# Accuracy of MRI Scanning for the Diagnosis of Meniscus Tears Associated with Knee Osteoarthritis

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## Abstract

**Objective:** To assess the validity of magnetic resonance imaging for the identification of meniscus tears related to knee osteoarthritis by taking arthroscopy as a reference standard.

**Methodology:** From August 2018 to August 2021, cross-validation research was conducted in the radiology department of Memon Medical Institute Hospital Karachi. A total of 147 patients with knee joint pain were selected and referred to MRI knee. MRI knee without contrast including proton density (PD) and fat saturation (Fat Sat) sequences was performed. The absence of an intrameniscal high signal was considered evidence of a normal meniscus. Grade 1 and grade 2 meniscal degeneration were considered positive if an intrameniscal high signal was present but did not advance toward the articular surface, but grade 3 meniscus tears were considered positive if an intrameniscal high signal intensity reached the articular surface. All patients were then assessed by arthroscopy. MRI results were compared with arthroscopic results in every patient. Data regarding age, gender, site, type and grade of tear with the final diagnosis were noted on proforma. SPSS version 25 was used to analyse the data.

**Results:** For MRI, the sensitivity was assessed to be 82.7%, the specificity to be 93%, the positive predictive value to be 93.5%, the negative predictive value to be 81.6%, and the accuracy to be an estimated 87.4%. For lateral meniscus tears, the sensitivity and specificity of MRI were 90% and 100%. The sensitivity and specificity of MRI in evaluating medial meniscus tears were 84% and 95%, respectively. However, the sensitivity and specificity of MRI for the detection of bilateral meniscal lesions were low such as 60% and 67%.

**Conclusion:** MRI can be utilized as a diagnostic modality for meniscus tears. Furthermore, pre-operative MRI is accurate to diagnose lateral and medial meniscal tears. However, it is not highly accurate in diagnosing bilateral meniscal tears.

**Keywords:** Osteoarthritis, meniscus tear, magnetic resonance imaging, tibio-femoral compartment

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## Introduction

The menisci of the knee are intricate anatomical structures that serve a number of roles in the knee. In the long run, meniscal loss raises the risk of developing degenerative osteoarthritis[1]. In osteoarthritis, assessing cartilage destruction is important for monitoring disease progression and

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evaluating therapeutic response[2]. Given that a reliable, accurate, and easily reproducible technique is used, a series of radiographs of afflicted joints appears to be a plausible way for documenting the disease progression over time[3]. Clinical signs and symptoms might help in diagnosis, but they can sometimes be deceiving and insufficient. As a result, meniscal injury must be confirmed with arthroscopy or MRI[3].

A non-invasive, high-resolution imaging method utilised in musculoskeletal imaging is magnetic resonance imaging (MRI)[4]. MRI can help in identifying and confirming the meniscal lesion, as well as determining its extent, type, relationship with a cyst, meniscal extrusion, and analysing subchondr-

al and cartilage bone[5]. MRI of the menisci has been acknowledged as useful during the last ten years, owing to its sensitivity (Sn) and accuracy for meniscal tears, which range from 90% to 95%[6-8]. A meta-analysis showed the overall Sn of MRI for the identification of meniscal tears was 92% and specificity (Sp) was 90%[9].

However, there are inconsistent findings in the literature when it comes to the usage of MRI[9,10]. Even though an MRI revealed a meniscal rupture, knee arthroscopy was not required if the patient had no clinical complaints[10,11]. In many cases, relying solely on an MRI without considering clinical judgement might have led to suboptimal treatment. Under no circumstances MRI did not prevent "unnecessary surgery"[10].

Arthroscopy, on the other hand, is an intrusive procedure that necessitates anaesthesia, hospitalization, as well as some risks, can be excruciating for some individuals, and considered as a reference standard for the identification of internal knee pathologies. Given the availability of other non-surgical diagnostic technologies such as MRI, it is proposed that arthroscopy be used for treatment objectives[11]. However, arthroscopic intervention has several lethal complications like deep vein thrombosis, pulmonary embolism, and pyogenic arthritis, and that is why its utilization should be carefully implemented and guidance should be given according to proper indications[12]. Therefore, the focus of this study was to assess the validity of magnetic resonance imaging for the identification of meniscus tears associated with knee osteoarthritis by taking arthroscopic findings as reference-standard. This study would help in deciding whether non-invasive procedure is reliable or can be used for definite diagnosis in future in place of knee arthroscopy.

