CHARLES UNIVERSITY

FACULTY OF PHYSICAL EDUCATION AND SPORT

DEPARTMENT OF PHYSIOTHERAPY

REHABILITATION OF A TOTAL ACHILLES TENDON RUPTURE

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Abstract

Rehabilitation of a Total Achilles Tendon Rupture
Rehabilitace Uplného Přetržení Achillovy Šlachy

This Bachelor Thesis encompasses a selected patient with an orthopaedic injury and investigates assets in relation to the diagnosis at hand. There is extensive research covering the anatomy of the Achilles tendon and foot, biomechanics, weight bearing, pathological foot types, clinical presentation of , diagnostics, treatment, and rehabilitation of an Achilles tendon rupture, as well the technique of PNF.

Examination and therapy was conducted on an adult male at Centrum léčby pohybového aparátu (CLPA), an orthopaedic and sport traumatology rehabilitation center in Prague, following a total Achilles tendon rupture that occurred during a soccer game. Rehabilitation took place two and a half months after surgical repair of the tendon, under my practice and the supervision of PhDr. Edwin Mahr PhD from 04.01.2010 to 19.01.2010. An additional check up therapy of PNF occurred on 02.02.2010. Therapy was focussed on reducing pain and improving the overall functional capability and stability of the patient.

Key Words: Achilles tendon, Achilles Tendon Rupture, Pes Valgus, Pes Planus, Proprioceptive Neuromuscular Facilitation

Declaration

I declare that this Bachelor Thesis has been solely based on my own individual work and practice from 04.01.2010 to 19.01.2010, with an additional visit on 02.02.2010. The practice took place in Centrum léčby pohybového aparátu (CLPA), an orthopedic and sport traumatology physiotherapy clinic in Prague. Additional information that has been included in this Bachelor Thesis has been taken from the list of literature located at the end of this Thesis.

Veronika Vlckova

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I am heartily thankful to my supervisor, PhDr. Edwin Mahr PhD, for his patience and guidance during my practice in CLPA, as well as to Mgr. Holubářová Jiřina, who has taught me much and guided me through my thesis.

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General Part

2.1 Anatomy of the Achilles tendon

The Achilles tendon (or the calcaneal tendon) is the strongest and thickest tendon in the human body, found in the posterior compartment of the leg. The posterior compartment is involved in plantar flexing the foot and flexing the digits (as well as being involved in flexing the knee). Muscles in the leg provide dynamic support for the arches of the foot. Intrinsic muscles of the foot modify the forces produced by tendons of the muscles of the leg, and provide dynamic support for the longitudinal arches of the foot when walking, especially when levering the body forward during stance phase of gait before toe off (6).

The Achilles tendon attaches the gastrocnemius, soleus, and plantaris muscles to the middle part of the posterior surface of the calcaneus by a stiff fibrocartilaginous expansion. It begins in the middle of the calf and it is approximately 15 centimeters long, with its narrowest part approximately 4 centimeters above its insertion. The fibers of the tendon rotate up to 90^{o} from the proximal to the distal end. The tendon is covered by a peritendinous sheet, with thin gliding membranes that reduce friction and allows free movement of the tendon against surrounding tissues (6).

The most superficial muscle, the gastrocnemius, originates by two heads. The medial head attaches to a roughening on the posterior aspect of the distal femur just behind the adductor tubercle and above the articular surface of the medial condyle. The lateral head originates from the upper posterolateral surface of the lateral femoral condyle where it joins the lateral supracondylar line. In the upper leg the heads combine to form a single muscle, which can be identified superficially as the calf. In the lower leg the muscle fibers join with those of the soleus to form the Achilles tendon. The gastrocnemius plantar flexes the foot at ankle joint and also flexes the leg at the knee joint. It is innervated by the tibial nerve (6).

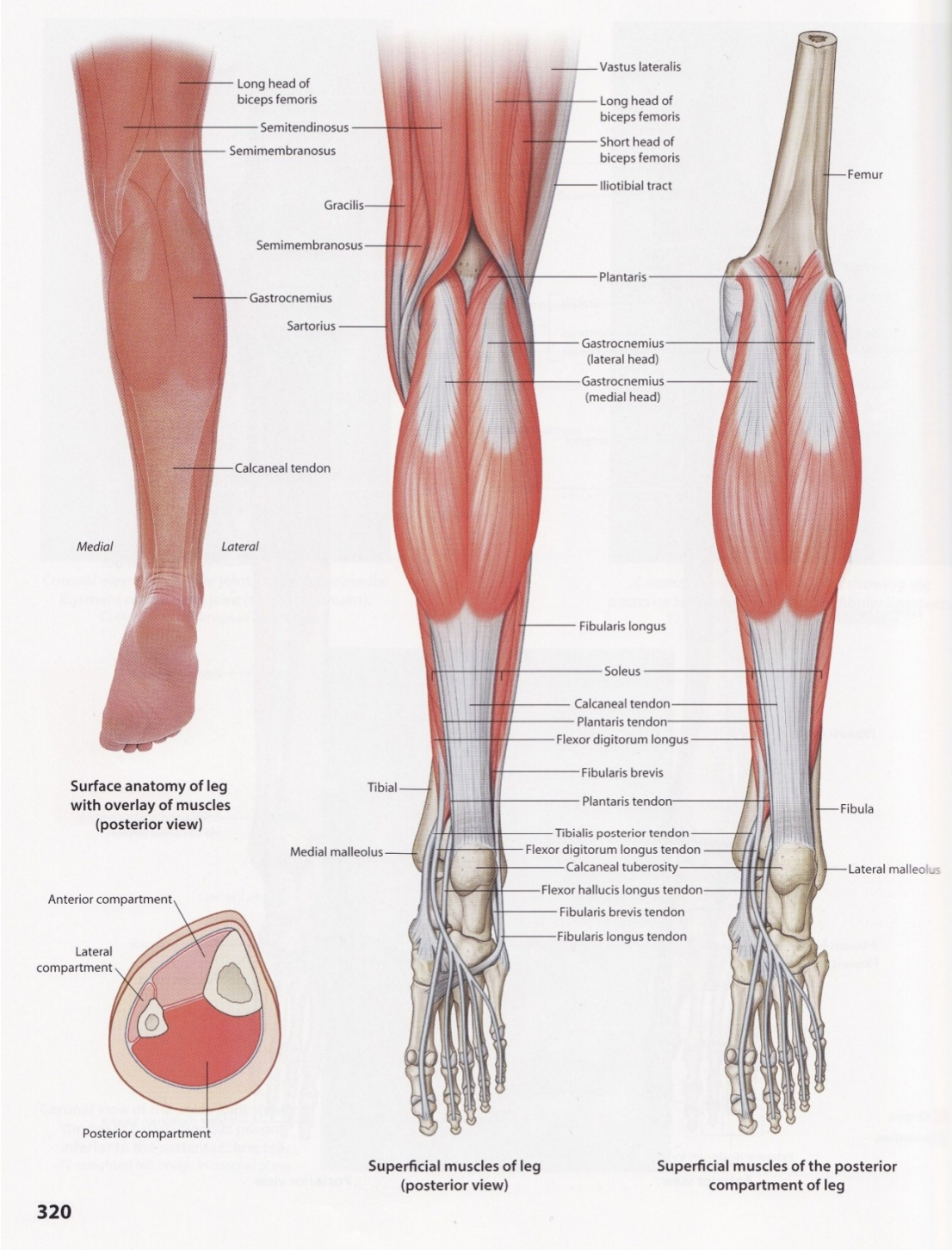

Fig. 1 - Posterior Leg: Superficial Muscles and the Achilles tendon (7)

Deep to the gastrocnemius is the soleus muscle. Its origin is the soleal line and medial border of the tibia, the posterior aspect of the fibular head and adjacent surfaces of the neck and upper shaft, and finally the tendinous arch which joins the tibular and fibular attachments. In the lower leg the soleus muscle makes up part of the Achilles tendon. It plantar flexes the foot and it is innervated by the tibial nerve (6).

Plantaris is a small muscle originating from the inferior part of the lateral supracondylar line of the femur and oblique popliteal ligament of the knee. This very short muscle descends medially deep to gastrocnemius. It forms a tendon which passes between the gastrocnemius and soleus muscles. Finally it fuses with the medial aspect of the Achilles tendon near its attachment to the calcaneus. It is involved in plantar flexion of the foot and flexion of the leg at the knee joint. It is also innervated by the tibial nerve (6).

The Achilles tendon is involved in plantar flexing the foot. The muscles involved are powerful because they propel the body forward off the planted foot during walking, and can elevate the body upward onto the toes when standing. The tendon can receive a load stress 3.9 times the body weight during walking and 7.7 times the body weight when running (6).

2.1.1 Blood Supply and Metabolism

The Achilles tendon is supplied with blood from three sites: from vessels coming from the muscle, those coming from the bone and periosteum, and those from the surrounding tissues of the tendon. Within the tendon the vessels are arranged longitudinally, where one artery is followed by two veins. Branches of these longitudinal arteries constitute the microvascular units of the tendon tissue. Since it is a tendon there is lower blood supply compared to other tissues, and the vascularity decreases with age. It has also been noted that there is an increase in peritendon blood flow during exercise, such as in plantar flexion of the ankle. The metabolic rate in the tendon is low, therefore there is a lower risk of ischemia and necrosis during long periods of standing. However, due to this, recovery is slow after injury (20).

2.1.2 Innervation

Motor innervation of the Achilles tendon is via the tibial nerve. Sensory innervation is from nerves located on the surface of the tendon. Within the tendon there are only a few sensory nerve fibers which follow the vasculature. The nerves anastomose with each other as well as terminate at sensory nerve endings. Inside the tendons there are four types of receptors: ruffini corpuscles are stretching and pressure sensors; vater-pacini corpuscles are pressure sensors that react to acceleration and deceleration movements; golgi tendon organs which are receptors that detect tension; and free nerve endings, which are pain receptors (20).

2.2. Biomechanics of the Achilles tendon

The Achilles tendon transmits tension that is generated by the soleus and gastrocnemius muscles to the calcaneus. To do this, the tendons must be able to resist high tensile forces with limited elongation. The tendon has the ability to transmit the forces to the bone but also deform and recover its original length. Its primary mechanical strength is dependent on extracellular formation of triple-helical collagen fibrils with molecular cross-links that act as stabilizers. It has been found that mechanical properties of tendons correlate to the diameter of fibrils, such that large fibrils can withstand greater tensile forces. Rotation has an important role in the biomechanics of tendons. As the Achilles tendon descends, it rotates, beginning above the point of attachment of the soleus. The overall mechanical behavior of the tendon depends on its length, cross-sectional area, and time. Therefore, a larger tendon is stiffer and a greater force is required to cause its failure. The stiffness decreases with longer tendon fibers, and the force to failure stays the same, but elongation to failure increases. The collagen that makes up the tendon begins to fail at 4% to 8% elongation of its original length, but elastin can elongate more, up to 70% of its original length without rupturing, and breaks at 150% (20).

In resting conditions, the collagen fibers and fibrils have a wavy structure, but when the tendon is stretched, this configuration disappears. If the strain placed on the tendon remains within the limits of most physiological loads, the fibers regain their initial configuration after the load is gone. Increasing strain causes the fibers to start to slide past one another, and cross-links begin to fail. With a strain over 8%, macroscopic ruptures occur due to tensile failure (20).

As we age, collagen becomes tougher, the fibers shrink, tensile strength is reduced, and the tendon becomes stiffer, and is more prone to tearing. Age and size of the Achilles tendon is important when coping with high stress levels. Young adults have a higher tensile rupture stress and lower stiffness; while an increase in age, cross-sectional calf muscle size, and body height, correlate with thicker Achilles tendons (20).

In runners, the cross-sectional area of the Achilles tendon is larger than in non-runners, and larger in elderly adults than those who are more passive. This shows that when one loads the tendon more, adaptation occurs (20).

Immobilization leads to a decrease in the production of collagen and increases its degradation. It also decreases the tensile strength of the tendon; however the low metabolic rate means that the effects of atrophy are slower than in the muscle. Muscle atrophy also occurs, and it is faster when the position of the foot is in the shortened position, as opposed to the neutral position, where atrophy is less severe. Even in one week, the muscles may begin to atrophy (20).

2.3 Anatomy of the foot

2.3.1 The Ankle Joint

The talocrural joint is a hinge joint which involves the articulation of the tibia and fibula of the leg with the talus of the foot (6). There is only one degree of freedom in the joint consisting of plantar flexion and dorsiflexion, which occur around the transverse axis of the talocrural joint. (controlling the movements of the foot relative to the leg in sagittal plane) (21).

The tibiotalar joint is the primary weight-bearing articulation, between the trochlea of the talus and the distal articular surface of the tibia. The tibia and fibula are linked by an interosseous membrane, and distally by a fibrous inferior tibiofibular joint known as a fibrous syndesmosis articulation. Only a little movement occurs between them. The fibulotalar joint is an articulation between the lateral malleolus of the fibula and the lateral articular surface of the talus (16). The ankle joint is most stable when it is in dorsiflexion (6).

The articular capsule of the ankle goes from the distal surfaces of the tibia and medial malleolus, the talus, and the lateral malleolus. Anteriorly and posteriorly the articular capsule is thin, while the lateral and medial surfaces are strong and reinforced by ligaments. The major

ligaments consist of the medial deltoid ligament and the three lateral ligaments, which include the anterior talofibular ligament, posterior talofibular ligament, and the calcaneofibular ligament. The malleoli are supported by these ligaments and are bound together by the tibiofibular ligaments to prevent sliding of the bones (6).

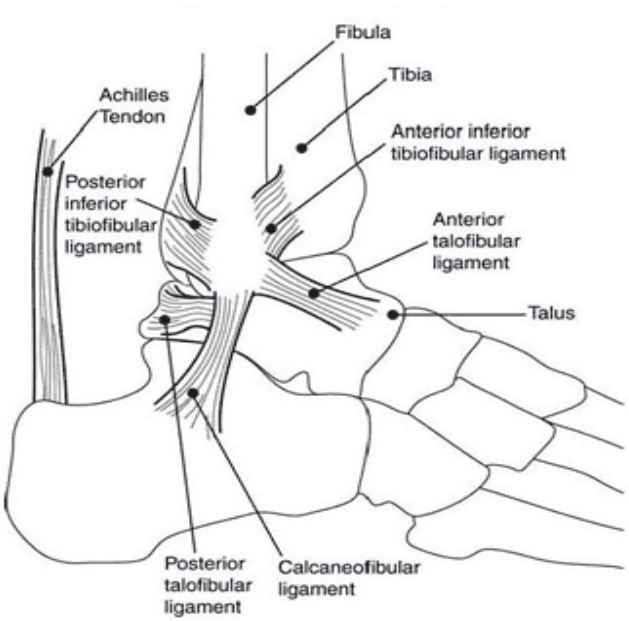

Fig. 2 - Ligaments of the Ankle and the Achilles tendon (26)

2.3.2 Tarsal Bones

The tarsal bones form the framework of the ankle, and are arranged in a proximal group and a distal group, with an intermediate tarsal bone on the medial side of the foot that is between the two groups known as the navicular (6).

The proximal group is made up of the talus and the calcaneus. The talus is situated on top of the calcaneus being the most superior bone of the foot. This articulation is known as the subtalar joint, or talocalcaneal joint. More specifically it is the joint between the large posterior calcaneal facet on the inferior surface of the talus and the corresponding posterior talar facet on

the superior surface of the calcaneus (6). It is a modified plane or gliding joint, allowing movements of inversion and eversion around the oblique axis of the subtalar joint. The talus further articulates with the navicular in the talonavicular joint (21).

