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DIAGNOSTIC ACCURACY OF MRI IN MENISCUS INJURY

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ABSTRACT:

Background: MRI provides many advantages over other radiological diagnostic imaging modalities; such as superior soft tissue details particularly ligaments & cartilages, very low incidence of side effects, no radiation exposure so they can be safely used in pregnancy & children, direct multi-planer capabilities, no bone or air artifact and totally non-invasive. **Objective:** To assess role of MRI and its sensitivity, specificity, and accuracy in the evaluation of meniscal lesions. **Patients and Methods:** A quasi-experimental study was conducted at the department of radiology in Iben Sena teaching hospital (MRI unit) during the period from October 2024 to the end of November 2024. Fifty patients (50knee) with suspected meniscal tear who were referred from orthopedic departments after full history and physical examination. Examination was performed on 1.5 Tesla SIEMENS – MAGNETOM Avanto. Super-conductive magnet with dedicated extremity coils (Quadrature coils) as both transmitter and receiver of radio frequency waves was applied. **Results:** The mean age of the studied group was 36.3. From the fifty patients, 29 were males (58%) and 21 were females (42%). trauma was the commonest causative mechanism of tear. 2 patients have isolated anterior horn tear while 7 patients have isolated anterior horn tear among lateral meniscus group with statistically significant difference (P= 0.02). From the other hand; 20 of medial meniscus group have isolated posterior horn tear and 6 of lateral meniscus group have isolated posterior horn tear with statistically significant difference (P<0.001). Knee joint effusion was found among 20 patients. the sensitivity of MRI in diagnosis of MM tear is (100%) which is better than the LM tear (86.7%). The specificity of MRI in the diagnosis of MM tear is (96.1%) compared to the LM tear (94.2%). The accuracy of MRI in the MM is (98%) and up to (92%) in the LM. The false negative occurs in the LM (13.3%) and no false negative occurs in the MM. The false positive occurs in the LM (5.7%) more than the MM (3.8 %). **Conclusion:** MRI of the knee in spite of few false positive and false negative results it shows an accurate result of highly significant of meniscal tear assisting in management decision.

KEYWORDS: MRI, Accuracy, Knee, Meniscus, Mosul, Iraq.

1. INTRODUCTION

The first comprehensive description of knee joint anatomy and the first set of MR images of meniscal tears were presented by Reicher et al., and Kean et al. initially proposed using MRIs to evaluate the menisci.[1] However, the most important development in MRI technology came in 2003 when Paul C. Lauterbur and Peter Mansfield were awarded the Nobel Prize for their discoveries of using MRIs as a diagnostic tool.[2]

MRI provides many advantages over other radiological diagnostic imaging modalities; such as superior soft tissue details particularly ligaments & cartilages, very low incidence of side effects, no radiation exposure so they can be safely used in pregnancy & children, direct multi-planer capabilities, no bone or air artifact and totally non-invasive.[3-4]

The fibro-cartilaginous C-shaped disks known as menisci of the knee joint are located in the area between the femur and the tibia. They are predominantly made of type 1 collagen in the organic matrix and contain around 75% water.[5]

From birth until mid-adolescence, the meniscus undergoes steady and slow changes that include an

increase in collagen content, a decrease in vascularity and cellularity. At first, the meniscus is extremely cellular. The anterior horn, bowtie-shaped body, and posterior horn of each meniscus are randomly divided and make up 50% of the medial and 70% of the lateral surface of the tibial plateau.[6] Because the meniscus's fibrocartilage has a low signal intensity in both T1 and T2-weighted images, magnetic resonance imaging (MRI) is the best method for evaluating the meniscus.[7] In sagittal and coronal images, the anterior and posterior horns of the medial and lateral menisci are centrally viewed as wedge-shaped, low-intensity features pointing toward each other.[8] The triangle anterior and posterior horns of the LM are similar in size on the lateral side of the knee, whereas the posterior horn of the MM is larger than the anterior horn on the medial side. The menisci's periphery is shaped like a bow tie; the meniscus's superior and inferior surfaces are typically equal in length, and the anterior and posterior horns are higher than the meniscus's thinner, intervening body, which has a flat undersurface and a concave superior surface. A deviation from this arrangement indicates that a tear may be present.[9] As shown in figures belows.

