

International Journal of Radiology and Diagnostic Imaging



E-ISSN: 2664-4444
P-ISSN: 2664-4436
IJRDI 2019; 2(1): 29-32
Received: 20-11-2018
Accepted: 22-12-2018

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A study on MRI appearance in injuries of knee

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DOI: <http://dx.doi.org/10.33545/26644436.2019.v2.i1a.24>

Abstract

The menisci serve the important function of shock absorption, distribution of nutrient synovial fluid within the joint, load transmission and stability. The normal adult meniscus is homogeneously low in signal intensity on all sequences. Children have intrasubstance signal within their menisci. The normal menisci on MRI, show triangular appearance and sharp central tip. In sagittal plane, on peripheral sections the anterior and posterior horns of menisci unite, forming a bowtie appearance. Purposive random technique is 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 T1, T2, PD, fat suppression and gradient echo sequences in various planes. The study had 30 patients out of which 20 were males and 10 were females with age ranging from 14 to 47 years with mean age of 26.5 years. 40 age group comprises the maximum number of patients which suffered knee injuries. Right knee joint commonly involved to left.

Keywords: MRI, injuries of knee, meniscus injury

Introduction

The knee is a complex joint allowing flexion, extension, anteroposterior gliding and internal-external rotation. The major articular surfaces are the medial and lateral condyles of the femur and patellar surface [1].

The menisci are wedge-shaped, semilunar (Cshaped), fibrocartilage structures composed of thick collagen fibers primarily arranged circumferentially, with radial fibers extending from the capsule, between the circumferential fibers. The medial meniscus is semicircular and the lateral meniscus is almost a complete circle. The superior surface of the meniscus is concave and the inferior surface is flat, allowing for maximal congruency between the femur and tibia. With weight bearing, the curved femoral condylar surfaces radially displace the menisci, creating circumferential hoop stresses. The anterior and posterior horns of the lateral meniscus are equal in size. The medial meniscus has a larger posterior than anterior horn and is firmly attached to the deep aspect of the medial collateral ligament. The menisci are further attached to the tibia at their central and inferior peripheral portions [2]. The anterior horns are attached by the transverse ligament. The posterior horn of the lateral meniscus is traversed by the popliteus tendon, which courses posterior and inferior from the lateral femoral condyle. The posterior horn of the lateral meniscus is also secured to the medial femoral condyle by the ligament of Wrisberg, which passes posterior to the Posterior cruciate ligament (PCL) and less constantly by the ligament of Humphrey, which passes anterior to the PCL [3].

The menisci serve the important function of shock absorption, distribution of nutrient synovial fluid within the joint, load transmission and stability. The normal adult meniscus is homogeneously low in signal intensity on all sequences. Children have intrasubstance signal within their menisci. The normal menisci on MRI, show triangular appearance and sharp central tip [4]. In sagittal plane, on peripheral sections the anterior and posterior horns of menisci unite, forming a bowtie appearance. In central sections, the meniscus normally has a rhomboid appearance. In coronal plane, for peripheral sections show the meniscus as broad and elongated structure extending far into the central portion of the joint. MCL is seen adjoining the mid portion of the medial meniscus, with an interface between it and outer portion of meniscus [5].

The ACL through its oblique course is intraarticular but extrasynovial. This is one of the main stabilizers preventing excessive anterior displacement of femur on tibia. The ligament is broader at tibial attachment with an average width of 11mm and length of 4cm. There are

two distinct anatomical fiber bundles (anteromedial & posteromedial), which are not usually distinguishable on MR images. AM bundle is taut during flexion & larger PM bundle is taut during extension. Typically anatomical appearance on MR images varies with ACL having multiple fibers, which are seen as linear areas of low signal intensities compared with the thickness and more uniform low SI of PCL.

Tears in ACL can occur due to multiple mechanisms of injury. Most often with forced valgus and external rotation, but can also follow external rotation with hyperextension, internal rotation with external and forward displacement of tibia. Upto 70% of patients have other intraarticular injuries, most often of MCL & the posteromedial meniscus (O'Donohues triad -ACL, MCL, MM tear).

