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Gul-e Khanda
Aga Khan University

Waseem Akhtar
Aga Khan University

Humera Ahsan
Aga Khan University

Nadeem Ahmad
Aga Khan University

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Assessment of Menisci and Ligamentous Injuries of the knee on Magnetic Resonance Imaging: Correlation with Arthroscopy

Gul-e-khanda, Waseem Akhtar, Humera Ahsan, Nadeem Ahmad
Radiology Department, Aga Khan University Hospital, Karachi.

Abstract

Objective: To evaluate the validity of MRI, in the assessment of the meniscal and cruciate ligamentous injuries of the knee joint and comparison with arthroscopic findings.

Methods: A one year prospective cross-sectional study from January 2006 to January 2007, was performed on 50 patients (32 males & 18 females) with knee injury presenting at the orthopedic unit of AKUH. The patients were referred to radiology department for MRI evaluation and arthroscopy.

Results: The sensitivity, specificity and accuracy for MRI of the menisci and ligaments were as follows: medial meniscus resulted in 100% sensitivity, 69.27% specificity, 90%PPV, 100%NPV and 92% accuracy; lateral meniscus resulted in 87.5% sensitivity, 88.23% specificity, 77% PPV, 93% NPV and 88% accuracy; anterior cruciate ligament resulted in 86.67% sensitivity, 91.43% specificity, 81% PPV, 94% NPV and 88% accuracy; posterior cruciate ligament resulted in 100% sensitivity, 95.83% specificity, 50% PPV, 100 NPV and 96% accuracy .

Conclusion: Magnetic resonance imaging is a good, accurate and non invasive modality for the assessment of menisci and ligamentous injuries. It can be used as a first line investigation in patients with soft tissue trauma to knee (JPMA 58:537; 2008).

Introduction

Since the introduction of Magnetic Resonance Imaging (MRI) for clinical use in 1984, the role of MRI in the diagnosis of knee lesions has now become more evident.¹⁻³ MRI is now the non-invasive imaging modality of choice for supplementing the physical examination in the evaluation of both intra articular and extra articular injuries of the knee.

The conventional method used for diagnosis of knee injury (i.e. ligaments and menisci) is arthrography in which contrast and small amount of air is injected into the joint space after applying local anaesthesia; however it is an invasive and painful procedure. Optimal arthrography needs an experienced operator. Only superficial surfaces of the internal structures of the joint are seen. Cruciate ligaments are not consistently seen.⁴ Plain x-ray carries its importance in diagnosis of bony structures. It can detect fracture, avulsion fracture, dislocation, subchondral sclerosis, joint space narrowing, degenerative changes and osteophytes. However it cannot detect ligament and menisci as well as soft tissue injuries to an adequate extent; it can only detect joint effusion which appears as displacement of fat pads indirect evidence of joint effusion, haemarthrosis and subcutaneous emphysema.

As a non-invasive modality, MRI has replaced conventional arthrography in the evaluation of ligaments and has decreased both morbidity and cost

associated with arthroscopic examination that yield negative results. MRI has also proved beneficial in the selection of patients, in prospective planning, in diagnosis and improves patient-doctor communication.^{5,6}

Diagnostic arthroscopy is the gold standard for diagnosis of cruciate ligaments and menisci, however it is invasive and expensive.⁶ The decrease in the cost of MRI knee studies also was contributed to even acceptance by the orthopaedic community as a non-invasive replacement for arthrography and non-therapeutic arthroscopy. The advantages of MRI are non-invasive nature, lack of ionizing radiation and its ability to detect non osseous structures such as ligaments, menisci, articular cartilage in multiplanar orientation.

Current literature reports 95 - 100% accuracy of MRI for anterior cruciate ligament tears, 90 - 95% for medial meniscal tears and 85 - 90% for lateral meniscal tears.⁷⁻⁹

Data regarding our part of world is limited especially after recent advances in imaging techniques and MRI equipment. The purpose of this study was to evaluate the validity of MRI in the assessment of menisci and cruciate ligaments in our population and comparison with arthroscopic findings which is currently regarded as the gold standard for diagnosis of internal derangements of the knee.

