Correlation between MRI and arthroscopic findings in injuries of knee joint

Manoj MK1, Brijesh Ray RS2, Jose Francis3

ABSTRACT

The introduction of MRI led to a revolutionary change in medical diagnosis. The comparison of MRI diagnosis and surgical/clinical findings has always been a challenge for the health professionals especially Orthopedic surgeons. MRI has proven to be accurate for the diagnosis of intra and periarticular pathology, especially for meniscal pathology (accounting for 86% of the indication for arthroscopy) and ligamentous injury.

Aims and Objectives: To compare and correlate the MRI appearances of meniscal and ligamentous injuries and its various types with arthroscopy, to find out the specificity, sensitivity, positive and negative predictive values of MRI in diagnosing different injuries, to know the role of different sequences in diagnosing these injuries and to study the limitation of MRI in detecting injuries of the knee.

Materials and Methods: This was a prospective study of 80 patients to compare and correlate the MRI appearances of meniscal and ligamentous injuries and its various types with arthroscopy.

Results: Out of the 80 patients 35(43.75%) showed ACL injury, 23(28.75%) showed medial meniscus tear, 11(13.75%) showed lateral meniscus tear, 4 (5%) showed PCL injury, 4(5%) showed MCL injury and 3(3.75%) showed LCL tear.

Conclusion: MRI is a very useful non-invasive modality having high sensitivity and specificity in detecting IDK. MRI can be considered at par with arthroscopy in the diagnosis of meniscal and cruciate ligament tears.

Keywords: MRI, arthroscopy, collateral ligaments, ACL, PCL, meniscus, specificity, sensitivity

INTRODUCTION

The introduction of MRI led to a revolutionary change in medical diagnosis. The comparison of MRI diagnosis and surgical/clinical findings has always been a challenge for the health professionals, especially Orthopaedic surgeons.

The injury to the intraarticular structures of knee joint is generally termed as “Internal derangement of knee” which was first coined by William Hey in 1784. In early days, knee injuries were assessed clinically and subjected to radiographs. A detailed clinical examination, with numerous stability tests provide almost 70-80% accuracy in diagnosing the pathology.

However, in the acute stage following injury, clinical tests may not be appropriate due to pain. Thus MRI is the preferred modality of investigation. MRI is very useful but, as is said of arthroscopy, it is no substitute for clinical acumen.

Rapidly progressing medical technology has all but obscured the importance of history and physical examination. MRI and a subsequent arthroscopic procedure has come of age.

MRI has proven to be accurate for the diagnosis of intra and periarticular pathology, especially for meniscal pathology (accounting for 86% of the indication for arthroscopy) and ligamentous injury. MRI knee can avoid about 35% of arthroscopies but a knee which is producing definite mechanical symptoms will need arthroscopic surgery whatever is shown on MRI.

The clinical problem is to try to avoid MRI for patients and to prevent invasive arthroscopy when there are no surgically treatable lesions. The specialist knee surgeon performed fewer negative arthroscopies and had more positive MRI scans than his colleagues. This suggests that better clinical skills allowed a more economical use of resources.
AIM OF THE STUDY

1. To compare and correlate the MRI appearances of meniscal and ligamentous injuries with arthroscopy
2. To find out the specificity, sensitivity, positive and negative predictive values of MRI in diagnosing different injuries.
3. To know the role of different sequences in diagnosing these injuries.
4. To study limitation of MRI in detecting injuries of the knee.

MATERIALS AND METHODS

The sample size was 40. All the patients who underwent both MRI and arthroscopy of the knee following injury to knee were included in the study. Patients with neoplasm, inflammatory or infectious disorders or patients suffering significant injury to the knee between time of MRI and arthroscopy were excluded. Cases with multiple ligamentous injuries in the same knee were also excluded.

