



ROLE OF MAGNETIC RESONANCE IMAGING IN EVALUATING TRAUMATIC KNEE INJURY AND ASSESSING ITS VARIOUS PATTERNS WITH ARTHROSCOPIC CORRELATION.

Radio-Diagnosis

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ABSTRACT

Background And Aim: MRI is a completely non-invasive modality for diagnosing with no ionizing radiation and plays an important role in assessment of wide spectrum of inter derangement of knee. Arthroscopy have high sensitive and specific in both diagnostic and therapeutic, but is invasive and can cause various complications. This study focus on assessing the role of MRI in evaluating traumatic injuries of knee joint and to compare and correlate MRI findings with arthroscopy findings in knee injury. **Methodology:** Hospital based prospective observational study involving 52 patients with knee injuries, carried out over a period of 18 months undergoing, MRI as well as arthroscopy of the knee. MRI findings of the patients were correlated with arthroscopic findings. Statistical analysis was performed for anterior cruciate, posterior cruciate ligaments, medial meniscus, lateral meniscus and medial & lateral collateral ligaments. MRI results were analyzed with Chi-Square test. Sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) of MRI is evaluated considering arthroscopy as gold standard of reference. **Results:** Out of the total 52 cases with knee injury 35 are males and 17 are females. Most of the cases were within age group of 36-45 years, road traffic accidents (RTA) and twisting injuries were the most common causes. Anterior cruciate ligament (ACL) tears identified by MRI being the most common at 78.4%, followed by medial meniscus (MM) in 33.3% cases. Posterior cruciate ligament (PCL) injuries in 17.6%, medial collateral ligament (MCL) injuries occurred in 29.4% of cases, while lateral collateral ligament (LCL) injuries were less common at 11.8%. The ACL has 97.5% sensitivity and 91.7% specificity, while the PCL has 100% sensitivity and high specificity (97.7%). Medial and lateral meniscus injuries have moderate sensitivity (66.7% and 69.2%, respectively) but high specificity (90.3% and 89.7%). Cruciate ligaments (medial and lateral) showed lower sensitivity (66.7% and 60%, respectively) and variable specificity (82.5% and 93.6%, respectively). **Conclusion:** MRI is highly sensitive and accurate at the identification of both ACL and PCL tears as evidenced by close agreement with arthroscopic diagnosis. The diagnostic agreement for the menisci and cruciate ligaments was moderate. Diagnosing articular fractures and specific pattern of bone contusions can guide us to narrow our diagnosis.

KEYWORDS

MRI, traumatic knee, arthroscopy, correlation, knee injuries.

INTRODUCTION

The knee is the hinge type synovial joint and is the biggest joint in the human body. Knee is the most commonly injured joint because of its anatomical structure, its exposure to external forces, and its functional demands. Injuries of the knee joint are increasing, as a result of trauma and sports injury, more commonly seen in young active individuals.^[1] An accurate diagnosis is therefore essential for early operative as well as non-operative treatment to prevent degenerative changes from setting in. Internal derangement of the knee.^[1,2] MRI examination is now routinely used to assess a wide spectrum of internal knee derangements and articular disorders and has virtually replaced conventional arthroscopy in the evaluation of the menisci and the cruciate ligaments, decreasing both morbidity and costs associated with negative arthroscopic examinations. The use of arthroscopy improves the accuracy of the diagnosis, but it's invasive and can cause complications.^[4] MRI is useful non-invasive diagnostic modality with high sensitivity, specificity, and accuracy in the identification of meniscal and cruciate ligament injuries.^[3] The present study was designed to compare effectiveness of MRI and arthroscopy findings in the diagnosis of knee injuries with latter considered as gold standard.

