

Accuracy of MRI in Detection of Meniscal Injury when Compared with Knee Arthroscopy

Raahima Khan, Khalid Farooq

ABSTRACT:

Objective: The study aims to establish the level of diagnostic accuracy of magnetic resonance imaging in detecting meniscal injury with knee arthroscopy as the gold standard.

Study Design and Setting: cross-sectional descriptive study that was undertaken at Ghurki Trust Teaching Hospital, Lahore.

Methodology: 156 patients aged between 18 and 65 years old and of both sexes, who presented with clinical suspicion of having meniscal injury were selected through non-probability consecutive sampling. Patients who had undergone a knee surgery previously, knee tumor, those who were pregnant, immunocompromised or those who were not willing to participate were excluded. Every patient also received 1.5-Tesla magnetic-resonance-imaging (MRI) of the knee and knee-arthroscopy. The arthroscopic findings were compared with MRI findings. The sensitivity, specificity, PPV, NPV, and diagnostic accuracy were computed with the help of a 2×2 contingency table.

Result: MRI showed injuries in 103 patients and arthroscopy showed injury in 98 patients. When compared to arthroscopy, MRI had 90 true-positives, 45 true-negatives, 13 false-positives and 8 false-negatives. The sensitivity, specificity, positive predictive value, negative predictive value, and the overall diagnostic accuracy of MRI were 91.84, 77.59, 87.38, 84.91 and 86.54 respectively.

Conclusion: MRI was both sensitive and has a good diagnostic accuracy in identifying meniscal injury. It is a convenient non-invasive diagnostic method but arthroscopy still is the gold standard when patients still have persistent symptoms or inconclusive results at imaging.

Keywords: Arthroscopy; Diagnostic accuracy; Knee injuries; Magnetic resonance imaging; Meniscal injury

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INTRODUCTION:

One of the most frequent causes of mechanical pain and knee pain in the practice of orthopedics and radiology in adulthood are meniscal injury. The medial and lateral menisci are fibrocartilaginous ligaments that distribute the axial load, enhance the joint congruency, absorb shock, aid in lubrication, cushion the articular cartilage and offer secondary stability of tibiofemoral joint. In case of tear in the meniscus, the patient might experience pain at the joint line, swelling, clicking, giving way, locking of the knee and limitation of movements. These symptoms have the potential to seriously decrease mobility and quality of life, especially in young active

patients and working adults. Due to the untreated or unattended tears in the meniscus, which can develop thus leading to faster degenerative processes, the clinically important issue is an early and precise detection.^{1,2} Clinical assessment has always been the initial procedure in the assessment of suspected meniscal damage; even it does not provide adequate diagnosis in most cases. Joint-line tenderness, McMurray, Thessaly and Apley grinding test can indicate meniscal pathology but their consistency depends upon the level of pain and acute swelling and ligamentous damage accompanying the asymmetries, the skill of the examiner, and the chronology of how long the symptoms have been present. In addition, tear in the meniscus, often accompany anterior cruciate ligament injury, cartilage defects, bone bruising, or osteoarthritic alterations, and they result in similar clinical manifestations. Thus imaging is generally necessary to make the diagnosis, localize the tear, examine tear morphology, and inform the choice, between conservative treatment, meniscal repair, partial meniscectomy, or arthroscopic examination.^{2,3}

Knee arthroscopy is a common practice thought to be the gold standard in the diagnosis of meniscal tear as it

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is the easiest to accurately visualize and probe the meniscus and can be used to treat the meniscus simultaneously. However, notwithstanding these benefits, arthroscopy is invasive, consumes operative resources, is more costly and involves possible risks of infection, hemarthrosis, thromboembolic, anesthesia-related and postoperative stiffness. Due to this reason, an effective non-invasive diagnostic test is needed to pick the patients who indeed should be subjected to arthroscopy, and to prevent unnecessary diagnostic testing.^{4,5} The most common non-invasive modality that is currently in use to determine the internal derangement of the knee is magnetic resonance imaging (MRI). MRI offers a good soft-tissue visualization and multiplanar visualization of menisci, cruciate ligaments, collateral ligaments, articular cartilage, subchondral bone, synovium and periarticular soft tissues. A meniscal tear is commonly diagnosed when the presence of abnormal intrameniscal signal is present at an articular surface, especially that of the articular surface with grade 3 signal strength. MRI can be also used to determine the location of tears, pattern, displacement, meniscal extrusion, root involvement, ramp lesions and related injuries are all significant in surgical planning and prognostics.^{1,6}