Patients and Methods

From January 2006 to January 2007, fifty patients

with history of acute knee injury or pain following a previous injury, referred from the orthopaedics clinic for MRI of the knee were studied. After obtaining history and clinical examination by the orthopaedic surgeon, these patients went through MRI with pre procedure written consent. MRI showed injury to either the meniscus or ligaments or both. Follow up of such patients were done by gold standard knee arthroscopy to compare the findings on MRI. Exclusion criteria were post operative cases, known cases of ligamentous injuries and those patients who had contra indication to MRI as pregnancy and patients with metallic implants.

MRI studies were performed on Visart TM series (model number 2B 900 -182 E, Toshiba 1.5 Tesla unit). The imaging protocol included sagittal T1, T2 and T2*; coronal and axial T2 weighted images. The imaging was performed with a dedicated extremity knee coil. The images were studied and reported by at least two trained and qualified Radiologists, who reached a consensus interpretation.

A modified version of the classification system of Lotysch et al⁷ to score meniscal injuries on MR images was used. A meniscal tear on MRI was defined as being of grade 3 signal intensity (i.e. intrameniscal signal intensity unequivocally extending to an articular surface). Anterior cruciate ligament (ACL) was considered partially torn when there was abnormal signal intensity within the ligament or when otherwise intact fibers appeared wavy on sagittal or coronal dual SE images. ACL was considered completely torn if there was disruption of all fibers or if it was not discernible at all on MRI.⁶ Standard criteria of signal inhomogeneity were used to establish a diagnosis of other abnormalities such as ligament tears and bone bruises.

All arthroscopic examinations were performed by an experienced orthopaedic surgeon. The arthroscope, which had a 30° viewing angle, was introduced into the knee through an anterolateral or transpatellar portal. All structures were probed as well as visualized. After the diagnostic part of the examination, the arthroscopist recorded the arthroscopic diagnosis and therapeutic intervention, if any. Next, depending on the diagnostic findings, the arthroscopist terminated the procedure or continued with the therapeutic part of the procedure. The various findings at MRI and arthroscopy were noted on data collection Performa and entered on SPSS computer program (version 15). Assessment of findings of meniscal and ligamentous injuries and their comparison with arthroscopic findings were carried out.

Statistical analysis was performed with the help of a statistician. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) and accuracy were calculated for MRI keeping arthroscopy as gold standard.

Results

Out of 50 cases, 32 (64%) showed meniscal injury alone. In 13 (26%) cases there was ACL tear along with meniscal injury. ACL tear in isolation was seen in 3 (6%) patients. PCL tear was seen in 4 (8%) cases. All PCL injuries had meniscal injuries also. No case of collateral ligament tear was detected. Two patients had ACL, PCL and meniscal injuries in combination. The left knee was involved in 30 (60%) cases and the right knee in 20 (40%) cases.

