Original Article

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Study of the Spectrum of MRI Findings in Traumatic Knee Joint

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Abstract

Background: The knee joint has three components, the lateral tibiofemoral, medial tibiofemoral and patellofemoral joints. Four bands of tissue, the anterior and posterior cruciate ligaments, and the medial and lateral collateral ligaments connect the femur and the tibia and provide joint stability. **Subjects and Methods:** The study was performed during a time period of 12 months. The results of the patients who had undergone both MR and arthroscopy studies were taken for analysis. **Results:** The most common age group to be involved was between 41-50 years. The following patterns of knee injuries were seen. Most common injury among cruciate ligaments was ACL tear of which complete tears were more common Posterior cruciate ligament tears were less common. **Conclusion:** Thus, the presence of an anteromedial femoral condyle bone bruise should increase the level of suspicion of a concurrent PLC Knee injury. In addition, we believe that the presence of a posteromedial tibial plateau bone bruise may be a secondary sign of a potential combined PLC injury in the setting of anterior cruciate ligament tear.

Keywords: MRI, Traumatic knee joint, Knee injury.

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Introduction

The knee is the largest joint in the body. It is a complex 'hinge' joint made up of the lower end of the femur, the upper end of the tibia and the patella, which slides in a groove on the end of the femur. The knee joint has three components, the lateral tibiofemoral, medial tibiofemoral and patellofemoral joints. Four bands of tissue, the anterior and posterior cruciate ligaments, and the medial and lateral collateral ligaments connect the femur and the tibia and provide joint stability.[1]

Strong thigh muscles give the knee, strength and mobility. The surfaces where the femur, tibia and patella touch are covered with articular cartilage, a smooth substance that cushions the bones and enables them to glide freely. Semicircular rings of tough fibrous-cartilage tissue called the lateral and medial menisci act as shock absorbers and the bones of the knee are surrounded by a thin, smooth tissue capsule lined by a thin synovial membrane which releases a special fluid that lubricates the knee, reducing friction to nearly zero in a healthy knee.[2]

MRI of knee is performed using transmit / receive general purpose extremity surface coil. Quadrature and phase array coils are also available. Increased spatial resolution and decreased signal to noise ratio are significant advantages of these coils.

Imaging is done with full extension in neutral position. A 14 to 16 cm field of view and a 3-4mm slice thickness. MRI is obtained in the Axial, Sagittal and coronal views.

A wide variety of MRI pulse sequences can be performed to produce diagnostic quality images. These include spin echo, fast (turbo) spin-echo, and gradient-echo sequences, which all have been proven suitable for knee imaging. T1 or proton density-weighted sequences are most suitable for visualizing the ligamentous anatomy. T2 or STIR sequences with fat saturation are essential to demonstrate bone marrow edema. Typically, a routine scanning protocol would consist of a combination of one or more of these sequence types performed in the axial, sagittal, and coronal planes using thin sections (maximum 3 mm with an interslice gap of 0.5 to 1 mm). A field-of-view of 12 to 16 cm depending on patient size is commonly used with a high-resolution matrix of at least 140 steps in the phase-encoding direction.[3]

Synovial Membrane appears on both sagittal and coronal images as linear medium signal intensity on T1 weighted and proton density images and as high signal intensity on T2 weighted images. Bursae around the knee joint are not usually seen on MRI unless they are inflamed and fluid filled.[4]

ACL is best seen on sagittal, oblique images with slices oriented parallel to the cortex of the lateral femoral condyle. It may appear as a solid band or as three or four separate low signal intensity bands. The tibial attachment is usually better seen than the femoral attachment because of partial volume averaging with lateral femoral condyle. Signal intensity on T1 weighted and spin density images at the tibial insertion is increased. The anterior border of taut ACL should nearly parallel the roof of the intercondylar notch. Coronal and axial images are useful in confirming the findings made on sagittal images. Coronal images show the

