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Original Research Article

ROLE OF MAGNETIC RESONANCE IMAGING IN THE EVALUATION OF MENISCAL TEARS IN A TERTIARY CARE CENTRE

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Abstract

Background: Meniscal tears occurring alone or with an association to ligamentous injury, can cause significant physical impairment. Pain, swelling, locking, catching, and loss of mobility are common clinical signs that necessitate surgical intervention. Diagnosis of these cases is very import to initiate the treatments. The present study aimed to evaluate the role of MRI in the diagnosis of meniscal tears and associated injuries with meniscal tear. **Materials and Methods:** The study was done in the department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari (Dist), Tamil Nadu. Based on the inclusion and exclusion criteria a total of 90 patients with knee joint diseases were included in the study. All the patients study procedure was explained and informed consent was obtained. The selected patients were subjected for MRI and data was collected. Results were expressed in number, percentage, mean and standard deviation. **Result:** In our study, 90 patients were studied and the incidence of Meniscal tears are more commonly found in males (74%) with predominant age group of around 21- 30yrs (64%). 70% of them had acute traumatic aetiology. 72 cases in this study had meniscal tear and in that 52% involved only the medial meniscus, 31% only the lateral meniscus and 17% involved both the menisci. The commonest type of medial meniscal tear detected in this study were vertical tear (24.4%) followed by horizontal tear (15.5%), complex tear (10%), bucket handle tear (6.6%), combined horizontal and radial tear (2.2%) and root tears (2.2%). As in medial meniscus, lateral meniscal tears were also commonly identified in posterior horn (19%). But in lateral meniscus anterior horn was more commonly torn (13.3%) when compared to medial meniscus. Vertical tear (12.2%) is the commonest type of lateral meniscal tear detected in this study followed by radial tear (6.6%), complex tear (4.4%), bucket handle tear (4.4%), horizontal tear (3.3%), and combination of radial and oblique tears (2.2%). Meniscocapsular separation was seen in 3 (3.3%) cases of our study and was involved in posterior horn of lateral meniscus. Grade III vertical tear was the most common type of tear seen in both medial and lateral menisci. Bucket handle tears were seen in 60% of the medial meniscus and 40% of the lateral meniscus in this study. Joint effusions were the most prevalent finding in our research, affecting 54 individuals (60%) and bone contusions (65.5%). (31 patients). The most common ligamentous injury is an anterior cruciate ligament (ACL) tear, which occurs in 53 cases (58.9%), followed by Medial collateral ligament (MCL) injuries, which occurred in 27 cases (30%), 25 Lateral Collateral ligament (LCL) injuries (27.8%), and 7 Posterior cruciate ligament (PCL) tears (7.8%). Bakers cyst was the commonest cystic lesion (4.4%) involving the knee joint followed by meniscal cyst 3.3%. **Conclusion:** Magnetic resonance imaging of the knee joint is a non-invasive, painless, and morbidity-free modality that is well accepted by patients which complements clinical examination and arthroscopy by providing an accurate preoperative anatomic assessment.

