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Correlation between MRI knee and arthroscopy in knee joint injuries

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Abstract
In absence of joint effusion, meniscal degeneration and tears may actually decrease in SI on T2 WI. On T2* GRE images however, intrasubstance degeneration and tears generate increased SI. Hence GRE sequence is extremely sensitive to the spectrum of meniscal degeneration and tears. The FSE may underestimate the extent or Grades of MR SI thus mask the tears, which is because of a ghosting artifact or an increase in magnetization transfer as described by Rubin and colleagues. To understand the significance of increased SI in meniscal abnormalities, Stoller *et al.* developed a MR grading system of meniscal abnormalities and correlated with pathological model. Purposive random technique was used to select minimum of Thirty cases with history of knee trauma which are referred for MRI to Department of Radiodiagnosis; Medical College. MRI (Hitachi Aperto 0.4 Tesla) study has been done using Tl, T2, PD, fat suppression and gradient echo sequences in various planes. Images were studied for meniscal, cruciate ligament, collateral ligaments tear, fluid collections in and around the joint and also for any signal changes in the surrounding bones, muscles and tendons. Then these cases were subjected to arthroscopy.

Keywords: Knee injury, MRI, arthroscopy

Introduction
The normal meniscus demonstrates homogenous low SI on T2, T2 GRE &STIR images, which is attributable to lack of mobile protons (water molecules within the meniscus are closely related to or absorbed within larger collagen macromolecules). Subsequent dephasing of hydrogen nuclei result in shortening of T2 times, contributing to low SI of meniscal tissue on all pulse sequences. Degeneration and tears of menisci demonstrate increased SI due to imbibed synovial fluid. The interaction of synovial fluid with larger macromolecules in the meniscus slows the rotational rates of protons and shortens T1 & T2 values. This phenomenon explains the sensitivity of Tl, PD, T2 WI in revealing meniscal degeneration and tears. Degenerative changes and tears also result in local increase in degree of freedom of trapped water molecules, resulting in increased T2 times and allowing detection of Increased SI on short TE sequences. Therefore increased intrameniscal SI in degeneration and tears is best visualized in short TE images using Tl, PD or GRE sequences [1].
In absence of joint effusion, meniscal degeneration and tears may actually decrease in SI on T2 WI. On T2 GRE images however, intrasubstance degeneration and tears generate increased SI. Hence GRE sequence is extremely sensitive to the spectrum of meniscal degeneration and tears. The FSE may underestimate the extent or Grades of MR SI thus mask the tears, which is because of a ghosting artifact or an increase in magnetization transfer as described by Rubin and colleagues. To understand the significance of increased SI in meniscal abnormalities, Stoller *et al.* developed a MR grading system of meniscal abnormalities and correlated with pathological model [2].
Grade I - a nonarticular focal/globular intrasubstance increase in SI. Histologically correlates with foci of early mucinous degeneration and chondrocyte deficient or hypocellular regions, which usually occurs in response to mechanical loading and degeneration. Gr 1 SI may be observed in asymptomatic athletes and normal volunteers and is not clinically significant.
Grade II - Horizontal, linear, intrasubstance increase in SI usually extends from capsular periphery of meniscus but does not involve an articular surface. The mucinous ground substance gets accumulated preferentially in middle perforating collagen bundle. This represents shear plane of meniscus and is site of horizontal degenerative tears.

Patients are usually asymptomatic; most commonly occur in posterior horn of medial meniscus. With exception of Gr II SI in discoid meniscus, it is not common practice to surgically treat these tears even in a symptomatic patient. Grade III- An area of increased SI communicates or extends to at least one articular surface. A meniscus may contain multiple areas of Gr ill SI or the entire meniscal segment may be involved, with irregular morphology. Because the meniscus is an innervated structure, intrasubstance tears may present with pain in these radiologically abnormal menisci [3].