Figure 1.1: Conventional spin-echo versus fast spin-echo imaging for meniscal tear in 33-year-old man. Sagittal proton density—weighted MR image obtained through medial meniscus shows oblique tear (arrow) of posterior horn, which was also seen on two adjacent images.

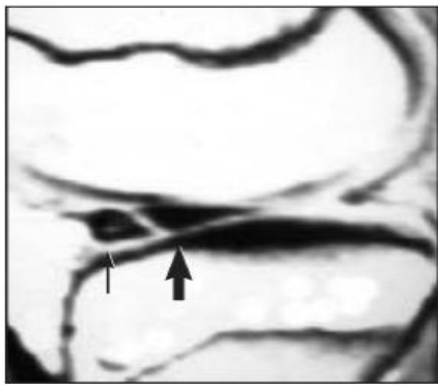


Figure 1.2: A sagittal view T1W. "double meniscus sign " in the anterior part of lateral compartment of the knee. The posterior horn of the LM is absent from its normal location & flipped over & pointing backward (large arrow) in the anterior portion of lateral compartment. The second structure more anteriorly (small arrow) is the normal anterior horn.

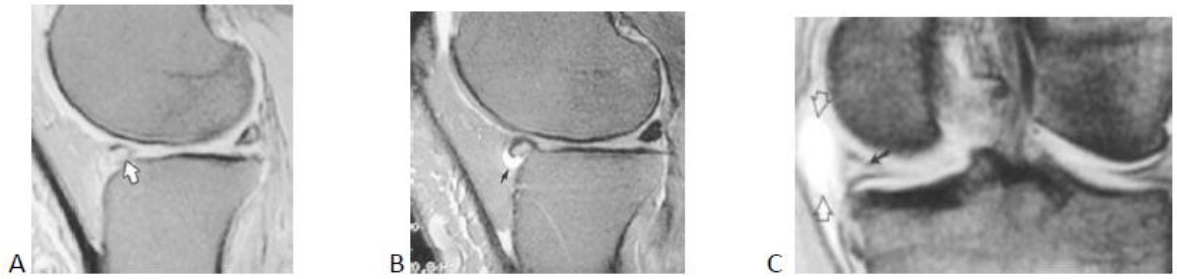


Figure 1.3: A. Sagittal proton density—weighted image with fat suppression obtained through medial meniscus shows swollen anterior horn (arrow) with high signal within, indicative of meniscal cyst.B. Sagittal Fast spin-echo T2-weighted image with fat suppression shows parameniscal component (arrow), which is similar to joint fluid in signal, whereas intrameniscal signal remains intermediate in intensity.C. Coronal fast spine echo T2-weighted image with fat suppression shows meniscal cyst (solid arrow) with intermediate signal throughout

medial meniscus with adjacent parameniscal component (open arrows), which is similar to joint fluid in signal intensity.