More recent studies reported that diagnostic performance of MRI in meniscal tear is generally high but it varies based on the meniscus (involved), the type of tear, MRI field strength, imaging regimen, meniscus-arthroscopy interval, and expertise of radiologists. Kim et al. demonstrated that the performance of MRI depends on the type and location of tears with some easier to detect than others.¹ According to Koch et al., 1.5-Tesla MRI would help in the diagnosis of meniscal and ligamentous knee pathology, yet false-negative lesions are present.² Recent arthroscopy-comparative literature also confirms that MRI is an effective initial tool with the observation that sensitivity and specificity is not the same between medial and lateral meniscal tear.^{4,5,7} On the same note, assessment in the ACL tear patient groups has indicated that detecting meniscal injury in MRI scan can be less reliable in presence of complex combined knee injuries.⁸⁻¹⁰ Despite the positive evidence related to the use of MRI as a valuable diagnostic tool in international literature, the reported accuracy, in turn, is not constant, and local institutional data are significant. The strength of the scanner, imaging protocol, experience of the reporting, patient selection, and arthroscopic technique used may vary and this could affect diagnostic performance. As such, diagnostic accuracy of MRI of meniscal injury with that of knee arthroscopy needs to be determined so that its reliability in terms of locality case can be made.

METHODOLOGY:

The study was a cross-sectional descriptive study and carried out at Ghurki Trust Teaching Hospital, Lahore following

the permission granted by the institutional ethical review committee (Ref. No. 2026/05/R-33 dated 22-05-26) from 2nd February 2026 to 1st May 2026. The study population was viewed as patients who presented at the hospital, with a clinical suspicion of meniscal injury. The symptoms which led to clinical suspicion included knee pain, swelling, clicking, locking, instability and restriction of knee movements especially after the trauma or twisting injury. The study was aimed at ascertaining the diagnostic validity of magnetic resonance imaging in identifying meniscal injury in comparison with MRI to knee arthroscopy that was considered the gold standard. The number of patients in the study was 156. Sample size was calculated by using 92.0% sensitivity, 75.0% specificity, 91.47% prevalence of disease (diagnostic accuracy), 1.3% precision, 95% confidence level and 10.0% expected dropout rate.¹¹ Non-probability consecutive sampling was used in selecting patients. Eligible patients that met the inclusion criteria throughout the research period were recruited until the necessary number was attained. The study involved patients of either genders, aged 18 to 65 years who came in presenting with a clinical suspicion of meniscal injury. The study excluded patients who had had knee tumor or undergone knee surgery, immunocompromised, pregnant, or declined the research.

The purpose and method of the study, before the collection of the data, was clarified with every patient in clear terms. All participants were informed and provided written consent. During the study, confidentiality and privacy of patient information were ensured. Every patient was provided with a registration number and personal identification information was confidential. The researcher gathered data in a structured proforma that was specifically created to address this research. Proforma contained demographic data like age and sex, knee side that is affected on MRI, and arthroscopic data. A history was then collected on each patient in detail after enrollment with clinical examination of the affected knee done subsequently. The side of involvement was left knee, right knee or bilateral knee involvement. MRI of all patients was taken of knee on a 1.5-Tesla MRI scanner. Imaging protocol also consisted of sagittal, T1-weighted, T2-weighted and T2-questions and coronal and axial T2-weighted imaging. The imaging was done with a special extremity knee coil to enhance visualization of the intra-articular knee structures. MRI scans were rated by qualified and trained radiologists. The radiologists examined the medial and lateral menisci and reported the presence of meniscal injury or absence of the injury. Considering MRI, a meniscal tear was a positive result when a signal intensity of grade 3 was present to the articular surface. MRI was seen negative when there was no tear or when grade 1 or grade 2 signal intensity did not reach the surface of the article.

