

Diagnostic accuracy of Magnetic Resonance Imaging in detection of meniscal tears of the knee joint in adults using Arthroscopy as the gold standard

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Abstract:

Objective: To determine the diagnostic accuracy of magnetic resonance imaging in the detection of meniscal tears of the knee joint in adults with knee injury taking arthroscopy as a gold standard.

Material and Methods: In this cross-sectional study, a total of 155 patients who presented with a knee injury were included. All patients underwent MRI followed by arthroscopy within one week. The orthopedic surgeons were unaware of the MRI results. Meniscal injuries on MRI were scored according to a grading system described by Lotysch et al. and Crues et al. All collected data were entered into the proforma and used electronically for research purposes. Diagnostic accuracy of MRI was evaluated for medial and lateral meniscal injuries individual-taking arthroscopy as the gold standard.

Results: The mean±SD of age was 33.6±10.56 years. In the distribution of gender, 104(67.1%) patients were males while 51(32.9%) were females. Diagnostic accuracy of MRI was 90% in the diagnosis of medial meniscus tear with sensitivity 82.35%, specificity 93.02% PPV 82.35% and NPV 93.02% by using arthroscopy findings as the gold standard while for lateral meniscal tears, it was 93.68% with sensitivity 94.44%, specificity 92.68%, PPV 94.44% and NPV as 92.68%.

Conclusion: It is to be concluded that although arthroscopy is the goldstandard in detecting medial and lateral meniscus tears. MRI is reasonably good and relatively comparable with histopathology.

Keywords: Arthroscopy, diagnostic accuracy, knee joint, magnetic resonance Imaging, Meniscal Tear

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Introduction:

The knee acts as an important weight-bearing joint that gives a wide range of mobility and stability in the course of physical activity as well as stability while standing. Traumatic knee injuries are commonly seen in daily life. These injuries are mainly sports-related and may cause severe pain and impairment, however, sometimes the symptoms of blunt knee trauma are confusing, and delay in diagnosis may result in a worse prognosis. The gold standard for diagnosis of knee ligamentous injuries has been arthroscopy with diagnostic accuracy of up to 94%. It also has

a therapeutic role. However, arthroscopy being an invasive procedure with relatively high cost, need for anesthesia, and hospitalization, it can cause complications like infection. Thus, MRI being non-invasive, having multi-planar qualities and exceptional soft tissue contrast is widely being used by surgeons in place of arthroscopy, particularly for sports-related knee injuries.^{1,2}

Diagnosis of meniscal tears is of vital importance because they act as cushions and distribute the load equally, protect against shocks, and maintain joint stability.³ Meniscus root tear or

meniscectomy exacerbates the pressure on the knee joint resulting in degenerative changes primarily involving articular cartilage over time.⁴ The management plan and treatment of meniscal tears are decided according to the location and grade of meniscal tears. Therefore, a precise diagnosis of a meniscal tear is necessary for its further management.⁵

In recent years, there is an inadequacy of local studies to evaluate the accuracy of MRI meniscal knee injury against arthroscopic findings. Therefore, the aim of this study is to look for the diagnostic performance of the MRI in the evaluation of medial and lateral menisci in the local population and compare it with arthroscopy which is currently regarded as the reference point. This study will also help us to reduce the number of pure diagnostic arthroscopies in suspected cases of meniscal injuries but also in the selection of proper treatment options.

Material and Methods:

A total of 155 patients who presented with knee injuries showing meniscal tears were included. The study was conducted from June 3, 2021, to December 2, 2021, in the Department of Radiology, Jinnah Post Graduate Medical Centre, Karachi. The inclusion criteria were both genders aged 18 to 55 years willing to undergo both MRI and arthroscopy. Exclusion criteria were patients not willing to give written consent, any prior significant knee ailment or knee surgery, patients with any additional knee injury after MRI examination, degenerative changes or evidence of loose bodies on plain radiography, patients who had previously undergone arthroscopy with the repair of menisci and ligaments, any contraindication for MRI like a pacemaker, metallic implants, and claustrophobia.

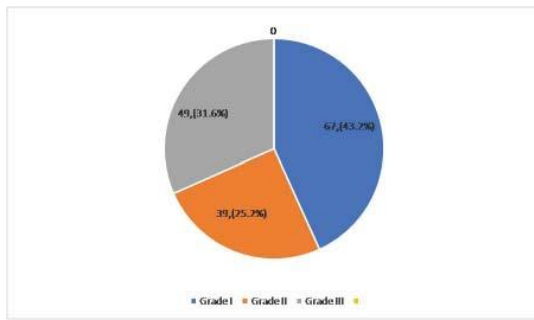
This study was conducted after the approval of the institutional research and ethical review committee and the College of Physicians and Surgeons Pakistan (CPSP). Informed consent was obtained from all the patients. A complete clinical history of patients was obtained along with demographic. MRI imaging was done with 1.5 TESLA Magnetic Resonance Imag-

ing equipment from GE-HDXT. Patients were placed in a supine position with the knee in a closely coupled HD transmit/receive knee array coil. The knee will be externally rotated 15-20° in order to facilitate the visualization of ACL completely on sagittal images. The knee was examined in the 3 standard planes – sagittal, axial, and coronal, using a FOV of 16 x16 cm, matrix size 320x224, and with 3 mm slice thickness. T1, T2 weighted Fat suppressed Proton-Density sequences in sagittal planes, Short tau inversion recovery (STIR), and Gradient recalled echo (GRE) and 3D Proton Density cube sequences were acquired in various planes. Images were studied for injuries to the ligaments in detail. Meniscal injuries on MRI were scored according to a grading system and then the patients were followed up for arthroscopy within 1 week of MRI.

