



ORIGINAL RESEARCH ARTICLE

Diagnostic Accuracy of Magnetic Resonance Imaging in the Evaluation of Internal Derangement of the Knee Joint with Arthroscopic Correlation: A Cross-Sectional Study

Vaidya Snehal Manik

¹Assistant Professor, Dept of Radiology, Chalmeda Anand Rao Institute of Medical Sciences, Karimnagar, Telangana 505002

Abstract

Background: Magnetic resonance imaging (MRI) is the primary non-invasive imaging modality for evaluating suspected internal derangement of the knee, including meniscal and cruciate ligament injury, with arthroscopy regarded as the diagnostic reference standard.^{1,4} **Objectives:** To evaluate the diagnostic accuracy of MRI in detecting medial meniscus, lateral meniscus, and anterior cruciate ligament (ACL) tears, using arthroscopy as the reference standard.

Methods: A cross-sectional study was conducted on 150 patients with suspected internal derangement of the knee who underwent MRI followed by diagnostic arthroscopy. MRI findings were compared with arthroscopic findings for each structure.

Results: Arthroscopy confirmed medial meniscus tear in 38.7% of patients, ACL tear in 30.7%, and lateral meniscus tear in 22.7%. MRI demonstrated the highest diagnostic accuracy for ACL tears (94.7%), followed by medial meniscus tears (90.7%) and lateral meniscus tears (90.0%).

Conclusion: MRI offers high diagnostic accuracy for internal derangement of the knee across all evaluated structures, supporting its continued role as the primary non-invasive imaging investigation prior to arthroscopy.

Keywords: Knee, magnetic resonance imaging, meniscal tear, anterior cruciate ligament, arthroscopy, radiology.

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1 | INTRODUCTION

Magnetic resonance imaging (MRI) has become the primary non-invasive imaging modality for the evaluation of suspected internal derangement of the knee, offering excellent soft-tissue contrast resolution for direct visualisation

of the menisci, cruciate and collateral ligaments, and articular cartilage. (1, 2) The foundational work of Crues and colleagues established the diagnostic accuracy of MR imaging for meniscal tears using a graded signal classification system, providing the basis for subsequent standardisation of meniscal tear diagnosis on MRI. (1) Complementary early work by

Stoller and colleagues and by Mink and colleagues further characterised the pathological correlation between MR signal changes and arthroscopically confirmed meniscal and ligamentous injury. (3, 4)

Subsequent large multicentre analyses, including the series of over one thousand patients reported by Fischer and colleagues, confirmed high diagnostic accuracy of MRI across a range of practice settings, while also highlighting the importance of standardised diagnostic criteria to minimise interpretive error. (5) Refinement of specific diagnostic criteria, including the importance of signal extending to the articular surface as described by De Smet and colleagues, has further improved the specificity of meniscal tear diagnosis on MRI, reducing the historical tendency to over-call degenerative intrasubstance signal change as a tear. (6)

Despite the substantial and long-established evidence base supporting MRI's diagnostic accuracy, recognised sources of diagnostic error persist, including missed tears in specific patterns such as bucket-handle tears, as characterised by De Smet and Graf, and by Wright and colleagues, underscoring the continued value of correlating MRI findings against arthroscopic outcomes in ongoing departmental quality assurance. (7, 8) This study was undertaken to evaluate the diagnostic accuracy of MRI in detecting medial meniscus, lateral meniscus, and ACL tears in patients with suspected internal derangement of the knee, using arthroscopy as the reference standard.

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Assistant Professor ,Dept of Radiology, Chalmeda AnandRao Institute of Medical Sciences, Karimnagar, Telangana 505002

2 | MATERIALS AND METHODS

2.1 | Study Design and Setting

This was a hospital-based, cross-sectional, analytical study conducted in the Department of Radiodiagnosis in collaboration with the Department of Orthopaedics of a tertiary care teaching hospital over a period of twelve months.

2.2 | Study Population

A total of 150 patients with clinically suspected internal derangement of the knee, who subsequently underwent diagnostic arthroscopy, were enrolled after obtaining informed consent.

