

# Descriptive study of knee lesions using magnetic resonance imaging and correlation between medical imaging diagnosis and suspected clinical diagnosis

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## ABSTRACT

**Objective:** This study aimed to assess the meniscus and cruciate ligament lesions of the knee using magnetic resonance imaging (MRI) and to investigate the correlation between clinical and MRI diagnoses. **Patients and Methods:** Herein, we reviewed the electronic medical records of 240 patients who underwent knee MRI. The images were evaluated and then the clinical and MRI diagnoses were compared. **Results:** Of the 240 patients, 66% were male and the mean age was  $40.6 \pm 15.5$  years (range, 2-79 years). Knee pain alone was the most common presenting symptom (50.64%) followed by pain after trauma (47.92%). Majority of the knee lesions were medial meniscus (MM) lesions (63%) followed by osteoarthritis (48%) and ACL lesions (35%). The majority of the MM and ACL lesions were tears (54.6% and 69.41%, respectively) followed by degeneration (33.55% and 17.65%, respectively). However, the MM lesions were predominantly observed in the posterior horn (Odds ratio [OR], 152; 95% confidence interval (CI), 21.550-1072.113;  $P < 0.001$ ). The ACL lesions were significantly more common in men than in women (OR, 0.355; 95% CI, 0.191-0.661;  $P = 0.001$ ), and altered signal intensity on T2- and proton density-weighted images was the most common sign ( $P < 0.001$ ). A strong compatibility was observed between the clinical and MRI diagnoses (Kappa = 0.141;  $P < 0.001$ ). **Conclusion:** MM and ACL lesions are the most common injuries of the knee, which can be diagnosed by physical examination in most cases. Further confirmation by MRI should be reserved for doubtful cases only.

**Keywords:** Clinical diagnosis, cruciate ligament lesions, meniscus lesions, magnetic resonance imaging diagnosis

## Introduction

Meniscus and anterior cruciate ligament (ACL) lesions are the most common injuries of the knee joint.<sup>[1]</sup> Meniscus lesions are

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more common in men than in women and can occur in all age groups, while peaking in the third decade of life.<sup>[2]</sup> Meniscus tears are one of the most common lesions of the knee in children and can occur in acute injuries or chronic degeneration,<sup>[3]</sup> such as osteoarthritis, which alters the structure and function of the menisci.<sup>[4]</sup> ACL lesions also have a significant annual incidence, showing predominance in men.<sup>[5]</sup>

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While there is no standard classification system for meniscus tears, the most common meniscus tears are described as horizontal, longitudinal, radial, root, complex, displaced, or bucket-handle tears.<sup>[6]</sup> While clinical history plus physical examination is the preferred diagnostic method for degenerative tears, confirmation by magnetic resonance imaging (MRI) is preferred for traumatic tears.<sup>[7]</sup> MRI enables excellent diagnostic accuracy for identifying the ligament, meniscus, tendon, and cartilage lesions of the knee<sup>[8,9]</sup> and has been described as the best noninvasive imaging modality for diagnosing the meniscus lesions.<sup>[6,10]</sup>

This study was intended to assess meniscus and ACL lesions of the knee using MRI and to investigate the correlation between the clinical and MRI diagnoses. The study elucidates that most of knee lesions can be diagnosed by physical examination. Because of primary care physicians play an important role in receiving, diagnosing, investigating, and follow-up patients with knee pain, this study is important for primary care physicians, general practitioners, medical doctors, surgeons, and orthopedic doctors to prevent overuse of MRI in clinical practice.

## Patients and Methods

### Patient selection

This cross-sectional, retrospective study was conducted at Prince Mohammad bin Abdul Aziz Hospital in Al Madinah Al Munawarah. The data of 240 patients who underwent knee MRI from January 1 to December 31, 2017 were retrieved from the computerised database of the Radiology and Medical Imaging Department.

### MRI assessment

The MRI of each patient was performed with a 1.5-T superconducting magnet (GE OPTIMA) using a standardised institutional protocol. Two-dimensional fast spin echo images were acquired along the sagittal, coronal, and axial anatomical planes using the following parameters: field of view, 16 cm; slice thickness, 3.5 mm with no gap; repetition time, 4000 to 6000 ms; echo time, 25 to 30 ms; echo train length, 8 to 16; bandwidth, 32 to 62.5 kHz over the entire frequency range; acquisition matrix, 512 × 256; and number of excitations, 1 to 2.

### Variables assessed

The electronic medical records were reviewed and the clinical and radiologic diagnoses were collected. Meniscus, ACL, posterior cruciate ligament (PCL), medial collateral ligament (MCL), and other ligament and cartilage lesions were assessed based on sagittal, coronal, and axial images. The medial and lateral menisci, ACL, and PCL were first viewed on the sagittal plane, and then the coronal and axial planes were critically reviewed to confirm any lesion. Each case was observed by two radiologists with more than 8 years of experience in MRI reading who were blinded to patient data in order to decrease interobserver variance.