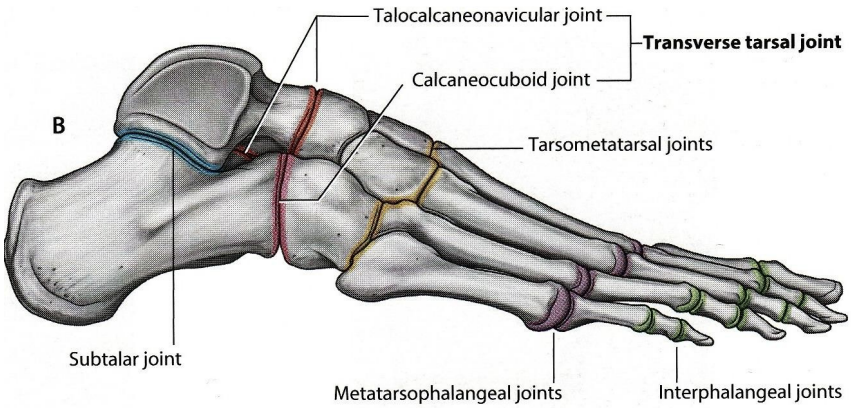

Fig 3. - Joints of the foot (7)

The transverse tarsal joints are synovial joints formed by the articulations of the talus with the navicular and the calcaneus with the cuboid, also known as Chopart's joint. They permit a gliding movement of ABD and ADD, and help movement to inversion and eversion. The joint may be divided into the talocalcaneonavicular joint and the calcaneocuboid joint (6).

The calcaneus is the largest tarsal bone and it supports the talus. Posteriorly it forms the heel and anteriorly it articulates with the cuboid, a distal tarsal bone on the lateral side of the foot. The distal row of tarsal bones articulate with the metatarsals at tarsometatarsal joints and also permit limited gliding movements. The deep transverse metatarsal ligaments link together the distal heads of the bones at the metatarsophalangeal joints and restrict the independent movements of the metatarsals (6).

2.3.3 Functional Aspect of Anatomy of the Foot

The foot has different curvatures called arches. The arches of the foot are formed by the tarsal and metatarsal bones, and strengthened by ligaments and tendons of the muscles of the leg and foot. They allow the foot to support the weight of the body in the erect posture with the least amount of load stress (21).

The arches are categorized as transverse and longitudinal arches of the foot. The bony points that support the arches are the calcaneal tuberosity, the head of the first metatarsal, and the head of the fifth metatarsal. This three point contact is important in gait, in which the line of transition of weight of the body runs from the tibia to the calcaneus, the midfoot, the fifth metatarsal head, and lastly to the first metatarsal head of the forefoot. The ligaments and plantar muscles oppose the tendency of pressure to flatten the curvature of the arches (21).

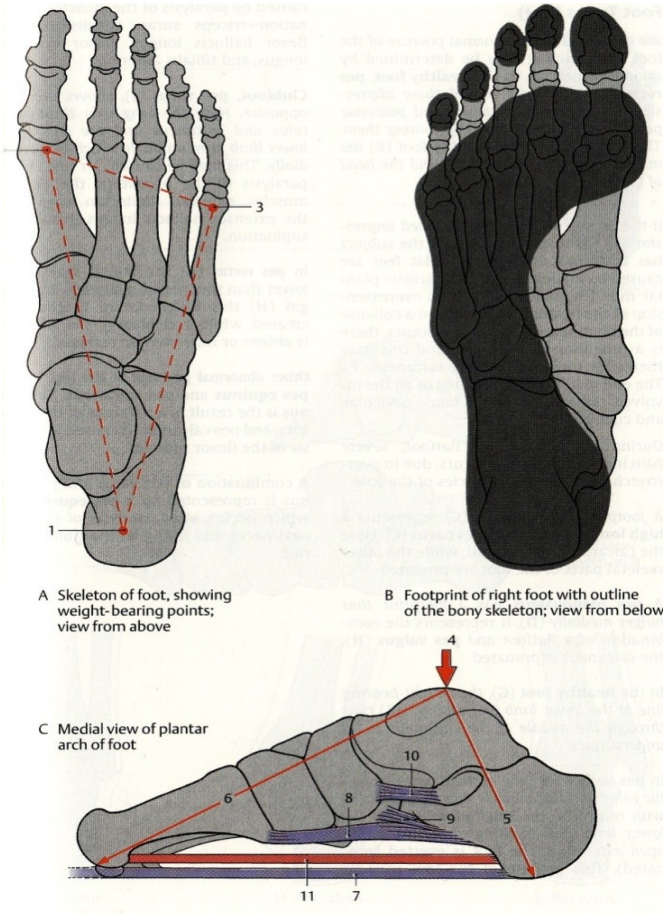

Fig. 4 – Plantar Arch and Three-Point Contact (21)

C. Medial view of the plantar arch of the foot (fig. 4)

4,5,6: Line of transmission of weight of the body

7: Superficial plantar aponeurosis

8,9: Long Plantar Ligament

10: Plantar calcaneonavicular ligament

11: Intrinsic muscles of the foot

Ligaments have a greater resistance to stress than muscles, however if they are overstretched they are unable to return to their previous shape. Important ligaments are divided into four groups: the plantar aponeurosis, the long plantar ligament, the plantar calcaneonavicular ligament, and the short plantar ligaments. The superficial plantar aponeurosis supports the longitudinal and transverse arches. The long plantar ligament braces the lateral tarsal bones. The plantar calcaneonavicular ligament and the short plantar ligaments form the deepest layer, and increase the size of the socket for the head of the talus (21).

Muscles of the foot also resist the effect of the weight of the body in flattening the foot. The muscles are easily fatigued and are weaker than the ligaments, but their tension can be regulated according to stress. The medial abductors play a more important role than the lateral abductors. There are two groups: the intrinsic muscles of the foot and the tendons of the extrinsic muscles of the foot. The intrinsic muscles, which stretch between the tarsals and metatarsals and phalanges, function as tensor muscles of the arches as they counteract the sagging tendency of the metatarsals (21).

2.3.4 Weight Bearing and Locomotion

Body weight is transferred to both lower extremities, which function to support this weight with minimal energy expenditure. When standing erect, the center of gravity is anterior to the edge of the second sacral vertebra in the pelvis, and the vertical line through the center of gravity is slightly posterior to the hip joints, and anterior to the knee and ankle joints, keeping the knee and hip joints in extension. Locomotion involves movements of all joints in the lower limbs to position the feet on the ground and move the proximal parts of the body over the feet. The foot consists of the dorsum, or the superior surface of the foot, and the sole, which is the inferior

surface. The body's point of contact with the ground is at the foot, which gives a stable platform for upright stance, and levers the body forward in gait (6).

2.4 Foot Types

A footprint may be made to determine the normal posture of a foot (fig. 5). In a healthy foot (pes rectus), a footprint would show impressions of five digits, anterior and posterior parts of the sole, and a strip joining them. Physiologically, load mainly transfers to the medial aspect of the calcaneus and to the head of the first metatarsal (fig. 5: diagram E: # 1, 2) (21).

Pathological foot types include pes planus, pes cavus, and pes planovalgus. In pes planus, or flatfoot, the entire sole of the footprint is wide and flat. It is caused by inadequate functioning of the intrinsic plantar muscles of the foot, leading to overextension of the ligaments and to collapse of the plantar arch. When this happens, the talus pronates, and may slide medially over the calcaneus (diagram F). As a result, the calcaneus, talus, navicular, and the cuboid are repositioned. Flatfoot can be accompanied with severe pain in the foot and leg from overstretching of the long muscles of the sole (21).

Pes cavus is a footprint with a high longitudinal arch. The calcaneus is supinated as the other tarsals and metatarsals are pronated. Pes planovalgus has a big medial bulge and has components of a flatfoot and pes valgus. In this case the calcaneus is pronated (21).

In a physiological healthy foot, the weight bearing line descends down through the middle of the calcaneus (fig. 6) (21). Figure five also shows a physiological position of the ankle, in which the valgus angle is from 0^{o}-6^{o}. In contrast, a valgus angle over 6^{o} is pes valgus, and any varus angle is pes varus (4). Referring back to figure six at pes valgus, the vertical axis through the talus and calcaneus makes a sharp angle with respect to the longitudinal axis of the lower extremity. The foot pronates (everts), and this position of the foot may be due to paralysis of the muscles of supination, namely triceps surae, tibialis posterior, flexor digitorum longus, flexor hallucis longus, and tibialis anterior (21).

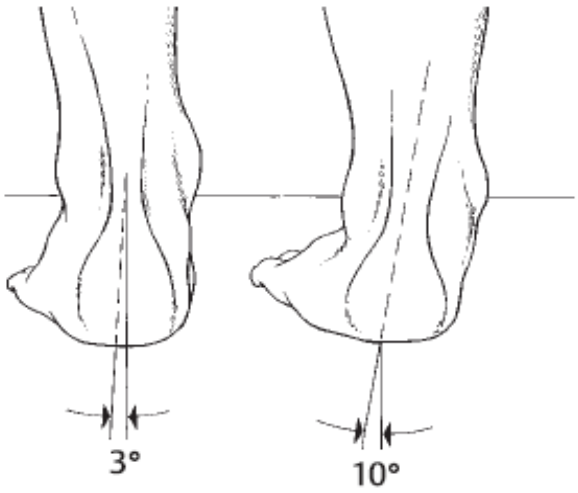

Fig. 5 – Position of the Hindfoot: Pes Rectus and Pes Valgus (4)

Pes varus, also known as clubfoot, is the opposite condition to pes valgus. The long axis through the talus and calcaneus, and the axis of the lower extremity form a medially opened angle. One cause may be due to paralysis of the pronators, the peroneal muscles, extensor hallucis longus, and extensor digitorum longus, causing supination of the foot. Physiologically the lateral malleolus should be lower than the medial malleolus. However, this height difference is increased in pes valgus, and decreased or absent in pes varus (21).

Pes calcaneus and pes equines are other abnormal postures of the foot. In pes calcaneus, there is paralysis of flexor muscles, while in pes equines there is paralysis of extensors. When there is paralysis of the peroneal nerve and injury to the tibialis anterior, the patient may adapt pes equinovarus, with a combination of pes varus and pes equinus (21).

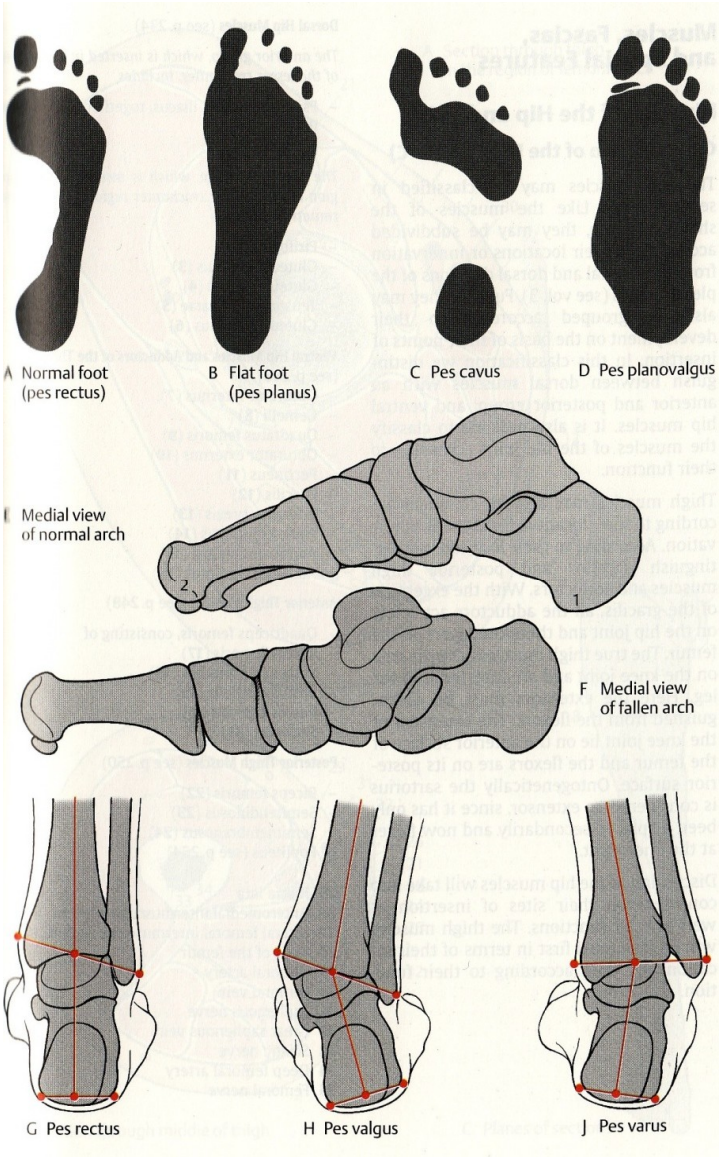

Fig.6 – Foot Types (21).

Problems in the foot may be due to several factors other than from weakness of the muscles of the arches. These include osteoarthritis, compression neuropathies (tarsal tunnel syndrome), stress fractures, disorders of sesamoid bones, and avascular necrosis. Some systemic diseases, such as diabetes mellitus, gout, psoriasis, peripheral arterial disease, and rheumatoid arthritis can cause symptoms in the foot (4).

It is important for physiotherapists to palpate the area of the foot, and assess the mobility of the joints and restrictions in soft tissues. Also, it is necessary to observe the foot during weight

bearing and walking. Often patients may have pain in the forefoot known as metatarsalgia. The most common deformity of the foot and the most common cause of metatarsalgia is splay foot. It involves the collapse of the transverse metatarsal arch due to weakness of the muscles and ligaments. This causes secondary changes in the foot with hammer toe, claw toe, and hallux valgus deformities. In addition, the patient may get plantar calluses from the increased stress on the metatarsal heads leading to more problems and possible pain (4).

2.5 Achilles Tendon Pathology and Examination

2.5.1 Etiology of Achilles tendon Rupture

A rupture or tearing of an Achilles tendon is a common condition. It usually occurs in adults between 30 and 50 years of age, who play sports every week (5). The cause of rupture may be due to indirect or direct trauma to the tendon, however direct injury is rare. There are three types of indirect trauma: pushing off with the weight-bearing forefoot while extending the knee joint, such as during the start of a sprint, sudden unexpected dorsiflexion of the ankle, as when one stumbles or slips, and violent dorsiflexion of a plantar-flexed foot, as when landing from jumping or falling (9).

The exact pathogenesis of an Achilles tendon rupture is not known, but the two most common theories are the degeneration theory and the mechanical theory. The degeneration theory states that repetitive microtrauma and hypovascularity in the tendon may lead to chronic degeneration, which eventually may cause rupture without excessive loads being applied to the lower extremity. Ruptures may also be associated with use of anabolic hormones and corticosteroids, as well as with systemic diseases such as rheumatoid arthritis, gout, and systemic lupus erythematosus (9).

2.5.2 Clinical Presentation and Diagnosis

Usually the diagnosis of an Achilles tendon rupture is easily made, and no specific imaging is required (20). Rather, ultrasonography or magnetic resonance imaging may be used for the differential diagnosis of partial Achilles tendon ruptures, acute peritendinitis, tennis leg (medial gastrocnemius tear), ligament injuries, calf muscle strains and ruptures, peroneal injuries,

fractures of the ankle and calcaneus, or posterior tibial tendon injury (20). Figure 7 below shows a complete rupture on MRI to show how it looks like inside.