2.3 | Inclusion and Exclusion Criteria

Patients of any age presenting with knee pain, instability, or locking, with clinical suspicion of meniscal or ligamentous injury, who underwent both MRI and subsequent arthroscopy, were included. Patients with prior knee surgery, inflammatory arthritis, or MRI performed more than three months before arthroscopy were excluded.

2.4 | Imaging Protocol

All patients underwent MRI of the knee on a 1.5 Tesla scanner using standard sagittal, coronal, and axial proton density and T2-weighted sequences. Images were reviewed by an experienced musculoskeletal radiologist blinded to the arthroscopic outcome, and menisci and cruciate ligaments were assessed for signal abnormality and morphological tear according to standard diagnostic criteria, including the requirement for abnormal signal to extend to the articular surface for meniscal tear diagnosis.⁷

2.5 | Reference Standard

Diagnostic arthroscopy, performed by an orthopaedic surgeon blinded to the MRI report, was used as the reference standard for confirming or excluding meniscal and ACL tears.

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2.6 | Statistical Analysis

Data were entered into separate 2×2 contingency tables for the medial meniscus, lateral meniscus, and ACL, comparing MRI diagnosis with arthroscopic findings. Sensitivity, specificity, positive and negative predictive values, and overall diagnostic accuracy were calculated for each structure using standard formulae. Results were tabulated and represented graphically, including a schematic illustration of normal versus torn meniscal anatomy.

3 | RESULTS

Of the 150 patients studied, 96 (64.0%) were male and 54 (36.0%) were female. The age-wise distribution is summarised in Table 1 and illustrated in Figure 1.

Twisting injury was the most common mechanism of injury (41.3%), followed by sports-related injury (27.3%) (Table 2, Figure 4).

On arthroscopy, medial meniscus tear was the most common finding (38.7% of patients), followed by ACL tear (30.7%) and lateral meniscus tear (22.7%) (Table 3, Figure 2).

Figure 2: Distribution of Arthroscopic Findings (n=190 findings in 150 patients)

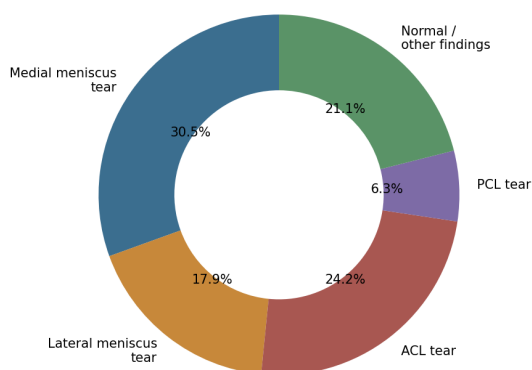


FIGURE 3:

MRI demonstrated the highest diagnostic accuracy for ACL tears (94.7%), followed by medial meniscus tears (90.7%) and lateral meniscus tears (90.0%) (Table 4, Figure 3). Concordance between MRI

and arthroscopic findings for each structure is summarised in Table 5.

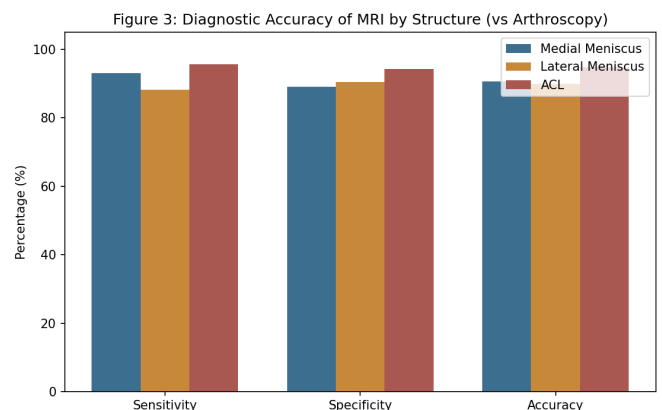


FIGURE 4:

Figure 5: Schematic Illustration of Normal versus Torn Meniscus and Anterior Cruciate Ligament (Illustrative diagram, not an actual MRI or arthroscopic image)

