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Comparative evaluation of magnetic resonance arthrogram with arthroscopy in knee pathologies

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ABSTRACT

Background: Magnetic resonance arthrogram (MRA) has emerged as a supplement to non-contrast magnetic resonance imaging (MRI), especially in the identification of meniscal and chondral pathologies. It has increased the diagnostic efficacy of MRI in the evaluation of knee pathologies. **Aims and Objectives:** The present study was carried out to evaluate the role of MRA in the diagnosis of various knee pathologies and to correlate its findings with arthroscopy. **Materials and Methods:** A total of 56 patients with knee pain scheduled to undergo arthroscopic evaluation were enrolled in the study and were assessed using MRA before arthroscopy. MRA findings were correlated with arthroscopic findings. The level of agreement was measured using kappa statistics. Diagnostic efficacy was assessed in terms of sensitivity, specificity, positive predictive value, and negative predictive value. **Results:** Cartilage involvement (48.2%), anterior cruciate ligament (ACL) tear and medial meniscus tear (37.5% each), bony injury (n = 12; 21.4%), chondral defect (n = 11; 19.6%), posterior cruciate ligament tear (n = 10; 17.9%), and lateral meniscus tear (n = 8; 14.3%) were the knee pathologies confirmed by arthroscopy. MRA had a sensitivity and specificity of 100% for pathologies such as ACL tear, lateral meniscus tear, medial meniscus tear, and bony injury. It was 100% specific for all the pathologies with no false positive detection. There was a strong to perfect agreement between MRA and arthroscopic findings for different knee pathologies. **Conclusion:** The present study found MRA to be a highly specific diagnostic tool for the diagnosis of different knee pathologies and it is useful in reducing the burden of undesired invasive arthroscopies.

Key words: MR arthrogram; Arthroscopy; Meniscal injury; Chondral pathology

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INTRODUCTION

Knee pain is among the most common musculoskeletal problem having a huge impact on the quality of life.[1,2] It is one of the most common causes of disability among adults.[3,4] At a particular time, nearly 25% of the adult population have complaints of knee pain for various reasons.[5] Assessment of knee pain and knowing the exact underlying etiology are important for deciding appropriate treatment. A skillful physical examination has to be done. This has to be followed by imaging, namely, standard radiography, ultrasound, bone scintigraphy, computed tomography (CT) scan, arthroscan, magnetic resonance imaging (MRI), and arthro-MRI. Each of these modalities has its own advantages as well as disadvantages.

Conventional radiography is useful in ruling out serious knee pathologies such as fractures, advanced degenerative changes, and neoplasms. However, it is not an imaging modality of choice for evaluation of the cruciate and collateral ligaments, the menisci, and the hyaline cartilage of the knee. Ultrasonography is highly efficient in the evaluation of periarticular soft tissue. However, it is highly operator-dependent.[6] CT detects the fractures and helps to provide better details. However, its usefulness is limited to traumatic bony injuries and it is considered less informative for the evaluation of degenerative pathologies involving soft tissue.[7,8] MRI has proven high efficiency in evaluating suspected meniscal and ligamentous injuries. Apart from being non-invasive, MRI, unlike CT, does not use ionizing radiation, provides multiplanar images, and provides

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illustrative images of soft-tissue structures that are difficult to obtain using other imaging modalities. Direct magnetic resonance arthrography (MRA) is an imaging examination that combines the injection of saline or dilute gadolinium solution into an articulation, followed by MR imaging of that articulation. MRA has increased the diagnostic efficacy of MRI in the evaluation of knee pathologies. It is a superior alternative for the assessment of underlying knee pathologies with results more or less comparable to arthroscopic evaluation which is an invasive one. Hence, the present study was planned to compare MRA with arthroscopy in the diagnosis of various knee pathologies.

Aims and objectives

The present study was carried out to evaluate the role of MRA in the diagnosis of various knee pathologies and to correlate its findings with arthroscopy.

MATERIALS AND METHODS

Study design

This was a comparative study

Study population

Data for the study were collected from the patients who present to OPDs with a history of shoulder pain and were referred to the Department of Diagnostic Radiology at Aarupadai Veedu Medical College and Hospital, over a period of 2 years.

Period of study

The period of study was October 2020–October 2022.

Place of study

The study was placed at the Department of Radiology, Aarupadai Veedu Medical College and Hospital, Puducherry.

