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Original Research Article

A study to evaluate the accuracy of MRI in comparison to knee arthroscopy in diagnosing cruciate ligament tear and meniscal tears in organized sports and physical exercise related knee injuries in armed forces personnel

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ABSTRACT

Background: Knee injuries related to organised sports and physical training related activities are a major component of injuries sustained by armed forces personnel. Knee instability caused by meniscal and ligamentous injuries cause varying degree of disabilities to the trained soldier and have a serious implication on the battle preparedness of the armed forces. MRI of the knee being a non-invasive modality is being increasingly used in pre and post op evaluation of patients in such cases.
Methods: A prospective observational study comprising of 161 patients of knee injuries sustained due to sports and physical training related activities was carried out. MRI and arthroscopic examination of the knee was done, and various statistical tests were performed to evaluate the accuracy of MRI in comparison to arthroscopy.
Results: ACL tears were seen in 122 patients (75.5%), PCL tears were seen in 67 patients (41.6%), while medial and lateral meniscus tears were noted in 93 (57.7%) and 50 (31%) patients respectively. The sensitivity and specificity of MRI in detecting ACL tear, PCL tear and medial meniscus injury ranged from 84% - 90.5% and for lateral meniscus it was 72.92% to 86.73 %. The accuracy of MRI in detecting the tear of ACL, PCL and menisci ranged from 82.61% to 89.97%.
Conclusions: The accuracy of MRI in detection of meniscal and ACL tears is very high. Pre-operative MRI in conjunction with adequate history and physical examination can help the clinician to make an accurate diagnosis and can help reduce unnecessary arthrosopic surgeries.

Keywords: Arthroscopy, Anterior cruciate ligament, Medial meniscus, Lateral meniscus, Organised sports

INTRODUCTION

One of the biggest health problems faced by Armed forces today is the increased incidence of musculoskeletal injuries sustained by the service personnel. Apart from injuries sustained during direct conflict with enemy and road traffic accidents, organized sports and physical training activities are an area in which a substantial number of these injuries are being reported. Depending on their severity, these physical injuries disable the trained soldier to a varying degree, lead to a high rate of manpower wastage and can have a significant effect on the battle preparedness of the armed forces. Lower limb involvement is common in sports related injuries and knee joint is the most commonly involved joint after ankle joint. Meniscal and ligamentous injury is the most

common cause of knee joint instability and increased patient morbidity.[1] MRI being a non-invasive modality is increasingly being used in evaluation of cases of internal derangement of knee and is also being used in pre and post op evaluation of meniscal and ligamentous pathologies. It has high spatial and contrast resolution and can detect most of the pathologies of the knee with high accuracy. This study was conducted to correlate the findings of MRI and arthroscopy in cases of knee trauma associated with sports and physical training related activities and in Armed Forces setup.

METHODS

After obtaining necessary clearance from the hospital ethical committee, a prospective observational study was conducted at a busy Orthopedic referral center of armed forces at Lucknow from May 2018 to October 2018 comprising of 161 patients admitted to the hospital with traumatic knee injury associated with sports and physical training related activities. Most of these patients were referred from other hospitals of the armed forces with diagnosis of internal derangement of knee. These patients underwent MRI of the knee and those found suitable for surgery were subsequently taken up for knee arthroscopy. Only those patients in whom both MRI and arthroscopy were performed were included in the study. Informed consent was taken from all patients before conduct of the study.

Inclusion criteria

All serving armed forces patients in the age group 18-48 years admitted in the hospital with knee injuries related to sports and physical training activities.

Exclusion criteria

- Families and dependents of armed forces personnel; retired personnel
- Individuals with knee trauma due to any other cause other than cited in inclusion criteria
- Previous knee surgery; knee injuries associated with fractures around knee
- Contraindications to use of MRI and anaesthesia.

MRI protocol

MRI of the Knee was performed on 1.5 Tesla magnet (Avanto, Siemens Medical Solutions, Erlangen, Germany) with dedicated knee coil. Initial localizers were acquired in three orthogonal planes followed by acquisition of T1axial, PDFS sagittal, axial and coronal images, T2FS coronal, sagittal and T2* coronal images of the knee.

Image evaluation

Acquired MR images were studied on dedicated workstations by experienced radiologists. ACL, PCL, medial and lateral menisci were evaluated for abnormal signals and disruption of fibres and the tears were graded based on their pathological appearance. All other associated pathologies were also noted.

Grading of meniscal tears is as follows

- Grade 1: globular increased intra-meniscal signal intensity that does not communicate with the articular surface.
- Grade 2: linear increased intra-meniscal signal intensity that does not communicate with the articular surface.
- Grade 3: linear increased signal intensity that communicates with the articular surface, a true tear.
- Grade 3a and b: more extensive articular involvement.
- Grade 4: complex tears with distortion of the meniscus.

MR classification of ACL tears is as follows

- Grade 1: intraligamentous injury without a change in ligament length.
- Grade 2: intraligamentous hyperintense signal intensity associated with and an increase in ligament length with partial disruption of fibers.
- Grade 3: complete ligamentous disruption.