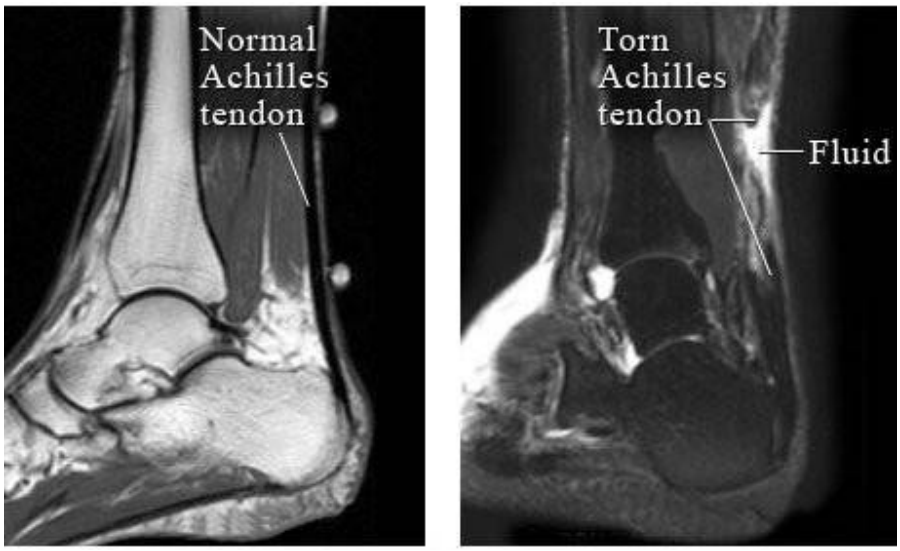

Fig. 7. - MRI: Normal and Torn Achilles tendon (25)

Achilles tendon ruptures may be closed or open, total or partial, and acute or chronic (9). An acute rupture is when there is a delay in treatment of up to one week at the most, while a chronic condition refers to a delayed treatment of four or more weeks. Total rupture typically occurs one to two inches proximal to the tendon's insertion on the calcaneus, and patients report feeling a snap or pop (5). There is a collapse of Kager's triangle, which is formed by the borders of the anterior Achilles tendon, posterior surface of the deep flexor tendon, and the upper part of the calcaneus (20). Patients may get acute episodes of severe pain in their calf that may feel as though they have been kicked in their calf. The pain may then suddenly decrease, as the calf becomes weak and swells up (5). Sometimes when referring to the history, patients report heel or tendon pain, with tenderness or stiffness of a weakened Achilles tendon; however the majority of patients do not.

A palpable defect and gap in the tendon may be felt, but the longer a patient waits to be examined, the more difficult it may be to palpate it to assess hematoma and edema (9). The

patient will have a difficult time walking up stairs, standing on the toes of the affected side, and will also feel a change in gait. The range of motion in the ankle joint may become stiff (5).

2.5.3 Specific Diagnostic Tests

There are several tests that may be used in the diagnosis of Achilles tendon ruptures. Some of them include the Thompson test, Simmond test, Hoffa sign, and the Achilles tendon tap test.

The Thompson test, also known as the Calf Compression Test, is the most common test used. It is done with the patient lying prone and with the feet over the edge of the examining table (fig.7). The physician squeezes the calf muscle and observes the response. In a normally functioning limb, squeezing the calf should provoke rapid plantar flexion of the foot. Absence of this movement indicates that the Achilles tendon is torn. Another examination that may be done to assess whether there is a tear is by seeing if the patient can stand on tiptoes, and on the affected side.

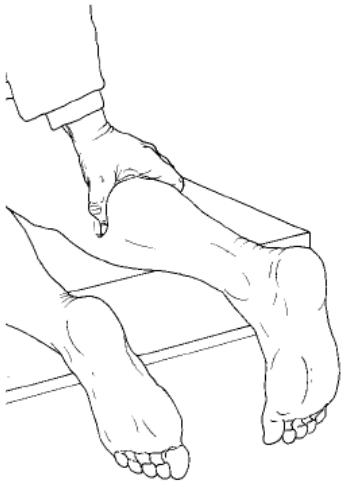

Fig. 8 - Thompson Test (4)

An alternative way to provide the test is in prone position with the knee in 90^{o} flexion. This test is often called the Simmond Test. The physician grasps the patient's calf with both hands and forcefully compresses the musculature. If plantar flexion is absent then this is a sign that the patient may have an Achilles tendon tear (4).

The Achilles tendon tap test is another test, in which the patient is asked to lie prone on an examining table with the knee of the affected lower extremity flexed to 90^{o}. The physician taps the distal third of the Achilles tendon with a reflex hammer. Signs of a tear in the Achilles tendon are indicated by increased pain and loss of plantar flexion. If there is no Achilles tendon reflex, a differential diagnosis should exclude neurological changes (4).

Hoffa Sign is a test used to diagnose a chronic Achilles tendon tear. The patient is lying prone with the feet over the edge of the examining table, as the physician passively dorsiflexes both feet. A positive result is when tension in the Achilles tendon is decreased and the affected foot can be dorsiflexed farther than the other foot. Next, the patient is asked to stand on tiptoes on each lower extremity, and the result will be that the patient will not be able to provide the movement (4).

2.6 Treatment Options

Treatment of an acute Achilles tendon rupture may be done surgically, being percutaneous or open, or conservatively with the use of a brace or cast immobilization. Both surgery and non-operative treatment involve placing the lower extremity in a cast or brace for at least six weeks.

Since the 1920s, surgery has been the treatment of choice, in which the tendon is operated on as soon as possible; however, both methods are acceptable. Surgery is necessary to get muscle strength back to the stretched muscle because the muscle no longer functions at the correct biomechanical length (20). Whether a patient gets surgical treatment or nonsurgical management depends on the site and thickness of the tear, along with goals of the patient (2).

2.6.1 Non-Surgical Treatment

Sometimes, surgery cannot be done due to medical conditions that may cause complications after surgery. It is therefore sometimes necessary to provide conservative treatment. It involves progressive casting immobilization of the ankle, or the use of a specially designed boot, in which the foot is placed in slight plantar flexion, and gradually moved to neutral position over time. It decreases the pressure and tension in the tendon and muscle. The approximate time of wearing

the cast or boot is from six to eight weeks. Following removal of the cast, a physical therapy program is made that focuses on strengthening and gentle stretching (5).

Although this treatment is used, there is a greater chance of re-rupture, with less strength and less endurance when compared to tendons that have been surgically repaired. This is due to the fact that the ends of the tendon are ruptured in an irregular manner, and as soon as this occurs, the gastrocnemius muscle continues to pull on the tendon, and the end of the ruptured tendon retracts. Also there is a risk of atrophy of the calf muscles (5).

2.6.2 Surgical Treatment

Surgical repair of a torn Achilles tendon consists of sewing torn ends together (5). Sometimes, if the tissue is poor or if the injury is chronic, local tissue such as tendon grafts or fascia may be used to reinforce the repair (20).

A big advantage of early repair is that the ankle joint will be able to move through early range of motion out of a cast. If surgery is done, there is a lower re-rupture rate (0-4%), greater strength and more endurance, with a greater chance of returning to sports. Surgery is important because there must be correct tension between muscle and tendon. This determines the strength of the muscle, and thus the only way to get the correct tension is by repairing the tendon ends (20). Generally, surgery may be more appropriate in younger, active patients, who would like to return to sports (5).

2.7 Rehabilitation Following Achilles Tendon Repair

Treatment goals in acute state consist of rest, ice application, compression, elevation, promotion of healing, and releasing restrictions in tissues such as the scar. It is necessary to control inflammation and pain, and provide soft tissue techniques of restricted tissues. A gentle transverse friction massage may be done to prevent adhesion formation (2). Further, pain-free range of motion is provided, and the ankle is immobilized with a walking boot or a cast in slight plantar flexion, which is kept for approximately six to eight weeks, depending on the severity of the case. This position is gradually moved to neutral position with serial bracing (5).

Exercises in acute state may include isometric in bed, as well as hip-knee-trunk strengthening and conditioning activities. A non-weight-bearing crutch gait is used until the physician determines the severity of the injury. Patients who play sports must expect to be out of competition for six to nine months after surgery and up to twelve months if the Achilles tendon was immobilized in plaster instead of being operated on (2).

At around this time and at every two to four week intervals, the cast may be removed to stretch the tendon back to normal length. This subacute state continues for four to eight weeks, with the main goals of therapy to protect the repaired tendon, decrease swelling, start gentle range of motion exercises, and begin weight bearing with the cast/boot when walking. Range of motion exercises allow collagen fibers to be laid down along the line of stress.

The patient is allowed to bear full weight on the operated leg at the subacute stage, as long as pressure is felt on the heel as he or she walks. Heat may be applied before rehabilitation and ice after rehabilitation, ultrasound may be used on the scar, and myofascial soft tissue mobilization techniques may be done. Exercises such as concentric contractions, ankle circles, straight leg lifts, dorsal flexion, and inversion and eversion may be done. Also, hip abduction exercises, hamstring curls, and strengthening the intrinsic muscles of the foot are beneficial, as well as riding a stationary bike at low resistance. Crutches are discontinued after six weeks of use and elevation of the lower extremity is still done to decrease swelling. In this stage, viscoelastic heel lift inserts are put into the patient's shoes to decrease stress on the Achilles tendon (2).

From weeks eight to twelve after surgery, the main goals are to continue with the same goals of therapy but with more strengthening exercises and to progress to full weight bearing using the brace when walking. The heel lift that keeps the plantar flexed position may be lowered. All exercises are done without pain, and thera band exercises may be added. Heat and cold therapy may be applied as previously (2).

Finally in weeks 12 to 24, the patient begins to walk normally, and further strengthening exercises are added. The brace is no longer used but a heel lift is kept in the shoes for one month until the patient stops limping. Red thera band exercises may be done, calf raises, and calf stretches, as well as exercises with ankle weights. Sensorimotoric training will help improve stability in the lower extremities, and magnetotherapy will successfully improve metabolism and promote regeneration in the ankle (2).

2.8 Proprioceptive Neuromuscular Facilitation (PNF)

Proprioceptive neuromuscular facilitation is a technique developed by Herman Kabat, MD and Margaret Knott, PT. It is a method of promoting the neuromuscular mechanism via stimulation of the proprioceptors. PNF uses “Mass Movements,” which are specific combinations of motions done diagonally, and involve certain sequences of muscles. It may be done to strengthen muscles or relax them (1).

Often patients after an Achilles tendon rupture will have stiffness in their ankle, three months post operation period. There may be restriction to plantar flexion along with weakness of the triceps surae due to the long duration treatment with the cast or brace. PNF may be used to strengthen these muscles and in turn range of motion may be influenced. When there is a muscle that we would like to strengthen we start in the most shortened position of the muscle. If we would like to relax a muscle, the opposite is true and we start in the most elongated position of the muscle.

SPECIAL PART

3.1 Methodology

A case study was conducted on an adult male, with a complete Achilles tendon rupture at Centrum Léčby Pohybového Aparátu, in Prague, Czech Republic. Examination and therapy was applied to the patient from 05.01.2010 to 19.01.2010, along with a final kinesiological examination. Later, a checkup therapy session was done on 02.02.2010 to provide PNF again to strengthen triceps surae and see the condition of the patient's ankle. The patient was set for individual physiotherapy every week, along with hydrotherapy, magnetotherapy, and fitness conditioning exercises for a total of 10 therapy sessions, 6 of which were in my care. General therapeutic approaches were used such as soft tissue techniques, PIR, PNF, mobilizations, thera band exercises, taping, gait, sensorimotor training, and stretching. Prior to working with the patient, an informed consent form was signed by him, in which his right to privacy was respected.

This case study has been approved by the Ethics Committee of the Faculty of Physical Education and Sport at Charles University in Prague.

3.2 Anamnesis

Patient: Male, H.T Year: 1973

Diagnosis: S860 Complete rupture of the Achilles tendon, left side.

Findings on entry exam

Weight: 96kg Height: 181cm BMI: 29.30

The patient came to CLPA on January 5, 2010, two and a half months after surgery, and he no longer requires the use of crutches. H.T. walks with a limp and has pain in his heel during walking, and therefore uses insoles in his shoes with padding at the heel as the only orthotic.

Subjective Response: H.T. is feeling good today but has some pain in the ankle and more so in the heel. The patient states that he will get newer insoles and a new heel lift for the month ahead.

Family Anamnesis: Mother has asthma. Cancer is in the family but the type is not specific to all members.

Personal Anamnesis

Chief complaint: Pain in the area of the scar but more so in the heel, especially when walking. The patient experiences pain when walking but there is no pain when he does not put weight on the foot. He also has pain on palpation. On a scale of one to ten with ten being the worst, the patient describes the pain as a 3 when walking and 4 when it is at its worst. He states that he is not able to go on his toes since it is too painful.

History of present problem: The patient played soccer once a week before his injury. According to the discharge summary from the Orthopedic Clinic in Fakultni Nemocnice Motol given to me by the patient, H.T's left Achilles tendon ruptured completely on 11.10.2009 around 19:45 during soccer. When he was injured, he was in the position of a sprint, and as he pushed off the ground to run for the ball the left Achilles tendon ruptured. The patient arrived to the Orthopedic Clinic at 21:30 on the same day, had the operation to suture the tendon a few hours later the following day on the twelfth of October, and was discharged on 13.10.2009. Rehabilitation in the hospital consisted of general exercises of thromboembolic prevention such as contracting the quadriceps and gluteus maximus, and moving the foot into dorsiflexion, plantar flexion and circumduction.

The patient's left foot was fixed in a cast for 6 weeks, in which the patient states he rested and did not put any weight on his foot. Following, it was in an orthopedic brace which was set to 15° plantar flexion slowly progressing to neutral position for one month and a half.

Injuries: hernia left side

Childhood disorders: none

Chronic disorders: asthma and infections in the airways-bronchitis

Previous operations: none

Pharmacotherapy: for asthma: Zyrtec, Cromomexal

Allergies: pollen; the patient does not use medications for his allergies

Abuses: alcohol occasionally

Occupational Anamnesis: H.T. is a Lawyer and spends much of his time in an office, which requires him to sit for longer periods of time.

Social Anamnesis: Before the injury the patient played soccer once a week. Since then, he has not done any physical activity. There are stairs where he lives which causes pain in his ankle while walking up.

Psychological Anamnesis: The patient is cooperative and positive. He has not done any activity since the injury and stated that he was worried to not make the ankle worse and wanted to wait for indication from a doctor.

Previous Rehabilitation

General thromboembolic prevention at the hospital; one day.

Patient's health documentation extract

As indicated in the documents of the discharge summary located on page

Indication towards RHB

Individual Physiotherapy 10 times from 5.01.2010; magnetotherapy and whirlpool on the left Achilles tendon 10 times.

Deliberation of Differentiation

The left Achilles tendon may have torn due to weakness and thinning of the tendon, becoming more prone to injury and rupture. The sudden forceful push-off with the foot that was made may have been too much for the weakened tendon, even at his young adult age.

The patient's pain is due to fiber damage in the tendon and healing is taking place with scar tissue buildup. It may take a few more weeks before the pain is gone, depending on the progress of the therapy. Pain in the heel is common since this is the point of attachment of the Achilles tendon and force is transferred to this region during loading of the foot.

