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Knee Injuries: correlation of MRI with arthroscopic findings

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Abstract

Introduction: Knee injuries are common among active adults. Achieving a correct clinical diagnosis is often difficult in acute presentations. Knee arthroscopy is considered the gold standard in diagnosing post-traumatic intra-articular lesions, but it is an invasive procedure requiring a certain degree of expertise. Magnetic Resonance Imaging (MRI) is a non-invasive, sensitive diagnostic tool for knee injuries. This study aims to correlate the findings of MRI with arthroscopy of the knee.

Method: This Prospective Observational Study was done at Shree Birendra Hospital, Kathmandu, Nepal from 13 Feb 2016 to 13 Jun 2016. The sensitivity, specificity, and accuracy of MRI findings in ligamentous, meniscal, and osteochondral injuries of the knee were analyzed using arthroscopic findings as standard.

Result: Fifty-two patients (35 male and 17 female), mean age 35.4 years were included in the study. The accuracy of MRI for anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial meniscus, lateral meniscus, and chondral lesions of the knee were 94%, 100%, 92%, 86%, and 86% respectively.

Conclusion: The MRI is accurate (86-94%) in diagnosing Meniscal and Ligamentous injuries of the knee. It has poor sensitivity (22%) for chondral lesions.

Keywords: anterior cruciate ligament, knee arthroscopy, magnetic resonance imaging

Introduction

Knee arthroscopy has diagnostic and therapeutic value in accurately identifying intra-articular pathologies of the knee. It is considered as “The Gold Standard” for diagnosing post-traumatic intra-articular lesions of the knee joint.¹⁻³ The “diagnostic only” arthroscopies have their complications owing to invasiveness and anesthesia.⁴ Clinical tests used to elicit meniscal and ligamentous pathologies of the knee have good accuracy^{5,6} but their use is limited in acute and sub-acute knee presentations.⁶

Magnetic Resonance Imaging (MRI) is a popular tool to diagnose Musculoskeletal disorders with an accuracy of around 85% and most appropriate for screening before therapeutic arthroscopy.^{3,7-15} The accuracy of MRI ranges from 77% to 96% in few studies done in the Asian continent.^{2,10,11} Few Nepalese studies show the accuracy ranging from 87% to 96%.^{5,10}

This study aims to analyze the findings and reliability of MRI and its correlation with Knee Arthroscopy in Nepal.

Method

A Prospective Observational study was conducted in the Department of Orthopedics, Shree Birendra Hospital, Kathmandu, Nepal. It was conducted from 13 Feb 2016 to 13 Jun 2016. All the patients who underwent knee arthroscopy and had an MRI of the knee with a report signed by a radiologist were included in the study. The MRIs were from various centers, with varying coil strengths, and reported by various radiologists with different levels of expertise.

Patients with previous surgery or arthroscopy on the same knee and patients unwilling to give written consent for the study were excluded. Arthroscopy was performed by one of the two senior arthroscopic surgeons and findings were recorded in patients' charts as well as in a separate proforma for the study.

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

- True-positive: MRI diagnosis of tear or injury, confirmed on arthroscopic evaluation;
- True-negative: MRI diagnosis of no tear or injury was confirmed on arthroscopy;
- False-positive: MRI showed a tear or injury but arthroscopy was negative;
- False-negative: If MRI images were negative but arthroscopy showed a tear or injury.

Accuracy: The ability of the MRI to identify the pathology correctly. i.e., $(\text{true positives} + \text{true Negatives}) / (\text{true positive} + \text{false positive} + \text{true negative} + \text{false negative}) \times 100$ percent

Sensitivity: The sensitivity of MRI is the ability of an MRI to detect an abnormality, i.e., $(\text{True-positive} / (\text{true-positive} + \text{false negative})) \times 100\%$.

Specificity: specificity of MRI is the ability of MRI to give how many detected tears are usually accurate, i.e., $(\text{True-negative} / (\text{true negative} + \text{false positive})) \times 100\%$.

Positive predictive value: It correlates a positive result of MRI with findings of arthroscopy, i.e., $\text{True-positive} / (\text{true-positive} + \text{false positive}) \times 100\%$.

Negative predictive value: It correlates a negative result on MRI with the findings of arthroscopy, i.e., $\text{True-negative} / (\text{true-negative} + \text{false-negative}) \times 100\%$.