Arthroscopy

Diagnostic as well as therapeutic arthroscopy was performed on the patients by well-trained orthopaedic surgeons under spinal anaesthesia. The pathology was identified after thorough knee examination and appropriate therapeutic reconstructions were performed subsequently.

Statistical analysis

The findings of the MRI and arthroscopic examination were recorded on a performa and considering arthroscopy as the Gold Standard, statistical tests were performed using IBM SPSS 21.0.0 statistical software package (IBM Inc.) to calculate sensitivity, specificity, negative predictive value and positive predictive value and the accuracy of MRI in detecting these tears was determined (Table 1).

RESULTS

Total of 161 patients in the age group 18-48years with a mean age of 28.3years were evaluated using MRI and subsequent knee arthroscopy. All of the study subjects were healthy males without any co-morbidities. Rt sided knee involvement was seen in 96 (59.63%) patients and left sided involvement seen in 65 (40.37%) patients.

ACL tears were seen in 122 patients (75.5%), PCL tears were seen in 67 patients (41.6%), while medial meniscus

and lateral meniscus tears were noted in 93 (57.7%) and 50 (31%) patients respectively. Other MRI findings which were observed were medial collateral ligament strain in 18 (11.2 %) patients, lateral collateral ligament strain in 27 (16.7%) patients, bone contusions in 32 (19.8%) patients, mild to moderate joint effusion in 38 (23.62%) patients, meniscal cysts in 13 (8.07%) patients and osteochondritis dessicans in 02 (1.24%) patients (Figure 1).

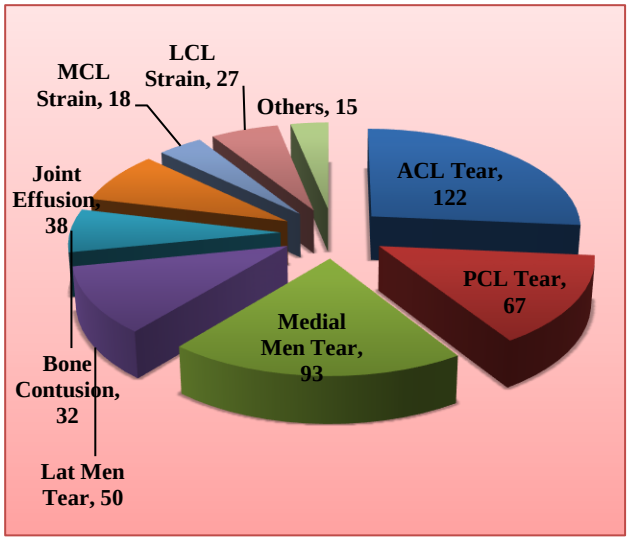

Figure 1: The absolute count and the complete spectrum of various knee pathologies as observed on MRI study.

Partial ACL tears comprised 43.4% (53 patients) and complete tears comprised 56.6% (69 patients) of all ACL injuries. Of all the meniscal injuries, Grade I and Grade II meniscal injuries comprised 23.0% (33 patients) and grade III and IV tears comprised 77% (110 patients) (Figure 2 and 3). Complex meniscal tears with meniscal distortion were seen in 16 patients that included bucket handle tears (13 patents) and complex root tears (03patients). Eleven patients with grade III meniscal tears had associated meniscal cysts while meniscal cysts were found associated with grade II meniscal tears in 02 patients. The true positives, false positives, true negatives and false positive results were calculated from the observed values and are enumerated in Table 1.

Table 1: Observed values of true and false positive results and true and false negative results.

	True positive	True negative	False positive	False negative
ACL tear	114	30	05	12
PCL tear	58	86	09	08
Medial meniscus tear	83	55	10	13
Lateral meniscus tear	35	98	15	13

The results are in respect of medial meniscus tear, lateral meniscus tear, ACL and PCL tear in comparative analysis of MRI with respect to knee arthroscopy using knee arthroscopy as diagnostic gold standard. ACL - Anterior cruciate ligament, PCL - Posterior cruciate ligament.

The sensitivity of MRI in detecting ACL tears was 90.4%, for PCL it was 87.85%, it was 86.4% for medial meniscus and for lateral meniscus its was 72.92%. The specificity of MRI for detecting ACL tear, PCL tear, medial meniscus tear, lateral meniscus tear was found to be 85.7%, 90.5%, 84.6% and 86.73% respectively. The accuracy of MRI was 89.44% for detecting ACL and PCL tears, 85.71% for detecting medial meniscus tears and 82.6% for detecting lateral meniscus tears. The positive and negative predictive values were 95.8% and 71.43%, 86.57% and 91.49%, 89.25% and 80.88% and 70.0% and 88.29% for ACL tear, PCL tear, medial meniscus tear and lateral meniscus tear respectively (Table 2).

Table 2: Evaluation of diagnostic tests in comparative analysis of MRI and arthroscopic findings of knee to calculate the specificity, sensitivity, NPV, PPV and diagnostic accuracy of MRI in detection of meniscal tears and cruciate ligament tears of knee.