**Patients and Methods**

This was a cross-validation study that was conducted in the department of radiology of Memon Medical Institute Hospital (MMIH) Karachi from August 2018 to August 2021. Sample size of 138 was estimated using sample size calculator by Dr. Lin Naing for diagnostic accuracy by taking statis-

tics of Sn and Sp of MRI for lateral meniscus as 87.5%[13] and 88.23%[13], prevalence of lateral meniscal injuries as 31.3%[14], margin of error for Sn as 8% and margin of error for Sp as 7.8%. Patients of age more than 25 years, of either gender diagnosed having osteoarthritis of knee on knee X-ray and referred to the hospital for MRI knee were included in the study using non-random purposive sampling method. Patients with joint diseases, e.g. rheumatoid arthritis or past knee surgeries, females with hyperparathyroidism, hormonal replacement therapy, systemic lupus erythematosus (SLE) and haemochromatosis were excluded from the study. Ethical review committee approved this study, and written, informed consent was obtained from all the eligible patients before data collection.

MRI knee without contrast including proton density (PD) and fat saturation (Fat Sat) sequences were taken. MRI results for meniscal and ligamentous wounds were assessed using MRI grading system[15] by a consultant radiologist. MRI knee without contrast including proton density (PD) and fat saturation (Fat Sat) sequences was performed. Absence of an intrameniscal high signal was considered evidence of a normal meniscus. Grade 1 and grade 2 meniscal degeneration were considered positive if an intrameniscal high signal was present but did not advance toward the articular surface, while grade 3 meniscus tears were considered positive if an intrameniscal high signal intensity reached the articular surface. All patients were then assessed on arthroscopy (reference sta-ndard). MRI results were compared with arthroscopic results in every patient. An orthopaedic surgeon having experience of more than 5 years performed the arthroscopy using 70° angled arthroscope. Data regarding age, gender, site, type and grade of tear with final diagnosis were noted on pre-designed proforma.

Data was analyzed using SPSS version 20 and MedCalc statistical software. Numeric data like age was presented as mean and SD, whereas categorical data like gender, affected knee, grade, location of tear and findings on MRI and arthroscopy were presented as frequency and percentage. Foll-

owing criteria was used to assess true negative (TN), true positive (TP), false negative (FN) and false positive (FP) cases.

TP= Positive findings i.e. tear on both MRI and arthroscopy

TN= Negative findings i.e. no tear on both MRI and arthroscopy

FP= Tear reported on MRI but there was no tear detected on arthroscopy

FN= No tear reported on MRI but there was tear detected on arthroscopy

Sn, Sp, positive predictive value (PPV), negative predictive value (NPV) and accuracy were estimated for MRI by taking arthroscopy as reference-standard. Agreement between MRI and arthroscopy was assessed using Kappa-statistics and p≤0.05 was considered as statistically significant.

**Results**

One hundred and thirty-eight patients were diagnosed with knee osteoarthritis and referred for MRI for the assessment of meniscus tear. Thirty-one patients did not give consent for MRI and in 12 patients arthroscopy was not performed. In final analysis, 95 patients were included in the analysis. The mean age of the patients was 55.62 ± 9.97 years (range: 33 to 71 years). About 55 patients were males (57.9%) and 40 were females (42.1%). In 57 patients, there was right knee involvement (60%), while in 34 patients left knee was affected (35.8%),. (Table 1) The STARD patient flow chart is displayed in Figure 1.

Out of 95 patients, grade 3 meniscus tear was identified on MRI in 43 patients (45.2%), while grade 2 signals were detected in 3 patients (2.1%), respectively. In 46 patients with meniscus tear (grade 3), 33 cases had medial meniscus involved, 9 had lateral meniscus involvement and 4 had bilateral meniscus lesions. There were 27 lesions present in posterior site, 10 lesions in body site, 8 lesions in anterior horn and 1 lesion in root site respectively.

Of 95 patients on arthroscopy, there were 52 positive findings for meniscus tear (54.7%), 12 cases of degeneration (12.6%) and 31 cases of normal menisci (32.6%). In 52 patients with meniscus tear, 39 cases had medial meniscus, 10 patients had lateral meniscus and 3 had bilateral meniscus. The most common tibio-femoral compartment on arthroscopy was posterior site (n=35) followed by body site (n=8).