## Statistical analysis

Data are presented as frequency and percentage for continuous variables and mean ± SD for descriptive variables. Cross-tabulation using the Chi-square test and measurement of agreement using the Kappa test were performed to compare the clinical and MRI diagnoses. Data analysis was performed using SPSS, version 23 for windows (IBM Corp., Armonk, NY) *P* value was assumed to be significant when <0.05.

## Results

In total, 240 patients who underwent knee MRI were included in this study. The mean age at diagnosis was 40.6 ± 15.5 years (range, 2–79 years); 66% were male and 34% were female. Binomial tests using Chi-square tests were performed to analyze the most common knee lesions and the association of knee lesions with sex and the affected side [Table 1], most common presenting clinical findings [Table 2], and most common knee lesions [Table 3]. The results showed that knee lesions affected men twice as frequently as women (*P* < 0.001), the most common indications for knee MRI were pain without trauma (50.64%) and pain after trauma (47.92%), and medial meniscus (MM) lesions were the most common knee lesions (63%) followed by osteoarthritis (48%) and ACL lesions (35%). While a strong association was observed between pain after trauma and male sex (*P* < 0.001), osteoarthritis was found to affect women more

**Table 1: The demographic characteristics of the patients of this study**

Category	Number	Percentage	<i>P</i>
Female	81	34	<0.001
Male	159	66	
Right	240	100	0.272
Left	111	46	
	240	100	

The table revealed significant tendency of knee lesion to male gender (*P*<0.001)

**Table 2: The clinical findings in the patients of this study**

Feature	State	Number	Percentage	<i>P</i>
Pain	Yes	233	97	<0.001
	No	7	3	
Trauma	Yes	240	100	0.949
	No	121	50	
Locking	Yes	119	50	<0.001
	No	240	100	
Tenderness	Yes	223	93	<0.001
	No	17	07	
Swelling	Yes	240	100	<0.001
	No	217	90	
		23	10	
		240	100	

Pain was a significant clinical feature in most cases of knee lesions (*P*<0.001) but trauma was present in half of cases

often than men (odds ratio [OR], 2.59; 95% CI, 1.492-4.498;  $P = 0.001$ ). MM lesions were found in 152 patients (63.33%), including tears in 83 patients (54.6%), degeneration in 51 patients (33.55%), and both tears and degeneration in 16 patients (10.52%); meniscectomy was observed in two patients (1.32%). However, all MM lesions affected the posterior horn (OR, 152; 95% CI, 21.550-1072.113;  $P < 0.001$ ) and the most important sign was ovoid or linear altered signal intensity on T2- and proton density-weighted sequences [Figure 1]. Upon cross-tabulation between MM lesions and age [Table 4], meniscus degeneration showed a peak in the fourth decade of life, while the MM tears increased with age and peaked in the eighth decade.

ACL lesions occurred in 85 patients (35%), including tears in 59 patients (69.41%) and degeneration in 15 patients (17.65%) and ACL reconstruction was observed in 11 patients (12.94%). The ACL lesions were found to be more common in men than women (OR, 0.355; 95% CI, 0.191-0.661;  $P = 0.001$ ). The most common and important sign of ACL lesion was altered signal intensity on T2- and proton density-weighted sequences, which was demonstrated in 74 patients (87.1%) with ACL lesions. Fiber discontinuity was the second most common sign, which was demonstrated in 43 patients (50.58%) [Table 5 and Figure 2].

**Table 3: The pathological findings of the patients of this study**

Feature	State	Number	Percentage	P
ACL lesion	Yes	85	35	<0.001
	No	155	65	
		240	100	
MM lesion	Yes	152	63	<0.001
	No	88	37	
		240	100	
LM lesion	Yes	30	13	<0.001
	No	210	87	
		240	100	
Osteoarthritis	Yes	114	48	0.478
	No	126	53	
		240	100	

Medial meniscus tends to be affected ( $P < 0.001$ ) in contrast to lateral meniscus that is usually not affected ( $P < 0.001$ ). ACL=anterior cruciate ligament, MM=medial meniscus, LM=lateral meniscus

Other rare findings of this study include MCL tears in 7 cases (2.92%), lateral collateral ligament sprains in 3 patients (1.25%), patellar subluxation in 9 patients (3.75%), patellar tendonitis in 2 patients (0.83%), gastrocnemius tendon tears in 2 patients (0.83%), and O'Donoghue's unhappy triad in 1 patient (0.42%).