What may be found are changes in the resistance of the soft tissues in the left foot, with a possible painful calcaneal spur due to the injury and plantar fasciitis. It may be possible that there is a difference in loading of the lower extremities, with a tendency to put more weight on the non affected lower extremity. It will be necessary to test gait and modification of gait to see the patient's walking pattern in different conditions of loading. It may reveal uncoordinated, disbalanced movement, and/or limping due to muscle weakness and pain. Other examinations will need to be done and appropriate therapy accordingly.

3.3 Initial Kinesiological Examination

All examinations were done according to standard testing procedure.

3.3.1 Aspection

Posture Examination (pictures at end of thesis) (11)

Standing Anterior View

- Base: at first in line with the hips, then narrow.
- Slight ER feet, more on the left side going from the hip
- Left foot and ankle are swollen
- Decreased longitudinal and transcerse arches of both feet; pes planus
- Activity of the toes, more on the left side
- Right foot, second digit, slight hammer toe in the distal interphalangeal joint.
- No weight on the hallux‘s
- Weight bearing: seems to be more on the right heel (will be confirmed later on the scales); toe flexors seem to be active possibly due to poor stability.
- Left calf looks slightly smaller than the right (will be confirmed in posterior view and anthropometry examination)
- Knees are aligned to the axis of the feet, going through the second toe
- Activity of the quadriceps
- Umbilicus on right side more; protrusion of abdomen
- Trunk: slight LF right; axillary angle slightly greater on right side
- Shoulders are level
- Rotation of the head slightly to the left and LF right
- Abdominal breathing

Standing Lateral View (left side)

- Different position of the right and left foot with the left foot slightly more forward
- More ER of the left foot
- Toe activity in the left foot, excluding the Hallux
- Extension of the knee
- Trunk: Lumbar hyperlordosis, flat lower thoracic region, CTh crossing kyphosis, slight cervical hyperlordosis
- Protraction of shoulders
- Slight head protraction

Lateral View (right side)

- Right knee slightly more extended than the left knee
- Right foot slightly more forward than the left foot.
- Slight activity of the toes except Hallux

Standing Posterior View

- Base is slightly narrower than hip width
- Load looks greater on the right foot (will be confirmed in scale examination)
- Slight ER of the feet, left more
- Valgosity of the ankles; loading the medial aspect of the heels
- Scar left side, looks overgrown (will be confirmed through palpation)
- Left ankle is swollen
- Reddish-purple color of the left foot and ankle
- Left calf may be slightly smaller in circumference; confirmation in anthropometry
- Knee angles are in the same level
- Gluteal line: level
- Trunk: slight LF to the right in the middle/lower thoracic area, and slightly greater axillary angle on the right side
- LF head right, rotation left

Note: Plumb line examination was not done due to unavailable place to hang the plumb line.

3.3.2 Palpation: Examination of the Pelvis (11)

Iliac crests	Posterior Superior Iliac Spines	Anterior Superior Iliac Spines	Comparing Iliac Spines Laterally on right side of the body	Comparing Iliac Spines Laterally on left side of the body
Same level	Same level	Same level	ASIS lower	ASIS lower

Table 1. Pelvis Examination

There is anterior tilt of the pelvis. The patient has protrusion of the abdomen, and examination must be done to see if there is shortness of iliopsoas muscles.

3.3.3 Scale Examination

	Weight on one scale (kg)	Weight on two scales (kg)	Difference (kg)
Both Feet	96	/	
Right Leg	/	51	6
Left Leg	/	45	

Table 2. Scale Examination

The scales were not 100% accurate, being approximately 1kg off. There is no significant difference in weight distribution, and therefore it is physiological. The patient states that he knows he puts more weight on the right foot due to pain during standing on the left foot; however he tried to have his weight distributed as equal as possible between the lower extremities.

3.3.4 Rhomberg Test (11)

The test was negative but there was some muscle activity.

Normal stance, eyes open: stable with slight activity of the quadriceps.

Feet together, eyes open: stable but there was some intermittent activity of the quadriceps.

Feet together with closed eyes for 10seconds: there was activity of the muscles in the feet, more on the left side seen as greater activity of toe flexors. Also, activity in the thigh muscles, more in the right lower extremity.

Modified Rhomberg test with normal base and closed eyes: Since there was slight activity when his eyes were open, we can assume that there would be slight activity with his eyes closed. This was confirmed.

3.3.5 Vele Test (23)

The patient stood with feet parallel to each other, and was asked to close his eyes, and he was slowly and slightly pushed forward. Activity of the foot flexors and stability of the lower extremities was examined. The test was negative, in that he did not lose balance or fall, however there was great activity in the toes, and more on the left side. This did cause some pain. The patient will need to work on sensorimotor training to improve proprioception and balance in the joints of the lower extremities.

3.3.6 Trendelenburg test (11)

- Positive-duck walking
- Done to 90° flexion in the hips

Hip dropped when doing the test on both sides; indication that the patient needs to strengthen gluteus medius and other muscles surrounding the hip that are involved in hip ABD. The pelvic tilt was mild on the left side but worse when standing on the left lower extremity. As the patient was standing with a slightly bent knee, the right hip dropped down more indicating increased weakness of the gluteus medius on the left side.

3.3.7 Gait Examination

- Patient contacted floor heels first; decreased 3-point contact of the left foot
- Slightly less valgosity of the ankles
- Most movement in the right knee and in the hips; big movements of the pelvis in lateral tilting (limping); duck walk
- ER still present and more in left foot
- Longer stride of the right LE; fast return of the right LE and longer and greater load
- Greater contact on the ground with the right LE
- Acrhes are a bit better- not as flat as during standing

- Change in the color of left foot (possibly due to standing on it longer time for examination); slight reddish-purple

Modifed tests: With closed eyes: wider base, able to walk in a straight line

On tiptoes and heels was not done due to pain, mostly psychological as stated by the patient himself.

3.3.8 Anthropometric Measurements

	Left LE (cm)	**Right LE** (cm)	**Difference**
Functional Length	108,5	108,5	
Anatomical Length	96,5	96,5	
Circumference 15cm above the knee	53,5	54	0.5
Circumference above the edge of the patella	41	41,5	0.5
Circumference above the patella	39,5	39,5	/
Circumference above the tibial tuberosity	35	35,5	0.5
Circumference of Calf	39	40	1
Circumference of Ankle	28	26,5	1.5
Circumference of Metatarsals	24	23	1

Table 3. Initial Length and Circumference of the Lower Extremities

3.3.9 Palpation

Temperature: slightly increased temperature in the left foot and ankle.

Area of edema: hard barrier

Achilles tendon feels thicker on the left side.

Left plantar fasciitis with increased tension in the muscles and plantar fasciae attached to the plantar aponeurosis; slight tenderness in area of medial calcaneous and painful quadratus plantae on palpation.

	Left LE	Right LE
Quadratus lumborum	Normal tone	Normal tone
Gluteus maximus	Normal tone	Normal tone
Gluteus medius	Normal tone	Normal tone
Piriformis	Normal tone	Normal tone
Iliopsoas (psoas major, iliacus)	Slight hypertone	Slight hypertone
Quadriceps (rectus femoris, vastus medialis, vastus lateralis)	Normal tone	Normal tone
Hamstrings (biceps femoris, semitendinosus, semimembranosus) & origin at ischial tuberosity	Hypertone; greater laterally in area of biceps femoris	Hypertone (slightly more); greater laterally in area of biceps femoris
Hip Adductors	Normal tone	Normal tone
Triceps surae (gastrocnemius and soleus)	Slight hypertone distally & greater laterally	Normal tone
Peroneus longus and brevis	Slight hypertone	Slight hypertone
Tibialis Anterior	Slight hypertone, distal aspect of shin	Slight hypertone, middle aspect of shin
Plantar fascia	Slight restriction in area around calcaneous and metatarsal heads.	Slight restriction
Quadratus plantae	Hypertone (painful and tender on palpation)	Normal tone
Flexor hallucis brevis	Normal tone	Normal tone
Abductor hallucis	Normal tone	Normal tone

Table 4. Initial Palpation Examination

3.3.10 Scar Examination

(patient lying in prone position, feet over edge of bed)

- One vertical scar in the area of the Achilles tendon, left ankle
- Reddish-purple coloration
- Perspiration-good
- Edema is present
- Palpation:

  Elongation, S curve, C curve

  Painful on palpation and restricted more cranially

  Slight restriction in the skin around the scar and left ankle

  Temperature: slightly increased in the area around and on the scar

  Sensation: good

3.3.11 Range of Motion

	LE	Internal Rotation	External Rotation	Flexion	ABD	ADD
Active	Right	0-25°	35°- 0	F knee: 0-120° E knee: 0-60°	40-0°	0-10°
	Left	0-25°	40°- 0	F knee: 0-120° E knee: 0-70°	40°-0°	0-10°
Passive	Right	0-30°	45-0	F knee: 0-125° E knee: 0-70°	45-0°	0-10°
	Left	0-30°	45-0	F knee: 0-125° E knee: 0-75°	45-0°	0-10°

Table 5. ROM of the HIP in Supine Position; Active and Passive Movement

During active right hip ABD there was some movement of the pelvis but when the pelvis was fixed in passive movement his lower extremities were able to be moved to the full range. While performing flexion in passive movement with both knees straight, the movement was stopped by a soft barrier. There was tension in the hamstrings and more on the right side.

		F (prone position)	E (supine position)
Active	**Right LE**	0-135°	0°
	Left LE	0-135°	0°
Passive	**Right LE**	0-140°	0°
	Left LE	0-140°	0°

Table 6. ROM of the Knee

	LE	DF with all Triceps Surae	DF w/ Soleus; Knee bent	PF	Inversion	Eversion
Active	Right	0-15°	0-20°	30-0°	0-20°	10-0°
	Left	0-10°	0-15°	15-0°	0-15°	10-0°
Passive	Right	0-15°	0-20°	30-0°	0-25°	15-0°
	Left	0-15°	0-15°	20-0°	0-20°	10-0°

Table 7. ROM of the Ankle in Supine Position

3.3.12 Muslce Strength Test (11)

Muscle/Muscle Groups and Position	Left Grade	Right Grade
Gluteus Maximus (prone)	5	5
Gluteus Medius (side-lying)	4	4+
Gluteus Minimus (side-lying)	4+	4+
External Rotators of the hip (sitting)	5	5
Internal Rotators of the hip (sitting)	5	5
Hip Adductors (side-lying)	5	5
Iliopsoas (sitting)	5	5
Hip Flexors (sartorius, tensor fasciae latae,	5	5

rectus femoris, iliopsoas) (sitting)		
Tensor fasciae latae (supine)	5	5
Quadriceps (sitting)	5	5
Semitendinosus & Semimembranosus (prone)	5	5
Biceps femoris (prone)	5	5
Gastrocnemius (standing)	3+ ◦	5
Soleus (prone)	4 ◦	5
Peroneus Longus (supine)	4 ◦	4+
Peroneus Brevis (prone)	4 ◦	4+
Tibialis Anterior (supine)	5	5
Tibialis Posterior (supine)	4 ◦	4+
Extensor Digitorum Longus & Brevis (supine)	4	4
Peroneus Tertius (supine)	4	4
Flexor Digitorum Longus (supine)	4	4+
Flexor Digitorum Brevis (supine)	5	5
Lumbricals (supine)	4	4
Plantar and Dorsal Interossei (supine)	3 Fifth toe: 3+	3 Fifth toe: 3+
Extensor Hallucis Longus (supine)	5	5
Flexor Hallucis Longus (supine)	5	5
Flexor Hallucis Brevis (supine)	5	5
Abductor Hallucis (supine)	3+	3+
Adductor Hallucis (supine)	3+	3+

Table 8. Muscle Strength Test

◦ ROM restriction

In performing the muscle test of the gastrocnemius in standing position, the patient refused to go on his toes due to slight pain but also due to psychological worry. However he did put weight on his right lower extremity and provided the movement in the left ankle against the floor and therefore against slight resistance. The patient has difficulty in performing eversion/inversion in both feet and PF in the left foot. Plantar flexion caused slight pain in the area of the heel and scar.

There was some weakness in the flexor digitorum longus of the left foot since there was slight hyperextension in the distal interphalangeal joints while performing flexion. This, along with weakness of the lumbricals, interossei, and other intrinsic muscles of the foot contribute to the decreased longitudinal and transverse arches leading to instability in the lower extremities. The same was seen in the right foot but there was slight flexion in the distal interphalangeal joints and the flexor digitorum was not as weak as on the left side.

3.3.13 Muscle Length Test (11)

	Left LE	Right LE
Hamstrings	1	1 (shorter in RLE)
Iliopsoas	1	1
Rectus Femoris	0	0
Sartorius	0	0
Tensor Fasciae Latae	0	0
Adductors (one joint and two joint)	0	0
Gastrocnemius	0	0
Soleus	0	0
Tibialis Anterior	1	1

Table 9. Muscle Length Test

3.3.14 Examination of Superficial and Deep Sensation

Done with the patient's eyes closed

Tactile-Touch Sensation

Only twice there was some uncertainty in the left foot which may indicate decreased activity/sensation of proprioceptors. An area of the patient's feet was touched and the patient had to guess the correct spot; numbers were also used. The patient generally knew where I had touched him and what number I drew on the plantar surface of his feet.

Temperature Sensation

He had no problems in temperature sensation. A cold surface of the neurological hammer was used and a warm finger. First one was placed on the patient's foot and then the other and the patient had to correctly say what he felt if cold or warm.

Deep sensation

There was slight decrease in proprioception in the left foot. Tests:

- Left and right hallux, 3rd & 4th toe: patient was able to detect a change in the position of the hallux in both feet, however detection of the start of movement in the 3rd and 4th toe of the left foot came a little later even though the movement already started.
- Ankle DF: the patient accurately detected the start and end of the movements in both feet.
- One foot was put into DF passively and the patient was asked to put the other foot in the same position, actively. The patient was able to accurately put his foot into the correct position.

3.3.15 Tendon Reflexes Examination

Patellar Reflex (L2-L4): 3° Normal for both LE's.

Achilles Tendon Reflex (L5-S2): Left: 1° Hyporeflexia: facilation by stretching to DF

Right: 2° Hyporeflexia

Medioplantar Reflex (L5-S2): 3° Normal for both LE's.

3.3.16 Joint Play (13)

Joint Play & position of LE	**Direction**	**Restriction/Blockage**	
		Left LE	**Right LE**
IP joints (supine)	Dorsal/Plantar/ Lateral	Hallux dorsal restriction	N
MTP joints (supine)	Dorsal/Plantar/ Lateral/ Rotation Hallux	Hallux restriction: plantar direction, laterolateral away from toes & rotation; 2nd MTP joint restrictoin: dorsal	Hallux restriction: plantar direction & rotation
Metatarsal heads MTH (supine)	Dorsal/Planar	Restrictions 1,2 MTH: Hallux-plantar 2nd –dorsal	1MTH plantar restriction

Tarsometatarsal joint (Lisfrank) (supine)	Dorsal/Plantar/ Rotation	N	N
Cuboideum (supine)	Dorsal/Plantar	Dorsal restriction	N
Navicular (supine)	Dorsal/Plantar	Slight blockage dorsal & plantar	Plantar restriction
Calcaneus (supine)	Laterolateral/Rotation	N	N
Talocrural Joint (supine)	Dorsal	N	N
Head of fibula (supine)	Ventral/Dorsal	N	N
Knee joint (supine)	Dorsal/Ventral/Lateral	N	N
Fibular head (supine with flexed knee)	Ventral/Dorsal	N	N
Patella (supine with extended knee)	Cranial	N	N
	Caudal	N	N
	Medial	N	N
	Lateral	Slight restriction	N
SI Joint	Dorsal/Ventral	N	

Table 10. Joint Play

N= normal

3.3.17 Movement Stereotypes

Patient performed each movement 3 times.