ACL as a curvilinear fan like structure adjacent to the horizontal segment of PCL, near the medial surface of the lateral femoral condyle. Axial images depict ACL as low signal band that is flattened against the medial surface the lateral femoral condyle. All imaging sequences demonstrate fat at the intercondylar notch.[5]

Sagittal images best depict the PCL, which appears as a uniformly low signal intensity structure with a nearly horizontal take off at the femoral origin and then an abrupt descent at about 45 degrees to the tibia. This angled portion of the ligament is normally directed towards the femur. The menisco- femoral ligaments of Humphrey and Wrisburg are seen as low signal intensity dots anterior and posterior to the PCL and should not be mistaken for displaced meniscal fragments or an intact PCL in presence of tear.

Medial and Lateral Collateral Ligament is best seen on coronal images where it appears as homogenously low signal intensity structure on all pulse sequences .Moderately increased signal intensities may be seen between superficial and deep fibers and below the superficial fibers at the distal tibial attachment site, where fat is normally interposed.

Oblique Popliteal Ligament (Posterior Oblique Ligament) is best seen on coronal and axial images. A coronal oblique plane along the supero inferior course of the OPL (POL) is also optimal for imaging.[6]

The sagittal plane is most important plane in assessing the menisci, with a coronal plane providing supportive rather than new information and the axial plane increasing the accuracy of the sagittal and coronal planes when combined. In general, sagittal images optimally show anterior and posterior horns of the medial and the lateral menisci, coronal images help in evaluating the Meniscal bodies and thin axial sections provide an additional view of menisci and their free edges.

The anterior and the posterior horns of menisci appear as isosceles triangles. The posterior horn of medial meniscus is twice the size of anterior horn. The anterior and posterior horns of lateral meniscus are of same size. The posterior horn of either menisci should never appear smaller than the anterior horn . On both sides, the menisci appear as flat bands. On lateral side, the more central slices take on bowtie configuration because of smaller radius of curvature.[4]

Mid portion of the knee produce best images of bodies of both menisci. They appear triangular and slightly larger laterally than medially. The capsular attachment on the medial side is incorporated in the tibial and medial collateral ligament. A small amount of fat may be interposed between the body of the medial meniscus and the capsule. On posterior coronal cross sections, the posterior horns appear as flat bands. On lateral cross sections, the popliteal tendon courses upward and laterally at 45 degrees. More anteriorly, the anterior horn of lateral meniscus appears as a band like structure. The anterior horn of medial meniscus extends more anteriorly than that of lateral meniscus.[6]

The medial and lateral menisci, the transverse ligament, and the menisco-femoral ligament appear homogenously dark on all pulse sequences. The vascular and avascular zones cannot be distinguished on MRI. The vascularized zone does not demonstrate enhancement with intravenous gadolinium.

Subjects and Methods

The study was performed during a time period of 12 months. The results of the patients who had undergone both MR and arthroscopy studies were taken for analysis.

Inclusion Criteria:

1. Patients with history of pain in the knee with or without swelling where MRI was used as a modality in diagnosing the cause.
2. Patients with clinically suspected tears.
3. Patients with restriction of movement at the knee joint following trivial trauma.
4. Only patients on whom arthroscopy was performed within thirty days of MRI were accepted for the study.

Exclusion Criteria:

1. Patients with acute traumatic fractures on x-ray
2. Patients diagnosed as having osteochondritis on plain x-ray
3. Patients with cardiac pacemakers and metallic implants were no subjected to MRI.
4. Post operative cases
5. Motion disorder and claustrophobia, if severe may make the examination difficult.

Arthroscopy

Knee joint is the joint in which arthroscopy have its greatest diagnostic and intraarticular surgical applications. Arthroscopy will be performed under strict aseptic precautions in an operating theatre under regional anesthesia. All the patients were screened with preliminary blood investigations and chest radiographs. The patients were put in supine position with the leg slightly abducted and immobilized. Antero-medial and Antero-lateral portals were made. The arthroscope with 30 degree lens used for the diagnostic and operative procedures.