The ACL should always be seen in a single slice to easily assess abnormalities. Review of coronal and axial images should also be performed to increase the accuracy of diagnosis. T2 WI is preferable as the high SI seen with acute lesions provide excellent contrast with the normal low SI ligaments.

Mink *et al.* found T2 WI to be more sensitive and accurate than T1 weighted images, sensitivity was 85%, specificity 95% accuracy 94% using T1 sequences 100%, 91%, 97% respectively for T2 weighted images.

Double echo technique (SE 2000/60/20) is preferable as increased signal intensity on second echo assists in confirming the acute nature of injury.

Primary and secondary signs have been described. Primary features can be applied to most ligaments and tendons. ACL tears are more common (PCL tears account for 2-23% of injuries) and are difficult to evaluate ^[4]. Acute tears are seen as areas of high signal intensities. Tears can occur at midsubstance (90%) or at the femoral (7%) or tibial attachments. With complete tears the signal intensities extend throughout the width of the tendon and there is usually separation of the ligament ends at site of tear with laxity or loss of normal straight appearance of ACL ^[6].

Methodology

30 cases with knee trauma referred to Department of Radiodiagnosis at Medical College Hospital for MRI. Then these patients are subjected to arthroscopy.

Method of collection of data

Purposive random technique is 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 T1, 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.

Inclusion Criteria

All cases with knee trauma of all age groups are included.

Exclusion Criteria

All cases with inflammatory conditions and tumors of the knee of all age groups are excluded.

Results

The study had 30 patients out of which 20 were males and 10 were females with age ranging from 14 to 47 years with mean age of 26.5 years to 40 age group comprises the maximum number of patients which suffered knee injuries.

Table 1: Sex Distribution

Sex	Number of cases	Percentage
Male	20	66%
Female	10	30%

Male patients are more in number compared to females. Right knee joint commonly involved to left

Table 2: Classification of structural injury based on MRI

	Number of Cases	Percentage
Anterior Cruciate Ligament	8	26.66%
Posterior cruciate ligament	2	6.66%
Medial Meniscus	9	30%
Lateral Meniscus	6	20%
Medial Collateral Ligament	3	10%
Lateral Collateral Ligament	2	6.66%
Articular Cartilage	3	10%
Bony Contusion	6	20%
Fractures	3	10%
Patella and its Cartilage	8	26.66%
Patellofemoral joint	1	3.33%
Patellar ligament	0	0
Medial patellar retinaculum	1	3.33%
Lateral patellar retinaculum	1	3.33%
Quadriceps tendon and muscle	2	6.66%
Joint effusion	18	60%
Meniscocapsular separation	1	3.33%
Extra articular soft tissue	2	6.66%
Bursae	2	6.66%
Loose bodies	3	3.33%
Joint capsule	2	6.66%

Discussion

A study done by Fritz and others ^[7] proved that MRI of the traumatic knee is a powerful alternative modality to investigate traumatic knee compared to arthroscopy. MRI is accepted as the most useful non-invasive diagnostic tool for the detection of cruciate ligament lesions.

Kojima and colleagues ^[8] showed coronal fat suppression fast spin echo images of the knee Evaluated with 202 patients with arthroscopic correlation showed a good correlation between MRI knee and arthroscopic findings.

Uaslan and colleagues ^[9] showed that MRI is the modality of choice for noninvasive evaluation of reconstructed ligaments, Menisco-capsular structures and soft tissues. Magnetic resonance imaging is considered the best imaging modality to evaluate the postoperative knee because it permits direct evaluation of the reconstructed ligament and any associated complications, as well as the menisci, articular cartilage and Subchondral bone.

Huegli and associates ^[10] concluded that MR imaging allows reliable grading of the extent of an isolated injury of the trochlear groove articular cartilage and assists in directing

surgical diagnosis and treatment.

