Original article

Diagnostic Accuracy of Magnetic Resonance Imaging (MRI) Knee in detecting Anterior Cruciate Ligament (ACL) Tears assuming Arthroscopy as Gold Standard

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ABSTRACT

Background: Anterior cruciate ligament is a core ligament of the knee joint and is vulnerable to injuries in sports and athletics. Timely diagnosis of ACL injuries can result in better management and fast repair. This study explores the diagnostic accuracy of Magnetic resonance imaging (MRI) of knee joint in ACL complete tear.

Patients and methods: To decide the diagnostic efficiency awareness, particularity, positive predictive values (PPV), negative predictive values (NPV) worth and demonstrative precision of X-ray in contrast with arthroscopy for identification of upper leg tendon tears of the knee. A total 78 patients were considered in this study with suspicion of ACL rupture. Patients underwent both MRI and arthroscopy for the detection of ACL tears. The outcomes of the MRI were compared with the accepted gold standard, arthroscopy.

Results: The mean age of the patients enrolled in the study turned out as 45.1 ± 12.8 ($p<0.001$). ACL tears were presented in 52.6% of the patients according to both arthroscopy and MRI. According to MRI, there were 39 true positives (TP), 2 false positives (FP), 2 false negatives (FN), and 35 true negatives (TN). It was found out that PPV was 90.3%, NPV was 97.2%, sensitivity was 95.12%, specificity was 94.59%, while accuracy was observed as 94.87%.

Conclusion: MRI can serve the patients in diagnosis such that it is non-invasive, cheap and can avoid unwanted arthroscopies in case of ACL tears diagnosis. These results also support the fact that MRI can be used as an alternative to arthroscopy in the Pakistani population. These findings can serve to better plan medical facilities in Pakistan.

Keywords:
MRI, ACL Tears, Tertiary care hospitals, arthroscopy and sports injury.

INTRODUCTION

Anterior cruciate ligament is most generally harmed tendon of knee joint .It is much of the time harmed in sport exercises including contact like football, hockey, aerobatic and engine vehicle mishaps particularly those including bikes which produce enough "unexpected" stress to disturb knee tendons.[1,2] Partial ACL (pACL) disruption can occur without direct contact following the sudden severe loading, like deceleration of a running athlete. Other cause of pACL injuries is because of day to day activities like stepping down from a bus or fall from stairs.[3] The anterior cruciate ligament (ACL) is formed of two distinct anatomical and functional bundles the Anteromedial bundle (AM) and Postertomedial bundle (PL).[4] The posterolateral group is generally close in expansion, restricting tibial revolution, while the anteromedial pack is fairly close in flexion restricting the antero-back interpretation of the knee.[5] There are two modalities (MRI and diagnostic Arthroscopy) used to diagnose ACL tears after proper history and clinical examination. X-rays, CT scan and MRI are painless imaging strategy with explicit elements for assessing knee sores, for example, great delicate tissue contrast, multi-boundary and multi-range pictures and high spatial goal. MRI has important role to diagnose ligaments injuries as well as associated meniscal and soft tissue injuries.[6,7] While arthroscopy is a invasive diagnostic method used to identify ACL damage, and has a high sensitivity.[6] It is currently considered as the gold standard for diagnosing intra-articular tears with 100 percent accuracy. The complications of arthroscopy can be associated with infection, adhesion and haemarthrosis. [8]

Although arthroscopy directly visualize ligaments of the knee joint but it is costly than magnetic resonance imaging because of requirement of special instruments and expert surgeon. MRI scans are careful to give the ultimate diagnostic certainty and a number of studies have shown different sensitivity, specificity and accuracy regarding anterior cruciate ligament injury on MRI.[9,10] The main rationale to investigate the diagnostic accuracy of MRI in diagnosing ACL tears in

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relation to arthroscopy in our hospital(tertiary care teaching hospital).