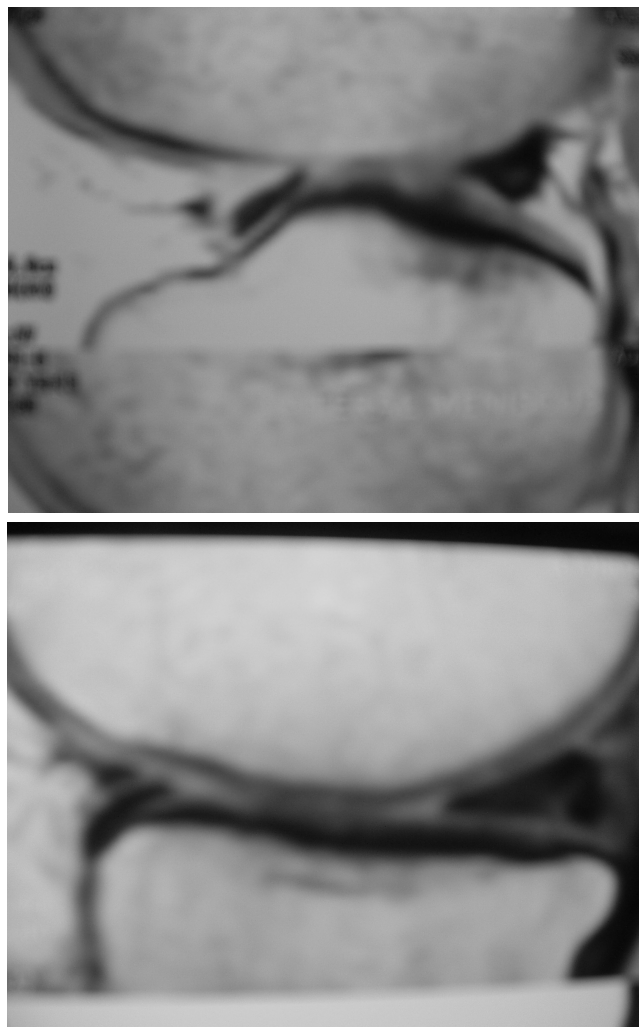


Figure: Figure of a same patient in sagittal proton density images showing hyperintense signal in posterior horn of medial meniscus representing grade 3 tear and grade 2 tear in the anterior & posterior horn respectively.

A total of 41 (82%) cases showed meniscal abnormalities in the medial meniscus. Eighteen patients (36%) had lateral meniscal injury.

Out of 41 cases of medial meniscal injury grade III tear was observed in 31 (62%) followed by grade II and I,

which were seen in 9 (18%) and 1 (2%) cases respectively. Most common site of involvement in the medial meniscus was the posterior horn which was involved in 35 patients (70%).

Lateral meniscal injuries were observed in 18 patients. Grade II injury was most frequently seen in 10 (20%) cases. Grade I and III were seen in 4 (8%) cases each respectively. Most common site of involvement was the anterior horn in 9 (18%) cases. The posterior horn was involved in 8 (16%) of lateral meniscus.

All patients underwent arthroscopy, which showed 41 (82%) medial meniscus tears, 18 (36%) lateral meniscus tears, 16 (32%) anterior cruciate ligament tears, and 4 (8%) posterior cruciate ligament tears.

Comparison of the arthroscopic and MRI findings yielded the following results. MRI evaluation of the medial meniscus revealed 37 true-positives, 9 true-negatives, 4 false-positives, and 0 false negative; these values resulted in 90.02% positive predictive value, 100% negative predictive value, 100% sensitivity, 69.27% specificity and 92% accuracy. For the lateral meniscus, the MRI interpretations consisted of 14 true-positives, 30 true-negatives, 4 false-positives, and 2 false negative, which resulted in 77.77% positive predictive value, 93.75% negative predictive value, 87.5% sensitivity, 88.23% specificity and 88% accuracy. MRI findings for the anterior cruciate ligament yielded 13 true-positives and 32 true-negatives with 3 false positive and 2 false negative, which resulted in 81.25% positive predictive value, 94.11% negative predictive value, 86.67% sensitivity, 91.43% specificity and 88% accuracy. For the posterior cruciate ligament MRI findings yielded 2 true-positives and 46 true-negatives with 2 false positive and no false negative, this resulted in 50% positive predictive value, 100% negative predictive value, 100% sensitivity, 95.83% specificity and 96% accuracy.

Apart from detecting meniscal and ligamentous injury, MR imaging showed good resolution of surrounding anatomical structures. In our study joint effusion was seen in 43 (86%) patients out of 50. Bone oedema or bone bruise was seen in 17 (34%) cases. Bone erosion was present in 6 (12%) cases and articular cartilage disruption was present on MRI in 10 (20%). Baker's cyst was present in 1 (2%) case. No case of infective arthritis was found.

