Original Article

Diagnostic Accuracy Of Magnetic Resonance Imaging (MRI) In The Diagnosis Of Meniscal Tears, Keeping Arthroscopy As The Gold Standard

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Abstract

Objective: To evaluate the accuracy of magnetic resonance imaging (MRI) in diagnosing meniscal tears.

Methods: A descriptive, cross-sectional validation study was carried out for 1 year on 71 patients who fulfilled the selection criteria after written informed consent. All patients had MRIS of the affected knee, and then arthroscopy was performed.

Results: On MRI, the diagnosis of meniscal tear was made in 29 (40.8%) patients. Arthroscopy confirmed meniscal injury in 30 (42.3%) cases. The sensitivity, specificity, PPV, NPV and accuracy of MRI for diagnosing meniscal tears were 86.5%, 92.7%, 89.7%, 90.4% and 90.1%, respectively, keeping arthroscopic findings as the gold standard.

Conclusion: In patients with meniscal tears, MRI showed a high sensitivity and specificity and an accuracy of keeping arthroscopy as the gold standard and thus can be used as a non-invasive screening tool for establishing the diagnosis in patients who have a suspicion of meniscal tear.

Keywords: Meniscal tears, Arthroscopy, Magnetic resonance imaging, Diagnosis.

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Introduction

Trauma incidence is between 1.1% and 1.4% and has been documented.[1] It is more challenging to determine the incidence of posttraumatic knee problems in secondary care as clinical studies are scarce in this field due to limitations of certain patient groups, i.e., athletes and children.[2] However, knee issues are equally frequent in the hospital setting.

For the healthy function of the knee, the meniscus can be considered a vital part, distributing body weight, absorbing shock, stabilising the knee joint, and resisting pressure.[3] Meniscus damage is a common occurrence, and arthroscopic surgery, the most popular technique used in knee joint surgery, is frequently required to treat it.[4] The second most frequently damaged body part is the knee, which also accounts for the majority of surgeries performed because of high school athletics.[5] Injuries from playing sports send an estimated 2.5 million teenagers to emergency rooms each year.[6] Meniscal injury accounts for roughly 7% of these sports-related injuries.[7]

There are two categories of meniscal injuries, i.e., degenerative and traumatic. Young, active individuals are more prone to traumatic injuries, which are frequently linked to ACL lesions. Historically, only a clinical examination and conventional radiological analysis could be used to diagnose meniscal lesions. Arthrography has been utilised for a very long time to help with the examination of ligamentous and meniscal problems. False diagnosis rates between 40 and 85% were the result of the clinical examination's frequent inability to yield precise results.[8]

The accuracy of arthrography has been found to range from 67% to 97%, and the method necessitates a specialist in findings reporting and interpretation. Ionising radiation exposure is also a part of it. [9,10]

Materials And Methods

A Descriptive Cross-Sectional Validation Study was carried out in the Orthopaedic Department at Holy Family Hospital, Rawalpindi Medical University. The study was carried out for a full year on the patients who presented with suspected Meniscal tear (as per operational definition). Sample size calculated by Prevalence 76%, the sensitivity 86%, specificity 69%. 71 patients with suspected meniscal tears were included. However diagnostic accuracy of MRI was analysed on those patients who completed arthroscopy. Non-probability, consecutive sampling was performed.

The study included all patients with suspected meniscus injury, with a duration of trauma < 4 weeks, aged between 20-65 years of both genders.

Patients with any Contraindication to MRI, history of knee surgery, having degenerative meniscal tears (Osteoarthritis), with a history of recurrent knee injury, those with a cardiac pacemaker, claustrophobic patients and Pregnant females, were excluded from the study.

After being approved by the Ethical Review Committee of Rawalpindi Medical University (RMU), Rawalpindi, Pakistan, all patients fulfilling the inclusion criteria were included in this study. All patients underwent MRI of the affected knee by using a 1.5 Tesla MR with SE T1W1, FS T2W1 and STIR after their informed consent. A single consultant radiologist with more than five years of post-fellowship experience interpreted the MRI films of each patient, and the researcher recorded the results for the presence or absence of a meniscus tear (according to the operational definition). In a patient with high clinical suspicion of meniscal injury, MRI was indicated and was done and followed by arthroscopy. In patients completing the arthroscopy, all data (age, gender, duration of trauma, side affected (right/left), type of meniscus (medial/lateral) and presence or absence of meniscus tears on MRI and arthroscopy) were recorded on a pre-designed proforma. Data analysis was done with SPSS 25.0. Age and trauma duration were measured, and the mean and standard deviation were computed. Gender, affected side (right or left), meniscus type (medial or lateral), and presence or absence of meniscus tears on MRI and arthroscopy were all taken into account when calculating frequency and percentage. For the calculation of specificity, sensitivity, NPV, PPV and diagnostic accuracy of MRI 2x2 contingency table was used. Effect modifiers like age, sex, duration of injury, side affected (right/left) and type of meniscus (medial/lateral) were stratified. Post-stratification, diagnostic accuracy was also calculated.