MRI and arthroscopic findings were compared for the medial meniscus and lateral meniscus individually. SPSS version 21 was used for data compilation and analysis. Frequency and percentage were computed for qualitative variables like gender, side of the knee, diabetes, hypertension, meniscal injury (medial meniscus/lateral meniscus), Grade (I/II/III), and diagnosis of medial and lateral meniscal tears on MRI (positive/negative) and on Arthroscopic findings (positive/negative). Mean±SD was calculated for quantitative variables i.e. age and duration of injury. Sensitivity, specificity, positive predictive value, negative predictive values, and the diagnostic accuracy of MRI were calculated taking arthroscopy as the gold standard. The stratification was done on age, gender, diabetes, hypertension, duration of injury, side of the knee, grade, and meniscal tears to see the effect of these modifiers on outcome. Post-stratification, sensitivity, specificity, positive predictive value, negative predictive values, and the diagnostic accuracy of MRI were calculated taking arthroscopy as the gold standard.

Results:

In this study, 155 patients were included to assess the diagnostic accuracy of magnetic resonance imaging in the detection of meniscal tears



Figure#1. Frequency of grades n=155

Table 1: Diagnostic accuracy of MRI findings for medial meniscal tears by using arthroscopy as gold standard n=95

Arthroscopy (Gold Standard)		
MRI findings	Positive	Negative
Positive	True positive(a) 51	False positive(b) 3
Negative	False negative(c) 3	True negative (d) 38
total	a + c= 54	b + d= 41

Table 1: Diagnostic accuracy of MRI findings for medial meniscal tears by using arthroscopy as gold standard n=95

95% confidence interval					
			lower	upper	
Sensitivity	a/ (a + c)	0.9444	94.44	0.8833	1.0055
Specificity	d/ (b + d)	0.9268	92.68	0.8471	1.0065
Prevalence of disease	(a+ c)/ (a+ b+ c+ d)	0.5684	56.84	0.4688	0.6680
Positive Predictive value	a/ (a + b)	0.9444	94.44	0.8833	1.0055
Negative Predictive value	d/ (c+ d)	0.9268	92.68	0.8471	1.0065
Overall accuracy**	(a+ d)/ (a+ b+ c+ d)	0.9368	93.68	0.8879	0.9858

Table 2: Diagnostic accuracy of MRI findings for lateral meniscal tears by using arthroscopy as gold standard n=60

Arthroscopy (Gold Standard)		
MRI findings	Positive	Negative
Positive	True positive(a) 14	False positive(b) 3
Negative	False negative(c) 3	True negative (d) 40
total	a + c= 17	b + d= 43

Table 2: Diagnostic accuracy of MRI findings for lateral meniscal tears by using arthroscopy as gold standard n=60

95% confidence interval					
			lower	upper	
Sensitivity	a/ (a + c)	0.8235	82.35	0.6423	1.0047
Specificity	d/ (b + d)	0.9302	93.02	0.8541	1.0064
Prevalence of disease	(a+ c)/ (a+ b+ c+ d)	0.2833	28.33	0.1693	0.3974
Positive Predictive value	a/ (a + b)	0.8235	82.35	0.6423	1.0047
Negative Predictive value	d/ (c+ d)	0.9302	93.02	0.8541	1.0064
Overall accuracy**	(a+ d)/ (a+ b+ c+ d)	0.9000	90.00	0.8241	0.9759

of the knee joint in adults taking arthroscopy as the gold standard and the results were analyzed as: Grade I was noted in 67(43.2%) patients, grade II in 39 (25.2%) while grade III was noted in 49(31.6%) patients as shown in figure 1.

Medial meniscus tears were found in 70 (73.7%) patients on magnetic resonance imaging (MRI). Medial meniscus tears were diagnosed in 54(56.8%) patients onarthroscopy findings (gold standard). Lateral meniscus tears were found in 41(68.3%) patients on magnetic resonance imaging (MRI). Lateral meniscus tears were diagnosed in 17(28.3%) patients on arthroscopy findings (gold standard).

Diagnostic accuracy of MRI was noted as 90% in the diagnosis of medial meniscus tear with sensitivity 82.35%, specificity 93.02% PPV 82.35%, and NPV 93.02% by using arthroscopy as the gold standard as shown in table 1.

