Journal of Advanced Medical and Dental Sciences Research

@Society of Scientific Research and Studies

Journal home page: www.jamdsr.com doi: 10.21276/jamdsr ICV= 85.10

(e) ISSN Online: 2321-9599; (p) ISSN Print: 2348-6805

Original Research

Determination of the role of magnetic resonance imaging (MRI) in the assessment of injuries related to anterior cruciate ligament compared to arthroscopy

Prem Sagar Sahni[1], Yogendra Singh[2]

[1]Associate Professor, Department of Radiodiagnosis, National Institute of Medical Sciences and Research, Jaipur, Rajasthan, India;
[2]Assistant Professor, Department of Endocrinology, National Institute of Medical Sciences and Research, Jaipur, Rajasthan, India

ABSTRACT:
Background: Apart from clinical examination multiple modalities (conventional radiography, MRI and arthroscopy) are currently used to evaluate knee injuries. This study is intended to compare the sensitivity and specificity of MRI in correlation of arthroscopy in diagnosing of knee injuries. **Aim of the work:** The aim of the study was to determine the role of magnetic resonance imaging (MRI) in the assessment of injuries related to anterior cruciate ligament compared to arthroscopy. **Methods:** This is a prospective study involving 70 patients with history of knee injuries who were admitted in the Department of Radio diagnosis, National institute of Medical Sciences and Research, Jaipur. MRI of the knee joint was done for all these patients either before or after admission. The patients were then subjected to diagnostic and therapeutic arthroscopy. Statistical analysis was used to calculate the sensitivity, specificity, positive predictive value and the negative predictive value, in order to assess the reliability of the MRI results. **Results:** Out of 70 patients included in the study; 39 were male (55.7%) and remaining 31 were female (44.3%). The age ranged from 15–80 years. Mean age of patients was 46.66 ±16.33 years. In our study the sensitivity of MRI in diagnosing medial meniscal and anterior cruciate ligament injuries was found to be 86.0%, specificity 70%, positive predictive value 96.0% and negative predictive value was found to be 39.0% and diagnostic accuracy was 84.0%. **Conclusion:** The present study supports that MRI is helpful in diagnosing medial meniscal and anterior cruciate ligament injuries. The negative predictive value of a MRI was found to be high for all structures of the knee joint and hence a MRI can be used to exclude pathology, thus sparing patients from expensive and unnecessary surgery.
Keywords: ACL, arthroscopy, knee, MRI

Received: 10 February, 2021 Accepted: 18 March, 2021

Corresponding author: Yogendra Singh, Assistant Professor, Department of Endocrinology, National Institute of Medical Sciences and Research, Jaipur, Rajasthan, India

This article may be cited as: Sahni PS, Singh Y. Determination of the role of magnetic resonance imaging (MRI) in the assessment of injuries related to anterior cruciate ligament compared to arthroscopy. J Adv Med Dent Scie Res 2021;9(4): 149-153.

INTRODUCTION

The anterior cruciate ligament is currently the most common ligament injury in the knee joint. The number of incidences is as many as 1 in 3,500 individuals each year. Sports like skiing, ice hockey, and gymnastics can also produce enough stress to disrupt knee ligaments. Automotive accidents, especially those involving motorcycles, are common causes of knee ligament disruptions[1]. Sudden severe loading without a fall or contact, like deceleration of a running athlete can also cause ligament disruption. The anterior cruciate ligament is the major stabilizer of knee joint[2]. It prevents the anterior tibial displacement over the femur. Selective sectioning of the anterior cruciate ligament has shown that the anteromedial band is tight in flexion, providing the primary restraint, whereas the posterolateral bulky portion of this ligament is tight in extension. The posterolateral bundle provides the primary resistance for hyperextension[3]. There are many modalities to diagnose the anterior cruciate ligament (ACL) injury, however good history and physical examination are