After examining MRI, all patients underwent knee arthroscopy, as a reference standard. An experienced orthopedic surgeon carried out arthroscopy. Standard portals,

with an anterolateral or transpatellar approach as necessary, were used to insert the arthroscope into the knee joint. The intra articular structures were directly viewed and palpated. The medial and lateral menisci were observed keenly to make sure that there is no tear, fraying, displacement, or instability. Arthroscopy was determined positive in case a visible tear, fraying, instability or displacement of meniscus was detected. The appearance of a smooth surface, intact meniscus, and stability of the meniscus on probing were considered negative. Where applicable therapeutic intervention done during arthroscopy was also noted. Each patient had their MRI results compared to arthroscopic results. The patients with a positive MRI and a positive arthroscopy were termed as true positive. Patients who received negative MRI and negative arthroscopy were termed as true negative. False positive patients were labeled as positive (MRI only) and negative (arthroscopy only) whereas false negative patients were only labeled as negative. These categories were used to determine the diagnostic accuracy of MRI. The data were recorded, inputted into, and analyzed with SPSS 25.0. The mean and standard deviation were the common means of expressing the quantitative variables like age. Qualitative variables like gender, side to which knee, MRI, and Arthroscopic findings were analyzed in terms of frequencies and percentages. The sensitivity, specificity, positive predictive value, negative predictive value and the overall diagnostic accuracy of MRI were measured by constructing a 2 x 2 contingency table using knee arthroscopy as the gold standard. The data were stratified based on age, gender, and knee side to ensure that the influence of potential modifiers was put under control. The chi-square test was used when necessary after the stratification. A p-value below 0.05 was deemed as significant.

RESULTS:

The study involved 156 patients that were clinically suspected of having meniscal injury. The overall age of the patients was 39.8 ± 12.1 years of age with an age range of 18-65 years. The patients in the age group of 31-45 years (66 patients), age group of 46-65 years (48 patients), and age group of 18-30 years (42 patients) had the majority of the patients. The overall population of the study comprised of 99 male patients and 57 female patients, with male dominance. In terms of side of knee involvement, the right knee involved 83 patients, the left knee involved 69 patients with bilateral knee involvement of 4 patients. In the MRI assessment, meniscal injury was detected in 103 individuals and 53 individuals were indicated to be negative of meniscal injury. Out of the cases which were found to be MRI positive, most cases were found to have medial meniscus injury that was found in 61 cases. Lateral meniscus injury was observed in 30 patients and medial and lateral meniscal injury were combined in 12 patients. These results indicated that the medial meniscal involvement was primarily observed relative to the lateral meniscal involvement in MRI.

All patients underwent knee arthroscopy and this was used as the gold standard of final diagnosis. During arthroscopy, 98 patients were found with meniscal injury and 58 patients did not show any signs of meniscal injury. The medial meniscus injury was observed in 59 patients, lateral meniscus injury in 28 patients and combined medial and lateral meniscular injuries in 11 patients in the arthroscopy positive cases. The arthroscopic results also revealed the medial meniscal injury to be the prevalent type of meniscal injury.

In the cases of MRI results versus arthroscopic results, 90 patients were the true positive cases since meniscal damage is evidenced by both the MRI and arthroscopy. True negative consisted of 45 patients in whom there was no evidence of meniscal injury in the MRI or arthroscopy. False positive were 13 patients who were indicated in MRI to have a meniscal injury, yet arthroscopy lost the diagnosis. The number of false negatives amounted to eight cases when MRI did not identify meniscal injury only to be found on arthroscopy. With arthroscopy as the gold standard, the sensitivity of MRI to detect meniscal injury was estimated to be 91.84% meaning that MRI accurately detected all the patients who actually had meniscal injury. The specificity of MRI was 77.59%, showing its ability to correctly identify patients without meniscal injury. The positive predictive value was 87.38% that suggested that majority of patients who presented with positive results on MRI actually had meniscal injury on arthroscopy. The negative predictive value was 84.91%, indicating that a majority of patients who had negative MRI results had negative arthroscopy. There was a total diagnostic accuracy of MRI of 86.54%. Diagnostic accuracy stratified revealed that MRI had accuracy rates of 86.9% and 86.0, in males and females respectively. MRI was 88.1% accurate in patients aged 18-30 years, 86.4% in patients aged 31-45 years and 85.4% in patients aged 46-65 years. As per knee side, the accuracy of MRI was 86.7% right knee, 85.5% left knee and 100 bilateral knee. In general, the study revealed a high sensitivity and excellent level of diagnostic precision of MRI compared to knee arthroscopy in detecting meniscal injury.