INTRODUCTION

Magnetic resonance imaging (MRI) has revolutionised cross-sectional imaging of the musculoskeletal system since its introduction in the 1980s, and it has become the most extensively used technology for a wide range of pathologic conditions.[1] For imaging of various menisci, cartilage, ligaments and other structures around the knee joint, MRI has proven to be an excellent modality.[2] The combination of multiplanar capabilities and superior soft tissue characterization accounts for this.[3] Over the last two decades, this modality has surpassed other modalities like radiographs and Computerized tomography (CT) scans.[4,5] It is a non-invasive diagnostic technique that does not have the radiation concerns that radiographs and CT do, and unlike ultrasound, is not operator reliant.[6] A meniscal tear is the most frequent knee injury, and it can occur during both athletic activities and daily living frequently in young adults, there is increased incidence of trauma related knee pathologies. Meniscal lesions or its degenerative changes account for around two-thirds of all knee joint derangements. Meniscal tears occurring alone or with an association to ligamentous injury, can cause significant physical impairment.[7] Pain, swelling, locking, catching, and loss of mobility are common clinical signs that necessitate surgical intervention. In the United States, one of the most common orthopaedic surgical procedures are arthroscopic treatment of meniscal injuries.[8] The extent and morphology of the meniscal lesion cannot be determined only by a clinical examination of the knee. To appropriately diagnose and treat such injuries the most common non-invasive imaging investigation used to evaluate the meniscus is MRI. It is crucial to diagnose a meniscal tear early in order to plan a treatment strategy. In view of evolving treatment strategies, it is important to correctly identify the tear and also describe its location, extent and pattern to guide and chose the appropriate treatment option.[9,10] As a result, the role of MRI is not only limited to diagnosis, but also in the management of meniscal injury, such as avoiding surgery. An accurate and precise diagnosis can facilitate pre-surgical planning and prevent unnecessary surgical exploration or repeat surgery.

MATERIALS AND METHODS

Study Design: Cross sectional study

Study Settings: The study was done in department of Radiodiagnosis, Sree Mookambika Institute of Medical Sciences, Kulasekharam, Kanyakumari (Dist), Tamil Nadu.

Study Period: The study was done for a period of 18 months. From Jan 2020-July 2021.

Inclusion Criteria

Patients referred to the Department of Radiodiagnosis with complaints of knee pain and suspected injury to the meniscus during the period of study.

Exclusion criteria

- Patients who have undergone meniscal reconstruction, repair or removal.
- Patients with infective aetiology of knee joint.
- Patients with no associated knee pain.
- Uncooperative, severe claustrophobia.
- Patients with history of metallic implants, pacemaker, aneurysm clip, implanted prosthetic valve.

Procedure

All the patients will be explained in detail about the procedure and informed consent will be obtained. After completion of the MR examination of knee joints, the type of meniscal tear and associated injuries with meniscal tear will be assessed. Whenever patient comes for MRI of knee joint, written informed consent will be taken and patient will be explained in detail about the procedure. Magnetic resonance imaging study of knee joint will be performed once. All knee joint MRI scans are performed on a 1.5T Siemens ESSENZA 16 channel. The type of meniscal tear and associated injuries with meniscal tear will be assessed. Sequences used were axial, coronal and sagittal PD FS; sagittal, axial and coronal T2 FSE and sagittal T1 FSE (Table-1). All MRI are reported in the department of Radiology, Sree Mookambika Institute of Medical Sciences, Where the films were discussed and reported together by senior radiologists.

A meniscal tear was identified in the magnetic resonance image by one of three criteria [11]

i. A linear or complex intrameniscal signal extending to the inferior or superior surface of the meniscus.
ii. Gross disruption of the normal meniscal contour with obvious foreshortening
iii. Complete absence of any meniscal structure.
iv. A linear intrameniscal signal that did not extend into either meniscal surfaces were interpreted as Grade 2.

An altered signal intensity which was globular and does not extend into articular surface was reported as grade 1.

i. Meniscal cysts dimensions and associated tears of the meniscus were reported.
ii. Meniscal degenerative tear is reported if a tear was associated with surrounding altered signal intensity (Table-1).

Statistical Analysis

The data was expressed in number, percentage, mean and standard deviation. Statistical Package for Social Science (SPSS 20.0) version used for analysis. Unpaired test applied to find the statistical significant. Pearson correlation test applied to find the correlation between the variables. P value less than 0.05 consider statistical significant at 95% confidence interval.

