INTRODUCTION

The menisci are 2 semilunar wedges in the knee joint positioned between the tibia and the femur. The medial meniscus is semicircular or C-shaped and approximately 3.5 cm in length from anterior to posterior. It is asymmetric with a considerably wider posterior horn than anterior horn. The lateral meniscus is more nearly circular or O-shaped and covers a larger portion of the tibial plateau surface than the medial meniscus. the middle portion of the medial meniscus being more firmly attached via connection with fibers of the deep medial collateral ligament But no attachment of the lateral meniscus to the lateral collateral ligament ***(Insall et al., 2001).***

Meniscal injuries may be the most common knee injury. The prevalence of acute meniscal tears is 61 cases per 100,000 persons. In patients older than 65 years, the rate of degenerative meniscal tears is 60% ***(Behairy et al., 2009).***

The classification of meniscal tears provides a description of patho anatomy. The types of meniscus tears include the following ***(Rodkey et al., 2000).***

- Longitudinal tears that may take the shape of a bucket handle if displaced
- Radial tears
- Parrot-beak or oblique flap tears

- Horizontal tears
- Root tears
- Complex tears that combine variants of the above.

One of the most common mechanisms for knee injury is direct trauma, which is commonly seen in athletic injuries ***(Nadafi et al., 2006).***

When injury occurs, the superficial MCL is the most commonly damaged ligament of the knee, usually induced by valgus stress, and can occasionally be accompanied by a tear in the medial meniscus ***(Blankstein et al., 2011).***

Magnetic resonance imaging (MRI) has historically been considered to be the golden standard imaging modality to diagnose medial knee injuries. However, there are significant limitations of using MRI, such as the presence of indwelling cardiac pacemakers, metal implants, patient intolerance due to claustrophobia and delay in treatment due to long wait periods ***(Blankstein et al., 2011).***

As a result, recent studies have demonstrated point-of-care ultrasound (POCUS) as an alternative, non-invasive and real-time imaging modality to evaluate the soft tissue pathology of the knee, including injuries to the medial meniscus and medial collateral ligament(MCL) ***(Razek et al., 2009).***

Ultrasound has become the primary diagnostic tool in traumatic, inflammatory and degenerative soft tissue conditions. It is also used to monitor the condition of joints, ligaments, cartilage and muscles ***(Sudo□-Szopi□ska et al., 2017).***

Ultrasound has some advantages over MRI,

- First, it costs less ***(Acebes et al., 2013).***
- Second, with ultrasound it is possible to obtain dynamic imaging and observe meniscal motion and dislocation by moving the knee ***(Acebes et al., 2013).***
- Third, all patients, including those who are claustrophobic, can undergo ultrasound ***(Naja□ et al., 2006).***
- Fourth, ultrasound facilitates bilateral comparison and repetitions at will ***(Friedman et al., 2003).***
- Fifth, many ultrasound machines can be brought to the patient, and explanation of the results can be rapid ***(Friedman et al., 2003).***

There are also limitations to using ultrasound. There is a relatively steep learning curve and dependence on the training, skill, and experience of the operator ***(Lee et al., 2001).***

A wide variety of MRI pulse sequences can be performed to produce diagnostic quality images. These include T1, proton density, T2, STIR, spin echo, fast (turbo) spin-echo, and gradient-echo sequences, which all have been proven suitable for knee imaging ***(Romulo Balthzar et al., 2009).***

- **The Menisci:**

Sagittal image:

The anterior and the posterior horns of menisci appear as isosceles triangles. The posterior horn of either menisci should never appear smaller than the anterior horn. On both sides, the menisci appear as flat bands. On lateral side, the more central the slices take on bowtie configuration because of smaller radius of curvature ***(Romulo Balthzar et al., 2009).***

Coronal images:

Mid portion of the knee produce best images of bodies of both menisci. They appear triangular and slightly larger laterally than medially. On posterior coronal cross sections, the posterior horns appear as flat bands. More anteriorly, the anterior horn of lateral meniscus appears as a band like structure. The anterior horn of medial meniscus extends more anteriorly than that of lateral meniscus ***(Romulo Balthzar et al., 2009).***

When using ultrasound to visualize a normal medial meniscus, a hyper echoic, homogenous triangle or wedge shaped structure can be seen ***(Blankstein et al., 2011).***

By MRI Two Diagnostic criteria for diagnosing a meniscal tear are commonly used ***(Gerngross et al., 2001).***

1. **Intrasubstance signal: It is graded as follows *(Gerngross et al., 2001):***

- Grade 1: Intrameniscal high signal intensity of irregular or globular appearance that is confined within the meniscus and does not extend to the articular surface.

