

SENSITIVITY AND SPECIFICITY OF MRI VERSUS ARTHROSCOPY IN INTERNAL DERANGEMENT OF KNEE

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Abstract- Introduction: Traumatic knee injuries were conventionally assessed clinically, and subjected to radiographs. In modern Orthopaedics, MRI and a subsequent arthroscopic procedure has come of age. Arthroscopy of the knee is a key hole surgery performed as a daycare procedure. There are many indications however, this study is to correlate the findings subsequent to an MRI diagnosis.

Material and methods: 40 patients of different age group and sex with internal derangement of knee (IDK) were subjected to MRI for determining ACL, PCL, medial and lateral meniscus injury and they were subjected to arthroscopy and the findings were recorded.

Results: Magnetic resonance imaging performed on the injured knees revealed 30 tears of the menisci, of which 20 were of medial meniscus and 10 tears of lateral meniscus. There were 21 tears of the cruciate ligaments, out of which 15 were tears of ACL and 6 of PCL.

50 menisci on MRI were normal, of which 20 were medial meniscus and 30 lateral meniscus. Of the 59 cruciates showing normal signal on MRI, 25 were of ACL and 34 of PCL.

Arthroscopy revealed 27 tears of menisci, 19 of these were of medial meniscus and 8 of lateral meniscus. 53 menisci were normal on arthroscopy, 21 of medial and 32 of lateral meniscus. There were 19 tears of cruciates, of which 14 were of ACL and 5 of PCL. There were 61 normal cruciates, of which 26 were ACL and 35 were PCL.

Discussion: The area under the curve of magnetic resonance imaging was 87.6% percent for the medial meniscus, 89.1 percent for the lateral meniscus, 76.1 percent for ACL, and 87.1 percent for PCL in this series of 40 patients. Various intra articular pathologies of the knee such as loose bodies, chondral fractures, degenerative changes, plicae can mimic a meniscal tear. Mucoïd and eosinophilic degeneration can cause false positive results on MRI¹⁵. Magnetic resonance imaging is useful as a diagnostic tool in internal derangements of the knee. It is useful in circumstances where there is a need for detailed differential diagnosis. Magnetic resonance imaging also helps the surgeon to plan the definitive management of a tear during the same session.

Conclusion: Magnetic resonance imaging is useful as a pre operative diagnostic tool in selected cases where a clinical examination cannot be performed as in acute injuries or in cases where clinical examination is inconclusive. The efficacy of MRI in diagnosing a tear varies among different intra articular structures.

Index Terms - MRI, IDK, ACL, PCL.

I. INTRODUCTION

The knee joint is one of the most commonly injured joints, as an isolated injury or a frequent component in a multiple trauma patient. The knee is a complex joint, consisting of two condylar joints between the corresponding condyles of femur and tibia and a sellar joint between the patella and femur¹.

The principal intraarticular structures in knee are the two menisci, the two cruciate ligaments, and the two collateral ligaments. The menisci serve to distribute joint fluid, cartilage nutrition, mechanical shock absorption, increasing the surface area of the joint and therefore the stresses, serve to stabilize the joint, and a weight bearing function. The cruciate ligaments function as stabilizers of the knee in both forward and backward motions of the tibia on the femur and provide an axis around which both medial and lateral rotary movements are assisted². The injury to these intraarticular structures is generally termed as "Internal derangement of knee" which was first coined by William Hey in 1784³.

Traumatic knee injuries were conventionally assessed clinically, and subjected to radiographs. In modern Orthopaedics, MRI and a subsequent arthroscopic procedure has come of age.

A detailed clinical examination, with the numerous stability tests provide an almost 70% accuracy in diagnosing the pathology^{4,5,6}. However, in the acute stage following injury, clinical tests may not be appropriate due to pain, thus an MRI is the preferred modality of investigation. It is non invasive, and considered to be highly sensitive to meniscal injuries^{7,8,9} but is less so for the Anterior cruciate ligament injuries¹⁰.

Arthroscopy of the knee is a key hole surgery performed as a daycare procedure. There are many indications however, this study is to correlate the findings subsequent to an MRI diagnosis.