PATIENTS AND METHODS

This research is cross-sectional design and was led in the Radiology and orthopedic surgery department of District Headquarter Hospital Gujranwala. All patients, regardless of gender, who sustained knee trauma and had a positive Lachman test result being conducted by Orthopedic surgeons for an anterior cruciate ligament tear for a minimum of six weeks and were between the ages of 18 and 60 were eligible to participate in this research. Individuals who were ineligible for MRI imaging due to arthritis, prior knee surgery, femoral condyle fractures, tibial plateau fractures, dislocated knees, or contraindications prostheses, or including claustrophobia, cardiac metallic plates were excluded from the study by filling up the detailed proformas before performing MRI test (Pre-requisite to MRI containing the detailed history of the patient). The collection of data was authorized by the hospital's ethics committee. Written informed consent was acquired from every patient. Appointments were made for patients requiring diagnostic arthroscopy. The standard operating procedure for diagnostic arthroscopy is to proceed for MRI first and perform arthroscopy in Orthopedic Department post admission.

MRI with 1.5 Tesla machine was done after the consent of the patient.T1 and T2 weighted proton density and fat-suppressed T2 weighted serial sections in axial, coronal and sagittal plane was done for accessing Anterior cruciate ligaments tears. After the MRI patient was discharged from the radiology department and MRI reporting was done by consultant available at the radiology department, if MRI is suggestive of ACL tear whether complete or partial the patient was referred to orthopedics department for arthroscopy and arthroscopic findings were collected for record of data in research.

A tear of the anterior cruciate ligament (ACL) identified by magnetic resonance imaging (MRI) was classified into four distinct categories. When an ACL tear that was detected on an MRI was confirmed by arthroscopy, this is referred to as a true positive (TP). If an anterior cruciate ligament (ACL) tear is not visible on MRI or arthroscopy, a true negative (TN) diagnosis is made. False positive (FP) in the event that an anterior cruciate ligament (ACL) tear is observed on magnetic resonance imaging (MRI) but not on arthroscopy. When an anterior cruciate ligament (ACL) tear is not visible on magnetic resonance imaging (MRI) but is found on arthroscopy, this is referred to as a false negative (FN).

The relevant data of respondents was entered into the MS-office excel and subjected to statistical analysis using SPSS (Statistical Package for Social Sciences), Version 26. Diagnostic accuracy of MRI was accessed by calculating sensitivity, specificity, positive predictive value and negative predictive value.

RESULTS

The potential for knee injury served as justification for 78 people to take part in this study. Patients in this study had both arthroscopy and MRI on their knees to assess knee damage in an effort to ascertain how useful MRI is at identifying knee trauma. The average age of the research participants, which was 45.1 years with a standard deviation of 12.6 years (p-value = 0.001). These patients were further divided into age group of 50 to 59 years old had the largest percentage of patients enrolled (59%), with the age group of 18 to 19 years old coming in second (3.8%). 91% of the participants had no prior history of knee injury, according to the data. Anterior cruciate ligament (ACL) tears were found in 52.6% of the patients during the arthroscopic assessment. 52.6% of the patients had an anterior cruciate ligament tear as a result of the MRI diagnosis.

The two-by-two compares the diagnosis made by an arthroscopy and an MRI. According to the findings, there were 39 true positives (TP), 2 false positives (FP), 2 false negatives (FN), and 35 true negatives (TN). Based on the acquired values of TP, FP, FN, and TN, calculations were performed to calculate sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV).

Table 1: Division of patients in different age groups (N= 78)

Age groups	Frequency	Percentage
18-19	3	3.8
20-29	10	12.8
30-39	12	15.4
40-49	7	9.0
50-60	46	59.0

Table 2: Frequency and percentage of patients with a history of knee trauma (N= 78)

Knee Trauma	Frequency	Percentage
Yes	7	9.0
No	71	91

Table 3: Frequency of ACL tears according to arthroscopy (N= 78)

ACL Tears on arthroscopy	Frequency	Percentage
Positive	41	52.6
Negative	37	47.4

Table 4: Frequency of ACL tears according to MRI diagnosis (N= 78)

ACL Tears on MRI	Frequency	Percentage
Positive	41	52.6
Negative	37	47.4

Table 5: Comparison of diagnosis via Arthroscopy and MRI (N= 78)

MRI Diagnosis	Arthroscopy Diagnosis		Total
	ACL Tears (Positive)	ACL Tears (Negative)	
Positive	39	2	41
Negative	2	35	37
Total	41	37	78

Table 6: Determination of Sensitivity, Specificity, PPV, NPV and Accuracy of MRI (N= 78)

Parameter	Value
Sensitivity	95.12%
Specificity	94.59%
Positive Predictive Value (PPV)	90.3%
Negative Predictive Value (NPV)	97.3%
Accuracy	94.87%

The computations were made with these values in mind. According to calculations, MRI has the following characteristics: 90.3% for positive predictive value (PPV), 97.2% for negative predictive value (NPV), 95.12% for sensitivity, 94.59% for specificity, and 94.87% for accuracy.

