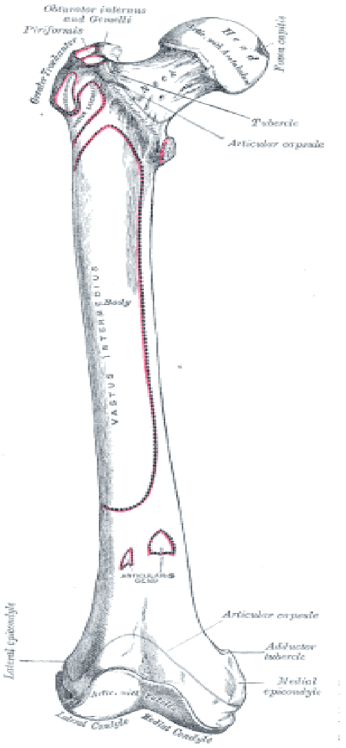


Figure 4 Anterior aspect of femur (18)

Femur is the longest and largest bone. Along with the temporal bone of the skull, it is one of the two strongest bones in the body. The average adult male femur is 48 centimeters in length and 2.34 cm in diameter and can support up to 30 times the weight of an adult. It forms part of the hip joint and part of the knee joint, which is located above. There are four eminences, or protuberances, in the human femur: the head, the Greater Trochanter, the Lesser Trochanter, and the lower extremity. They appear at various times from just before birth to about age 14. Initially, they are joined to the main body of the femur with cartilage, which gradually becomes ossified until the protuberances become an integral part of the femur bone, usually in early adulthood. (18)(3)

2.5 Anatomy of joints

2.5.1 Anatomy of the hip joint

The hip joint is a ball- socket joint. The hip joint is a synovial joint formed by the articulation of the rounded head of the femur and the cup-like acetabulum of the pelvis. It forms the primary connection between the bones of the lower limb and the axial skeleton of the trunk and pelvis. Both joint surfaces are covered with a strong but lubricated layer called articular hyaline cartilage. The cuplike acetabulum forms at the union of three pelvic bones, the ilium, pubis, and ischium.

The capsule attaches to the hip bone outside the acetabular lip which thus projects into the capsular space. On the femoral side, the distance between the head's cartilaginous rim and the capsular attachment at the base of the neck is constant, which leaves a wider extracapsular part of the neck at the back than at the front. The strong but loose fibrous capsule of the hip joint permits the hip joint to have the second largest range of movement and yet support the weight of the body, arms and head. The capsule has 2 sets of fibers: longitudinal and circular. (18)

Ligaments of the hip

The hip joint is reinforced by five ligaments, of which four are extracapsular and one intracapsular. The extracapsular ligaments are the iliofemoral, ischiofemoral, and pubofemoral ligaments attached to the bones of the pelvis. All three strengthen the capsule and prevent an excessive range of movement in the joint. Of these, the Y-shaped and twisted iliofemoral ligament is the strongest ligament in the human body. In the upright position, it prevents the trunk from falling backward without the need for muscular activity. In the sitting position, it becomes relaxed, thus permitting the pelvis to tilt backward into its sitting position. The ischiofemoral ligament prevents medial rotation while the pubofemoral ligament restricts abduction in the hip joint. (18)(3)

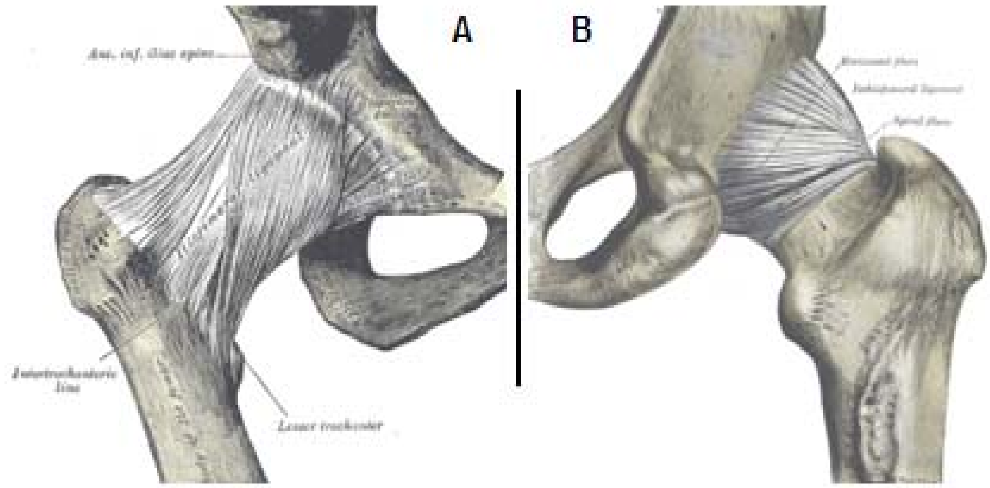


Figure 5 Extracapsular; A Ligament Anterior, B Posterior View(18)

The Zona Orbicularis, which lies like a collar around the narrowest part of the femoral neck, is covered by the other ligaments which partly radiates into it. The Zona Orbicularis acts like a buttonhole on the femoral head and assists in maintaining the contact in the joint. The intracapsular ligament, the ligament teres, is attached to a depression in the acetabulum and a depression on the femoral head. It is only stretched when the hip is dislocated, and may then prevent further displacement. It is not that important as a ligament but can often be vitally important as a conduit of a small artery to the head of the femur.

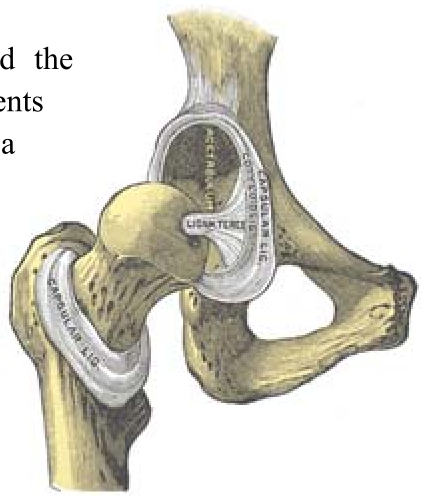


Figure 6 Intracapsular Ligaments; Lateral View with Removed Capsule(18)

This arterial branch is not present in everyone but can become the only blood supply to the bone in the head of the femur when the neck of the femur is fractured or disrupted by injury in childhood. (18)(3)

2.5.2 Blood supply of the hip

The hip joint is supplied with blood from the medial circumflex femoral and lateral circumflex femoral arteries, which are both usually branches of the deep artery of the thigh (Profunda Femoris), but there are numerous variations and one or both may also arise directly from the femoral artery. There is also a small contribution from a small artery in the ligament of the head of the femur which is a branch of the posterior division of the obturator artery, which becomes important to avoid avascular necrosis of the head of the femur when the blood supply from the medial and lateral circumflex arteries are disrupted The hip has two anatomically important anastomoses, the cruciate and the trochanteric anastomoses, the latter of which provides most of the blood to the head of the femur. These anastomoses exist between the femoral artery or Profunda Femoris and the gluteal vessels. (3)

2.6 Anatomy of the knee joint

The knee is a complex, compound, condyloid variety of a synovial joint. It actually comprises three functional compartments: the femoropatellar articulation consists of the patella, or "kneecap", and the patellar groove on the front of the femur through which it slides; and the medial and lateral femorotibial articulations linking the femur, or thigh bone, with the tibia, the main bone of the lower leg. The joint is bathed in synovial fluid which is contained inside the synovial membrane called the joint capsule. The articular bodies of the femur are its lateral and medial condyles. These diverge slightly distally and posteriorly, with the lateral condyle being wider in front than at the back while the medial condyle is of more constant width. The pair of tibial condyles is separated by the intercondylar eminence composed of a lateral and a medial tubercle. (1)

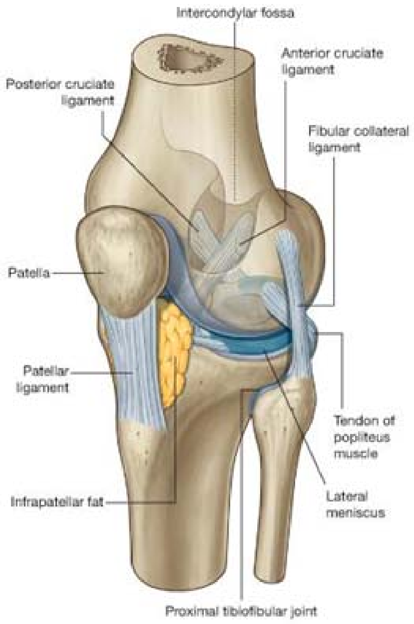


Figure7 Knee Joint (19)

The patella is inserted into the thin anterior wall of the joint capsule. On its posterior surface are a lateral and a medial articular surface both of which communicate with the patellar surface which unites the two femoral condyles on the anterior side of the bone's distal end.

2.6.1 Ligaments of the knee joint

The ligaments surrounding the knee joint offer stability by limiting movements and, together with several menisci and bursa, protect the articular capsule. Knee is consisted form intracapsular and extracapsular ligaments. The knee is stabilized by a pair of cruciate ligaments. The anterior cruciate ligament (ACL) stretches from the lateral condyle of femur to the anterior intercondylar area The ACL is critically important because it prevents the tibia from being pushed too far anterior relative to the femur. It is often torn during twisting or bending of the knee. The posterior cruciate ligament (PCL) stretches from medial condyle of femur to the posterior intercondylar area. Injury to this ligament is uncommon but can occur as a direct result of forced trauma to the ligament. This ligament prevents posterior displacement of the tibia relative to the femur. The transverse ligament stretches from the lateral meniscus to the medial meniscus. It passes in front of the menisci. It is divided to several strips in the 10% of cases.

The two menisci are attached to each other anteriorly by the ligament. The posterior and anterior meniscofemoral ligaments stretch from posterior horn of lateral meniscus to the medial femoral condyle. They pass posteriorly behind the posterior cruciate ligament. The posterior meniscofemoral ligament is more commonly present (30%); both ligaments are present less often. The meniscotibial ligament stretches from inferior edges of the mensici to the periphery of the tibial plateaus. The patellar ligament connects the patella to the tuberosity of the tibia. It is also occasionally called the patellar tendon because there is no definite separation between the quadriceps tendon (which surrounds the patella) and the area connecting the patella to the tibia.

This very strong ligament helps give the patella its mechanical leverage and also functions as a cap for the condyles of the femur. Laterally and medially to the patellar ligament the lateral and medial patellar retinacula connect fibers from the Vastus Lateralis and Medialis muscles to the tibia. Some fibers from the iliotibial tract radiate into the lateral retinaculum and the medial retinaculum receives some transverse fibers arising on the medial femoral epicondyle. The medial collateral ligament (MCL) stretches from the medial epicondyle of the femur to the medial tibial condyle. It is composed of three groups of fibers, one stretching between the two bones, and two fused with the medial meniscus.

The MCL is partly covered by the tendon of the Semimembranosus, which passes under it. It protects the medial side of the knee from being bent open by a stress applied to the lateral side of the knee (a valgus force). The lateral collateral ligament (LCL) stretches from the lateral epicondyle of the femur to the head of fibula. It is separated from both the joint capsule and the lateral meniscus. It protects the lateral side from an inside bending force (a varus force).Lastly, there are two ligaments on the dorsal side of the knee. The oblique popliteal ligament is a radiation of the tendon of the Semimembranosus on the medial side, from where it is direct laterally and proximally. The arcuate popliteal ligament originates on the apex of the head of the fibula to stretch proximally, crosses the tendon of the popliteus muscle, and passes into the capsule. (18)(3)

2.6.2 Blood supply of knee

The blood vessels around the knee form an extensive anastomosis linking the femoral artery above with the popliteal and tibial arteries below. During its course, the popliteal artery gives off the medial and lateral superior genicular artery, the middle genicular artery, the sural artery and the lateral inferior and medial inferior genicular arteries.

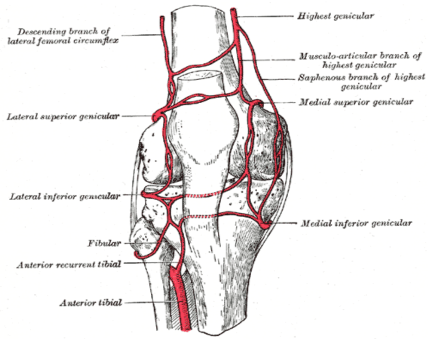


Figure 8 Blood Supply of the Knee (3)

All these vessels together supply the muscles, tendons, ligaments and bone of the knee joint as well as the synovial membrane lining the knee joint and capsular structures. (18)(3)

2.7 Muscles acting on thigh

There are several ways of classifying the muscles of the hip: (I) By location or innervations (ventral an dorsal divisions of the plexus layer); II) by development on the basis of their points of insertion (a posterior group in two layers and an anterior group) and (III) by function (i.e. extensors, flexors, adductors, and abductors).Some hip muscles also act on either the knee joint or on vertebral joints.

Muscles	Origin	Insertion	Innervation	Function
Sartorius	Ant.Sup.Iliac spine	Sup. Part of Tibia medially	Femoral n.	F.ABD.LR of hip
Iliacus	Iliac fossa	With Psoas to Less. Trochanter	Femoral n.	F, hip to trunk
Psoas	12^{th} Th. and L1-5 transverse proc.	Lesser Trochanter	Lumbar plexus	F, hip to trunk and vice versa
Pectineus	Superior ramus of Pubis	Upper end shaft o femur	Femoral n.	F,ADD of hip
Rectus Femoris	Ant,Inf,Iliac spine	Tibial tuberosity	Femoral n.	E. of knee and F. of hip
Vastus Lateralis	Upper end of shaft of femur	Tibial tuberosity	Femoral n.	E. of knee
Vastus Intermedius	Anterior & lateral 2/. of femur shaft	Tibial tuberosity	Femoral n.	E. of knee
Vastus Medialis	Upper end of shaft of femur	Tibial tuberosity	Femoral n.	E. of knee

Table 1 Muscles of the anterior compartment of the thigh (9)

Muscles	Origin	Insertion	Innervation	Function
Gracilis	Inferior ramus of pubis	Upper shaft of tibia medially	Obturator n.	ADD. Of hip
Adductor Longus	Body of pubis	Posterior shaft of femur	Obturator n.	ADD hip Assists in LR
Adductor Brevis	Inferior ramus pubis	Posterior shaft of femur	Obturator n.	ADD hip Assists in LR
Adductor Magnus	Inf. pubis ramus, Ischial tuberosity	Poster shaft of femur	Obturator n. Sciatic n.	ADD hip Assists in LR

Table 2 Muscles of the medial compartment of the thigh (9)

Additionally, because the area of origin and insertion of many of these muscles are very extensive, these muscles are often involved in several very different movements. In the hip joint, lateral and medial rotation occur along the axis of the limb; extension (also called dorsiflexion or retroversion) and flexion (anteflexion or anteversion) occur along a transverse axis; and abduction and adduction occur about a sagittal axis.