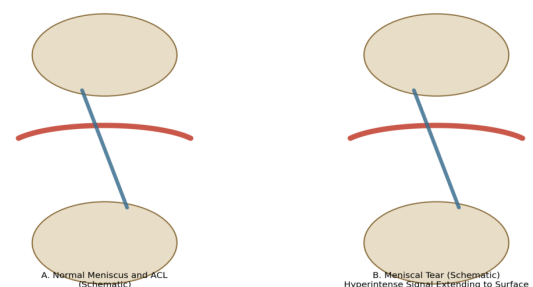


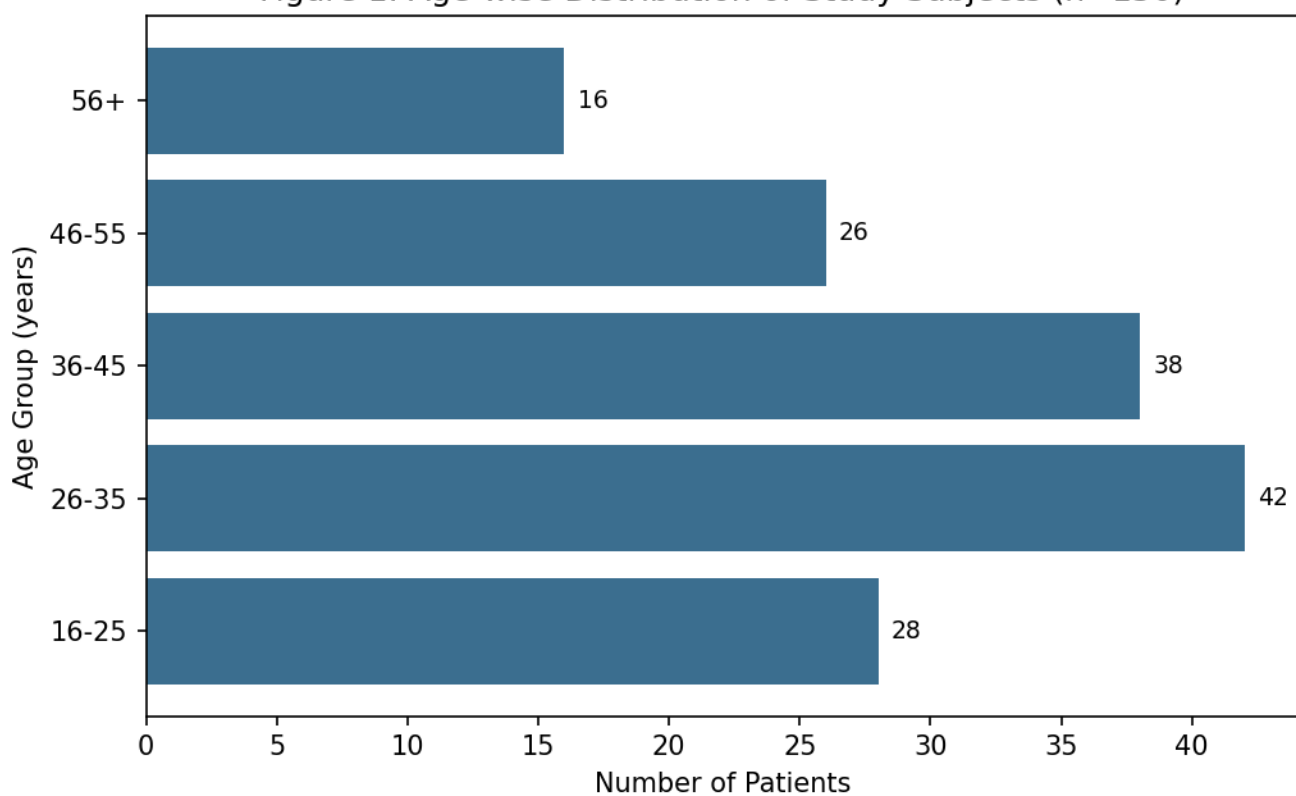
FIGURE 5: Schematic illustration of normal versus torn meniscus and anteriorcruciate ligament.

