

MRI Evaluation of Knee Injury with Arthroscopic Correlation

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ABSTRACT

Background: Magnetic Resonance Imaging has emerged as the primary investigation for evaluation of the knee injury because of its high resolution and accuracy and it has often been regarded as the noninvasive alternative to diagnostic arthroscopy. The objective of this study was to find out the various types of traumatic lesions of the knee on MRI, to correlate the results with arthroscopy, and to establish the accuracy of MRI in detecting ligament and meniscal injury.

Methods: This cross sectional study was conducted on 40 patients with knee injury over a period of one year. MRI of the knee followed by arthroscopy was performed in each case. Arthroscopy was done within 30 days of MRI examination and was considered as gold standard.

Results: Various types of lesion seen on MRI were as follows: joint effusion 27 (67.5%), anterior cruciate ligament tear 23 (57.5%), medial meniscus tear 20 (50%), bone contusion 18 (45%), lateral meniscus tear 16 (40%), medial collateral ligament injury 16 (40%), lateral collateral ligament injury 14 (35%) and posterior cruciate ligament tear 14 (35%). Sensitivity, specificity and accuracy of MRI in detecting meniscal and cruciate ligament injury were as follows: medial meniscus: 85.7%, 89.4%, 87.5%; for lateral meniscus: 83.3%, 95.4%, 90%; for anterior cruciate ligament: 91.3%, 88.2%, 90%; and for posterior cruciate ligament: 92.8%, 96.1%, 95% respectively.

Conclusions: MRI is a noninvasive, useful and reliable diagnostic tool for evaluating knee injury and it can be used as a first line investigation in patients with knee injury.

Keywords: arthroscopy; knee injury; MRI.

INTRODUCTION

The knee is one of the most commonly involved joint in the external injuries and early detection of the cartilage and ligament abnormalities is vital for early intervention to prevent further degeneration. When compared with other diagnostic methods, MRI has the advantage of demonstrating the cartilages, bones, soft tissues and ligaments directly, in detail, and in different planes.^{1,2} Arthroscopy is considered as the gold standard for diagnosis of traumatic intra-articular knee lesions, however, it is an invasive procedure requiring hospitalization and anaesthesia.^{3,4} With the availability of the specialized extremity coil, the knee has become the most frequently studied articulation on MRI.⁵ The

purpose of this study was to find out the various types of traumatic lesions of the knee on MRI, to correlate the results with arthroscopy, and to establish the accuracy of MRI in detecting ligament & meniscus injury considering arthroscopy as gold standard.

METHODS

A cross sectional study was conducted on 40 patients with knee injury at B.P. Koirala Institute of Health Sciences (BPKIHS), Dharan, Nepal over a period of one year from February 2010 to January 2011. As it was a time bound hospital based study, sample size comprised of all the cases of knee injury presenting during the study period and who fulfilled the inclusion criteria. All the patients

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with knee injury, referred for MRI evaluation and who were planned for subsequent arthroscopy were included in the study. Patients with neoplasm, inflammatory or infectious disorders of knee, post-operative cases and those who had contraindication to MRI were excluded from the study. Informed consent was taken from all the patients. Approval of ethical clearance was taken from Institutional Ethical Review Board, BPKIHS.

MRI of the knee was performed on SIEMENS Magnetom C! Syngo MR Machine with field of strength 0.35T using an extremity coil. The knee was imaged in three standard planes i.e. coronal, axial & sagittal planes using T1W, T2W, PD, STIR & GRE sequences with 4 mm slice thickness. The patient was placed in supine position with the knee externally rotated 15-20 degree in order to facilitate the visualization of anterior cruciate ligament (ACL) completely on sagittal images.

A meniscal tear on MRI was defined as intrameniscal signal extending to the articular surface of the meniscus (i.e. grade 3 signal) and/or abnormal meniscal morphology. Morphologic changes for the meniscal tear included blunting of the tip of the inner free edge of the meniscus, displacement of a portion of the meniscus, interrupted appearance of the meniscus, and abnormal size of a segment of the meniscus. ACL was considered partially torn when there was abnormal signal intensity within the ligament with contour irregularity and completely torn if there was disruption of all the fibers or if it was not discernible at all on MRI. Similarly, posterior cruciate ligament (PCL) was considered partially torn when there was abnormal signal intensity within the ligament and completely torn when there was loss of anatomic integrity with abnormal signal intensity. Collateral ligament injury was considered as grade 1 sprain (intrasubstance tears) when there was increased signal intensity within the ligament secondary to intrasubstance edema, grade 2 sprain (incomplete tears) when there was extension of the internal signal to the superficial or deep surface of the ligament, grade 3 sprain (complete tears) when there was complete disruption of the low-signal-intensity band with redundancy of its proximal and distal portions.⁶⁻⁸

All arthroscopic examinations were performed by an orthopedic surgeon within thirty days of MRI evaluation. Statistical analysis was performed using SPSS software. Chi-square test was used to test the significance of variables. Statistical significance was defined as p-value <0.05 with 95% confidence interval.