II. AIM AND OBJECTIVES

1. To observe the sensitivity and specificity of MRI in detecting cruciate ligament tears, confirmed subsequently with Arthroscopy.
2. To observe the sensitivity and specificity of MRI in detecting meniscal tears.
3. To categorize discrepancies in findings of the menisci and cruciate ligaments between arthroscopy and MRI.

III. MATERIAL AND METHODS

We studied 13 females and 27 males who were consecutively referred from general practitioner presented to the department of ORTHOPAEDICS between February 2010 and January 2011, clinically diagnosed to have an internal derangement of knee, and who underwent an MRI, followed by Arthroscopy of the knee, are included in the study.

A thorough history was taken and physical examination of the injured knee was performed.

MRI examination were performed on all patients in the study, at our institute using a Siemens Sonata- Maestro class 1.5T MRI system with a gradient strength of 40mT/m. with dedicated knee coils. The scans were made in sagittal, coronal, and axial planes of the knee, with T1- , T2- ,STIR, PD and PD with fat suppression images. All the sections were 3mm thick. Patients were placed supine in MRI scanner and the involved extremity was flexed 15 degrees during the sagittal images to obtain better sections of the ACL¹¹.

MRI images were reported on an objective proforma by a single senior consultant radiologist, who was blinded to the clinical findings.

After reaching to a MRI diagnosis, the patients were subjected to an arthroscopy of the affected knee. All the arthroscopies were performed by a single knee surgeon. The arthroscopic findings were recorded. Then the findings of MRI and arthroscopy were compared and analyzed.

MRI diagnosis were placed into one of the four categories after arthroscopic evaluation¹² :

1. True positive: When MRI diagnosis of tear was confirmed on arthroscopic evaluation.

2. True negative: If the diagnosis of no tear was confirmed on arthroscopy.

3. False positive: If MRI showed a tear but arthroscopy was negative

4. False negative: If MRI images were negative but arthroscopy showed a tear.

Based on the above categories, five parameters were calculated to assess the reliability of the MRI results¹³:

1. Sensitivity: sensitivity of MRI is the ability of the MRI to detect an abnormality. It is determined by the equation :
 $\text{True-positive} / (\text{true-positive} + \text{true negative}) \times 100 \text{ per cent.}$

2. Specificity: specificity of MRI is the ability of MRI to give how many detected tears are usually accurate. It is determined by the equation:

$\text{True-negative} / (\text{true negative} + \text{false positive}) \times 100 \text{ per cent.}$

3. Positive predictive value: It correlates a positive result of MRI with findings of arthroscopy. It is calculated by the equation:

$\text{True-positive} / (\text{true-positive} + \text{false positive}) \times 100 \text{ per cent.}$

4. Negative predictive value: It correlates a negative result on MRI with the findings of arthroscopy. It is calculated by the equation:

$\text{True-negative} / (\text{true-negative} + \text{false-negative}) \times 100 \text{ per cent.}$

Statistical analysis

All the continuous data were represented by mean with standard deviation. Categorical data were presented by frequency with percentage and it was analyzed by using Chi-square and Fischer exact test. Sensitivity, specificity, Positive predict value and

Negative predictive value was used for comparison between MRI and Arthroscopy.

All the analysis was done by using SPSS 19.0 version, A p value less than 0.05 was considered as significant.

IV. RESULTS

The results obtained from MRI were compared to those of arthroscopic findings.

Magnetic resonance imaging performed on the injured knees revealed 30 tears of the menisci, of which 20 were of medial meniscus and 10 tears of lateral meniscus. There were 21 tears of the cruciate ligaments, out of which 15 were tears of ACL and 6 of PCL.

50 menisci on MRI were normal, of which 20 were medial meniscus and 30 lateral meniscus. Of the 60 cruciates showing normal signal on MRI, 25 were of ACL and 35 of PCL.

Arthroscopy revealed 27 tears of menisci, 19 of these were of medial meniscus and 8 of lateral meniscus. 53 menisci were normal on arthroscopy, 21 of medial and 32 of lateral meniscus. There were 19 tears of cruciates, of which 14 were of ACL and 5 of PCL. There were 61 normal cruciates, of which 26 were ACL and 35 were PCL (table 1).

