

ORIGINAL RESEARCH

Study of correlation between MRI and arthroscopic findings in anterior cruciate ligament and meniscal injuries of the knee joint at a tertiary hospital

Bethi Anirudh Reddy¹, V Sahethya Mohan Rao², Vikram Goud³, Sujitkumar Vakati R⁴, Nayan Raj Puvvada⁵, S. Venkatraman⁶

¹Assistant Professor, Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, Telangana 500090, India.

²Assistant Professor, Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, Telangana 500090, India.

³Assistant Professor, Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, Telangana 500090, India.

⁴Associate Professor, Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, Telangana 500090, India.

⁵Senior Resident, Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, Telangana 500090, India.

⁶Professor And Hod, Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, Telangana 500090, India.

ABSTRACT

Background: Complete evaluation of knee injury includes a detailed history, thorough clinical examination, radiological evaluation, and arthroscopic examination. Present study was aimed to study correlation between MRI and arthroscopic findings in anterior cruciate ligament and meniscal injuries of the knee joint at a tertiary hospital.

Material and Methods: Present study was hospital based, prospective, comparative, observational study, conducted in patients admitted to the hospital with traumatic knee injury, underwent MRI knee followed by arthroscopy.

Results: During study period 60 patients of knee injury underwent MRI knee followed by arthroscopy considered for study. Majority were male (86.67 %), from 20-29 years age group (60 %), had injury due to motor vehicle accident (43.33 %) & sports related activity (35 %). We compared injuries to ACL, PCL medial meniscus & lateral meniscus mentioned during MRI study with respect to knee arthroscopy using knee arthroscopy as diagnostic gold standard. In cases of ACL tear, MRI had sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) & accuracy values as 86.66 %, 73.33 %, 90.69 %, 64.70 % & 83.33 % respectively. In cases of PCL tear, MRI had sensitivity, specificity, PPV, NPV & accuracy values as 86.36 %, 89.47 %, 82.60 %, 91.89 % & 88.33 % respectively. In cases of Medial meniscus tear, MRI had sensitivity, specificity, PPV, NPV & accuracy values as 86.11 %, 87.5 %, 91.17 %, 80.76 % & 86.66 % respectively. In cases of lateral meniscus tear, MRI had sensitivity, specificity, PPV, NPV & accuracy values as 83.33 %, 88.09 % & 75 %, 92.5 % & 86.66 % respectively.

Conclusion: MRI is an excellent, non-invasive, radiation free imaging modality with multiplanar capabilities and excellent soft tissue delineation.

Keywords: Anterior cruciate ligament, Arthroscopy, Knee, Magnetic resonance imaging

Corresponding Author: Dr. Sujitkumar Vakati R, Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, Telangana 500090, India.

Email: vsujitkumar@gmail.com / www.drsojitkumar.com

INTRODUCTION

The knee is a complex joint, consisting of two condylar joints between the corresponding condyles of femur and tibia and a sellar joint between the patella and femur. The knee joint is a common site of injury, mainly due to trauma, repetitive activities and sports activities. It is necessary to diagnose if injury results in fracture, ligament injury, meniscus injury or it's a combination of injuries.¹

Important structures within the knee joint include the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial meniscus (MM) and the lateral meniscus (LM). Meniscal injuries occur secondary to trauma produced by the compressive load with a flexed knee and whereas the type and location of the meniscal tear depends on the direction and magnitude of the force acting on the knee. Meniscal injuries are a common cause of knee dysfunction and leads to two-third of all knee disturbances.² Similarly ACL tears also leads to significantly unstable knee joint. Despite being the most frequently injured ligament of the knee, its clinical diagnosis remains difficult.³

Complete evaluation of knee injury includes a detailed history, thorough clinical examination, radiological evaluation, and arthroscopic examination. Arthroscopy is the current gold standard assessment for ligament and meniscal injuries but is invasive and has many associated risks.⁴ Magnetic resonance imaging (MRI) is a recommended to detect meniscal, ligament injuries, and other soft-tissue injuries including chondral injuries.⁵ Present study was aimed to study correlation between MRI and arthroscopic findings in anterior cruciate ligament and meniscal injuries of the knee joint at a tertiary hospital.