Moon & associates^[11] and Li & collaborators^[12] were the first to describe the potential of MRI in assessing the knee. Reicher and coworkers provided further evidence of this potential using close imaging-pathologic correlation in cadaveric knees & imaging-arthroscopic correlation in knees of symptomatic patients. With technical advances in the field, MR imaging of the knee became sharper and findings more definite. Three dimensional gradient echo imaging, reformatted/reconstructed images & innovative and faster imaging methods for assessing the knee were given attention. Further more as many of MR imaging abnormalities were seen more easily in presence of knee effusion, the added benefit of using intraarticular administration of Gadolinium was studied.

The work of Hajek and coworkers in 1987 gave birth to the concept of Gadolinium enhanced MR arthrography. However it is time consuming and invasive and may require access to fluoroscopy room for injection of contrast. Then the question came whether MR imaging is needed as a supplement to clinical assessment in an age in which diagnostic and therapeutic arthroscopy is being used increasingly?

Boden and associates in an analysis of financial impacts of diagnostic methods used to evaluate the acutely injured knee concluded that arthroscopy is more cost effective than MRI if 78% or more of scanned patients undergo arthroscopy.

Spiers & Coworkers in a study of 58 patients with internal derangements of knee concluded that MRI studies on all patients scheduled for arthroscopy, would lead to modest increase in cost of treatment but one that represented "a small price to pay for a reduction in morbidity associated with arthroscopy, & liberation of theatres and surgeons for other work".

Ruwe and collaborators^[13] in another study addressing the issue of cost effectiveness indicated that the results of MRI in 53 of 103 patients avoided a potentially unnecessary diagnostic arthroscopy.

Noble^[14] emphasized the need to avoid unnecessary arthroscopy, indicating that the results of MRI of knee in some patients augment the clinical judgement leaving the arthroscope to bring about a practical solution for the patient's demonstrable (&verified) problem. Few would argue that a diagnostic test, such as MRI, is not indicated if treatment will not be affected by the result, no matter what the result might be. Furthermore owing to the occurrence of positive findings on MRI of knee in asymptomatic patients, the result of MRI examination must be correlated with those from careful clinical assessment.

The value of MRI for imaging musculoskeletal conditions such as tumor and osteonecrosis was apparent almost immediately after the introduction of this modality in the early 1980's^[4]. With the introduction of special closely coupled extremity RF coils, high field systems and other technical advances, the utility of MRI in the knee has expanded dramatically. These made knee imaging one of the fastest growing application of MRI, which has essentially replaced arthrography in the evaluation of knee pathology^[4]. MRI has been demonstrated as a cost-effective technique by reducing unnecessary surgery^[13].

The greatest impact of musculoskeletal MRI has been in the evaluation of the knee. Reicher and coworkers initiated a bright future for MRI of the knee in 1985 with their initial description of MRI used for meniscal tear detection and

other knee disorders. The examination is highly accurate and has a high negative predictive value. Although MRI is unlikely to replace arthroscopy as the standard examination for internal derangements of the knee, it is important in the evaluation of meniscal tears, discoid meniscus, cruciate and collateral ligaments injuries, occult bone trauma, chondromalacia, ACL reconstruction and masses^[13].

MRI is a common accurate & cost-effective diagnostic study in the evaluation of internal derangements of the knee. Within a decade of its introduction MRI became the imaging method of choice for meniscal pathology in knee. Several large MRI studies have found sensitivity ranges from 87-97% for medial meniscal tears & 69-92% for LM tears; Specificity ranges from 82-91% for medial meniscus and 91-98% for lateral meniscus^[3].

Conclusion

- Knee joint injuries are common. The need to accurately evaluate the knee injuries is very crucial for the proper management and outcome, otherwise it will lead to chronic debility to the patient.
- MRI is average sensitive in detection of articular cartilage injuries. Newer sequences dedicated to imaging articular cartilage can improve the sensitivity of MRI in diagnosing articular cartilage injuries.

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