	Physiological (order of muscle contractions)	**Patient's Movement Stereotype** (order of muscle contractions)
Hip Abduction (side-lying on left LE)	1. Gluteus medius & minimus 2. Tensor fasciae latae 3. Quadratus lumborum 4. Iliopsoas & rectus femoris 5. Abdominal and back muscles	1. Rectus femoris & iliopsoas 2. Gluetus medius and minimus 3. Quadratus lumborum 4. Tensor fasciae latae 5. Abdominal and back muscles
Hip Abduction (side-lying on right LE)		1. Rectus femoris & iliopsoas 2. Quadratus lumborum 3. Gluetus medius and minimus 4. Tensor fasciae latae 5. Abdominal and back muscles
Hip Extension right & left LE (prone with knee E)	1. Gluteus maximus & ipsilateral biceps femoris 2. Contralateral errector spinae, L 3. Ipsilateral errector spinae, L 4. Contralateral errector spinae, ThL 5. Ipsilateral errector spinae, ThL No activation of shoulder girdle or upper trapezius	Hip Extension yielded the same results for the right and left LE: 1. Ipsilateral biceps femoris 2. Gluteus maximus 3. Contralateral erector spinae, L 4. Ipsilateral erector spinae, L 5. Contralateral erector spinae, ThL 6. Ipsilateral erector spinae, ThL Slight bilateral activation of the upper trapezius during the movements.

Table 11. Movement Stereotypes

3.3.18 Results

From this initial kinesiological examination it can be concluded that the patient's posture has adjusted to the injury. The patient has greater load on the right lower extremity due to the pain in the left foot, with shortness of the hamstrings, and with slight LF of the trunk to the right to keep balance. Since the left LE is in slight ER at the hip, the patient may be subconsciously trying to put less weight on the left LE due to the injury. This fact may also conclude why the Trendelenburg test yielded positive results, being worse when standing on the left LE, despite muscle strength test results showing that the strength of the left gluteus medius was good. Since the patient was required to stand on the left LE which is still in its painful state, he may have subconsciously avoided stressing the foot by semiflexing the knee joint and 'lazily' bringing up the right LE to 90°.

The patient has one foot slightly forward than the other possibly due to the avoidance of fully loading the left lower extremity. Since the right knee is slightly more extended, this foot misalignment may have been adapted to give him some stability. Also, he may have been unstable due to the slight decrease in proprioception of the left foot.

Generally the extensors of the feet are stronger than the flexors such as the tibialis anterior. In standing the extensor hallucis longus muscles were active since the hallux's of both feet were extended and not fully touching the ground. The patient has pes planus of both feet due to weakness of the muscles of the transverse and longitudinal arches of the feet and those in the legs. The weakness of these muscles (i.e. lumbricals, interossei, adductor hallucis, abductor hallucis, etc) and the flexor digitorum longus, can be seen by the collapsed arches and the increased activity of the toes, leading to poor stability. Sensorimotor exercises will need to be done to improve muscle strength, balance and stabilization. Also, short foot and extension of the toes will be good techniques to improve the strength of the intrinsic foot muscles, and in addition may improve his posture.

Range of motion, specifically to PF and inversion needs to be increased. The patient has valgosity in his ankles and therefore strengthening tibialis posterior may decrease the tendency of his ankles to go to eversion, and simultaneously improve plantar flexion in his ankle. Proprioceptive neuromuscular facilitation will be an excellent technique to solve this problem. Post-isometric relaxation may be used to relax tibialis anterior and the peroneal muscles, and

mobilization of joint restrictions and blockages are necessary to promote optimal function in his feet.

The patient has a painful left sided calcaneus and a painful quadratus plantae with plantar fasciitis, and therefore it will be necessary to treat movement restrictions between the tarsal bones, provide STT's in areas of restriction, and teach short foot to relax quadratus plantae. Since his left ankle is still swollen and red, the patient will be advised to put an ice pack on it and elevate the lower extremity at home. Also, the patient stated in the anamnesis that he will get a new heel lift for the month. This is good to have at this time while he is still limping to decrease stress on the Achilles tendon. In general he wears insoles but gaining strength in the muscles of the planta will be stressed since insoles do not solve the problem of the feet.

3.4 Short-term and Long-term Rehabilitation Plan

Short-Term Rehabilitation Plan:

Therapy will be mainly focused on improving the state of the left foot and general conditioning of the body.

- Decrease inflammation around the left foot, ankle, and calf: ice and elevation of the LE.
- Heel lift and taping to decrease stress on the Achilles tendon
- S.T.T of the scar, area around the ankle, planta, hamstrings, and left calf.
- Improve ROM and strength in the left foot via exercise with a red thera band and calf raises; PIR of shortened muscles (tibialis anterior, hamstrings, iliopsoas, quadratus plantae); gentle stretching to DF and stretching hamstrings.
- Improve proprioception via sensorimotor training: hedgehog, balance boards, wobble boards, posturomed, rope.
- Improve joint play in the left IP, MTP, MTH, left patella, left cuboid, and navicular bones in their restricted directions.
- Correction of faulty movement patterns in hip ABD and E; improving gait to avoid duck walking; using balance shoes.
- PNF to improve PF with inversion of the foot; strengthening triceps surae, specifically tibialis posterior and decreasing valgoisty in the ankle.

- Improve posture: focus on toe extension when seated, standing, or walking, which may change the breathing pattern to lower thoracic breathing and further change posture; proper seating position so that the soles of the feet are touching the floor.
- Whirlpool bath for the LE to prepare it for therapy; Slightly hypothermic due to inflammation state, 10min, 28/29°C
- Magnetotherapy to promote optimal healing of the tissues, relieve pain and stiffness, increase hyperaemia and improve metabolism in the area.

  -setting at P-15, 25min around the left ankle of the foot.
- Autotherapy: some low resistance exercises at home ex: elliptical machine, swimming, or moderate cycling; PIR self therapy of extensors of the foot, hamstrings, and the short muscles attached to the plantar aponeurosis and quadratus plantae.

Long-Term Rehabilitation Plan:

- Patient is getting insoles: but needs to also focus on strengthening muscles of the planta.
- Continue improving strength, stability, and ROM in both LE's; correct muscle disbalances and posture by staying on an exercise program.
- Focusing on proper gait
- Gentle stretching (especially if the patient will want to return to soccer)
- Work on the deep stabilization system: strengthening abdominals, importantly transversus abdominus; correcting posture to help decrease hyperlordosis and anterior tilt of the pelvis to avoid back pain in the future.

Prolonged anterior tilt of the pelvis may cause pain in the future. Blockages in the lower lumbar area and/or sacroiliac joint may lead to restrictions in movement and pain, and therefore it will be important to strengthen the muscles of the deep stabilization system such as the abdominals and pelvic floor. Typically the transversus abdominus and levator ani are important muscles that need to be strengthened to avoid problems of back pain in the future and to improve breathing. By focusing on strengthening these muscles as well as extending the toes when sitting, standing, or walking, the patients breathing may change to lower thoracic breathing, and simultaneously improve the patients' posture.

3.5 Therapy Progress

Therapeutic Unit 1: 05.01.2010

Time: 10:00am

Subjective Response: The patient feels slight pain in his heel while walking and pain in the scar on palpation. Overall he is positive with examination and therapy but he is worried he will hurt his left ankle. The patient has stated that he has not exercised since the injury.

Conducted Therapy		**Execution** Therapy was done according to standard procedure.
Soft Tissue Techniques	Scar Therapy and STT posterior surface of the left ankle around the scar	Scar therapy: patient lying prone with relaxed LE's and feet over edge of bed. Pressure massage- applying pressure with the thumb on the scar and waiting for release of the tissues below. Scar and surrounding area: Elongation, S curve, C curve, and Kibler fold; holding in position until release.
	Plantar surface of the left and right foot	Prone, leg in passive flexion; releasing restrictions in the calcaneus and the fascia of the forefoot; going to the barrier and waiting for release; both feet.
	Hamstrings and left triceps surae	Releasing restrictions in fascia and muscles; supine with knee flexed; prone position for hamstrings.
PIR (13)	Short foot to relax trigger point in quadratus plantae	Short foot/PIR Quadratus plantae: sitting and standing with one foot at a time. In sitting this exercise was done with the foot in front of the knee and then under the knee. Exteroreceptive facilitation and guidance was done to help the patient do the proper movement.
	PIR to relax hypertone and shortened muscles	PIR - done 4 times for each muscle(group) until release was felt Hamstrings & Iliopsoas: left & right LE For the hamstrings PIR was done with passive F of the LE at the hip and it was also done in ADD & IR hip to decrease the hypertone in biceps femoris.

		Tibialis Anterior and muscles involved in inversion of the feet (tibialis posterior, flexor digitorum longus, and flexor and extensor hallucis longus): supine with knees extended and feet off the edge of the table. Muscles involved in eversion (extensor digitorum longus, peroneus tertius, peroneus longus, and peroneus brevis): supine with knees extended and feet off the edge of the table.
Joint Play (13)	Mobilizations to restore joint play in the feet and left patella	IP joint of the hallux: dorsal direction MTP joints: left hallux in plantar and laterolateral direction, and rotation away from the toes; second toe of the left foot in dorsal direction; right hallux in plantar direction and rotation away from toes. MTH: left & right hallux in plantar direction; left second toe in dorsal direction Left Cuboid: dorsal direction Navicular: left foot in dorsal/plantar direction right foot plantar direction Left patella: lateral direction Plantar and Dorsal fan: mobilization of the metatarsal bones of both feet.
Proprioception	Sensorimotor training to improve proprioception	Hedgehog: stepping barefoot on the hedgehog, first with one foot, then the other; next, stepping on the hedgehog with both feet and walking on one spot on the hedgehog. Balance board: positioned in front of a mirror with a hand rail: the patient placed one foot on the balance board and then the other, making sure his feet, legs, and trunk were in proper alignment. Following, the patient stepped on the balance board with both feet to get the feel of it and stayed in position for 15-20 seconds.

		Attention was focused not only on maintaining stability but on keeping the knees slightly bent, the feet straight and in alignment with the hips, and looking forward. This was repeated three times and he was asked to try to avoid holding onto the hand rail if possible. Wobble board: same exercises as on the balance board.
Gait	Teach correct walking pattern; balance shoes	Correction of walking pattern: emphasis was given on the 3-point contact, starting at the heel, and avoidance of limping. Also extension of toes was provided to improve walking, breathing, and posture simultaneously. By extending the toes, the patient automatically began to breathe more in the lower ribs and his posture improved. He was asked to walk in one spot keeping the position of extended toes and then to walk a few steps forward and back. Finally, walking with balance shoes was attempted.
Stretching	Hamstring stretch	Long black band placed around the end of the foot and held at both ends. The patient was lying down and raised one leg up trying to keep the leg extended to stretch the hamstrings, as well as the calf. He brought the leg up and out to the sides to stretch the different muscle groups: medially for biceps femoris, laterally for semitendinosis and semimembranosus; held up in position for 20 seconds and it was repeated.

Table 12. Therapy Unit 1

Result

The patient was positive but slightly resistant to therapy due to uncertainty and pain. PIR of the hypertone quadriceps slightly released their restriction but will need to be done more times, especially in the other muscles. Mobilization of the interphalangeal joint of the left hallux, MTP

joint of the left second toe, and the left patella in lateral direction improved joint play. Joint play in the other joints is still restricted and will need to be tested in the next therapeutic unit.

Sensorimotor training was important to stimulate the nervous system, provoke hyperemia in the area and improve proprioception. The patient used the handrail in front of him for support to get on the balance board and to familiarize himself with the feeling while on it. He was able to let go only for a few seconds. Walking with balance shoes was not successful due to pain and the patient discontinued walking in them after approximately twenty seconds.

Since the initial examination took up more time, this was all that was done. After the therapy session his left ankle was inflamed as before and in addition had a reddish-purple color. I informed the patient that he may feel more discomfort later on in the day due to the work that was done in today's therapy unit. He was also advised to go to hydrotherapy first and end the therapy session with magnetotherapy for optimal healing of his ankle.

Autotherapy

-Rest; Scar therapy-elongation, S curve, C curve, kibler fold, pressure massage.

-Stretching the hamstrings in sitting position or with a towel/band in supine position.

-Short foot PIR three times a day in sitting position and standing; may be done in both feet (13).

-Ice pack on the ankle with the foot elevated to decrease inflammation.

Therapeutic Unit 2: 06.01.2010

Time: 8:00am

Subjective Response: Greater pain in the ankle today and the patient has not done autotherapy.

Examination	Location	Result
Scar	Left ankle	Restriction, more cranial.
Soft tissues	Plantar surface of the feet	Left foot: Fasciae restriction around the calcaneous and in the area of metatarsal heads; slight tenderness medial side of calcaneous. Right foot: less restriction
	Dorsal side of the left ankle	Restriction posteriorly around the scar.

	Hamstrings and left triceps surae	Restriction distally in left LE triceps surae laterally; greater restriction in right hamstrings, area of biceps femoris.
Joint play (13)	Left MTP Hallux:	Restricted latero-lateral & rotation away from toes.
	Right MTP	Restricted in rotation away from toes
	Left Hallux MTH	Restricted in plantar direction
	Left Cuboid	Restricted in dorsal direction
	Left & Right Navicular	Plantar restriction
	Left Interphalangeal joint, Patella, and 2nd MTP joint	Joint play physiological.
Muscle length test (11)	Hamstrings, tibialis anterior, iliopsoas	1 Moderate shortness in both lower extremities.
ROM feet	Active and passive	Restricted as in the previous therapeutic unit.

Table 13. Objective Examination 2

Conducted Therapy		**Execution** Therapy was done according to standard procedure.
Soft Tissue Techniques	Scar & posterior surface of the left ankle	According to the previous therapy unit. Scar therapy: patient lying prone with relaxed LE's and feet over edge of bed. Pressure massage- applying pressure with the thumb on the scar and waiting for release of the tissues below. Scar and surrounding area: Elongation, S curve, C curve, and Kibler fold; holding in position until release.