Microsoft Excel 2016 was used for data analysis to find out Sensitivity, Specificity, Positive Predictive Value, Negative Predictive Value, and Accuracy of MRI and compared with knee arthroscopy findings.

Result

The total cases were 52, mean age 35.4 y, 35(67%) male, and 17(33%) female. The MRI showed 89.5% sensitivity in diagnosing complete Anterior Cruciate Ligament (ACL) tears, Table 1. Two partial ACL tears in MRI

were found to have complete tears in arthroscopy.

There were three Posterior Cruciate Ligament (PCL) injuries identified by MRI, Table 1. One case of intact PCL in MRI had a partial tear in Arthroscopy.

On analysis of overall meniscal tears, MRI had 95.4% sensitivity, 88.3% specificity, 94.4% positive predictive value, 94.1 % negative predictive value, and 94% accuracy. Sensitivity to identify Posterior Horn tear was 88.9%,

Bucket Handle tear was 40% and Body tear was 100%. Specificity for Posterior Horn tear was 81.4%, Bucket Handle tear was 100% and Body tear was 97.9%. Accuracy was 82%, 88%, 98% for posterior horn, bucket handle, and body tear, respectively. Among 6 intra-substance degenerations, one case had a posterior horn tear.

Overall lateral meniscal tears had 77.7% sensitivity, 88.3% specificity, 58.3% positive predictive value, 95% negative predictive value, and 86% accuracy.

Table 1. MRI correlation with Arthroscopic findings in knee injuries, N=52

Structures involved		Sensitivity %	Specificity %	Positive predictive value %	Negative predictive value %	Accuracy %
ACL ^a	Complete tear	89.5	96.9	94.4	94.1	94
PCL ^b	Complete tear	100	100	100	100	100
Medial Meniscus ^c	Overall tear	95.4	90.0	87.5	96.4	92
	Posterior horn tear	88.9	81.4	50	97.2	82
	Bucket handle tear	40	100	100	87.5	88
	Body tear	100	97.9	75	100	98
Lateral Meniscus ^d	Overall tear	77.7	88.3	58.3	95	86
	Posterior horn tear	100	93.8	50	100	94
	Bucket handle tear	50	100	100	98	98
Chondral/ Osteochondral lesions		22.2	100	100	86	86

Note: ^aTwo partial ACL tears in the MRI had complete tears in arthroscopy; ^bOne without PCL tear in MRI had a partial tear in arthroscopy, ^camong 6 intra-substance degenerations of medial meniscus one had posterior horn tear in arthroscopy, ^damong 5 intra-substance degenerations of lateral meniscus, one had a radial tear; two discoid tears in MRI had discoid tears in arthroscopy

On analyzing subgroups of Lateral meniscal tears, MRI had 100% sensitivity for posterior horn tears, and only 50% sensitivity for bucket handle tears, however, it had 100% specificity to diagnose bucket handle tears and 94% to posterior horn tears.

Among five intra-substance degenerations, one case had a radial tear and MRI was correct to identify two discoid meniscal tears.

Sensitive of MRI was only 22.2% to identify chondral lesions in the knee; however, it has 100% specificity. The overall accuracy was 86% in identifying chondral/osteochondral lesions.

Discussion

In our study, the sensitivity and accuracy of complete ACL tears were 89% and 94%. A multi-center analysis among 1014 cases, found that the accuracy of MRI diagnosis was 93% for ACL. Their results varied substantially among centers with increased accuracy from the centers which had a stronger magnetic field.¹ A study done in Pakistan had 88% accuracy for ACL tears² and an Iranian study showed 88.5% MRI accuracy for ACL injuries.⁷ Other studies done at university hospitals had 90% sensitivity for high-grade ACL tears.⁸ In a systemic review, which reviewed 59 articles with 7367 MRI scans and 5416 arthroscopies, it was concluded that MRI is a highly accurate tool to diagnose ACL injuries with >85% accuracy.⁹

The results are comparable to our study with similar sensitivity and accuracy values.

