ROLE OF MRI IN INTERNAL DERANGEMENT OF KNEE JOINT IN CORRELATION WITH ARTHROSCOPY

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ABSTRACT

BACKGROUND

Trauma to knee joint is a significant cause of morbidity in the young, active individuals, especially amongst sports persons, trained soldiers and athletes. The most widely used diagnostic modalities to assess the joint injury are Arthroscopy and MRI. Magnetic Resonance Imaging (MRI) has now been accepted as the best imaging modality for non-invasive evaluation of knee injuries.

Aim **-** This study was undertaken to study the types and incidence of ligament injuries in traumatic knee joint by MR imaging and to compare with Arthroscopy findings.

MATERIALS AND METHODS

This is a prospective study of 50 cases of internal derangements of the knee, admitted to Government General Hospital, Kurnool between May 2011 and October 2013 who underwent MRI (XGy 0.35 Tesla) and Arthroscopy of the knee. Cases were taken according to exclusion and inclusion criteria, i.e. patients with knee problems more than 6 weeks old with symptoms of locking of the knee, patients with undiagnosed knee pain and knee injury. Only patients between 18 - 60 years are included in the study. Patients with claustrophobia, metal implants and cardiac pacemakers were excluded from the study.

RESULTS

MRI shows very good sensitivity in detecting meniscal tears and excellent sensitivity in detecting Anterior Cruciate Ligament (ACL) injuries with a very fewer number of false positives. MRI shows excellent sensitivity and specificity in cases of Posterior Cruciate Ligament (PCL) tears and osseous/Osteochondral Defects (OCD). Our study found that the accuracy of the MRI scans in diagnosing Internal Derangement of Knee (IDK) is in the order of PCL, OCDs, ACL and meniscal lesions.

CONCLUSION

MRI (magnetic resonance imaging) is an excellent, non-invasive, radiation free imaging modality with multiplanar capabilities and excellent soft tissue delineation. MRI has also very few false negative and false positive results. The negative predictive value of a scan was found to be high for all structures of the knee joint and hence a 'normal' scan can be used to exclude pathology, thus sparing patients from expensive and unnecessary surgery**.**

KEYWORDS

Knee, Arthroscopy, Internal Derangement, Menisci.

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BACKGROUND

Trauma to knee joint is a significant cause of morbidity in the young, active individuals, especially amongst military recruits, trained soldiers and athletes. Magnetic Resonance Imaging (MRI) has now been accepted as the best imaging modality for non-invasive evaluation of knee injuries. It has been reported to have a high diagnostic accuracy and does not involve the use of ionizing radiation. Since its introduction for clinical use in the mid-1980s, the role of MRI in the diagnosis of knee lesions has been well established. MRI is proved reliable, safe and offers advantages over diagnostic Arthroscopy, which is currently regarded as the reference standard for the diagnosis of internal derangements of the knee. In the context of trauma, post-traumatic limited range of motion and mechanical knee symptoms, MRI is generally considered a valuable diagnostic tool. MRI is a well-accepted imaging modality in the diagnostic work-up. The role of MRI in the diagnosis of patients with knee complaints and has largely replaced diagnostic Arthroscopy for this purpose. MRI is proved reliable, safe and offers advantages over diagnostic Arthroscopy, which is currently regarded as the reference standard for the diagnosis of internal derangements of the knee.

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Aims and Objectives

The present study was done to know the occurrence of ligament injuries following knee injuries, to compare the sensitivity and specificity of MRI and Arthroscopy in diagnosing internal derangements of the knee and to prove that MRI is mandatory in all cases of IDK.