Muscles	Origin	Insertion	Innervation	Function
Biceps Femoris	Long head Ischial tuberosity short head femur shaft	Head of Fibula	Long head Tibial n. Short head Peroneal n.	F. LR. of leg. long head E. of hip
Semi tendinosus	Ischial tuberosity	Upper shaft of Tibia	Tibial n	F.MR Knee joint, E and MR of hip
Semi mebranosus	Ischial tuberosity	Medial condyle tibia	Tibial n.	F.MR Knee joint, E and MR of hip
Adductor Magnus	Ischial tuberosity	Adductor tubercle of femur	Tibial n.	E of hip

Table 3 Muscles of the posterior compartment of the thigh (9)

3. Physiology of the involved structures and bones

3.1 Bone healing

Bone healing or fracture healing, is a proliferative physiological process in which the body facilitates the repair of a bone fracture. In the process of fracture healing, several phases of recovery facilitate the proliferation and protection of the areas surrounding fractures and dislocations. The length of the process depends on the extent of the injury, and usual margins of two to three weeks are given for the reparation of most upper bodily fractures; anywhere above four weeks given for lower bodily injury. The process of the entire regeneration of the bone can depend on the angle of dislocation or fracture. While the bone formation usually spans the entire duration of the healing process, in some instances, bone marrow within the fracture having healed two or fewer weeks before the final remodeling phase. While immobilization and surgery may facilitate healing, a fracture ultimately heals through physiological processes. The healing process is mainly determined by the periosteum (the connective tissue membrane covering the bone). The periosteum is the primary source of precursor cells which develop into chondroblasts and osteoblasts that are essential to the healing of bone. The bone marrow (when present), endosteum, small blood vessels, and fibroblasts are secondary sources of precursor cells. (20)

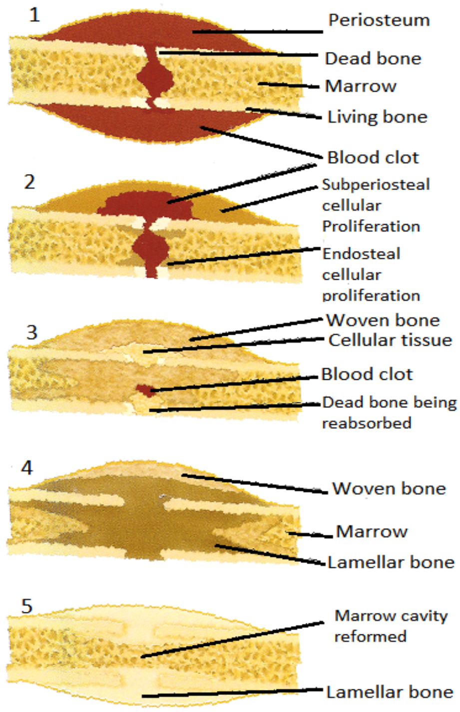


Figure 9 Stages of fracture healing (20)

There are three major phases of fracture healing, two of which can be further sub-divided to make a total of five phases: 1) Reactive phase i) Fracture and inflammatory phase, ii) Granulation tissue formation, 2) Reparative phase iii) Callus formation, iv) Lamellar bone deposition 3) Remodeling phase

3.1.1 Phases of bone healing

Reactive phase

Reactive phase is after fracture, the first change seen by light and electron microscopy is the presence of blood cells within the tissues which are adjacent to the injury site. Soon after fracture, the blood vessels constrict, stopping any further bleeding. Within a few hours after fracture, the extra vascular blood cells, known as a "hematoma", form a blood clot. All of the cells within the blood clot degenerate and die. Some of the cells outside of the blood clot, but adjacent to the injury site, also degenerate and die. Within this same area, the fibroblasts survive and replicate. They form a loose aggregate of cells, interspersed with small blood vessels, known as granulation tissue.(O.James Garden 2007)(20)

Reparative phase

Days after fracture, the cells of the periosteum replicate and transform. The periosteal cells proximal to the fracture gap develop into chondroblasts and form hyaline cartilage. The periosteal cells distal to the fracture gap develop into osteoblasts and form woven bone. The fibroblasts within the granulation tissue also develop into chondroblasts and form hyaline cartilage. These two new tissues grow in size until they unite with their counterparts from other pieces of the fracture. This process forms the fracture callus. Eventually, the fracture gap is bridged by the hyaline cartilage and woven bone, restoring some of its original strength.(20)(Thompson 2005)

Remodeling phase

The remodeling process substitutes the trabecular bone with compact bone. The trabecular bone is first resorbed by osteoclasts, creating a shallow resorption pit known as a "Howship's lacuna". Then osteoblasts deposit compact bone within the resorption pit. Eventually, the fracture callus is remodelled into a new shape which closely duplicates the bone's original shape and strength.(Thompson 2005)(20)

3.2 Healing process of the soft tissues

There are three major phases of the healing process of the soft tissues 1) Reaction or Inflammatory phase, 2) Regeneration and Repair or fibroelastic/collagen phase, and 3) Remodeling phase. (20)(10)

3.2.1 Reaction or Inflammatory phase

This first phase can last up to 72 hours, and involves a number of inflammatory responses, manifested by pain, swelling, redness, and increased local temperature. Accumulation of exsudate and edema begins the process of tissue repair following injury when a blood clot forms and seals the area. In musculotendinous injuries, there is myofilament reaction and peripheral muscle fiber contraction within the first two hours. Edema and anoxia result in cell damage and death within the first 24 hours, and the release of protein breakdown products from damaged cells leads to further edema, tissue hypoxia, and cell death. Edema and joint swelling, with or without pain, is associated with a reflex inhibition of spinal activation of skeletal muscle. Phagocytosis then begins to rid the area of cell debris and edema.(10)(20)

3.2.2 Regeneration/repair or fibroelastic/collagen phase

This phase lasts from 48 hours up to 6 weeks. During this time structures are rebuilt and regeneration occurs. Fibroblasts begin to synthesize scar tissue. These cells produce Type III collagen, which appears in about four days, and is random and immature in its fiber organization. Capillary budding occurs, bringing nutrition to the area, and collagen cross-linking begins. As the process proceeds, the number of fibroblasts decreases as more collagen is laid down. This phase ends with the beginning of wound contracture and shortening of the margins of the injured area. (10)

3.2.3 Remodeling phase

This phase lasts from 3 weeks to 12 months. Gradually, cross-linking and shortening of the collagen fibers promote formation of a tight, strong scar. It is characterized by remodeling of collagen so as to increase the functional capabilities of the muscle, tendon, or other tissues. Final aggregation, orientation, and arrangement of collagen fibers occur during this phase. Regeneration of the injured muscle does not fully restore muscle tissue to its prior levels, as fibrous scar tissue slows muscle healing. The two processes of healing and fibrosis compete with each other and impair complete regeneration. Transforming Growth Factor–Beta 1(TGF-β1) is a substance allover that initiates a cascade of events that activate both myogenesis and fibrosis. (10)

4. Kinesiology

4.1 Kinesiology of the hip joint

Figure 10 Axes of the three planes of hip joint (8)

The hip is the proximal joint of the lower limb and, being located at its root, allows the limb to assume any position in space. Therefore are three axes and three degrees of freedom. Transverse axis XOX, is lying in a frontal plane and controlling movements of flexion (F), and extension (E). The anterior posterior axis YO, is lying in a sagittal plane and controlling movements of adduction (ADD), and abduction (ABD). The vertical axis OZ coincides with the long axis of the limb OR when the hip joint is in straight position. It controls movements of medial rotation (MR) and lateral rotation (LR). As shown in figure 10; the movements of the hip occur at a single joint. Hip join (coxo-femoral joint) it is a ball and socket joint with a marked degree of interlocking. Hip joint has more limited range of movement (ROM), partially compensated by movement of the lumbar vertebral column. Hip joint is the most difficult joint to dislocate and thus reflects to its function of supporting the body weight and locomotion. (I.A.Kapandji 1987)(13)

4.1.1 Movements of flexion of the hip

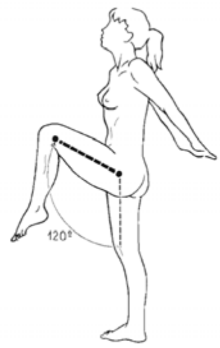


Figure 11 Flexion movements of the hip (8)

Flexion of the hip joint is the movement that approximates thigh to the trunk from the anterior aspect of view. The range of flexion depends if the flexion is passive or active also range is influenced of the position of the knee joint. Active flexion of the hip with knee extended reaches 90^{0} and with flexed knee can reach up to 120^{0} (fig-11).Passive flexion with extended knee can reach the 120^{0} but with flexed knee exceeds 140^{0}.In case of passive flexion of both hips with flexion of the knees the anterior part of thighs can come into contact with the crest, that is why posterior tilt of the pelvis occur simultaneously. (I.A.Kapandji 1987)(13)

4.1.2 Movements of extension of the hip

Figure 12 Extension moves of the hip (8)

Extension is the movement that moves the lower extremity away from the trunk or away from the frontal plane. If compare the range of movement to flexion we can see that the extension is much more limited and this because of the iliofemoral ligament. Similar like in flexion active extension range is less than the passive. Also when the knee is flexed, hamstring loses some of their efficiency and thus the range is less than 20^{0}. (I.A.Kapandji 1987)(13)

4.1.3 Movements of abduction of the hip

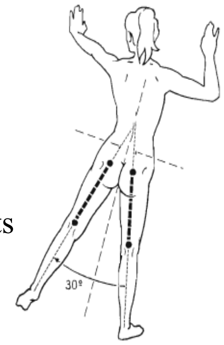


Figure 13 Abduction moves of the hip (8)

Abduction of the hip is the movements that takes away laterally the thigh from its symmetrical position .At 30^0 of abduction lateral tilting of pelvis is noticed when we compare the positions of the two posterior superior iliac spines.(fig-13).When abduction reaches maximum the angle between the two limbs is at 90^0. In this position, pelvis is tilted laterally a 45^0 to the supporting limb. (I.A.Kapandji 1987)(13)

4.1.4 Movements of adduction of the hip

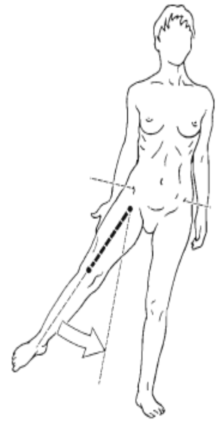


Figure 14 Adduction movement of hip (8)

Adduction is the movement of the thigh medially towards the symmetry position (fig-14). In our daily life there are many combinations of adduction with flexion or extension), also there are combination of adduction with abduct of the other leg. All these combination are performed with pelvic tilt and bending of the spine for the better stability of the individual. Among all these movements one of the most common is when sitting on a chair with our legs crossed, then adduction is associated with flexion and external rotation. (I.A.Kapandji 1987)(13)

4.1.5 Rotational movements of the hip

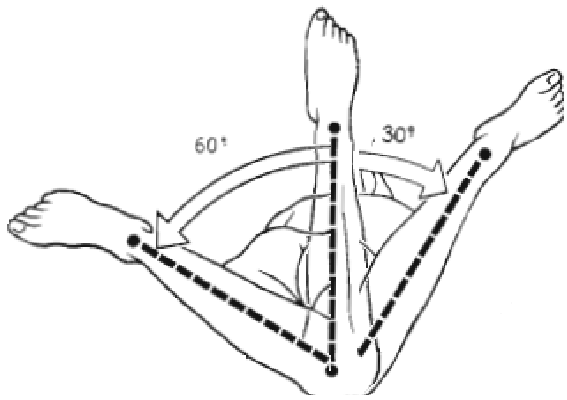


Figure 15 Rotational movement of hip (8)

The rotational movements of the hip when estimated in lying prone position as reference point, the leg is at right angles with the thigh and is vertical. From this position when moves laterally we have maximum 30^0 angle, and medially a 60^0 angle.(fig.-15).When the individual is in sitting position in the edge of the table with knee in flexed position the same criteria apply. When the leg moves medially is the lateral rotation of hip, and when leg moves laterally is the medial rotation of the hip. Because the hip flexors are relaxed, the lateral rotation can be larger than in prone position. Iliofemoral and pubofemoral ligaments play a vital part in lateral rotation estimation. (I.A.Kapandji 1987)(13)

4.2 Kinesiology of the knee

4.2.1 Extension movements of knee joint

Extension of the knee joint is defined as the movement of the posterior aspect of the leg away from the posterior surface of the thigh. There is strictly no absolute extension since the position of reference the limb is maximally extended. However, passive extension can be achieved up to 5^0 or $10^{\ 0}$. Active extension goes more than the position of reference rarely and still then only slightly, and this depends on the position of the hip joint. The efficiency of the rectus femoris muscle as the extensor of the knee increases with extension of the hip, so that extension of the hip sets the movement for the knee extension. (I.A.Kapandji 1987)(13)

4.2.2. Flexion movements of knee joint

Flexion is the movement of the posterior aspect of the leg towards the posterior aspect of the thigh. The knee range at flexion varies according the position of the hip and according if the movement is active or passive. Active flexion ranges as far as 140^0 if the hip is flexed already), and about 120^0 if the hip is extended. Passive flexion of knee goes as far as 160^0 and allows the heel to touch the buttocks. (I.A.Kapandji 1987)(13)

4.2.3 Axial rotation of the knee

Rotation of the leg around its long axis can only be performed with the knee flexed at right angles.Medial rotation brings the toes to look medially and plays an important rolein adduction of foot.Lateral rotation brings the toes to look laterally and plays an important role in abduction of the foot. Passive axial rotation can be measured in prone position with the knee flexed. (I.A.Kapandji 1987)(13)

4.3 Forces acting on knee

Isolating the knee joint as it is possible to see in the figure 16 can show that the forces that acting on patella femoral joint (PFJ) on extension of the knee are the quadriceps muscular force (F_Q), the force is transmitted to the patellar tendon (F_{PT}) and the reaction force generated on the PFJ (F_{PFJR}). So the F_{PFJR} increases proportionally with the knee flexion, not only increases with knee flexion due to the resultant force rise but also because of the flexor lever arm, which requires a quadriceps response, increases in length.

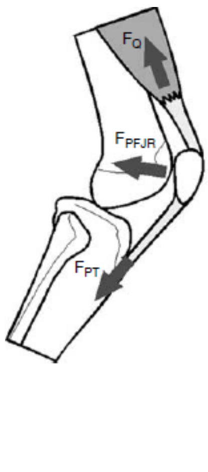


Figure 16 Forces acting on knee (8)

As a general rule it is not advisable to bend the knees excessively, when they are under strain. Additionally it seems now very logic that losing weight obese patients can improve their conditions since the F_{PFJR} is decreased, since it has less weight to support. (I.A.Kapandji 1987)(13)

5. Common fractures of femur and patella

5.1 Classification of fractures

Fractures now days in the modern orthopedics needed to be classified in order for the better estimation of the trauma and the best possible treatment of it. Thus for these reasons we separate fractures in two main categories: 1) closed fractures, 2) open fractures.

5.1.1 Closed fractures

The main problem of a closed fracture assessment involves is the fact that the closed skin hides beneath of it a possible damage of muscles, periosteum, tendons and the rest soft tissues vessels and nerves. The only information we have is from inspection palpation and the history from the patient about the energy of the accident that caused the trauma. So in Europe is widely using the Tscherne classification for the estimation of soft injuries damage. Tscherne classification has a four score scale. (14) (7)

Grade-0	**Indirect forces negligible soft tissue injury**
Grade-1	Limited soft tissue injury resulting from fracture pressure
Grade-2	Higher fracture pressure from with it superficial contusion or abrasion results
Grade-3	Ruptures of vessels or nerves high risk of compartment syndrome, all types of fracture are included.

Table 4 Tscherne classification of closed fractures (14)

5.1.2 Open fractures

Open fractures are more complicated in management because the fractured bone is escorted with displaced fracture, opening of the skin and usually is accompanied with damage of vessels and maybe nerve damage. Estimation of the opened fractures is assisted with the Gustillo's – Andersons's classification (10) (O.James Garden 2007)

I	**Low energy trauma. Wound less than 1 cm**
II	Wound larger than 1 cm, moderate soft tissue damage
III	Hi energy trauma, wound larger than 1cm with extensive soft tissue injury Adequate soft tissue cover Inadequate soft issue cover Associated with arterial injury

Table 5 Gustillo's –Anderson's classification of open fractures (4)

5.2 fractures of the shaft of femur

There are distinguished from orthopedics the types of long bones fractures, and thus of femur also. So, the patterns are:

1) Complete fractures where the bone fragments are completely separated.

2) Incomplete fracture where the bone fragments are not separated.

3) Linear fracture is the fracture which is parallel to the long axis of the bone.

4) Transverse fracture is the fracture which is in right angle with the long axis of the bone.

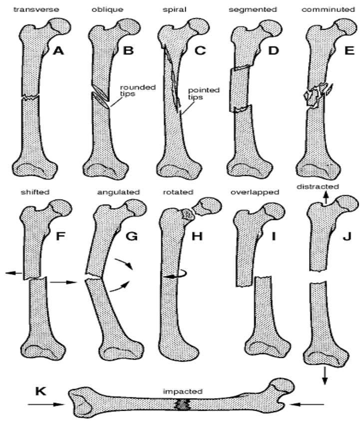


Figure 17 Patterns of femoral fractures (4)

5) Oblique fracture is the fracture which is in diagonal to with the long axis of the bone.

