Al-Azhar Med. J . (Medicine). *Vol. 52 (2), April, 2023, 649-660*
DOI: 10.21608/amj.2023.291655
https://amj.journals.ekb.eg/article_291655.html

MRI VERSUS ULTRASOUND IN DIAGNOSIS OF MENISCAL INJURY IN THE KNEE JOINT

By

Al-Kaseh Farag Abd El-Ati Mohamed, Mohammed Farok Aggag, Emad Mohammed Zayed* and Mohammed Hasan Tawfik

Departments of Radiodiagnosis and Orthopaedics*, Faculty of Medicine, Al-Azhar University, Egypt

***Corresponding author:** Al-Kaseh Farag Abd El-Ati Mohamed,

E-mail: alkaseh_faragabdelati11@gmail.com

ABSTRACT

Background: The knee joint is a compound type of synovial joint. Due to the lack of bony support, the stability of the joint is highly dependent on its supporting ligamentous structures and, therefore, injuries of ligaments and menisci are extremely common. MRI has been considered to be the golden standard imaging modality to diagnose knee injuries. However, there are significant limitations of using MRI. As a result, recent studies have demonstrated US as an alternative, non-invasive and real-time imaging modality.

Objective: To compare the ultrasonographic findings with the MRI finding to evaluate the ability of high-resolution ultrasonography to diagnose meniscal lesions mainly tears and degenerations.

Patients and methods: This study was conducted on 40 patients attended to Orthopedics Department, Al-Azhar University Hospitals, with history of knee trauma and clinically suspicious cases of post traumatic knee injuries for radiological evaluation by ultrasound and MRI. They were 31 males and 9 females, and their ages ranged from 20 to 58 years with a mean age of 35.3+10.4, during the period from January 2021 to July 2021.

Results: Regarding our statistical results for meniscal tears, US was consistent with MRI in 20 (90.9%) lesions out of 22; as it yielded 20 true positive and 3 true negative meniscal tears. Sensitivity of US in detecting meniscal tears was found to be 90.9% specificity 60%, while accuracy was 85.2%. US was consistent with MRI in 9 (90.9%) lesions out of 13; as it yielded 9 true positive and 3 true negative lesions. Sensitivity of US in detecting meniscal degeneration was found to be 69.2%, specificity 75%, and the overall accuracy of US in diagnosis of meniscal degeneration was 70.6%.

Conclusion: There was an overall accuracy of 85.2% for US diagnosis of meniscal tear and 70.6% for US diagnosis of meniscal degeneration in correlation with MRI. So, US was of value in assessment of meniscal tear more than meniscal degeneration.

Keywords: MRI, Ultrasound, Meniscal Injury, Knee Joint.

INTRODUCTION

Menisci play important roles in the maintenance of homeostasis in the knee joints, force transmission, shock absorption, joint lubrication, joint stability and proprioception. Currently, meniscal pathology is most often diagnosed based on history, clinical examination, magnetic resonance imaging (MRI), and/or arthroscopic visualization. Early and accurate diagnosis of meniscal pathology is vital for determining type and timing of treatment, as well as prognosis for return to function in the short term and degree of

morbidity in the long term *(Akatsu et al., 2016)*.

MRI is accepted as the gold standard imaging technique for evaluation the internal derangements of menisci including tears and degeneration. However, MRI is not always available on demand, does not allow dynamic testing and is a rather lengthy and expensive imaging modality *(Unlu et al., 2014)*.

On light of the developments in ultrasonographic technology, the application of this imaging method is believed to be ideal for evaluating meniscal lesions of the knee *(Dai et al., 2015)*.

Compared with MRI, ultrasonography is inexpensive and can be performed rapidly. It is widely available, and is readily acceptable by patients. In addition, it provides a dynamic, real-time assessment as well as an easy side-to-side comparison. Although there have been some studies on the value of ultrasonography in the diagnosis of meniscal tears, the sensitivity and specificity of these studies have varied greatly *(Cook et al., 2014)*.