MATERIALS AND METHODS

Prospective hospital based study conducted in the Department of Radio-Diagnostic at R.L. Jalappa Hospital and Research Center attached to Sri Devaraj Urs Medical College. Conducted for a period 18 months. Assuming alpha error of 0.05 (95% Confidence limit), Hence a maximum sample size of 52 subjects was enrolled for the study. Patients referred for MRI knee scanning following traumatic knee injury were included for the study. Patient with previous history of knee surgery, claustrophobia, ferromagnetic implants, pacemakers and aneurysm clips were excluded.

Informed written consent was taken from every patient. MRI scan was performed on SIEMENS® MAGNETOM AVANTO, 1.5 Tesla, 18 channel MRI machine Patient is placed in supine position with the knee in a closely coupled extremity coil. Following Imaging sequences were used as follows: T1- weighted Axial, Coronal. T2- weighted Axial, Coronal, and Sagittal. PDFS- Sagittal, Axial. STIR- Coronal 3D

DESS- Coronal/ Sagittal. After the MRI scan the patient went under arthroscopy, findings of the both were recorded. MRI findings of the patients were correlated with arthroscopy.

Statistical Analysis: Comparison of continuous variable across the subgroups were performed using the student's t test. Comparison of categorical variables (sex, type of injury, mode of injury, etc.) across study groups were done using Chi square test. P-value of <0.05 was considered statistically significant. Statistical analysis was performed for medial meniscus, lateral meniscus, anterior cruciate and posterior cruciate ligaments, and cartilage surfaces considering arthroscopy as gold standard. MRI results were analyzed with Chi-Square test. Sensitivity, specificity, accuracy, positive predictive value (PPV) and negative predictive value (NPV) were evaluated considering arthroscopy as standard of reference.

RESULTS

Out of 52 patients injuries on the right side are more frequent, accounting for 60.8% (31) of cases, while left side injuries represent 41.2% (21). This indicates a higher occurrence of injuries on the right side compared to the left. Age Incidence: The average age in our study population was 30 years. The youngest patient being 19 years and oldest patient being 58 years. The largest group being 36-45 years (33%), followed by 16-25 years (29%) and 26-35 years (19%). The 46-55 age group constitutes 13%, and the smallest group is 56-65 years (6%). Mode of Injury: Among 52 cases. Road traffic accidents (RTA) and twisting injuries being the most common, each accounting for 27%. Falls account for 20% of injuries, while sports injuries make up 16%. Direct trauma is the least common mode, comprising 12% of cases.

Type Of Injury: Prevalence of various injuries among the study population, with ACL tears identified by MRI being the most common at 78.4%, followed by MM in 33.3% cases. Joint effusions were observed in 80.4% of cases. PCL injuries in 17.6%, MCL injuries in 29.4% of cases, while LCL injuries were less common at 11.8%. Bone contusions (BC) were noted in 46.1% and LM tears in 25.5%. Fractures were present in 13.4% of cases.

