The Role of Ultrasound in Evaluation of Meniscal Injury

Nada Sayed Mahdy*, Hossam Mousa Sakr, Allam Elsayed Allam
Radiology Department, Faculty of Medicine, Ain Shams University, Cairo, Egypt
*Corresponding author: Nada Sayed Mahdy Sorial, **Mobile:** +201159149249, **E-Mail:** Nada.sayedmahdy@yahoo.com

ABSTRACT

Background: meniscal tear is one of the most common injuries of knee joint , MRI is considered to be 1st choice to diagnose meniscal tear. The Question of the study is if we can use U/S as screening tool for Meniscal injuries before MRI. **Aim of the Work:** 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. **Patients and Methods:** this study was carried out in Radiology department, Ain Shams University hospitals. 15 patients with MRI proven Meniscal tear underwent knee ultrasound examination. **Results:** the overall sensitivity of ultrasound examination for meniscal tears was 77%. **Conclusion:** ultrasound appears to be useful for the screening of meniscal tears but detection of the morphology of meniscal tears seems insufficient.

Keywords: Meniscal Tear, Magnetic Resonance Imaging, Musculoskeletal Ultrasound

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 [1]. 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 [2]. 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 [3, 4, 5]. Meniscal injuries may be the most common knee injury [6]. 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% [7]. The classification of meniscal tears provides a description of pathoanatomy. The types of meniscus tears include the following [1]: 1. Longitudinal tears that may take the shape of a bucket handle if displaced, 2. Radial tears, 3. Parrot-beak or oblique flap tears, 4. Horizontal tears, 5. Root tears, 6. 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 [2]. 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 [5]. 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 treatmentdue to long wait periods [3]. 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) [7]. 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 [4]. *Ultrasound has some advantages over MRI* [4]*:* 1. First, it costs less, 2. Second, with ultrasound it is possible to obtain dynamic imaging and observe meniscal motion and dislocation by moving the knee, 3. Third, all patients, including those who are claustrophobic, can undergo ultrasound, 4. Fourth, ultrasound facilitates bilateral comparison and repetitions at will, 5. Fifth, many ultrasound machines can be brought to the patient, and explanation of the results can be rapid. 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 [7]. A wide variety of MRI pulse sequences can be performed to produce diagnostic quality images [8]. 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 [9]. **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 [9]. ***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 [9]. When using ultrasound to visualize a normal medial meniscus, a hyper echoic, homogenous triangle or wedge shaped structure can be seen [1]. By MRI Two Diagnostic criteria for diagnosing a meniscal tear are commonly used [5]. 1) Intrasubstance signal: It is graded as follows: [4] *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. Both grade 1 and grade 2 lesions do not represent a tear, but indicate mucinous and mucoidintrasubstance 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 [6]. (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 [6]. 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 [4]. 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 [7]. Recently reported excellent performance of quantitative and semi-quantitative ultrasound assessment of medial meniscal extrusion defined by 2mm threshold in patients with chronic knee pain in comparison to MRI. Weobserved 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 [10, 11].

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.

PATIENTS AND METHODS

Patients: During a period of 6 months duration from December 2017, fifteen patients were enrolled in the study. All patients with Meniscal tear proven by MRI underwent knee ultrasound. **The study was approved by the Ethics Board of Ain Shams University and an informed written consent was taken from each participant in the study. Inclusion criteria:** Patients with history of knee injury or pain, no sex predilection, age group: 15-80 years. **Exclusion criteria:** Patients with contraindication to MRI e.g. pacemaker. **Ultrasound imaging:** Resolution of Ultrasound Used for Defining Meniscal Tears. A high-resolution ultrasound machine with a 6.0 to 14.0-MHz linear transducer was used to define meniscal tears throughout the study, and the resolution of this machine was assessed. Menisci were observed at a depth of 5 to 20mm; therefore, the ultrasound configuration was a focus of 15 mm and a maximum depth of 22.5 mm. **Ultrasound data analysis:** 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. **Statistical analysis:** Data were coded and entered using the statistical package SPSS (Statistical Package for the Social Sciences) version 23. Data was summarized using

