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Effectiveness of magnetic resonance imaging in assessing the meniscus and ligament tear in knee injuries

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Abstract

Background: With the recent development in imaging techniques such as higher resolution, lesser artifacts, shorter imaging timing and higher accuracy MRI had changed the traditional algorithm for workup of knee joint pathology particularly in twisting injuries of knee where there is a chance of internal derangement is suspected.

Aim: To assess the efficacy of MRI in detecting ligament, meniscal and bony injuries of knee joint among the patients with knee joint injuries.

Methodology: A cross-sectional study was conducted for a period of one year among patients reported with knee joint injuries in the age group between 15 and 35 years. A total of 60 patients were taken as our study sample. All patients initially screened with X-ray followed by MRI using 1.5 tesla Siemens 16 machine. Meniscal and ligament tear were evaluated and graded based on the radiological grading and any other pathological conditions appeared in the bones or soft tissues were also noted.

Results: Identifying the anterior and posterior cruciate ligament tear was more with MRI technique compared to X-ray and the difference was also found to be statistically significant ($p < .05$) and similarly for medial and lateral meniscus tear whereas finding out the medial and lateral collateral ligament tear was almost similar both in X-ray and MRI ($p > .05$). Similarly joint effusion, bone marrow edema and certain bony lesions are picked up by MRI rather than X-ray.

Conclusion: Though X-rays are considered as the investigation of choice by orthopedicians for diagnosing bony pathologies, MRI is highly efficacious in detecting the internal derangements that occurs in knee injuries other than the bony lesions.

Keywords: Knee joint injuries, MRI, X-rays

Introduction

Knee joint is the most common site of injury among the sports person and also in most of the road traffic accidents. Rotational, compressive and trans-axial forces act together or separately to produce these type of injuries [1]. X-rays act as the first investigation of choice for these types of injuries. Most of the time the various radiological views obtained which were obtained after the knee injuries fails to detect most of the soft tissue injuries and some of the subtle radiological changes such as the meniscal and ligament injury. To overcome this limitation now a days MRI imaging of knee had become a routine practice among the practitioners whenever they come across patients with knee injuries [2]. With the recent development in imaging techniques such as higher resolution, lesser artifacts, shorter imaging timing and higher accuracy MRI had changed the traditional algorithm for workup of knee joint pathology particularly in twisting injuries of knee where there is a chance of internal derangement is suspected [3-5]. MRI has revolutionized our ability to understand the soft tissue anatomy and pathology of musculoskeletal system [6]. Increased soft tissue contrast along with multi-planar slice capability has made MRI as the ideal modality for imaging complex anatomy. Previous studies had shown that MRI has a higher sensitivity and specificity in detecting the ligament, meniscal and cartilage injuries [7, 8]. Further it can also detect the contusions in the bone, marrow changes and the fractures occurring in tibial plateau. Failure of timely identification and management of knee injuries would result in poor quality of life and early osteoarthritis changes [9]. Today most of the orthopaedicians are using arthroscopy as a dual technique for both diagnostic and therapeutic modality for knee injuries but this being a invasive and expensive MRI can act as an alternative to it as few

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studies had compared arthroscopy and MRI and had proved that the sensitivity and specificity of MRI is almost in par with arthroscopy findings [10] As of today in this part of the country only few studies had been conducted in assessing the efficacy of MRI in detecting the lesions in knee joint after a knee trauma or injury and so the present study was conducted in assessing the efficacy of MRI in knee injury patients.

Aim

To assess the efficacy of MRI in detecting ligament, meniscal and bony injuries of knee joint among the patients with knee joint injuries.

Methodology

A cross-sectional study was conducted for a period of one year among patients reported with knee joint injuries in the age group between 15 and 35 years. Patients previously operated for knee injuries and with absolute contraindications for MRI study were excluded. A total of 60 patients were taken as our study sample. The study was started after getting clearance from the institutional ethical committee and the informed consent was obtained from all the study subjects involved in our study. All patients were initially screened with X-ray knee joint with AP and lateral view. Following the X-ray, MRI was done for all patients using 1.5 tesla Siemens 16 machine. Different sequences that were performed are PDW-sag, PDW-mSPIR-sag, STIR-coronal, T2-coronal, T1-coronal, T1-axial, STIR-axial, STIR-axial with thin cuts and 3D WATS-sag. The MR images which were taken were studied by the investigator and it was cross checked by another radiologist working outside our institution to validate the findings. Meniscal and ligament tear were evaluated and graded based on the radiological grading and any other pathological conditions appeared in the bones or soft tissues were also noted.

Grading of meniscal tear detected by MRI was done based on the following grading system

Grade 1: Globular increase in the intra-meniscal signal intensity and there is no communication with the articular surface.