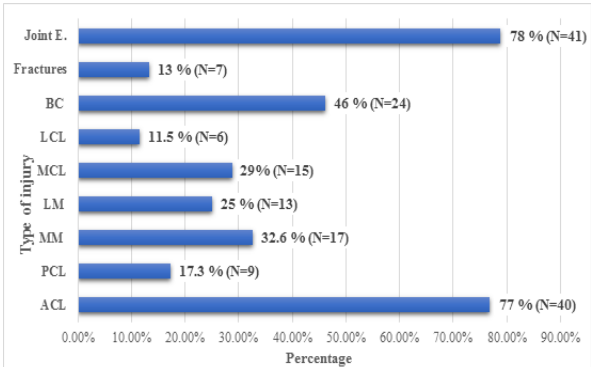


Figure No: 1 Distribution of various injuries on MRI

Injuries: Among 40 cases with ACL injury. Partial tears are the most common (47.5% of cases). Complete tears account for 30%, while sprains or edema constitute 22.5%. This indicates that nearly half of the ACL injuries are partial tears. PCL injuries were seen among 9 cases. Partial tears being the most common, making up 55.6 % of cases. Complete tears and Sprain/edema each constituted 22.5%. Buckling of PCL was seen in 8 patients with other knee injuries. Medial meniscus injury was seen among 17 cases. Grade II injuries are most prevalent, accounting for 41.2%. Out of all 14 had injury in posterior horn. LM injury Grade I (30.8%) seen in 4 cases, Grade II (46.2%), Grade III (15.4%), and one case of complex tear (7.7%). Out of all 9 had injury in posterior. MCL & LCL Injury was seen in 15 & 6 cases respectively. In both injuries minor sprain injuries were the most common 46.7% (7 cases) & 16.7 % (1 cases) in LCL. Out of 52 cases, 24 cases (46.1 %) had bony contusion out of which 19 cases (79.1 %) were associated with PCL & ACL injury and shows some common bony patterns as described below:

Table No. 1 Distribution of common bony contusions with ACL and PCL injury

Types of bony contusions/bruises	ALC Injury		PCL Injury	
	Complete	Partial	Complete	Partial
Lateral femoral condyle and Tibial plateau (<i>posterolateral</i>)	5	2	1	-
Anterior tibial plateau and anterior femoral condyle	1	2	1	1
Lateral femoral condyle and lateral tibial plateau and/or medial femoral condyle	2	1	1	-
Anterior tibia and/or Posterior patella	2	-	-	-
TOTAL	15		4	

Total number of cases to have joint effusion on MRI were 41 (78 %) out of which 36 (69 %) cases had joint effusion on arthroscopy. Similarly, total number of cases with articular fracture on MRI were 7 (13 %), cases diagnosed on arthroscopy were 9 (17 %). Accuracy of MRI for diagnosing Joint effusion was (90.3 %) and accuracy in diagnosing articular fractures was calculated to be (96.1 %). ACL and PCL have high sensitivity and specificity, reflecting excellent diagnostic accuracy. The ACL has 97.5% sensitivity and 91.7% specificity, while the PCL has perfect sensitivity (100%) and high specificity (97.7%). Medial and lateral meniscus injuries have moderate sensitivity (66.7% and 69.2%, respectively) but high specificity (90.3% and 89.7%). Cruciate ligaments (medial and lateral) show lower sensitivity (66.7% and 60%, respectively) and high specificity (82.5% and 93.6%). PPV and NPV follow similar trends, with higher values for ACL and PCL, and moderate values for meniscus and cruciate ligaments, indicating varying predictive reliability.

Table No. 2 Diagnostic accuracy of MRI and demonstrating Sensitivity, Specificity, Positive predictive value and Negative predictive value (NPV) for different injuries.

	Sensitivity	Specificity	PPV	NPV	Accuracy
Anterior cruciate ligament	97.5%	91.7%	97.5%	91.7%	98.0%
Posterior cruciate ligament	100.0%	97.7%	88.9%	100.0%	100.0%
Medial meniscus	66.7%	90.3%	82.4%	82.4%	82.4%
Lateral meniscus	69.2%	89.7%	69.2%	89.7%	86.3%
Medial collateral ligament	66.7%	82.5%	53.3%	89.2%	80.4%
Lateral collateral ligament	60.0%	93.6%	50.0%	95.7%	92.2%

MRI & Arthroscopy: Case of ACL sprain & medial meniscus tear.



Figure No 2 Sagittal PDFS images (A & B). (A) Intrinsic PDFS hyperintensity with no obvious fibers discontinuity noted – Likely sprain (white arrow). (B) Complex tear involving posterior horn of medial meniscus (white arrow). (C) Arthroscopy confirmed medial meniscus tear (black arrow).

DISCUSSION

Joint injury has been recognized as a potent risk factor for the early onset of osteoarthritic changes. MRI, due to its excellent soft tissue contrast resolution and multiplanar imaging capabilities provides significant advantages over other imaging techniques in the evaluation of traumatic injuries of knee joint. MRI is highly sensitive and specific in the diagnosis of complete cruciate ligament tears and high grade meniscus tears^[5].