6) Spiral fracture is the fracture in which at least one fragment has been twisted.

7) Comminuted fracture is the fracture in which the fragments of the bone are moved towards each other, 8) Segmental fracture is the fracture that is separates the shaft to at least three segments. (4)(10)

5.3 Fractures of patella.

5.3.1 Patella

Patella is a triangular flat bone also described as sesamoid bone that articulates with the distal part of femur and its function is to protect the tendon of quadriceps femoris and increases the lever of the tendon. Patella is composed of a dense cancellous tissue, in its center of ossification presents a tuberculated outline. Patella is ossified from a single center and rarely has two centers of ossification .the completion of ossification is fulfilled in the age of puberty. (4)

5.3.2 Classification of fractures of patella

The patella fractures are classified upon the mechanism of trauma and upon their morphology. The two major mechanism of patella fracture is by i) direct impact or ii) indirect injury. Direct injuries of patella can be caused either by direct fall and contact to the ground or by injury inflicted by motor vehicle accidents. Indirect fractures of patella can be due to jumping or even through sudden and rapid flexion of the knee against fully contracted quadriceps muscle.

The natural anatomy and biomechanics of patella creates a three point pressure and tension on the patella which can be sufficient to produce a fracture. Fractures resulting from indirect injury have the tendency to be comminuted fractures more from those of direct trauma, but they are more often displaced and transverse.

Though most fractures are produced from a combined mechanism of direct and indirect trauma, for example almost no one crushes on the dashboard of car with relaxed quadriceps muscle. Classification of patella can be done by the pattern and by separation of the fragments, a) displaced fractures in which the fracture fragments are separated, b) Undisplaced fractures in which the components are not separated. I) Transverse in which the fracture occurs through the midline dividing the bone into two parts, upper and lower.

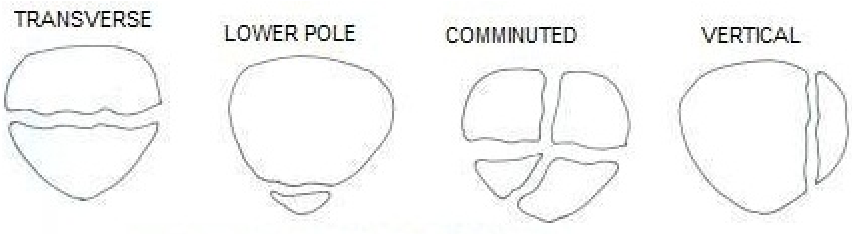


Figure 18 Fractures of patella (19)

II) Longitudinal in which there is a vertical split in the bone. III) Lower or upper pole fractures, IV) Comminuted fractures in which there are multiple pieces. (4) (10) (5)

6. Treatment of Orthopedic Injuries

6.1 Initial assessment

Priorities of managements include the following steps.

6.1.1 Assessment and management of ABCs (airway, breathing, circulation)

This is the very first step of evaluating the patient in the place of the injury site take precedence over extremity injuries. Polytrauma patients benefit from aggressive treatment of extremity and pelvic trauma. (10) (19)

6.1.2 History

History is one important parameter. In addition to standard medical history, the mechanism of injury, especially the relative energy associated with the injury, is important for understanding and planning the help and management and prognoses the musculoskeletal injured patient. (10) (19)

6.1.3 Examination

Examination is the next step in the initial assessment which includes inspection, palpation, and physical examination. Systematic approach includes comparison to the unaffected side in isolated injuries and a complete skeletal evaluation in the polytrauma patients. Inspection of injured extremity looks for bruising, for swelling and lacerations, for abrasions and deformity and asymmetry. Palpation of the extremities is to evaluate if there is a noticeable tenderness, crepitus, and deformity of the underlying bone.(14) (G. R. McLatchie 2005)

6.1.4 Physical examination

Physical examination includes range of motion of the joints associated with the site of injury, stressing the joint in non-motion planes to determine stability. Other more special tests can be performed for further evaluation of the patient afterwards. (14)

6.1.5 Assessment of the extremity vascular status

Vascular assessment of the extremity is performed by checking the presence of the pulses, capillary refilling, temperature and color. Always compare it with the unaffected extremity. (10)

6.1.6 Sensomotoric evaluation

Muscle strength evaluation in the setting of acute spinal cord injury or peripheral nerve injury is critical and serial exams are often required. A sensory examination includes light touch in dermatomal and peripheral nerve distributions. (10)

6.2 Screening/imaging studies

6.2.1 Projection plain radiography (X-ray)

X-ray imaging is the most widespread method used for evaluation of the fracture, are produced by the transmission of X-Rays through a patient to a capture device then converted into an image for diagnosis. The original and still common imaging produces silver impregnated films. In Film - Screen radiography an x-ray tube generates a beam of x-rays which is aimed at the patient.

The film is then developed chemically and an image appears on the film. Now replacing Film-Screen radiography is Digital Radiography, (DR), in which x-rays strike a plate of sensors which then converts the signals generated into digital information and an image on computer screen. X-ray plain examination is still considered in our days the examination with the lower cost and is the examination with the best imaging results concerning bone fractures and is the key examination method to estimate the pattern of the fracture and its separation f there is any.(20)(4)(O.James Garden 2007)

6.2.2 Magnetic Resonance Imaging (MRI)

MRI uses strong magnetic fields to align atomic nuclei within body tissues, then uses a radio signal to disturb the axis of rotation of these nuclei and observes the radio frequency signal generated as the nuclei return to their baseline states plus all surrounding areas. An advantage of MRI is its ability to produce images in axial, coronal, sagittal and multiple oblique planes with equal ease.

MRI scans give the best soft tissue contrast of all the imaging modalities. With advances in scanning speed and spatial resolution, and improvements in computer 3D algorithms and hardware.MRI, is one of the most useful tools in examination of musculoskeletal system, but it has some disadvantages in comparison with the x-ray plain. As examination is more expensive than x-ray, the examination procedure takes place in a very tight chamber that the patient should remain long periods of time still in a very noisy environment .

MRI is contraindicated for patients with pacemakers, cochlear implants, some indwelling medication pumps, certain types of cerebral aneurysm clips, metal implants, endoprosthesis, etc.(20)(10)(O.James Garden 2007)

6.2.3 Computer Tomography (CT)

CT imaging uses X-rays in conjunction with computing algorithms to image the body In CT, an X-ray generating tube opposite an X-ray detector (or detectors) in a ring shaped apparatus rotate around a patient producing a computer generated cross-sectional image (tomogram). CT is acquired in the axial plane, while coronal and sagittal images can be rendered by computer reconstruction. Radio-contrast agents are often used with CT for enhanced delineation of anatomy. CT has become the test of choice in estimation of soft tissue injuries or clotting of vessels and other urgent conditions. (19)(20)(4)

6.2.4 Ultra-Sound (US)

Ultrasound is used to visualize soft tissue structures in the body in real time. No ionizing radiation is involved, but the quality of the images obtained using ultrasound is highly dependent on the skill of the person performing the exam. Ultrasound is also limited by its inability to image through air (lungs, bowel loops) or bone. Small portable ultrasound devices now replace peritoneal lavage in the triage of trauma victims by directly assessing for the presence of hemorrhage in the peritoneum and the integrity of the major viscera including the liver, spleen and kidneys.(Doherty 2006)(20)

6.3 General management principles of fractures

Treatment of fractures first includes reduction, if indicated, and then appropriate immobilization. Appropriate immobilization helps to prevent further injury to the neighboring soft tissues and is required for fracture healing. Fractures that cannot be reduced closed, are too unstable to maintain adequate reduction, or have significant joint involvement are generally treated surgically with open reduction and either internal fixation (plates, screws, and wires), intramedullary nailing, external fixation, or in some cases primary joint arthroplasty. (19)

6.4 Soft tissue injuries, principles of management

In general isolated soft tissue injuries, such as ligament sprains and muscle strains, are treated with rest, ice, compression, and elevation, is the so called RICE therapy, with or without immobilization. (20)

6.4.1 Skin lacerations / defects

All devitalized tissue should be cleaned from any kind of debris. If the wound cannot be closed due to excessive tension, it should be covered with a moist saline dressing, and a delayed primary closure or skin grafting should be planned.(20) (O.James Garden 2007)

6.4.2 Muscle injuries

Mechanism of muscle injuries can be strains of the musculotendinous units are usually secondary to violent contraction or excessive stretch. Injury of a muscle is in the range from stretch of the fibers up to the complete tear with loss of function. In physical examination, swelling, tenderness, and pain with movement take place. Defect on the site of injury can be palpable. RICE – type treatment of the muscle involved is adequate for most of such injuries. (20) (O.James Garden 2007)

6.4.3 Tendon injuries

Lacerated, ruptured, or avulsed tendons should be surgically repaired because such injuries results in loss of function. Examination reveals loss of motion or weakness. Open wounds with a tendon laceration are irrigated thoroughly, debrided and closed primarily with early planned repair of the tendon in the operating room. In grossly contaminated wounds, incision and debridement in the operating room are needed. Splints are applied with the extremity in a functional position.(20) (19)

6.4.4 Ligament injuries

Ligament sprains range from mild stretch to complete tear and are commonly sports related. Pain, localized tenderness, and joint instability may be present on examination. If the involved joint is clinically or radiographically unstable, treatment involves immobilization in a reduced position. If no instability evidence is present, treatment based on the RICE treatment is used and early range of motion is encouraged. (20) (4)

6.4.5 Reduction technique of femoral fracture

Traction is applied first in the direction of the angulations in order to recreate the injury to release the impaction of the bony ends, and then in -line parts with the long axis of the femur to correct the alignment, rotation, and length. Pressure is applied to the distal fragment in the direction of the reduced position. Post reduction x-rays, are obtained in all cases and the extremity is immobilized in the reduced position. (10)

6.5 RICE treatment, what is it and why we need it

One of the most recommended icing techniques for reducing inflammation and treating minor injuries is R.I.C.E., an acronym for rest, ice, compression and elevation. It is best used for pulled muscles, sprained ligaments, soft tissue injury, and joint aches. Applying R.I.C.E. treatments will decrease pain, inflammation, muscle spasms, swelling and tissue damage. It achieves this by reducing blood flow from local vessels near the injury and decreasing fluid hemorrhaging as a result of cell damage.

The following guidelines for RICE application are introduced from the American Academy of Orthopedic Surgeons. Rest: Immediately stop using the injured body part. Ice: Application of ice-packs by the use of a covering or a towel to protect skin from frostbites. Compression: Usage of a pressure bandage around or over the ice pack to help reduce swelling. Never tight the bandage or wrap to the point of cutting off blood flow. Must not be pain felt or a tingly sensation while using compression. Elevation: The injured part should be raised above the level of heart in order to promote blood circulation. (10)

6.6 Common methods of fracture immobilization

6.6.1 Plaster of Paris (PoP)

This is a plaster – impregnated bandage which can be moulded to the part when wet, which sets in time solid. The standard method of external splinting is still plaster of Paris. Synthetic materials are now used for splinting some fractures because of their light-weight and waterproof properties. Custom made light weight thermoplastics can be moulded to the limb and remoulded if swelling or atrophy cause changes in the limb contour. Some synthetic casting materials, however, have less properties and cannot be moulded for example as effectively as plaster of Paris, and occasionally can cause allergies. (16)

Advantages of PoP	**Disadvantages of PoP**
No surgery	May crack
Quick to apply	May not possible to reduce the fracture
No infection risks	Heavy material
Cheap material easy to apply	May rub the skin and cause sores
X-ray translucent	Plaster needs removal to inspect the skin
Rapid patient discharge	If swelling, removal and reapplication must.
Absorbs fluid e.g. blood	

Table 6 Advantages and disadvantages of the Plaster of Paris (16)

6.6.2 Functional bracing

It has now been found unnecessary to fix some fractures as rigidly as was thought in the past, and an example of this is cast bracing (functional bracing). Functional braces have hinges to allow movement. Soft tissues of the limb squeeze against the inside of the brace and, in conjunction with the use of a heel cup, permit weight to be taken through the substance of the brace. This has reduced many of the problems that were seen as a direct result of prolonged immobilization. Another benefit of allowing movement of joints, provided that it does not stress the fracture site, is that it may promote union by improving the area's blood supply. (16)

6.7 Femoral Shaft fracture management

6.7.1 Non surgical approach of fracture of shaft of femur

Treatment depends upon the patient age and medical status, as well as the site and pattern of the fracture. Closed treatment of femoral shaft fractures in adults is rarely indicated. Skeletal traction is generally the most effective form of closed treatment. However 2-3 months of traction are often required, followed by external plaster or brace support. Acceptable alignment may be difficult to achieved, and joint stiffness is frequent result. Other complications of prolonged recumbence like pressure sores and deep vein thrombosis (DVT) can have disastrous consequences. Fractures of the distal femoral shaft are more suitable for cast brace treatment. After 6 weeks in traction, the patient may be placed in a cast brace[1] to allow early mobilization and progressive weight bearing. (19) (4)

6.7.2 Surgical approach of fracture of shaft of femur

Most fractures in the middle third of femur can be internally fixed by an intramedullary rod. Intramedullary rod fixation of the shaft of femur allows immediate mobilization of the patient, more anatomic alignment, and improved knee function. The procedure may perform open or blind. In open nailing the fracture site is opened and the nail is driven retrograde from the fracture site into the proximal fragment. The fracture then is reduced and the nail driven across the fracture into the distal fragment. This requires a long incision and major manipulation of the fracture fragments, with significant blood loss.

Figure 19 Surgical approach of femoral shaft fracture (19)

Advantages of ORIF	Disadvantages of ORIF
Permits detailed inspection	Surgery causes additional trauma
Accurate surgical assessment	Converts closed fracture to open
	Increased risk of infection

Table 7 Advantages and disadvantages of ORIF (16)

In blind nailing, the fracture is reduced by closed manipulation on the fracture table under fluoroscopic control. An 8 -10 cm long incisions is made proximal to the Grater Trochanter, and the nails inserted through the trochanteric notch down to the intramedullary canal. The fracture site is not opened and thus decreased chances of infection and nonunion due to the decreased amount of tissue been dissected. The rod may be removed after 1 year to 1 ½ years after the healing is complete. The healing rate of femoral shaft fractures is very high and approaches 100% after blind nailing. (19) (4)

6.7.3 External fixation

Pins or wires are driven into the fragments of the fracture and held by a piece of apparatus on the outside of the body.

Advantages of External Fixation	Disadvantages of External Fixation
Minimal disruption of the fracture site	Infection of risk at pin sites
Enables inspection of the wound and fracture	Needs extremely wound care
Can be adjusted with minimal trauma	Cosmetically ugly
Can be used for limb lengthening	Restriction of neighboring joints
Can be used to pin multiple fragments	Heavy apparatus
Allows preservation of tissues	High anesthetic risks and late discharge

Table 8 Advantages and disadvantages of external fixation of fractures (16)

[1] Long- leg cast with a hinged knee

6.8 Patellar fracture management

6.8.1 Non- surgical approach of patella

Figure 20 Knee immobilizer (19)

Patellar fracture that is displaced 2 mm. or less and has intact extensor mechanism can be treated with a knee immobilizer o cylinder cast, with the knee kept in full extension for 4-6 weeks. Patients may begin weight bearing if they can tolerate it. (19) (4)

6.8.2 Surgical approach of patella

Indications for open fracture reduction and internal fixation include open fractures, comminuted fractures, and fractures that show more than 2 mm of articular incongruity or displacement. Transverse fractures can be fixed with the tension band and either Kirscher wires[2] or screws. Inferior pole fractures may require reattachment of the patellar tendon and excision of the fragment if it is too small to be stabilized. Partial or total patellectomy is indicated only in severely comminuted fractures that cannot be reduced and stabilized. If the retinaculum is disrupted, it must be repaired. Complications of patellar fractures include loss of motion and extensor strength. Non-union, malunion, infection, and post-traumatic arthritis may occur after internal fixation. (19) (4)

6.9 Complications of the fractures and their management

One of the most severe complications of the patient with fractures of the femur and long bones is the Acute Respiratory Distress Syndrome (ARDS) due to the free embolus of fat that passes the blood circulation and finally reaches the pulmonary circulation via the IVC to the heart and to the pulmonary arteries. DVT and FE are more common complications after fractures of the long bones. Infection of the wound is always another complication that must be expected postoperatively. Also pressure or traction sores in those patients treated conservatively on splints.