mean, standard deviation, median, minimum and maximum in quantitative data and using frequency (count) and relative frequency (percentage) for categorical data. Comparisons between quantitative variables were done using the non-parametric Kruskal-Wallis and Mann-Whitney tests. ROC curve was constructed with area under curve analysis performed to detect best cutoff value of Knee ultrasound for detection of meniscal tear. P-values less than 0.05 were considered as statistically significant.

RESULTS

The 15 patients enrolled in this study were ranging from 15 to 60 years with mean age of 30.4 years.

Table (1): Demonstrating age of the patients

Age	Number of cases	Percentage
15-24	8	53%
25-34	2	13%
35-44	1	6%
45-54	2	13%
55-60	2	13%

Table (2): Knee pathology

Structure injured	MRI	U/S
AHMM	2	2
PHMM	7	5
AHLM	3	3
PHLM	3	3

Table (3): Accuracy OF U/S

Structure	Sensitivity %
AHMM	100
PHMM	77.78
AHLM	100
PHLM	100

The study revealed that the sensitivity of high resolution ultrasound in the diagnosis of both medial & lateral meniscal injury.Sensitivity of AHMM was 100%, sensitivity of PHMM was 77.78%, sensitivity of AHLM was 100% and sensitivity of PHLM was 100%. Overall sensitivity was 88.24%.

DISCUSSION

Two Diagnostic criteria for diagnosing a meniscal tear are commonly used. **1) Intrasubstance signal: It is graded as follows** [5]**:** *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. *Gzade 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. Both grade 1 and grade 2 lesions do not represent a tear, but indicate mucinous and mucoidintrasubstance degenerative change and are usually encountered after the third or fourth decade. In children and adolescents, prominent vasularity may resemble grade 1 or grade 2[6].

Figure (1): Sagittal PD WI shows abnormal signal intensity in the posterior horn of the medial meniscus reaching the articular.

(ii) 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), the remaining peripheral portion appears small and often truncated. The displaced portion usually lies within the intercondylar notch beneath the PCL. Coronal views are helpful in further identifying such displaced fragments. 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[6].
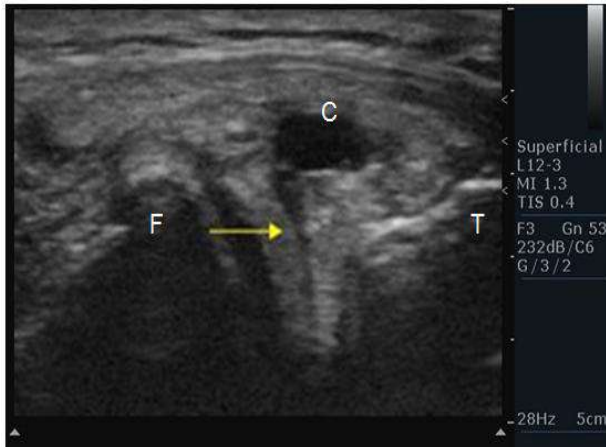

Figure (2): Longitudinal view showing anechoic Parameniscal cyst (C) with hypoechoic tear (Arrow) involving the PHMM, Femur (F) and Tibia (T).