MATERIALS AND METHODS

This is a prospective study involving 50 patients with a history of knee injuries who were admitted in the Department of Orthopaedics, Kurnool Medical College, Andhra Pradesh. MRI of the knee joint was done for all these patients either before or after admission with 0.35 Tesla XGY closed permanent magnet. The patients were then subjected to diagnostic and therapeutic Arthroscopy in the Department of Orthopaedics, Kurnool Medical College, between May 2011 and October 2013. Patients who suffered from knee problems like pain, instability for more than 6 weeks' duration, patients with recent symptoms of locking of the knee or effusion, chronic knee pain, doubtful knee injury and patients aged between 18 – 60 yrs. are included in the study. Patients who had previously undergone Arthroscopy with repair of the menisci and ligaments, patients not consenting to the study, patients with cardiac pacemakers, metal implants, neurostimulators and patients before 18 years and over 60 years were excluded from the study. MR images were reviewed by a senior radiologist in the Department of Radiodiagnosis for evidence of injuries to menisci, cruciate ligaments, collateral ligaments, articular cartilage, loose bodies, meniscal cysts and bony contusions in the knee joint. These patients were then taken for diagnostic and therapeutic Arthroscopy. Operative findings were documented in the operation theatre, which included the survey of the entire joint and anatomical structure, lesions involved with the presence or absence of tear, its location, status of the articular cartilage and others. The composite data was tabulated and studied for correlation with MRI findings and grouped into four categories as follows:

1. **True-Positive** - If the MRI diagnosis was confirmed by arthroscopic evaluation.
2. **True-Negative** - When the MRI negative for lesion and confirmed by Arthroscopy.
3. **False-Positive -** When the MRI shows lesion, but the Arthroscopy was negative.
4. **False-Negative** - Result when Arthroscopy was positive, but the MRI showed negative findings.

Statistical analysis was used to calculate the sensitivity, specificity, Positive Predictive Value (PPV) and the Negative Predictive Value (NPV) in order to assess the reliability of the MRI results. Data was analysed for the significant correlation between MRI knee and arthroscopic findings. If the sensitivity is between 90 - 100%, it is regarded as excellent correlation is there in between MRI and Arthroscopy; if it is between 80 - 90%, very good; if it is between 70 - 80%, good correlation; if it is 60 - 70%, average; and if it is less than 60% it is regarded as poor correlation.

RESULTS

In this prospective study involving 50 patients, of which 38 (76%) were males and 12 (24%) were females. The patient's age group ranged from 18 to 60 yrs. Maximum number of cases 28 (56%) were between 21 - 30 yrs. who were young and active individuals, especially sports persons. The right knee joint (28 patients) was found to be more commonly involved than the left knee joint (22 patients). The most common injuries were ACL tears followed by osseous/osteochondral defects. The sensitivity and specificity of MRI with respect to Arthroscopy in ACL tear is 93.2% and 83.4% (Table 1), for PCL tear was 100% and 100% (Table 2), for medial meniscal tears was 91.7% and 92.1% (Table 3), for lateral meniscal tears was 87.5% and 95.2% (Table 4) and for osseous/osteochondral defects is 100% and 100% (Table 5) respectively. Our study found that the accuracy of the MRI scans in diagnosing IDK is in the order of PCL, OCDs, ACL and meniscal lesions (Table 6).

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	41	1	42
Negative	3	5	8
	44	6	50

Table 1. Showing Comparison of ACL Injuries in MRI and Arthroscopy

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	3	0	3
Negative	0	47	47
	3	47	50

Table 2. Showing Comparison of PCL Injuries in MRI and Arthroscopy

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	11	3	14
Negative	1	35	36
	12	38	50

Table 3. Showing Comparison of Medial Meniscus Injuries in MRI and Arthroscopy

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	7	2	9
Negative	1	40	41
	8	42	50

Table 4. Showing Comparison of Lateral Meniscus Injuries in MRI and Arthroscopy

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	26	0	26
Negative	0	24	24
	26	24	50

Table 5. Showing Comparison of Osteochondral Injuries in MRI and Arthroscopy

Structure	Sensitivity	Specificity	Accuracy
ACL	93.2%	83.4%	92%
PCL	100%	100%	100%
Medial Meniscus	91.7%	92.1%	92%
Lateral meniscus	87.5%	95.2%	94%
Osseous/ Osteochondral defects	100%	100%	100%

Table 6. Showing Sensitivity, Specificity and Accuracy of the MRI in Diagnosing IDK in Correlation with Arthroscopy

Abbreviations

MRI - Magnetic Resonance Imaging.
ACL - Anterior Cruciate ligament.
PCL - Posterior Cruciate Ligament.

MM - Medial Meniscus.
LM - Lateral Meniscus.
OCD - Osteochondral Defects.
IDK - Internal Derangement of Knee Joint.
SPECT - Single Photon Emission Computed Tomography.