Compartment syndrome, if muscles become damaged or inflamed at the time of injury, and intramuscular pressure builds up with no means of release, death (necrosis) of the tissues from ischemia may result. It is defined as the condition with in which high pressure within a closed fascia sheath reduces capillary blood perfusion below the level of necessary for tissue viability. Clinical signs of a limb compartment syndrome are the five Ps: Pale, Pain, Pulseless, Paraesthisia, and Paralyzed. Treatment revolves accurate diagnosis. Surgical decompression is done by fasciotomy to alleviate the increased pressure.

Avascular necrosis is another possible complication of fractures.. Bone receives its blood supply by the soft-tissue structures attached to it by intra-osseous vessels. In certain instances one part of the bone can be very dependent on the inter-osseous vessels for its blood

[2]Kirschner wires or K wires or pins are basically sterilized, sharpened, smooth stainless steel pins. Introduced in 1909 by Martin Kirschner, the wires are now widely used in orthopaedics.

supply, and if this is interrupted because of a fracture, avascular necrosis occurs. Femoral fractures are in the highest risk as also as fractures of scaphoid bones. (16) (14)

7. Post-surgical management

Postsurgical management refers to the patients visit to the physical therapist office for evaluation of his condition and planning of the rehabilitation program in order to return the patient on his pre-traumatic condition, before the fracture.

7.1 Inpatient physical therapy

Immediately after surgery the patient should be treated with very gentle exercises and mobilization twice per day for about 4 days to week. The purpose of such mobilization is to avoid decubitus, DVT, and less stiffened muscles for the rehabilitation plan that is about to follow.

7.2 First visit to outpatient physical therapy

Patient in his/she very first visit to the outpatient explains his condition, what kind of surgery he had, and his main problem and which problems causes him/her in the activities of daily living (ADL) after surgery.

7.3 Evaluation of the patient

7.3.1 Posture evaluation

Posture evaluation is very important for evaluation because we can receive information about the nature of the patients' problem. Adaptation of an analgesic posture for a long time can bring structural and functional changes on the body.

7.3.2 Inspection

By inspection we can see some deformities or edemas in the operated area of the body. Also color of the skin can give a general idea about the blood supply of the area and oxygen perfusion of the patient if cyanosis is present or not. Also presence of hematomas or seromas after surgery can be easily seen if present.

7.3.3 Gait analysis

Evaluation of gait analysis can give us information about the pattern of walking and if there are alteration of walking phases due to pain or weakness of a muscle or group of muscles.

7.3.4 Gait cycle

The gait cycle is a series of movements made by the lower limbs when walking. Observation of human gait has led to the development of the diagram above, which shows one step of the right leg.

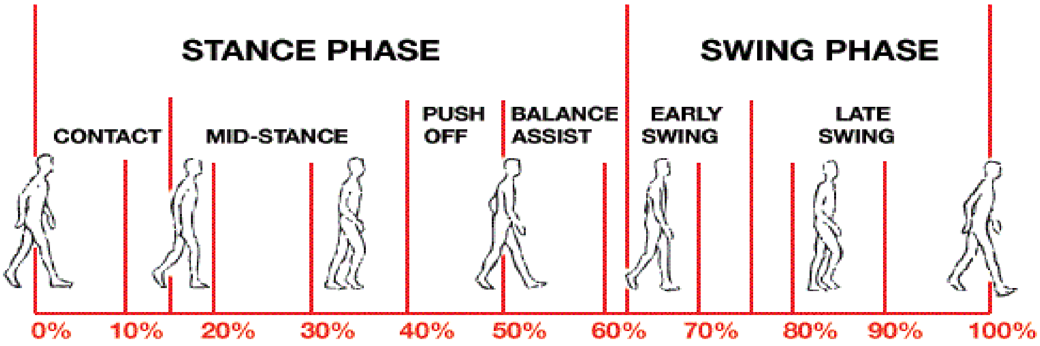


Figure 21 Gait cycle (15)

Stance Phase is when the right limb in the diagram is in contact with the ground. It is broken into different sections: Contact When the heel hits the ground, it is necessary for the body to absorb shock. It does this by bending and internally rotating (twisting inwards) the hip and knee, slowing the movement of the foot to the floor (so it doesn't slap) and pronating (rolling inwards) the foot.

Mid-Stance is when weight is taken onto the right limb and the left limb is swinging through to take the next step. As mid-stance progresses, only the right limb is in contact with the ground (as the left limb is swinging through the air to take the next step). Initially, the lower limb is in a similar position to the contact phase, but, as the left leg swings through the air and weight is taken onto the right limb, the opposite starts to happen, with the hip and knee beginning to straighten and stop rotating inwards. The ankle joint bends more and the foot should stop rolling inwards.

Push-Off At this point, the right leg, instead of absorbing shock, needs to become rigid and springy to push-off onto the next step. The hip and knee are externally rotating and extending, the ankle begins to flex again, after bending to 100 degrees at the end of mid-stance, load is taken onto the forefoot and pressure is directed between the 1st and 2nd toes, allowing the big toe joint to bend.

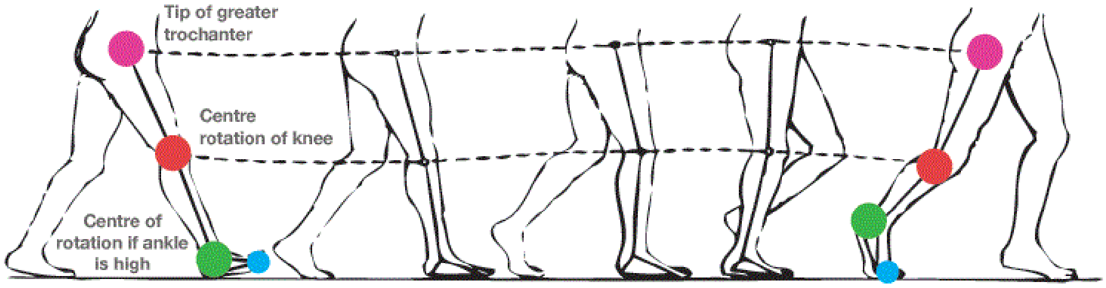


Figure 22 the four points of the biggest pressure group during walking (15)

Balance Assist Load is then transferred to the tips of the toes, as the left heel hits the ground and both legs are momentarily in contact with the ground at the same time. The big toe is the last to leave the ground as pressure is taken on the other foot.

Swing Phase this is when the right limb in the diagram is swinging through to take the next step and is broken down into 2 phases:

Early Swing: The primary function in early swing is to clear the limb from the ground, as it passes the other leg. The hip, knee, ankle and big toe joint all flex to shorten the limb and enable its passage past the weight-bearing leg.

Late Swing: Once past the standing leg and as the centre of gravity of the body moves forwards, the hip continues to flex, but the knee begins to straighten again to throw the leg forwards in order to take the next step. (15)

7.3.5 The lower spine and pelvis

As weight is transferred from one leg to the other in gait, the rest of the body is also moving. Movement of one leg can never be seen as truly independent when walking, as any movement of the lower limb, via the hip, pelvis and lower spine, alters the position of the opposing side of the pelvis and, therefore, hip and lower limb position, as can be seen in the diagrams below. (15)

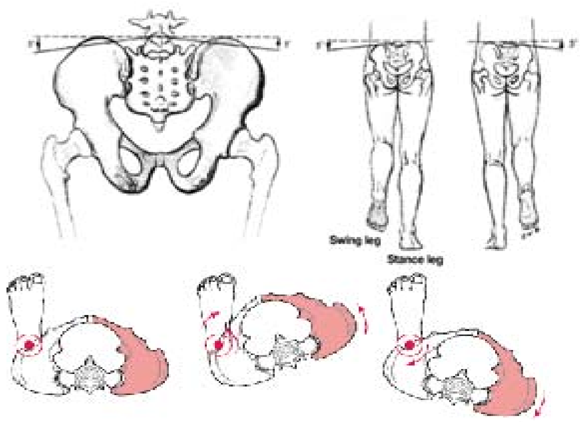


Figure 23 Alternating movements of hip & pelvis and lower spine during walk (15)

7.3.6 Palpation of patient

Palpation of the patient can give us information about the condition of a patient concerning the skin, if it's hydrated or dehydrated, if they are any palpable masses around the problematic area. Also information about the general condition of the scar healing after the surgical incision and if there is signs of hypertonisity or hypotonisity on a muscle or muscle group on the affected area.

7.3.7 Function Tests

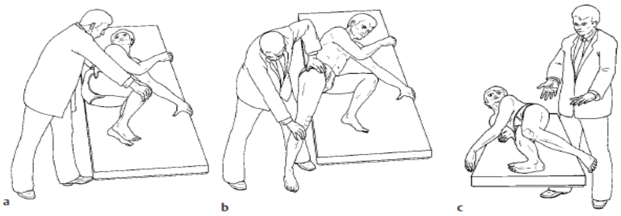


Figure 24 Ober Test a) starting position, b) adduction maneuver, c) drop maneuver (2)

Ober test is used for the assessment of contracture of the iliotibial tract. If iliotibial tract is shortened, the degree of hip adduction will be limited in direct proportion to the degree of shortening. A shortened iliotibial tract leads to chronic pain in the lateral thigh and to functional impairment in the patellofemoral joint. (12)

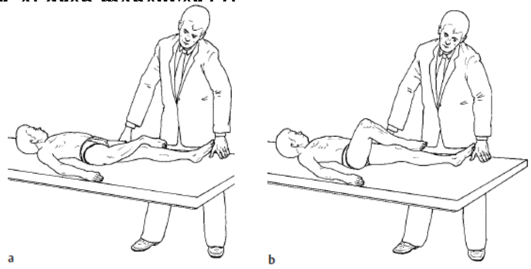


Figure 25 Fabere or Patric's tests. a) Normal response b) abnormal response, adductors are short or tensed. (2)

Fabere Test or Patrick's Test. Normally the abducted should approximate the table, the examiner provides comparative measurements to estimate the distance of the knee from the bed on both sides. Test is positive when the movement is impaired and patient feels the adductors stretched and painful. In young people before adolescence this can be indication for Legg Calve Perthes disease. (12)

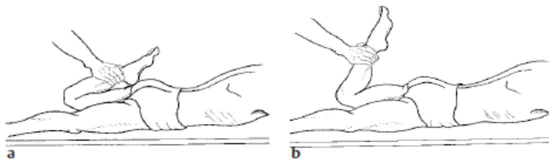


Figure 26 Rectus Femoris traction test. a)pressing heel against buttocks, b) shortened hamstrings (2)

Rectus Femoris Traction Test. Normally knee flexion will be greater than 90^0 with the hip in flexion. Shortening in Rectus Femoris will lead to deficits of knee flexion, with total flexion less than 90^0. (12)

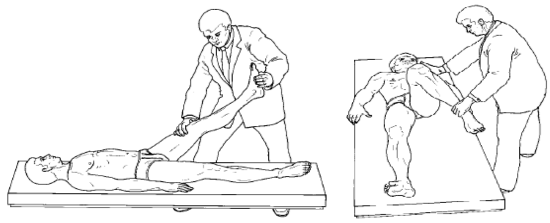


Figure 27 (left) Laseque test, (right) Bonner test. (2)

Laseque sign, Straight Leg Raising test. Intense pain in the Sacrum and leg suggests nerve root irritation. Sciatic nerve can be also irritated when passes through Piriformis muscle. It is also known as Bonner or Piriformis sign, adduction and internal rotation of the leg stretches Sciatic nerve that passes through Piriformis.(William E. Prentice PhD 2005)

Vele's Reflex Stability Test

Patient is asked to lean forward from the ankles without bending at the waist. Activation of gripping toes is observed. If test is positive treatments to consider: stretching/relax of calf, foot mobilization, facilitation/strengthening of intrinsic muscles of the foot, sensory motor training. (12)

The Q Angle

The Q-angle is often measured when examining the knee, especially when kneecap problems are being evaluated. Three landmarks are needed to determine the Q-angle:

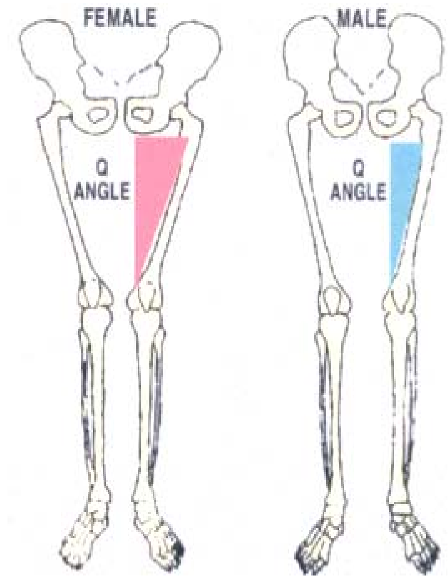


Figure 28 Q angle in male and female (2)

- **Anterior Superior Iliac Spine (ASIS)**
  The ASIS is the front of the pelvic bone that is felt in front of the hip at the level of your waist.
- **Center of the Patella (Kneecap)**
  The center of the kneecap is best identified by locating the top, bottom and each side of the kneecap, and then drawing intersecting lines.
- **Tibial Tubercle**
  The tibial tubercle is the bump about 5 centimeters below the kneecap on the front of the shin bone (tibia).

The Q-angle is formed from a line drawn from the ASIS to the center of the kneecap, and from the center of the kneecap to the tibial tubercle. To find the Q-angle, measure that angle, and subtract from 180 degrees.

A normal Q-angle in men is 14 degrees and in women is 17 degrees. An increase in Q-angle can mean a higher risk of kneecap problems including patellar subluxation and patellar dislocation. (12)

7.3.8 Evaluation of range of motion (ROM)

Evaluation of range of motion can be examined either passive or active. Passively the movement is performed by the therapist only and actively is performed only by the patients' effort. This examination can reveal if there are any limitations of a certain movement. Usually active limited ROM is due to a functional problem; so to speak weakness or pain to muscle .Restricted ROM due to passive performance indicates that the limitation is caused due to a structural problem of the joint. (9)

7.3.9 Manual Muscle Strength examination

Manual examination can reveal muscle weakness by means of muscle strength test or can limited ROM of a joint or even reveal restriction of a joint and thus limitation of ROM. By means of joint play mobilization or manipulation can have even immediate results of alleviation of patients' condition. (9)

7.4 Physical therapy modalities

Physical therapy modalities includes the usage of natural sources like cold or heat, water, or artificial sources such as light or electrical current to cause changes of the soft tissues like hyperemia to promote healing of the tissues or relief patient from pain, analgesic effect ,or even for muscle strengthening by means of electric stimulation.(11)

The modalities to be covered in this paper are:
1) Pulsed magnetic field therapy
2) Laser therapy
3) Interferential therapy
4) Low intensity pulsed ultra-sound

7.4.1 Pulsed Magnetic Field Therapy

Pulsed magnetic field therapy (PMFT), is defined in the treatment of fractures as the application of time-varying magnetic fields that induce voltage wave-form patterns in bone similar to those resulting from mechanical deformation. The electrical voltage is induced at right angles to the pulsed, or dynamic, magnetic field.

The strength of the magnetic field in clinical applications is usually from 30 Gauss (30G) to as much as 1,000G – the Earth's magnetic field in comparison is in the region of 0.5G – and a frequency range of 1 Hz to about 200 Hz is typically used.
Magnetic fields may be measured in Tessla. There are 10,000 Gauss units to one Tessla.
The FDA in America approved the use of PMFT in the treatment of fractures and non-union fractures in 1979.

Nelson et al demonstrated that application of PMFT caused up-regulation of messenger RNA (mRNA) along with protein synthesis of TGFâ and BMP gene group, all of which have been shown to enhance fracture repair. They concluded that PMFT is indicated in established non-unions, failed arthrodesis and congenital pseudarthrosis. Ryaby et al showed that PMFT causes differentiation of osteogenic precursor cells along with up-regulation of TGFâ, BMPs and IGF. (11)

The physiotherapist would need to mark on the cast the approximate area of the fracture, referring to the X-rays for guidance.