After labelling knees as "no tear" (grade II) and "meniscus tear" (grade III) on MRI, overall diagnostic accuracy for MRI for the detection of meniscus tears associated with knee osteoarthritis was estimated by taking arthroscopy as a reference standard. A Sn of 82.7% and Sp of 93% were calculated for MRI, while the PPV was 93.5% and the NPV was 81.6%, and accuracy was estimated to be 87.4%. The kappa value between arthroscopic and MRI findings was 0.75, indicating good agreement (*p* = 0.001). (Table 2)

The Sn and Sp of MRI were 90% and 100%, respectively, with an accuracy of 91% for lateral meniscus injuries. The PPV and NPV values were 100% and 50%, respectively, showing that MRI had a greater Sp and PPV than Sn or NPV in the diagnosis of lateral meniscus injury. For lateral meniscus injuries, the kappa value between arthroscopic and MRI findings was 0.62, suggesting moderate agreement (p = 0.026). In the detection of medial meniscus tears, the PPV and NPV of MRI were 94% and 86%, respectively, but the Sn and Sp were 84% and 95% with an accuracy of 89.5%, showing that MRI had better Sp and PPV than Sn and NPV. The kappa value between arthroscopic and MRI findings for medial meniscus tears was 0.79, indicating good agreement (p = 0.001). However, the Sn and Sp of MRI for the detection of bilateral meniscal lesions were low such as 60% and 67% and the kappa value is 0.25, indicating poor agreement between arthroscopic and MRI findings. (Table 3)

**Table 1.** Baseline characteristics of included patients (n=95)

| Age in years | 55.6±9.97 |
|---|---|
| **Gender** | |
| Female | 40 (42.1) |
| Male | 55 (57.9) |
| **Osteoarthritis with meniscal tear in affected knee** | |
| Right knee | 57 (60) |
| Left knee | 34 (35.8) |
| Both knees | 4 (4.2) |

Data presented as mean ± SD, n(%)
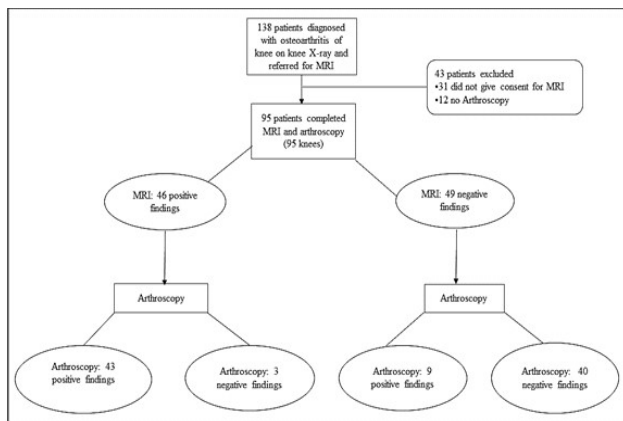


**Fig 1.** Flow chart of the included study participants from diagnosis till arthroscopy

**Table 2.** Validity of MRI for the identification of meniscus tears associated with knee osteoarthritis by arthroscopy as reference standard (n=95)

| | Arthroscopy | | Statistics |
|---|---|---|---|
| **MRI** | **Tear** | **No tear** | Sn= 83%,Sp=93%, |
| **Tear** | 43 (93.5%) | 3 (6.5%) | PPV=93.5%,NPV=82%, |
| **No tear** | 9 (18.4%) | 40 (81.6%) | Accuracy=87% |
| **Total** | 52 | 43 | |

**Table 3.** Validity of MRI for the detection of location meniscus tears associated with knee osteoarthritis by arthroscopy as reference standard (n=95)

| Location | MRI | Arthroscopy Tear | No tear | Statistics |
|---|---|---|---|---|
| Lateral meniscus (n=11) | Tear | 9(100%) | 0 | Sn=90%,Sp=100%,PPV=100%, |
| | No Tear | 1(50%) | 1(50%) | NPV=50%, Accuracy=91% |
| Medial meniscus (n=76) | Tear | 31(93.9%) | 2(6.1%) | Sn=84%,Sp=95%,PPV=94% |
| | No tear | 6(13.9%) | 37(86.1%) | NPV=86%, Accuracy=89.5% |
| Bilateral meniscal lesions n=8) | Tear | 3 (75%) | 1(25%) | Sn=60%,Sp=67%,PPV=75%, |
| | No tear | 2 (50%) | 2(50%) | NPV=50%, Accuracy=63% |

## Discussion

Menisci are the integral and fundamental part of the knee joint acting as shock absorbers and load bearers. Tears in the meniscus are prevalent, resulting in extrusion, displacement and narrowing of interarticular space[3.] Arthroscopy is one of the most common methods used to assess the meniscus tear; however recent trials have indicated no added advantage of arthroscopy when compared with non-surgical interventions[3,6]. Moreover, the criteria for the diagnosis of meniscal tear are not well defined and provision differs widely among regions of the same country. Recently, MRI is gaining popularity for the diagnosis of meniscal tears in symptomatic as well as asymptomatic individuals[3, 5, 13, 16]. Knee osteoarthritis is usually found in asymptomatic individuals using MRI; however, its prevalence differs significantly between studies[3, 5, 13, 16]. Thus, in the present study we aimed to assess the validity of MRI for the diagnosis of meniscus tears associated with knee osteoarthritis by taking arthroscopy as the reference standard.