Table.1

	Normal		Tears	
	MRI	SCOPY	MRI	SCOPY
ACL	25(62.5%)	26(65%)	15(37.5%)	14(35%)
PCL	34(85%)	35(87.5%)	6(15%)	5(12.5%)
Medial meniscus	20(50%)	21(52.5%)	20(50%)	19(47.5%)
Lateral meniscus	30(75%)	32(80%)	10(25%)	8(20%)

With regards to tears of medial meniscus, comparison of the findings of magnetic resonance imaging with those of arthroscopy revealed 17 true positive, 18 true negative, 3 false positive and 2 false negative images. Area under the curve 87.6%, sensitivity was 89.5 per cent, specificity was 85.7 per cent, positive and negative predictive values were 85.0 and 90.0 per cent respectively.

For the lateral meniscus, there were 7 true positive, 30 true negative, 2 false positive and 1 false negative results. Area under the curve 89.1%, sensitivity was 87.5, specificity was 93.8 per cent. Positive and negative predictive values were 77.8 and 96.8 per cent respectively.

For the anterior cruciate ligament, there were 23 true positive, 10 true negative, 4 false positive and 3 false negative results. Area under the curve 76.1%, sensitivity was 88.5 percent, specificity was 71.4 percent and positive and negative predictive values were 85.2 and 76.9 percent respectively.

For the posterior cruciate ligament, there were 4 true positive and 33 true negative results. There were 2 false positive, and 1 false negative results and area under the curve is 87.1%, sensitivity is 80%, specificity is 94.3, positive predictive value 66.7% and negative predictive value were 97.1%.

V. DISCUSSION

The area under the curve of magnetic resonance imaging was 87.6% percent for the medial meniscus, 89.1 percent for the lateral meniscus, 76.1 percent for ACL, and 87.1 percent for PCL in this series of 40 patients.

Imaging of the menisci showed 5 false positive and 3 false negative results of which 3 false positive results were of medial meniscus, and 2 of lateral meniscus. 2 false negative images were of medial meniscus and 1 of the lateral meniscus.

Among the 3 false positive results of medial meniscus, 2 menisci showed significant fraying due to degeneration, which was reported as a tear on MRI, and 1 knee showed a loose body whose signal was falsely reported as a tear in medial meniscus.

In both the false positive results of lateral menisci, the normal signal of the transverse meniscal ligament was reported as a tear of anterior horn.

The false negative results which were obtained were 2 for the medial and 1 for the lateral meniscus. Out of this 1 medial meniscus and the lateral meniscus had a tear on arthroscopy but it was reported as intra substance degeneration on MRI.

Imaging of the cruciate ligaments in this study showed 4 false positive and 3 false negative results, all of which were for the anterior cruciate ligament. There were no false positive or false negative results for the PCL in this study.

The false positive results for ACL were attributed to the presence of large ligamentum mucosum, which was reported as a tear in the substance of ACL.

In 2 of the 3 false negative results, the ACL was found to be lax on probing, which was probably due to a partial tear, and 1 tear was proximal and ACL was found attached to the PCL, which was hence reported as normal.

The receiver operating characteristic (ROC) analysis was used to validate the discriminative ability of MRI in distinguishing between a tear and normal pathology, which was confirmed or proven wrong by arthroscopy. The area under the curve (AUC) was 87.6%, 89.1%, 76.1%, and 87.1% respectively for medial meniscus, lateral meniscus, ACL and PCL respectively, which is statistically significant¹⁴.

The results of this study is in accordance to the literature which suggests an accuracy of 68 to 88 percent for the meniscal tears¹⁵ and 80 to 94 percent for the cruciate ligament tears¹⁶.

Various intra articular pathologies of the knee such as loose bodies, chondral fractures, degenerative changes, plicae can mimic a meniscal tear. Muroid and eosinophilic degeneration can cause false positive results on MRI¹⁵.

Post operative cases with metallic implants around the knee produce artifacts on MR images and an erroneous interpretation of the images is likely in such cases.

Magnetic resonance imaging is useful as a diagnostic tool in internal derangements of the knee. It is useful in circumstances where there is a need for detailed differential diagnosis. It is also an important diagnostic tool in cases of acute and painful knees, where clinical examination is difficult to perform.