- Grade 2: The signal is linear and does not intersect the inferior or superior articular surface. It may, however, contact the capsular margin at the posterior aspect of the meniscus.

- Grade 3: Tears characterized by linear high or intermediate signal intensity that extends to the superior and/or inferior articular surface.

- Grade 4: It is sometimes added to indicate a complex tear with multiple components or fragmentation.

NB:

Both grade 1 and grade 2 lesions do not represent a tear, but indicate mucinous and mucoid intrasubstance degenerative change and are usually encountered after the third or fourth decade. In children and adolescents, prominent vascularity may resemble grade 1 or grade 2 lesions ***(Romulo Balthzar et al., 2009).***

2. Abnormal Meniscal morphology:

Morphologic changes of the meniscus associated with meniscal tears include blunting of tip of the inner free meniscal edges of the meniscus, displacement of a portion of the meniscus, interrupted appearance of the meniscus and abnormal size of a segment of the meniscus is detached (a bucket handle tear). An abrupt change in contour of the meniscus, known as the 'notch' sign, is an important indicator of a meniscal tear. Although the normal meniscal flounce can simulate it, the presence of abnormal intrameniscal signal makes the notch sign a more definite indicator of a meniscal tear ***(Bruno et al., 2005).***

Sonographic findings of meniscal tears include a hypo echoic band or stripe that can be seen within the meniscus, resulting in heterogeneity of the meniscus ***(Razek et al., 2009).***

The size and shape of the hypo echoic band will vary depending on the size, shape, and location of the meniscal tear. It should be noted that the posterior horn is usually larger than the anterior horn, and it is easier to visualize tears in the outer margin of the medial meniscus compared to the inner margin due to it being more superficial ***(Lee et al., 2001).***

Recently reported excellent performance of quantitative and semi-quantitative ultrasound assessment of medial meniscal extrusion defined by 2 mm threshold in patients with chronic knee pain in comparison to MRI. We observed a similar sensitivity for ultrasound to detect meniscal extrusion using a threshold of 3 mm, however, specificity and accuracy were lower than described previously. The differences might be caused by distinct measurement setup as standardized measurement method of meniscal extrusion by ultrasound has not yet been established ***(Nogueira-Barbosa et al., 2015).***

Aim of the Work

The purpose of this study is to determine the clinical usefulness of ultrasonography for diagnosis of meniscal pathology in patients with acute knee pain and compare its diagnostic accuracy to MRI in a clinical setting.

Chapter 1

ANATOMY

The knee is the most complex joint in the human body, It is a hinge joint that is responsible for weight-bearing and movement. The position of the knee between the two longest lever arms of the body, the femur and tibia, and its role in weight bearing renders it susceptible to injuries, it consists of bones, meniscus, ligaments, and tendons ***(Whiteside et al., 2001).***

1) Bones

It consists of two bony articulations: the articulation between the femur and tibia and the articulation between the patella and femur ***(Whiteside et al., 2001).***

2) Ligaments

Ligaments are fibrous bands of tissue that connect bone to bone and provide support to joints. The knee is reinforced by two collateral ligaments, one on the medial side and another on the lateral side, as well as two stronger ligaments (the cruciate ligaments), The patellar ligament attaches proximally to the apex of the patella and distally to the tibial tuberosity, and is the inferior continuation of the quadriceps femoris tendon, Other ligaments, such as the transverse, arcuate popliteal, oblique popliteal, medial collateral ligament (MCL), lateral collateral ligament (LCL), and popliteofibular ligament all act as knee stabilizers ***(Zlotnicki et al., 2016).***

ACL (anterior cruciate ligament):

The ACL resists anterior and rotational displacement of the tibia relative to the femur ***(Rohman et al., 2016).***

PCL (posterior cruciate ligament):

The PCL prevents posterior displacement of the tibia relative to the femur ***(Rohman et al., 2016).***