The age range of our patients was between 33-71 years. A meta-analysis also revealed that the frequency of knee osteoarthritis increases with age and is more common in middle and older age groups[17,18]. Concerning gender, we found majority of the patients were males 58% and rest were females. Similar findings were reported in previous studies, most of the patients were males[3,6,16,18]. This may be because males are more likely to have knee injuries during daily activities and sports, but women are more likely to get meniscal degeneration caused by weight bearing owing to obesity[19,20].

Our study showed that MRI can be used as a diagnostic tool. The overall accuracy of MRI was 87%, Sn was 83% and Sp was 93% for the diagnosis of meniscus tears associated with knee osteoarthritis. We also found a good agreement between MRI and arthroscopic findings. Results of a meta-analysis of 17 studies showed that the overall Sn of MRI for the diagnosis of meniscal tears was 92% and Sp was 90%[9]. Another study showed that the Sp and Sn of MRI for diagnosis of meniscal tears range from 82% to 96%[21]. The differences in the results could be because of the different study populations and sample sizes.

For the diagnosis of lateral meniscus tears, we found MRI scanning was 90% sensitive and 100% specific. Concerning the medial meniscus, the Sn and Sp of MRI were 84% and 95% respectively. We found a good agreement between MRI and arthroscopic findings for medial meniscus tears, whereas moderate and poor agreement between MRI and arthroscopic findings for lateral and bilateral meniscal tears were observed. The results of our study are comparable to numerous studies[22-24]. In a study conducted by Kim et al.[3], the diagnostic accuracy of an MRI scan was 85.8% whereas, in our study, the diagnostic accuracy was slightly higher for lateral and medial meniscus, but lower for bilateral meniscus. A meta-analysis included nineteen studies for lateral and medial meniscal tears. The overall results showed 87% Sn and 93% Sp for diagnosis of the medial meniscus with MRI which varies from our study results whereas, for lateral meniscus tears, the Sn and Sp are lower than our study results[25]. Another study conducted by Krakowski P et al. showed 95.6% Sn for medial meniscus tears[11]. Ahmed et al. found accuracy, Sn, Sp, PPV, and NPV of MRI as 90%, 96%, 50%, 87% and 88.4% for the diagnosis of medial meniscus tears. While, for lateral meniscus signals, the accuracy, Sn, Sp, PPV, and NPV of MRI were 87%, 85%, 88%, 92%, and 83%, respectively.[16] Yaqoob et al. also conducted a similar study and reported the accuracy, Sn, Sp, PPV, and NPV of MRI for medial meniscus as 95%, 88%, 100%, 100%, and 90%, while for lateral meniscus signals, as 93%, 95%, 86%, 95%, and 86%, respectively.[7] Yoon KH et al. conducted a similar study and found 74% Sn of MRI. However, the study included knee injuries with hemarthrosis whereas our study included patients with meniscal tears.[26] It is also noteworthy that location plays an important role in diagnosis. Firm evidence has been established regarding the lower accuracy of MRI in diagnosing lateral meniscal tears[9,16]. In our study bilateral meniscus tear was 63% accurately diagnosed using MRI.

Our study has several limitations; the sample size was small. Hence, the generalizability of results is still questionable. Although literature has favoured using MRI scans as diagnostic tools, our study showed that MRI scans can be used for diagnosing lateral and medial meniscal tears. The bilateral meniscal tear will still require arthroscopy[22-24]. Based on our data, we recommend conducting further in-depth studies to find out the accuracy of MRI at different locations with an expanded sample size.

**Conclusion**

MRI can be utilized as a diagnostic modality for meniscus tears. Furthermore, pre-operative MRI is accurate to diagnose lateral and medial meniscal tears. However, it is not highly accurate in diagnosing bilateral meniscal tears.

**Conflict of Interest:**

Authors have no conflict of interest and no grant/funding from any organization

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