Introduction

The Achilles tendon is the thickest and strong tendon in the human body . it is 12-15cm long, it originates from the aponeuroses of the medial, lateral and soleus gastrocnemius muscle (triceps surae) and is inserted into the posterior calcaneal tuberosity. It is the major planter flexor of the foot and contributes to the maintenance of the upright position **(Gervsio et al., 2014).**

Gastrocnemius and Soleus muscles of the calf are conjoined by Achilles tendon and attaches them to the calcaneus. The Achilles Tendon is the thickest tendon of the Human body, enclosed by Fascia and is protruding behind the bone; the gap being filled by an areolar and adipose tissue (**Sahi et al., 2018).**

Disorders of Achilles tendon are common health problem among middle-aged active people. Due to increasing sport activities in the general population, as the number of abuse injuries has elevated. Tendon disorders represent 30–50% of all sports related injuries. There is still a lack of knowledge about the etiology and pathogenesis of these injuries, despite its high occurrence **(Borg et al., 2016).**

Achilles tendon injuries: may be classified as insertional (25%), non-insertional (75%). Insertional injuries include insertional tendinosis may be associated with: Haglund deformity, enthesopathy, inflammatory arthropathy, Haglund syndrome. Non-insertional injuries include diffuse acute and chronic paratendonitis, tendinosis/tendinopathy including hypoxic degenerative, mucoid, lipoid, and calcifying, rupture/tear may be partial or complete **(Borg et al., 2016).**

Normally, the tendon appears homogeneously hypointense in signal in all imaging sequences. In some asymptomatic cases, small internal signals in its distal segment may be due to artefact related to magic angle phenomenon; not because the tendon itself changes its axis but the internal fibres take spiral twist near the calcaneal insertion. The margin of a normal tendon should be smooth and well defined on different orthogonal planes. It has no tendon sheath but is covered by thin, intermediate signal peritenon. Tendon integrity can easily be assessed on sagittal images, on which the distal end of the calf muscle should be included. The adjacent structures such as muscle, calcaneus, retro calcaneal bursa, Kager's fat pad and subcutaneous fat plane should also be evaluated for associated changes **(Tam and Lui, 2017).c**

Multiple imaging modalities have been used to diagnose Achilles tendon injuries, as plain radiography, magnetic resonance imaging (MRI), and ultrasound. Each modality has its own advantages and disadvantages. MRI & US have been widely used to confirm the diagnosis of Achilles tendon injuries **(Ibrahim and Elsaeed, 2013).**

Newer imaging modalities such as ultrasound tissue characterization and sono-elastography have yielded promising initial results in improving sensitivity, specificity and accuracy in diagnosis. Further studies may be needed to investigate their role and application in the management of Achilles tendinopathy **(Pearce and Tan, 2016).**

MRI has excellent contrast resolution for assessment of the Achilles tendon, contrast injection usually gives no additional information and plain MR imaging is good enough for assessment **(Tam and Lui, 2017).**

Both US and MRI scans have traditionally been considered to have same accuracy in the diagnosis of Achilles tendinopathy. Few studies have compared ultrasound with MRI in the diagnosis of Achilles tendinopathy. Early studies seem to indicate that MRI

scans are better for characterizing degeneration in the tendoAchilles. However, later research has shown equal or better accuracy with ultra-sound when compared with MRI scans in the detection of tendinopathy. Of note, grey scale ultrasound was found to be more sensitive, whereas color Doppler ultrasound had higher correlation with patient's symptoms. We recommend ultrasound as it is generally more cost-effective **(Pearce and Tan, 2016).**

MRI is an excellent technique for those cases where the diagnosis is uncertain; it is the most suitable for assessment of bone and soft tissue for persistent pain following injury. Owing to its multiplanar imaging capabilities and excellent soft tissue contrast characteristics, MRI is a useful modality for imaging the Achilles tendon **(Wijesekera et al., 2011).**

Achilles tendon pathologies can either be due to an acute injury, mostly occurring in relation to sports, or have a chronic background and are called tendinopathies. Achilles tendinopathy is one of the most frequent tendon pathologies caused by overuse or overload stresses, which lead to repetitive micro-traumata. It is characterized by swelling, pain and reduced function **(Klatte-Schulz et al., 2018).**

Aim of the Work

The aim of this study is to evaluate the role of Magnetic Resonance Imaging (MRI) in the diagnosis of Achilles tendon disorders.