Findings On MRI	**Findings On Arthroscopy**	
	Positive	**Negative**
Positive	True Positive (Tp)	False Positive (Fp)
Negative	False Negative (Fn)	True Negative (Tn)

Results

Seventy-one patients were enrolled. The patients' mean age was 30±7.76 years. The average length of trauma was 2.4±0.65 weeks. 63(88.7%) patients of the total were between the ages of 20 to 40 years, and only 8 (11.3%) patients were between 41 to 65 years.

With a 4:1 ratio, there were 14 (19.7%) females and 57 (80.3%) males. Meniscus tear occurred on the right knee in 45 (63.4%) patients and on the left knee in 26 (36.6%) patients. Concerning the type of meniscal tear, medial meniscal tear occurred in 35 (49.3%) patients, and lateral meniscal tear occurred in 36 (50.7%) patients.

On MRI, the diagnosis of meniscal tear was made in 29 (40.8%) patients. Arthroscopy confirmed meniscal injury in 30 (42.3%) cases.

The sensitivity, specificity, PPV, NPV and accuracy of MRI for diagnosing meniscal tears were 86.5%, 92.7%, 89.7%, 90.4% and 90.1%, respectively, keeping arthroscopic findings as the gold standard (Table 1).

Table 1: 2X2 Table for determining the diagnostic accuracy of mri keeping arthroscopy as gold standard

	Positive result on Arthroscopy	**Negative result on Arthroscopy**
Positive on MRI	**True positives (TP)** 26 (36.6%)	**False positives (FP)** 3 (4.2%)
Negative on MRI	**False negatives (FN)** 4 (5.6%)	**True negatives (TN)** 38 (53.5%)

Sensitivity= 86.5%
Specificity= 92.7%
PPV= 89.7%
NPV= 90.4%
Accuracy= 90.1%

Data was stratified for age, gender and duration of trauma. Concerning age, the sensitivity, specificity, PPV, NPV and accuracy of MRI for meniscal tears for age group 20 to 40 years were 91.9%, 92.2%, 88.4%, 94.7% and 92.1%, and the association between findings on MRI and arthroscopy was statistically significant (p=0.000). Concerning age group 41 to 65 years, the sensitivity, specificity, PPV, NPV and accuracy of MRI for meniscal tears were 60%, 100%, 100%, 60% and 75%, and the association between findings on MRI and arthroscopy was statistically insignificant (p=0.09) (Table 2).

Table 2: Stratification of diagnostic accuracy of mri for meniscal tear by age

Age Group 20 To 40 Years					
Findings On MRI	**Findings On Arthroscopy**		**Total**	**P Value**	**Diagnostic Accuracy**
	Meniscal Tear Present	**Meniscal Tear Absent**			
Meniscal Tear Present	23 (36.5%)	3 (4.8%)	26 (41.3%)	0.000	Sensitivity=91.9% Specificity=92.2% PPV=88.4% NPV=94.7% Accuracy=92.1%
Meniscal Tear Absent	2 (3.2%)	35 (55.6%)	37 (58.7%)		
Total	25 (39.7%)	38 (60.3%)	63 (100%)		
Age Group 41 To 65 Years					
Findings On MRI	Findings On Arthroscopy		Total	P Value	Diagnostic Accuracy
	Meniscal Tear Present	Meniscal Tear Absent			
Meniscal Tear Present	3 (37.5%)	0 (0%)	3 (37.5%)	0.09	*Sensitivity=60%* *Specificity=100%* *PPV=100%* *NPV=60%* *Accuracy=75%*
Meniscal Tear Absent	2 (25%)	3 (37.5%)	5 (62.5%)		
Total	5 (62.5%)	3 (37.5%)	8 (100%)		

Table 3: Stratification of diagnostic accuracy of mri concerning gender

For Male Gender:					
Findings On Mri	**Findings On Arthroscopy**		**Total**	**P Value**	**Diagnostic Accuracy**
	Meniscal Tear Present	**Meniscal Tear Absent**			
Meniscal Tear Present	20 (35.1%)	3 (5.3%)	23 (40.4%)	0.001	Sensitivity=86.9% Specificity=91.3% Ppv=86.9% Npv=91.3% Accuracy=89.5%
Meniscal Tear Absent	3 (5.3%)	31 (54.4%)	34 (59.6%)		
Total	23 (40.4%)	34 (59.6%)	57 (100%)		
For Female Gender:					
Findings On Mri	**Findings On Arthroscopy**		**Total**	**P Value**	**Diagnostic Accuracy**
	Meniscal Tear Present	**Meniscal Tear Absent**			
Meniscal Tear Present	6 (42.9%)	0 (0%)	6 (42.9%)	0.001	Sensitivity=85.9% Specificity=100% Ppv=100% Npv=87.6% Accuracy=92.9%
Meniscal Tear Absent	1 (7.1%)	7 (50%)	8 (57.1%)		
Total	7 (50%)	7 (50%)	14 (100%)		