DISCUSSION

In comparison to arthroscopy, which was thought to be the gold standard, The MRI test for the study showed that it was 94.59% specific and 95.12% sensitive. The high sensitivity of magnetic resonance imaging (MRI) has made it a useful screening tool for finding people who may have torn their ACL. Because it is so specific, MRI seems to be able to properly tell whether a patient has an ACL tear or not. MRIs have been shown to be useful for diagnosing ACL injuries in the past, and these results back that up.[11] According to a study on 54 patients, MRI had 88% sensitivity and 94% specificity for finding ACL injuries to be one example.[12] These results, which are very similar to our own, show that MRI is a consistent and reliable way to find ACL damage. The results of the study showed an amazing NPV of 97.2%. This number is very important in the medical world because it shows how well an MRI can rule out ACL damage when the test comes back negative. This ability is what makes this measure important. A high negative predictive value (NPV) lets patients and doctors know that an MRI result that is negative is a very good way to rule out the chance of an ACL injury.[13]

When you think about how cost-effective healthcare is generally, this becomes very important. When an exact and reliable diagnostic tool like an MRI is available, like Afzali et al says, the number of unnecessary arthroscopies can be cut down.[14] These are expensive and invasive procedures. MRIs are very important for healthcare systems because they help decide how to use limited resources because they have a high net present value (NPV). This fits with what another study found, which said that MRI's high net present value can help stop people from getting needless arthroscopies.[15] They said that this might cut down on the number of unnecessary arthroscopies. However, it's important to keep in mind that PPV can change depending on how popular an illness is in the community being studied even though the MRI in this study had a PPV of 90.3%. There are different positive predictive values based on prevalence. A higher prevalence can mean a better positive predictive value. In spite of the fact that ACL tears do happen quite often, the PPV of 90.3% is still high enough to be clinically important. Still, the pre-test probability and patient traits must be taken into account when figuring out the positive predictive value (PPV).[16]

When doctors try to figure out what an MRI means, they have to look at the whole patient's medical background and any risk factors that might be important. When an MRI shows a positive result, even if the test has a high negative predictive value (NPV), more clinical judgement is needed because the test has a low positive predictive value (PPV). This method is similar to what Anderson et al. said should be done to improve the accuracy of MRI-based diagnoses: a full review of the patient's medical history and current symptoms.[17-19] An analysis showed that an MRI can accurately diagnose an ACL tear 95% of the time and 100% of the time.[20] Apart from the conformity with recent literature, this study has its limitations. First of all, the sample of the study was 78 people which can be expanded to obtain better statistical significance. A large sample size comprising over multiple cities could provide more relevant results to the general population.

It is possible to expand the scope of MRI techniques under investigation. MRI variations like diffusion-weighted imaging and magnetic resonance spectroscopy make MRI even better at diagnosing ACL tears. Such variations could be included to obtain better results. Also, studies that look at how cost-effective magnetic resonance imaging (MRI) is for diagnosing anterior cruciate ligament tears might be helpful. These studies should look at things like how much healthcare resources are used, how well patients do, and the effects on the economy. The final results of this study add to the body of proof that knee MRI can be used to diagnose ACL injuries. Magnetic resonance imaging

(MRI) is a useful diagnostic tool for doctors because it is correct overall, has high sensitivity and specificity, and a negative predictive value. These results have a big effect on how healthcare resources are shared, how clinical decisions are made, and how patient care is managed.

In clinical settings, magnetic resonance imaging (MRI) can act as a gatekeeper to help cut down on the amount of unnecessary arthroscopies. There is, however, a need to look at this information along with the patient's history and clinical judgement in order to come up with the most correct diagnosis. The fact that these results are the same as those of an earlier study makes MRI even more important in current medical care. This shows that MRI is a reliable way to diagnose an ACL rupture.

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