MATERIAL AND METHODS

Present study was hospital based, prospective, comparative, observational study, conducted in Department of Orthopaedics, Mamata Academy of Medical Sciences Hospital, Bollaram Industrial Area, Hyderabad, India. Study duration was of 2 years (January 2020 to December 2021). Study approval was obtained from institutional ethical committee.

Inclusion criteria

- Patients admitted to the hospital with traumatic knee injury, underwent MRI knee followed by arthroscopy, willing to participate in present study

Exclusion criteria

- Patients with a previous history of knee arthroscopy or any other knee surgery, history of previous episodes of knee locking, nontraumatic cause of meniscal and ligamentous pathology, degenerative knee joint arthritis, infection, and neoplasm, with a previous open knee injury, intra-articular fractures
- Patients with contraindications for an MRI assessment,
- Patients who were unfit for anaesthesia.
- Patients who did not give consent to participate in the study,

Study was explained to patients in local language & written consent was taken for participation & study. All patients underwent detailed history taking, followed by clinical examination. Clinical tests to detect meniscal injuries included McMurray's test and eliciting point tenderness. Anterior cruciate ligament (ACL) injuries were tested with Lachman and anterior drawer tests. Posterior cruciate ligament (PCL) injuries were tested with the posterior drawer test and posterior sagging of the tibia.

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. 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.

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. The findings of the MRI and arthroscopic examination were recorded in Microsoft Excel, analysed using SPSS 23.0 version. Frequency, percentage, means and standard deviations (SD) was calculated for the continuous variables, while ratios and proportions were calculated for the categorical variables. Difference of proportions between qualitative variables were tested using chi-square test or Fisher exact test as applicable. P value less than 0.5 was considered as statistically significant.

RESULTS

During study period 60 patients of knee injury underwent MRI knee followed by arthroscopy considered for study. Majority were male (86.67 %), from 20-29 years age group (60 %), had injury due to motor vehicle accident (43.33 %) & sports related activity (35 %).

Table 1: General characteristics

	No. of patients	Percentage
Age groups (in years)		
<20	4	6.67%
20-24	19	31.67%
25-29	17	28.33%
30-34	7	11.67%
35-39	6	10.00%
>40	7	11.67%
Mean age (mean±SD)	35.7 ± 5.85	
Gender		
Male	52	86.67%
Female	8	13.33%
Laterality		
Right knee	34	56.67%
Left knee	26	43.33%
Mode of injury		
Motor vehicle accident	26	43.33%
Sports	21	35.00%
Domestic falls	8	13.33%
Others	5	8.33%

We compared injuries to ACL, PCL, medial meniscus & lateral meniscus mentioned during MRI study with respect to knee arthroscopy using knee arthroscopy as diagnostic gold standard.

Table 2: Observed values of true and false positive results and true and false negative results.

	True positive	True negative	False positive	False negative
ACL tear	39	11	4	6
PCL tear	19	34	4	3
Medial meniscus tear	31	21	3	5
Lateral meniscus tear	15	37	5	3

In cases of ACL tear, MRI had sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) & accuracy values as 86.66 %, 73.33 %, 90.69 %, 64.70 % & 83.33 % respectively. In cases of PCL tear, MRI had sensitivity, specificity, PPV, NPV & accuracy values as 86.36 %, 89.47 %, 82.60 %, 91.89 % & 88.33 % respectively.

In cases of Medial meniscus tear, MRI had sensitivity, specificity, PPV, NPV & accuracy values as 86.11 %, 87.5 %, 91.17 %, 80.76 % & 86.66 % respectively. In cases of lateral meniscus tear, MRI had sensitivity, specificity, PPV, NPV & accuracy values as 83.33 %, 88.09 % & 75 %, 92.5 % & 86.66 % respectively.

Table 3: Comparative analysis of MRI and arthroscopic findings

MRI findings	Sensitivity	Specificity	PPV	NPV	Accuracy
ACL tear	86.66 %	73.33 %	90.69 %	64.70 %	83.33 %
PCL tear	86.36 %	89.47 %	82.60 %	91.89 %	88.33 %
Medial meniscus tear	86.11 %	87.5 %	91.17 %	80.76 %	86.66 %
Lateral meniscus tear	83.33 %	88.09 %	75 %	92.5 %	86.66 %

DISCUSSION

Due to the lack of bony support, stability of the joint is highly dependent on its supporting ligamentous structures, and therefore diagnosis & treatment of injuries of ligaments and menisci are extremely for better functioning of individual. Menisci and cruciate ligaments are among the frequently injured structures of the knee hence one of commonest causes of knee pain. Due to its anatomical structure and functional requirements, injury affecting such structures can lead to failure of the knee joint's normal functions such as stability and body weight bearing, and will impair the physical functioning that can lead to interruption of the patient's daily activities impairing him physically and economically. It is therefore of paramount importance to treat these injuries that may affect these structures.