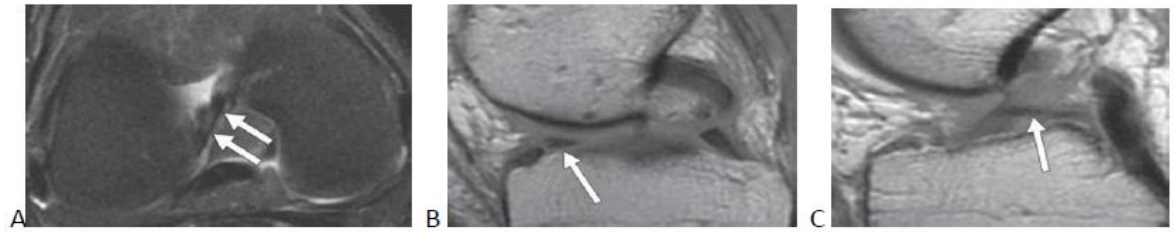


Figure 1.4: A. Axial fat suppressed T2 image shows ligament (arrows) passing from anterior horn of MM to posterior horn of LM. B & C. Sagittal PD images show ligament adjacent to anterior horn of MM (arrow, B) resembling meniscal fragment & ligament at its posterior horn LM attachment (arrow, C)

The study aimed to assess role of MRI and its sensitivity, specificity, and accuracy in the evaluation of meniscal lesions.

2. PATIENTS AND METHODS

A quasi-experimental study was conducted at the department of radiology in Iben Sena teaching hospital (MRI unit) during the period from August 2024 to the end of September 2024.

Fifty patients (50knee) with suspected meniscal tear who were referred from orthopedic departments after full history and physical examination. Examination was performed on 1.5 Tesla Philips Ingenia. Super-conductive magnet with dedicated extremity coils (Quadrature coils) as both transmitter and receiver of radio frequency waves was applied. No patient's preparation or sedation was required. The patients who have a contraindication for MRI examination were excluded. The patient was examined in the tunnel of the machine in supine position. Data were converted into a Computerized database structure. Statistical analysis was done using SPSS (Statistical Package of Social Sciences) aided by an expert statistical advice. Frequency distribution for selected variables was done first. The statistical significance of difference between 2 proportions or the association between categorical variables was assessed by Chi-square test. P values less than the 0.05, level of significance was considered statistically significant.

3. RESULTS

The mean age of the studied group was 36.3. From the fifty patients, 29 were males (58%) with mean age of 35.3 years and 21 were females (42%) with mean age 44.6 years. Regarding male gender, the age groups 30 to less than 40 and 40 to less than 50 were prevalent among all of the age groups with 8 (38.1%) for each one of them. With regards to female gender; the age group of 30 to less than 40 was the most prevalent group with 12 (41.4%) of the female participants. As shown in table 3.1.

Table 3.1: Distribution of study sample according to ages.

Variable	Female		Male		Total	
Age in years	**No.**	**%**	**No.**	**%**	**No.**	**%**
Less than 30	1	4.8	10	34.5	11	22
30 less than 40	8	38.1	12	41.4	20	40
40 less than 50	8	38.1	5	17.2	13	26
More than 60	4	19	2	6.9	6	12
Total	**21**	**100**	**29**	**100**	**50**	**100**

Table 3.2 show the distribution of study sample according to the mechanism of affection by age and gender shows that trauma was the commonest causative mechanism of tear and the rate of traumatic mechanism decrease with increasing age and the observed negative trend was statistically significant. Moreover; gender had no statistically significant association with the mechanism of injury. As shown in table 3.2.

Table 3.2: Age and gender distribution of study sample according to mechanism of affection.

Mechanism of affection	Nontraumatic		Traumatic		Total	
Age in years	**No.**	**%**	**No.**	**%**	**No.**	**%**
Less than 30	0	0	11	100	11	100
30 less than 40	1	5	19	95	20	100
40 less than 50	6	46.2	7	53.8	13	100
More than 60	5	83.3	1	16.7	6	100
P (x^2 of trend) = 0.04						
Gender						

Female	5	23.8	16	76.2	21	100
Male	7	24.1	22	76.1	29	100
P (x^2) = 0.61						

Table 3.3 and figure 3.1 show among the study population, 25 (50%) patients have no medial meniscus tear and 35 (70%) have no lateral meniscus tear with statistically significant difference (P=0.05), moreover; among medial meniscus affected group, 2 patients (4%) have isolated anterior horn tear while 7 (14%) patients have isolated anterior horn tear among lateral meniscus group with statistically significant difference (P= 0.02). From the other hand; 20 (40%) of medial meniscus group have isolated posterior horn tear and 6 (12%) of lateral meniscus group have isolated posterior horn tear with statistically significant difference (P<0.001). Furthermore; Combined tear was observed among 3 (6%) and 2 (4%) of medical and lateral meniscus groups respectively. The medial/lateral meniscal tear ratio was 25/15 =1.7:1.