the key steps. The patient's history of the experience (i.e., the knee's buckling or jumping out of place; an audible pop; the location, severity, and relative time at the onset of pain; the ability to walk after the injury occurred) is important. In physical examination, anterior drawer and Lanchman tests are most useful tests[4,5]. The Lanchman test is most sensitive for anterior tibial displacement.4–6 Imaging and arthroscopy are two most common modalities. Magnetic resonance imaging has several advantages over arthroscopy. Magnetic resoance imaging is sensitive, non-invasive and accurate in detecting soft tissue injuries of knee. It is a reliable method to confirm the clinical diagnosis and may even reveal the ligament tears which may be missed by arthroscopy. Ligament tears can be accurately assessed with MRI, but distinguishing partial tears from ruptures of the ACL can be challenging. Determining the extent of a partial tear is often extremely difficult to accurately assess[6]. However, it is a routinely prescribed test in suspecting soft tissue injuries of knee. Kostov H. et al reported 83% sensitivity, 88.37% specificity, 93% positive predictive value, 74.5% negative predictive value, 82.5% accuracy in detecting anterior cruciate ligament. The prevalence of ACL tear in knee injuries is 14.4%. Arthroscopy directly visualizes all the internal structures of the knee joint. It can be used as a diagnostic and at the same time as a therapeutic tool. The knee is the joint in which arthroscopy has its greatest diagnostic and intra articular surgical application. The usefulness of arthroscopic techniques in diagnosis and treatment of intra articular pathology has been well documented. Arthroscopy needs special instruments and expert surgeons. This makes arthroscopy more costly than magnetic resonance imaging (MRI). The main aim of this study is to determine the efficacy of MRI in detecting the anterior cruciate ligament injuries in our set up[7-10].

PATIENT SELECTION

This study Included (70) patients referred to the Radiology Department of National institute of Medical Sciences and Research, Jaipur, India from April 2019 to January 2021. The patients presented with suspected ACL injury. All patients were submitted to history taking and clinical provisional diagnosis and each patient exposed to MRI examination followed by arthroscopy.

INCLUSION CRITERIA

Inclusion criteria are suspicious injury of ACL (tear) and meniscal injuries.

EXCLUSION CRITERIA

1. Contraindications to magnetic resonance imaging, e.g. claustrophobia, cardiac prosthesis, and metallic plates.
2. Patients with previous history of knee operations.

METHOD

MR imaging was performed on a 1.5-T MR imaging unit (Achieva, Philips medical system). All patients were imaged in the supine position using phased-array knee coil at radiology department. Protocol of MR imaging Preliminary scout localizers in sagittal, coronal and axial sections were done. The axial view serves as a localizer for achieving the coronal and sagittal oblique sections. The coronal sections are graphically arranged on an axial image from the patella to the posterior surfaces of the femoral condyles. The planes are oriented parallel to the anterior/posterior surfaces of the femoral condyles. The sagittal sections are graphically prescribed from the lateral to the medial collateral ligament and aligned parallel with the anterior cruciate ligament. The coverage included all the anterior, posterior, medial, and lateral supporting structures of the knee. Superiorly, the distal aspects of the quadriceps tendon also included. The distal insertions of the patellar tendon must be included inferiorly. The standard knee protocols (sagittal dual DRTSE, sagittal PD SPIR, coronal T1, coronal PD SPAIR, axial PD SPIR and axial FFE) were performed in all cases. MRI Analysis The ability to delineate the anteromedial and posterolateral bundles of the ACL near the tibial insertion, the mid-portion, and near the femoral origin was assessed. Musculoskeletal radiologists who were unaware of arthroscopic findings, reviewed all knee MR examinations and ACL status by consensus. Firstly, the standard imaging planes of the knee were evaluated with each ACL bundle being classified as intact, partially torn, or completely torn. Intact ACL was defined by the normal• appearance of both ACL bundles Partial ACL tear or ACL tear was defined by• high signal intensity within the ACL or individual, focal swelling or thinning of the ACL or ACL and/or a wavy course of the ACL or ACL with maintained continuity. complete ACL tear or ACL tear was defined as a• complete lack of continuity of the ACL or ACL bundle tear with or without gapping/retraction. Other knee structures are commonly injured with• ACL especially during a complicated rotational trauma (MM, LM, MCL, LCL). In our study, we focused on medial and lateral menisci injuries (ML LM), The two most important criteria for meniscal tears are an abnormal shape of the meniscus and high signal intensity unequivocally contacting the surface on MRI images. MRI results were compared with those of the• arthroscopic findings. Arthroscopic analysis All arthroscopies were performed by orthopedic surgeons, with experience in knee arthroscopy. At arthroscopy, each bundle was classified as normal, partially torn, or completely torn. An intact ACL was appeared as fibers which• were taut and visibly intact from the tibial to the femoral attachment. Partial ACL tear was diagnosed when some, but• not all fibers were visibly torn on direct inspection and the remaining fibers exhibited