MCL (medial collateral ligament):

The MCL provides stability to the medial aspect of the knee, preventing excessive valgus stress during external rotation of the knee, becoming tight during extension and external rotation, and loose during flexion and internal rotation ***(Rohman et al., 2016).***

LCL (lateral collateral ligament):

The LCL runs from the femur to the fibula to stabilize the lateral aspect of the knee, preventing excessive varus stress and external rotation at all positions of knee flexion ***(Rohman et al., 2016).***

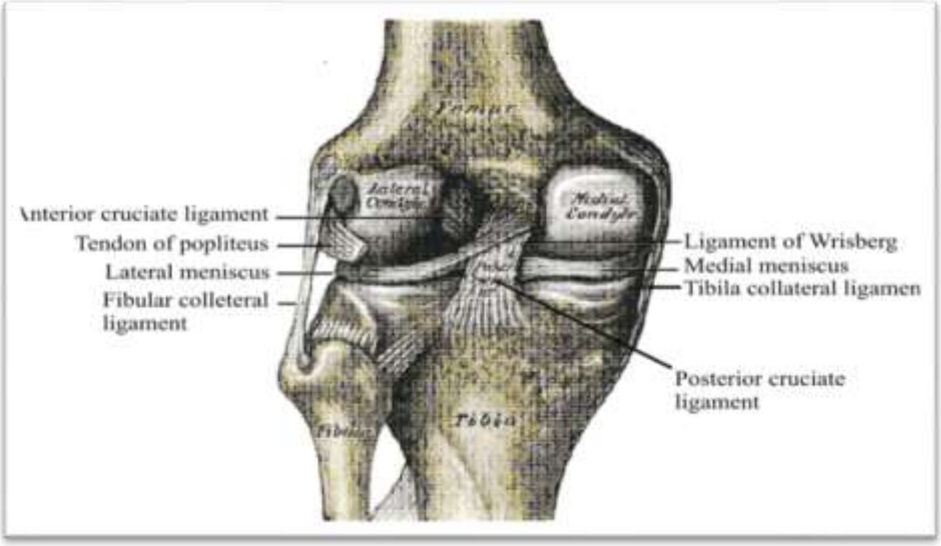

Figure (1): Left knee joint from behind, showing interior ligaments ***(Newell, 2005).***

3) Cartilage

Two fibro cartilaginous menisci, medial and lateral, are positioned between the medial and lateral femoral condyles and the tibia, which accommodate changes in the shape of the articular surfaces during activity. They provide a good 'seat' on the tibial condyles for the corresponding femoral condyles. Articular cartilage covers both the femoral and tibial condyles and provides a frictionless surface that allows joint movement. They also act as shock absorbers for the body load and dynamic movements. The lateral menisci are much more mobile than the medial menisci, and this is reflected by the higher rate of medial side injuries. This may be due to the fixed meniscus being less able to compensate for joint forces and rotations during movement. Nonetheless, it provides greater restraint to anterior translation of the tibia on the femur. Injury to the lateral meniscus is more devastating than a medial meniscus injury, leading to instability of the lateral side of the knee, and the rapid development of osteoarthritis, hence making its rehabilitation more challenging than medical meniscus injury ***(Goldblatt et al., 2003).***

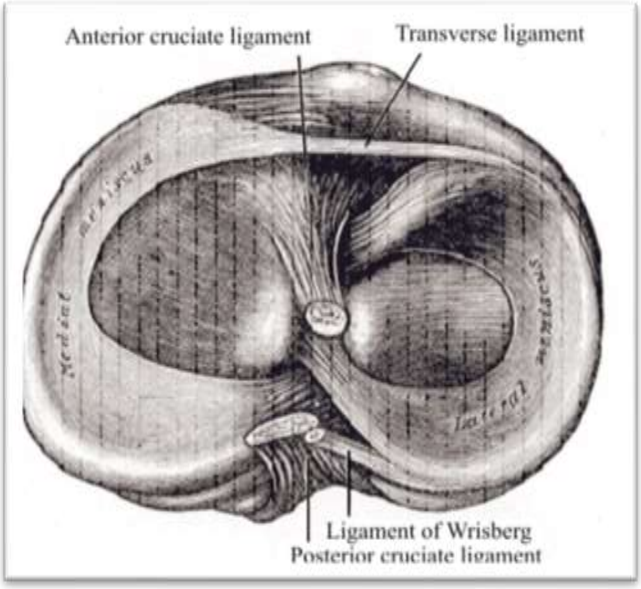

Figure (2): Head of right Tibia seen from above, showing menisci and attachments of ligaments ***(Newell, 2005).***