Anatomy of the Achilles Tendon

The Achilles tendon is the thickest and strongest tendon in the human body. It is 12–15 cm long; it originates from the aponeuroses of the medial, lateral and soleus gastrocnemius muscles (triceps surae) and is inserted into the posterior calcaneal tuberosity. It is the major plantar flexor of the foot and contributes to the maintenance of the upright position. Anteriorly, the Achilles tendon is connected to the muscle belly of the flexor hallucis longus (from which it is separated by the interposition of a mass of adipose tissue occupying Kager's triangle) and in the pre insertional area it is connected to the calcaneal tuberosity from which it separated is by a synovial bursa, referred to as the deep retro calcaneal bursa. Superficially it is in contact with the subcutaneous adipose tissue at the calcaneal tuberosity by the interposition of a synovial bursa (superficial retro calcaneal bursa). **(Gervasio et al., 2014).**

The Achilles tendon forms from the fusion of the aponeuroses of the medial and lateral heads of the gastrocnemius and the soleus muscles. This musculotendinous unit crosses three joints (knee, tibiotalar, and subtalar) making it more susceptible to injury**(Fig.1)**.

The Achilles tendon internally rotates by a variable amount such that at the insertion the tendon fibers from the soleus are located medially, the tendonfibers from the medial head of the gastrocnemius muscle are located posterlaterally,and the fibers arising from the lateral head of the gastrocnemius muscle are located anterolaterally. In the newborn, thick fibers extend from the Achilles tendon insertion to the plantar fascia. With increasing age, the fibrous continuity between the Achilles tendon insertion and the plantar fascia gradually diminishes resulting in clear separation in the elderly foot. **(Stadnick, 2017).**

It is formed by confluence of the individual tendons of the gastrocnemius and soleus muscles. During its course, the tendon fibers rotate laterally for 90 degrees so that those of the soleus component insert into the postero-medial aspect and that from the gastrocnemius inserts into the postero-lateral aspect of the calcaneus. **(Bianchi et al., 2005)**.

The Achilles Tendon is a conjoined tendon of Gastrocnemius and Soleus muscles of the calf and it attaches to calcaneus. The tendon is thickest tendon of the body and is covered by Fascia and is prominent behind the bone, the gap being filled by Adipose tissue and areolar tissue. (**Sahietal , 2018).**

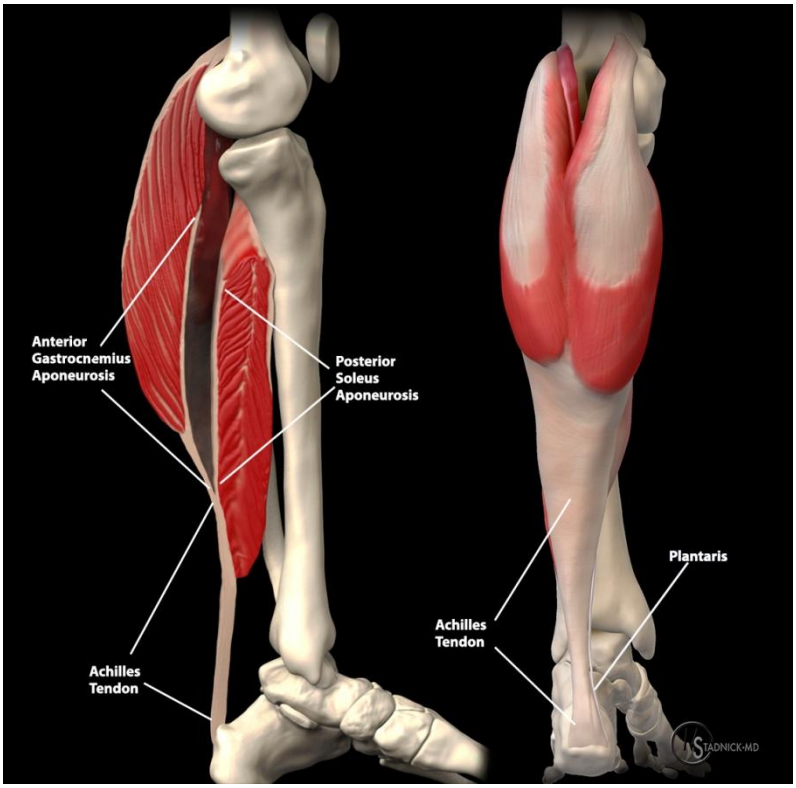

Fig. (1): The Achilles tendon forms from the aponeuroses of the gastrocnemius and soleus muscles. The plantaris tendon extends to the medial surface just proximal to the level of fusion and extends distally to its insertion **(Stadnick ,2017).**

The gastrocnemius accounts for two thirds of the fibers of Achilles tendon and soleus contributes one third **(Fig. 2)**, but variation in this pattern occurs in adults, the tendon is about 10 to 15 cm in length and has a thickness of 4-7 mm. **(Bianchi et al., 2005)**.

It has no sheath, however there is a vascular peritenon that has extend into tendon substance. Two to six cm above the ankle there is some reduction in the vascular supply. (**Davies, 2005)**.