	Plantar surface of feet; hamstrings and left triceps surae	Plantar surface of the feet: Prone, leg in passive flexion; releasing restrictions in the calcaneus and the fascia of the forefoot; going to the barrier and waiting for release; both feet. Hamstrings and left triceps surae: Releasing restrictions in fascia and muscles; supine with knee flexed; prone position for hamstrings.
PIR (13)	Short foot	According to the previous therapy unit. Short foot/PIR Quadratus plantae: sitting and standing with one foot at a time. In sitting this exercise was done with the foot in front of the knee and then under the knee. Exteroreceptive facilitation and guidance was done to help the patient do the proper movement.
	PIR of hypertone and shortened muscles (hamstrings, iliopsoas, tibialis anterior)	According to the previous therapy unit. Done 4 times for each muscle(group) until release Hamstrings & Iliopsoas: left & right LE For the hamstrings PIR was done with passive F of the LE at the hip and it was also done in ADD & IR hip to decrease the hypertone in biceps femoris. Tibialis Anterior and muscles involved in inversion of the feet (tibialis posterior, flexor digitorum longus, and flexor and extensor hallucis longus): supine with knees extended and feet off the edge of the table. Muscles involved in eversion (extensor digitorum longus, peroneus tertius, peroneus longus, and peroneus brevis): supine with knees extended and feet off the edge of the table.
Joint Play (13)	Mobilizations to restore joint play in the feet and left patella	Mobilization MTP joint: left hallux laterolateral; right & left hallux rotation away from toes. Mobilization MTH: left hallux plantar direction Mobilization left Cuboid: dorsal direction

		Mobilization left and right Navicular: plantar Plantar and Dorsal fan: mobilization of the metatarsal bones of both feet.
PF exercise	Strengthening muscles of PF	Sitting on a mat, LE's and knees extended, with an oval thera-band ball against the wall. Slowly performed PF of each foot against the ball; 3 sets, 10 reps per foot.
DF Stretch	Stretching soleus: Post PF stretch	Standing facing the wall, with the LE to be stretched in front of the other foot; gently leaning forward, bending the injured knee over the ankle; held for 20 seconds and repeated.
Calf stretch	Stretching calfs: Post PF stretch	Stretching triceps surae passively by standing on the calf stretch incline for one minute. Also, standing facing the wall, with the LE to be stretched behind the other foot, knee extended. Feet remain in full contact with the ground; held for 20 seconds and repeated.
Proprioception	Sensorimotor training to improve proprioception	Hedgehog, balance board and wobble board exercises as done in the previous therapy unit. Posturomed: one foot at a time, making sure the feet were straight including the spine; both feet with slight flexion in the knees, moving the posturomed forward-back and side-to-side; movement is from the hips down; standing on the posturomed and slowly lifting one leg up in slight flexion, holding for at least 10-15 seconds and switching legs.
Stretching	Hamstring Stretch	As in the previous therapy unit. Long black band placed around the end of the foot and held at both ends. The patient was lying down and raised one leg up trying to keep the leg extended to stretch the hamstrings, as well as the calf. He brought

		the leg up and out to the sides to stretch the different muscle groups: medially for biceps femoris, laterally for semitendinosis and semimembranosus; held up in position for 20 seconds and it was repeated.

Table 14. Therapy Unit 2

Results:

The patient has not been to magnetotherapy and hydrotherapy yet since he had forgotten to sign up and there was no room for him. He will be scheduled to go the following week.

Joint play has improved but ROM is still decreased and hypertone is still present in the muscles. The patient had difficulty maintaining stability while getting on and off of the balance and wobble boards, however when he had to remain standing on one he did not lose stability. While on the posturomed, the patient tried his best but was very unstable and could not get the posturomed to fully stop moving when standing. He could not hold his LE's up in slight flexion for longer than 2 seconds.

Autotherapy

- Scar therapy: elongation, S curve, C curve, kibler fold, pressure massage.
- Autotherapy PIR hamstrings with band/towel, or prone over edge of bed; 2-3×/day, 3-5 repetitions, both LE's (13).
- Autotherapy PIR of tibialis anterior in sitting; 3×/day, 3-5 repetitions, both LE's (13).
- Short foot whenever possible during the day; sitting or standing (13).
- Toe raises: whenever possible, with both LE's.
- Ice pack on the ankle every day when he finds the time with the foot elevated to decrease inflammation.

Therapeutic Unit 3: 08.01.2010

Time: 8:15am

Subjective Response: The patient is tired, has slight pain in the heel during weight bearing, and states that he did not do autotherapy at home, except that he put ice on his ankle once.

-Reexamination ABD movement stereotype of both LE's: incorrect pattern

Examination	Location	Result
Scar	Left ankle	Restriction, more cranial.
Soft tissues	Plantar surface of feet	Fasciae restricted in the left foot.
	Dorsal side of left ankle	Restriction posteriorly around the scar.
	Hamstrings and left triceps surae	Restriction in left LE triceps surae, right aspect, and more restriction in right hamstrings as before.
Joint play (13)	Left interphalangeal joint, MTP joints, MTH left hallux, left cuboid, right navicular, and left patella	Joint play is physiological.
	Left Navicular	Slight plantar restriction.
Muscle length test (11)	Hamstrings, tibialis anterior, iliopsoas	Iliopsoas: no shortness Hamstrings & tibialis anterior: 1 Moderate shortness in both lower extremities, more in the right hamstrings.
ROM feet	Active and passive	Restricted as in the previous therapy units.
Movement pattern	Hip ABD	Faulty movement pattern as in the initial kinesiological examination. See page 34
	Hip E	

Table 15. Objective Examination 3

Conducted Therapy		Execution Therapy was done according to standard procedure.
Soft Tissue Techniques	Scar Therapy and STT posterior surface of the left ankle around the scar	As in the previous therapy unit. Also a soft ball was used. Scar therapy: patient lying prone with relaxed LE's and feet over edge of bed. Pressure massage- applying pressure with the thumb on the scar and waiting for release of the tissues below. Scar and surrounding area: Elongation, S curve, C curve, and Kibler fold; holding in position until release.

	Plantar surface of the left foot; Hamstrings and left triceps surae	Going to the barrier and waiting for release as in the previous therapy unit. Plantar surface of the left foot: Prone, leg in passive flexion; releasing restrictions in the calcaneus and the fascia of the forefoot. Hamstrings and left triceps surae: Releasing restrictions in fascia and muscles; supine with knee flexed; prone position for hamstrings.
PIR (13)	PIR to relax hypertone and shortened muscles	According to the previous therapy unit. Done 4 times for each muscle(group) until release Hamstrings: left & right LE For the hamstrings PIR was done with passive F of the LE at the hip and it was also done in ADD & IR hip to decrease the hypertone in biceps femoris. Tibialis Anterior and muscles involved in inversion of the feet (tibialis posterior, flexor digitorum longus, and flexor and extensor hallucis longus): supine with knees extended and feet off the edge of the table. Muscles involved in eversion (extensor digitorum longus, peroneus tertius, peroneus longus, and peroneus brevis):supine, knees E & feet off the edge of the table.
Joint Play (13)	Mobilization to restore joint play in the feet and left patella	Mobilization left Navicular: plantar direction Plantar and Dorsal fan: mobilization of the metatarsal bones of both feet.
Correction of Faulty Movement Pattern	Hip ABD Hip E	Correction of the position of the patient and the execution of the movement indicated; 2sets of 10 repetitions both sides.

PF exercise	Strengthening muscles of PF	According to the previous therapy unit. Sitting on a mat, LE's and knees extended, with an oval thera-band ball against the wall. Slowly performed PF of each foot against the ball; 3 sets, 10 reps per foot.
Improving strength and stability around ankle	Red thera band: providing PF, DF, Inversion, Eversion of both feet	Red thera band was placed around both feet and feet were brought out to eversion. The thera band was also used to provide inversion, PF and DF; two sets of 10 repetitions.
Proprioception	Sensorimotor training to improve proprioception	Hedgehog, balance board and wobble board exercises, and stability training on the posturomed as done in the first therapy unit. The patient was also instructed to walk across several balance/wobble boards without losing balance and contacting the floor. After each step on a board the patient was asked to hold the position for a few seconds. While balancing, an inflatable ball was passed to the patient and different maneuvers were done with it (i.e. throwing it up and down, passing it around his body and under one leg).
Stretching	Hamstring stretch	As in the previous therapeutic session Long black band placed around the end of the foot and held at both ends. The patient was lying down and raised one leg up trying to keep the leg extended to stretch the hamstrings, as well as the calf. He brought the leg up and out to the sides to stretch the different muscle groups: medially for biceps femoris, laterally for semitendinosis and semimembranosus; held up in position for 20 seconds and it was repeated.

Table 16. Therapy Unit 3

Results

After therapy, joint play was physiological and the soft tissues were less restricted, including the scar. The scar is still painful on palpation. Abduction and extension at the hip of the lower extremities did not follow the correct movement pattern, and therefore the patient was guided toward the proper movement stereotype. After correction the patient was able to provide the movements correctly, but had a more difficult time with abduction. Also the patient still had great difficulty providing eversion and inversion of his feet. In some moments he could provide the movement but it was easier for him after exteroreceptive facilitation was used to help.

Autotherapy

- Scar therapy: elongation, S curve, C curve, kibler fold, pressure massage.
- Autotherapy PIR hamstrings with band/towel, or prone over edge of bed; 3×/day, 3-5 repetitions, both LE's (13).
- Autotherapy PIR of tibialis anterior; 3×/day, 3-5 repetitions, both LE's (13).
- Short foot whenever possible during the day; sitting or standing (13).
- Toe extension: whenever possible.
- Hip ABD and E of the LE's 3×/day; 3 sets of 10 repetitions.
- Ice pack with lower extremity elevated

Therapeutic Unit 4: 12.01.2010

Time: 10:00am

Subjective Response: The patient stated he had to shovel snow on the weekend and therefore his ankle is sore today. He did not do self therapy at home.

Examination	Location	Result
Scar	Left ankle	Slight restriction, cranial
Soft tissues	Plantar surface of left foot	Fasciae restriction slightly improved.
	Dorsal side of left ankle	Restriction posteriorly around the scar. Slight reddish color in the ankle, possibly due to the stress put on the ankle over the weekend.
	Hamstrings and left triceps surae	There is still more restriction in the right hamstrings. The left triceps surae is in slight restriction, distally and more laterally.

Joint play (13)	All joints	Joint play is physiological.
Muscle length test (11)	Hamstrings, tibialis anterior, iliopsoas	Iliopsoas: physiological length. Hamstrings & tibialis anterior: 1 Moderate shortness in both LE's but slightly improved.
ROM feet	Active and passive	Restricted but improved.
Movement patterns	Hip ABD and HIP E	Hip ABD: better than last time but needs to be corrected again. Hip E: physiological

Table 17. Objective Examination 4

Conducted Therapy		**Execution** Therapy was done according to standard procedure.
Soft Tissue Techniques	Scar Therapy; STT posterior surface of the left ankle;	As done in the previous therapy units. Scar therapy: patient lying prone with relaxed LE's and feet over edge of bed. Pressure massage- applying pressure with the thumb on the scar and waiting for release of the tissues below. Scar and surrounding area: Elongation, S curve, C curve, and Kibler fold; holding in position until release.
	Plantar surface of the left foot; Hamstrings and left triceps surae	As in previous therapy units. Plantar surface of the left foot: Prone, leg in passive flexion; releasing restrictions in the calcaneus and the fascia of the forefoot; going to the barrier and waiting for release. Hamstrings and left triceps surae: Releasing restrictions in fascia and muscles; supine with knee flexed; prone position for hamstrings.

PIR (13)	PIR to relax hypertone and shortened muscles	Done 4 times for each muscle(group) until release. Hamstrings: left & right LE's For the hamstrings PIR was done with passive F of the LE at the hip and it was also done in ADD & IR hip to decrease the hypertone in biceps femoris. Tibialis Anterior and muscles involved in inversion of the feet (tibialis posterior, flexor digitorum longus, and flexor and extensor hallucis longus): supine with knees extended and feet off the edge of the table. Muscles involved in eversion (extensor digitorum longus, peroneus tertius, peroneus longus, and peroneus brevis): supine with knees extended and feet off the edge of the table.
	Short foot to release restrictions in quadratus plantae	As done previously in standing position. Short foot/PIR Quadratus plantae: Exteroreceptive facilitation and guidance was done to help the patient do the proper movement.
Correction of Faulty Movement Pattern	Hip ABD	Correction of the position of the patient and the execution of the movement; 3 sets of 10 repetitions both sides.
PF exercise	Strengthening muscles of PF	Sitting on a mat, LE's and knees extended, with an oval thera-band ball against the wall. Slowly performed PF of each foot against the ball; 3 sets, 10 repetitions per foot.
Improving strength and stability around the ankle	Red thera band: providing PF, DF, Inversion, Eversion of both feet	According to the previous therapy unit. Red thera band was placed around both feet and feet were brought out to eversion. The thera band was also used to provide inversion, PF and DF; two sets of 10 repetitions.

Proprioception	Sensorimotor training to improve proprioception	Hedgehog, balance board and wobble board exercises, and stability training on the posturomed as done in the first therapy unit. The patient was also instructed to walk along a rope, try to maintain stability and balance, and look ahead. While balancing an inflatable ball was passed to the patient and different maneuvers were done with it (i.e. throwing it up and down, passing it around his body and under one leg).
Stretching	Hamstring stretch	As in the previous therapeutic unit. Long black band placed around the end of the foot and held at both ends. The patient was lying down and raised one leg up trying to keep the leg extended to stretch the hamstrings, as well as the calf. He brought the leg up and out to the sides to stretch the different muscle groups: medially for biceps femoris, laterally for semitendinosis and semimembranosus; held up in position for 20 seconds and it was repeated.
Hydrotherapy	Whirlpool bath for left LE	Slightly hypothermic due to inflammation state, 10min, 28/29°C
Magnetotherapy	Magnetotherapy around the left ankle	P-15, 25min around the ankle of the left foot.

Table 18. Therapy Unit 4

Results

It is advisable for the patient to have a whirlpool bath first before continuing with the rest of the therapy, however since the spots were full with other patients it was not possible. He was advised to arrange to have hydrotherapy first ahead of time to get the optimal therapeutical effect.

The patient had a difficult time balancing on the rope while holding the inflatable ball. Overall, he has improved a lot in sensorimotor training and is able to walk across the balance boards without losing stability.

Autotherapy

- Patient is advised to do calf raises twice a day: 3 sets of 10 repetitions
- Stretching hamstrings whenever he finds the time
- Autotherapy PIR of tibialis anterior: 3×/day, 3-5 repetitions, both LE's (13)
- Short foot whenever possible during the day; sitting or standing (13).
- Toe extension: whenever possible
- Hip ABD LE's: twice a day, 3 sets of 15 repetitions.
- Ice pack on the ankle and elevate lower extremity to decrease inflammation.

Therapeutic Unit 5: 14.01.2010

Time: 8:30am

Subjective Response: Today the patient stated that he is tired from the long week and that he doesn't have much strength. Overall the pain is decreased in his ankle when he walks.

Examination	Location	Result
Scar	Left ankle	Slightly restricted, cranial
Soft tissues	Plantar surface of left foot	Improved; decreased painful calcaneal spur.
	Dorsal side of left ankle	Restricted posteriorly around the scar but less than before.
	Hamstrings and left triceps surae	Slightly less restriction in the right hamstrings. Left triceps surae is in normal tone (except in area of scar-Achilles tendon)
Joint play (13)	All joints	Joint play is physiological.
Muscle length test (11)	Hamstrings, tibialis anterior, iliopsoas	Iliopsoas: physiological length. Hamstrings & tibialis anterior: 1 Moderate shortness but improved.
ROM feet	Active and passive	Restricted but improved.

Movement patterns	Hip ABD and HIP E	Hip ABD: patient sometimes activates quadratus lumborum before gluteus medius and minimus. Hip E physiological.