Currently MRI is gaining popularity as a diagnostic tool in knee injuries due to increasing sports injuries, and road traffic accidents.

A further improvement in the techniques and increasing experience in interpretation of the images is likely to reduce the false positive and false negative results in future.

Magnetic resonance imaging also helps the surgeon to plan the definitive management of a tear during the same session.

VI. CONCLUSIONS

1. Magnetic resonance imaging is useful as a pre operative diagnostic tool in selected cases where a clinical examination cannot be performed as in acute injuries or in cases where clinical examination is inconclusive.
2. The efficacy of MRI in diagnosing a tear varies among different intra articular structures.
3. MRI has a high accuracy in diagnosing a tear of PCL.
4. Sensitivity for medial meniscal tear is higher as compared to lateral meniscus and high for PCL as compared to ACL.
5. MRI has a high positive predictive value for ACL, but has a low negative predictive value.
6. For PCL tears, MRI has a high negative predictive value which indicates that with a negative result for PCL on MRI, a diagnostic arthroscopy can be avoided.

REFERENCES

- [1] Peter L Williams, Roger Warwick : Arthrology; Gray's anatomy 36th ed. 482
- [2] Robert H, Miller III, Frederick M. Azar : Knee injuries; Campbell's operative orthopaedics. 11th ed. 2410.
- [3] Hughston JC: Acute knee injuries in athletes, Clin Orthop 23:114,2962.
- [4] Terry GC, Tagert BE, Ypung MJ. Reliability of the clinical assessment in predicting the cause of internal derangement of the knee. Arthroscopy 1995;11:568-576
- [5] Abdou P, Arnbjornsson AH, Egrund N, Lindstrand A, Odenbring S, Pettersson H. Lateral meniscal lesions in patients with clinically suspected medial lesions, Acta Orthop Scan 1989;60:453-456.
- [6] Munk B, Madsen F, Lundorf E: Clinical MRI and arthroscopic findings in knees. Journal of Arthroscopy. 1998 March;4(2):171-5.
- [7] Gillies, Hamish, Seligson, David: Precision in diagnosis of meniscal lesions: A comparison of clinical evaluation, Arthrography, and arthroscopy. J. Bone and joint surg., 61-A: 343-346, April 1979
- [8] Edwin H. G. Oei, Msc, Jeroen J. Nikken, MD, Antonia C. M. Verstijnen, Msc, Abida Z. Ginai, MD, PhD and M.G. Myriam Hunink, MD, PhD: MR imaging of the menisci and cruciate Ligaments: A systematic review. Radiology 2003;226:837-848.
- [9] Quinn SF, Brown TF. Meniscal tears diagnosed with MR imaging versus arthroscopy: how reliable a standard is arthroscopy? Radiology 1991; 181:843-847.
- [10] Barry KP, Mesgarzadeh M, Triolo J, Moyer R, Tehranzadeh J, Bonakdarpour A. Accuracy of MRI patterns in evaluating anterior cruciate ligament tears. Skeletal Radiol 1996;25;365-370.
- [11] Lerman JE, Gray DS, Schweitzer ME, Bartolozzi A . MR evaluation of the anterior cruciate ligament: value of axial images. J comput assist tomogr. 1995 jul-aug; 19(4): 604-7.
- [12] Fleiss JL. The statistical basis of meta-analysis. Stat Methods Med Res. 1993;2(2):121-45.
- [13] Mackenzie R, Palmer CR, Lumas DJ. Magnetic resonance imaging of the knee: diagnostic performance studies. Clin Radiol 1996; 51:251-255.

- [14] Moses LE, Shapiro D, Littenberg B. Combining independent studies of a diagnostic test into a summary ROC curve: data-analytic approaches and some additional considerations. *Stat Med.* 1993 Jul 30;12(14):1293-316.
- [15] Herman LJ, Beltran J: Pitfalls in MR imaging of the knee, *Radiology* 167:775,1988.
- [16] Tung GA, Davis LM, Wiggins ME, Fadale PD. Tears of the anterior cruciate ligament: Primary and secondary signs at MR imaging. *Radiology*, 1993;188:661-7.

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