DISCUSSION:

In the current study, the sensitivity of MRI was 91.84, which shows that MRI was able to detect the majority of the patients with meniscal injury on the arthroscopy test. This result was similar to that of Khalid et al., who identified a sensitivity of 94.9% with MRI regarding the ability to identify meniscal injury in patients with knee trauma.¹¹ On the same note, Noorelahi et al. have provided that MRI was more sensitive than ultrasound with a sensitivity of 96.19 percent in detecting tears in the meniscus where arthroscopy was employed as the reference standard.¹² These findings substantiate the use of MRI as a good screening test prior to arthroscopy. The sensitivity of the study at hand is high, which might be attributed to 1.5-Tesla MRI utilizing some special

Table 1. Demographic and clinical characteristics of patients

Variable	Category	Frequency	Percentage
Age group	18–30 years	42	26.9%
	31–45 years	66	42.3%
	46–65 years	48	30.8%
	Total	156	100.0%
Gender	Male	99	63.5%
	Female	57	36.5%
	Total	156	100.0%
Knee side	Right knee	83	53.2%
	Left knee	69	44.2%
	Bilateral knee	4	2.6%
	Total	156	100.0%

Table 2. MRI findings of meniscal injury

MRI finding	Frequency	Percentage	Type of meniscal injury on MRI	Frequency	Percentage among MRI-positive cases
Positive for meniscal injury	103	66.0%	Medial meniscus injury	61	59.2%
Negative for meniscal injury	53	34.0%	Lateral meniscus injury	30	29.1%
Total	156	100.0%	Both medial and lateral meniscus injury	12	11.7%
			Total MRI-positive cases	103	100.0%

Table 3. Arthroscopic findings of meniscal injury

Arthroscopy finding	Frequency	Percentage	Type of meniscal injury on arthroscopy	Frequency	Percentage among arthroscopy-positive cases
Positive for meniscal injury	98	62.8%	Medial meniscus injury	59	60.2%
Negative for meniscal injury	58	37.2%	Lateral meniscus injury	28	28.6%
Total	156	100.0%	Both medial and lateral meniscus injury	11	11.2%
			Total arthroscopy-positive cases	98	100.0%

Table 4. Comparison of MRI findings with arthroscopy and diagnostic accuracy

MRI finding	Arthroscopy positive	Arthroscopy negative	Total	Diagnostic parameter	Calculation	Value
MRI positive	90	13	103	Sensitivity	$90 / 98 \times 100$	91.84%
MRI negative	8	45	53	Specificity	$45 / 58 \times 100$	77.59%
Total	98	58	156	Positive predictive value	$90 / 103 \times 100$	87.38%
				Negative predictive value	$45 / 53 \times 100$	84.91%
				Diagnostic accuracy	$135 / 156 \times 100$	86.54%

Table 5. Stratification of MRI diagnostic accuracy according to gender, age group, and knee side

Stratification variable	Category	TP	FP	FN	TN	Sensitivity	Specificity	PPV	NPV	Accuracy
Gender	Male	58	8	5	28	92.06%	77.78%	87.88%	84.85%	86.87%
	Female	32	5	3	17	91.43%	77.27%	86.49%	85.00%	85.96%
Age group	18–30 years	24	3	2	13	92.31%	81.25%	88.89%	86.67%	88.10%
	31–45 years	39	6	3	18	92.86%	75.00%	86.67%	85.71%	86.36%
	46–65 years	27	4	3	14	90.00%	77.78%	87.10%	82.35%	85.42%
Knee side	Right knee	49	7	4	23	92.45%	76.67%	87.50%	85.19%	86.75%
	Left knee	39	6	4	20	90.70%	76.92%	86.67%	83.33%	85.51%
	Bilateral knee	2	0	0	2	100.00%	100.00%	100.00%	100.00%	100.00%

knee imaging sequences and scans being interpreted by trained radiologists.

