

Accuracy of Magnetic Resonance Imaging (MRI) in Anterior Cruciate Ligament (ACL) Tears.

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Abstract

Knee joint is the most frequently evaluated joint by magnetic resonance imaging (MRI) due to high susceptibility of injuries for variety of reasons. Currently, MRI is considered as a gold-standard imaging modality guiding the orthopedic and arthroscopic surgeons. High-resolution dedicated knee MRI coils are available in the market for better visualisation of important structures within the joint cavity. Anterior cruciate ligament (ACL) is a frequently injured structure leading to significant morbidities. Hence, we conducted a study for understanding the role of MRI in ACL involvement.

Introduction

Anterior cruciate ligament (ACL) is the most common ligament injured in the knee joint. Maximum injuries to ACL are attributed to sporting activities like skiing, ice-hockey and gymnastics followed by automotive accidents especially those involving motorcycles [1]. ACL is a major stabilizer of knee joint preventing anterior tibial displacement over the femur. ACL has thin anteromedial band that is taut in flexion and thicker posterolateral band that is taut in extension [2]. Imaging and arthroscopy are two most common methods for diagnosing ACL injuries. Other knee structures commonly injured with ACL especially during a complicated rotational trauma are medial & lateral meniscus and medial & lateral collateral ligaments.

Magnetic resonance imaging (MRI) has several advantages over arthroscopy. MRI is sensitive, non-invasive and very accurate imaging tool in detecting soft tissue injuries of knee joint. It serves as a reliable method to confirm the clinical diagnosis and may even reveal the ligament tears which may be missed by arthroscopy. However, detecting partial tears of ACL can be challenging [3]. Arthroscopy directly visualizes all the internal structures of the knee joint and can be used as diagnostic & therapeutic tool. The usefulness of arthroscopic

techniques in diagnosis and treatment of intra-articular pathology has been well documented. Beside the requisite of special equipments & expertise in arthroscopy, it is expensive than MRI. Hence, the main aim of this study was to determine the efficacy of MRI in detecting ACL injuries in our set-up.

Material and Methods

This multicentric pilot study included twenty-five (25) patients with suspected ACL injury. All patients were thoroughly examined clinically followed by MRI examination and arthroscopy within a week of imaging.

Patients with previous history of knee surgery and those with contraindications to MRI were excluded from the study-group.

MRI was performed on a 1.5T scanner using a high-resolution, knee coil in supine position. The standard protocol included T1W, T2W, T2GRE and STIR images sequences in multiple planes especially targeting optimal ACL visualisation. MRI scans were reviewed by radiologists and ACL findings were recorded in predefined format as follows:

- ACL bundle intact or partially torn, or completely torn;
- Intact ACL – normal appearance of both ACL bundles;
- Partial ACL tear - high signal intensity within ACL or individual, focal swelling or thinning of ACL and/or a wavy course of the ACL with maintained continuity;
- Complete ACL tear - complete lack of continuity of

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ACL or ACL bundle tear with or without gapping/ retraction.

MRI results were compared with those of arthroscopic findings performed by orthopedic surgeons with considerable experience in knee arthroscopy. At arthroscopy, each bundle was classified as normal, partially torn, or completely torn. An intact ACL appeared as a band of taut fibers visibly intact from tibial to femoral attachment. Partial ACL tear was diagnosed when some, but not all fibers were torn. A complete tear was diagnosed when there was no continuity of ACL with complete lack of tautness on direct probing.

Statistical analysis was performed to find out the values of sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy as per the following formulae:

- 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)].
- Accuracy** = True +ve + True -ve / Total.

Results

In our study, MRI examination was performed on twenty-five (25) patients with complaints of knee injury, 18 (72%) were male and 07 (28%) were female explainable by outdoor activities of males.

The most common age-group affected was 21-39 years explainable by the highest activity in this age-group.

MRI diagnosis was placed into one of the four categories after arthroscopic evaluation as follows:

1. **True positive:** MRI diagnosis of tear, confirmed on arthroscopic evaluation
2. **True negative:** No tear on MRI, confirmed on arthroscopy
3. **False positive:** MRI showed a tear but arthroscopy was negative
4. **False negative:** MRI was negative for ACL tear but tear on arthroscopy

Table 1: ACL findings of MRI compared with Arthroscopy

Statistical Parameter	True Positive	False Positive	True Negative	False Negative
ACL Findings	16	1	6	2

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

Table 2: Statistical Values of ACL Abnormality by MRI

Structure Studies	Sensitivity	Specificity	PPV	NPV	Accuracy
ACL	88.9	85.7	94.1	75	88

Discussion

The role of MRI has steadily increased through last two decades making it the investigation of choice for majority of lesions in knee joint in the present state of medicine practice. It is used for both pre and post operative evaluation in knee joint pathologies. It is a noninvasive technique that does not require contrast administration in majority of cases and is not operator dependent [4]. Arthroscopy is used equivocal cases and remains the gold standard for many years in ACL tears with a diagnostic accuracy of 69-99% providing an option of therapeutic procedure as well but is an invasive & operator-dependent procedure with a complication rate of 2.5% including infections, neurovascular injuries (peroneal & saphenous nerve) and occasionally pulmonary embolism [4]. Occasionally, ACL tears may be missed on arthroscopy [5].

Age distribution evaluation in our study revealed that majority of patients with ACL injuries were less than 40 years with majority being males, almost similar to the study done by Kostov et al [6]. Similar results were also noted in several other studies [7-9].

Panigrahi et al reported the sensitivity, specificity, PPV, NPV and accuracy of 94.7%, 78.6%, 92.3%, 84.6% and 90.4%, respectively [10] which were similar to our study. The results of our study were also comparable to that done by Behairy et al, Jah et al, Vincken et al and Oei et al [11-14].

The radiologist’s skill and experience are essential factors in interpretation of MRI. Also, reliable statistical data of diagnostic role of MRI are also linked to the independent base of reference [15]. This assumes that arthroscopy is 100% accurate in the diagnosis of all possible ACL injuries. Yet, this is not always true. Arthroscopy is a technically demanding technique and the results are different according to surgeon’s training and experience, particularly in complicated cases [16].

Conclusion

Our study revealed that MRI has high sensitivity, specificity and accuracy for ACL injuries of the knee joint. Hence, it should be used commonly prior to diagnostic arthroscopy as an effective screening tool because it is not only faster & non-invasive but also does not involve morbidity associated with arthroscopy. MRI findings

before arthroscopy help in deciding the mode of management, ultimately improving patient outcome.

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