Table 19. Objective Examination 5

Conducted Therapy		**Execution** Therapy was done according to standard procedure.
Soft Tissue Techniques	Scar Therapy; STT posterior surface of the left ankle	As in previous therapy units. Scar therapy: patient lying prone with relaxed LE's and feet over edge of bed. Pressure massage- applying pressure with the thumb on the scar and waiting for release of the tissues below. Scar and surrounding area: Elongation, S curve, C curve, and Kibler fold; holding in position until release.
	Plantar surface of the left foot; Hamstrings and left triceps surae	As in previous therapy units. Plantar surface of the left foot: Prone, leg in passive flexion; releasing restrictions in the calcaneus and the fascia of the forefoot; going to the barrier and waiting for release Hamstrings and left triceps surae: Releasing restrictions in fascia and muscles; supine with knee flexed; prone position for hamstrings.
PIR (13)	Release restrictions in quadratus plantae	According to the previous therapy session. Short foot/PIR Quadratus plantae: standing with one foot at a time. Exteroreceptive facilitation and guidance was done to help the patient do the proper movement.

	Relax hypertone and shortened muscles	According to the previous therapy session. Done 4 times for each muscle(group) until release Hamstrings & tibialis anterior: left & right LE's
Taping	Release tension in tissues below; area of Achilles tendon	Taping left Achilles tendon.
Correction of Faulty Movement Pattern	Hip ABD	Correction of the position of the patient and the execution of the movement as in the previous therapy session; 3 sets of 10 repetitions both sides
PNF	Second diagonal extension pattern for strengthening triceps surae	Second diagonal extension pattern with knee extension: technique Hold-Relax-Active Movement; supine position, repeated several times.
Calf raises	Strengthening muscles of PF	Standing facing the handrail against the wall: 3 sets of 10 repetitions.
Improving strength and stability around the ankle	Red thera band: providing DF, Inversion, Eversion of both feet	According to the previous therapy unit. Red thera band was placed around both feet and feet were brought out to eversion. The thera band was also used to provide inversion, PF and DF; two sets of 10 repetitions.

Proprioception	Sensorimotor training to improve proprioception	Hedgehog, balance board and wobble board exercises, and stability training on the posturomed as done from the beginning of therapy with different stability maneuvers. An inflatable ball was given to the patient while on the posturomed and he was asked to provide different maneuvers with it (i.e throwing it up in the air, passing it around his body or under one LE, and passing it back and forth with me).
Gait Training	Balance shoes	Walking with balance shoes on one spot, to the sides, and in a squat, with fast and slow steps.
Stretching	Hamstring stretch	As in previous therapy units. Long black band placed around the end of the foot and held at both ends. The patient was lying down and raised one leg up trying to keep the leg extended to stretch the hamstrings, as well as the calf. He brought the leg up and out to the sides to stretch the different muscle groups: medially for biceps femoris, laterally for semitendinosis and semimembranosus; held up in position for 20 seconds and it was repeated.
Hydrotherapy	Whirlpool bath for left LE	Slightly hypothermic due to inflammation state, 10min, 28/29°C
Magnetotherapy	Magnetotherapy around the left ankle	P-15, 25min around the ankle of the left foot.

Table 20. Therapy Unit 5

Results

Since autotherapy is not successful the patient is asked to do more of the exercises in the clinic. After taping was applied the patient felt some decrease in tension and overall comfort when

walking. The calf raises provoked slight discomfort on the last set, but the patient was able to complete them. Walking in the balance shoes was successful. The patient was able to walk in all different manners, and although he was slightly unstable, he did not experience pain as before. When doing PNF, the patient had some difficulty understanding the movement pattern but was able to do it in the end.

Autotherapy

The patient is encouraged to do the self therapy as indicated in the previous therapeutic unit.

Other advice:

- Elliptical machine with low resistance or swimming once or twice a week
- Calf raises to improve strength of triceps surae
- Calf stretch and DF stretch after calf raises

Therapeutic Unit 6: 19.01.2010

Time: 10:00am

Subjective Response: The patient stated that the taping helped decrease pain and tension in his ankle and he took it off on the weekend. He did his exercises as instructed in the previous therapeutic unit only on Sunday, since he had been busy at work every other day. Overall he feels a bit better and the pain in his heel has decreased.

Examination	Location	Result
Scar	Left ankle	Freely movable
Soft tissues	Plantar surface of left foot	Decreased restriction and pain on palpation
	Dorsal side of left ankle	Still slight restriction.
	Hamstrings and left triceps surae	Left triceps surae is in normal tone while there is some restriction in the muscles of the hamstrings, more in the area of biceps femoris. Slight restriction in fasciae but decreased from before.
Joint play (13)	All joints	Joint play is physiological.
Muscle length test (11)	Hamstrings, tibialis anterior, iliopsoas	Iliopsoas: Physiological length. Hamstrings: 1 Moderate shortness right side. Tibialis anterior: 1 Moderate shortness bilateral

ROM feet	Active and passive (orientation test)	Restricted but improved.
Movement patterns	Hip ABD and HIP E	Physiological

Table 21. Objective Examination 6

Conducted Therapy		**Execution** Therapy was done according to standard procedure.
Hydrotherapy	Whirlpool bath for the left LE	Slightly hypothermic due to inflammation state, 10min, 28/29°C
Soft Tissue Techniques	Scar Therapy; STT posterior surface of the left ankle	According to previous therapy units. Scar therapy: patient lying prone with relaxed LE's and feet over edge of bed. Pressure massage- applying pressure with the thumb on the scar and waiting for release of the tissues below. Scar and surrounding area: Elongation, S curve, C curve, and Kibler fold; holding in position until release.
	Plantar surface of the left foot; Hamstrings and left triceps surae	According to previous therapy units. Plantar surface of the left foot: Prone, leg in passive flexion; releasing restrictions in the calcaneus and the fascia of the forefoot; going to the barrier and waiting for release. Hamstrings and left triceps surae: Releasing restrictions in fascia and muscles; supine with knee flexed; prone position for hamstrings.

PIR (13)	Release restrictions in quadratus plantae	According to previous therapy units. Short foot/PIR Quadratus plantae: standing with one foot at a time. Exteroreceptive facilitation and guidance was done to help the patient do the proper movement.
	Relax hypertone and shortened muscles	According to previous therapy units. Done 4 times for each muscle(group) until release. Hamstrings & tibialis anterior: left & right LE's; main focus on left side tibialis anterior.
PNF	Second diagonal extension pattern for strengthening triceps surae	-Second diagonal extension pattern: technique Hold-Relax-Active Movement as in the previous therapy session. Done several times with the knee in extension.
Calf raises	Strengthening muscles of PF	Standing facing the handrail against the wall: 3 sets of 10 repetitions; provided on one extremity at a time and in the third set with both feet.
Calf stretch	Stretching calfs: Post PF stretch	According to therapy unit 2. Stretching triceps surae passively by standing on the calf stretch incline for one minute. Also, standing facing the wall, with the LE to be stretched behind the other foot. Feet remain in full contact with the ground; held for 20 seconds and repeated.
Improving strength and stability around the ankle	Red thera band: providing PF, DF, Inversion, Eversion of both feet	According to the previous therapy unit. Red thera band was placed around both feet and feet were brought out to eversion. The thera band was also used to provide inversion, PF and DF; two sets of 10 repetitions.

Proprioception	Sensorimotor training to improve proprioception	Hedgehog, balance board and wobble board exercises, and stability training on the posturomed as done previously; walking along a rope; use of inflatable ball.
Gait Training	Balance shoes	As in the previous therapy session. Walking with balance shoes on one spot, to the sides, and in a squat, with fast and slow steps.
Hamstring Stretch	Stretch hamstrings and calfs	As in the previous therapeutic session; holding for 20 seconds, 3 repetitions.
Magnetotherapy	Magnetotherapy around the left ankle	P-15, 25min around the ankle of the left foot.

Table 22. Therapy Unit 6

Results

PNF was successful, and the patient was able to feel the triceps surae working and being strengthened. The patient did not report any pain during the exercises; however his ankle is still swollen and slightly pink in coloration.

Autotherapy

The patient is strongly encouraged to do some self therapy that has been advised to him at the therapy sessions.

Check Up Therapy 7: 02.02.2010

Time: 8:15am

Subjective Response: Since the last therapy session the patient has not come in for rehabilitation. He has no more pain in the ankle and heel, and no pain on palpation. The patient only experiences slight discomfort after stressing the left lower extremity for a longer period of time. He states that he feels better but that his ankle is still swollen because he works all day.

Objective Examination:

-Aspection of the patient in standing position.

The patient's left heel looked a bit better but it was still swollen; feet in slight ER, flat arches.

Conducted Therapy:

- Measurement (cm) between heels: 14cm (variable)
- PNF: (10) Second diagonal extension pattern with the technique Hold-Relax-Active Movement to strengthen triceps surae: specifically the tibialis posterior, but also the medial head of the gastrocnemius, and the medial part of soleus. Done several times in supine position with knee extension. With the knee extended the patient was able to strengthen tibialis anterior best.

Results:

The patient cooperated very well during PNF and was able to perform the movements correctly as previously.

Autotherapy:

The patient is advised to do some of the self therapy exercises mentioned before. He needs to continue to go to individual physiotherapy, magnetotherapy, and to hydrotherapy for the rest of his sessions to improve the overall condition in his left ankle.

3.6 Final Kinesiological Examination

Examination was done on 19.01.2010, in the fitness room, and according to standard testing procedure.

3.6.1 Posture Examination (11)

Standing Anterior View

- Base: narrow
- Slight ER feet; decreased on the left side
- Left foot and ankle are still swollen but not as much as before
- Decreased longitudinal and transverse arch of both feet
- Decreased activity of the toes, but still more activity on the left side
- Right foot, second digit hammer toe in the distal interphalangeal
- No weight on the hallux‘s
- Calf’s look equal in size (will be confirmed in anthropometry)
- Knees in good alignment with the feet
- Contraction of the quadriceps
- Umbilicus on right side more
- Trunk: slight LF right; axillary angle slightly greater on right side

- Shoulders are level
- Rotation of the head slightly to the left and LF right

Standing Lateral View (left side)

- Very slight ER left foot
- Feet in alignment
- Slight activity of the toes besides the Hallux
- E of the knee, but still slightly less than on the right side
- Trunk: Lumbar hyperlordosis, flat lower thoracic region, CTh crossing kyphosis, slight cervical hyperlordosis
- Protraction of shoulders
- Slight head protraction

Standing Lateral View (right side)

- Right knee extension
- Feet more in alignment
- Slight ER right foot
- Activity of the toes in the right foot except Hallux

Standing Posterior View

- Base is hip width apart; Slight ER of the feet
- Loading slightly more on the right foot (will be confirmed in scale examination)
- Valgosity of the ankles; loading the medial aspect of the heels
- Scar on the left side looks better
- Left ankle is still swollen and pink
- Calfs look the same in circumference (will be confirmed in anthropometry)
- Knee angle level
- Trunk: slight LF to the right in the middle/lower thoracic area, and slightly greater axillary angle on the right side
- LF head right, rotation left

3.6.2 Examination of the Pelvis

Iliac crests	Posterior Superior Iliac Spines	Anterior Superior Iliac Spines	Comparing Iliac Spines Laterally on right side of the body	Comparing Iliac Spines Laterally on left side of the body
Same level	Same level	Same level	ASIS lower	ASIS lower

Table 23. Final Examination of the Pelvis

3.6.3 Scale Examination

	Weight on one scale (kg)	Weight on two scales (kg)	Difference (kg)
Both Feet	97	/	
Right Leg	/	50	3
Left Leg	/	47	

Table 24. Final Scale Examination

There is no significant difference in weight distribution, and therefore it is physiological.

3.6.4 Rhomberg Test (11)

Normal stance, eyes open: stable with activity of the quadriceps.

Feet together, eyes open: stable with little activity of the quadriceps (not intermittent).

Feet together with closed eyes for 10seconds: same results as in the initial examination however decreased. Now there is less activity in the quadriceps and toes.

3.6.5 Vele Test (23)

The Vele test was done according to standard procedure as in the initial kinesiological examination and yielded the same results, negative. Stability was better, with less activity of the muscles in the toes.

3.6.6 Trendelenburg test (11)

Standing, bringing each LE up to 90^{o} flexion. The strength of gluteus medius was better than before, however the test is still positive. When standing on the left lower extremity there is still

lateral tilt of the pelvis right. Duck walking has decreased a lot due to increased self confidence, decreased pain in the left foot, and strengthening gluteus medius via hip abduction exercises.

3.6.7 Gait Exammination

- 3 point contact and arches are slightly better
- ER is less but still slightly more in the left foot
- Less valgosity of the ankles
- Only slight lateral tilt of the pelvis: normal stride lengths
- Movement is slightly greater in right knee
- Slight pink color in the left foot

Modifed tests:

With closed eyes: the patient is able to walk in a straight line and has a slightly wider base.

On tiptoes and heels: able to walk in both stances without a problem and without pain.

On tiptoes the patient was able to keep the feet straight; on heels his feet were turned out in ER.

3.6.8 Anthropometric Measurements

	Left LE (cm)	**Right LE** (cm)	**Difference**
Functional Length	108,5	108,5	/
Anatomical Length	96,5	96,5	
Circumference 15cm above the knee	53,5	54	0,5
Circumference above the edge of the patella	41	41,5	0,5
Circumference above the patella	39,5	39,5	/
Circumference above the tibial tuberosity	35,5	35,5	/
Circumference of Calf	39,5	40	0.5
Circumference of Ankle	28	26.5	1.5
Circumference of Metatarsals	23.5	23	0.5

Table 25. Final Length and Circumference of the Lower Extremities

The left ankle and foot are still slightly swollen.

3.6.9 Palpation

Area of edema: restriction in ankle

Achilles tendon thicker left side.

Decreased tension in muscles of the planta and plantar fasciae.