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RESULTS

Maximum patients are belonging to age between 21-30 years (n=34) and minimum belong to age between 61-70 years (n=2). 21 patients had age between 31-40 years followed by 14 had age between 41-50 years. The mean age of the patients is 33 with standard deviation of 1.89. Male are more (n=67) compared to females (n=23). Maximum percentage of patients (70.0%) is present with history of trauma and 27 had no history of trauma. Maximum number of patients present with medial meniscus tear (n=55) and 35 not had meniscus tear. Maximum patients (n=35) showed medial meniscus tear at posterior horn (PH) site. 8 showed tear at Anterior horn, Body and Posterior horn (AH/B/PH) followed by 5 at Body and Posterior horn (B/PH), 3 at (Anterior horn) AH, 2 at Body (B) and 2 at Root (RO). Maximum number of patients belongs to Vertical (VER) (n=22) type of medical meniscus tear followed by 14 Horizontal (HOR), 6 Bucket Handle (BH), 9 Complex (COMP), 2 Horizontal and Radial (HOR/RAD) and 2 Root (ROT) type of tears [Table 2].

Maximum patients belong to (n=25) Grade III medial meniscus tear followed by 10 with Grade I, 13 with Grade II and 7 with Grade IV [Figure 1]. Maximum percentage of peoples belongs to absence (63.33%) of lateral meniscus tear and 36.67% had tear. Maximum patients (n=17) had lateral meniscus tear at Posterior Horn (PH) site followed by 12 at Anterior Horn (AH), 2 at Body and Posterior Horn (B/PH) and 2 at Posterior and Anterior Horn (PH/AH). Maximum patients had (n=11) Vertical (VER) type of lateral meniscus tear followed by 6 Radial (RAD), 4 Bucket Handle (BH), 4 Complex (COMP), 3 Horizontal (HOR), 3 Menisco-capsular separation (MCS) and 2 Radial/Oblique (RAD/OBL) types of tear. Maximum percentage (16.67%) are belong to Grade III lateral meniscus tear followed by 12.22% grade II, 5.56% grade IV and 2.22% grade I. Maximum number of patients (n=53) belongs to presence of ACL tear and 37 do not have ACL tear [Table 3].

Maximum percentage of patients (92.22%) does not had PCL tear and 7 had PCL tear. minimum number (n=27) had MCL tear and 63 are not with MCL tear. Maximum number (n=65) are belong to absence of LCL tear followed by 25 presence of tear. Maximum percentage (60.0%) had joint effusion followed by 40.0% absent. Maximum percentage 65.56% are absent with bone contusion 34.44% are present. Maximum patients had Chondromalacia Patella (CMP) (n=6) and Bakers Cyst (BAK) (n=4) and oedema of Hoffa's fat pad (EHF) (n=4) &. Meniscal cyst was present in 3 patients. Rest of findings had each of 2 patients [Table 4]. Maximum number (n=55) had medial meniscus tear and 34 are had lateral meniscus tear. 13 are belong to grade-II and 25 are belong to grade III in medial but in lateral the number was less in grade II (n=11) and Grade III (n=16). Maximum numbers (n=10) are belong to medial and 2 in lateral had grade-I tear [Table 5].

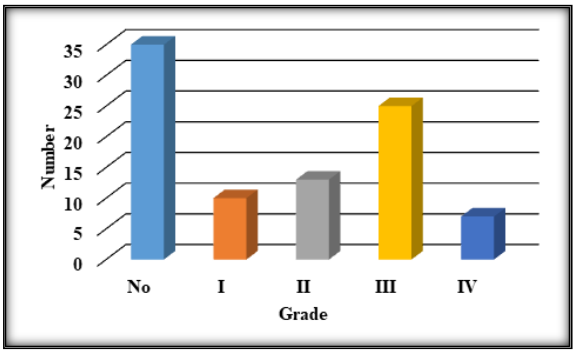

Figure 1: Distribution of patients based on the medical meniscus tear grade

Table 1: MRI knee joint imaging protocol

Sequence	Field of view (cm)	Slice Thickness (mm)	Matrix	Nex
Axial T2 FSE	18	5/Skip 1	320x194	4
Sagittal T2 FSE	16	4/skip 0.5	320x224	2
Coronal T2 FSE	16	4/skip 0.5	320x224	4
Sagittal T1 FSE	16	4/skip 0.5	320x224	2
Axial PD Fat sat	18	4/skip 0.5	320x224	2
Sagittal PD Fat Sat	16	4/skip 0.5	320x224	2
Coronal PD Fat Sat	16	4/skip 0.5	320x194	4