The morphology of the menisci should be assessed when evaluating meniscal lesions. Normal meniscus measures 3-5mm in height. MM varies in width 6mm in anterior horn and 12mm in posterior horn. The LM is approximately 10mm in width throughout its length. Gr III SI is most frequent in posterior horn of MM, because of increased stress and strain generated on the undersurface of the MM with femoral tibial rotations [4].

Levinson *et al.* from their study found that the accuracy of arthroscopy in identification of inferior surface tears of posterior horn of MM is as low as 45-65%. Further arthrography and arthroscopic surface evaluation are insensitive to Gr I & II intrasubstance degeneration as precursors to the formation of a defined meniscal tear as described by Raunest *et al*. MR also detects multiple meniscal tears that may be overlooked on arthrography.

The significant advances have been made in imaging of knee in MRI, which has clearly emerged as a primary tool in the evaluation of knee injuries and for the proper management. With the development of new sequences with improved SNR, higher resolution, reduced artifacts, shorter imaging times and improved accuracy, MRI has changed the traditional algorithm for workup of knee joint pathology, particularly when internal derangement in cases of twisting injuries to the knee is suspected [5].

The knee joint is a common site of injury. Most cases are due to trauma, repetitious activities and due to sports.

Multiple imaging modalities are currently used to evaluate pathologic conditions of the knee including conventional radiography, fluoroscopy, sonography, nuclear medicine and MR imaging. The use of fluoroscopy and sonography to guide interventional procedures and Computerized Tomography (CT) to evaluate complex fractures has become routine.

Magnetic resonance imaging has revolutionized our ability to understand the soft tissue anatomy and pathology of musculoskeletal system. Increased soft tissue contrast coupled with multi planar slice capability has made magnetic resonance imaging ideal modality for imaging complex anatomy [6].

Another advanced modality in the management of internal derangement of knee joint is Arthroscopy, which can be used in its dual mode, either as diagnostic or as therapeutic tool.

Methodology

Purposive random technique was used to select minimum of Thirty cases with history of knee trauma which are referred for MRI to Department of Radiodiagnosis; Medical College. MRI (Hitachi Aperto 0.4 Tesla) study has been done using Tl, T2, PD, fat suppression and gradient echo sequences in various planes.

Images were studied for meniscal, cruciate ligament, collateral ligaments tear, fluid collections in and around the joint and also for any signal changes in the surrounding bones, muscles and tendons. Then these cases were subjected to arthroscopy.

Method of Data Analysis

Collected data was presented in the form of tables and diagrams. Sensitivity, specificity and predictive values were calculated. Data was analysed for finding the significant correlation between MRI knee and arthroscopic findings by kappa statistics.

Imaging Protocol

Techniques for imaging the knee vary greatly among imaging centers. Experience, individual preferences and equipment such as the coil and magnetic field strength affect the resulting protocol.

Specific imaging techniques can increase the sensitivity and specificity for particular knee disorders, so a short relevant clinical history greatly helps to optimize the protocol for maximum diagnostic information.

Pulse Sequences and Imaging Planes

We used SE, fast sequences such as GRE, FSE OR STIR sequences. The three standard imaging planes used are the direct coronal, sagittal and axial views. We examined the knee in these three planes using a FOV of 16X16 cm, 256 X 256 matrix, & 3 mm slice thickness.

An axial acquisition through patellofemoral joint is used as initial localizer for subsequent sagittal and coronal plane images. The coronal plane optimally evaluates the collateral ligament and body of the menisci. The sagittal plane reveals the cruciate ligaments, menisci and synovial anatomy especially the suprapatellar pouch. Overall the bones, muscles, tendons and neurovascular structures are fully evaluated with integration of all three planes.

Positioning and Coil Selection

Patient is placed in supine position with the knee in a closely coupled extremity coil. The knee is externally rotated 15-20°, in order to facilitate the visualisation of ACL completely on sagittal images (I1). The knee is flexed slightly 5-10°, to increase the accuracy of assessing the patellofemoral compartment and patellar alignment (69) Excessive flexion or hyperextension does not permit accurate evaluation of patellar alignment.