Results

Table 1: Age Distribution

Age	No. Of Patients	Percentage
11 - 20 Years	06	08%
21 - 30 Years	15	20%
31 – 40 Years	15	20%
41 – 50 Years	21	28%
51 – 60 Years	12	16%
61 – 70 Years	06	08%

Table 2: Showing clinical symptoms based distribution

Presentation	No. of Cases
Instability of Knee Joint	36
Pain	27
Swelling	03
Trivial Trauma	09

Table 3: Showing distribution according to duration of symptoms

Duration of symptoms	No. of patients	%
Upto 1 week	16	21.6
1 week – 2 week	14	17.1
2 week – 3 week	6	8.1
3 week – 4 week	7	9.9
1 month – 6 month	17	22.5
> 6 months	15	20.7
Total	75	100

Table 4: Showing distribution in patients with and without joint effusion

Joint effusion	Number (n=75)	%
Present	60	80.2
Absent	15	19.8

Table 5: showing distribution in patients with and without ACL tear

ACL tear	Number (n=75)	%
Absent	35	46.7
Present	40	53.3
Partial	35	47.4
Complete	40	52.6

Table 6: showing distribution of patients with and without PCL tear

Present	51	68
Absent	24	32

Table 7: showing distribution of patients with and without MCL tear

MCL tear	Number (n=75)	%
Absent	74	98.7
Present	1	1.33

Table 8: showing distribution of patients with and without LCL tear

LCL tear	Number (n=75)	%
Absent	73	97.3
Present	1	2.7

Table 9: showing distribution of patients with and without MM tear

MM tear	Number (n=75)	%
Absent	28	37.4
Present	47	62.6

Table 10: showing distribution of patients with and without LM tear

LM tear	Number (n=75)	%
Absent	45	60
Present	30	40

Table 11: Showing distribution of patients with or without osseous/osteochondral lesions

	Number (n=75)	%
Absent	35	46.8
Present	40	53.2

Table 12: showing distribution of combined/multiple injuries

Combined / Multiple injuries	Number (n = 75)	%
Isolated	28	38.09
Two injuries	30	40
Three injuries	12	17.14
Four injuries	4	4.8

Table 13: showing percentage of positive cases on MRI

Structure	No. Of Cases	Percentage
Anterior Cruciate Ligament(ACL)	40	53.3%
Posterior Cruciate Ligament(PCL)	24	32%
Lateral Meniscus (LM)	30	40%
Medial Meniscus (MM)	48	62.6%
Medial Collateral Ligament(MCL)	01	1.33%
Lateral Collateral Ligament(LCL)	02	2.66%

Discussion

Amreen Abdul Bari et al in the study Evaluation of MRI Versus Arthroscopy in Anterior Cruciate Ligament and Meniscal Injuries in the year 2014 showed the sensitivity, specificity, PPV and NPV was calculated (in %). For ACL it was 87.87, 81.57, 80.55, 88.57 for MM 93.54, 87.50, 85.29, 94.59 and for LM 77.77, 81.81, 72.41, 85.71 respectively. MRI is a non-invasive, radiation free and an excellent imaging modality to evaluate ligaments of the knee joint and surrounding soft tissue. The diagnostic yield is increased with appropriate use of sequences and proper analysis of images in all planes. Almost all the ligamentous and meniscal injuries can be diagnosed with high level of confidence. Pathological entities should be carefully differentiated from normal variants, pitfalls and artifacts of imaging.[7]

Rudresh Halawar et al in the study Occurrence of isolated and combined anterior cruciate ligament injuries in traumatic knee-by MRI in 2014 concluded that ACL tear noted in 76 (68.5) patients. Isolated injury noted in 35(46.05%) and combined injuries in 41(53.94%) patients. Most common combined injury is ACL with medial menisci tear (31.7%) and ACL with lateral menisci tear (7%).Arthroscopy done in 21 patients. There was no statistically significant difference noted in MRI and arthroscopic findings (ã =1.02).[8]