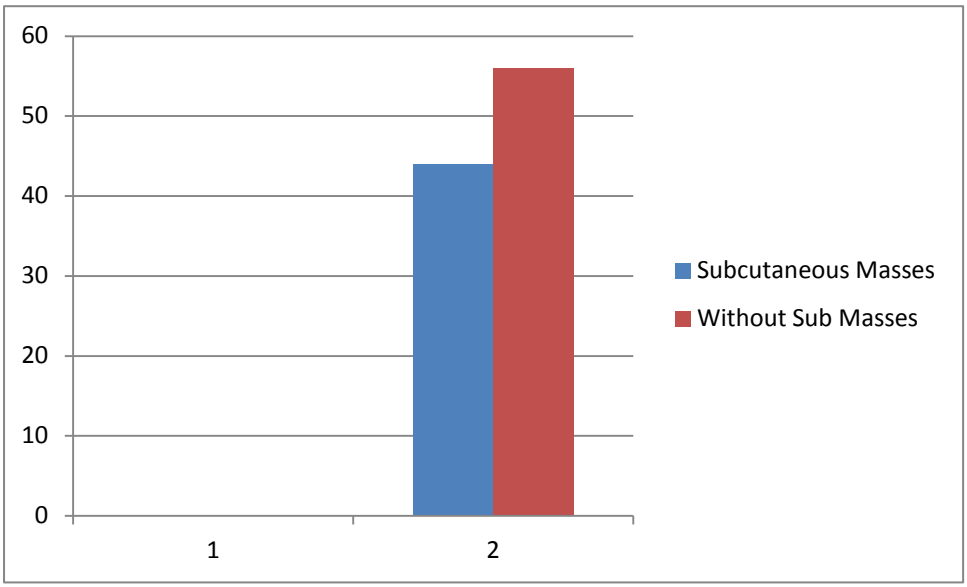
expected resistance to deformation on physical probing. * A complete tear was diagnosed when there was no continuity of the ACL and complete lack of tautness on direct probing. Statistical analysis Data were analyzed using Statistical Program for Social Science (SPSS) version 20.0. Quantitative data were expressed as mean± standard deviation (SD). Qualitative data were expressed as frequency and percentage.

STATISTICAL ANALYSIS

The following tests were done Chi-square test of significance was used in order to compare proportions between two qualitative parameters. Receiver operating characteristic (ROC curve) analysis was used to find out the overall predictivity of parameter in and to find out the best cut-off value with detection of sensitivity and specificity at this cut-off value. - Sensitivity = (true +ve)/ ((true +ve) + (false –ve)). - Specificity = (true –ve) / ((true –ve) + (false +ve)). - PPV = (true +ve) / ((true +ve) + (false +ve)). - NPV = (true –ve)/ ((true –ve) + (false –ve)). Probability (P-value) - P-value 0.05 was considered insignificant.

RESULTS

In our study MRI examination was performed on (70) patients with complaints of knee injury, 39 were male (55.7%) and remaining 31 were female (44.3%). Regarding the most common age group affected was the age group of (21-39) and this is explained by the fact that this age group being the most active group. Out of 70 patients who underwent MRI without subcutaneous masses (56%) were more common than the lesions with subcutaneous masses (44%) as shown in Graph 1.