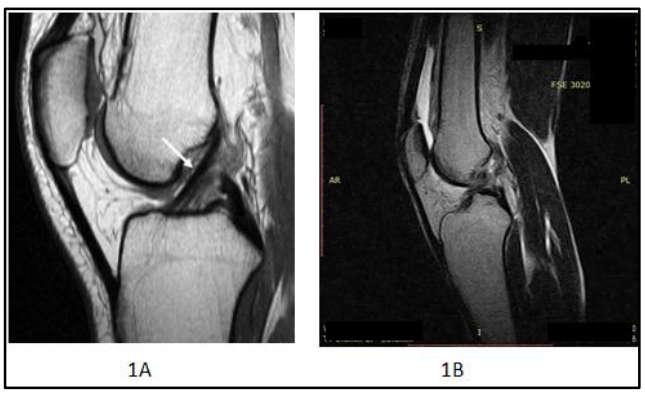

Image 1. Sagittal Proton-Density Image of the Knee showing Intact ACL with Striated Appearance in Figure 1A and Torn ACL with Fibre Discontinuity in Figure 1B

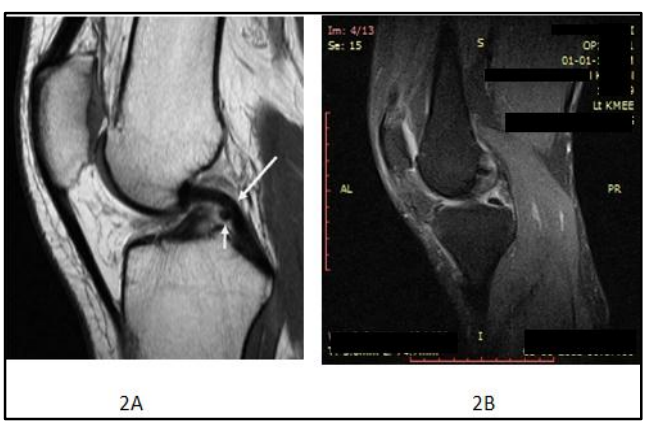

Image 2. Sagittal Proton-Density Image of the Knee showing Intact PCL in Figure 2A and Complete Tear PCL in Figure 2B Remove the Patient and Institute Name from the Figure

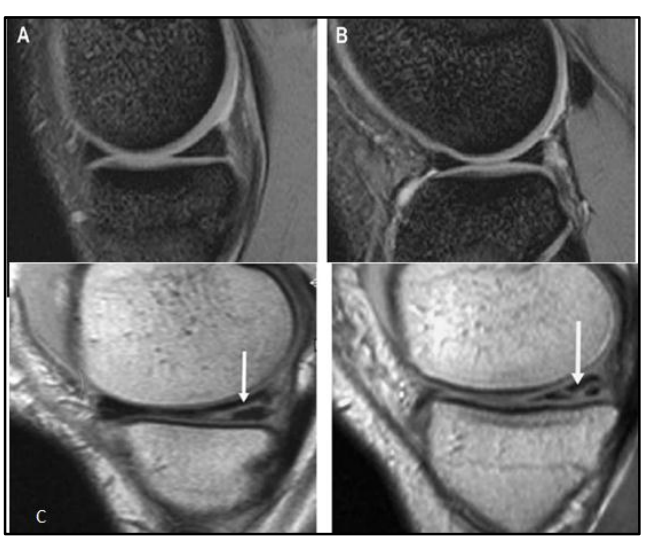

Image 3. Sagittal Proton-Density Image of the Knee showing Intact Medial and Lateral Meniscus in Figure 3A and 3B and Complex Tear Noted in Posterior Horn of Medial Meniscus in Figure 3C

DISCUSSION

In this prospective study involving 50 patients, 38 were males and 12 were females. The age groups ranging from 18 - 60 years. The youngest male patient was aged 18 yrs. and the oldest male was 43 yrs. and the youngest female was aged 18 yrs. and the oldest female was aged 57 yrs. This showed that there was a tendency of males being injured and getting operated at an earlier age. In the present study, males comprise the predominant number of patients suffering from knee injuries who are actively involved in sports. Young patients of age group 20 – 30 yrs. are maximum who suffered knee injuries. In our study, 28 patients were falling in this age group comprising 56% of the patients. The right knee was involved in 28 cases and left was involved in 22 cases and no bilateral involvement.