Table 3.3: The type of horn tear injury by side of meniscus examined.

Final diagnosis	Medial meniscus		Lateral meniscus		P- value
	No.	%	No.	%	
No tear	25	50	35	70	0.05
Isolated Anterior Horn tear	2	4	7	14	0.02
Isolated Posterior Horn Tear	20	40	6	12	<0.001
Combined tear	3	6	2	4	-----
Total	**50**	**100**	**50**	**100**	

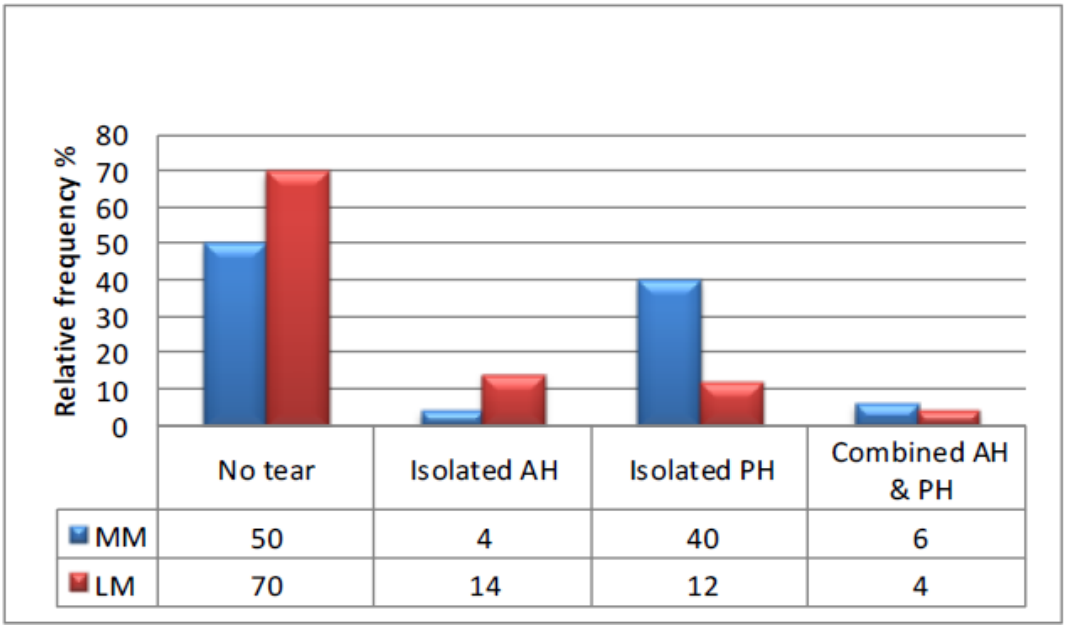


Figure 3.1: Bar chart showing the relative frequency of horn tear by side of meniscus examined.

Table 3.4 shows the side of meniscus's examination findings; vertical tear was found among 15 (30%) and 10 (20%) of medial and lateral menisci groups respectively. Moreover; horizontal tear was found among 8 (16%) and 4 (8%) of medial and lateral menisci groups. Lastly; the bucket handle tear more in medial menisci 2 (4%) than lateral menisci 1 (2%). There was no statistically significant difference between the type of tear and side of meniscus involved (P= 0.43).

Table 3.4: The type of tear by side of meniscus examined.