Grade 2: Linear increase in the intra-meniscal signal intensity without communicating with the articular surface.

Grade 3: It is considered as a true meniscal tear with a linear increase in the signal intensity, where there is a definite communication with the articular surface.

Grade 3a and b: based on the extent of the articular involvement.

Grade 4: complex tears with complete distortion of the meniscus

Grading of ligament tear based on MRI

Grade 1: Ligament injury without any change in the length of the ligament

Grade 2: Ligament injury associated with increase in the length of the ligament along with a partial disruption of the ligament fibres.

Grade 3: Complete disruption of the ligament.

All data collected were entered and analyzed using SPSS version 22. Mean and SD were calculated for all parametric variables and percentage was calculated for all frequency variables. Chi-square test was used to derive the statistical inference in assessing the efficacy of MRI in comparison with X-rays in detecting the meniscal, ligament and other tissue injury in the knee joint.

Results

Majority of the study subjects were in the age group between 25 and 35 years with a mean age of 27.6 years among males and 26.3 years among females. Most of the patients reported with knee injuries were males with a male: female ratio of 4:1 (table 1). The mode of injury for majority of the subjects was either sports related injury or injury due to road traffic accidents. Anterior cruciate ligament was found to be more commonly injured than the posterior cruciate ligament and the ligament injury grading was done and based on that grade II tear was more common and among the posterior ligament tear we found grade III tear was more common and among the patients with anterior cruciate ligament tear PCL buckling was seen in 11 (18.3%) patients and none of our patients had complex grade IV ligament tears (table 2). Among the types of meniscal tear, medial meniscal tear was found to be more common than the lateral meniscal tear and among the medial meniscal tear grade II tear was found to be more common and among the lateral meniscal tear it was grade III type (complete distortion of the menisci) which was more commonly reported (table 3). All our patients were first screened with X-ray before subjecting them to MRI and the results of both the imaging technique was compared. Identifying the anterior and posterior cruciate ligament tear was more with MRI technique compared to X-ray and the difference was also found to be statistically significant ($p < .05$), whereas finding out the medial and lateral collateral ligament tear was almost similar both in X-ray and MRI ($p > .05$). With regard to meniscus tear, both the medial and lateral meniscus tear was identified and seen better in MRI compared to X-ray and the difference was found to be statistically significant ($p < .05$). More than just identifying the ligament or meniscus tear MRI helps in grading those tears which is most important for orthopaedicians in deciding on the type of intervention (table 4). Apart from meniscus and ligament tear lesions in bone and joint were also viewed in MRI and X-ray. Reduction in joint space was better viewed in X-ray than that of MRI but the difference was not statistically significant whereas joint effusion is identified by MRI more easily than X-ray and the difference was found to be statistically significant ($p < .05$). Bony lesions such as bone marrow edema in femur and tibia were seen only in MRI and X-ray was not able to pick up the marrow edema. The sub-articular cystic changes were seen in similar number in both MRI and X-rays. Bony changes in tibia such as fractures and presence of osteophytes were picked up both by X-rays and MRI, but slightly more by MRI but the difference was not found to be statistically significant.

Table 1: Age and gender wise distribution of the study subjects

Age group	Male	Female	Total
<=20	5 (10%)	1 (10%)	6 (10%)
21 – 25	12 (24%)	3 (30%)	15 (25%)
26 – 30	16 (32%)	5 (50%)	21 (35%)
31 – 35	17 (34%)	1 (10%)	18 (30%)
Total	50 (100%)	10 (10%)	60 (100%)
Mean ± SD	27.6 ± 6.9	26.3 ± 5.4	

Table 2: Ligament tear finding and grading of it by MRI

Ligament tear		Frequency	Percentage
ACL (anterior cruciate ligament)	Grade 1	18	33%
	Grade 2	33	55%
	Grade 3	6	10%
PCL (posterior cruciate ligament)	Grade 1	1	1.6%
	Grade 2	1	1.6%
	Grade 3	4	6.6%

Table 3: Meniscal tear finding and grading of it by MRI

Meniscal tear		Frequency	Percentage
MMT (medial meniscal tear)	Grade 1	1	1.6%
	Grade 2	41	68.3%
	Grade 3	1	1.6%
LMT (lateral meniscal tear)	Grade 1	2	3.3%
	Grade 2	7	11.6%
	Grade 3	10	16.6%

Table 4: Comparison between MRI and X-ray findings in identifying the ligament and meniscus lesions