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

1. True positive: MRI diagnosis of tear, confirmed on arthroscopic evaluation
2. True negative: MRI diagnosis of no tear was confirmed on arthroscopy
3. False positive: 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, four parameters were calculated to assess the reliability of the MRI results:

- Sensitivity: sensitivity of MRI is the ability of the MRI to detect an abnormality. It is determined by the equation: True-positive/ (true-positive + true negative) x 100 per cent.
- Specificity: specificity of MRI is the ability of MRI to give how many detected tears are usually accurate. It is determined by the equation: True-negative/ (true negative + false positive) x 100 per cent.
- Positive predictive value: It correlates a positive result of MRI with findings of arthroscopy. It is calculated by the equation: True-positive/ (true-positive + false positive) x 100 per cent.
- Negative predictive value: It correlates a negative result on MRI with the findings of arthroscopy. It is calculated by the equation: True-negative/ (true-negative + false-negative) x 100 per cent.

OBSERVATIONS

Age ranged between 15-61 years. 12.5% were below 20 years, 63.7% were between 21-40 years, 18.75% were between 41-60 years. More than 60 years 5%. The mean age was 30 years and the maximum number of patients affected belongs to the age group of 21-40 years. Males comprised 65.31% of the cases, and females 34.68%.

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACL tears</td>
<td>43.75</td>
</tr>
<tr>
<td>Med. Meniscal tear</td>
<td>28.75</td>
</tr>
<tr>
<td>Lat. Meniscal tear</td>
<td>13.75</td>
</tr>
<tr>
<td>PCL tears</td>
<td>5</td>
</tr>
<tr>
<td>MCL tears</td>
<td>5</td>
</tr>
<tr>
<td>LCL tears</td>
<td>3.75</td>
</tr>
</tbody>
</table>

Table 1. Distribution of ligament pathology

<table>
<thead>
<tr>
<th>Location of tear (%)</th>
<th>MRI</th>
<th>Arthroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid substance</td>
<td>65.75</td>
<td>62.85</td>
</tr>
<tr>
<td>Femoral attachment</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Tibial attachment</td>
<td>14.25</td>
<td>17.15</td>
</tr>
</tbody>
</table>

Table 2. Location of tears in the anterior cruciate ligament

<table>
<thead>
<tr>
<th>Posterior Cruciate Ligament</th>
</tr>
</thead>
<tbody>
<tr>
<td>No of tears identified by Arthroscopy : 4</td>
</tr>
<tr>
<td>No of tears identified by MRI : 4</td>
</tr>
<tr>
<td>Accuracy of MRI in diagnosing PCL injuries : 100%</td>
</tr>
</tbody>
</table>

Meniscal Tears

Only grade 3 tears were compared as grade 1 / 2 do not reach up to the articular surface and hence invisible to arthroscopic surface evaluation. Out of 80 patients 23 (28.75%) showed medial meniscus and 11 patients (13.75%) showed lateral meniscal tears on MRI. 18 patients (78.95%) had posterior horn tear and 5 patients (21.05%) had anterior horn.
tars of medial meniscus. On arthroscopy posterior horn tears were seen in 17 patients (73.91%), anterior horn tears in 4 patients (17.4%) and middle one third tears in 2 patients (8.7%).

The accuracy for MRI in demonstrating medial meniscal tears was 95% and for lateral meniscal tears it was 93.75%. The accuracy in demonstrating horizontal tears was 95%. The accuracy for longitudinal tears was 96.25%, complex tears and radial tears 98.75%. For bucket handle and root tears, the accuracy was 100%.

Collateral ligaments
MRI detected 4 medial collateral ligament and 3 lateral collateral ligament injury which was confirmed by arthroscopy, thus giving a 100% accuracy rate.

DISCUSSION
Out of the 80 patients 35(43.75%) showed ACL injury, 23(28.75%) showed medial meniscus tear, 11(13.75%) showed lateral meniscus tear, 4 (5%) showed PCL injury, 4(5%) showed MCL injury and 3(3.75%) showed LCL tear.

Cruciate Ligament Tears
Most common sign of ACL Injury in MRI was hyperintensity. A critical review of false positive and false negative findings in MRI showed 1 false positive and 1 false negative case. False positive case had both primary and secondary findings. Cause of primary finding was non visualisation of ACL and the causes for the secondary findings is unclear; they may have reflected the physiological ligamentous laxity.