Study procedure

Patients above 18 years of age presenting with a history of knee pain to orthopedics OPD and planned for arthroscopy were enrolled and MRA was performed in them. Patients who had previously undergone arthroscopy with the repair of the menisci and ligaments and also patients with any previous surgery to the knee were excluded from the study. MR arthrography was performed with approximately 25 mL of a dilute gadolinium solution and saline to prepare a contrast mixture by dissolving 0.15 mL of gadolinium in 20 mL of normal saline. A 22-gauge needle was placed beneath the center of the articular surface of the patella. MR arthrography was performed in all patients immediately after conventional MR imaging. All injections were placed successfully within the joint space. After the injection of the contrast mixture into the knee joint, the knee was exercised. All patients exercised the knee by actively extending and bending the knee continuously for 5 min while seated before repeat imaging. Before and after exercise, T1-weighted, fat-saturated coronal, sagittal, and axial MR images were obtained for comparison. MRA imaging of that joint was performed using a 1.5 Tesla MRI machine. Features such as cartilage involvement, anterior cruciate ligament (ACL) tear, posterior cruciate ligament (PCL) tear, lateral meniscus involvement, medial meniscus involvement, bony injury, and chondral defects were noted and compared with the findings of arthroscopy done later on, in that same joint in orthopedics department.

Statistical analysis

The statistical analysis was done using Statistical Package for Social Sciences Version 21.0 Statistical Analysis Software.

RESULTS

In total 56 patients, the age of patients ranged from 19 to 68 years. The mean age of patients was 44.93±15.68 years. Majority (55.4%) of patients were <50 years of age. More than two-thirds (69.6%) of patients were males. The sex ratio (M: F) of the study population was 2.29:1. Majority of patients had traumatic injuries (83.9%). Proportion of those having traumatic etiology was higher in males (n=35/39; 89.7%) as compared to that in females. However, no significant difference in age and injury type was observed between the two sexes. Majority of patients had acute complaints (<6 weeks) (71.4%). Comorbidities were seen in 25 (44.6%) cases. Hypertension (26.8%) and diabetes (12.5%) were the most common comorbidities which are not of any significance. On MR arthrography, ACL tear and medial meniscus tear (n=21; 37.5% each) were the most common underlying pathologies, followed by cartilage involvement (n=15; 26.8%), bony injury (n=12; 21.4%), chondral defect and lateral meniscus tear (n=8; 14.3% each), and PCL tear (n=7; 12.5%), respectively (Table 1 and Figure 1).

On arthroscopy, cartilage involvement (n=27; 48.2%) was the most common finding, followed by ACL tear and medial meniscus tear (n=21; 37.5% each), bony injury (n=12; 21.4%), chondral defect (n=11; 19.6%), PCL tear

Table 1: Magnetic resonance arthrogram findings

Finding	Number of cases (%)
Cartilage involvement	15 (26.8)
ACL tear	21 (37.5)
PCL tear	7 (12.5)
Lateral meniscus tear	8 (14.3)
Medial meniscus tear	21 (37.5)
Bony injury	12 (21.4)
Chondral defect	8 (14.3)

ACL: Anterior cruciate ligament, PCL: Posterior cruciate ligament

(n=10; 17.9%), and lateral meniscus tear (n=8; 14.3%), respectively (Table 2 and Figure 2).

For pathologies such as ACL tear, lateral meniscus tear, medial meniscus tear, and bony injury, MR arthrography had the same detection rate as for arthroscopy. MR arthrography underdetected 12 cases with cartilage involvement and 3 cases each with PCL tear and chondral defects, respectively. MR arthrography was 100% sensitive and 100% specific for the diagnosis of ACL tear, lateral meniscus tear, medial meniscus tear, and bony injury, respectively.

For cartilage involvement, the sensitivity, specificity, positive predictive, and negative predictive values of MRA were 55.6%, 100%, 100%, and 70.7%, respectively. For cartilage involvement, MRA was 78.6% accurate.

For PCL tears, the sensitivity, specificity, positive predictive, and negative predictive values of MRA were 70%, 100%, 100%, and 93.9%, respectively. For PCL tears, MRA was 94.6% accurate.

For chondral defects, the sensitivity, specificity, positive predictive, and negative predictive values of MRA were 72.7%, 100%, 100%, and 93.8%, respectively. For chondral defects, MRA was 94.6% accurate (Table 3 and Figure 3).

DISCUSSION

In recent years, MRA that employs the use of intra-articular contrast during magnetic resonance imaging helps to provide a superior alternative for the assessment of underlying knee pathologies with results almost comparable to arthroscopic evaluation. However, there are limited studies highlighting its clinical significance against invasive diagnostic modalities such as arthroscopy. Hence, the present study was planned to compare MRA with arthroscopy in the diagnosis of various knee pathologies.

