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ORIGINAL ARTICLE

Arthroscopic and Low-Field MRI (0.25 T) Evaluation of Meniscus and Ligaments of Painful Knee

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ABSTRACT

Objective: Magnetic resonance imaging (MRI) is an accurate, non-invasive, cost-effective technique for examination of the soft tissue and osseous structures of the knee. The purpose of this study was to evaluate the accuracy of low-field MRI by comparing the results with subsequent arthroscopy. **Materials and Methods:** MR imaging study of 146 patients was done using 0.25 T ESTOATE G-SCAN and the sequence used were SE, FSE and GRE in all the three planes. The comparison was based on five parameters: accuracy, sensitivity, specificity, positive predictive value, and negative predictive value. **Result:** Our study showed high accuracy (98.08%) and negative predictive value (98.62%) for MRI in comparison with arthroscopy. **Conclusion:** Low-field MRI alleviates the need of arthroscopy for detection of meniscus tears and ligament tears.

Key words: Arthroscopy, ligaments, low field magnetic resonance imaging, meniscus, painful knee

INTRODUCTION

MRI is the examination of choice in the evaluation of internal joint structures of the knee like menisci, cruciate ligaments, and articular cartilage. The diagnostic accuracy of MRI, although variable for different individual structures, compares well with arthroscopy, which is considered the Gold Standard, especially when assessing knee injury, in appropriately identifying patients who require arthroscopic therapy.[1,2] MRI of the knee joint has effectively replaced arthrography[3] and as the imaging modality of choice in the evaluation of both acute and chronic disorders causing pain in the knee.[4]

Low-field MRI is adequate for imaging the knee. Studies have shown that it is as effective as high-field MRI machines in evaluating meniscal tears[5-7] and ligaments especially Anterior Cruciate Ligament (ACL).[6-8] Low-field MRI has been readily accepted by both patients and referring clinicians. MR 0.25 T magnet is a safe and valuable adjunct to the

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clinical examination of the knee in preoperative planning[3,9] and in avoiding diagnostic arthroscopy.

MATERIALS AND METHODS

MRI studies of the knee were performed on 146 patients (87 females, 59 males with a history of painful knee joints) using a 0.25 T ESTOATE G-SCAN machine. The sequences used were SE, FSE, and GRE in all three planes: sagittal, coronal, and axial. The slice thickness of 4.5 mm and a 256×256 matrix were used with knee coil slightly flexed and internally rotated. The criteria for selection of patients were history of painful knee with no previous history of surgery. The study period was from January 2011 to October 2011. All patients underwent subsequent arthroscopy within the time frame of 12 days from the date of MRI examinations. Meniscus and the ligaments were Graded 1, 2, 3 [Tables 1 and 2]. Three radiologists analyzed all the images. We determined the reliability of magnetic resonance imaging for the medial meniscus, the lateral meniscus, the anterior cruciate ligament, and the posterior cruciate ligament (PCL). Five parameters were calculated: (i) accuracy - the percentage of patients for whom the diagnosis based on magnetic resonance imaging was correct, (ii) sensitivity - the percentage sensitivity - the percentage of patients in whom an arthroscopy confirmed tear preoperatively diagnosed on the basis of MRI, (iii) specificity - the percentage of patients who had no tear at arthroscopy and who had been found to have no tear on the basis of MRI, (iv) negative predictive value (NPV) - the percentage of patients who were diagnosed as having no tear on the basis of MRI and were subsequently found to have no tear at arthroscopy, and (v) positive predictive value (PPV) - the percentage of patients who were diagnosed as having a tear on the basis of MRI and were subsequently seen to have a tear at arthroscopy.

Table 1: Grading of meniscal tears

Grade	Meniscus
Grade 1	Presence of amorphous or high signal shadow but not reaching the meniscal articular surface
Grade 2	Presence of linear high signal on the image, continuation of Grade 1 and reaching the margin of the articular surface
Grade 3	Linear or diffuse high signal extending to the joint surface

Table 2: Grading of ligament tears

Grade	Ligament (on MRI)	Ligament (on physical examination and arthroscopy)
Grade 1	Fluid around ligament	Some tenderness and minor pain at the point of the injury. This means that there have been small tears in the ligament.
Grade 2	Fluid around ligament along with partial disruption of ligament fibers	Noticeable looseness in the knee. There is major pain and tenderness on the inner side of the knee as well as swelling with single bundle tear but it is not completely torn.
Grade 3	Complete disruption of fibers	Considerable pain, tenderness, swelling, and marked joint instability with complete tears of ligament.

RESULTS

The study population consisted of patients in the age group 11-78 years with a majority of the patients belonging to the age group of 40-60 years. This study also showed a female preponderance for knee pain, accounting for 59.6% of the cases. Of the 146 patients with knee pain, 45.9% were in the left knee and 54.1% were in the right knee.

In this study, 78 patients had meniscal tears with 36 belonging to anterior horn and 42 belonging to posterior horn. Of these, 38 had medial meniscal tears [Figure 1] of whom 4 had Grade 1 tear, 8 had Grade 2 tear, and 26 had Grade 3 tear. A total of 40 had lateral meniscal tears of whom 4 had Grade 1 tear, 6 had Grade 2 tear, and 30 had Grade 3 tear. In this study, 19 patients had ACL tears [Figure 2] of whom 2 had Grade 1 tear, 4 had Grade 2 tear, and 13 had Grade 3 tear. In this study 2 patients had PCL tears [Figure 3] of whom one was Grade 2 and other was Grade 3. The accuracy, sensitivity, specificity, PPV, and NPV of the above have been calculated and shown in Tables 3 and 4.