Final Diagnosis	Medial meniscus		Lateral meniscus	
	No.	%	No.	%
No tear	25	50	35	70
Horizontal tear	8	16	4	8
Vertical tear	15	30	10	20
Bucket handle tear	2	4	1	2
Total	**50**	**100**	**50**	**100**
P (x2) = 0.43				

Table 3.5 shows that the agreement between MRI and final diagnosis were 95/100. In other words; 2/60 who was negative by MRI, proved to have vertical tear on final diagnosis and 3/61 who had no tear on final diagnosis falsely showed vertical tear on MRI.

Table 3.5: Agreement between MRI, and final diagnosis regarding the type of tear.

	Final diagnosis				
MRI Diagnosis	**No tear**	**Horizontal tear**	**Vertical tear**	**Bucket handle tear**	**Total**
No tear	58		2		60
Horizontal tear		12			12
Vertical tear	3		22		25
Bucket handle tear				3	3
Total	**61**	**12**	**24**	**3**	**100**
P (x2) = 0.43					

Table 3.6 and figure 3.2 express the distribution of sample according to associated findings. Knee joint effusion was found among 20 (40%) patients, followed by ACL, none, baker cyst, contusion, cyst among 16 (32%), 12 (24%), 6 (12 %), 4 (8%) and 2 (4%) respectively.

Table 3.6: Distribution of sample according to associated findings.

Variable	No.	%
Effusion	20	40
ACL tear	16	32
None	12	24
Baker Cyst	6	12
Contusion	4	8
Cyst	2	4
Total	**50**	**100**

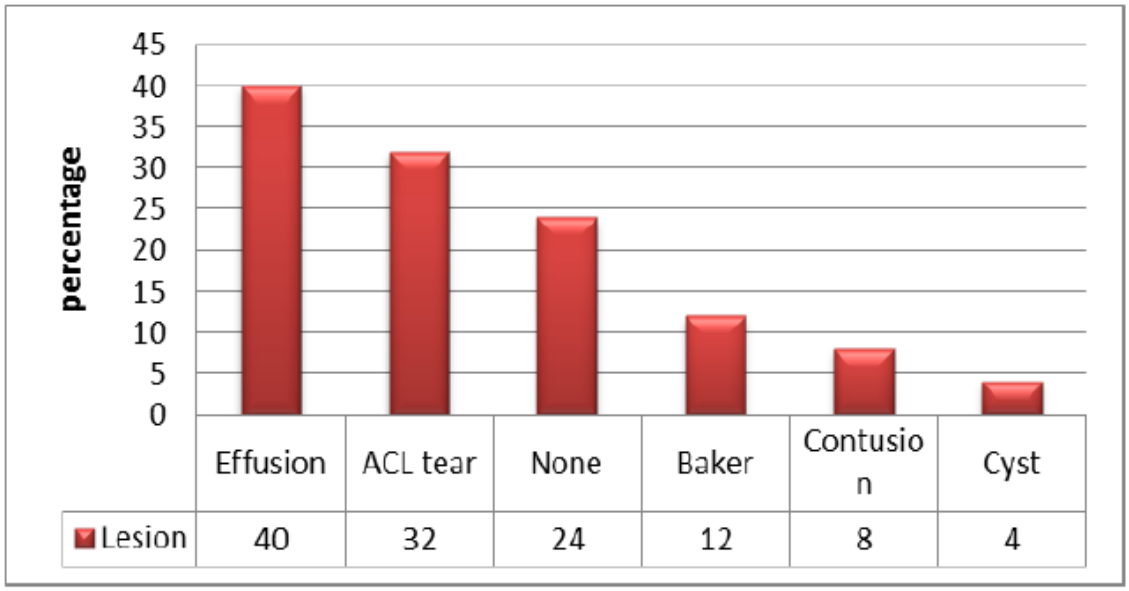
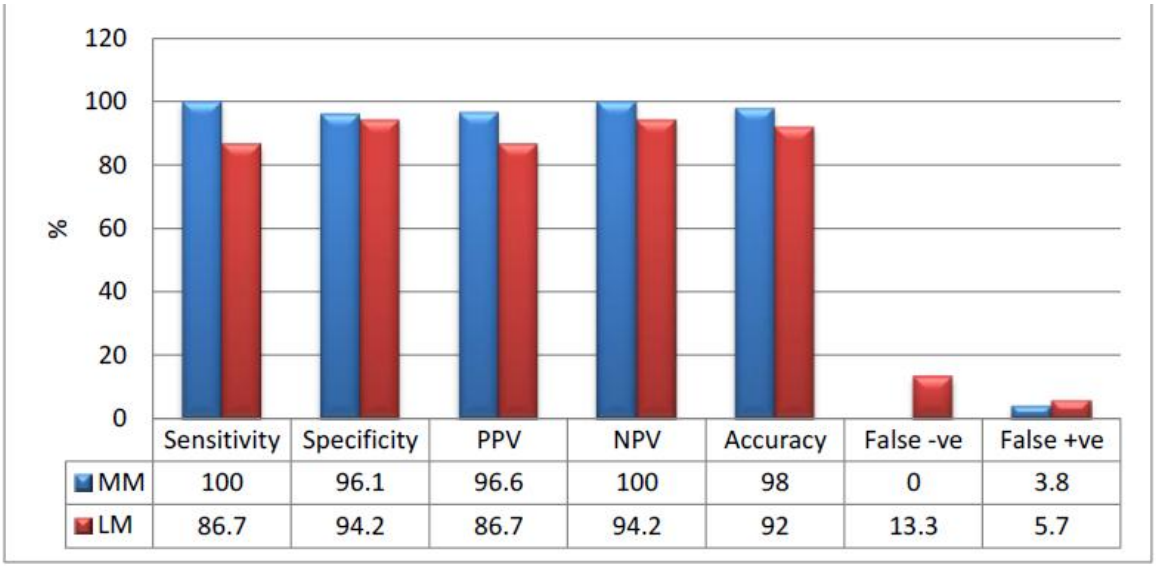