The aim of this work was to compare the ultrasonographic findings with the MRI finding to evaluate the ability of high-resolution ultrasonography to diagnose meniscal lesions mainly tears and degenerations.

PATIENTS AND METHODS

This was a prospective study included 40 patients, 31 males and 9 females. Their ages ranged from 20 years to 58 years with the mean age 35.3 years. They were performed on symptomatic patients with clinical suspicion of meniscal injury suffering from knee joint disorders like pain, swelling, locking, limitations of movements post traumatic. They were referred to the Radiology Department from the outpatient clinic and internal wards of the Orthopedic Surgery, at Al-Azhar University Hospitals during the period from January 2021 to July 2021.

The research ethical committee of Al-Azhar Faculty of Medicine approved the protocol of this study. An informed consent was taken from every participant in this study.

Inclusion criteria: History of trauma and clinically suspicious cases of knee injuries and USS and MRI examination, and patients approved to be enrolled in this study.

Exclusion criteria: Any absolute contraindication for MRI. Previously operated patients for knee injuries. Patients with knee joint neoplasm.

All patients were submitted to the following:

I. **Data collection:** Demographic data were collected (patient's name, age and full clinical history taking regarding the clinical presentation, duration of complaint, family and past history, presence of malignancy “primary”, other diseases or any taken medications “as anticoagulants”, previous intervention as “biopsy”, trauma).

II. **Clinical examination:** Physical examination and careful clinical examination by the referring clinician. The clinical diagnosis was established on the basis of history and clinical examination.

III. **US examination:** All the patient's knees were imaged by high resolution USG transducer of 6-12 MHz of General electric company (GE) health care model GE Logic P5, and P6 and Samsung (HS40).

Sonographic exams using US device were performed with (6 to 12 MHz) probes in prone and supine positions through the anterior, lateral and posterior approaches using static and dynamic techniques. Most of the imaging was done in the longitudinal plane. A copious amount of gel was applied over the surface of the lesions. A high-resolution probe (6-12 MHz) was used. In the static technique, the anterior horns of the menisci were imaged in supine position with the knee in full extension and 30−45 degrees of flexion. Then the probe was moved to sides to visualize the bodies of the menisci. Afterwards the patients were placed prone and posterior horns were imaged with the knee in extension first then 45 degrees flexion. In dynamic imaging, the knee was subjected to mild internal and external varus stresses to allow better imaging of the menisci using movements.

All patients' knees were examined by gray scale and color Duplex US for evaluation of the anterior and posterior horns of both medial and lateral menisci.

IV. **MRI examination:**

All the patient's knees were imaged by high TESLA (1.5 T) MRI.

Technique:

Dedicated knee coils were used in all studies and the patients were placed in supine position with the knee in extension in all exams. A small field of view (FOV) typically in the range 14-16 cm. The following sequences will be selected as required: T1WI (Coronal), T2WI (Axial, Sagittal) STIR (Coronal), proton density (sagittal), and fat suppressed proton density (Sagittal).

Statistical methods:

Data management and statistical analysis were done using SPSS vs.25. (IBM, Armonk, New York, United states). Numerical data was summarized as means and standard deviations and Categorical data was summarized as numbers and percentages. Diagnostic indices including sensitivity, specificity, PPV and NPV were calculated for US for diagnosing meniscal lesions. P value < 0.05 was considered significant.

RESULTS

Patients were 31 males and 9 females; their ages range from 20 years to 58 years. The mean age of study group was 35.3+10.4 **(Table 1)**.

Table (1): Age, sex, and weight distribution of the studied group

Sex	No.	%
Sex		
Males	31	77.5%
Females	9	22.5%
Age (years)		
Mean ±SD	35.3±10.4	
Weight (Kg)		
Mean ±SD	83.7±14.02	

Thirty-two cases of the studied group showed positive findings regarding meniscal injuries, while 8 cases were found normal with no evidence of meniscal injury by US.