7.4.2 Laser Therapy

"Laser" stands for Light Amplification by Stimulated Emission of Radiation. The main differences between Laser light and high-intensity light is that Lasers emit a coherent beam i.e. all photons are in phase and synchronized, the light is monochromatic i.e. one single, very specific wavelength and the Laser is applied with a specific dosage in mind, usually measured in Joules per square centimeter. Some Lasers are used in contact with, or very close to, skin and usually have an optical lens giving a divergent beam, frequently in the region of 6 degrees, while some more powerful Lasers emit a non-divergent beam which can scan along easily set parameters along X and Y axes to cover a larger area. The use of a non-divergent beam means that the inverse square law does not apply although clearly it does in the case of the 6 degree divergent beams.

The usual therapeutic wavelengths are in the far red to near infra- red (FR/NIR) wavelengths, ranging from about 600 nm (visible red) to 1000 nm (non-visible infra-red). Most therapeutic Lasers typically have outputs ranging from 5 mW (0.05W) to

1000 mW (1.0W) and treatment times can vary from mere seconds to several minutes. Some more powerful scanning Lasers can deliver 3W continuous output and have the capability to produce a thermal burn if applied inappropriately. Some research studies indicate tissue response may be dose dependent as well as being dependent on the irradiation time and irradiation mode

Photon irradiation by light in the FR/NIR spectral range has been found to modulate various biological processes in cell culture and animal models. The mechanism of photo-bio-modulation by FR/NIR at the cellular level has been ascribed to the activation of mitochondrial respiratory chain components. Growing evidence suggests that cytochrome oxidase is a key photo-acceptor of light in the FR/NIR spectral range.

Cytochrome oxidase is an integral membrane protein having a strong absorbance in the FR/NIR spectral range, detectable in vivo by NIR spectroscopy.

Far red cellular irradiation has been shown to increase electron transfer in cytochrome oxidase, increase levels of mitochondrial respiration and ATP synthesis in isolated mitochondria and also to up-regulate cytochrome oxidase activity in cultured neuronal cells. This photo-stimulation also induces a cascade of signaling events such as activation of immediate early genes, transcription factors, cytochrome oxidase subunit gene expression as well as other enzymes and pathways related to increased oxidative metabolism. (11)

7.4.3 Interferential Therapy

Interferential therapy (IF): Most physiotherapists should be fully acquainted with the theory and practice of IF. IF may be applied using quadric-polar or bi-polar techniques. As in all electrical therapies, the exact site of the lesion is identified – in this case, the fracture – and the electrodes are placed accordingly, bearing in mind the depth and extent of the fracture site. Care must be observed in patients with associated loss of skin sensation due to local nerve damage since patient feedback on the extent of the current sensation is essential in the application of IF.

The fact that capacitive skin resistance at 4 KHz is 80 times lower than with a frequency of 50 Hz means that dosage can be significantly increased, so improving the ability of the current to access deeper structures. Laabs demonstrated in 1980 that when IF is applied across a bone, the IF field is present within the fracture site, with the highest intensity being within the medullary cavity.

It has been suggested that the 4 main clinical applications for IF are:-Analgesia

Skeletal muscle stimulation, Vasodilation, Edema reduction

Claims are also made for the role of IF in stimulating healing and repair, which is likely to be due to the above effects and, although the benefits of vasodilatation and edema resorption in the surroundings of a fracture are self-evident, no definitive studies exist proving that these effects do apply to IF current when applied to bone. It could, however, also be argued that there should be no physiological reason to suppose that IF would not produce these effects in bone.

The importance of increased alkaline phosphatase (AP) in fracture sites has already been stressed to demonstrate increased osteoblastic activity. (11)

7.4.4 Low Intensity Pulsed Ultra-Sound

Ultra-sound (US) is an acoustic pressure-wave form of mechanical energy which can be transmitted through and into body tissue at above audible frequencies. Depending on the intensity, it can be used diagnostically, therapeutically or surgically. Therapeutic US is usually applied in frequencies of 1 MHz – 3 MHz, at intensities of $0.3W/cm^2$ – $3\ W/cm^2$ and

with pulse options usually being 1:4, 1:2, 1:1. When used in continuous mode, therapeutic US can have a considerable thermic effect.
Surgically, intensity levels of up to 300 W/cm^2 are used in bursts for lithotripsy and removal of peri-prosthetic cement in cases of prosthesis revision.

Most studies over the past 20 years and most currently available LIPUS equipment use current intensities varying from $20mW/cm^2$ to 200 mW/cm^2. This intensity is now widely accepted as being therapeutically beneficial in the acceleration of fresh fracture healing as well as the initiation of healing in non-unions. LIPUS was approved by the Food and Drug Administration (FDA) in the United States in 1994 for the accelerated healing of fresh fractures and approved by the same body in 2000 for the treatment of established non-union fractures. The studies presented to the FDA demonstrated that LIPUS had a positive effect during the three main stages of fracture healing – inflammatory, reparative and remodeling by enhancing angiogenesis, chondrogenesis and osteogenesis. (11)

7.5 Therapy plan

Therapy plan is divided to short term and long term therapy plan. This depends completely from the patient’s status and needs.

7.5.1 Short term therapy plan

At short term plan the priorities are set to help the patient with problems such pain. Relief of pain should be the main priority in order to continue later with the rest of the rehabilitation procedures and help the patient to return as soon as possible to his/hers ADLs. Short term plan usually takes about 4 weeks more or less with 3 x sessions per week depending on the severity of the patients’ condition. The main first goal is to relief any pain if exists, and possible blockages on the restricted joints.

7.5.2 Long term therapy plan

Long term therapy plan usually refers to the set of goals that takes more time to achieve such us strengthening of a muscle or stretching of a shortened muscle or improvement of ROM, for example.

7.6 Education of patient

In this part, therapist helps the patient to understand the patient of his condition severity level and what he must do to follow correct the therapist advices. Education involves understanding of the procedures that are about to follow during rehabilitation, education of how to use special advices such as braces, walking by assistance of crutches and how to use them properly, Also reeducation of the patient in his ADLs and how to perform them in fashion of safety not to injure or aggravate his condition.

8. First part

Clinical Case Study

8.1 Methodology

Clinical case study took place in the Military Hospital (UVN, Ústřední vojenská nemocnice Praha 1200/1, 162 00 Praha 6) from 11.1.2010 up to 22.1.2010. In that time I was able to see my patient 6 times during the outpatient hours plus I visited hospital in advance four more times in order to fulfill my final kinesiology examination by giving some extra time to the patient to exercise in order to have a more clear and spherical view of his progress. My patient was after surgery of repair fracture of shaft of femur after motorbike accident.

There is a written informed consent signed from the patient, that I can use his study case for developing my thesis work.

There is a written informed consent of the project of the thesis by the Ethics Committee of the faculty of Physical Education and Sport at Charles University.

8.2 Anamnesis

Examinated person: A.J.

Sex: Male

Date of birth: 3/10/1962

Height: 178 cm

Weight: 75 kg

BMI: 23.7

Diagnosis: T068 After extraction surgery of fracture of shaft of femur

8.2.1 Chief complains:

Patient has weakness to descend or ascend stairs; he feels pain on his right lower extremity. Patient also claims that he observes his right extremity and has the impression that the right thigh is thinner than the left thigh. Also he feels pain when he palpates the lateral side near the Greater Trochanter of his right thigh. In addition, also he mentioned about pain on the area of his lateral knee above the head of fibula.

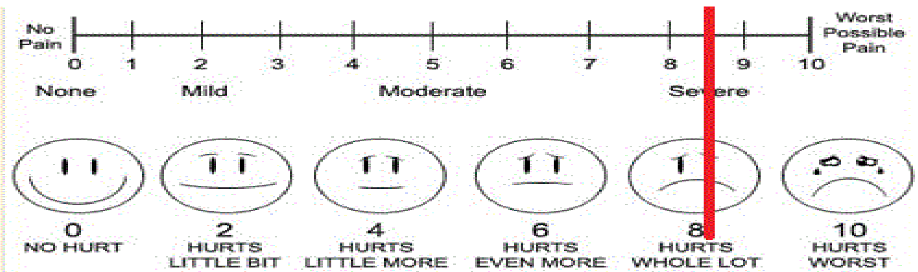


Figure 29 Patient's pain scale (14)

Patient on the pain scale from 1-10 he complained of 8.5 .That pain is translated as severe pain that annoys him a lot at his ADL.

8.2.2 Mechanism of injury

Patient was driving with his motorbike on 21/7/2008 in a high speed street when the car in front of him break down suddenly and he crushed on the back side of the car and he actually passed through the back window of the stopped car. Patient suffered fracture of his right diaphysis of femur when he came with force in contact with the bumper on the back side of the car.

8.2.3 Previous Operations

Partial patellectomy and repair with Kirscher wires, intramedullary fixation of the fracture of the right shaft of femur, and 2 extraction operations of the nails and rod. Intramedullary nailing and Partial patellectomy took place on 21/7/2008, the extraction operations took place, the first on the 3/4/2009 and the second operation of extraction of osteosynthetic material from his right femur on 27/10/2009 and follow up is after six months time.

8.2.4 Personal Anamnesis

Patient does not have any actual physical activities on his daily life due to the nature of his work. As supervisor in a company that he works for most of the time he is was an office work or he drives to the company stores to control the incomes and outcomes.

When he was discharged from the hospital after his extraction surgery he noticed that his right thigh is thinner from his left and he was stressfully asked for evaluation and rehabilitation treatment if is necessary.

8.2.5 History of diseases

Patient had in the past only the usual childhood diseases, Infectious Mononucleosis. Patient has clear history of chronic systemic diseases.

8.2.6 Occupational Anamnesis

Patient is supervisor in an office. The nature of his job is mainly in an office sitting but occasionally his is driving with his motorbike to visit other places cooperating with the office he works.

8.2.7 Medications

No medications prescribed to the patient. But the patient occasionally takes Ibuprofen, NSAID drug to deal with his pain.

8.2.8 Abuses

Patient is a social smoker of about 2-3 cigarettes per day, and he is a social drinker. He usually drinks beer and sometimes white wine on his summer vacations

8.2.9 Allergies

Patient has allergy in PNC (penicillin) and in ACP (Acylpyrine) and during the spring time he has allergy on the pollen of flowers.

8.2.10 Previous Rehabilitations

Patient has been twice under rehabilitation post-operatively due to his two extraction operations since April 2009. Rehabilitation both times was concerning, strengthening of the knee joint, bicycling, swimming and walking without assistance of crutches and learning how to load his weight on his both legs.

8.2.11 Family Anamnesis

Both parents are in full health without facing any vigor problems.

8.2.12 Social Anamnesis

Patient is married with two kids, patient lives with his wife and children in a big family house with garden, and two stores with internal stairs, stairs are not many but are enough to cause him problem through his ADL.

8.2.13 Statement from the patient's medical ambulatory documentation

He was immediately transferred to the hospital for his treatment and evaluation; Patients vital signs didn't show any danger for his life. Isochoric reflex was physiological; blood pressure was 170/90, Oxygen saturation at 100%. Breathing was symmetrical with no further chest injuries only a hematoma at his right upper chest quadrant. Abdominal injuries were not suspected since his abdomen was soft and free without pain, and after urinary catheter no blood was found in urine.

X-rays confirmed the deformity for fracture of the shaft of the femur and comminuted fracture of patella. Also skin lacerations were treated on the left popliteal fossa. Ultra-Sound examination did not reveal any damage of the solid internal organs neither the hollow organs. CT brain scan was clean except a small closed not separated fracture of the nasal bone. Orthopedic examination showed that RLE was defigurated with edema, hematoma, due to right diaphysis fracture and comminuted patellar fracture. Pelvis was straight with no signs of any injury.

8.2.14 Statement from the patient's medical surgical documentation

Patient's condition is after extraction of screws and rod of his right leg after the repair operation for fracture of the shaft of femur. Scar after from incision of his right lateral femur looks clean without secretions and signs of inflammation. Patient was discharged from the hospital in a stable condition. BR is 16 breathes per minute, BP, 120/80.

8.2.15 Statement from the patient's rehabilitation documentation

Increase of ROM of the Right knee joint and intensive rehabilitation for right knee strengthening, riding on bicycle and swimming and walking with full load without crutches.

8.2.16 Differential diagnosis

Patient is complaining for restriction of movement in the knee when goes upstairs, or downstairs, so a weakness of the quadriceps muscle can be one reason. Other reason can be restriction of the fascias of the thigh that can cause the pathogenic condition. Patella restriction can be also another one reason. Also hypertonic and stiffened muscles after the surgery are common condition, so it can also be the cause of pain and restriction of knee movement. Trigger points on the muscles around the knee can be also one reason for painful movement.

Pain on the lateral side of the knee above the head of fibula can be explained by blockage of the head of the fibula. Additionally the pain above the lateral area of the thigh can be due to hypertension of Piriformis muscle. Pens Anserinus[3] also is possible on patient after sustained an injury as a major cause of chronic knee weakness and chronic pain. Also difference in patients' extremity length can be the cause of pain. Insufficient previous rehabilitation can also be the reason of the patient's problem due to unsuitable exercises or not well performed exercises.

[3] The **pes anserinus** ("goose's foot") is the insertion of the conjoined tendons of three muscles. onto the anteromedial (front and inside) surface of the proximal extremity of the tibia. The three muscles are Sartorius, Gracilis and Semitendinosus

8.3 Initial kinesiology examination

8.3.1 Postural examination

Postural examination of patient performed for the anterior, posterior, and lateral view. Plumb line is used for the assessment.

Anterior view: Patient has a normal base with a very slight external rotation of feet. Knee joints are in extension. Hip joint is also extended.

Posterior view: Patient presents. The left knee looks again to be hyperextended. Lumbar and Thoracic spine are flat and the Cervical spine is slightly hyperextended. Scapulas are abducted. Patient has a smaller thoracobrachial triangle on the left side, and a slight rotation of the trunk from left to right, like clockwise.

Lateral view: The patient with ankle joints in a slight plantar flexion position. The shoulders are protruded forward and head also is more forward. Patient's pelvis looks to be in posterior tilt.

8.3.2 Inspection

Patient's skin has a physiological color, and the areas above the scars looking nicely healed with no signs of secretion or any inflammation. No signs of edema around the knee joint and no signs of deformity of the aligned right femur. It is though almost clearly visible a hypotrophy of the right thigh with respect to the patients left thigh.

8.3.3 Breathing Examination

Patient during examination is breathing in a normal pattern of 16 breaths per minute. No signs of any paradoxical type of breathing are present. Mainly patient uses his diaphragm for his breathing and his upper abdominal muscles. Thoracic chest movement is clearly visible mainly during deep inhalation.

8.3.4 Palpation

Superficial palpation shows that patient has hydrated skin with no signs of increased temperature that can be result of an inflamed condition. Kibbler's fold around the scars of the femur and knee is not so good with restrictions as well as fascias restriction of the thigh.

Around the area of the Greater Trochanter of the right thigh, a painful area was noticed and I turned patient in the prone position to palpate his Piriformis muscle who was indeed hypertonus.

Patient also felt pain on the area of the head of fibula during palpation so a blockage of the head of fibula is very possible.

During palpation I found Rectus Femoris hypertonus but Vastus Medialis was almost hypotonus. Adductors of the thigh were also hypertonic, Hamstring muscles were hypetonus also.

Trigger points on the Gracilis muscle were found on the muscle its self, they were painful only during palpation and there was no reference from the patient for a more generalized pain around the muscle.