Diagnostic accuracy of MRI was noted as 93.68% in the diagnosis of lateral meniscus tear with sensitivity 94.44%, specificity 92.68%, PPV 94.44%, and NPV as 92.68% by using arthroscopy as gold standard as shown in table 2.

Discussion:

MRI has gained popularity in recent years as a first-line examination because of being a non-invasive investigation of suspected knee injuries. It has increased soft tissue contrast, multiplanar visualization, improved signal-to-noise ratio (SNR), and higher resolution without ionizing radiation.^{6,7} Despite of having higher accuracy in identifying meniscal tears, a number of lesions in meniscal tears are missed on MRI, given the wide variability in its accuracy.⁸ It is now widely used for imaging injuries of internal structures of the knee and has replaced conventional arthrography and diagnostic arthroscopy. It is superior to computed tomography (CT) for imaging of soft tissue structures.⁹ MRI is performed more commonly on the knee than on any other joint, and it is an excellent diagnostic tool that can aid in the evaluation of almost of sports-related injuries involving the ligaments, tendons, menisci, osseous structures, and articular surfaces. It has

currently become the most widely used non-invasive imaging method for detecting meniscal injuries, with a reported diagnostic accuracy of as high as 98%, compared to arthroscopy, remaining the gold standard for confirming the diagnosis of meniscal tear.¹⁰

In the current study, medial meniscus tears were found in 70(73.7%) patients on magnetic resonance imaging (MRI) while diagnosed in 54(56.8%) patients on arthroscopy findings (gold standard). Yaqoob J, et al, reported that on arthroscopy, medial meniscus tears were found in 26 patients (48%).¹⁰ As per the study findings of Kim SH, et al, on MRI, there were 302(55.6%) cases of medial meniscus tears while 261(48.1%) cases of medial meniscus tears were diagnosed on arthroscopy.³ Arican G, et al, observed medial meniscal tears in 292(64.60%) patients on MRI while as per arthroscopy, 284(62.83%) patients had medial meniscal tears.¹¹

In recent study lateral meniscus tears were found in 41(68.3%) patients on magnetic resonance imaging (MRI) while diagnosed in 17(28.3%) patients on arthroscopy findings (gold standard). The prevalence of medial and lateral meniscus was found at 51.43% and 26.19%⁵ whereas Yaqoob J, et al, noted that on arthroscopy, lateral meniscus tears were found in 9 patients (16.6%).⁵ The study by Kim SH, et al, found that on MRI, 258 (47.5%) cases of lateral meniscus tear while 271 (49.9%) cases of lateral meniscus tear on arthroscopy.³ On MRI, lateral meniscal tears in 96(21.23) patients while as per arthroscopy, 108(23.89%) patients had lateral meniscal tears.³

The present study reported diagnostic accuracy of MRI findings as 90% in the diagnosis of medial meniscus tear with sensitivity 82.35%, specificity 93.02% PPV 82.35%, and NPV was found to be 93.02% by using arthroscopy findings as the gold standard. The study of Khandelwal K, et al, reported the sensitivity, specificity, and accuracy of MRI for medial meniscus tear as 95.69%, 94.87%, and 95.23%, respectively¹² while Yaqoob J, et al, documented 94.4% diag-

nostic accuracy with 100% sensitivity, 88.4% specificity, 90% positive predictive value and 100% negative predictive value for medial meniscal injury.¹⁰ In another study, the diagnostic accuracy of 85.8% was reported with sensitivity of 91.82%, a specificity of 79.93%, and PPV and NPV were 81.79% and 90.87%, respectively.¹¹ Khalil A, et al, noted 93.9% sensitivity and 66.6% specificity.¹³ The study of Arican G, et al, determined diagnostic accuracy at 94%, sensitivity at 94%, and specificity at 89%.¹¹ This study noted diagnostic accuracy of MRI findings as 93.68% in the diagnosis of lateral meniscus tear with sensitivity 94.44%, specificity 92.68% PPV 94.44%, and NPV was found to be 92.68% by using arthroscopy findings as the gold standard. Kim SH, et al, noted diagnostic accuracy of 83.1%, with a sensitivity of 80.74%, specificity of 85.35%, PPV of 84.49%, and NPV of 81.7% in the diagnosis of lateral meniscus tear⁸ while Arican G, et al, noted diagnostic accuracy 94%, sensitivity 84% and specificity 91%.¹¹

The diagnostic accuracy of MRI in detecting meniscal injury compares favorably with the reported literature taking arthroscopic findings as the gold standard.

Conclusion:

It is to be concluded that although arthroscopy is the gold standard in detecting medial meniscus tear and lateral meniscus tears. MRI is reasonably good and relatively comparable with histopathology. More prospective and well-controlled trials are needed to validate the current findings.

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Role and contribution of authors:

Muhammad Asadullah, collected the data, references and did the initial write-up.

Shaista Shoukat, collected the data, references and helped in discussion writing

Afnan Shoukat, collected the references and

helped in tabulation.

Samrah Bukhari, typically review the article and made the final changes.

Sumera Tabassum, collected the references and helped in discussion writing

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