Table 4: Stratification of diagnostic accuracy of MRI concerning duration of trauma

For Duration Of Trauma 1-2 Weeks:					
Findings on MRI	**Findings on Arthroscopy**		**Total**	**P Value**	**Diagnostic Accuracy**
	Meniscal tear present	**Meniscal tear absent**			
Meniscal tear present	13 (37.1%)	2 (5.7%)	15 (42.9%)	0.001	Sensitivity=81.2% Specificity=89.5% PPV=86.4% NPV=85.1% Accuracy=85.7%
Meniscal tear absent	3 (8.6%)	17 (48.6%)	20 (57.1%)		
Total	16 (45.7%)	19 (54.3%)	35 (100%)		
For Duration Of Trauma >2 To <4 Weeks					
Findings on MRI	**Findings on Arthroscopy**		**Total**	**P Value**	**Diagnostic Accuracy**
	Meniscal tear present	**Meniscal tear absent**			
Meniscal tear present	13 (36.1%)	1 (2.8%)	14 (38.9%)	0.001	Sensitivity=92.8% Specificity=95.4% PPV=92.8% NPV=95.4% Accuracy=94.4%
Meniscal tear absent	1 (2.8%)	21 (58.3%)	22 (61.1%)		
Total	14 (38.9%)	22 (61.1%)	36 (100%)		

Discussion

MRI had a sensitivity of 86.5%, specificity of 92.7% and accuracy of 90.1%, while keeping arthroscopic findings as the gold standard. The accuracy of MRI was seen to be higher in patients who were between 20 to 40 years, had a duration of trauma of>2 weeks and were females.

The menisci are crucial and play a critical role in the knee joint.[9] They help to lubricate the joint, increase the area of contact between the femur and the tibial condyles, lessen the load placed on the articular cartilage, and improve knee stability.[11] Meniscal injuries are frequently observed in athletes and young, energetic individuals.[12] When axial and rotational forces are present at the same time, meniscal damage results.[13] The medial meniscus is less flexible than the lateral meniscus and, as a result, more prone to injury. The posterior horn of the medial meniscus is also more frequently injured than the anterior horn.[14]

Because the meniscus is involved in the absorption of shock, distribution of load and stabilisation of the joint, meniscus tears are important clinically. Increased joint contact pressure brought on by meniscus root tears or meniscectomy can eventually cause articular cartilage degradation.[15] Depending on where and what kind of meniscal tears are, the appropriate therapy must be chosen. Therefore, accurate diagnosis of a meniscal tear is essential for managing it afterwards. Clinical history, physical examination of the knee joint and specific tests for meniscal injuries are all necessary for a precise diagnosis of meniscal injuries; however, none of these tests is pathognomonic. The most reliable imaging method is magnetic resonance imaging (MRI), which has taken the lead in the field of meniscal injury diagnosis [16]

The results of the present study are by a study carried out by Daniel Khalid et al. 2024 where they found that MRI has a high sensitivity in the diagnosis of meniscus injuries. It is an effective tool in diagnosing patients who could benefit from therapeutic arthroscopy.[17] Depending on where and what kind of meniscal tears are, the appropriate therapy must be chosen. Therefore, accurate diagnosis of a meniscal tear is essential for managing it afterwards. Clinical history, clinical knee joint examination and specific tests for meniscal injuries are all necessary for a precise diagnosis of meniscal injuries; however, none of these tests is pathognomonic. MRI has an 86.5% sensitivity, 92.7% specificity and 90.1% accuracy, while keeping arthroscopic findings as the gold standard. Based on the sensitivity and specificity of MRI, it is a reliable diagnostic tool for meniscus injuries.[18] The results are also in accordance conducted by M Sajid et al. 2023 where he confirmed that arthroscopy is the gold standard for accurate diagnosis, although MRI can be done as a tool of screening for these patients.[19] The study of Seong Hwan Kim et al. showed that MRI can be used in the diagnosis of meniscus injuries, but it lacks accuracy in diagnosing the type and location of meniscus injuries.[20]

Conclusions

MRI had a high sensitivity and a high specificity and had an accuracy of 90.1%, while keeping arthroscopic findings as the gold standard. Our study results propose that MRI can be routinely used as a screening tool before going for arthroscopy, as it is less invasive and can be conveniently used for assessment purposes.

Author Information

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