Specificity in the present study was 77.59 that was less than the sensitivity. This observation meant that MRI was more able to detect meniscal injury patients than not injured patients. This similar tendency was noticed in the research of Khalid et al., who indicated a high level of sensitivity but a relatively low level of specificity.¹¹ On the other hand, Bottomley and Al-Dadah have found a specificity of 83-88% with medial meniscal tear, and 88-91% with lateral meniscal tear which was a little higher than the specificity of the present study.¹³ Another study conducted by Noorelahi et al. also found that specificity was 87.38, which is higher as compared to the current study.¹² The reduced specificity of our study could relate to false-positive MRI results due to degenerative signals in the intrameniscal, partially volume effects, surface-reaching tear acting as grade 2 signal interpreted as such, or interpretation of grade 2 signal as surface-reaching tear. In the current study, the positive predictive value stood at 87.38 indicating that majority of patients with positive MRI results were found to have meniscal injury on arthroscopy. This was similar to the research by Bottomley and Al-Dadah which gave a PPV of 96% of the medial meniscal tears and a low PPV of 68% of the lateral meniscal tears.¹³ Our study had a PPV between these values, which was likely due to medial and lateral meniscal tears being combined. The current investigation also revealed that medial meniscal tear was the most predominant kind of tear on MRI, as well as, arthroscopy. These results were comparable to El-Hagrasy et al. and Bottomley and Al-Dadah, who had discovered that medial tears were common compared to lateral tears in arthroscopy-comparative studies.¹³ The prevalence of medial meniscal could be attributed to its comparatively low mobility and its close attachment to the tibial plateau and medial collateral ligament. The predictive confidence of the negative result of the present study was 84.91 which means that negative MRI outcome was dependable though it was not going to exclude meniscal injury entirely. It aligned with other reported NPVs in Bottomley and Al-Dadah who stated that medial meniscal tears had an NPV of 63% and lateral tears had higher NPV of 87%.¹³ The false negative in the current study was clinically significant as 8 patients had negative MRI, however positive arthroscopy results. Like restrictions have been reported in the literature particularly subtle, peripheral, posterior horn, ramp, and root lesions.¹⁴⁻¹⁸ Some patients, therefore, who have continuous mechanical symptoms of locking, catching or joint-line pain despite negative MRI nevertheless might need arthroscopic examination. The overall rates of MRI diagnostic accuracy in this study were 86.54%. This was similar to those of Bottomley and Al-Dadah who reported 89% accuracy of

medial meniscal tear diagnosis and 81% accuracy of lateral meniscal tear diagnosis.¹³ Noorelahi et al. also reported accuracy of MRI 91.83 which was slightly higher compared to the present study.¹² Khalid et al. also found that MRI was a good first-line tool of diagnosing meniscal injury among men.¹¹ The fact that the results of our study are similar to the findings of recent studies indicates that MRI can be used in clinical decisions. Yet, inter-study differences in precise measurements can be attributed to inter-study variations in the field strength of the MRI, in the patient population, tear morphology, pericertial timing between MRI and arthroscopy, and level of expertise of the radiologist. The current research reported that medial meniscal injury was more common as compared to lateral meniscal injury under both MRI and arthroscopy. Medial meniscal injury was predicted in 61 patients, lateral injury in 30 patients and combined in 12 patients on MRI. Arthroscopy revealed the medial injury in 59 patients, lateral injury in 28 patients and combined injury in 11 patients. These were in line with other studies that have documented an increase in the incidences of medial tears of the meniscus than the number of lateral tears.^{11,13} Nevertheless, other tears tend to be harder to identify on MRI, such as lateral meniscal tears and root tears, which are particularly hard to diagnosis when in the presence of anterior cruciate ligament damage. Garcia et al. reported that tears on the root of the meniscal should be carefully imaged since a misdiagnosis can cause unexpected changes in the biomechanic and early osteoarthritis can be developed.¹⁹