Table 2: Distribution of patients based on demographic data

Demographic data	Number	Percentage (%)
Age (Years)		
Less than 20	13	14.44
21-30	34	37.78
31-40	21	23.33
41-50	14	15.56
51-60	6	6.67
61-70	2	2.22
Gender		
Male	67	74.44
Female	23	25.56
History of trauma		
Present	63	70.00
Absent	27	30.00
Medial meniscus tear		

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Present	55	61.11
Absent	35	38.89
Medial meniscus tear site		
No	35	38.89
AH	3	3.33
AH/B/PH	8	8.89
B	2	2.22
B/PH	5	5.56
PH	35	38.89
RO	2	2.22
Medial meniscus tear type		
No	35	38.89
BH	6	6.67
COMP	9	10.00
HOR	14	15.56
HOR/RAD	2	2.22
VER	22	24.44
ROT	2	2.22

Table 3: Distribution of patients based on meniscus tears

Demographic data	Number	Percentage (%)
Lateral meniscus tear		
Present	33	36.67
Absent	57	63.33
Lateral meniscus tear site		
No	57	63.33
AH	12	13.33
B/PH	2	2.22
PH	17	18.89
PH/AH	2	2.22
Lateral meniscus tear type		
No	57	63.33
BH	4	4.44
COMP	4	4.44
HOR	3	3.33
MCS	3	3.33
VER	11	12.22
RAD	6	6.67
RAD/OBL	2	2.22
Lateral meniscus tear grade		
No	57	63.33
I	2	2.22
II	11	12.22
III	15	16.67
IV	5	5.56
ACL tear		
Present	53	58.89
Absent	37	41.11

Table 4: Distribution of patients based on meniscus tears

Demographic data	Number	Percentage (%)
PCL tear		
Present	7	7.78
Absent	83	92.22
MCL tear		
Present	27	30.00
Absent	63	70.00
LCL tear		
Present	25	27.78
Absent	65	72.22
Joint effusion		
Present	54	60.00
Absent	36	40.00
Bone contusion		
Present	31	34.44
Absent	59	65.56
Associated findings		
No	65	72.22
CMP	6	6.66
BAK	4	4.44
CMC	2	2.22
EHF	4	4.44

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GC-ACL	2	2.22
MC	3	3.33
MD/ACL/PCL	2	2.22
MMD	2	2.22

Table 5: Distribution of patients based on the grade of tears

Grade	Medial meniscus tear grade	Lateral meniscus tear grade	Total number	Total percentage (%)
I	10	2	12	13.48
II	13	11	24	26.97
III	25	16	41	46.07
IV	7	5	12	13.48
Total	55	34	89	100.00

DISCUSSION

The participants in this study were 90 people who were clinically suspected of having a meniscal injury in their knee.[11] The participants in this study belonged to the age group from 15 to 64 years old, with a mean age of 33.2 years. The majority of the subjects were young people between the ages of 21 to 30. (38%). Men outweighed females in all age categories in this study, with males accounting for 74% of the participants. 70% of the subjects were in the acute traumatic category. This is in accordance with Majewski et al, in his study acute traumatic knee injuries were predominant in the 20-29 age group, with 70% of them being traumatic.[12] Acute traumatic injuries to the knee were also detected in 70% of the patients in our study. As a result, young people were mostly imaged for clinically suspected ligamentous or meniscal injuries, with the majority of them having had significant knee trauma. Meniscal tear was detected by an area of abnormal signal intensity within the meniscus on at least a single image that extends into the articular surface, or an abnormal morphology of the meniscus. The sensitivity for a meniscal tear rises from 56% to 94% medially and from 30% to 90 %laterally, when the altered signal is seen extending into the articular surface on two or more planes.[13] 72 cases in this study had meniscal tear and in that 31% only the lateral meniscus and 52% involved only the medial meniscus, and 17% cases showed involvement in both the menisci.