Demographic Features: In our study, out of 52 patients males were more commonly affected, accounting for 35 cases (67.3 %) and right side was also more commonly involved, accounting for 60.8% (31 cases) and left side in 41.2% (21 cases). Similar study conducted by Rajasekhar et al^[6], Umap et al^[1] and Shetty et al^[7] showed males are more commonly affected by knee injuries with right more commonly involved than left. The largest group being 36-45 years. Study by Thapa M et al^[2] shows maximum patients were between 30-50 years and another study by Ishani et al^[8] maximum number of patients belonged to the age group of 30-46 years with eldest patient being 57 years, which was similar to the finding in our study. In the study conducted by Thapa M et al^[2], sport injuries were the most common mode of knee injury. The 2nd common mode of injury was fall injury. In our study, RTA and twisting injuries are the most common, each accounting for 27%. Falls account for 20% of injuries, while sports injuries make up 16%. Direct trauma is the least common, comprising 12% of cases which is in concordance with above study. ACL injury: 40 cases (76.9 %) have ACL tear. Out of which partial ACL tears are the most common, making up 47.5% (19 cases). Complete tears account for 30% (12 cases), while sprains or edema constitute 22.5% (9 cases), indicating sprains are nearly half of the partial ACL tear. Similar study conducted by Nenezic et al.^[9] among 149 patients showed higher incidence of ACL tear 134 (89.9%) with partial tear being most common. Other similar studies conducted by Bollen et al.^[10], Gupta et al.^[11] and Singh et al.^[12] showed similar incidence. PCL injury: Out of 52 cases, in our study PCL tear was observed in 9 cases (17.3%). Of these 9 cases partial tear was observed in 5 cases (55.6 %), complete tear in 2 cases (22.2%) and 2 cases (22.5%) had Sprain. A study done by Esmailiet al.^[13] also found almost similar percentage of incidence of PCL tear i.e. 11 cases (15.4%) among 71 cases with knee injury. MM injury: 17 cases (32.6 %) had medial meniscus tear out of which Grade II injuries were most prevalent, 9 cases had injury in posterior horn. Similar study was conducted by Manoj et al.^[15] found almost similar incidence of medial meniscus injury (29%). LM injury: 13 cases (25.0%) had LML injury. Grade I injury was seen in 4 cases (30.8%), grade II in 6 cases (46.2%), grade III in 2 cases (15.4%) and complex tear in 1 case (7.7%). It shows a predominance of Grade II injuries, various subtypes, 9 cases had injury in posterior horn which was again quite similar to the study conducted by Manoj et al.^[14] and Astur et al.^[15] Jeevika et al^[16] found that among meniscal injuries medial meniscal tears (46.5%) were more common than lateral meniscus (37.2%) and the posterior horn of medial meniscus (55%) is commonest site of

involvement. Our study also showed similar outcome. MCL injury: In our study, 15 cases (28.8 %) had MCL injury, out of which minor sprain injuries (grade I) was the most common. The lowest incidence of injury was observed in complete tears, i.e. 3 cases (20%). This was in concordance with a study conducted by Bollen et al.^[10] had 29% cases of MCL tear. Thapa M et al.^[2] showed highest incidence of grade I injuries which is similar to our study. LCL injury: 6 cases (11.5 %) had LCL tear where sprain injuries (grade- I) minor was the most common and complete tear was observed in 1 case (16.7 %). MCL injury was more common than LCL which is due to the fact that LCL is superficially located and is not attached to lateral meniscus. A study conducted by Manoj et al.^[14] and Bollen et al.^[10] also found decreased incidence of LCL tear as compared to that of MCL which is similar to our study with grade I injury predominance in LCL.

Tables representing sensitivity, Specificity, Positive predictive value (PPV), Negative predictive value (NPV) and accuracy of our study compared to other similar studies.