Meniscal tears were classified as torn or not torn; Anterior Cruciate Ligaments (ACL) and Posterior Cruciate Ligaments (PCL) were either completely torn or not. Any other knee pathologies including osteochondral defects, bone oedema and chondral lesions were grouped as other pathology.

The medial meniscus injury was noted in 14 patients and lateral meniscal injury was noted in 9 patients. In our study MRI detected 14 cases of medial meniscal injury; Arthroscopy confirmed only 12 cases. Sensitivity and specificity of MRI with respect to Arthroscopy is 91.7% and 92.1% showing an excellent correlation with Arthroscopy in diagnosing medial meniscal injuries. Elvenes et al[1] in their study found the sensitivity, specificity, positive and negative predictive value of MRI in medial meniscal tears were 100%, 77%, 71% and 100% respectively. In the present study sensitivity, specificity, positive and negative predictive value is 91.7%, 92.1%, 78.6% and 97.3% respectively and correlate with the findings of the above mentioned studies. Overall, MRI has a higher specificity (92.1%) than sensitivity (91.7%) and a higher NPV (97.3%) than the PPV (78.6) for medial meniscal injuries.

In our study, MRI detected 9 cases of lateral meniscal injury and Arthroscopy positive cases are 8 out of 50 cases. Sensitivity and specificity of MRI in relation to Arthroscopy are 87.5% and 95.2%. It had a very good correlation with Arthroscopy in diagnosing lateral meniscal injuries. The positive predictive value of MRI in detecting lateral meniscal injuries is 77.8% with negative predictive value of 97.5%. Overall, MRI has a higher specificity (95.2%) than sensitivity (87.5%) and a higher NPV (97.5%) than the PPV (77.8%). Elvenes et al[1] in their study found that sensitivity, specificity, positive and the negative predictive value of MRI for MM were 100%, 77%, 71% and 100% respectively, while values for LM were 40%, 89%, 33% and 91% respectively. The overall accuracy of MRI for MM and LM combined was 84%. On the basis of high negative predictive value, they concluded that MRI is useful to exclude patients from unnecessary Arthroscopy.

The sensitivity for diagnosing isolated medial meniscal tears in Rubin's series[2] was 98% and it decreased when other structures were also injured. The specificity in isolated lesions was 90%. In a multicentric analysis Fisher et al[3] reported an accuracy of 78 - 97% for the anterior cruciate ligament and 64 - 95% for medial meniscus tears. The menisci are composed of fibrous cartilage and appear as low signal structures on all pulse sequences. The sensitivity and specificity of MRI in detecting meniscal tears exceed 90%. Ryan et al[4] in a prospective study of comparison of clinical examination, MRI,

bone SPECT to detect meniscal tear reported high diagnostic ability of MRI along with bone SPECT to detect meniscal tears with a sensitivity and specificity of 80% and 71% respectively. Simultaneous injury to several supporting structures is relatively common in the knee. When more than one lesion was present, completely correct diagnosis was rendered only 30% of the time. This phenomenon was reported by Rubin.[2] In a prospective study reported by Imhoff et al,[5] the negative predictive value was 94%, but the positive predictive value was 54%. They concluded that due to a high negative predictive value, a normal MRI scan allows eliminating a meniscal lesion and so there is no need for a diagnostic Arthroscopy. However, in our study, MRI showed false results in a very few number of cases. For example, as far as medial meniscus concerns there were 03 false positive and 01 false negative diagnoses, whereas for lateral meniscus there were 02 false positive and 01 false negative diagnoses (PPV 78.6% and 77.8%; NPV 97.3% and 97.5%; for medial meniscus and lateral meniscus tears respectively).