After excluding cases with no available clinical diagnosis, 202 patients remained for analysis. Kappa and Chi-square tests [Table 6] were used to determine the correlation between the provisional clinical diagnosis made by the physician and the final MRI diagnosis made by the radiologist. Ultimately, the results revealed significant compatibility between clinical and MRI diagnoses (82.4% for ACL lesions, 47.4% for both ACL and MM lesions, and 42.3% for MM lesions; Kappa = 0.141;  $P < 0.001$ ).

### Discussion

This study intended to describe knee lesions using MRI and to determine the correlation between clinical and MRI diagnoses. The results showed that knee lesions predominantly affected men, which is consistent with the studies by Ridley *et al.*, Yaqoob *et al.*, Alrubayyi *et al.*, and Mehta *et al.*, who reported that knee lesions were more common in men.<sup>[2,8,11,12]</sup> However, our results showed only a slight predominance of MM lesions to affect men, which is consistent with the research of Colak *et al.*,<sup>[13]</sup> Hegedus *et al.*,<sup>[14]</sup> and Mansori *et al.*,<sup>[15]</sup> who reported that MM lesions tend to affect men more often than women.

In our study, the mean body mass index (BMI) of the patients was  $28.38 \pm 9.08 \text{ kg/m}^2$ . This BMI is compatible with the studies by Englund *et al.*<sup>[16]</sup> and Glass *et al.*,<sup>[17]</sup> who reported mean BMIs of  $28.5 \pm 5.6$  and  $30.6 \pm 6.3 \text{ kg/m}^2$ , respectively. Mansori *et al.*<sup>[15]</sup> and Alsarani *et al.*<sup>[18]</sup> reported that increased BMI was a significant risk factor for MM tears, demonstrating that most knee lesions were diagnosed in overweight and obese individuals, apart from lesions caused by trauma.

This study revealed that MM tears and degeneration were the most common knee lesions. In multiple studies reported previously, MM tears and degeneration were reported as the main lesions of the knee joint.<sup>[1,2,6,12,18-20]</sup> Our results revealed a

**Table 4: Cross-tabulation of medial meniscus lesions with age**

Decades	No. (%)					No. (%)
	Normal	Degeneration	Tear	Degeneration + Tear	Meniscectomy	
1 <sup>st</sup>	1 (100)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	1 (100)
2 <sup>nd</sup>	12 (66.7)	2 (11.1)	3 (16.7)	1 (5.6)	0 (0.0)	18 (100)
3 <sup>rd</sup>	25 (53.2)	6 (12.8)	15 (31.9)	1 (2.1)	0 (0.0)	47 (100)
4 <sup>th</sup>	30 (48.4)	17 (27.4)	11 (17.7)	3 (4.8)	1 (1.6)	62 (100)
5 <sup>th</sup>	12 (25.0)	12 (25.0)	20 (41.7)	3 (6.3)	1 (2.1)	48 (100)
6 <sup>th</sup>	6 (17.1)	8 (22.9)	16 (45.7)	5 (14.3)	0 (0.0)	35 (100)
7 <sup>th</sup>	2 (8.0)	5 (20.0)	15 (60.0)	3 (12.0)	0 (0.0)	25 (100)
8 <sup>th</sup>	0 (0.0)	1 (25.0)	3 (75.0)	0 (0.0)	0 (0.0)	4 (100)
Total	88 (36.7)	51 (21.3)	83 (34.6)	16 (6.7)	2 (0.8)	240 (100)

The table revealed that medial meniscus degeneration peaks at the 4<sup>th</sup> decade but tear increases with increasing age ( $P = 0.003$ )

significant increase in MM tears with increasing age, consistent with the results of the studies by Ridley *et al.*,<sup>[2]</sup> Colak *et al.*,<sup>[13]</sup> Mansori *et al.*,<sup>[15]</sup> and Englund *et al.*<sup>[16]</sup> Our findings also showed that MM degeneration peaked in the fourth decade of life, consistent with the results of the studies by Metha *et al.*<sup>[12]</sup> and Beaufilet *et al.*,<sup>[21]</sup> who reported that meniscus degeneration is a common finding in middle-aged patients. However, in our study, MM tears showed double peaking in the third decade and

in the elderly, consistent with the research findings of Doral *et al.*<sup>[11]</sup> and Ridley *et al.*<sup>[2]</sup> In our study, all MM lesions affected the posterior horn, similar to the findings of Yaqoob *et al.*<sup>[8]</sup> and Mansori *et al.*<sup>[15]</sup>

In our study, ACL tears were more common than ACL degeneration and more frequently affected men than the women. This result is consistent with the studies by Alrubayyi *et al.*<sup>[11]</sup> and Xu *et al.*,<sup>[22]</sup> who reported that ACL lesions had a tendency to occur in men. Our study also found that altered signal intensity of the ACL was the most common sign of ACL injury, similar to the studies conducted by Xu *et al.*<sup>[22]</sup> and Hash *et al.*<sup>[23]</sup> who reported that the direct signs of ACL tear were fluid signal intensity traversing its fibers or swelling of the ligament with high signal intensity on fluid-sensitive sequences.