8.3.5 Pelvis examination

By measuring, the Anterior Superior Iliac Spine ASIS level of left and right side of the patient pelvis, no lateral shift is marked, a fact that is confirmed also by the measurement of the level of the Posterior Superior Iliac Spine PSIS, which are both ASIS and PSIS on the left and right side are on the same level. When measuring the level between the ASIS and the PSIS a marked posterior tilt of the pelvis was revealed

8.3.6 Anthropometric measurements

Measurement	Description	R.L.E.	L.L.E.
Anatomical length	Is measured from Greater Trochanter up to the Malleolus Lateralis	84 cm	84.5 cm
Functional Length	Is measured from Spina Iliaca Anterior Superior up to the Malleolus Medialis and from Umbilicus to the Malleolus Medialis	A.S.I.S. 87 cm Umbilicus 93 cm	A.S.I.S. 87 cm Umbilicus 93.5 cm
Length of the Thigh	Is measured from Greater Trochanter to the knee joint or to the head of Fibula	Trochanter to Fibula 47 cm	Trochanter to Fibula 47 cm
Length of the middle leg	Is measured from the knee joint or head of Fibula to the Malleolus Lateralis	Fibula to Lat. Malleolus 37 cm	Fibula to Lat. Malleolus 37.5 cm
Length of the foot	Is measured from heel to the longest toe	26.5 cm	26.5 cm
Circumference of thigh	Measured 15 cm above the knee cap (when testing the m. Quadriceps as a whole) and 10 cm above the knee cap when we want to measure hypotrophy of Vastus Medialis.	Quadriceps 48 cm Vastus Medialis 40 cm	Quadriceps 50 cm Vastus Medialis 47 cm
Circumference of knee join	Is measured around the knee and knee cap	38 cm	38 cm
Circumference of the calf	Is measured in the place of the highest volume	35 cm	35 cm
Circumference of the ankle and foot	Is measured around the Malleolus Medialis and Lateralis Foot is measured around the metatarsal heads	26 cm 25 cm	26 cm 25 cm

Table 9 Anthropometric measurements of initial kinesiologic examination

8.3.7 Gait examination

I asked the patient to stand up without shocks and with shorts in order to provide for me his normal walking and some other modifications of gait for diagnostic purposes. Patient's gait had a characteristic feature of the loading of his left leg more than the right leg. He showed a nice synkinesis of the trunk and arms, but a very small ankle dorsal flexion of the ankles, especially on his right leg. I asked the patient later to try gait modifications such us backwards walking, on his toes, and on his heels. During backward walking I have noticed that the patient used more flexion of the knees with respect to the hip movement. When patient tried to walk with his toes and his heels he did not met any problem to perform it.

8.3.8 Range Of Movement Tests

Patient examined for the range of movement of the hip, knee and even the ankle joint.(Kendall 2005)

	Left Hip		Right Hip	
	Passive	**Active**	**Passive**	**Active**
Flexion	125	125	125	90
Extension	10	10	10	10
Ext. Rotatio	45	40	40	40
Int. Rotatior	45	40	45	20
Adduction	10	10	10	10
Abduction	45	40	45	30

Table 10 ROM examination results for the hip joints

	Left Knee		Right Knee	
	Passive	**Active**	**Passive**	**Active**
Extension	0	0	0	0
Flexion	140	130	140	100

Table 11 ROM examination results of the knee joints

	Left Ankle		Right Ankle	
	Passive	**Active**	**Passive**	**Active**
Dorsal Flexion	20	20	10	10
Plantar Flexion	45	40	45	40
Inversion	40	40	40	20
Eversion	20	20	20	20

Table 12 Initial ROM examination results of the ankle joints

8.3.9 Muscle Strength Test (by means of Kendall)

Patient was examined his muscle length test for his hip knee and ankle joint where the limited ROM was found.(Kendall 2005)

	Left Extremity	Right Extremity
Quadriceps	4+	3
Hamstrings	4+	3+
Tibialis Anterio	4+	3+

Gastrocnemius	4+	4

Table 13 Muscle strength test of initial examination

8.3.10 Muscle Length Test.

	Right Extremity	Left Extremity
Hamstrings	Grade 1	Grade 1
Quadriceps	Grade 2	Grade 2

Table 14 Muscle length test results by Janda

Shortness of both one joint and two joint hip flexors was observed. Sartorius and TFL muscles were with no shortness during hip flexor testing. Hamstrings were found short during the length test for Hamstring muscles. (Kendall 2005)(18)

8.3.11 Joint Play Examination

Patient was examined for possible restrictions of the knee and ankle joints.

Patient's examination of Calcaneus to the lateral direction was found slightly restricted in the right leg. Examination of the right talocrural joint in dorsal direction revealed marked restriction. Left Calcaneus was with no restriction, but slight restriction was found on the left talocrural as well.

Examination of the right knee in tibial and fibular directions discovered restrictions, with respect to the left Knee that was without restriction.

Examination of the patella did not show any restriction, but the examination of the right head of Fibula showed restriction to the dorsal direction. Left head of fibula was free of restriction. (18)

8.4 Neurological assessment

Laseque test	negative
Deep sensation test	negative
Rhomberg Balance Test	negative

Reflex testing

Patient was tested for the patellar reflexes and Achille's tendon reflexes. Reflexes are present on both lower extremities at the same quality level.

8.4.5 Single Leg Test

Patient stands on one leg and tries to hold his balance, and afterwards changes his standing leg to compare results. (19) (17)

Patient when he was standing on his left leg he had no significant difficulties to maintain his balance, but when patient tried to stand on his right leg he was swinging trying to hold his balance.

8.4.6 Superficial sensation testing

With a very smooth brush like instrument and a pin, I tested the skin sensation of the patient. I followed the paths of the dermatomes; in anterior aspect I tested the dermatomes L1, L2, L3, L4, L5, and S1.

Patient did not had any problem with sensation on the dermatomes with the only exception on the sites of the scars which is absolutely physiological

8.4.7 Vele's Reflex Stability Test

Patient is asked to lean forward from the ankles without bending at the waist. Activation of gripping toes is observed. Test is positive

8.5 Conclusion of Examination

After the finish of the Initial kinesiology examination plus all the informations of the rest examinations such neurological and manual muscle testing, I am sure that the problem is not of neurological nature. Due to the prolonged fixation of the right lower extremity, the result was to have some hypotrophy of the Quadriceps Femoris muscle, and especially the portion of whom refers to Vastus Medialis. Patient is workaholic and obsessed with his profession and he did not pay any attention of the physicians advises for mobilization of the operated leg. So, as result restriction of the knee in tibial and fibular directions, also the head of fibula is restricted to the dorsal direction as well as the Calcaneus to lateral direction and talocrural joint to dorsal direction.

8.6 Rehabilitation Plan

The rehabilitation therapies are going to be planned in the basis that the patient must firstly stop feeling any pain in order to proceed to a more complicated exercises that aims to the strengthening of the weakened and atrophied muscles, as well as improvement of the proprioception of the patient of his right lower extremity. Thus the Short term rehabilitation plan will include the following priorities. The long term plan will include procedures that their goals of therapy takes more time to achieve such as the strengthening of the muscles to return them in the normotrophic condition, and sensomotoric exercises to improve the proprioception and balance of the patient.

8.6.1 Short & Long Term Rehabilitation Plan.

Short – Term Rehabilitation Plan

Relief of pain of Gracilis muscles due to presence of Trigger points by pointing technique.

Sensomotoric exercises of the lower extremities to improve balance.

Release the hypertonus Piriformis muscle using PIR technique.

Release the hypertonus of the Rectus Femoris muscle using PIR.

Release the hypertonus of the Hamstrings muscles using PIR.

Stretching exercises for the shortened muscles such as is Rectus Femoris, Hamstrings, Gastrocnemius.

Mobilization of the Calcaneus, talocrural, knee joint, and the head of fibula

Light exercises in aquatherapy of the department of rehabilitation of the UVN hospital to start increasing the ROM and strength the weak muscles.

Release of the fascias of the thigh is essential to alleviate restrictions.

Long –Term Rehabilitation Plan

Strengthening exercises to improve muscle strength and stability of the joints.

Increase of ROM of knee and ankle joint.

Education of the patient is fundamental to improve posture and loading of his weight equally to his both lower extremities.

The short term rehabilitation plan is based on the principles to bring the patient in an acceptable condition in order to fulfill his treatment through long term rehabilitation plan, following the procedures above. (18)

8.6.2 Instruments used in the Rehabilitation procedures

For the procedures of exercises and rehabilitation we need the usage of some tools and instruments. Such as Thera-Band, overball, weights, spike balls, Trampoline, swing-surface for balance and walking, Wobble boards, Gymnastic ball.

8.7 Visits / Sessions

SECOND PART

8.7.1 Date: 11.1.2010

Session #1

Subjective Report: Patient complains for stiffness of the knee joint and difficulties of the movement when he has to flex his right knee. He feels also discomfort when he tries to laterally rotate his right hip; all of this is escorted with a general feeling of weakness and uncertainty of falling down.

Assessment: Painful tension in Piriformis, restriction of the fascias of the thigh, hypertonic Rectus Femoris and hamstrings and adductors of the hip. Painful trigger points of the Gracilis, restriction of Calcaneus, Talocrural, Knee joint, and head of Fibula, always in respect to the pain of the patient.

Today's Plan: Alleviation of hypertonic muscles must be achieved, releasing of restricted fascias, mobilization of the restricted joints is essential, relief the trigger points from Gracilis muscle.

Today's Procedures:

- Stretching exercises for the Rectus Femoris muscle, Gastrocnemius, and Hamstrings adductors of the hip muscles.
- Light exercises in Aqua-therapy 20 min. 38 C^0, training movements of hip in F, ABD, and E as conditioning exercises. Aqua-massage from the ankles to the hip and low back.
- PIR 3 x times for Piriformis muscle, Rectus Femoris muscle and for adductors of the hip and Hamstrings.
- Mobilization of the Calcaneus, Talocrural, knee. Manipulation head of fibula.
- Release of Gracilis muscle trigger points is performed.
- Mobilization of the deep fascias of the thigh is required formation of Kibler's fold and fold formation up to the barrier and soft springing pressure applied.

Results: There is response concerning the decrease of the hypertonic muscles of Piriformis, Rectus F. and adductors of the hip and Hamstrings but he needs a lot of work until he reaches the desired level of fitness. The fascias and scars are still restricted but it is matter of few sessions to follow until they are completely released. Trigger points are most of them released but not all of them. Joint play is slightly released the blockage of the Calcaneus and talocrural joint, but only slightly, knee and head of fibula still remains restricted.

Rehabilitation Prognosis: Promising for good prognosis in the future.

8.7.2 Date: 13.1.2010

Session #2

Subjective: Stiffness on his knee with a slight improvement. Weakness though of his right knee is marked. Painful Piriformis slight improvement.

Assessment: Piriformis is in painful tension, Restriction of the fascias of the thigh. Hypertonic Rectus Femoris and adductors of the hip and Hamstrings, Restricted Calcaneus, Talocrural, knee joint, and the head of fibula, Trigger points of Gracilis muscle are present still but are not painful.

Today's Plan: Alleviation of hypertonic muscles, release of restricted fascias, and increase joint play of the restricted joints. Facilitate proprioception and aquatherapy, Release the restricted deep fascias of the thigh must be performed. Relief the trigger points from Gracilis muscle.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- Light exercises in Aqua-therapy for 20 minutes at 38 C^0 training movements of hip in F., ABD. and E.. Aqua-massage from the ankles up to the hip and low back.
- PIR 3xtimes for adductors of the hip, Piriformis muscle, for Rectus Femoris muscle and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction). Manipulation of the head of Fibula in lateral direction.
- Sensomotoric stimulation massage with the help of a spike ball at his right lower extremity, and around the joints from ankle to knee.
- Mobilization of the deep fascias of the thigh is required formation of Kibler's fold and fold formation up to the barrier and soft springing pressure applied.
- Release of Gracilis muscle from trigger points by pointing technique.
- Exercises in the fitness room: 5min. bicycle. Overball exercises, sets of 15 repetitions by holding and pressing overball between his knees. Pressing the overball against bed (ball is placed under knee and afterwards under Achilles tendon). 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise.

Results: Fascias and scar seems to be looser now in comparison with the result of our first session. Piriformis muscle Rectus Femoris and Hamstrings and adductors of the hip have decreased tonus than before, but still are hypertonic in respect with the left lower extremity muscles. Joint play starts to be appeared in the restricted joints of knee and Calcaneus, to lateral directions. Talocrural joint and head of fibula still remains restricted. Trigger points that remained of the Gracilis muscle looks to be painless.

Rehabilitation Prognosis: Good

8.7.3 Date: 15.1.2010

Session #3

Subjective: Feels still stiffness to his knee but with a slight improvement, Feeling of weakness of the right knee joint. Problems with maintain balance.

Assessment: Piriformis is hypertonus-no pain, Rectus Femoris muscle, adductors of the hip and the Hamstrings are less hypertonic since last time. Restricted calcaneus, talocrural, knee joint, and mobilization of the head of fibula, Trigger points of Gracilis muscle that remained are painless.

Today's Plan: Alleviation of hypertonic muscles and release of restricted fascias, increase joint play of the restricted joints. Facilitate proprioception and aquatherapy. Moderate exercises for muscle strengthening, Mobilization of the deep fascias of the thigh and scar. Relief the trigger points from Gracilis muscle.

- **Today's Procedures:**
- Stretching of the Rectus Femoris muscle, Gastrocnemius, Adductors of the hip and Hamstrings muscles.
- Light exercises in Aqua-therapy 20 min. at 38 C^0 exercises of hip in F., ABD., and E. as conditioning exercises. Aqua-massage from the ankles up to the hip and low back.
- Release of Gracilis muscle trigger points by pointing technique. Mobilization of the deep fascias of the thigh is required
- PIR 3x times for Piriformis, Rectus Femoris, adductors of the hip and for Hamstring muscles.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Mobilization of the deep fascias of the thigh is required formation of Kibler's fold and fold formation up to the barrier and soft springing pressure applied.
- Sensomotoric stimulation massage with a spike ball on his right lower extremity around the joints from ankle to knee.
- Fitness room: 5min. bicycle. Overball exercises, sets of 15 repetitions by holding and pressing overball between his knees. Pressing the overball against bed (ball is placed under knee and afterwards under Achilles tendon). Against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg. 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise.

Results: Fascias and scar seems to be almost fully released now in comparison with the result of the first session. Piriformis muscle Rectus Femoris, adductors of the hip and Hamstrings have decreased tonus even more than before, but still some hypertonus in respect with the left lower extremity muscles is present. Joint play starts to be appeared in all the restricted joints of knee and Calcaneus, to lateral directions and Talocrural joint and head of fibula that until today they were restricted. Trigger points seems to be released fully.

Rehabilitation Prognosis: Good

8.7.4 Date: 18.1.2010

Session #4

Subjective: Patient see a significant improvement since the pain is no more, and due to the fact that weakness is present only after his training (fatigue) and no during his ADLs.

Assessment: Piriformis is slight hypertonus painless, Rectus Femoris, adductors of the hip muscle and the Hamstrings are also slight hypertonic since last time. Slight joint play of calcaneus, talocrural, knee joint, and mobilization of the head of fibula are present but not fully released.

Today's Plan: Alleviation of hypertonic muscles. Release the restricted fascias. Mobilize the restricted joints. Light exercises for proprioception and aquatherapy. Moderate exercises for muscle strengthening, Mobilization of the deep fascias of the thigh.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- Light exercises in Aqua-therapy 20 min. at 38 C^0 training movements of hip in F, ABD, and E as conditioning exercises. Aqua-massage from the ankles up to the hip and low back.
- PIR 3x times repetition for Piriformis muscle, for adductors of the hip, Rectus Femoris muscle and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Mobilization of the deep fascias of the thigh by formation of Kibler's fold and fold formation up to the barrier and soft springing pressure applied.
- Sensomotoric stimulation massage with a spike ball on his right lower extremity around the joints from ankle to knee.
- Exercises in the fitness room: 5 min. bicycle. Overball exercises, 1 set of 15 x times by holding and pressing overball between his knees. Pressing the overball against bed (ball is placed under knee and afterwards under Achilles tendon). Against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg. With 2 sets of 10 x times each of 5 kg for the muscle strengthening of Quadriceps muscle. 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise.

Results: Fascias and scar seems to be fully released now in comparison with the result of the first session. Piriformis muscle Rectus Femoris, adductors of the hip and Hamstrings have decreased tonus even more than before, and looks normotonus in respect with the left lower extremity muscles. Joint play starts to be increased in all the restricted joints of knee and Calcaneus, to lateral directions and Talocrural joint and head of fibula that until today they had blockage.