The age of patients enrolled in the study ranged from 19 to 68 years. The mean age of patients was 44.93±15.68 years (Median age: 45 years). High variability in the age and sex profile of patients has been shown in different studies. Most of the previous studies similar to the present study showed a dominance of males. Cellar et al.,[9] in their study reported the mean age of patients as 41.7 years which is close to that in the present study; however, they had an equal representation of both males as well as females. Júnior et al.,[10] on the other hand reported a relatively younger age profile (mean age 34 years) and a higher dominance of males (84.7%). In the present study, the majority of patients had knee trauma (83.9%). There are previous studies that have exclusively included traumatic knee injury patients.[11-13] Some other workers have assessed

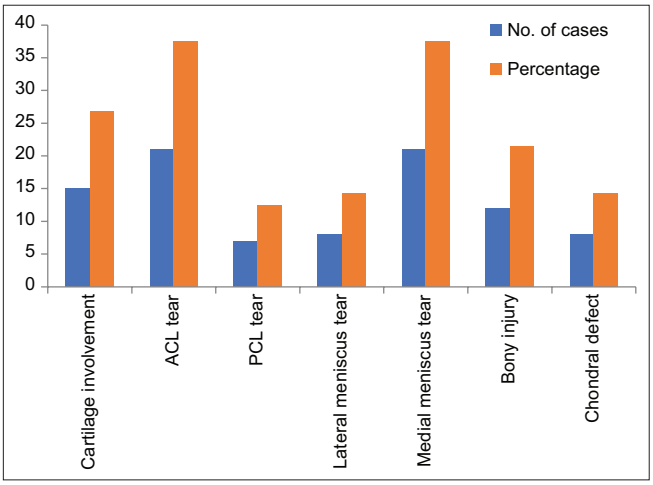

Figure 1: MR arthrogram findings

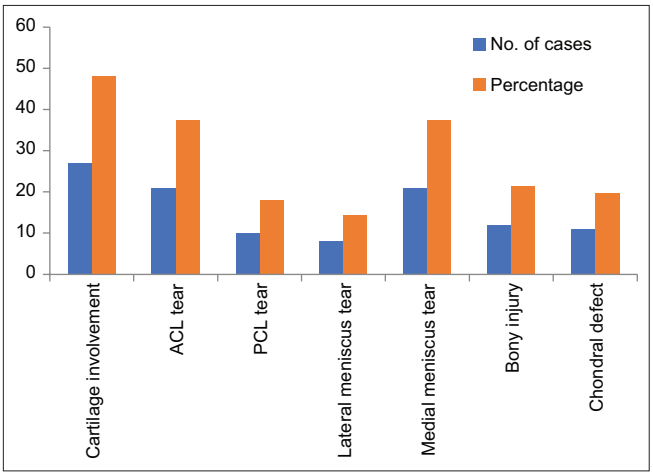

Figure 2: Arthroscopic findings

Table 2: Arthroscopic findings

Finding	Number of cases (%)
Cartilage involvement	27 (48.2)
ACL tear	21 (37.5)
PCL tear	10 (17.9)
Lateral meniscus tear	8 (14.3)
Medial meniscus tear	21 (37.5)
Bony injury	12 (21.4)
Chondral defect	11 (19.6)

ACL: Anterior cruciate ligament, PCL: Posterior cruciate ligament

the usefulness of MRI/MRA in post-surgical follow-up cases.[14]

In the present study, the most common MRA finding was ACL tear and medial meniscus tear (37.5% each), followed by cartilage involvement (26.8%), bony injury (21.4%), chondral defect and lateral meniscus tear (14.3% each), and PCL tear (12.5%). Siddiqui et al.,[12] who included all the cases with traumatic knee injury reported medial meniscus, lateral meniscus, and ACL injury as the most common

Table 3: Difference in number of different pathologies between magnetic resonance arthrogram and arthroscopy

Finding	MRA (%)	Arthroscopy (%)	Difference (%)	Direction of MRA findings
Cartilage involvement	15 (26.8)	27 (48.2)	12 (21.4)	Under
ACL tear	21 (37.5)	21 (37.5)	0	Same
PCL tear	7 (12.5)	10 (17.9)	3 (5.4)	Under
Lateral meniscus tear	8 (14.3)	8 (14.3)	0	Same
Medial meniscus tear	21 (37.5)	21 (37.5)	0	Same
Bony injury	12 (21.4)	12 (21.4)	0	Same
Chondral defect	8 (14.3)	11 (19.6)	3 (5.4)	Under

MRA: Magnetic resonance arthrogram, ACL: Anterior cruciate ligament, PCL: Posterior cruciate ligament