Ligament/meniscus lesion	MRI	X-ray	P value
Anterior cruciate ligament tear	57 (95%)	36 (60%)	<.001
Posterior cruciate ligament tear	6 (10%)	2 (3.3%)	0.0318
Medial collateral ligament tear	3 (5%)	3 (5%)	1.000
Lateral collateral ligament tear	13 (21.6%)	12 (20%)	0.871
Medial meniscus tear	43 (71.6%)	33 (55%)	0.0261
Lateral meniscus tear	19 (31.6%)	10 (16.6%)	0.0151

Table 5: Comparison between MRI and X-ray findings in identifying the bone and joint lesions

Bone/joint lesion	MRI	X-ray	P value
Reduction in joint space	30 (50%)	32 (53.3%)	0.764
Joint effusion	47 (78.3%)	39 (65%)	0.0124
Femur marrow edema	5 (8.3%)	0	0.0129
Tibia marrow edema	3 (5%)	0	0.0719
Bony changes in tibia	22 (36.6%)	17 (28.3%)	0.084
Sub-articular cystic changes	2 (3.3%)	2 (3.3%)	1.000

Discussion

Knee joint is the most common joint for the occurrence of fracture or injuries mainly due to sports activities or as result of a road traffic accidents. The most cost effective tool for evaluating the knee joint is X-rays and other than that, high definition ultrasonography, arthrography and arthroscopy were also used to evaluate the knee joint after any injury. Though in recent years arthroscopy is considered as the gold standard investigation of choice for evaluating knee joint injuries, it has certain limitations in diagnosing certain lesions such as tear in peripheral meniscus or in the inferior surface of meniscus and conditions such as osteochondritis dessicans would go unnoticed in arthroscopy. MRI has the advantage to overcome these limitations and apart from that it is a non-invasive procedure and because of its high resolution and non-requirement of contrast today MRI had become investigation of choice for

evaluating knee injuries [11, 12]. In the present study we evaluated 60 patients reported with knee joint injuries through two type of imaging techniques one is X-ray and the other is MRI. The mean age of the study subjects was 26 years with male dominating more than females as because most of the knee joint injuries occur in sports related activities and similar studies done in past by Watt S *et al* and an Indian study by JP Singh *et al* had also reported similar results [13, 14]. Of the various soft tissue injuries reported in the present study the most common injury was tear in the anterior cruciate ligament and in the medial meniscus and most of the studies done earlier by JP Singh *et al*, Berquist *et al* and Bui-Mansfield *et al* had also showed a similar type of results [14-16]. Among the cruciate ligament tears Gentili *et al* showed in patients majority of the tears were not communicating with the articular surface (Grade II) and in our study also we found the grade II ACL tears are more common [5]. The incidence of posterior cruciate ligament tear in our study was 10% and it was almost in par with the studies done by Sundar Rajan *et al* where he showed the incidence of PCL tear as 6% and another study by Manoj *et al* it was 12% [17, 18]. Similarly in the present study the medial meniscus tear is more common than the lateral meniscus tear and most of the tears are with partial disruption of the meniscal fibers (grade II) and it is in par with the studies done by Singh *et al*, Atul Bucha *et al*, Chiranjib Murmu *et al*, where all the studies had quoted that the incidence of lateral meniscal injuries is three to four times more common than the medial meniscal injuries [14, 19, 20]. In the current study diagnosing the anterior and posterior cruciate ligament tear, along with medial or lateral meniscus injury was found to be more with MRI compared to X-rays and the difference was found to be statistically significant, whereas the medial and lateral collateral ligament tear was equally picked up by X-ray as that of MRI and no statistical significant difference was observed between them and these results are almost in par with studies done earlier [21, 22].

In this study we haven't validated the MRI with X-ray in diagnosing the knee joint injuries, as it is a known fact that MRI is more superior mode of imaging modality than X-ray in visualizing the ligaments and meniscus but there are certain lesions in the bones and joints where X-rays would be more useful or in par with MRI in recognizing the lesions such as narrowing of joint space, presence of sub-articular cystic lesions and certain bony changes such as presence of fractures or osteophytes as mentioned in the previous studies [23, 24] and our study had proven it by not showing statistical significant difference in the identification of narrowing of joint space and sub-articular cystic changes between MRI and X-ray but a statistical significant difference was seen with MRI identifying more number of joint effusion, marrow edema and certain bony changes.

Conclusion

The present study concludes that MRI is considered as the investigation of choice in detecting meniscus and ligament tears that occurs in knee joint injuries. This investigation being a non-invasive one adds more advantage for the patient compared to arthroscopy. So whenever a patients with knee joint trauma reports to the clinician, a thorough clinical examination along with X-ray and MRI evaluation helps him to make the correct diagnosis and plan the treatment accordingly. The results of our study had shown that MRI is highly efficacious in detecting the internal

derangements that occurs in knee injuries other than the bony lesions which is quite often identified by the X-rays.

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