	Left LE	**Right LE**
Quadratus lumborum	Normal tone	Normal tone
Gluteus maximus	Normal tone	Normal tone
Gluteus medius	Normal tone	Normal tone
Piriformis	Normal tone	Normal tone
Iliopsoas (psoas major, iliacus)	Normal tone	Normal tone
Quadriceps (rectus femoris, vastus medialis, vastus lateralis)	Normal tone	Normal tone
Hamstrings (biceps femoris, semitendinosus, semimembranosus) & origin at ischial tuberosity	Slight Hypertone of muscles, more in the biceps femoris	Slight Hypertone of muscles, more than in left LE; more in the biceps femoris.
Hip Adductors	Normal tone	Normal tone
Triceps surae (gastrocnemius and soleus)	Normal tone	Normal tone
Peroneus longus and brevis	Slight hypertone	Slight hypertone
Tibialis Anterior	Slight hypertone	Slight hypertone
Plantar fascia	Slight restriction in area of calcaneus and metatarsal heads	Normal tone
Quadratus plantae	Normal tone; not painful on palpation	Normal tone
Flexor hallucis brevis	Normal tone	Normal tone
Abductor hallucis	Normal tone	Normal tone

Table 26. Final Palpation Examination

3.6.10 Scar Examination

(patient lying in prone position with feet over edge of bed)

- Slightly pink color
- Perspiration-good
- Edema is still present
- Palpation:

  Elongation, S curve, C curve

  Freely moveable (no restriction) and no pain

  Temperature: same on both ankles

  Sensation: good

3.6.11 Range of Motion

	LE	Internal Rotation	External Rotation	Flexion	ABD	ADD
Active	Right	0-25^{o}	40^{o}-0	F knee: 0-120^{o} E knee: 0-75^{o}	40^{o}-0	0-10^{o}
	Left	0-25^{o}	40^{o}-0	F knee: 0-120^{o} E knee: 0-80^{o}	40^{o}-0	0-10^{o}
Passive	Right	0-30^{o}	45^{o}-0	F knee: 0-125^{o} E knee: 0-75^{o}	45^{o}-0	0-10^{o}
	Left	0-30^{o}	40^{o}-0	F knee: 0-125^{o} E knee: 0-85^{o}	45^{o}-0	0-10^{o}

Table 27. Final ROM of the HIP in Supine Position; Active and Passive Movement

		F (prone position)	E (supine position)
Active	**Right LE**	0-135°	0°
	Left LE	0-135°	0°
Passive	**Right LE**	0-140°	0°
	Left LE	0-140°	0°

Table 28. Final ROM of the Knee

	LE	DF with all Triceps Surae	DF w/ Soleus; Knee bent	PF	Inversion	Eversion
Active	Right	0-15°	0-20°	30°-0	0-20°	10°-0
	Left	0-15°	0-20°	25°-0	0-20°	10°-0
Passive	Right	0-15°	0-20°	30°-0	0-25°	15°-0
	Left	0-15°	0-20°	30°-0	0-20°	15°-0

Table 29. Final ROM of the Ankle in Supine Position

3.6.12 Muscle Strength Test (11)

Muscle/Muscle Groups and Position	Left Grade	Right Grade
Gluteus Maximus (prone)	5	5
Gluteus Medius (side-lying)	4+	4+
Gluteus Minimus (side-lying)	5	5
External Rotators of the hip (sitting)	5	5
Internal Rotators of the hip (sitting)	5	5
Hip Adductors (side-lying)	5	5
Iliopsoas (sitting)	5	5

Hip Flexors (sartorius, tensor fasciae latae, rectus femoris, iliopsoas) (sitting)	5	5
Tensor fasciae latae (supine)	5	5
Quadriceps (sitting)	5	5
Semitendinosus & Semimembranosus (prone)	5	5
Biceps femoris (prone)	5	5
Gastrocnemius (standing)	5 ^{o}	5
Soleus (prone)	5 ^{o}	5
Peroneus Longus (supine)	4+ ^{o}	4+
Peroneus Brevis (prone)	4+ ^{o}	4+
Tibialis Anterior (supine)	5	5
Tibialis Posterior (supine)	4+ ^{o}	4+
Extensor Digitorum Longus & Brevis (supine)	4+	4+
Peroneus Tertius (supine)	4+	4+
Flexor Digitorum Longus (supine)	4+	4+
Flexor Digitorum Brevis (supine)	5	5
Lumbricals (supine)	4	4
Plantar and Dorsal Interossei (supine)	3+	3+
Extensor Hallucis Longus (supine)	5	5
Flexor Hallucis Longus (supine)	5	5
Flexor Hallucis Brevis (supine)	5	5
Abductor Hallucis (supine)	4-	4-
Adductor Hallucis (supine)	4	4

Table 30. Final Muscle Strength Test (8)

^{o} ROM restriction: restriction is less than in initial kinesiological examination

3.6.13 Muscle Length Test (11)

Muscle(s)	Left LE	Right LE
Hamstrings	0	1
Iliopsoas	0	0
Rectus Femoris	0	0
Sartorius	0	0
Tensor Fasciae Latae	0	0
Adductors (one joint and two joint)	0	0
Gastrocnemius	0	0
Soleus	0	0
Tibialis Anterior	1	1

Table 31. Final Muscle Length Test

Decreased shortness of the hamstrings and tibialis anterior, but the patient is advised to do autotherapy PIR for both and stretching at home.

3.6.14 Examination of Superficial and Deep Sensation

Done with the patient's eyes closed

Tactile-Touch Sensation

The patient could identify where he was touched on his foot and what numbers or letters had been drawn on his planta.

Temperature Sensation

No problems in temperature sensation.

Deep sensation

There was a slight decrease in proprioception in the left foot, however there has been improvement; same tests performed as before.

3.6.15 Tendon Reflexes Examination

Patellar Reflex (L2-L4): 3° Normal for both LE's.

Achilles Tendon Reflex (L5-S2): Left: 1° Hyporeflexia: facilitation by stretching to DF

Right: 2° Hyporeflexia

Medioplantar Reflex (L5-S2): 3° Normal for both LE's.

3.6.16 Joint Play (13)

No blockages or restrictions in any joint.

3.6.17 Movement Stereotypes

Patient performed each movement 3 times.

	Physiological (order of muscle contractions)	**Patient's Movement Stereotype** (order of muscle contractions)
Hip Abduction (side-lying on left & left LE)	1. Gluteus medius & minimus 2. Tensor fasciae latae 3. Quadratus lumborum 4. Iliopsoas & rectus femoris 5. Abdominal and back muscles	1. Gluetus medius and minimus 2. Tensor fasciae latae 3. Quadratus lumborum 4. Iliopsoas and rectus femoris 5. Abdominal and back muscles In doing the movement the second time while abducting the left LE, the patient used the quadratus lumborum slightly sooner than the tensor fasciae latae but after corrected himself.
Hip Extension right & left LE (prone with knee E)	1. Gluteus maximus & ipsilateral biceps femoris 2. Contralateral errector spinae, L 3. Ipsilateral errector spinae, L 4. Contralateral errector spinae, ThL 5. Ipsilateral errector spinae, ThL 6. No activation of shoulder girdle or upper trapezius	Same in both LE's; physiological. 1. Gluteus maximus & ipsilateral biceps femoris 2. Contralateral errector spinae, L 3. Ipsilateral erector spinae, L 4. Contralateral erector spinae, ThL 5. Ipsilateral erector spinae, ThL Slight activation bilateral upper trapezius, and more during left side hip extension

Table 32. Final Movement Pattern Examination

3.7 Evaluation of the Effect of Therapy

Overall therapy improved ROM, decreased restrictions in soft tissues, improved joint play and gait, strengthened muscles of PF, and enhanced stability and proprioception in the lower extremities. However, inflammation has only slightly decreased in the calf and the area of the metatarsal heads, and remains the same around the ankle. Also ROM to plantar flexion still needs to be improved, and the tibialis posterior strengthened.

Examination	Variable	Initial Examination Results	Final Examination Results post Therapy
Aspection	Base	Wider	Narrower
	Arches	Pes planus; decreased longitudinal and transverse	Pes planus: decreased longitudinal and transverse
	Ankle	Valgosity- loading medial aspect of heel. Inflammation: yes with a reddish-purple color	Valgosity-loading medial aspect of heel Inflammation: decreased but still swollen and pink.
	Feet Alignment	Side view: difference in position between right & left feet (not aligned). Also greater ER of the left foot.	Better alignment of the feet in standing. Decreased ER left foot.
	Knee	Slightly greater extension in the right LE	Slightly greater extension in the right LE
	Pelvis	Anterior tilt & protrusion of abdomen	Anterior tilt & protrusion of abdomen (not as great as before)
	Breathing	Abdominal	Abdominal and slightly lower thoracic breathing
Scale	Difference	6kg	3kg = more equal loading
Rhomberg Test (11)	Normal stance	Activity of quadriceps	Stable with activity of the quadriceps.

	Feet together, eyes open	Intermittent activity of the quadriceps.	Stable with little activity of the quadriceps (not intermittent).
	Feet together, eyes closed 10 seconds	Increased activity in the toes, more in the left foot & intermittent activity of quadriceps, more in the right LE	As in the initial examination however decreased. Now there is less activity in the quadriceps and toes.
Vele Test (23)	Observing toe flexors	Negative: patient did not lose balance but there was great activity in the toes, more in the left foot.	Negative: less activity of toe flexors and better stability.
Trendelen-burg Test (11)	Standing on one LE	Worse when standing on left LE; weakness of gluteus medius. Duck walk	Worse when standing on the left LE, however now there is decreased lateral tilt of the pelvis
Gait	Swing and stance phase	Duck walk: great lateral tilt of the pelvis; decreased 3 point contact of the left foot and slightly less valgosity in ankles; Longer stride length of the right LE, fast return, and longer and greater load; Modified gait with closed eyes: wider base and not as confident.	Slight lateral tilt of the pelvis when walking. The strength of the gluteus medius has improved and the stride lengths are now equal. Modified gait: Closed eyes: generally able to walk straight; no difference. Tiptoes: feel aligned well Heels: feet went to ER
Anthropom-etry	Circumference	Greater circumference around the left calf, ankle, and metatarsal heads	Still greater circumference in the left ankle. Decreased circumference in the calf by 0.5 and around the metatarsal heads by 0.5.

Palpation	Iliopsoas	Slight hypertone both LE's	Normal tone
	Hamstrings	Both sides hypertone, greater in the right LE, area of biceps femoris.	Still hypertone as in initial examination but decreased.
	Peroneus Longus and Brevis; Tibialis Anterior	Slight hypertone in both LE's	Slight hypertone in both LE's but decreased
	Plantar Fascia & Quadratus Plantae	Plantar Fascia: Restriction in both feet. Quadratus Plantae: hypertone & painful on palpation	Plantar Fascia: slight restriction in area of calcaneus and metatarsal heads. Quadratus Plantae: normal tone and no pain on palpation.
Scar Exam	Vertical length	Restricted more cranially. Pain in area during gait and on palpation.	Freely moveable and without pain. Pain only occurs after increased stress over time (ex: walking for a longer period).
ROM	Hip	<u>Passive Movement</u> <u>F with knee E</u> Right LE: 70^{o} Left LE: 75^{o}	<u>Passive Movement</u> <u>F with knee E</u> Right LE: 75^{o} Left LE: 85^{o} Physiological is 80^{o}-90^{o}, therefore there is slight restriction in the right LE.
	Ankle PF	<u>Passive Movement PF</u> Right LE: 30^{o} Left LE: 20^{o}	<u>Passive Movement PF</u> Right LE: 30^{o} Left LE: 30^{o} Physiological: 45^{o} therefore there is still restriction

	Ankle Inversion & Eversion	<u>Passive Movement Inversion</u> Right LE: 25° Left LE: 20° <u>Passive Movement Eversion</u> Right LE: 15° Left LE: 10°	<u>Passive Movement Inversion</u> Right LE: 25° Left LE: 20° <u>Passive Movement Eversion</u> Right LE: 15° Left LE: 15° Physiological Inversion: 40° Physiological Eversion: 20° Restriction in both LE's.
Muscle Strength Test (11)	Gluteus medius	Right: 4+ Left: 4	Right: 4+ Left: 4+
	Gastrocnemius	Right: 5 Left: 3+	Right: 5 Left: 5
	Soleus	Right: 5 Left: 4	Right: 5 Left: 5
	Peroneus Longus & Brevis	Right: 4+ Left: 4	Right: 4+ Left: 4+
	Tibialis Posterior	Right: 4+ Left: 4	Right: 4+ Left: 4+
	Intrinsic foot muscles	Such as Lumbricals, Dorsal/Plantar Interossei, ABD Hallucis, & ADD Hallucis: generally all weak	These muscles slightly improved in strength due to exercises of short foot and toe extension.
Muscle Length Test (11)	Iliopsoas	Right: 1 Moderate Shortness Left: 1 Moderate Shortness	Right: No Shortness Left: No Shortness
	Hamstrings	Right: 1 Moderate Shortness Left: 1 Moderate Shortness (greater shortness right side)	Right: 1 Moderate Shortness (decreased compared to initial examination) Left: No Shortness
	Tibialis Anterior	Right: 1 Moderate Shortness Left: 1 Moderate Shortness	Right: 1 Moderate Shortness Left: 1 Moderate Shortness

Exam of Deep Sensation	Deep Sensation	Position change detection of start of movement: slightly less accurate in the left LE & therefore slight decrease in proprioception.	Slight decrease in proprioception in the left foot; better than in initial examination.
Tendon Reflexes	Patellar Reflex (L2-L4)	3° Normal for both LE's.	3° Normal for both LE's.
	Achilles Tendon Reflex (L5-S2):	Left: 1° Hyporeflexia: facilitation by DF stretch Right: 2° Hyporeflexia	Left: 1° Hyporeflexia: facilitation by stretching to DF Right: 2° Hyporeflexia
	Medioplantar Reflex (L5-S2):	3° Normal for both LE's.	3° Normal for both LE's.
Joint Play (13)	Cuboid	Left dorsal restriction	Physiological joint play
	Navicular	Left slight blockage dorsal & plantar. Right restriction plantar.	Physiological joint play. Joint play in all other joints of the LE's are physiological.
Movement Stereotype	Hip ABD	Faulty movement pattern. LE's tended to ER using rectus femoris & iliopsoas first before the gluteus medius and minimus. This was followed by quadratus lumborum in left hip ABD.	Physiological. Patient did use the quadratus lumborum slightly sooner than the tensor fasciae latae but after corrected himself and did the movement correctly the next time without instruction.
	Hip E	Faulty movement pattern. Ipsilateral biceps femoris was contracted before the gluteus maximus. Some upper trapezius activity.	Physiological. There was slight bilateral activation of the upper trapezius during the movements and more during left side hip extension.

Table 33. Evaluation of the Effect of Therapy

Prognosis

If the patient does not do any autotherapy at home as well as give his left ankle some rest during the day, then it will continue to be inflamed for a longer time and his range of motion will continue to be decreased. The patient will eventually like to go back into playing soccer, and therefore he is advised to do some self therapy that was indicated at least 3-4 times a week, which should include some low resistance exercise on a bike ergometer, rotoped, or swimming. Therapy needs to be continued or his adapted gait and posture from the injury may stay. These changes may lead to more muscle disbalances, blockages, and pain may arise in other areas of the body, such as in the lower lumbar region.

4 Conclusion

This patient, who was three months post operation, came with great restriction of plantar flexion, along with weakness of the left triceps surae. He had a typical 'duck walk' with weakness of the gluteus medius and his sense of balance was decreased. Now, after therapy, all elements of examination have somewhat improved. Range of motion in the left ankle has improved, joint play is physiological, and muscle shortness has decreased overall. Since the patient has valgosity in the ankles with decreased plantar flexion, PNF was used, and together with strengthening exercises such as calf raises and thera band exercises, helped strengthen the triceps surae, and especially tibialis posterior. These exercises need to be continued to achieve optimal effects. Also, the patient still has inflammation in the ankle, which may be due to stresses outside of the clinic or due to lack of autotherapy. There was a lack of hydrotherapy and magnetotherapy in the first few therapy units which may be part of the reason for the continued inflamed state of his ankle. The patient typically displayed similar features in both lower extremities, however the left side was worse.

Overall his sense of balance and gait has improved the most. He no longer walks with a big limp, with lateral flexion of the pelvis. Pain has diminished, however he does feel some discomfort and pain after longer periods of stress. The patient now is able to take on greater loads during strengthening exercises and is more confident in his abilities. If therapy continues, the inflammation should decrease and the patient will further improve the overall functional capability of his left lower extremity.

5. Literature

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ACRONYMS

ABD: Abduction
ADD: Adduction
ASIS: Anterior Superior Iliac Spine
CLPA: Centrum Léčby Pohybového Aparátu
CTh: Cervical Thoracic Crossing
DF: Dorsal Flexion
E: Extension
ER: External Rotation
F: Flexion
IR: Internal Rotation
IP: Interphalangeal
L: Lumbar
LE: Lower Extremity
LF: Lateral Flexion
MT: Metatarsals
MTH: Metatarsal Heads
MTP: Metatarsophalangeal
PF: Plantar Flexion
PIR: Post Isometric Relaxation
PNF: Proprioceptive Neuromuscular Facilitation
PSIS: Posterior Superior Iliac Spine
RLE: Right Lower Extremity
ROM: Range of Motion
STT: Soft Tissue Techniques

Table of Figures