4) Bursa

The knee has bursa, which are fluid-filled cavities located at tissue sites that facilitate movement of the tendons and skin over the joint. They are filled with synovial fluid and help in reducing friction between adjacent moving structures, five of which are located at the frontal aspect of the knee, with another four at the lateral side and another five on the medial side of the knee joint. They are distributed around high-motion areas to ensure smooth, friction-free movement. A common site of bursitis is at the deep infra patellar bursa due to its vital role in preventing friction between the patellar tendon and the tibia ***(Haviv et al., 2016).***

5) Muscles

The majority of the muscles around the knee that are mono articular act to primarily mobilize and secondarily stabilize the knee. Some of these muscles have additional actions at the hip joint (bi articular) where they have dual actions at both the knee and hip. The anterior aspect of the knee consists predominantly of the quadriceps muscles, namely the rectus femoris (bi articular), vastus lateralis (mono articular), vastus medialis, and vastus intermedius, and the primary function of these muscles is to extend the knee joint.The posterior aspect of the knee consists of the biceps femoris (bi articular), semimembranosus (mono articular), and semitendinosus (mono articular), which form the hamstring group of muscles which function as knee flexors, The plantaris muscle and the medial and lateral heads of the gastrocnemius muscle are also part of the posterior musculature of the knee.The medial musculature of the knee consists of the sartorius and gracilis muscles, which both aid in knee flexion. In addition, the semitendinosus acts as a medial rotator of the knee. Finally, the musculature of the lateral aspect of the knee consists of the iliotibial band and the popliteus muscles. The primary function of these muscles, along with the semimembranosus and semitendinosus, is to flex the knee, but these muscles also act as hip extensors ***(Musumeci et al., 2017).***

6) Tendons

These tough bands of soft tissue provide stability to the joint. They are similar to ligaments, but instead of linking bone to bone, they connect bone to muscle. The largest tendon in the knee is the patellar tendon, which covers the kneecap, runs up the thigh, and attaches to the quadriceps ***(Burgener et al., 2002).***

Nerve supply

The knee is innervated by branches of the obturator, femoral, tibial, and common fibular nerves. Each structure within the knee is innervated by a shared or a specific nerve ***(Hirschmann et al., 2015).***

Blood supply

The vascular supply to the knee consists of a network of many arteries. The genicular branches of the femoral and popliteal arteries, the circumflex fibular arteries, and the recurrent branches of the anterior tibial artery, all supply blood to the knee. The blood supply of the medial and lateral knee cartilage (menisci) differs. The medial menisci receive a greater blood supply than do the lateral menisci and consequently, injuries involving the lateral menisci require longer rehabilitation ***(Hirschmann et al., 2015).***

Chapter 2

PATHOLOGY

Meniscal injuries usually are associated with pain that results in gait deviation and loss of time from work and/or sport. A study by Yasuda et al suggested that medial meniscus tears cause spontaneous osteonecrosis of the knee (SONK). Specifically, the study found medial meniscus extrusion and femortibial angle to be significantly associated with SONK stage and volume in the medial femoral condyle ***(Yasuda et al., 2017).***

Meniscal tears are suspected to affect critical functions of the meniscus, such as joint congruency, load transmission, and shock absorption leading to the classic signs and symptoms of a meniscal tear: catching, locking, or clicking; joint line pain; and a feeling of ‘giving out’ or instability ***(Fox et al., 2012; Lowery et al., 2006).***

Despite the importance of the meniscus tissue for function, incidental findings of asymptomatic tears on magnetic resonance imaging (MRI) are relatively common, suggesting the presence of a meniscal tear does not directly correlate to knee disability ***(Walczak et al., 2008).***

Traumatic meniscal tears are most frequently observed in younger, active individuals (below 40 years of age) following a high-energy trauma, for example, during sport, whereas