MRI diagnosis was placed into one of the four categories after arthroscopic evaluation: 1. True positive: MRI diagnosis of tear, confirmed on arthroscopic evaluation 2. True negative: MRI diagnosis of no tear was confirmed on arthroscopy 3. False positive: MRI showed a tear but arthroscopy was negative 4. False negative: If MRI images were negative but arthroscopy showed a tear

Table 1: Different feature measured through MRI

Test	True Positive	False Positive	True Negative	False Negative
ACL MRI Findings	35	2	1	12
PCL MRI Findings	3	0	0	47
MM MRI Findings	13	4	27	6
LM MRI Findings	9	2	35	4

Based on the above categories, sensitivity, specificity, PPV, NPV were calculated to assess the reliability of the MRI results.

Table 2: Different feature measured through MRI

Investigation Area	Sensitivity	Specificity	PPV	NPV	Accuracy
ACL	69	89	79	79	69
PCL	91	84	91	93	84
MM	89	99	81	94	99
LM	81	82	89	78	82

DISCUSSION

The role of MRI has steadily increased and now it has become the investigation of choice for most of the lesions of knee. It is also being used for pre-and post-operative evaluation. It is a noninvasive technique that does not require contrast administration and is not operator dependent[11]. Arthroscopy is used to clarify doubtful cases of meniscal tears and remains the gold standard for many years in ACL tears with a diagnostic accuracy of 69 to 99% but is an invasive and risky surgical procedure for diagnosing the ACL tears, with a complication rate of 2.5%, including superficial and deep infections, peroneal and saphenous nerve injures, blood vessels injuries and pulmonary embolism. Occasionally, arthroscopy may reveal no abnormality in the ACL[11,12]. Age distribution evaluation in this research displayed a narrow range (20-40) years. The percentage of patients younger than 30 years (20- 30 years) was 60% and older than 30 years was 40. Sex distribution of patients was 18 males and 2 females. This indicated that knee injuries prevail mostly in young males. Almost similar results, have shown that most patient by Kostov et al[13]. suffered knee injuries were in the age group of 21- 30 years and were mostly males Other investigators displayed similar results[14-16]. Clayton et al., Nasir and Avcu et al. Also, other study performed by Avcu et al demonstrated that males are most likely to suffer knee injuries since they are active in sports and the right knee was more frequently injured than left. In our study, we made a differentiation between complete and partial ACL tear. Nonvisualization and discontinuity of ACL fibers were considered indicator of a complete ACL tear. Thus, a complete ACL tear was seen on MRI in 10 patients (50%) and partial tear identified also in 10 patients (50%) but in arthroscopy, a complete tear was in 14 patients (70%) and partial tear was in 6 patients (30%).This means that 4 cases with complete ACL tear was diagnosed as partial tear by MRI. Panigrahi et al.[17] reported, when he studied MRI of 76 patients of ACL tear against arthroscopy, the sensitivity, specificity, PPV, NPV and accuracy were 94.7%, 78.6%, 92.3%, 84.6% and 90.4%, respectively and 4 cases with complete ACL tears were missed on MRI and detected as partial tear of ACL In our study, we have correlated the MRI finding with arthroscopy in 20 patients, we compared the finding of ACL injury in MRI with arthroscopy regarding type of injury (partial and complete), we found that sensitivity and specificity were (90%, 70%) respectively in partial ACL injury. And the sensitivity, specificity in complete ACL injury were (78.4%, 100%)respectively, which was near to the study done by Behairy et al.[18] who reported that the sensitivity of MRI was 77.8% and specificity was 100 %. Jah et al.[19] found that sensitivity and specificity of MRI were 78.3% and 95.7% respectively. and AbdulBari et al. showed the sensitivity and specificity of MRI were 87.8% and 81.5%, respectively. Vincken et al.[20] said that patients who required arthroscopic management could be properly identified by MRI examination, due to the sensitivity rate of 87% and specificity rate of 88%(61) . Oei et al[21] reported by using firm exclusion and inclusion criteria and 30 patients were included in his study of the MRI examination in suspected ACL injury and he revealed that ACL tears collective sensitivities and specificities were 94%, 91% respectively.