Observed MRI findings	Statistical values						
	Sensitivity	Specificity	Positive likelihood ratio	Negative likelihood ratio	PPV	NPV	Accuracy
ACL tear	90.48%	85.71%	6.33	0.11	95.80%	71.43%	89.44%
PCL tear	87.88%	90.53%	9.28	0.13	86.57%	91.49%	89.44 %
Medial meniscus tear	86.46%	84.62%	5.62	0.16	89.25%	80.88%	85.71%
Lateral meniscus tear	72.92%	86.73%	5.49	0.31	70.0%	88.29%	82.61%

Figure 2: PDFS Sagittal images of knee in different patients showing (A): increased hyperintensity involving the AMB of ACL without disruption of fibers - grade I interstitial tear; (B): hyperintense signal involving ACL with partial disruption of fibers - grade II tear; (C) complete disruption of ACL fibers in its mid-substance with ranterior translation of tibia - grade III tear.

Figure 3: PDFS sagittal images of posterior horn of medial meniscus knee in different patients showing: (A): increased globular signal not communicating with articular surface - grade I tear; (B): Linear hyperintensity within the meniscus not communicating with articular surface - grade II tear; (C): oblique hyperintense signal within the meniscus communicating with the articular surface with small globular cyst associated with it - grade III tear with meniscal cyst.

DISCUSSION

Knee joint is a commonly involved joint in sports related injuries. Various imaging modalities are available for evaluation of knee joint pathologies like radiography, high-resolution ultrasonography, arthrography, MRI and arthroscopy. All the internal structures of the knee are not amenable to complete evaluation by radiography, arthrography and ultrasonography. Arthroscopy, the present gold standard in evaluation of knee injuries is an invasive procedure but is also limited in its ability to accurately diagnose lesions such as peripheral meniscal tears, tears involving the inferior surface of meniscus and osteochondritis dessicans not associated with articular cartilage damage.

High magnetic strength MR systems equipped with strong gradient coils and improved imaging sequences have steadily increased the role of MRI in evaluation of injuries and pathologies around knee joint. Non-invasive nature of the MRI technique combined with high contrast resolution and non-requirement of contrast administration has made it the investigation of choice. MRI is also being used for pre and post-operative evaluation of knee injuries. Ligamentous tears and meniscal injuries are the most common cause of knee joint dysfunction in sports related trauma. ACL tears alone account for almost two-third of all knee disturbances.[2] In present study, ACL tear was the most commonly found pathology which was seen in 77.30% cases and medial meniscal tears (59.63%) were more common than lateral meniscal tears (29.81%). PCL tear was encountered in 40.99% of the cases. Singh et al, in a similar study also found ACL tear to be most common finding and medial meniscal tears more common than lateral meniscal tears.[3]

In present study, the sensitivity and specificity of MRI in detecting ACL tear, PCL tear and medial meniscus injury was very high and ranged from 84% - 90.5%. However, the sensitivity of MRI in detecting lateral meniscus injury was low at 72.92% with a specificity of 86.73% (Table 2). Few earlier studies conducted by Rayan F et al and Bari AA et al, also showed low sensitivity of MRI in detecting lateral meniscus tears.[4,5]

The accuracy of MRI in detecting the tear of ACL, PCL and menisci ranged from 82.61% to 89.97% in present study (Table 2). A recent similar study by Kulkarni OP et al, reported the accuracy of MRI to be between 83-88% with highest accuracy for detection of ACL tears and least for tears of lateral meniscus.[6] However, Oei et al, in their systematic review found higher sensitivities and specificities for ACL tears, medial and lateral meniscal injuries as compared to present study.[7] Meniscal tears are commonly missed at arthroscopy, as the tears that extend to the inferior surface of the meniscus may be technically difficult to visualize. Grade 1 and 2 tears confined to the substance of the meniscus with intact outer contour lines are also not visible at arthroscopy.[8] Also, an inability of the orthopedic surgeon to completely visualize the involved meniscal surface at arthroscopy may be another reason for the same. All these factors could contribute to large number of false positive cases of medial and lateral meniscus tears on MRI.

Radial meniscal tears involving the free edge of meniscus are difficult to visualize on MRI. Hence, they account for a large number of tears missed by MRI and this may explain the large number of false negative cases detected in present study. MRI has become the non-invasive imaging technique of choice in evaluating knee pain after traumatic injuries.[9] The high NPV and high specificity confirm its use as a screening tool which can be highly predictive in avoiding unnecessary arthroscopic surgeries. Although MRI is being used with increasing frequency, it should be used in connection with patient history and clinical findings to provide a more complete picture, especially in complex injuries.

CONCLUSION

The accuracy of MRI in detection of meniscal and ACL tears is very high. Most of the knee joint pathologies can be detected non-invasively and without causing much discomfort to the patient. Pre-operative MRI in conjunction with adequate history and physical examination can help the clinician to make an accurate diagnosis and can help reduce unnecessary arthroscopic surgeries. The results which we got in present study support the efficacy of MRI in the diagnosis of internal derangements of the knee associated with organized sports and physical training related activities.

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