Figure 3.2: Bar chart showing the relative frequency of different types of associated findings.

Figure 3.3 illustrates the study validity parameters of MRI in diagnosis of meniscal tears, it's shows that the sensitivity of MRI in diagnosis of MM tear is (100%) which is better than the LM tear (86.7%). The specificity of MRI in the diagnosis of MM tear is (96.1%) compared to the LM tear (94.2%). The accuracy of MRI in the MM is (98%) and up to (92%) in the LM. The false negative occurs in the LM (13.3%) and no false negative occurs in the MM. The false positive occurs in the LM (5.7%) more than the MM (3.8 %). Moreover; MRI when used as a diagnostic tool it can detect up to (94.9%) possible cases which represented the overall sensitivity. And MRI when used in establishing the diagnosis in clinically suspicious cases, it gives a positive test or can be (92.5%) confident that there is really tear which represent the overall positive predictive value. But when it's used in exclusion of possible diagnosis it gives a negative test or can be (96.7 %) confident that there is really no tear which represent the overall negative predictive value.



	Sensitivity	Specificity	PPV	NPV	Accuracy	False -ve	False +ve
MM	100	96.1	96.6	100	98	0	3.8
LM	86.7	94.2	86.7	94.2	92	13.3	5.7

Figure 3.3: Bar chart comparing the validity parameters of MRI in diagnosis of medial & lateral meniscal tear.