Table No.3 Results between MRI and arthroscopy findings for ACL tears

Name of study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Our Study	97.5	91.7	97.5	91.7	98
Ishani Patel et al. ^[8]	95.4	87.5	95.4	87.5	93.3
Rajan and Mohamed ^[17]	94.59	80.00	94.50	80.00	94
Bidur Gyawali et al. ^[18]	89.5	96.9	94.4	94.1	94
Khandelwal et al. ^[19]	97.4	90.4	96.8	92.2	95.71

Table No.4 Results between MRI and arthroscopy findings for PCL tears

Name of study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Our Study	100	97.7	88.9	100	100
Ishani Patel et al. ^[8]	90.1	100	100	80	93.3
Rajan and Mohamed ^[17]	100	100	100	100	100
Bidur Gyawali et al. ^[18]	100	100	100	100	100
Sanjay N et al. ^[20]	100	97.4	-	-	97.7

Table No. 5 Results between MRI and arthroscopy findings for MM tears

Name of study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Our Study	66.7	90.3	82.4	82.4	83
Nikolaou et al. ^[21]	83.3	69.0	83.3	69.1	81
Rajan and Mohamed ^[17]	68.42	86.66	76.47	81.20	80
Bidur Gyawali et al. ^[18]	95.4	90.0	87.5	96.4	92

Table No.6 Results between MRI and arthroscopy findings for LM tears

Name of study	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)
Our Study	69.2	89.7	69.2	89.7	86.3
Ishani Patel et al. ^[8]	75	77.27	54.55	89.47	76.67
Rajan and Mohamed ^[17]	69.23	94.10	81.81	88.88	88
Bidur Gyawali et al. ^[18]	77.7	88.3	58.3	95	86

In our study, collateral ligaments have the least incidence of injury and among collateral ligament, MCL injury seen in 15 cases (28.8%) are more common than LCL which accounts for 6 cases (11.5%). Most of the injury encountered are minor sprain and partial tear for both MCL & LCL. MCL & LCL both had high FP. In our study MCL had 66.7% sensitivity, 82.5% specificity and accuracy of 80.4 %. LCL had 60.0% sensitivity, 93.5% specificity and accuracy of 92.2 %. The increased accuracy of LCL is probably due to less number of cases. PPV and NPV follow similar trends, with higher values for ACL and PCL, and moderate values for meniscus and cruciate ligaments, indicating varying predictive reliability. Study conducted by Derby et al.^[22] investigated the value of MRI in detecting the posterior lateral corner and medial corner injuries for patients with knee dislocations, MCL (89% accuracy, 97% specificity) and LCL had (76% accuracy, 100% sensitivity, 67% specificity).

CONCLUSION

MRI is an excellent, non-invasive, radiation free imaging modality with multilane capabilities and excellent soft tissue delineation for the assessment of knee injury and provide the most detailed evaluation in cases of various soft tissue injuries. ACL and MM are more

commonly torn when compared to PCL and LM. While ACL and MCL tears show predilection toward MM tear, lateral collateral ligament tear showed a strong relationship with LM tear. MRI have high accuracy in diagnosing joint effusion, articular fractures and bony contusions where specific pattern can guide us to narrow our diagnosis. MRI was highly sensitive and accurate at the identification of both ACL and PCL tears as there was close agreement with arthroscopic diagnosis. However, the diagnostic agreement for the menisci and cruciate ligaments was moderate. Hence MRI is reliable and accurate in diagnosing cruciate ligament and high grade meniscal injuries as compared to low grade meniscus injuries and collateral ligament sprains/partial injury where it shows moderate accuracy.

Limitations Of Study

- Small sample size; a bigger sample size would have shown better results.
- Inter-observer variation in terms of reporting of the MRIs performed has not been taken into consideration as it's observed by single radiologist.
- Collateral ligaments injury were seen in less cases.

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