RESULTS

Out of total 40 cases, 24 (60%) were male and 16 (40%) were female. The age of the patients ranged from 17 to 47 years with mean age 30.35 years. The right knee

was involved in 22 (55%) cases and the left knee in 18 (45%) cases. The various types of lesion in knee injury detected on MRI are shown in Table 1.

Table 1. MRI finding in knee injury in our study.

Type of Lesion	n (%)
Joint effusion	27 (67.5)
Anterior Cruciate Ligament (ACL) tears	23 (57.5)
Medial Meniscus (MM) tears	20 (50.0)
Bone contusion	18 (45.0)
Lateral Meniscus (LM) tears	16 (40.0)
Medial Collateral Ligament (MCL) injury	16 (40.0)
Lateral Collateral Ligament (LCL) injury	14 (35.0)
Posterior Cruciate Ligament (PCL) tears	14 (35.0)

Meniscal tears: Out of 40 patients, 20 (50%) showed medial meniscus (MM) and 16 (40%) patients showed lateral meniscus (LM) tears on MRI. Only grade 3 signals on MRI were considered as tear (Figure 1) and compared with arthroscopy as grade 1 and 2 signals do not reach upto the articular surface and hence are invisible to arthroscopic surface evaluation. Posterior horn was the commonest site of tear in both medial (50%) and lateral meniscus (56.2%).



Figure 1. Coronal PD image showing tear (grade 3 signal) in the body of lateral meniscus.

Cruciate ligaments tears: Out of 40 patients, 23 (57.5%) patients showed ACL tears and 14 (35%) patients showed PCL tears on MRI. Out of 23 patients of ACL tears, 12 patients had partial tears and 11 had complete tears (Figure 2) on MRI. Out of 14 patients of PCL tears, eight

patients had partial tears and six had complete tears (Figure 3).

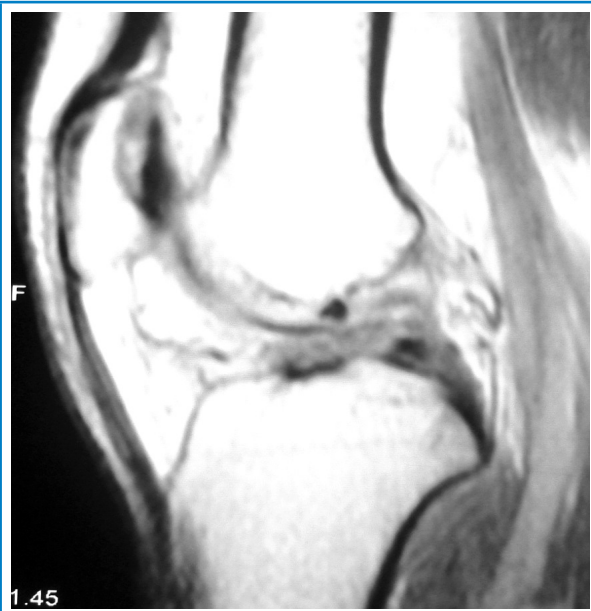


Figure 2. Sagittal PD image showing complete tear of ACL.



Figure 3. Sagittal PD image showing complete tear of PCL.

Collateral ligament injury: Out of 40 patients, 16 (40%) patients showed MCL injury and 14 (35%) patient showed

LCL injury on MRI. Grade 1 sprain was the commonest traumatic lesion in both MCL (37.5%) & LCL (42.8%).

Combined MM & LM injuries were seen in six cases and combined ACL & PCL tears were seen in three cases on MRI. ACL tear was associated with MM and LM injury in seven and five cases respectively on MRI. Similarly, PCL tear was associated with MM and LM injury in five and four cases respectively on MRI.

All the patients underwent arthroscopy which showed MM tear in 21 (52.5%), LM tear in 18 (45%), ACL tear in 23 (57.5%) and PCL tear in 14 (35%) cases.