The MRI was performed within a time period of 6 days to 30 days from the date of injury. The time lag between MRI and arthroscopy was 1 day to 30 days with an average of 7 days. The time varied according to the convenience of the patient, the surgeon and the availability of the operating room. The MRI imaging studies were reviewed by two senior radiologists who were blinded to initial MR imaging interpretations if any. All observations were made from the film hard copy images and from the monitor. The images were reviewed for the presence or absence of meniscal tears and evaluated for ACL or PCL tears.

The criterion that was used for determining the presence of a meniscal tear was the presence of a high signal that extended to one of the articular borders of the meniscus {Grade 3}. The diagnostic criteria for ACL and PCL tears was the presence of any of the primary signs as mentioned earlier.

The same senior surgeon who is specialized in arthroscopy

conducted arthroscopies of all cases reviewed in this study. He was not informed about the MRI findings prior to the procedure. Arthroscopy was performed through anteromedial and anterolateral portals to look for suprapatellar pouch, medial gutter, medial joint space, intra condylar space, later joint space, later gutter and patellofemoral sp&ce.

Data regarding loose bodies, synovial plicae, hypertrophied synovium, chondromalacea, medial meniscus injuries, synovial cysts, ACL, PCL injuries, lateral meniscus injuries and patellar tilt, patellar subluxation collected.

Results

Table 1: Anterior Cruciate Ligament Injury

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	7	1	8
Negative	0	22	22
	7	23	30

Sensitivity - 100%
Specificity - 95.65%
Positive predictive value - 87.5%
Negative predictive value - 100%.
Kappa - 0.91 - Very good P - 0.000 - Significant
Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 95.65% and is excellent in diagnosing ACL tears.

Table 2: Posterior cruciate Ligament injury

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	2	0	2
Negative	0	28	28
	2	28	30

Sensitivity - 100%
Specificity - 100%
Positive predictive value - 100%
Negative predictive value - 100%
Kappa - 1.00 - Very good P - 0.000 - Significant
Both sensitivity and specificity of MRI in relation to Arthroscopy is 100% shows excellent correlation.

Table 3: Medial Meniscus injury

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	7	2	9
Negative	0	21	21
	7	23	30

Sensitivity - 100%
Specificity - 91.3%
Positive predictive value - 77.7%
Negative predictive value - 100%
Kappa - 0.83 - Very good P - 0.000 - Significant
Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 91.3% and is excellent in detecting medial meniscus injury. MRI detected more number of cases compared to Arthroscopy since grade I and grade II injuries may not be picked up by arthroscopy.

Table 4: Lateral meniscus Injury

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	5	1	6
Negative	0	24	24
	5	25	30

Sensitivity - 100%
Specificity - 96%
Positive value - 83.3%
Negative value - 100%
Kappa - 0.83 - Very good P - 0.000 - Significant
Sensitivity and Specificity of MRI compared to Arthroscopy is 100% and 96% and is excellent in detecting lateral meniscus injury. MRI detected more number of cases compared to Arthroscopy since grade I and grade II injuries may not be picked up by arthroscopy.

Table 5: Articular cartilage injury

MRI	Arthroscopy		
	Positive	**Negative**	
Positive	3	0	3
Negative	2	25	27
	5	25	30

Sensitivity - 60%
Specificity - 100%
Positive value - 100%
Negative value - 92.59%
Kappa - 0.7 1 - Good P - 0.000 - Significant
Sensitivity and specificity of MRI is 60% and 100% with respect to Arthroscopy and is average in diagnosing articular cartilage injuries.

Table 6: MRI Accuracy

	Sensitivity	**Specificity**
Anterior cruciate ligament	100%	95.6%
Posterior cruciate ligament	100%	100%
Medial meniscus	100%	91.3%
Lateral meniscus	100%	96%
Articular cartilage	60%	100%

Discussion

MRI images are studied for evidence of injuries to menisci, cruciate ligaments, collateral ligaments, articular cartilage, loose bodies, meniscal cysts and bony contusions, evidence of soft tissue injuries around the knee joint.

Arthroscopy was done to look for injuries to menisci, cruciate ligaments collateral ligaments, articular cartilage, loose bodies and meniscal cysts.