4. DISCUSSION

In this study MRI examination was performed on 50 patients (50 knees) with suspected meniscal tears. Regarding referred patients it showed high male preponderance (58%) and this finding probably reflect the outpatient population, this is consistent with findings of P Krakowski et al.[10] Moreover; the most common age group affected was the age group of (30-less than 40 years) and this is explained by the fact of this age group having marked daily and athletic activities. No significant difference was found in the incidence of affection between the right and left knee joint. This study shows that most common cause was traumatic and it's occurring mostly at age between 30-less than 40 years while non traumatic occurs mostly over the age of 40 years and above, this is parallel with thesis conducted by Bob J. Evers et al.[11] The study shows that medial meniscus is more frequently encountered than the lateral one because of its anatomical arrangement and being less mobile than the lateral one which runs with Marc A. Raj et al finding[12], additionally the isolated anterior horn tear was significantly more frequent in the LM (14%) compared to the MM (4%) which is comparable to Vasilios Raoulis et al results[13] and the isolated posterior horn tear was significantly more frequent in the MM (40%) compared to the LM (12%) which is in turn comparable to Peishi Jiang et al results.[14] Traumatic tears occur typically in younger individuals and the vertical tears are quaintly seen following acute trauma, whereas horizontal tears are often caused by degeneration of the meniscus and may be associated with osteoarthritic changes in the knee, furthermore; The horizontal type of tears occurs fewer commons than the vertical tears (are mostly occurring in the MM, mostly in the posterior horn) and it occur most commonly in the posterior horn of MM which is comparable to Philippe Beaufils et al findings.[15] Bucket handle tears more in the MM (4%) than LM (2%) this accepted with Ahmad Alomari et al findings.[16] In this study, as in other series there were occasional discrepancies between the appearance of the menisci on MRI and the findings at subsequent arthroscopy or arthrotomy, and it shows that the agreement between MRI and final diagnosis were 95/100. there are 2 false negative errors located in the LM and no false negative are seen in the MM, this was in agreement with Hayat Ahmad Khan et al results.[17] The study shows that the most common associated finding with the meniscal tear was joint effusion (40 %). A joint effusion can accompany knee injury & is non-specific response to many intra-articular irritants.[18] It can be seen that MRI may be relied upon to detect the most majority of meniscal tear (sensitivity 94.9%) while only occasionally normal menisci be misinterpreted as torn (specificity 95 %). Observer performance, different study populations, and technical factors including the use of different sequences may cause the chance variation. There are still some problems with the diagnosis on MRI; they have been a number of instances of false positive and false negative results. The sensitivity, specificity, accuracy, PPV and NPV in the MRI detection of meniscal tears in this study agreed with those reported by Harshadrai Joshi et study.[19]

5- CONCLUSION

1) MRI of the knee in spite of few false positive and false negative results it shows an accurate result of highly significant of meniscal tear so it's an important and significant tool in the diagnosis of internal derangement of the knee including meniscal tear as well as assisting in management decision.

2) MRI as a non-invasive imaging technique, free of complication is regarded as a good choice in evaluating suspected meniscal tear and probability it, decreasing the number of diagnostic arthroscopy and a helpful tool for surgeon who is going to do operative arthroscopy or arthrotomy.

3) Familiarity with normal meniscal anatomy and common imaging pitfalls reduces but does not

completely eliminate MR imaging interpretation errors so more experience is needed for MRI observer to avoid the error in the diagnosis.

6- RECOMMENDATION

1) Encourage collaboration between surgeons and radiologists in the interpretation of films and in subsequent decisions about patient management.

2) Comparative study of arthroscopic findings and MRI results of meniscal injuries on large scale in all aspects regarding the accurate diagnosis, advantages, disadvantages, limitation, complications etc. are needed.