There are several explanations for the misleading results of MRI regarding the menisci. Firstly, meniscal tears and meniscus degenerative changes have the same appearance on MRI by giving high signals within the meniscus.[6] Diagnosis then depends on the expansion of the high signal line towards the meniscus articular surface. Moreover, one of the most frequent causes for false positive MRI regarding the lateral meniscus is the misinterpretation of the signal coming from the inferior knee artery.[7] Helman et al[8] accredited in this structure about 38% of false positive MRI results. Often, the popliteal bursa or Humphrey's ligament may mimic posterior lateral meniscal tears as well. The occurrence of the false positive and false negative meniscal tears at MRI imaging has been noted earlier. There are explanations for this apparent discrepancy between the findings at MR imaging and Arthroscopy, Mink et al.[9]

- Misinterpretation of normal anatomy like meniscofemoral ligaments, etc.
- Osteochondral flap avulsion lesions mimic meniscal tears accounting for false positive cases.
- The observer dependency of MRI.
- The presence of loose bodies.
- Radial meniscal tears are difficult to visualise on MRI; hence, they account for number of tears missed by MRI.
- Some false positive findings on MRI can be attributed to inadequate visualisation of the meniscus at surgery and to the fact that the diagnosis of the tear can be subjective.
- False positive MRI scans seen in the posterior horn of medial meniscus may reflect an inability to completely visualise the area at Arthroscopy, and tears that extend to the inferior surface of the meniscus may be difficult to see.

Among the structure involved in knee injuries ACL injury is the most common accounting for 42 cases in MRI, of which 1 was false positive and Arthroscopy detected 41 of the 42 cases plus 3 new cases from the remaining (false negative of MRI). Sensitivity and Specificity of MRI with respect to Arthroscopy is 93.2% and 83.4% excellent with arthroscopy in diagnosing ACL tears. The positive predictive value of MRI is 97.6%, negative predictive value of MRI is 62.5%. Disruption of the anterior cruciate ligament, a major stabiliser of the knee, leads to loss of stability of the knee and potentially significant dysfunction, although the ACL is the most frequently torn ligament of the knee; the ACL tear has remained clinically elusive. These injuries account for a large number of referrals to hospitals. The evaluation of these lesions remains a difficult clinical problem. The MRI is a frequently used diagnostic modality for these internal derangements, because of being non-invasive, painless and unassociated with risk of radiation.

Ruptures near the ligaments insertion may be missed and MRI examination reveals an intact ACL. On the contrary, false positive ACL ruptures occur in cases of intrabody's mucosal or eosinophilic degeneration of ACL.[10] The accuracy, sensitivity and specificity values for knee lesions vary widely in the literature. Rubin et al[2] reported 93% sensitivity for diagnosing isolated ACL tears. Similarly, several prospective studies have shown a sensitivity of 92 - 100% and specificity of 93 - 100% for the MR imaging diagnosis of ACL tears.[11]

Out of 50 cases, MRI detected 3 PCL injury which was confirmed by Arthroscopy and hence sensitivity, specificity and positive and negative predictive values remains at 100% and shows excellent correlation in detecting PCL injuries. PCL injuries are most commonly associated with chip fractures near the tibial attachment. Three cases of PCL tear was detected both by MRI and Arthroscopy. The use of MRI to identify PCL tears has proven to be extremely accurate. This might be expected in light of the fact that the PCL is usually very easily visualised as a homogeneous, continuous low signal structure. Several studies have reported sensitivity, specificity, accuracy, positive and negative predictive value to be 99 - 100%. In our study too the sensitivity, specificity, accuracy, positive and negative predictive value was 100%.

There are 8 patients with collateral ligament injuries, which are confirmed by MRI; 5 patients have medial collateral ligament injuries and 3 patients have lateral collateral ligament injuries. In contrast to MCL which is injured frequently, LCL is relatively a strong stabiliser of the knee joint and is injured only in case of significant trauma. Collateral ligament injuries are best visualised in Coronal T2W sequence followed by STIR coronal and IRFSE coronal sequences in our study. In our institute, the arthroscopic surgeons do not as a routine study the collateral ligaments and arthroscopic repair of collateral ligaments is not done. In case MR imaging shows significant strain of collateral ligament and clinical tests for tear are also positive, then the orthopaedic surgeons perform an open surgery for repair of these ligaments. Hence, the arthroscopic correlation of collateral injuries was not available in this study.