Adil Ismail Nasir et al 2013 in the study the role of MRI in knee joint injuries concluded that MRI can accurately diagnose the ligament injuries of knee joint,which is an ideal technique in the diagnosis of ligament injuries of knee joint, and should be used as a routine examining method. So MRI affect the diagnosis and management of the knee injuries by decreasing the number of arthroscopic procedures, improving clinician diagnostic certainty, and assisting in management decision.MRI of the knee provides the potential for the rapid, definitive diagnosis with a non invasive examination.[9]

Saurav Singla, Nitin Kansal et al 2013 conducted a study sensitivity and specificity of MRI versus Arthroscopy in internal derangement of knee concluded that sensitivity and specificity for medial meniscus were 89.5% and 85.7% respectively. NPV and PPV were 90% and 85% respectively. For LM, sensitivity, specificity, PPV and NPV were 87.5%, 93.8%, 77.8% and 96.8% respectively. For ACL and PCL, the results of MRI were 88.5%, 71.4%, 85.2%, 76.9 and 80%, 94.3%, 66.7% and 97.1% respectively.[10]

S Gupta et al conducted Comparison study Of Clinical Examination, MRI And Arthroscopy In Knee Injuries in 2012 concluded that Diagnostic accuracy of MRI was 66.67% for medial meniscus and 90% for lateral meniscus GRADE 1 and 2 meniscal tears have low sensitivity 50% as compared to GR 3 and 4 with 88%. In the case of ACL tears, diagnostic accuracy for both clinical examination and MR examination came out to be 90% Conclusion: We can avoid diagnostic arthroscopy in patients with ACL and PCL injuries having equivocal clinical and MRI examination and go on for therapeutic modality. In case of meniscal injuries graded as 1 and 2 on MRI, are rarely seen on arthroscopy hence arthroscopy is not required for these meniscal injuries.[11]

Mandelbaum et al 2012 done a systematic approach to establish anatomical and pathoanatomical correlations, as well as the role of MRI in the management of knee injuries. Results indicated that for the medial meniscus MRI demonstrated a 95.7% sensitivity, 81.8% specificity, 90% accuracy, 88.2% positive predictive value (PPV), and 93.1% negative predictive value (NPV). Imaging of the lateral meniscus demonstrated a 75% sensitivity, 95% specificity, 91% accuracy, 80% PPV, and 94% NPV. MRI of the ACL revealed 100% sensitivity, specificity, accuracy, positive and negative predictive values. MRI is a noninvasive tool which uses no ionizing radiation and can accurately define and characterize anatomy and pathoanatomy.[12]

Elvenes et al 2012 Studied Forty-one knees in 40 patients underwent MRI and arthroscopy. Compared with arthroscopy, the sensitivity, specificity, positive predictive value and negative predictive value for MRI for the medial meniscus were 100%, 77%, 71% and 100%, respectively, while the values for the lateral meniscus were 40%, 89%, 33% and 91%, respectively. The overall accuracy for MRI of the medial and lateral menisci combined was 84%. On the basis of the high predictive value of negative MRI, we conclude that MRI is useful to exclude patients from unnecessary arthroscopy.[13]

DeepaR. et al 2011 Identified the injury patterns in the pediatric knee both overlap and differ from the adult. Differences between the adult and pediatric populations include an open physis, which serves as a relative point of weakness before physeal fusion; changing mechanics; and differences in ligamentous support. When differences in pathology, disease prevalence,and mechanism of injury are acknowledged,a more accurate interpretation of the MRI findings can be rendered in the pediatric population. In addition, awareness and understanding of normal variants and normal evolution of bone marrow signal may aid in the interpretation of MRI and help avoid unnecessary further workup or intervention.[14]

Conclusion

- Magnetic Resonance Imaging of the knee affected the orthopedists diagnosis, improved clinician diagnostic certainty and reduced the need for arthroscopy. Thus MRI contributed in planning the correct treatment of internal derangement of the knee joint.
- Higher tesla machine for example 1.5T machine might have improved sensitivity and specificity.

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