Thirty-five cases of the studied group show positive findings regarding meniscal injuries, while 5 cases were found normal with no evidence of meniscal injury by MRI.

Twenty-two cases showed meniscal tear by USG, while the other 10 positive cases showed meniscal degeneration by US.

Twenty-two cases showed meniscal tear by MRI, while the other 13 positive cases showed meniscal degeneration **(Table 2)**.

Table (2): Duration between trauma and investigation, US, MRI, injury diagnosed by MRI findings among the studied group

	No.	%
No. of weeks:		
1	10	25
2	10	25
3	9	22.5
4	6	15
5 or more	5	12.5
Range	(1-7)	
Mean ±SD	2.7± 1.47	
US findings:		
Positive	32	80
Negative	8	20
MRI findings:		
Positive	35	87.5
Negative	5	12.5
Type of injury By US:		
Tear	22	68.75
Degeneration	10	31.25
Type of injury By MRI:		
Tear	22	62.9
Degeneration	13	37.1

Sensitivity of US in diagnosis of meniscal injury was 85.7%, specificity of US in diagnosis of meniscal injury was 60%, PPV of US in diagnosis of meniscal injury was 93.8%. NPV of US in diagnosis of meniscal injury was 37.5%, accuracy of US in diagnosis of meniscal injury was 82.5%.

Out of 35 positive cases for meniscal injuries, US detected 30 true positive cases, while 5 cases were considered as false negative. On the other hand, out of 5 negative cases, US could detect only 3 true negative cases and the other 2 cases were considered as false positive **(Table 3)**.

Table (3): Comparison between US and MRI findings regarding all meniscal injuries

		MRI		
		Positive	Negative	Total
US	Positive	30	2	32
	Negative	5	3	8
	Total	35	5	40

Sensitivity of US in diagnosis of meniscal tear was 90.9%, specificity of US in diagnosis of meniscal tear was 60%, PPV of US in diagnosis of meniscal tear was 90.9%, NPV of US in diagnosis of meniscal tear was 60% and accuracy of US in diagnosis of meniscal tear: 85.2%.

Out of 22 positive cases for meniscal tears, USS could detect 20 true positive cases while 2 cases were considered as false negative. On the other hand, out of 5 negative cases, USS could detect only 3 true negative cases and the other 2 cases were considered as false positive **(Table 4)**.

Table (4): Comparison between US & MRI findings regarding all meniscal tear

		MRI		
		Positive	Negative	Total
US	Positive	20	2	22
	Negative	2	3	5
	Total	22	5	27

Sensitivity of US in diagnosis of meniscal degeneration was 69.2%, specificity of US in diagnosis of meniscal degeneration was 75%, PPV of US in diagnosis of meniscal degeneration was 90%, NPV of US in diagnosis of meniscal degeneration was 42.9% and accuracy of US in diagnosis of meniscal degeneration was 70.6%.

Out of 13 positive cases for meniscal injuries, USS could detect 9 true positive cases while 4 cases were considered as false negative. On the other hand, out of 4 negative cases, USS could detect only 3 true negative cases and the other 1 case was considered as false positive.

Table (5): Comparison between US and MRI findings regarding all meniscal degeneration

		MRI		
		Positive	Negative	Total
US	Positive	9	1	10
	Negative	4	3	7
	Total	13	4	17

Out of 35 cases were diagnosed as positive meniscal lesions by MRI, only 32 cases were correctly diagnosed by US. These three cases were found to be of meniscal degeneration by MRI. Another 3 cases showed different positive findings; one of them was found to be meniscal degeneration by USS and tear on MRI study, the other two were found to be tear by USS and degeneration on MRI study.

Table (6): Comparison between US & MRI findings regarding tear and degeneration injuries

		MRI			
		Normal	Degeneration	Tear	Total
US	Normal	5	3	0	8
	Degeneration	0	10	0	10
	Tear	0	0	22	22
	Total	5	13	22	40

DISCUSSION

Tears and degenerations constitute the majority of meniscal lesions and correct diagnosis is important because surgery or arthroscopy is relying on this diagnosis *(Anatolia, 2014).*

In this study we wanted to assess the role of US in evaluation of knee meniscal injury in correlation with MRI.