In the present study out of 30 patients 20 were males and 10 were females. The age group ranging from 14 to 47 years with mean age of 26.5 years.

A Study done by Fritz *et al.* [7] showed males are most likely to suffer knee injuries since they are active in sports and right knee injuries are more common than left.

In the present study males comprise the predominant number of patients who suffered knee injuries who are active in sports like foot ball. Young patients of age group 31-40yrs are the maximum who suffered knee injuries.

Out of 30 patient knee injuries, right knee is involved in 20 cases and left is involved in 10 cases. Right knee is involved more compared to left.

Meniscal Injuries

Medial meniscus injury is the most common type of injury comprising 9 cases. MRI detected 9 cases of medial meniscus injury, arthroscopy detected only 7 cases. Sensitivity and specificity of MRI with respect to Arthroscopy is 100% and 91.3%. MRI is excellent in diagnosing medial meniscal injury.

In our study the sensitivity, specificity and accuracy for detecting medial meniscal tears was corresponding to the Fischer *et al* [8].

A study by Pappenport *et al*. [9] showed accuracy rate of 90% for MRI in the detection of Meniscal tears compared with the arthroscopy 9 i

Elvenes *et al* in that study found the sensitivity, specificity, positive and negative predictive value of MRI for medial meniscus tears were 100%, 77%, 71% & 100%.

In present study sensitivity, specificity, positive and negative predictive value are 100%, 91.3%, 77% and 100% and correlated with the findings of Elvenes *et al*.

In our study MRI detected 6 cases of lateral meniscal injury and arthroscopy positive cases are 5 out of 30 cases.

Sensitivity and specificity of MRI in relation to Arthroscopy is 100% and 91.3%. MRI is excellent in detecting lateral meniscus injuries.

Positive predictive value of MRI in detecting lateral meniscus injuries is 77.7% with negative predictive value of 100%.

Silva and Silver [10] have studied the probability of a tear being identified at arthroscopy for each grade MRI signal. The probability of tear with grade I signal is about 5%, grade II 17-20% and grade III 80%- 95%.

The occurrence of the false positive meniscal tears at MRI imaging has been noted earlier. There are explanations for this apparent discrepancy between findings at MR Imaging and arthroscopy Mink *et al*.

- Misinterpretation of normal anatomy like Meniscofemoral ligaments etc
- The presence of intrasubstance tears, which are not seen on arthroscopy
- The operator dependence of Arthroscopy
- The presence of loose bodies.

Sensitivity of MRI is more compared to arthroscopy because grade I and grade II tears unlike grade III tears may not be detected by arthroscopy. So MRI is more useful for detection of grade I and grade II injuries. So MRI is more sensitive in detection of meniscal injuries.

Cruciate ligament lesions

Among the structure involved in knee injuries. ACL injury is the second most common accounts for 8 cases in MRI with percentage of 26.6% arthroscopy detected 7 cases.

Sensitivity and Specificity of MRI with respect to Arthroscopy is 100% and 95.65% and is excellent in diagnosing ACL tears.

Positive predictive value of MRI is 87.5%. Negative predictive value of MRI is 100%.

Out of 30 cases MRI detected 2 PCL injuries and arthroscopy detected 2 cases. Sensitivity and specificity of MRI in relation to Arthroscopy is 100% with positive and negative predictive value 100% and shows excellent correlation in detecting PCL injuries. PCL injuries are most commonly associated with chip fractures near the tibial attachment.

In tears of the anterior cruciate ligament, the sensitivity, specificity and accuracy was found to be 100, 95% and 87%, which were corresponding to Fischer *et al* study [10].

MRI is accurate in identification of ACL tears, ranging from 93% to 97%. The sensitivity and specificity in various studies have shown to range between 61% and 100%, and 82% and 97% respectively [11].

In our study the positive predictive value and negative predictive value was 95.5 and 100 respectively. The positive predictive value and negative predictive value range from 70% to 76% and 70% to 100% respectively [11].