This study showed that (80%) of injuries were combined injuries (associated with meniscus injuries) in MRI examination, while only (20%) were isolated. also, we noted that the incidence of medial meniscus tear (60%) was more than lateral meniscus tear (20%). Hetta and Niazi[22] reported that Only 28% of patients were represented with isolated injury and 72% of patients were represented with combined injuries and the incidence of medial meniscal tear was more than lateral meniscal tear, and this result was also near to that results revealed by Lim and Peh[23]. In our study, regarding comparison between MRI and arthroscopy in cases of medial and lateral meniscal tears, we found that the sensitivity, specificity, NPV, PPV and accuracy of medial meniscal tear were (99.8%, 91.7%, 92.3%, 100%, 94%) respectively and the sensitivity, specificity, NPV, PPV of lateral meniscal tear were (95.4 %, 97.3%, 99%,100%, 98%) respectively. Yaqoob at al.[24] reported that the sensitivity, specificity, NPV, PPV and accuracy of medial meniscal tear were (100%, 88.4%, 90%, 100%, 94.4%) respectively and the sensitivity, specificity, NPV, PPV of lateral meniscal tear were (85.7%, 95%, 85.7%, 95%, 92. 5%) which were near to our results. Abdul Bari et al. was showed that during statistical analysis of 71 patients having arthroscopic correlation with MRI, the sensitivity and specificity of medial meniscus tear were (93.54%, 87.50%) respectively while the sensitivity and specificity were (77.77%, 81.8%) respectively.The radiologist's training, skill and experience were essential factors in interpretation of MRI. Also, reliable statistical data of the diagnostic role of the MRI are also linked to the independent base of reference[25]. This assumes that arthroscopy is 100% accurate in the diagnosis of all possible ACL

injuries. Yet, is not constantly true. Arthroscopy is a technically demanding technique and the results are different according to surgeon's training and experience, particularly in complicated cases[26].

CONCLUSION

Our study revealed that MRI having high sensitivity, specificity and accuracy for meniscal and ligament injuries of the knee joint. Results of the present study are consistent with earlier larger studies, therefore there is substantial evidence to conclude that MRI is highly accurate in diagnosing meniscal and ACL tears. MRI is now commonly used before diagnostic arthroscopy in most settings, and is considered an effective screening tool in most patients because it is faster, non-invasive and does not involve morbidity associated with arthroscopy. MRI findings before arthroscopy help in the management of meniscal and ligament injuries, ultimately improving patient outcome.