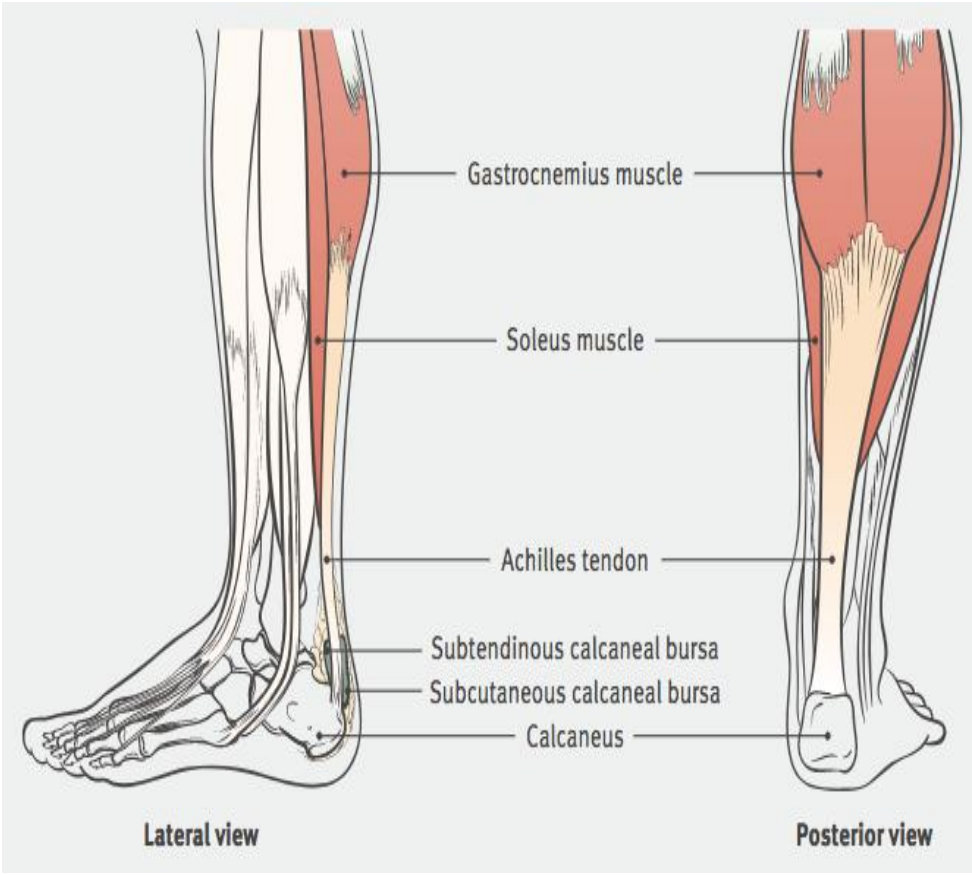

Fig (2): Anatomy of the Achilles tendon. (**Asplund and Best, 2013)**.

Muscle origins:

- **Gastrocnemius:**

The gastrocnemius muscle**(Fg.2)** is a fusiform muscle with the medial head arising from the popliteal surface of the femur, posterior to the medial supracondylar line and the adductor tubercle. The lateral head is shorter than the medial head. It originates from the posterolateral aspect of the lateral femoral condyle, from a region extending from proximal and posterior to the lateral epicondyle to the most distal aspect of the lineaaspera. **(Standring et al., 2005)**.

The fabella is a sesamoid bone in the lateral head of the gastrocnemius. It is an inconsistent structure, which, when present, always has a fabello-fibular ligament running parallel to the lateral collateral ligament. **(Doral et al., 2010)**.

- **Soleus:**

The soleus**(Fg.2)** lies deep to the gastrocnemius and is a broad, pennate muscle. It is a large flat muscle that was given its name from its resemblance to the sole, a flat fish. It originates from the oblique line and the middle third of the medial border of the tibia, from a fibrous arch between

the fibula and the tibia and from the posterior surface of the head of the fibula. It acts only on the ankle joint and can be palpated on either side of the gastrocnemius when the subject stands on the tiptoes. Together with the gastrocnemius, it forms the three-headed triceps surae. The triceps surae acts to plantar flex the ankle joint via its conjoint tendon, the Achilles tendon. **(Doral et al., 2010)**.