Rehabilitation Prognosis: Good

8.7.5 Date: 20.1.2010

Session #5

Subjective: Patient during the weekend he claimed that he worked in the gym with small weights 3-5 kg and he stretched the quadriceps muscles and hamstrings, adductors of the hip and he feels that muscle endurance is much better than before we start the treatment. The pain is not more and stiffness is markedly decreased.

Assessment: Piriformis is without hypertonus neither pain, Rectus Femoris, adductors of the hip muscle and the Hamstrings are also near to normotonus. Joint play of calcaneus, talocrural, knee joint, and of the head of fibula are increased but not to the wanted level of our goal.

Today's Plan: Decrease the remain hypertonisity of the Piriformis, Quadriceps, adductors of the hip and Hamstring muscles, increase joint play mobilization of the knee, calcaneus, head of fibula and talocrural joint. Facilitate proprioception, aquatherapy. Moderate exercises for muscle strengthening.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- Light exercises in Aqua-therapy for 20 minutes at 38 C^0 training movements of hip in F, ABD, and E as conditioning exercises.
- Aqua-massage from the ankles up to the hip and low back.
- PIR 3 times repetition for Piriformis muscle, for Rectus Femoris, adductors of the hip muscle and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Mobilization of the deep fascias of the thigh by formation of Kibler's fold and fold formation up to the barrier and soft springing pressure applied.
- Sensomotoric stimulation massage with a spike ball on his right and left lower extremity around the joints from ankle to knee.
- Exercises in the fitness room: 5min. bicycle. Overball exercises, 1 set of 15 x times by holding and pressing overball between his knees. Pressing the overball against bed (ball is placed under knee and afterwards under Achilles tendon). Against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg. Weights, for strengthening his weak Quadriceps, Hamstrings, and Anterior Tibialis muscles.
- Quadriceps curls: 3 sets x 10
  Right leg 1^{st} 5kg, 2^{nd} 15kg, 3^{rd} 15kg
  Left leg 1^{st} 20kg, 2^{nd} 20kg, 3^{rd}, 20kg

- Hamstring curls: 3 sets x 10
  Right (only) 1st 7.5kg, 2nd 10kg, 3rd 15kg
- Anterior Tibialis muscle was worked with patient in standing position lifting on his toes with performing inversion of the foot. With Thera-band exesercises. 3 sets x 10 repetitions.

Results: Fascias are fully released and the Piriformis, Quadriceps, adductors of the hip and Hamstring muscles looks normotonus. Joint Play increased also but still a blockage remains in talocrural joint and head of fibula.

Rehabilitation Prognosis: Good

8.7.6 Date: 22.1.2010

Session #6

Subjective: Patient feels better with no pain and his weakness seems to fade away day by day, and that gives him more motivation to work harder with his treatment.

Assessment: Piriformis is painless, Rectus Femoris, adductors of the hip muscle and the Hamstrings are seems to be normotonus. Joint play of calcaneus, talocrural, knee joint, and of the head of fibula are increased but not to the wanted level of our goal yet. Fascias are without restriction.

Today's Plan: Vanish the remaining hypertonisity of Piriformis, Quadriceps, adductors of the hip and Hamstring muscles, Increase joint play of the knee, calcaneus, head of fibula and talocrural joint, Facilitation of proprioception. Moderate exercises for muscle strengthening.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- PIR 3x times for Piriformis muscle, for Rectus Femoris muscle, adductors of the hip and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Sensomotoric stimulation massage with a spike ball on his right and left lower extremity around the joints from ankle to knee.
- Exercises in fitness room: 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise. Warm up with bicycle for 5 min. against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg.
- Quadriceps curls: 3 sets x 10
  Right leg 1st 5kg, 2nd 15kg, 3rd 15kg
  Left leg 1st 20kg, 2nd 20kg, 3rd, 20kg
- Hamstring curls: 3 sets x 10
  Right (only) 1st 7.5kg, 2nd 10kg, 3rd 15kg
- Anterior Tibialis muscle was worked with patient in standing position lifting on his toes with performing inversion of the foot. With Thera-band exercises. 3 sets x 10 repetitions.

Results: Fascias are fully released and the Piriformis, Quadriceps, adductors of the hip and Hamstring muscles looks normotonus. Joint Play increased also but still a blockage remains in talocrural joint and head of fibula. Balance problem seems still to be present but it is early to make conclusion for it. Endurance and muscle strength of the right leg seems to improve significantly.

Rehabilitation Prognosis: Good

8.7.7 Date: 25.1.2010

Session #7

Subjective: No pain is present but he is a little bit anxious about his balance instability.

Assessment: Piriformis is without pain, Rectus Femoris, adductors of the hip muscle and the Hamstrings are normotonus. Joint play of calcaneus, talocrural, knee joint, and of the head of fibula are increased but not to the wanted level of our goal yet. Fascias are without restriction.

Today's Plan: Maintenance of normotonus for Piriformis, Quadriceps, adductors of the hip and Hamstring muscles, Increase joint play mobilization of the knee, calcaneus, head of fibula and talocrural joint, Facilitation of proprioception. Moderate exercises for muscle strengthening.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- PIR 3x time's repetition for Piriformis muscle, for Rectus Femoris muscle, adductors of the hip and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Sensomotoric stimulation massage with a spike ball on his right and left lower extremity around the joints from ankle to knee. .
- Exercises in the fitness room: 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise. Against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg. Trampoline jumping on it in a ''cross-shape'' alike. Weights, for strengthening his weak Quadriceps, Hamstrings, and Anterior Tibialis muscles.
- Warm up with bicycle for 5 min.
- Quadriceps curls: 3 sets x 10
  Right leg 1st 5kg, 2nd 15kg, 3rd 15kg
  Left leg 1st 20kg, 2nd 20kg, 3rd, 20kg
- Hamstring curls: 3 sets x 10
- Right (only) 1st 7.5kg, 2nd 10kg, 3rd 15kg
- Anterior Tibialis muscle was worked with patient in standing position lifting on his toes with performing inversion of the foot. With Thera-band exercises. 3 sets x 10 repetitions.

Results: Fascias are fully released and the Piriformis, Quadriceps, adductors of the hip, and Hamstring muscles are normotonus. Joint Play is almost at the desired level. Balance problem seems still to be present but it is obvious that is only matter of time to overcome it. Endurance and muscle strength of the right leg seems to improve day by day.

Rehabilitation Prognosis: Good

8.7.8 Date: 27.1.2010

Session #8

Subjective: No pain is present but he is a little bit anxious about his balance instability.

Assessment: Piriformis is without pain, Rectus Femoris muscle, adductors of the hip and the Hamstrings are normotonus. Joint play of calcaneus, talocrural, knee joint, and of the head of fibula are increased and almost reached the desired level of our goal. Muscle strength is much better than the day we have started the therapy.

Today's Plan: PIR for maintaining normotonus of the Piriformis, Quadriceps, adductors of the hip and Hamstring muscles, Increase joint play of the knee, calcaneus, head of fibula and talocrural joint, Facilitation of proprioception.. Moderate exercises for muscle strengthening.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- PIR 3 times repetition for Piriformis muscle, for Rectus Femoris muscle, adductors of the hip and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Sensomotoric stimulation massage with a spike ball on his right and left lower extremity around the joints from ankle to knee. .
- Exercises in the fitness room: 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise. Against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg. Trampoline jumping on it in a ''cross-shape'' alike.
- Warm up with bicycle for 5 min.
- Quadriceps curls: 3 sets x 10
Right leg 1^{st} 5kg, 2^{nd} 15kg, 3^{rd} 15kg
Left leg 1^{st} 20kg, 2^{nd} 20kg, 3^{rd}, 20kg
- Hamstring curls: 3 sets x 10
Right (only) 1^{st} 7.5kg, 2^{nd} 10kg, 3^{rd} 15kg
- Anterior Tibialis muscle was worked with patient in standing position lifting on his toes with performing inversion of the foot. With Thera-band exercises. 3 sets x 10 repetitions.

Results: Fascias are fully released and the Piriformis, Quadriceps, adductors of the hip and Hamstring muscles are normotonus. Joint Play is looks to be at the desired level. Balance problem seems to have some improvement, but still is an issue. It is only matter of time to overcome it. Endurance and muscle strength of the right leg improves day by day.

Rehabilitation Prognosis: Very good

8.7.9 Date: 29.1.2010

Session #9

Subjective: No pain is present and he is more confident about his balance instability.

Assessment: Painless and normotonus Piriformis, Rectus Femoris muscle, adductors of the hip and the Hamstrings are normotonus. Joint play of Calcaneus, talocrural, knee joint, and of the head of fibula reached the desired level of our goal. Muscle strength is much better day by day.

Today's Plan: PIR for maintenance of normotonus Piriformis, Quadriceps, adductors of the hip and Hamstring muscles, also joint play mobilization of the knee, Calcaneus, head of fibula and talocrural joint. Facilitation of proprioception is essential. Moderate exercises for muscle strengthening.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- PIR 3 x times for Piriformis muscle, for Rectus Femoris muscle, adductors of the hip and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Sensomotoric stimulation massage performed with a spike ball on his right and left lower extremity around the joints from ankle to knee.
- Exercises in the fitness room: 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise. Against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg. Trampoline jumping on it in a ''cross-shape'' alike.
- Warm up with bicycle for 5 min.
- Quadriceps curls: 3 sets x 10
  Right leg 1^{st} 5kg, 2^{nd} 15kg, 3^{rd} 15kg
  Left leg 1^{st} 20kg, 2^{nd} 20kg, 3^{rd}, 20kg
- Hamstring curls: 3 sets x 10
  Right (only) 1^{st} 7.5kg, 2^{nd} 10kg, 3^{rd} 15kg
- Anterior Tibialis muscle was worked with patient in standing position lifting on his toes with performing inversion of the foot. With Thera-band exercises. 3 sets x 10 repetitions.

Results: Fascias are fully released and the Piriformis, Quadriceps, adductors of the hip and Hamstring muscles are normotonus. Joint Play is looks to be at the desired level. Balance problem seems to have some improvement, but still is an issue. It is only matter of time to overcome it. Endurance and muscle strength of the right leg improves day by day.

Rehabilitation Prognosis: Very good

8.7.10 Date: 1.2.2010

Session #10

Subjective: No pain is present. He feels the improvement by his self but he is aware of the fact that it will take him more time to achieve his previous condition.

Assessment: Painless and normotonus Piriformis, Rectus Femoris muscle, adductors of the hip and the Hamstrings are normotonus. Joint play of Calcaneus, Talocrural, knee joint, and of the head of fibula reached the desired level of our goal. Muscle strength looks to be in a very satisfied level.

Today's Plan: PIR for maintenance of normotonus Piriformis, Quadriceps, adductors of the hip and Hamstring muscles, also joint play mobilization of the knee, Calcaneus, head of fibula and talocrural joint. Facilitation of proprioception is essential. Moderate exercises for muscle strengthening. At the end of the session will be the final kinesiologic examination.

Today's Procedures:

- Stretching of the Rectus Femoris muscle, Gastrocnemius, and Hamstrings muscles.
- PIR 3 x times for Piriformis muscle, for Rectus Femoris muscle, adductors of the hip and for Hamstrings.
- Mobilization of the restricted joints (Talocrural, calcaneus and knee to lateral direction) and manipulation of the head of Fibula to ventral direction.
- Sensomotoric stimulation massage performed with a spike ball on his right and left lower extremity around the joints from ankle to knee.
- Exercises in the fitness room: 6-7 parts of wobble-boards in the floor and the patient from floor started to walk on this wobble boards for stability exercise. Against the wall 2 sets of Squats x 5 times with knees in valgus position and hyperpronation of the feet. And 2 sets of step forward squat 10 x times each leg. Trampoline jumping on it in a ''cross-shape'' alike.
- Warm up with bicycle for 5 min.
- Quadriceps curls: 3 sets x 10
  Right leg 1st 5kg, 2nd 15kg, 3rd 15kg
  Left leg 1st 20kg, 2nd 20kg, 3rd, 20kg
- Hamstring curls: 3 sets x 10
  Right (only) 1st 7.5kg, 2nd 10kg, 3rd 15kg
- Anterior Tibialis muscle was worked with patient in standing position lifting on his toes with performing inversion of the foot. With Thera-band exercises. 3 sets x 10 repetitions.

Results: Patient finished and today's rehabilitation plan with no problem and with no pain in any muscle or joint. He is ready for the final kinesiologic examination in order to see also by himself his own work and progress the last 10 sessions with me and his personal work he did alone at his home.

Rehabilitation Prognosis: Very Good.

8.8 Final Kinesiologic Examination

8.8.1 Postural Examination

Postural examination was performed by inspection of the patient from the anterior posterior and lateral view and by the usage of a plumb line.

Anterior view: Patient has a normal base with a very slight external rotation of feet. Knee joints are in extension. But not hyperextension, Hip joint is also extended.

Posterior view: Patient presents. The knee looks again to be hyperextended. Lumbar and Thoracic spine are flat and the Cervical spine is slightly hyperextended. Scapulas are abducted. Patient has a smaller thoracobrachial triangle on the left side, and a slight rotation of the trunk from left to right, like clockwise.

Lateral view: The patient with ankle joints in a slight plantar flexion position. The shoulders are protruded forward and head also is more forward. Patient's pelvis looks to be in posterior tilt.

8.8.2 Palpation

Superficial palpation shows that patient has a well hydrated skin with no signs of increased temperature that can be result of an inflamed condition. Kibbler's fold around the scars of the right femur and knee is easily performed with no restrictions as well as fascias of the thigh are with no restriction.

Around the Greater Trochanter of the right thigh, there is no more painful areas.

The pain around of the head of the fibula is no more present.

During palpation of the right lower extremity, i found Rectus Femoris normortonus and Vastus Medialis was also normotonus. Adductors of the thigh were normotonus as well as the Hamstrings.

Trigger points on the Gracilis muscle are gone.

By measuring, the Anterior Superior Iliac Spine ASIS level of left and right side of the patient pelvis, no lateral shift is marked, a fact that is confirmed also by the measurement of the level of the Posterior Superior Iliac Spine PSIS, which are both ASIS and PSIS on the left and right side are on the same level.

8.8.3 Anthropometric Reevaluation

Anthropometric measurements have performed with the measurement of the whole lower extremity on both sides' right and left.

Measurement	Description	R.E.	L.E.
Anatomical length	Is measured from Greater Trochanter to the Malleolus Lateralis	84 cm	84.5 cm
Functional Length	Is measured from Spina Iliaca Anterior Superior to the Malleolus Medialis and from Umbilicus to the Malleolus Medialis	S.A.I.S. 87 cm Umbilicus 93 cm	S.A.I.S. 87 cm Umbilicus 93.5 cm
Length of the Thigh	Is measured from Greater Trochanter to the knee joint or to the head of Fibula	Trochanter to Fibula 47 cm	Trochanter to Fibula 47 cm
Length of the middle leg	Is measured from the knee joint or head of Fibula to the Malleolus Lateralis	Fibula to Lat. Malleolus 37 cm	Fibula to Lat. Malleolus 37.5 cm
Length of the foot	Is measured from heel to the longest toe	26.5 cm	26.5 cm
Circumference of thigh	is measured 15 cm above the knee cap (when testing the m. Quadriceps as a whole) and 10 cm above the knee cap when we want to measure hypotrophy of Vastus Medialis.	Quadriceps 48 cm Vastus Medialis 45 cm	Quadriceps 50 cm Vastus Medialis 47 cm
Circumference of knee join	Is measured around the knee and knee cap	38 cm	38 cm
Circumference of the calf	Is measured in the place of the highest volume	36 cm	36 cm
Circumference of the ankle and foot	Is measured around the Malleolus Medialis and Lateralis Foot is measured around the metatarsal heads	26 cm	26 cm

Table 15 Anthropometric examination of the final kinesiologic examination

8.8.4 Gait Reevaluation

I asked the patient to stand up without shocks and with shorts in order to provide for me his normal walking and some other modifications of gait for diagnostic purposes. Patient's gait showed that now he loads both legs equally. He showed a nice synkinesis of the trunk and arms, but a satisfactory ankle dorsal flexion of the ankles, especially on his right leg. I asked the patient later to try gait modifications such us backwards walking, on his toes, and on his heels. During backward walking I have noticed that the patient used a balanced flexion of the knees and the hips movement with respect to the initial gait examination. When patient tried to walk with his toes and his heels he did not met any problem to perform it.