Since medial meniscus is a less mobile structure and helps in transmitting more force during weight bearing it was commoner to get torn and 39% of tears involved the posterior horn. According to Jee et.al, 56% of the tear was involved in the posterior horn of medial meniscus.[14] In our study the anterior horn tear was seen in 3.3% of cases which is in accordance with the study done by De Smet et.al., that showed 2% involvement of anterior horn of medial meniscus in his cases.[15] 25 cases (27.7%) had Grade III tear followed by Grade II in 14.4%, making the grade III tear as commonest tear in medial meniscus. The commonest type of medial meniscal tear detected in this study were vertical tear (24.4%) followed by horizontal tear (15.5%), complex tear (10%), bucket handle tear (6.6%), combined horizontal and radial tear (2.2%) and root tears (2.2%). Bucket handle tear was the commonest type of meniscal tear to involve the whole of the meniscus. According to Helms et al, 10% of meniscal tears involving the medial meniscus were of bucket handle type which is similar to the occurrence of bucket handle tears (6.6%) in our study. All 6 cases of bucket handle tear of medial meniscus in our study showed double PCL sign, where the displaced fragment appeared as a hypointense structure which is parallel to PCL in all MR sequences.[16] When it comes to identifying bucket-handle tears MR has a sensitivity of 27% to 44% and a specificity of 98% to 100%. Wright et al, highlighted the relevance of MR imaging in identifying meniscal displacements and fragments with accuracy. Displaced meniscal fragments are frequently clinically important lesions that require surgical intervention, thus they must be diagnosed. Flap tears, bucket-handle tear, and free fragment displacement are forms of displaced meniscal injuries that can occur in both the medial and lateral meniscus. The identification of the meniscal flap is a solid indication for MR in clinically suspected meniscal tears. It's crucial since arthroscopy may be required to remove or reattach it.[17] MR imaging is a sensitive, non-invasive way of detecting meniscal rips and their displaced pieces, according to Lynn K Lecas et al, Preoperative planning and the discovery of inferiorly displaced fragments that could have gone unnoticed during surgery may benefit from presurgical MR imaging. As in medial meniscus, lateral meniscal tears were also commonly identified in posterior horn (19%). But in lateral meniscus anterior horn was more commonly torn (13.3%) when compared to medial meniscus. Vertical tear (12.2%) is the commonest type of lateral meniscal tear detected in this study followed by radial tear (6.6%), complex tear (4.4%), bucket handle tear (4.4%), horizontal tear (3.3%), and combination of radial and oblique tears (2.2%). Meniscocapsular separation was seen in 3 (3.3%) cases of our study and was involved in posterior horn of lateral meniscus. Least type of tear was Grade I found in 2.2%, and Grade III (16.6%) was the commonest tear, followed by Grade II in 12.2%, and Grade IV in 5.5%. Grade III tear was the most common type of tear in seen in both medial and lateral menisci.[18] The assessment for superior menisco-popliteal fascicle was done in cases of lateral meniscal injuries and disruption of superior menisco-popliteal fascicle was

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seen in 82% of lateral meniscal tear and in 18% without lateral meniscal injury. According to a study done by Blankenbaker et al, which compared MR findings with arthroscopy, found that abnormal fascicle attributes with a lateral meniscal tear but not specific for a tear. Fascicle abnormalities are seen with lateral meniscal tears because of the biomechanic forces that causes tearing of the meniscus also cause disruption of the fascicles. In 2 of medial meniscal tear, a root tear was detected. Because of the inconsistency of clinical symptoms, tears of the posterior meniscal root might be undetected without a comprehensive arthroscopic investigation.[19] So Yeon Lee et al, found in a retrospective analysis that MRI of the knee is reliable and accurate for detecting radial tears of the medial meniscal root, with Coronal T2WI being the most helpful MRI sequence.