The ACL tears are diagnosed with visualization of high signal intensity or edema in body, bundles, or attachment sites of ACL, or non-visualization of ACL.^{16,17,18} We had two cases of partial tears of ACL reported in MRI which were found to be complete tears in Arthroscopy. Since MRI is a static study and radiologist give reports without seeing the patients, it fails to identify the functional status of the structure being reviewed. We think that a detailed clinical history and examination findings are written in the MRI request form for Radiologists to see beforehand.

The PCL is a homogeneously low signal, continuous structure in MRI. Any signal changes and structural discontinuity are easily identified; hence MRI is highly accurate in diagnosing PCL pathologies.¹⁶ In a study, sensitivity, specificity, and accuracy of PCL tears were 93%, 96%, and 95% respectively.³ In other studies, the accuracy of PCL injury detection by MRI was 98%⁴ and 100%.⁵ These results are similar to our findings of 100% sensitivity and accuracy of MRI in detecting complete PCL tears, although the number of cases was only three in our study. We had one partial PCL tear which was not detected by MRI.

Accuracy of MRI for Medial Meniscal tears was 89%, sensitivity was 93% and specificity was 84%, for lateral meniscus, accuracy was 88%, sensitivity was 69% and specificity was 94%.⁶ A study was done in a private teaching hospital of Kathmandu, found that the sensitivity, specificity, and accuracy of MRI for medial meniscal tear was 92.3%, 100%, and 95.1% and for lateral meniscus, it was 84.6%, 96.4%, and 92.6% respectively.⁷ A systemic review of 29 studies found the pooled sensitivity and specificity of medial meniscal tears to be 93% and 88% respectively and the pooled sensitivity and specificity of the lateral meniscus to be 79% and 95%.⁷ A Study done in the US found that anterior horn tears usually do not have clinical signs and are detected on MRI.⁸ Overall results are similar to our study

with a sensitivity of medial meniscus more than lateral (95.4 vs 77.7) and specificity of medial and lateral meniscus being similar (90 and 88.3%). The sensitivity of bucket-handle tears is poor for both the menisci (40 & 50%). Among intra-substance degenerations (grade 1 and 2 tears), one out of six medial menisci were found to have a tear extending to the joint surface in arthroscopy (17%) and one out of five lateral menisci had a tear (20%). Two discoid tears in the lateral meniscus were correctly identified by MRI.

The MRI is considered the most accurate non-invasive modality to study articular cartilage.^{19,20} It can give information on the biochemical and physiological condition of Hyaline cartilage.¹⁹ But, in our study MRI showed very poor sensitivity (22.2%) to detect chondral and osteochondral lesions of the knee joint. It had 100% specificity with an overall accuracy of 86%. The poor results might be because the field strength of the scanner is 1.5 Tesla. MRI had significant inferior accuracy (60%) as far as chondral lesions are concerned, it had 42% sensitivity and 73% specificity to detect chondropathy.³ One study found that the sensitivity, specificity, and accuracy of chondromalacia of the patella, tibial and femoral condyles to be 52%, 76%, and 68% respectively.⁹ MRI has an accuracy of 45% to diagnose Osteochondritis Dissecans of the knee. The accuracy can be improved to 85% by interpreting the high signal T2 as a predictor of instability only when it was accompanied by a breach in the cartilage on a T1-weighted image.¹¹

The common approach to knee injuries is clinical examination complemented by an MRI scan of the knee. MRI fares better in acutely painful knee and multiple injuries. As MRI has become readily available and less expensive, it has largely limited the role of Arthroscopy to a 'therapeutic' purpose only.

Our results are consistent with some larger studies and meta-analyses. However, our study has a relatively smaller sample size and few PCL and Chondral injuries, rendering the analysis of these structures less significant.

Conclusion

The MRI is highly accurate in diagnosing Ligamentous and Meniscal injuries of the knee, with an accuracy of up to 95%. It can be largely used to replace diagnostic arthroscopy; however, it was found to have poor sensitivity (22%) for chondral and osteochondral lesions of the knee.

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Conflict of Interest

The authors have no financial or non-financial conflict of interest to declare.

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Author Contribution

Concept, design, planning - BG, AJ, NK. Literature review - BG. Data collection /analysis – BG. Draft manuscript - BG, AJ, NK. Revision of draft - BG, AJ, NK. Final manuscript – BG, AJ, NK. Accountability of the work - BG, AJ, NK.

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