Discussion

Injuries to the knee resulting from acute trauma can occasionally limit full extension of the knee,¹⁰ due to swelling, and muscle spasm.¹¹ MRI has proved reliable and safe and offers advantages over diagnostic arthroscopy, which is currently regarded as the reference standard for the

diagnosis of internal derangements of the knee. Arthroscopy is an invasive procedure with certain risks and discomfort for the patient. It is preferably performed only for treatment purposes, provided that alternative noninvasive diagnostic modalities such as MRI are available.¹¹

A normal MR knee examination is highly accurate in excluding any internal derangement.^{2,6,12} It shows meniscal, ligamentous and cartilaginous abnormalities. It is now the preferred investigation by most orthopaedic surgeons.¹³

The role of arthrography is well established despite the challenge presented by arthroscopy and newer imaging techniques, such as CT scan and MRI.¹⁴ Arthrography is complementary to Arthroscopy in diagnosing meniscal and ligamentous injuries of the knee in our study no patient underwent knee arthrography.¹⁵

Noble¹⁶ emphasized the need to avoid unnecessary arthroscopy indicating that the results of MR imaging in some patients augment the clinical judgment, leaving the arthroscopist to bring about a practical solution for the patients demonstrable and verified problem.

Arthroscopic correlation of MRI findings in a study by R Mackenzie et al¹² revealed overall sensitivity of MRI for menisci and cruciates to be 88% and overall specificity 94%. Our study had 50 cases that underwent MRI and arthroscopy and showed an excellent correlation between the two modalities and results were comparable to the aforementioned study.

Meta-analysis by Oei and colleagues¹⁷ combined 29 studies from 1991 to 2000 that evaluated the validity of MRI with respect to meniscal and cruciate ligament disorders of the knee. The pooled sensitivity of medial and lateral menisci was 93% and 79% while pooled specificities were 88% and 95% respectively. For ACL and PCL tear, pooled sensitivities and specificities were 94%, 91% and 94%, 99% respectively.

In most meniscal tears, the medial meniscus is involved more often than the lateral meniscus, and the posterior horn of the medial meniscus and anterior horn of lateral meniscus are most frequently involved.¹⁸ Sensitivity, specificity and accuracy of MRI for meniscal injuries have been reported in 80-95% range.^{2,12} In our study the results were the same.

Quinn and Brown¹⁹ retrospectively analyzed the arthroscopic videotapes of false-positive MR imaging results and found that the suspected area of the meniscus was never visualized in these cases. Therefore, false-negative findings at arthroscopy could potentially account for many false-positive MR imaging results. ACL tears are known to occur in isolation in only a small number of cases. Discontinuity of the ACL and no visualization of ACL are predictors of an ACL

tear. Only 13% of ACL tears are isolated, the rest being associated with meniscal tears (94% ACL are torn when both menisci are torn). In one study 45% of medial meniscus and 50% of lateral meniscus tears were associated with an ACL tear.¹⁶ If a tear of the ACL is detected special attention should be given to the subtle peripheral tears that may be present in either meniscus, but more commonly in the posterior horn of the lateral meniscus. These tears are difficult to detect on MRI.^{19,20} In our study the association of ACL tears with meniscal tear was also confirmed and 13 out of 16 patients and three patients had ACL tears in isolation [06%].

The PCL is not usually visualized during arthroscopy if the ACL is intact, and in this case, physical examination is often performed with the patient anesthetized to demonstrate a rupture of the PCL. As a result, arthroscopy is ideally performed with knowledge of the findings from the preceding MRI. Although injury to the PCL accounts for only 3%-20% of all capsulo ligamentous injuries to the knee, the PCL has recently become a focus of research.²¹⁻²³ In our study 4 out of 50 cases were found on MRI and two were confirmed by arthroscopy.

Conclusion

Our study revealed high sensitivity (100-86%), high specificity (96-70%) and accuracy (96-88%) for the meniscus and ligaments injuries of knee joint in comparison to arthroscopy. Findings of this small scale study of our population are consistent with larger studies in this field. So we have sufficient evidence to conclude that MRI is highly accurate in the diagnosis of tears of the menisci and cruciate ligaments. MRI is an appropriate screening tool for therapeutic arthroscopy, making diagnostic arthroscopy unnecessary in most patients.

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