8.8.5 Range Of Movement Reevaluation

Patient was examined for the range of movement of the hip, knee and even the ankle joint.(Kendall 2005)

	Left Hip		Right Hip	
	Passive	Active	Passive	Active
Flexion	125	125	125	125
Extension	10	10	10	10
Ext. Rotatio	45	40	40	40
Int. Rotatior	45	40	45	40
Adduction	10	10	10	10
Abduction	45	40	45	40

Table 16 ROM reexamination results for the hip joints

	Left Knee		Right Knee	
	Passive	Active	Passive	Active
Extensio	0	0	0	0
Flexion	140	130	140	125

Table 17 ROM reexamination results of the knee joints

	Left Ankle		Right Ankle	
	Passive	Active	Passive	Active
Dorsal Flexion	20	20	20	20
Plantar Flexion	45	40	45	40
Inversion	40	40	40	40
Eversion	20	20	20	20

Table 18 ROM reexamination results of the ankle joints

8.8.6 Muscle Strength Reevaluation

Patient was examined his muscle length test for his hip knee and ankle joint where the limited ROM was found.(Kendall 2005)

	Left Extremity	Right Extremity
Quadriceps	4+	4
Hamstrings	4+	4+
Tibialis Anterio	4+	4
Gastrocnemius	4+	4

Table 19 Muscle strength test reevaluation

8.8.7 Muscle Length Reevaluation

	Right Extremity	Left Extremity
Hamstrings	Grade 1	Grade 1
Quadriceps	Grade 2	Grade 2

Table 20 Muscle length test reevaluation by Janda

Reevaluation of physiological length of both hip flexors 'one joint and two joint' performed. Hamstrings were not short during the length test for Hamstring muscles. (Kendall 2005)

8.8.8. Conclusion of Reexamination

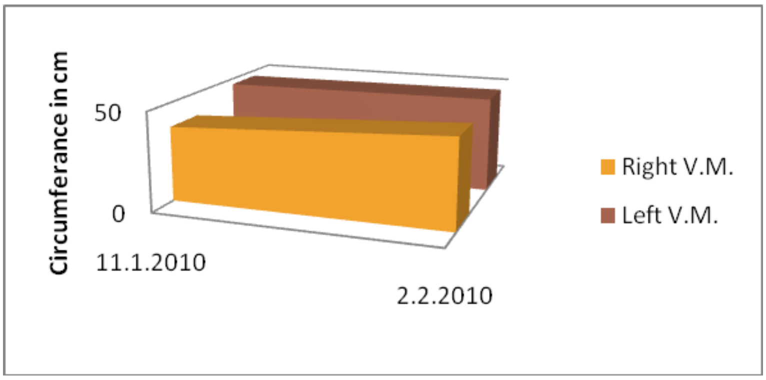
Patient showed a remarkable improvement since he gained the full range of movement on his hip, knee, and ankle joint.

Therapy effect was remarkable efficient and fast. This is due because of the patient's hard work and the right guidance I had from my supervisor in the hospital.

Prognosis of the patient is very good and his has the capacity to improve even more his condition, but that suggests continuing alone training and following the instruction and plan we had during our sessions.

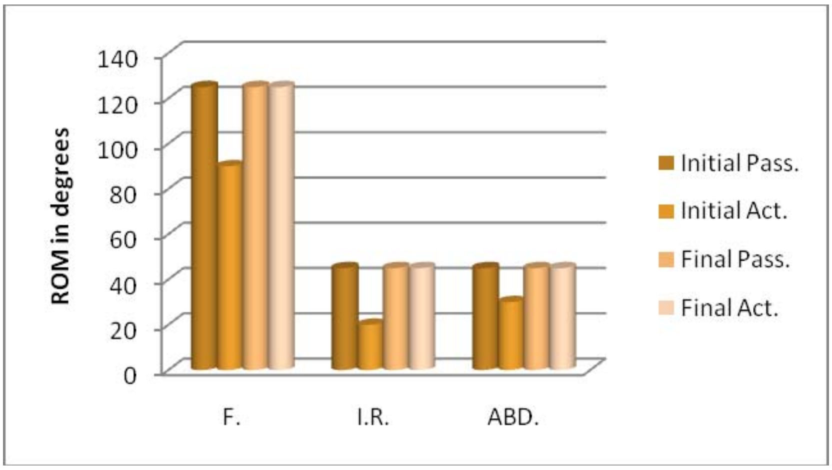
Home Therapy Plan of Rehabilitation: Patient should continue stretching exercises and strengthening his muscles of both his lower extremities in a similar pattern and fashion as we did in the fitness room. Also exercises concerning the stimulation of the deep muscles of foot and sensory motor massage with spike ball around his joints for facilitation of deep sensation/proprioception.

Patient's progress: Anthropometric measurements showed that Quadriceps muscle on the level of Vastus Medialis 10 cm above patella gained 5 cm of circumference. Muscle strength reevaluations showed a significant improvement of the weakened muscles.



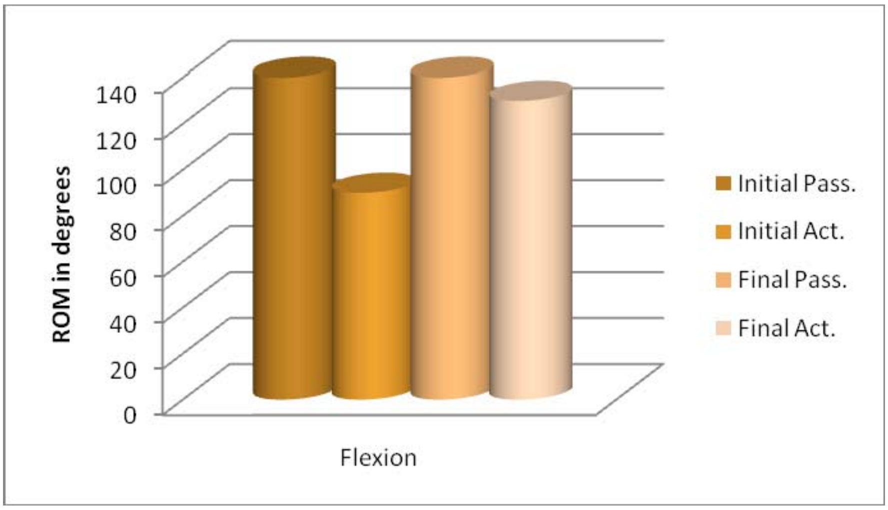
Graph 1 Muscle circumference progress of right & left Vastus Medialis at 1st and last session

In the graph 1 we can see that the weak right Vastus Medialis was strengthened, and gained in mass and therefore as we going to see below also in strength.



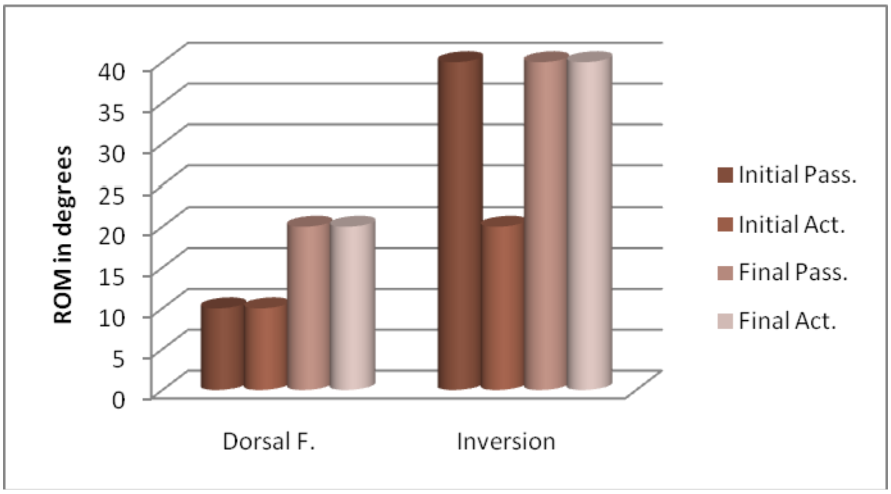
Graph 2 Progress of the passive and active ROM in right hip joint.

This Graph shows the improvement through time of the initial kinesiologic examination of the passive and active range of motion of the right hip.



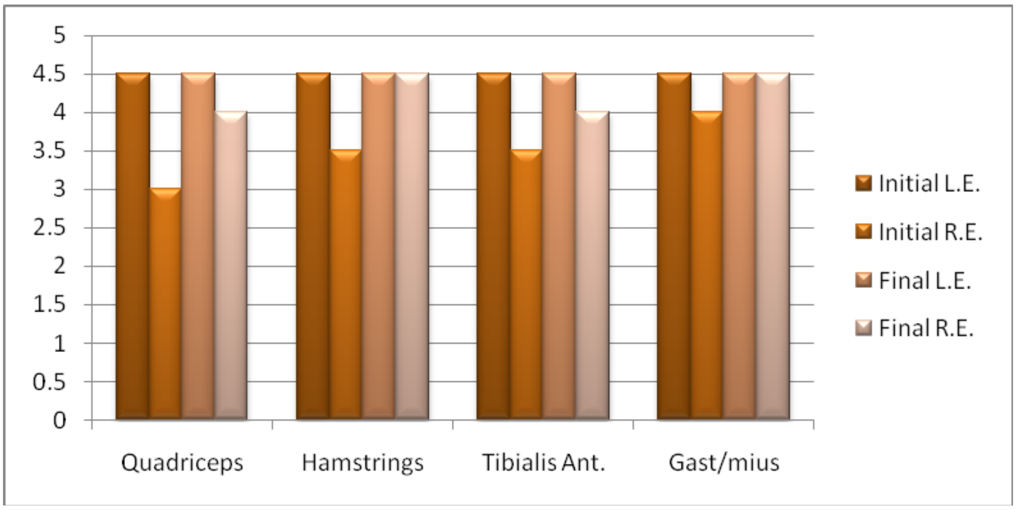
Graph 3 Progress of the ROM in the right knee joint.

The above graph demonstrate the increase of the ROM of the right knee in flexion from the first day and initial kinisiological examination up to the last session with me and the final reevaluation.



Graph 4 Progress of the ROM in the right ankle joint.

The graph 4 illustrates the increase of ROM in right ankle for dorsal-flexion and inversion due to the last 10 sessions of training with my patient.



Graph 5 Progress of strengthening of the weakened muscles.

The graph 5 give you an idea about the progress and difference of the strength of the Quadriceps, Hamstrings, Tibialis Anterior and Gastrocnemius muscles between the first session with my patient and the last session.

9. Discharge of Patient

Patient reached a satisfactory condition and functional level concerning his daily activities. Thus does not mean that he have to stop training but continue until he reaches a much better level of balance and stability and an even better condition that refers to his muscle strength that would need a further more strengthening in order patients both extremities will be equally strong.

10. Conclusion

I am very happy because I fulfill the two main goals of my thesis. I proved that I can use effectively my therapeutic knowledge and the most important is that I proved that physiotherapy is an indispensable part of Rehabilitation and combination of knowledge, skills and experience through the years of practice that I wish to gain myself during my future practice.

I want to thank my patient Mr. A.J. for his trust from the very first session and for his hard work that he did during our cooperation which had as result amazing results concerning his condition.

Finally the most important benefit is the experience I have earned working in great environment with beautiful people working and advising me in every step of my thesis work.

Abbreviations

ACL	Anterior Cruciate Ligament
PCL	Posterior Cruciate Ligament
MCL	Medial Collateral Ligament
LCL	Lateral Collateral Ligament
ASIS	Anterior Superior Iliac Spine
PSIS	Posterior Superior Iliac Spine
F	Flexion
E	Extension
ABD	Abduction
ADD	Adduction
MR/IR	Middle Rotation/ Internal Rotation
ER/LR	External Rotation/Lateral Rotation
DR	Digital Radiography
MRI	Magnetic Resonance
CT	Computer Tomography
IM	Intramedullary
US	Ultra-Sound
ARDS	Acute Respiratory Distress Syndrome
IVC	Inferior Vena Cava
ADL	Activities of Daily Living
FE	Fat Embolism
PNC	Penicillin
ACP	Acylpyrin
BP	Blood Pressure
ROM	Range Of Movement
DVT	Deep Vein Thrombosis
RLE	Right Lower Extremity
LLE	Left Lower Extremity
PMFT	Pulsed Magnetic Field Therapy
FT-NIR	Fourier Transform Near Infrared spectroscopy
IF	Interferential Therapy
LIPUS	Low Intensity Pulsed Ultra Sound
NSAID	Non Steroid Anti-inflammatory Drugs
IM	Intramedullary Nailing

Bibliography

1. Anderson N.Kenneth, Anderson E. Lois, Glanze. D. Walter *MOSBY'S Medical, Nursing, and Allied Health.* St. Louis, Missouri: Mosby, 1994.0801672252

2. Brammer M Christopher, Spires M.Catherine. *Manual of Physical Therapy and Rehabilitation.* Philadlphia: Hanley & Belfus, 2002.1560534796

3. Dalley, F. Keith L. Moore Arthur. *Clinical Oriented Anatomy.* Lippincott Williams & Wilkins, 2009 0781736390

4. Doherty, M. Gerard *Current Surgical Diagnosis & Treatment.* McGraw-Hill Companies,Inc, 2006.0071105107

5. Garden O.James, Bradbury W.Andrew, Forsythe L. R John., Parks W.Rowan. *Principles & Practice of Surgery.* Edinburgh: Churchill Livingstone Elsevier, 2007.9780443101571

6. Guyton C.Arthur,. Hall E John, *Textobook of Medical Physiology.* Missisipi: H.I.E. Saunders, 2000. 0808921878

7. Ip, David. *Orthopedic Traumatology a residents guide.* Berlin: Springer Berlin Heidelberg New York, 2006.9783540290650

8. Kapandji I.A, Churchill Livingstone**.** *The physiology of joints vol.2 Lower Limb.* Paris: Librairie, Maloine,Paris, 1987.0443036187

9. Kendall, Florence Peterson. *Muscles Testing and Function with Posture and Pain.* Lipincott Williams & Wilkins, 2005.0781747805

10. Klingensmith E Mary, Li Ern Chen, Glasgow C.Sean,. Goers A Trudie, Melby. J.Spencer. *The Washington Manual of Surgery.* Lippincott Williams & Wilkins, 2005.9780781774475

11. Lewit, Karel. *Manipulative Therapy in Rehabilitation of the Locomotor System.* Butterworth & Heinemann, 1999. 0750629649

12. Liebenson Craig. *Rehabilitation of the Spine a practitioner's manual.* Los Angeles: Lippincott Williams & Wilkins, 2007.9780781729970

13. Lippert, S. Lynn *Clinical Kinesiology & Anatomy.* Philadelphia: F.A. DAVIS COMPANY,Philadelphia, 2006.9780803612433

14. McLatchie G. R., Leaper D. J. *Oxford Handbook of Clinical Surgery.* OXFORD University Press, 2005.019262388

15. Perry. Jacquelin, *Gait Analysis.* SLACK incorporated, 1992.1556421923

16. Porter Stuart. *tidy's physiotherapy.* Manchester: Butterworth & Heinemann, 2003.0750632119

17. Prentice E.William Quillen S William. *Theraputic Modalities in Rehabilitation.* North Carolina: McGraw-Hill companies, 2005.9780071441230

18. Standring, Susan. *Gray's Anatomy.* ELSEVIER CHURCHILL LIVINGSTONE , 2008.0443071691.

19. Stucchi Becker. *Essentials of Surgery.* Philadelphia: Saunders Elsevier, 2006.139780721681863

20. Thompson, Michael M. Henry & Jeremy N. *Clinical Surgery.* London: Elsevier Saunders, 2005.0702027197

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