DISCUSSION

This study was conducted to determine the reliability and accuracy of low-field MRI diagnosis of meniscal and ligament lesions when compared to diagnostic

Table 3: Number of patients with true and false, positive and negative results for meniscus and ligament tears

	True positive	False positive	True negative	False negative
Medial meniscus	38	1	105	2
Lateral meniscus	40	1	102	3
ACL	19	2	124	1
PCL	2	1	143	0

Table 4: Accuracy, sensitivity, specificity, positive predictive value, negative predictive value of MRI (as percentages) for diagnosing different types of meniscus and ligament tears

	Accuracy	Sensitivity	Specificity	Positive predictive value	Negative predictive value
Medial meniscus	97.9	95	99.1	97.44	98.13
Lateral meniscus	97.2	93.02	99.03	97.56	97.14
ACL	97.9	95	98.4	90.4	99.22
PCL	99.32	100	99.22	66.67	100

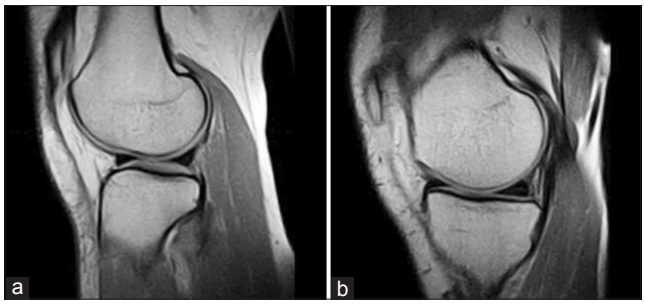

Figure 1: Sagittal view of the knee shows (a) normal meniscus, (b) medial meniscus posterior horn Grade 3.

Figure 2: Sagittal view of the knee shows (a) normal anterior cruciate ligament, and (b) ACL tear Grade 2.

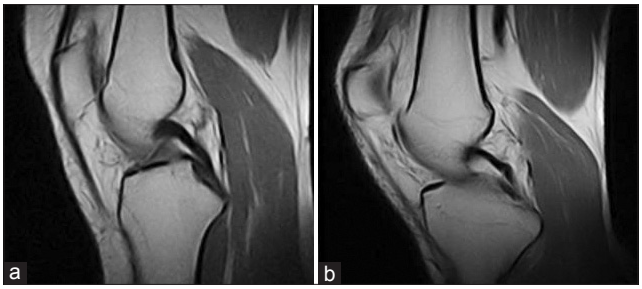

Figure 3: Sagittal view of the knee shows (a) normal posterior cruciate ligament, and (b) PCL tear Grade 2.

arthroscopy. Although arthroscopy has been considered the Gold Standard in diagnosis of meniscal and ligament lesions, MRI remains a reliable, non-invasive modality, which can reduce the use of diagnostic arthroscopy. In this study on 146 patients, the accuracy of magnetic resonance imaging was 97.9% for the medial meniscus, 97.2% for the lateral meniscus, 97.9% for the anterior cruciate ligament, and 99.32% for the posterior cruciate ligament. In a prospective study of 561 patients who also underwent arthroscopy, Justice and Quinn[10] reported an accuracy rate of 93% for the lateral meniscus and 95% for the medial meniscus, which was comparable to results of our study. In a retrospective study by De Smet and colleagues, on 400 MRI examinations (800 menisci), there were 83 original diagnostic errors, yielding an accuracy rate of 90%. De Smet's group also provided an analysis of causative errors.[11] Errors were classified as unavoidable errors (40%), errors related to equivocal MRI findings (21%), and interpretation errors (21%). Unavoidable errors (discordant MRI-arthroscopic correlation) were represented by 21 false-negative and 12 false-positive diagnoses. Subtle or equivocal MRI findings resulted from inter-observer differences in interpretations. Of the interpretation errors, 38% were attributed to normal MRI variants mistaken for a meniscal tear. Even in retrospective review, 6% of the meniscal tears could not be diagnosed. A small (1.5%) false-positive diagnosis attributed to healed tears[12] or tears overlooked at arthroscopy. This study emphasizes that observer variation as represented in the equivocal MRI finding category can affect MRI accuracy rates in diagnosis of meniscal tears. Other studies have minimized differences in observer performance. Increased observer experience may improve accuracy with subtle or equivocal MRI findings, including Grade 1 versus Grade 2 signal intensities, flap tears, and peripheral tears. Correlating peripheral meniscal signal intensity on sagittal MR images with coronal plane images of the corresponding menisci may reduce false-positive MR interpretations, especially in the posterior horn of the medial meniscus. Behairy et al.,[13] in their prospective study of 70 patients showed 94% of accuracy in detecting ACL tears that is a little lower than in our study that showed 97.33% accuracy for ACL.

Vaz et al.,[14] in their study observed sensitivity of 97.5%, and specificity of 92.5% for medial meniscus; sensitivity of 91.9%, and specificity of 93.6% for lateral meniscus; sensitivity of 99%, specificity of 95.9%, and accuracy of 96.6% for ACL; and for PCL sensitivity of 100%, specificity of 99.6%, and accuracy of 84.6% for PCL, which is comparable to the results in our study.

Khandha et al.,[15] in their study of 50 patients observed sensitivity, specificity, and accuracy of 100%, 69.27%, and 92% for medial meniscus, 87.5%, 88.23%, and 88% for lateral meniscus, 86.67%, 91.43%, and 88% for ACL and 100%, 95.83%, and 96% for PCL which is lower than the results obtained in our study. The reason for this difference has been discussed earlier.

MRI is highly accurate and helps in indentifying patients needing surgery thus avoiding diagnostic arthroscopy.[16,17] Various previously published studies also support our view that results obtained by using low-field MRI are comparable to results with high-field MRI.[18-21]

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