Regarding the demographic data; the distribution of the patients according to sex, our study revealed that the percentage of males was 77.5% and the percentage of females was 22.5%, which was similar to those studies done by *El-Monem and Enaba (2012)* and *Nasir (2013).* This could be explained by the fact that males were more vulnerable to such traumatic knee injury during daily activity and sports injury, while females were more vulnerable to meniscal degeneration resulting from weight bearing due to obesity. Sex of the patient itself did not

affect the diagnostic accuracy of meniscal tears, findings that were similar to the results reported by *Wareluk and Szopinski (2012)*.

The patient's age in our study ranged between 20 and 58 years with a mean of 35.3±10.4 SD, which was higher than the study done by *El Monem and and Enaba (2012)* as the average age in their study was 26.5 years.

Regarding our statistical results for meniscal tears, US was consistent with MRI in 90.9%. Sensitivity of US in detecting meniscal tears was found to be 90.9%, specificity was 60%, positive predictive value of 90.9 % and a negative predictive value of 60 %. The overall accuracy of US in diagnosis of meniscal tears was 85.2%.

Results were nearly the same compared to the study done by *El Monem and and Enaba (2012)*, and to lesser extent the study done by *You et al. (2014)*.

Out of 22 positive cases for meniscal tears, US could detect 20 true positive cases while 2 cases were considered as false negative. On the other hand, out of 5 negative cases, US could detect only 3 true negative cases and the other 2 cases were considered as false positive.

The two false negatives were most likely due to the obesity of those patients as they weighted 115 kg and 102 kg. The first case as well showed limitation of movement on US examination due to pain. The US device used in both cases was of fair resolution making the meniscal tear difficult to be detected, but this issue wasn't that significant as the same device was used in accurate diagnosis of about 8 cases. Also, none of the fore mentioned studies determine the resolution of US for defining meniscal tears. So, we couldn't compare their results and ours to evaluate the effect of US resolution on diagnostic accuracy.

The two false positive cases shared the same issue that they showed marked limitation of movement causing difficulty in accurate probe positioning which most likely led to giving artifact similar to meniscal tear.

Regarding our statistical results for meniscal degeneration, US was consistent with MRI in 90.9%. Sensitivity of US in detecting meniscal degeneration was hence found to be 69.2% specificity was 75%, positive predictive value of 90 % and a negative predictive value of 42.9%. The overall accuracy of US in diagnosis of meniscal degeneration was 70.6 %. These results were more or less correlated with that study done by *Alizadeh et al. (2013)*.

Out of 13 positive cases for meniscal degeneration in our study, USS could detect 9 true positive cases, while 4 cases were considered as false negative. On the other hand, out of 4 negative cases, USS could detect only 3 true negative cases and the other 1 case was considered as false positive.

Compared to our results for meniscal tears, these results on the contrary showed higher false negative cases. This could be illustrated that the majority of cases showed meniscal degeneration were of old age which pathologically showed increased rate of mucoid degeneration producing inhomogeneous echogenicity. Decrease in cartilage thickness as well resulted in joint space narrowing which limits the field of view during

sonography. Marginal osteophytes around the knee may produce posterior shadows that limit the penetration of US beam, thus produce inappropriate view of deep portions of the meniscus.

Regarding our collective results for all the study group cases, three of them showed different positive findings; one of them was found to be meniscal degeneration by US and tear by MRI study, the other two were found to be tears by US and degeneration by MRI study. These differences were related to the fore mentioned difficulties that we faced and illustrated above.