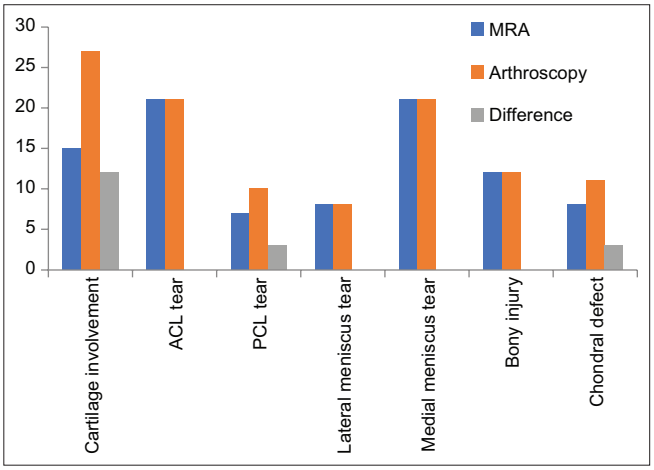

Figure 3: Difference in number of different pathologies between MRA and arthroscopy

pathologies. Gupta et al.,[15] found the joint effusion, cruciate ligament tear, and medial meniscus tear as the most common pathologies diagnosed on MR evaluation. Khan et al.,[13] found ACL injury and medial meniscal injury as the most common pathologies in their study. In the present study, cartilage injuries were seen in 26.8% of cases. Jandaghi et al.,[16] in their study also found cartilage damage in 30% of the cases which is comparable to the findings of the present study.

In the present study, on arthroscopy, cartilage involvement (48.2%) was the most common finding, followed by ACL tear and medial meniscus tear (37.5%), bony injury (21.4%), chondral defect (19.6%), PCL tear (17.9%), and lateral meniscus tear (14.3%), respectively.

In the present study, on MRA, the most common abnormality was ACL tear and medial meniscus injury in 21 cases each but on arthroscopy, cartilage involvement was the most common pathology seen in 27 cases. In the study by Khan et al., on arthroscopy, ACL injury was the most common pathology (61.5%), however, on MRI, meniscus injury was the common diagnosis (76.9%). In the present study, we found huge gap between MRA and arthroscopy for cartilage involvement. The reason for the poor performance of MRA for the detection of cartilage defects may be owing to the occurrence of cartilage defects at some specific locations where contrast distribution would not have been even. Jandaghi et al.,[16] however, did not find a gap between MRA and arthroscopy for cartilage damage. Wong et al.,[17] in their study, despite reporting MRI to be reliable for assessment of meniscus tears and cartilage defects found that cartilage injuries affecting the medial femoral condyle or medial patella facet were often missed by MRI. With respect to chondral defects, the findings in the present study are in agreement with the observations of Mathieu et al.,[18] who also found MRA to be highly specific (99%) but less sensitive (75%) for detection of chondral defects. In the present study, we also found that cartilage involvement and chondral defects were more common in older as compared to the younger population. The role of age-associated degenerative changes as the possible etiology in these cases can thus not be ruled out.

In ACL tear, lateral meniscus tear, medial meniscus tear, and bony injury MRA had the same detection rate as for arthroscopy, however, for pathologies such as cartilage involvement, PCL tear, and chondral defects, MRA was found to have underdetection. It was the cartilage involvement for which the underdetection was maximum (21.4%). For PCL tear and chondral defects, the underdetection was only for 5.4% of cases. As far as the evaluation of bone is concerned, they are reliable even in conventional radiography or CT.

It could be seen that while almost all the studies find MRA to be highly specific yet with respect to sensitivity, the performance of MRA has been found to be slightly less accurate for certain pathologies that do not follow a specific trend. However, MRA was effective in diagnosing most of the pathologies with absolute accuracy which is in agreement with the observations of Jandaghi et al.,[16] The present study had a limitation of sample size, owing to which slight differences in detection rate accounted for huge sensitivity or specificity loss. Study with a larger sample size could thus help to compensate for this.

Limitations of the study

The MRI has a longer learning curve and takes years of practice and expertise to perform. None of the studies

were correlated with the gold standard investigation. The progression of the disease was not assessed in the study since follow-up was difficult.

CONCLUSION

MR arthrography showed a perfect agreement with arthroscopy for the detection of ACL tear, lateral meniscus tear, medial meniscus tear, and bony injuries. For other pathologies, its sensitivity ranged from 55.6% (cartilage involvement) to 72.7% (chondral defects). For all the pathologies, MR arthroscopy was 100% specific and did not have any false positive cases. The findings of the study thus show that MR arthrography is a very useful non-invasive measure to assess knee pathologies. Further studies with larger sample sizes and a proper representation of atraumatic etiology cases are recommended in improvising the diagnostic value of MRA.

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HDP- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article; **PCP-** Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision; **PCP-** Design of study, statistical analysis, and interpretation; **HDP, BJ-** Review manuscript; **PCP-** Review manuscript; **BJ-** Literature survey and preparation of figures; **PCP-** Coordination and manuscript revision.

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