REFERENCES

1. Kiapour AM, Murray MM. Basic science of anterior cruciate ligament injury and repair. Bone Joint Res. 2014;3:20–31.
2. Butler DL, Noyes FR, Grood ES. Ligamentous restraints to anterior-posterior drawer in the human knee. A biomechanical study. J Bone Joint Surg Am. 1980;62:259–70.
3. Kiapour AM, Wordeman SC, Paterno MV, Quatman CE, Levine JW, Goel VK, et al. Diagnostic value of knee arthrometry in the prediction of anterior cruciate ligament strain during landing. Am J Sports Med. 2014;42:312–9.
4. Stannard JP, Sherman SL, Cook JL. Soft tissues about the knee. In: Grauer JN, editor. AAOS Orthopaedic Knowledge Update 12. Ch. 36. 2017. pp. 1–13.
5. Ellman MB, Sherman SL, Forsythe B, LaPrade RF, Cole BJ, Bach BR, Jr, et al. Return to play following anterior cruciate ligament reconstruction. J Am Acad Orthop Surg. 2015;23:283–96.
6. Duchman KR, Lynch TS, Spindler KP. Graft selection in anterior cruciate ligament surgery: Who gets what and why? Clin Sports Med. 2017;36:25–33.
7. Sherman MF, Lieber L, Bonamo JR, Podesta L, Reiter I. The long term followup of primary anterior cruciate ligament repair. Defining a rationale for augmentation. Am J Sports Med. 1991;19:243–55.
8. DiFelice GS, van der List JP. Arthroscopic primary repair of proximal anterior cruciate ligament tears. Arthrosc Tech. 2016;5:e1057–61.
9. Van der List JP, DiFelice GS. Primary repair of the anterior cruciate ligament: A paradigm shift. Surgeon. 2017;15:161–8.
10. Nyland J, Mattocks A, Kibbe S, Kalloub A, Greene JW, Caborn DN, et al. Anterior cruciate ligament reconstruction, rehabilitation, and return to play: 2015 update. Open Access J Sports Med. 2016;7:21–32.
11. Achtnich A, Herbst E, Forkel P, Metzlaff S, Sprenker F, Imhoff AB. 2014. Acute proximal anterior cruciate ligament tears: Outcomes after arthroscopic suture anchor repair versus anatomic single-bundle reconstruction. Arthroscopy. 8(12): 5-13.
12. Abdul Bari A, Shivali V, Bhushan N, Mohammad S (2014): Evaluation of MRI Versus Arthroscopy in Anterior Cruciate Ligament and Meniscal Injuries. Journal of Clinical and Diagnostic Research, 8(12): RC14-RC18.
13. Crawford R, Walley G, Bridgman S and Maffuli N. (2007): Magnetic resonance imaging versus arthroscopy in the diagnosis of knee pathology, concentrating on meniscal lesions and ACL tears: a systematic review. Br Med Bull., 84 (1):5-23.
14. Kostov H, Stojmenski S and Kostova E (2014): Reliability Assessment of Arthroscopic Findings Versus MRI in ACL Injuries of the Knee. Acta Inform Med.,22(2):111–114.
15. Clayton RA and Brown CM (2008):The epidemiology of musculoskeletal tendinous and ligamentous injuries. Pub med., 39(12):1338-44.
16. Nasir A et al. (2013): The role of magnetic resonance imaging in the knee joint injuries, International Research Journal of Medical Sciences, 1(5):1-7.
17. Avcu S, Altun E, Akpinar I, Eresov K (2010): Knee joint examination by MRI: the correlation of pathology, age and sex N Am J Med Sci., 2(4): 202–204.
18. Panigrahi R, Priyadarshi A, PaloN et al. (2017): Correlation of Clinical Examination, MRI and Arthroscopy Findings in Menisci and Cruciate Injuries of the Knee. Arch Trauma Res., 6(1):e30364.
19. Behairy N, Dorgham M, Khaled S (2009):Accuracy of routine magnetic resonance imaging in meniscal and ligamentous injuries of the knee: comparison with arthroscopy. International Orthopaedics (SICOT), 33:961– 67.
20. Jah A, Keyhani S, Zarei R, Moghaddam A (2005): Accuracy of MRI in comparison with clinical and arthroscopic findings in ligamentous and meniscal injuries of the knee. Acta Orthopedic., Belg., 71:189-96.
21. Vincken PW, Ter Braak AP, Van Erkel AR et al. (2007): MR imaging: effectiveness and costs at triage of patients with nonacute knee symptoms. Radiology, 242(1):85–93.
22. Oei EH, Nikken JJ, Verstijnen AC, Ginai AZ, Myriam Hunink MG (2003): MR Imaging of the Menisci and Cruciate Ligaments: A Systematic Review. Radiology, 226: 837-848.
23. Hetta W and Niazi G (2014): MRI in assessment of sports related knee injuries. The Egyptian Journal of Radiology and Nuclear HMedicine, 45:1152-1165
24. Lim SY and Peh WC (2008): Magnetic Resonance Imaging of Sports Injuries of the Knee. Annals Academy of Medicine, 37:4.
25. Yaqoob J, Alam MS, Khalid N (2015): Diagnostic accuracy of Magnetic Resonance Imaging in assessment of Meniscal and ACL tear: Correlation with arthroscopy. Pak J Med Sci., 31(2):263-268.
26. Navali AM, Bazavar M, Mohseni MA, Safari B, Tabrizi A (2013):Arthroscopic evaluation of the accuracy of clinical examination versus MRI in diagnosing meniscus tears and cruciate ligament ruptures. Arch Iran Med., 16(4): 229-232.