The distribution of the lesions according to the affected horn, 94.2% was the percentage of the posterior horn lesions, and 5.8% was the percentage of the anterior horn lesions, which were a bit similar to the results reported by *Mostafa et al. (2019)*, but were different from the results reported by *Nasir (2013)*, with a percentage of 46.2% posterior horn lesions and 53.8% anterior horn lesions. The site of injury regarding which horn is injured didn't show significant affection for the diagnostic accuracy of ultrasound compared to MRI.

Our results revealed that the method of trauma didn't show significance in detection of meniscal tear or degeneration by US in correlation to MRI. We couldn't find this item reviewed at any of the previous studies.

Our study had some limitations first, the small sample size of only 40 patients, second, the accuracy of MRI in the diagnosis of meniscal tears was dependent on the experience of the interpreter and his/her knowledge of the potential imaging pitfalls, and third, correlation with arthroscopy was not obtained as the arthroscopy with solely diagnostic purpose was not done routinely at our institution and not all patients need a therapeutic arthroscopic procedure. It was difficult to comment on the type of tear with an USG evaluation alone.

CONCLUSION

There was an overall accuracy of 85.2% for US diagnosis of meniscal tear and 70.6% for US diagnosis of meniscal degeneration in correlation with MRI. So, US may be of value in assessment of meniscal tear more than meniscal degeneration.

REFERENCES

1. **Akatsu Y, Yamaguchi S, Sasho T, Takahashi K, Akagi R, Muramatsu Y. (2016):** Accuracy of high-resolution ultrasonography in detecting meniscal tears. J Endo., 21: 63-69.
2. **Alizadeh A, Jandaghi AB, Zirak AK, Karimi A, Mardani-Kivi M and Rajabzadeh A. (2013):** Knee sonography as a diagnostic test for medial meniscal tears in young patients. European Journal of Orthopaedic Surgery & Traumatology, 23(8):927-31.
3. **Anatolia AM. (2014):** The role of ultrasound in the diagnosis of meniscal tears and degeneration compared to MRI and arthroscopy. Acta Med Anatol., 2(3):80-7.
4. **Cook JL, Cook CR, Stannard JP, Vaughn G, Wilson N, Roller BL, Stoker AM, Jayabalan P, Hdeib M and Kuroki K. (2014):** MRI versus ultrasonography to assess meniscal

abnormalities in acute knees. The journal of Knee Surgery, 27(04):319-24.

5. **Dai B, Garrett WE, Gross MT, Padua DA, Queen RM and Yu B. (2015):** The effects of 2 landing techniques on knee kinematics, kinetics, and performance during stop-jump and side-cutting tasks. Am J Sports Med., 43(2):466-74.
6. **El-Monem SA and Enaba MM. (2012):** Comparative Study between High Resolution Ultrasound (HRUS) and MRI in Diagnosis of Meniscal and Cruciate Ligaments Injury of the Knee. European Journal of Orthopaedic Surgery and Traumatology, 11: 233-236.
7. **Mostafa M, Adel H, Elfotuh A, Mohamad A and Alsakka MM. (2019):** MRI Versus Ultrasound In Diagnosis Of Meniscal Tear In Knee Joint. Egyptian Journal of Hospital Medicine, 74(2): 153-158.
8. **Nasir AI. (2013):** The role of magnetic resonance imaging in the knee joint injuries. International Research Journal of Medical Sciences, 1(5):1-7.
9. **Unlu EN, Ustuner E, Saylisoy S, Yilmaz O, Ozcan H and Erden I. (2014):** The role of ultrasound in the diagnosis of meniscal tears and degeneration compared to MRI and arthroscopy. Acta Medica Anatolia., 3: 80-88.
10. **Wareluk P and Szopinski KT. (2012):** Value of modern sonography in the assessment of meniscal lesions. European Journal of Radiology, 81(9):2366-9.
11. **You MW, Park JS, Park SY, Jin W and Ryu KN. (2014):** Posterior root of lateral meniscus: the detailed anatomic description on 3T MRI. Acta Radiologica, 55(3):359-65.