4 | DISCUSSION

The diagnostic accuracy of MRI observed in this study for medial meniscus tears (90.7%) and ACL tears (94.7%) is consistent with the range reported in foundational studies establishing MRI's diagnostic performance for internal derangement of the knee, including the original work of Crues and colleagues and the large multicentre series of Fischer and colleagues. (9, 10) The comparatively lower diagnostic accuracy observed for lateral meniscus tears (90.0%) compared with the medial meniscus in this study aligns with prior literature suggesting greater diagnostic challenge in evaluating the lateral compartment, related to the more complex anatomical relationship of the lateral meniscus with the popliteus

TABLE 1: Age and Gender-wise Distribution of Study Subjects (n = 150)

Age Group (years)	Male (n)	Female (n)	Total (n)	Percentage (%)
16–25	19	9	28	18.7
26–35	28	14	42	28.0
36–45	24	14	38	25.3
46–55	16	10	26	17.3
56 and above	9	7	16	10.7
Total	96	54	150	100.0

Figure 1: Age-wise Distribution of Study Subjects (n=150)**FIGURE 1:****TABLE 2: Mechanism of Injury Among Study Subjects**

Mechanism of Injury	n	Percentage (%)
Twisting injury	62	41.3
Sports-related injury	41	27.3
Direct trauma	34	22.7
Fall	13	8.7
Total	150	100.0