- **Bursae:**

Two important bursal sacs are associated with the Achilles tendon insertion: a retrocalcaneal bursa between the insertion of the tendon and the calcaneus, and a subcutaneous bursa**(Fg.2)** between the distal tendon and the skin. Pathology in the Achilles tendon can cause the bursae to become inflamed. The retrocalcaneal bursa may be seen in normality, although a bursa >1 mm anteroposteriorly, 11 mm transversely, or 7 mm craniocaudally is abnormal. The subcutaneous bursa is acquired, and its presence usually indicates local trauma or inflammation. **(Wijesekera et al., 2011).**

- **Kager's fat pad:**

Kager’s fat pad is a mass of adipose tissue occupying Kager’s triangle. It has three regions that are closely related to the sides of the triangle. Thus, it has parts

related to the Achilles and flexor hallucis longus (FHL) tendonsand a wedge of fat adjacent to the calcaneus. Fibrous connections linking the fat to the Achilles tendon anchor and stabilize it proximally and thus contribute to the motility of its tip. The three regions of Kager's fat pad have specialized functions: a FHL part which contributes to moving the bursal wedge during plantar flexion, an Achilles part which protects blood vessels entering this tendon, and a bursal wedge which we suggest minimizes pressure changes in the bursa. All three regions contribute to reducing the risk of tendon kinking and each may be implicated in heel pain syndromes. **(Theobald et al., 2006).**

- ## Achilles tendon and insertion:

The average length of the AT is 15 cm and ranges from 11 to 26 cm. The mean width of the AT is 6.8 cm (4.5– 8.6 cm) at its origin, gradually becoming thinner at the midsection being 1.8 cm (1.2–2.6 cm). Then, it becomes more rounded until approximately 4 cm above the calcaneus before expanding. The mean width of the AT is 3.4 (2.0–4.8 cm) at its insertion to the midpoint of the posterior surface of the calcaneus. The relative contribution of the soleus and gastrocnemius to the AT varies between subjects: the exact degree of contribution can be difficult to

accurately measure given the changing orientation of the tendon fibers **(Doral et al., 2010**).

- **Spiralling of AT fibers:**

The fibers of the AT are not aligned strictly vertically and display a variable degree of spiraling or winding after the AT is formed from the fusion of the gastrocnemius and soleus muscles. In spanning between the muscle and the bone, the fibers of the AT spiral by up to 90 degrees producing an area of concentrated stress. The tendinous fibers from the gastrocnemius insert into the posterolateral and those from solutes insert into the posteromedial aspect of the calcaneus. Twisting may cause constriction of the vascular networks, however, and results in less fiber buckling when the tendon is lax and less deformation of individual strands when under tension. In this way, fiber distortion and inter-fiber friction may decrease resulting in increase of strength. **(Doral et al., 2010**).

- **Calcaneal insertion:**

The calcaneal insertion of the AT is highly specialized and has been described as an “enthesis organ”, designed to aid stress dissipation from the tendon to its bony attachment. The enthesis organ is formed by the

osteotendinous junction between the AT and the calcaneum, a sesamoid fibrocartilage near the dorsal deep surface of the tendon adjacent to the junction, a fibrocartilage layer covering the periosteum of the superior tuberosity of the calcaneum and the tip of Kager's fat pad. **(Doral et al., 2010**).

The shape of the insertion into the calcaneus is a wide, deltoid-shaped attachment with the AT becoming broad prior to its insertion. The region of contact between the AT and the calcaneum creates a fulcrum, providing the AT with a mechanical advantage by increasing its lever arm. Kager's fat pad is mobile and protrudes into the retrocalcaneal bursa during plantar flexion (AT contraction) and retracts during ankle dorsiflexion. The protrusion into the bursa during plantar flexion is thought to reduce the development of negative pressure in the bursa and perhaps reduce AT kinking under loading. The bursae themselves are thought to promote free movement between the AT and bone.**(Doral et al., 2010**).

- **Vascularity of the Achilles tendon:**

The blood supply of the Achilles tendon consists mainly of longitudinal arteries that course the length of the tendon. Two main blood vessels supply the tendon. The

posterior tibial artery supplies both the proximal and distal section. The peroneal artery supplies the middle section. Overall, the tendon has relatively poor blood supply throughout its length, as measured by vessels per cross-sectional area. In addition, there is a relatively hypovascular area in the midsection which correlates to the location of many injuries, specifically, the area approximately 2 to 6 cm from the insertion point. It is also suggested that poor vascularity contributes to diminished healing after trauma. Blood supply to the tendon also diminishes with age.**(Wong and kiel, 2018)**.

The distribution of vascularity throughout the Achilles tendon is not homogeneous. Despite varying reports, the majority of authors on the subject believe that the blood supply to the midsection of the tendon is the poorest, with an area of lowest vascularity approximately 2 to 6 cm proximal to the tendon insertion. As this area of relative hypovascularity correlates with the most common site of rupture of the Achilles tendon, it is believed that the lack of blood supply either directly decreases the tensile strength or indirectly weakens the tendon through degenerative changes **(Nickisch, 2009)**.