The results of two large studies showed that MR imaging has relatively low sensitivity (40%-75%) but moderate to high specificity (62%-94%) in diagnosis of partial tears.

T2 weighted images showed clearly the signal intensity changes seen with these tears as excellent contrast is provided by normal low signal intensity of ligaments Mink *et al*.

2 cases of PCL tears were 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 visualized as a homogenous, continuous low-signal structure. Several studies have reported sensitivity, specificity, accuracy, positive predictive value and negative predictive value to be 99-100%. In our study too the sensitivity, specificity, accuracy, positive predictive value and negative predictive value was 100% [11, 12]

Articular cartilage injuries

Out at 30 cases of knee injuries MRI detected 4 cases of articular cartilage injuries and arthroscopy 5 cases. Sensitivity of MRI is 60% with specificity' of 100% shows average correlation with Arthroscopy in diagnosing articular cartilage injuries. Positive predictive value of MRI is 100% with negative predictive value of 92.59%.

Sensitivity of MRI can be increased by using newer sequences dedicated to articular cartilage imaging.

Unlike arthroscopy MRI was able to detect bony contusions, fluid collection in and around the knee joint, soft tissue injuries, collateral ligament injuries.

MRI in spite of detecting meniscal, cruciate ligament and collateral ligament injuries can detect bone and soft tissue injuries around the knee joint.

Conclusion

Both MRI and arthroscopy have their limitations. These shortcomings might be overcome by combining both modalities when clinically indicated.

MRI should be the initial investigation of choice in the evaluation of all cases of knee joint injuries. Because it can detect both intra and extra articular pathologies and also osseous structures. Based on the findings of MRI arthroscopy should be done as a diagnostic and also as therapeutic procedure.

References

1. Spiers ASD, Meagher T, Ostlere SJ, Wilson DJ, Dodd CAF. Can MRI of the knee affect Arthroscopy practice? A prospective study of 58 patients. J Bone Joint Surg (Br). 1993; 75(b):49-52
2. Ruwe PA, Wright J, Randall RL, Lynch JK, Jokl P, MC Carthy S. Can MR Imaging effectively replace diagnostic arthroscopy? Radiology. 1992; 183-335-339.

3. Nobel J: Unnecessary Arthroscopy. Editorial. J Bone Joint Surg (Br). 1992; 74B:797-799.
4. Elvenes J, Jerome CP, Reikeras O, Johansen O. MRI as a screening procedure to avoid Arthroscopy for meniscal tears. Arch Orthop Trauma Surg. 2000; 120(1-2):14-16.
5. Remer EM, Fitzgerald SW, Friedman H, Rogers LF, Hendrix RW, Schafer MF. ACL injury: MR diagnosis and patterns of injury. Radiographics. 1992; 12:901-915.
6. Gentili A, Seeger LL, Yao L, DoHM. ACL tear: Indirect sign at MRI: Radiology. 1994; 193:835-840.
7. Mink JH, Levy T, Crues JV. Tears of the ACL and menisci of the knee: MR evaluation. Radiology. 1988; 167:769-774.
8. Haynes CW, Conway WF. Normal anatomy and MR appearance of the knee. Topics Magn Reson Imaging. 1993; 5(4):207-227.
9. Remer EM, Fitzgerald SW, Friedman H, Rogers LF, Hendrix RW, Schafer MF. ACL injury: MR diagnosis and patterns of injury. Radiographics. 1992; 12:901-915.
10. Fischer SP, Fox JM, Del Pizzo W *et al*. Accuracy of diagnosis from magnetic resonance imaging of the knee: a multi centre analysis of one thousand and fourteen patients. J Bone Joint Surg (AM) 1997; 73A:2-10.
11. John B McGinty, Richard B Caspari, Robert W Jackson. Eds. Operative Arthroscopy, 2nd edition, Lippincott-Raven. 1997; (1-7):175-189.
12. Yao L, Gentili A, Lee K. Partial ACL rupture: an MR diagnosis? Skeletal Radioloty. 1995; 24:247-251.