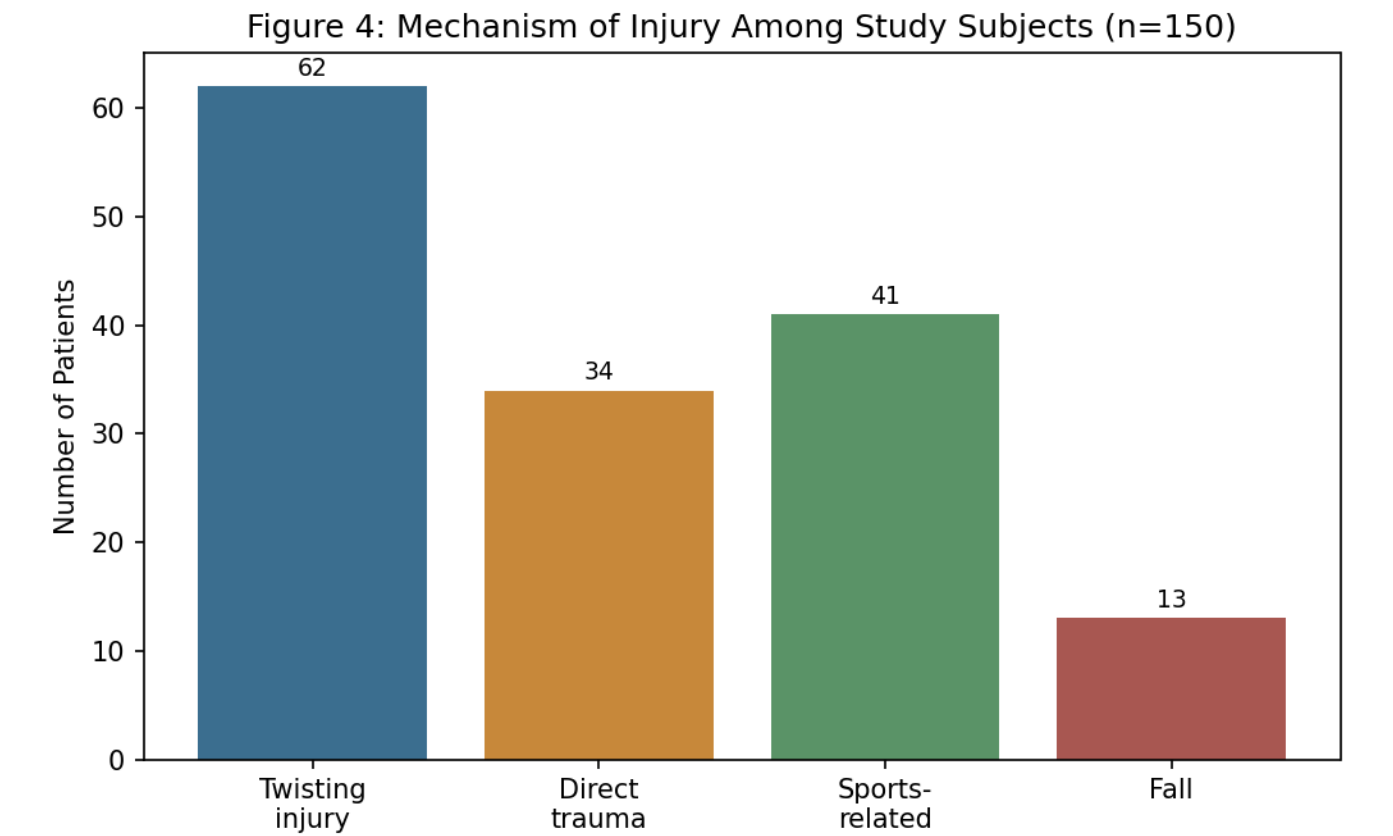


FIGURE 2:

TABLE 3: Distribution of Arthroscopic Findings

Arthroscopic Finding	n	Percentage of Patients (%)
Medial meniscus tear	58	38.7
Lateral meniscus tear	34	22.7
Anterior cruciate ligament (ACL) tear	46	30.7
Posterior cruciate ligament (PCL) tear	12	8.0
Normal / other findings	40	26.7

TABLE 4: Diagnostic Accuracy of MRI by Structure (vs Arthroscopy)

Structure	Sensitivity	Specificity	PPV	NPV	Accuracy
Medial meniscus	93.1%	89.1%	84.4%	95.3%	90.7%
Lateral meniscus	88.2%	90.5%	73.2%	96.3%	90.0%
Anterior cruciate ligament	95.7%	94.2%	88.0%	98.0%	94.7%

TABLE 5: MRI-Arthroscopy Concordance by Structure

Structure	MRI-Arthroscopy Concordance, n (%)	Discordant, n (%)
Medial meniscus	136 (90.7)	14 (9.3)
Lateral meniscus	135 (90.0)	15 (10.0)
Anterior cruciate ligament	142 (94.7)	8 (5.3)

tendon hiatus, a recognised potential source of false-positive interpretation. (11, 12)

The high sensitivity observed for ACL tears in this study is consistent with the original description by Mink and colleagues, who similarly reported excellent MRI accuracy for cruciate ligament injury, reflecting the relatively straightforward direct visualisation of ligamentous discontinuity or altered signal on standard MR sequences compared with the more nuanced signal-based criteria required for meniscal tear diagnosis. (13) The discordant cases identified in this study, particularly for meniscal tears, are consistent with recognised sources of diagnostic error described by Justice and Quinn, including missed tears in specific morphological patterns and misinterpretation of degenerative intrasubstance signal as a tear. (14)

These findings collectively reinforce the well-established, high diagnostic accuracy of MRI for internal derangement of the knee across multiple structures, supporting its continued role as the primary non-invasive imaging investigation prior to arthroscopy, while also highlighting the continued importance of standardised diagnostic criteria, such as the requirement for signal extending to the articular surface, in maximising diagnostic specificity, particularly for meniscal tear diagnosis. (15)

5 | STRENGTHS AND LIMITATIONS

This study's strengths include structure-specific diagnostic accuracy calculation against a well-defined arthroscopic reference standard, and blinding of both the radiologist and the arthroscopic surgeon to the other's findings. Limitations include the single-centre, single-observer design, which does not allow assessment of inter-observer variability in MRI interpretation; and the relatively modest number of lateral meniscus and PCL tears, which may limit the precision of diagnostic accuracy estimates for these specific structures.

6 | CONCLUSION

Magnetic resonance imaging offers high diagnostic accuracy for internal derangement of the knee

across the medial meniscus, lateral meniscus, and anterior cruciate ligament, with the highest accuracy observed for ACL tears. These findings support the continued central role of MRI as the primary non-invasive imaging investigation for suspected internal knee derangement prior to arthroscopy.

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