In our study, osseous/osteochondral lesions were seen in 26 patients (52%). Most of these were bony contusions involving the femoral and tibial condyles. Sensitivity of MRI is 100% with a specificity of 100% shows excellent correlation with Arthroscopy in diagnosing osseous/osteochondral lesions. The positive predictive value of MRI is 100% with a negative predictive value of 100%. Ruwe et al[12] reported that preoperative MRI can prevent unnecessary Arthroscopy in 50% of patients, so is of great value and must be done preoperatively. Boeree et al[13] believe that clinical examination is of minor significance with sensitivity in diagnosing medial meniscus, lateral meniscus and ACL tear of 67%, 48% and 55% respectively.

CONCLUSION

Magnetic Resonance Imaging (MRI) is of great aid in the diagnosis of knee lesions. Most diagnostic studies comparing MRI and arthroscopy have shown good diagnostic performance in detecting lesions of the menisci and cruciate ligaments. Arthroscopy has remained the reference standard for the diagnosis of internal derangements of the knee against which alternative diagnostic modalities should be compared. The present study supports that MRI is very helpful in diagnosing meniscal and cruciate ligament injuries. Our study found that the accuracy of the MRI scans in diagnosing IDK is in the order of PCL, OCDs, ACL and meniscal lesions. The negative predictive value of a scan was found to be high for all structures of the knee joint and hence a 'normal' scan can be used to exclude a pathology, thus sparing patients from expensive and unnecessary surgery and MRI should be done in every suspected case of internal derangement of knee joints. In our Government General Hospital, Kurnool, we have done the study with low field strength MRI (0.35 Tesla) scanner. Cartilage injuries and various other minor lesions cannot be picked up by this 0.3 Tesla MRI. We evaluate mainly for grossly visible lesions like meniscal tears, cruciate ligament tears and collateral ligament injuries in our study. MR Arthrogram is not done in our study, as it is invasive and technically demanding procedure.

REFERENCES

1. Elvenes J, Jerome CP, Reikeras O, et al. MRI as a screening procedure to avoid arthroscopy for meniscal tears. Arch Orthop Trauma Surg 2000;120(1-2):14-6.
2. Rubin DA, Kettering JM, Towers JD, et al. MR imaging of knee having isolated and combined ligament injuries. AJR 1998;170(5):1207-13.
3. Fisher SP, Fox JM, Pizzo DW, et al. Accuracy of diagnosis from magnetic resonance imaging of the knee. A multi-centric analysis of one thousand and fourteen patients. JBJS Am 1991;73(1):2-10.
4. Ryan PJ, Reddy K, Fleetcroft J. A prospective comparison of clinical examination, MRI, bone SPECT, and arthroscopy to detect meniscal tears. Clin Nucl Med 1998;23(12):803-06.
5. Imhoff A, Buess E, Holder J, et al. Comparison between magnetic resonance imaging and arthroscopy for the diagnosis of knee meniscal lesions. Rev Chir Orthop Reparatrice Appar Mot 1997;83(3):229-36.
6. Dixon AK. Magnetic resonance imaging of meniscal tears of the knee. JBJS Br 1996;78(2):174-6.
7. Spiers AS, Meagher T, Ostlere SJ, et al. Can MRI of the knee affect arthroscopic practice? A prospective study of 58 patients. JBJS Br 1993;75(1):49-52.
8. Herman LJ, Beltran J. Pitfalls in MR imaging of the knee. Radiology 1988;167(3):775-81.
9. Mink JH, Levy T, Crues JV. Tears of the anterior cruciate ligament and menisci of the knee: MR imaging evaluation. Radiology 1988;167(3):769-74.
10. Hodler J, Haghighi P, Trudell D, et al. The cruciate ligaments of the knee: correlation between MR appearance and gross and histologic findings in cadaveric specimens. AJR Am J Roentgenol 1992;159(2):357-60.
11. Lee JK, Yao L, Phelps CT, et al. Anterior cruciate ligament tears. MR imaging compared with arthroscopy and clinical tests. Radiology 1998;166(3):861-4.
12. Ruwe PA, Wright J, Randall RL, et al. Can MR imaging effectively replace diagnostic arthroscopy? Radiology 1992;183(2):335-9.
13. Boeree NR, Watkinson AF, Ackroyd CE, et al. Magnetic resonance imaging of meniscal and cruciate injuries of the knee. JBJS Br 1991;73(3):452-7.