Anterior cruciate ligament (ACL) tear is currently the most common ligament injury to the knee joint, occurring in as many as 1 in 3,500 individuals each year.⁶ The loss of function of the ACL causes into an anteromedial joint instability, where the tibial head has increased mobility relative to the thigh. Changes in the kinematics of the knee joint leads to an increased stress on the menisci, whereby increased damages to the cartilage can be observed over several years.⁷

A detailed history and a thorough clinical examination are crucial in the diagnosis of ligamentous injuries of the knee. However, clinical examination may be inaccurate and inconclusive in many cases, especially with meniscal injuries.^{8,9} Clinical tests like the McMurray test for meniscus is reported to be positive in only 58% of the cases and a negative McMurray test does not rule out a meniscal tear.⁹ Also, the clinical examination is subject to inter observer variations.⁸

Juwarkar AS, et al.,¹⁰ studied MRI findings of 70 patients including 60 (85.7%) male and 10 (14.28%) female patients, the most commonly detected injuries were of anterior cruciate ligament. The sensitivity, specificity and accuracy of MRI for detecting medial meniscal injury were 92.3%, 90.9% and 91.4% respectively. Lateral meniscus (88.0%, 88.9% and 88.6% respectively). Anterior cruciate ligament (91.8%, 95.2% and 92.9% respectively) and posterior cruciate ligament (100%, 98.5% and 98.6% respectively). MRI is highly sensitive and accurate at identification of cruciate ligament and meniscal tears. A close agreement was obtained between MRI and arthroscopic diagnosis.

In study by Machagge, H et al.,¹¹ median age of patients was 40 years. Clinical examination had sensitivity of 93.62% and specificity of 40% for diagnosing meniscal tears; and sensitivity of 100%; and specificity of 97.67% for diagnosing ACL tear. MRI had sensitivity of 85.11%, and specificity of 40% for meniscal tear diagnosis and 71% and 100% respectively for ACL tear diagnosis. Diagnostic accuracy was 84.21% for meniscal and 98.24% for ACL tears by clinical examination and by MRI was 77.19% and 92.98% respectively.

In study by Kumar VM et al.,¹² specificity, sensitivity, PPV, NPV, accuracy of clinical examination, and MRI were similar for anterior cruciate ligament (ACL) and posterior cruciate ligament (PCL) injuries. The diagnostic accuracy of clinical examination and MRI were 82.5% and 90%, respectively, and 95% and 92.5% for medial meniscal and lateral meniscal injuries, respectively, and 97.5% and 100% for ACL and PCL injuries, respectively. Rejeesh S et al., studied 40 patients, 60% patients showed medial meniscal tears alone, 30% patients showed lateral meniscal tears alone and 10% patients showed both medial and lateral meniscal tears on MRI. Sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) for detecting medial meniscal tears was 96.15%, 85% 92.8%, and 91.4% respectively. In the detection of lateral meniscal tears the sensitivity, specificity, PPV and NPV were 88.2%, 95.6%, 93.7%, and 91.66% respectively. Detection of lateral meniscus anterior horn tears, lateral meniscus body tears, bucket handle tears and root tears showed a higher sensitivity and specificity.

Although experienced surgeon can determine the presence of meniscal and ligament injuries through physical examination, MRI is recommended to avoid unrequired arthroscopies which results from false positive physical tests, especially in presence of multiple injuries. Soft tissue discrimination with MR imaging is excellent and differentiation can be made among cortex, marrow, ligaments, tendons, muscles, synovium, vascular and cartilage elements. Additional advantages of MR imaging are multiplanar and thin section capabilities and the ability to evaluate subchondral bone and marrow and no radiation exposure.¹⁴

Moreover the ligaments of knee are divided into intra-articular and extra-articular, consequently MRI plays a most important role in their evaluation. This division is important as the extra-articular ligaments are not visible on routine arthroscopic procedures. MRI is beneficial in clinically significant knee injuries for preoperative evaluation and better planning of surgical procedures and objective documentation of findings.