In the false negative case that had a partial tear as seen in arthroscopy the MR image showed a linear band of intact fibers normally oriented in expected location of the ACL. Studies have show that MR imaging has low sensitivity (40-75%) but moderate to high specificity (62-94%) in diagnosis of partial tears.

In light of the fact that PCL is usually very easily visualised as a homogenous, continuous low signal structure in MRI all PCL tears were accurately detected and the same confirmed in arthroscopy.

Meniscal tears
Medial meniscus tears are twice as common as lateral meniscus tears. Grade III tear of the medial meniscus was seen in 23 cases (28.75%), grade II in 10(12.5%) and grade I in7 (8.75%). Grade III tear of the lateral meniscus was seen in 11 cases (13.75%), grade II in 7(8.755%) and grade I in 6 (7.5%).

Explanation for apparent discrepancy between MRI and arthroscopy
1. Misinterpretation of normal anatomy like meniscofemoral ligaments etc
2. The presence of intrasubstance tears
3. Operator dependence
4. Presence of loose bodies

Two false positive cases in MRI involved the posterior horn of medial meniscus. Exact cause were not apparent. 1 false positive lateral meniscal tear may be due to pseudo tear appearance caused by meniscofemoral ligament. Studies have shown that accuracy of arthroscopy in identification of inferior surface tears of posterior horn of lateral meniscus is as low as 45%-65%.

Eight cases showed horizontal oblique tear in both MRI/Scope. There were two false positive and false negative results each. False positive results may be due to misinterpretation of intrameniscal degenerative grade II signal for tear. False negative results were noted in cases with associated ACL tears and indicate the reduced sensitivity of MRI in identification of meniscal tear in the setting of ACL injuries.

Radial tears were noted in 4 cases of MRI and 5 cases of arthroscopy. All tears were noted on the posterior horn. Two cases showed cleft sign and one showed abrupt truncation of inner part of meniscus. Sensitivity was 80%. Sensitivity of MRI detecting radial tears is 37%-89%.

Four patients had bucket handle tears in MRI confirmed by subsequent arthroscopy. One showed double PCL sign and one had absent bow tie sign. Double PCL sign is 98% specific but 32% sensitive and absent bow tie sign is 62% specific and 71% sensitive. All patients showed more mobility of medial meniscus in association with ACL tears.

SUMMARY AND CONCLUSION
The degeneration and tears of menisci demonstrated as high signal intensity were due to imbibed synovial fluid. These tears are better demonstrated in short TE (Time of echo) images like T1 PD (Proton density) and GRE T2 images. This has been explained by stroller et al in their study. The interaction of synovial fluid with large macromolecules in menisci slows rotational rate of protons and shortens T1 and T2 values. In this study T2 weighted GRE images clearly depicted the tears than FSE images.
Double PCL sign, fragment in the notch sign, absent bow tie sign and truncated meniscus sign are the useful signs in detecting bucket handle tears.

Ghost sign, cleft sign, truncated triangle sign and marching cleft sign increases its sensitivity in identifying radial tears. Common cause of false positive findings in MRI is misinterpretation of intrameniscal signal changes (grade II signal changes or normal anatomy as tears. Presence of associated ACL injury decreases the sensitivity of MRI in identifying meniscal tears.

MRI should be done in all patients suspected of ligamentous injury, thus preventing unwanted arthroscopies. The astute orthopedic surgeon must be able to associate the findings on MRI in the decision making before and during arthroscopy. When one menisci or ligament is injured, always look diligently for other derangements.

Regarding generation of images, one should obtain spin echo or fat saturated fast spin echo images in all 3 planes, including both T1 and T2 weighted sagittal images. Sagittal images should be obtained in true orthogonal plane. In difficult cases, obtain additional history. One may also consider performing an additional flexed knee imaging or a double oblique coronal thin section T2W sequence. MRI is superior to Arthroscopy in detecting inferior surface tears of menisci.

REFERENCES

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