Comparison of MRI and arthroscopy: MM tear was found in 20 cases on MRI, out of which only 18 cases showed tears during arthroscopy. MRI showed no tears of MM in rest 20 cases, out of which 3 cases showed tears during arthroscopy. MRI showed tears of LM in 16 cases, out of which only 15 cases showed tears during arthroscopic evaluation. MRI showed no tears of LM in rest 14 cases, out of which three cases showed tears during arthroscopy. MRI showed tears of ACL in 23 cases, out of which only 21 cases showed tears during arthroscopy. MRI showed no tears of ACL in rest 17 cases, out of which two cases showed tears during arthroscopy. MRI showed tears of PCL in 14 cases, out of which only 13 cases showed tears during arthroscopy. MRI showed no tears of PCL in rest 26 cases, out of which tears was found in one during arthroscopy. Statistical analysis showed that there was no significant difference between MRI and arthroscopy findings (p-value was > 0.05).

Calculated sensitivity, specificity and accuracy of MRI in detecting meniscal and cruciate ligament injury were as follows: medial meniscus: 85.7%, 89.4%, 87.5%; for lateral meniscus: 83.3%, 95.4%, 90%; for anterior cruciate ligament: 91.3%, 88.2%, 90%; and for posterior cruciate ligament: 92.8%, 96.1%, 95% respectively (Table 2).

Table 2. Validity of MRI findings considering arthroscopy as gold standard reference.

Results	MM	LM	ACL	PCL
True Positive	18	15	21	13
True Negative	17	21	15	25
False Positive	2	1	2	1
False Negative	3	3	2	1
Sensitivity %	85.7	83.3	91.3	92.8
Specificity %	89.4	95.4	88.2	96.1
Accuracy %	87.5	90	90	95
Positive Predictive Value %	90	93.7	91.3	92.8
Negative Predictive Value %	85	87.5	88.2	96.1

DISCUSSION

MRI is a reliable and safe modality 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 and is preferably performed only for treatment purposes, provided that alternative noninvasive diagnostic modalities such as MRI are available.⁹ 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.¹⁰⁻¹²

Arthroscopic correlation of MRI findings in a study by R Mackenzie et al,¹³ revealed overall sensitivity of MRI for menisci and cruciates to be 88% and overall specificity 94%. Meta-analysis by Oei and colleagues,¹⁴ 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 tears, pooled sensitivities and specificities were 94%, 91% and 94%, 99% respectively.

Arthroscopic correlation of MRI findings in a study with 173 patients by Singh JP et al,¹⁵ revealed the sensitivity, specificity and accuracy of MRI in detecting meniscal and cruciate ligamentous injuries as follows: medial meniscus: 96.5 %, 98.28 %, 97.69 %; for lateral meniscus: 87 %, 99.29 %, 97.11%; for anterior cruciate ligament: 98.72 %, 98.94 %, 98.84 %; and for posterior cruciate ligament: 98.72 %, 98.94 %, 98.84 %.

In a study done by Riel et al,¹⁶ on 0.2T MRI the sensitivity, specificity, and accuracy were respectively 93%, 97%, and 95% for tears of the medial meniscus; 82%, 96%, and 93% for tears of the lateral meniscus; 100%, 100%, and 100% for tears of the posterior cruciate ligament; and 98%, 98%, and 97% for tears of the anterior cruciate ligament.

Our study had 40 cases that underwent MRI and arthroscopy and showed a good correlation between the two modalities. The sensitivity, specificity and accuracy of MRI in detecting meniscal and cruciate ligament injury was as follows: medial meniscus: 85.7 %, 89.4 %, 87.5 %; for lateral meniscus: 83.3 %, 95.4 %, 90 %; for anterior cruciate ligament: 91.3 %, 88.2 %, 90 %; and for posterior cruciate ligament: 92.8 %, 96.1 %, 95 % respectively. Findings of our study are comparable with the findings of other similar studies. This study has shown the ability of low field MRI system to accurately identify meniscal and cruciate ligament injury of the knee.

In our study there were three false-positive interpretations of meniscal tears on MRI compared with arthroscopy. These tears were within the vascularized red zone of the meniscus. It is possible that these MRI findings that had the appearance of a tear were healed tears. This area can also be difficult to visualize at arthroscopy, so it is also possible that meniscal tears were present in these areas but were not seen during arthroscopy. Timing of MRI may also be an issue. A substantial delay between injury and MRI may allow the meniscus to heal, but intrameniscal signal may persist, leading to false positive MRI reading. Similarly a delay between MRI and arthroscopic evaluation could allow healing and a false positive result.¹⁷ In the present study, all subjects were symptomatic and MRI was done on average of 10 days before arthroscopic procedure. Vincken PW et al,¹⁸ conducted a study to see the effectiveness of MRI in selection of patients for arthroscopy of the knee and concluded that MRI is an effective tool in the selection of patients for arthroscopy from among a general population.

CONCLUSIONS

MRI is a noninvasive, useful & reliable diagnostic tool for evaluating knee injury and it should be done in suspected menisci and ligamentous injury, to be posted for arthroscopy, thus preventing unwanted diagnostic arthroscopy.

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