CONCLUSION

MRI is an excellent, non-invasive, radiation free imaging modality with multiplanar capabilities and excellent soft tissue delineation. It can accurately detect, localize and characterize various cruciate ligament and meniscal injuries and help in arriving at a correct anatomical diagnosis, thereby guiding further management of the patient.

REFERENCES

1. Robert H, Miller III, Azar FM. Knee injuries. In: Canale ST, Beaty JH, editors. Campbell's Operative Orthopaedics, 11th edition. Mosby Elsevier; 2008: 2395-2600.

2. Schurz M, Erdoes JT, Platzer P, Petras N, Hausmann JT. The value of clinical examination and mri versus intraoperative findings in the diagnosis of meniscal tears. *Scripta Medica (BRNO)*. 2008;81(1):3-12.
3. Ali Akhbar Ismaili Jah, Sohrab Keyhani, Reza Zarei, Ali Kalhor Moghaddam. Accuracy of MRI in comparison with clinical and arthroscopic findings in ligamentous and meniscal injuries of the knee. *Acta Orthop.Belg*. 2005;71:189-96.
4. Winters K, Tregonning R. Reliability of magnetic resonance imaging for traumatic injury of the knee. *N Zealand Med J* 2005; 118:1- 8.
5. Sanders TG, Miller MD. A systematic approach to magnetic resonance imaging interpretation of sports medicine injuries of the knee. *Am J Sports Med* 2005; 33:131- 48.
6. Barber-Westin SD, Noyes FR (2011) Factors used to determine return to unrestricted sports activities after anterior cruciate ligament reconstruction. *Arthroscopy* 27:1697–1705
7. Arnoldi AP, Weckbach S, Nussbickel C, Horng A, Nöbauer I, Zysk S, Reiser M, Glaser C (2011) MRI based volumetric assessment of knee cartilage after ACL reconstruction, correlated with qualitative morphologic changes in the joint and with clinical outcome. Is there evidence for early posttraumatic degeneration? *Röfo* 183:1138–1144.
8. Crawford R, Walley G, Bridgman S, Maffulli N. Magnetic resonance imaging versus arthroscopy in the diagnosis of knee pathology, concentrating on meniscal lesions and ACL tears: a systematic review. *Br Med Bull*. 2007; 84:5-23.
9. Keshav Shenoy, Santosh S Jeevannavar, Prasanna Baindoor, Clinical, MRI and arthroscopic correlation of meniscal and anterior cruciate ligament injuries of the knee, *International Journal of Orthopaedics Traumatology & Surgical Sciences*, December-May 2019, Volume- 05, Issue 01, Page 100-105
10. Juwarkar AS, Pal NL. Ligament and meniscal injuries following knee trauma- role of the MRI and its correlation with arthroscopy. *J. Evolution Med. Dent. Sci*. 2017;6(81):5733-5738
11. Machagge, H., Mrita, F., Muhamedhussen, M., Haonga, B. and Mcharo, C.N. (2021) Evaluation of Accuracy of Clinical Examination and MRI on Diagnosing Anterior Cruciate Ligament and Meniscal Tears in Comparison to Diagnostic Arthroscopy among Patients Attending at Muhimbili Orthopedic Institute. *Open Journal of Orthopedics*, 11, 353-370.
12. Kumar VM, Karuppall R. Comparison between clinical, magnetic resonance imaging, and arthroscopic findings in meniscal and cruciate ligament injuries: A Cross- sectional study. *Apollo Med* 2022; 19:137-41.
13. Rejeesh Saseendran, Shameem Ahamed M, Mohanan K, Joy P Verghese. MRI with arthroscopic correlation in meniscal injuries of knee. *International Journal of Contemporary Medicine Surgery and Radiology*. 2018; 3(2):B70-B73.
14. Sudół-Szopińska I, Mróz J, Ostrowska M, Kwiatkowska B. Magnetic resonance imaging in inflammatory rheumatoid diseases. *Reumatologia*. 2016;54(4):170–176.