REFERENCES

1. Reicher MA, Haitzrnan S, Duckwiler GR, Bassett LW, Anderson LJ, Gold RH. Meniscal injuries: Detection using MRI. Radiology, 1986; 159: 753-757.
2. Tal Geva. Magnetic Resonance Imaging: Historical Perspective. Journal of Cardiovascular Magnetic Resonance, 2006; 8: 573-80.
3. Akram R, Silva FD, de Silva LN, Gupta A, Basha A, Chhabra A. Three-Dimensional MRI of Foot and Ankle: Current Perspectives and Advantages Over 2D MRI. InSeminars in Roentgenology 2024 Jun 25. WB Saunders.
4. Bednarova I, Bednarova S. Musculoskeletal and Bone Imaging. The Radiology Survival Kit: What You Need to Know for USMLE and the Clinics., 2022 Jan 12; 203-57.
5. Polito U. THE MENISCUS: BASIC SCIENCE TO IMPROVE KNOWLEDGE FOR TISSUE ENGINEERING.
6. Pasiński M, Zabrzyńska M, Adamczyk M, Sokołowski M, Głos T, Ziejka M, Augustynowicz P, Boguszewski K, Piotrowski W, Michał B, Górska J. A current insight into Human Knee Menisci. Translational Research in Anatomy., 2023 Sep 1; 32: 100259.
7. Zhang L, Mai W, Mo X, Zhang R, Zhang D, Zhong X, Zhao S, Shi C. Quantitative evaluation of meniscus injury using synthetic magnetic resonance imaging. BMC Musculoskeletal Disorders, 2024 Apr 15; 25(1): 292.
8. Liu Y, Du G, Liu J. Meniscal anterior and posterior horn heights are associated with MRI-defined knee structural abnormalities in middle-aged and elderly patients with symptomatic knee osteoarthritis. BMC Musculoskeletal Disorders, 2022 Mar 8; 23(1): 218.
9. Muro S, Kim J, Nimura A, Tsukada S, Akita K. Morphometric Analysis of the Tibial Attachment Shape of the Anterior Cruciate Ligament and Its Relationship With the Location of the Anterior Horn of the Lateral Meniscus. The American Journal of Sports Medicine, 2024 Mar; 52(3): 682-90.
10. Krakowski P, Karpiński R, Jonak J, Maciejewski R. Evaluation of diagnostic accuracy of physical examination and MRI for ligament and meniscus injuries. InJournal of Physics: Conference Series, 2021; 1736(1): 012027. IOP Publishing.
11. Evers BJ, Van Den Bosch MH, Blom AB, van der Kraan PM, Koëter S, Thurlings RM. Post-traumatic knee osteoarthritis; the role of inflammation and hemarthrosis on disease progression. Frontiers in medicine, 2022 Aug 22; 9: 973870.
12. Matthew A. Bubnis. Knee Meniscal Tears, StatPearls, July 17, 2023.
13. Raoulis Sr V, Fyllos A, Baltas C, Schuster P, Bakagiannis G, Zibis AH, Hantes M. Clinical and radiological outcomes after isolated anterior horn repair of medial and lateral meniscus at 24 months' follow-up, with the outside-in technique. Cureus, 2021 Sep; 13(9).
14. Jiang P, Cui J, Chen Z, Dai Z, Zhang Y, Yi G. Biomechanical study of medial meniscus after posterior horn injury: a finite element analysis. Computer Methods in Biomechanics and Biomedical Engineering, 2020 Mar 11; 23(4): 127-37.
15. Beaufils P, Becker R, Kopf S, Matthieu O, Pujol N. The knee meniscus: management of traumatic tears and degenerative lesions. EFORT open reviews, 2017 May 11; 2(5): 195-203.
16. Ahmad Alomari, Bucket-handle meniscal tear, radiopaedia, 21 Sep 2024.
17. Khan HA, Ahad H, Sharma P, Bajaj P, Hassan N, Kamal Y. Correlation between magnetic resonance imaging and arthroscopic findings in the knee joint. Trauma monthly, 2015 Feb; 20(1).
18. Hegmann KT, Biggs JJ, Hughes MA, Lichtblau E, Coward DB, Iorio CD, Logerstedt DS, Nicola SF, Saechao K, Spector JT. Knee disorders.
19. Joshi H. A Prospective Study Of Clinical, MRI And Arthroscopic Correlation In Meniscal And Cruciate Ligament Injuries Of Knee Joint.