التصوير بالرنين المغناطيسي مقابل الموجات فوق الصوتية في تشخيص إصابة الغضروف الهلالي في مفصل الركبة

الكاسح فرج عبدالعاطي محمد، محمد فاروق عجاج، عماد محمد زايد*،

محمد حسن توفيق

قسمي الاشعة التشخيصية، جراحة العظام*، كلية الطب، جامعة الازهر

E-mail: alkaseh_faragabdelati11@gmail.com

خلفية البحث: مفصل الركبة مركب من المفاصل الزلالية، وبسبب عدم وجود دعم عظمي، ويعتمد إستقرار المفصل بشكل كبير على هياكله الداعمة، وبالتالي فإن إصابات الأربطة والغضاريف الهلالية شائعة للغاية. وأكثر الأسباب شيوعا لآلام الركبة وصعوبة الحركة هي إصابات الغضاريف الهلالية. وتعد إصابات الغضاريف الهلالية شائعة في كل من الرياضيين والناس العاديين. والموجات فوق الصوتية وسيلة تصوير فعالة في تشخيص وتقييم الجهاز العضلي الهيكلي. ومن ضمن مزاياه سهولة توفره وقدراته المتعددة، بالإضافة إلى المزايا الاقتصادية. وتعتبر القدرة على التقييم الديناميكي ومقارنته بسهولة مع الجانب الآخر أمرا مفيدا.

الهدف من البحث: مقارنة نتائج الموجات فوق الصوتية بنتائج التصوير بالرنين المغناطيسي لتقييم قدرة الموجات فوق الصوتية عالية الدقة لتشخيص إصابة الغضروف الهلالي في مفصل الركبة.

المرضى وطرق البحث: أجريت دراستنا في مستشفيات جامعة الازهر على عدد 40 مريضا حضروا إلى قسم العظام بمستشفى الحسين، بإصابة الركبة والاشتباه إكلينيكيا بحدوث إصابة بالغضاريف الهلالية من أجل التصوير بواسطة الموجات فوق الصوتية و كذلك الرنين المغناطيسي. وكانوا 31 من الذكور وه من الإناث، تتراوح أعمارهم بين 20 إلى 58 سنة, ومتوسط أعمارهم كان 35.3+10.2.

نتائج البحث: فيما يتعلق بنتائجنا الإحصائية لإصابات الغضاريف الهلالية. كانت نتائج الموجات فوق الصوتية متماشية مع التصوير بالرنين المغناطيسي في 20

90.9% من الحالات من أصل 22؛ كما أسفرت عن 20 نتيجة إيجابية حقيقية و 3 نتائج سلبية حقيقية. وقد وجد أن حساسية الموجات فوق الصوتية في اكتشاف إصابات الغضاريف الهلالية 90.9%, ونوعيتها بنسبة 60 % ، في حين أن دقته كانت 85.2%. وفيما يتعلق بنتائجنا الإحصائية لضمور الغضاريف الهلالية. كانت نتائج الموجات فوق الصوتية متماشية مع التصوير بالرنين المغناطيسي في 9 (90.9%) من الحالات من أصل ١٣؛ كما أسفرت عن ٩ نتائج إيجابية حقيقية و٣ نتائج سلبية حقيقية. وقد وجد أن حساسية الموجات فوق الصوتية في اكتشاف ضمور الغضاريف الهلالية 69.2% ونوعيتها بنسبة 75%، في حين أن دقته كانت 70.6%.

الاستنتاج: الدقة الإجمالية للموجات فوق الصوتية 85.2٪ في تشخيص إصابات الغضاريف الهلالية 70.6% في تشخيص ضمور الغضاريف الهلالية مقارنة بالرنين المغناطيسي. ولذلك يمكننا الاعتماد علي الموجات فوق الصوتية في تشخيص إصابات الغضاريف الهلالية اكثر من تشخيص ضمورها.

الكلمات الدالة: التصوير بالرنين المغناطيسي، الموجات فوق الصوتية، إصابة الغضروف الهلالي في مفصل الركبة.