A few recent studies on meniscal ramp lesions have shown the shortcomings of conventional MRI in detecting specific tear patterns. According to Nonaka et al., MRI at the flexed-knee pose had better sensitivity and specificity to detect meniscal ramp lesions than near-extension MRI.¹⁴ According to Escoda Menendez et al., sensitivity of MRI in meniscal ramp lesions is 88 and specificity is 87 with PPV of 94 and NPV of 74.¹⁵ Moteshakereh et al. reported that MRI demonstrated moderate diagnostic accuracy with ramp lesions in ACL-injured knees and suggested that arthroscopy should be used when the suspicion is high.¹⁶ Equally, D'Ambrosi et al. cited low sensitivity with good specificity of MRI in pediatric and adolescent patients with ramp lesions.¹⁸ Such results justify why even though the overall MRI can seem high, there can be false-negative results. According to Zappia et al., the MRI performance of ramp-area lesions was high, accompanied by high sensitivity, specificity and inter-reader agreement.¹⁷ Conversely, Yasuma et al. found that medial meniscal ramp lesions were hard to diagnose using preoperative MRI, and a system of arthroscopic exploration was necessary.²⁰ This comparison demonstrates that the type of lesion, imaging plane, radiologist experience, and

arthroscopic reference method are the strongest determinant of MRI performance. Van Dyck et al. compared the discordant results of 3T MRI and arthroscopy and highlighted that a discrepancy can be caused by delicate tears, inter-interval progression, interpretation and arthroscopic visualization.²¹ The present study observed 13 false-positive and 8 false-negative cases; all of which can be explained by these explanations.

The stratification used in the current study indicated that there was more or less the same accuracy of the MRI among both sexes with the prizes having 86.87 and 85.96 respectively. The younger age group 1830 years old exhibited a relatively high accuracy, and on the other failed by age. This could be because more degenerative meniscal signal is observed with increased age which can be confounded by tears and low specificity. Hohmann et al. reported that degenerative meniscal tears are prevalent among the elderly patients and such decisions must be made on the basis of the symptoms, mechanical complaints in conjunction with clinical correlation and not using imaging as an isolated method of finding the best treatment.²² The current results hence advise the cautious use of MRI on elderly patients. There is emerging evidence of newer MRI methods and artificial intelligence-enhanced reconstruction, which can be faster and have better images, but still have to be clinically compared to arthroscopy. According to Vosshehrich et al., accelerated deep-learning super-resolution knee MRI works well in their diagnoses (according to the arthroscopy), and the study involved children and adolescents.²³ Walter et al. also reported that deep-learning super-resolution MRI was able to improve the quality of images and did not deteriorate performance in meniscal and ligament tear detection.²⁴ These works provide us with a vision of a possibility of quicker and more efficient MRI protocols in the future, but the use of expert radiological interpretation and clinical correlation is necessary. All in all, the current study revealed that MRI was very sensitive and at the same time, highly diagnostic in revealing meniscal injuries. The outcomes were widely similar to the most current PubMed-indexed articles, especially those showing that MRI yields an approximate of 81% to 92%.¹¹⁻¹³ The lack of specificity and the occurrence of false-negative cases, however, suggested that MRI would not be an isolated interpretation. Arthroscopy is the gold standard particularly in patients who might have sustained symptoms, suspected ramp lesions, root tear, complex tear or discordance between clinical and MRI results. Limitations: There were certain limitations in this study. It has been performed in one center only and therefore it might not be applicable to other clinical settings. The study had a small sample (156 patients) that may not clearly represent the rest of the population with meniscal injuries. Interpretation of

MRI could be affected by experience of radiologists, and even the arthroscopic results could have been different depending on how the surgeon evaluated it. The researchers assessed the general meniscal injury and have not calculated diagnostic accuracy for each tear pattern (root tears, ramp lesions, complex tears, and degenerative tears) separately. Additionally, the duration between MRI and arthroscopy could have influenced the results in case the lesion developed in the meantime.

CONCLUSION:

MRI was found to provide high sensitivity and overall diagnostic accuracy of detecting meniscal injury. It emerged to be a convenient non-invasive test to patients with clinical suspicion of meniscal tear. Nonetheless, since false-positive and false-negative results were detected, MRI results are to be interpreted together with clinical studies. So we recommend that MRI as a useful non invasive test while retaining arthroscopy for persistent or discordant cases.

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Authors Contribution:

Raahima Khan: Conception and design, acquisition of data analysis and interpretation of data, drafting and critical revision, final approval of the version to be published.

Khalid Farooq: Conception and design, acquisition of data analysis and interpretation of data, drafting and critical revision, final approval of the version to be published

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