Radial tears must be diagnosed on magnetic resonance imaging (MRI) because a precise characterization and description of this tear can alert the clinician and allow for better preoperative planning.[20] However, other studies have found a 2:1 medial-to-lateral involvement ratio in bucket-handle tears. Fragment in notch, double PCL, or flipped meniscus sign are all signs of a misplaced fragment. In our investigation, double PCL sign was detected in 6 patients and fragment in notch was seen in 4 cases. The flipped meniscus sign was not seen. With a specificity range of 98% to100% and a PPV of 93%, the double PCL sign is a highly precise sign of a bucket-handle tear.104 However, MR imaging's sensitivity for diagnosing bucket handle tears is lower than for other meniscal tears. Joint effusions were the most prevalent finding in our research, affecting 54 individuals (60%) and bone contusions (65.5%). (31 patients). The most common ligamentous injury is ACL tear, which occurs in 53 cases (58.9%), followed by MCL injuries, which occurred in 27 cases (30%), 25 LCL injuries (27.8%), and 7 PCL tears (7.8%). The other findings seen were chondromalacia patella in 6.66% patients followed by oedema of Hoffa's fat pad (4.4%) and 2 (2.2%) patients had myxoid degeneration of ACL and PCL. 3 cases in our study had meniscal cysts and 2 were in association with horizontal tear of medial meniscus and 1 was as in association with lateral meniscal complex tear. Bakers cyst was the commonest cystic lesion (4.4%) involving the knee joint followed by meniscal cyst 3.3% and ganglion cyst (2.2%). A similar finding has been reported previously by Sohali K et al, (10%). Baker's cysts were associated with joint effusion, medial meniscal tear and ACL tear. MRI detects an associated disorder in 94% cases of baker's cysts. An association of baker's cyst with joint effusion, meniscal tear and ACL tear has been previously reported .The finding of meniscal cyst involving the posterior horn of medial meniscus and its association with horizontal tear compares favourably with the reported literature.[21] MR examination is a precise and non-invasive diagnostic technique for evaluation of menisci, ligaments and other soft tissue structures around the knee joint. Analysis of images using appropriate sequences in all three planes increases the yield of diagnosis.

The majority of meniscal and ligament injuries can be identified with sufficient confidence. Artefacts, anatomical variances, and other imaging pitfalls must be carefully evaluated and distinguished from pathogenic entities. In the examination of intra-articular knee lesions and, more generally, in traumatic situations, MR imaging has developed as the most commonly conducted radiologic investigation. Pre-arthroscopic MR assessment after a traumatic injury has proven to be cost-effective. Although other imaging modalities like arthroscopy have revolutionised the diagnosis and treatment of knee lesions, most orthopaedists recognise the procedure's invasiveness and limitations, particularly in the evaluation of extra-articular lesions; cost and rarity, as well as the procedure's potential complications. They admit that accurate diagnostic imaging supplements their clinical examination by giving a comprehensive intra-articular and extra-articular evaluation of the knee. Clinicians employ magnetic resonance imaging (MRI) to aid non-surgical care or confirm injuries that require arthroscopic treatment or open surgery. It is critical to detect a meniscal tear as soon as possible in order to develop a treatment plan. In light of changing treatment options, it's critical to accurately diagnose the tear, as well as characterise its position, extent, and pattern, in order to guide and select the best treatment choice. As a result, MRI is used not only for diagnosis but also for treatment of meniscal injuries, such as avoiding unwanted surgery.[22]

CONCLUSION

MR imaging of the knee joint is a non-invasive, painless, and morbidity-free modality that is well accepted by patients which complements clinical examination and arthroscopy by providing an accurate preoperative anatomic assessment. When combined with a clinical evaluation, MR imaging would be the most effective pre arthroscopic diagnostic tool. It has taken the role of needless diagnostic arthroscopy and is now used in conjunction with therapeutic arthroscopy.

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