This is a study to assess the resolutionof ultrasound for defining meniscal tears, the visible areas of the menisci with use of knee ultrasound, and the effects of the meniscal tear pattern on the diagnostic accuracy of ultrasound. The reported the sensitivity of ultrasound for diagnosing meniscal tears to be 74%, a machine with a linear array probe of 5.0 to 13.0 MHz was used. However, because those authors did not determine the resolution of ultrasound for defining meniscal tears, we cannot directly compare their results and ours to evaluate the effect of ultrasound resolution on diagnostic accuracy. Future studies might be better able to provide an objective index for resolution to further understanding of the contribution of resolution level. Although five of the six patients with such a study had a BMI of >25 kg/m2 and the BMI of these six patients tended to be higher than that of the rest of the patients, BMI was not a significant factor (p = 0.08). In the present study, the diagnostic accuracy of ultrasound for meniscal tears was relatively high. However, although ultrasound performed well for detection of a discoid lateral meniscus, detection of the morphology of meniscal tears was difficult. On this basis, ultrasound appears to be useful for the screening of meniscal tears but detection of the morphology of meniscal tears seems insufficient.

CONCLUSION

The findings of this study suggest that ultrasound examination may be suitable for screening for meniscal tears. We recommend starting with high resolution ultrasound examination as screening tool. Ultrasound appears to be useful for the screening of meniscal tears but detection of the morphology of meniscal tears seems insufficient.

CONFLICTS OF INTEREST

There are no conflicts of interest.

REFERENCES

1. **Acebes C, Romero FI, Contreras MA *et al.* (2013):** Dynamic ultrasound assessment of medial meniscal subluxation in knee osteoarthritis. Rheumatology (Oxford), 52(8): 1443-7.

2. **Najafi J, Bagheri S and Lahiji FA (2006):** The value of sonography with microconvex probes in diagnosing meniscal tears compared with arthroscopy. J Ultrasound Med., 25(5):593-7.

3. **Nogueira-Barbosa MH, Gregio-Junior E, Lorenzato MM *et al.* (2015):** Ultrasound assessment of medial meniscal extrusion: a validation study using MRI as reference standard. American Journal of Roentgenology, 204(3): 584-8.

4. **Razek A, Fouda N, Elmetwaley N *et al.* (2009):** Sonography of the knee joint. J Ultrasound, 12(2): 53e60.

5. **Rodkey WG (2000):** Basic biology of the meniscus and response to injury. Instr Course Lect., 49: 189-93.

6. **Balthzar R, Ma C, Shankman S *et al.* (2009):** CT and MRI of the whole Body. 5th edition. Philadelphia, 2317- 2368.

7. **Sudoł-Szopińska I, Jans L and Teh J (2017):** Rheumatoid arthritis: what do MRI and ultrasound show. J Ultrasound, 17: 5–16.

8. **Behairy NH, Dorgham MA and Khaled SA (2008):** Accuracy of routine magnetic resonance imaging in meniscal and ligamentous injuries of the knee: comparison with arthroscopy. Int Orthop., 8(4): 144-165.

9. **Blankstein A (2011):** Ultrasound in the diagnosis of clinical orthopedics: the orthopedic stethoscope. World J Orthop., 2(2):13-24..

10. **Vande Berg BC, Malghem J, Poilvache P et al. (2005):** Meniscal tears with fragments displaced in notch and recesses of knee: MR imaging with arthroscopic comparison. Radiology, 234(3): 842-50.

11. **Friedman L, Finlay K, Popovich T et al. (2003):** Sonographic findings in patients with anterior knee pain. J Clin Ultrasound, 31(2):85-97.

12. **Gerngross H, Sohn C, Arthrosc J et al. (2001):** Ultrasound scanning for the diagnosis of meniscal lesions of the knee joint. Ultrasound of the knee. Skeletal Radiology, 30-7: 361-77.

13. **Jain M and Samuels J(2010):** Musculoskeletal ultrasound in the diagnosis of rheumatic disease, 68:183-190.

14. **Lee D and Bouffard J (2001):** Ultrasound of the knee. Eur J Ultrasound, 14(1): 57e71.

15. **Nadafi J, Bagheri S and Abdolahzedeh L (2006):** The value of sonography with micro convex probes in diagnosing meniscal tears compared with arthroscopy. J Ultrasound Med., 25(5): 593e7.