Our study found high compatibility between clinical and MRI diagnoses (82.4%, 42.3%, and 47.4% for ACL only, MM only, and both ACL and MM lesions). This finding is consistent with that of Orlando *et al.*<sup>[9]</sup> and Siddiqui *et al.*,<sup>[24]</sup> who reported that careful clinical examination can provide a precise diagnosis of knee lesions, especially ACL lesions. Rayan *et al.*<sup>[25]</sup> reported that compared with MRI, clinical examination may provide better diagnostic information about knee lesions with an accuracy of 96% for ACL tears, 85% for lateral meniscus (LM) tears, and 79% for MM tears. Similarly, Patel *et al.*<sup>[26]</sup> reported diagnostic accuracies of 93.33%, 80%, and 76.67% for the clinical examination for ACL, MM, and LM lesions, respectively. Konan *et al.*<sup>[27]</sup> reported that the joint line tenderness test has a diagnostic accuracy of 81% and 90% for MM and LM tears,

**Table 5: MRI features of ACL lesions**

Sign of ACL lesion	No.	%
Altered SI	66	77.64
Swelling ACL	40	47.1
Fiber Discontinuity	43	50.58
Abnormal course	13	15.29

Table shows that altered SI is the most common feature of ACL tear (Kappa=0.365, P<0.001).  
ACL=anterior cruciate ligament. SI=signal intensity

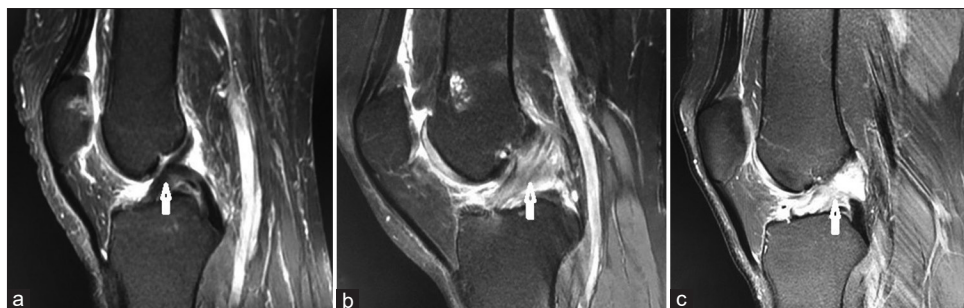
**Table 6: Cross-tabulation between clinical and Final diagnoses by MRI**

Final diagnosis by radiologists	Suggested clinical Diagnosis by the Physicians (No. (%))				Total cases no. (%)
	ACL lesion	MM lesion	ACL + MM	Other	
ACL lesion	14 (82.4)	3 (17.6)	0 (0.0)	0 (0.0)	17 (100)
MM lesion	11 (14.1)	33 (42.3)	5 (6.4)	29 (37.2)	78 (100)
ACL & MM lesion	14 (24.6)	2 (3.5)	27 (47.4)	14 (24.6)	57 (100)
Other	11 (22.0)	7 (14.0)	12 (24.0)	20 (40.0)	50 (100)
Total	50 (24.8)	45 (22.3)	44 (21.8)	63 (31.2)	202 (100)

The table revealed significant compatibility between the clinical and final diagnoses (Kappa=0.141), (P=0.001). ACL=anterior cruciate ligament, MM=medial meniscus



**Figure 1:** Sagittal MRI images of the knee of different patients demonstrate a) normal medial meniscus, b) medial meniscus degeneration in the posterior horn (arrow), and c) transverse tear in the posterior horn of medial meniscus with meniscal cyst (arrow)



**Figure 2:** Sagittal MRI images of the knee of different patients demonstrate a) normal anterior cruciate ligament (arrow), b) mucoid degeneration in the anterior cruciate ligament (arrow), and c) complete tear of the anterior cruciate ligament (arrow)

respectively. A combination of the joint line tenderness test with McMurray's test or Thessaly's test will increase the accuracy of clinical diagnosis of meniscus tears.<sup>[27]</sup> MRI should only be used for doubtful cases to rule out lesions rather than as a routine examination.<sup>[9,24-27]</sup>

## Limitations

Although high compatibility was reported between clinical and MRI diagnoses, this study is limited by its retrospective nature, which did not allow for collection of more accurate clinical diagnoses by select observers. Moreover, the study was a single-center study.

## Conclusion

MM and ACL lesions are the most common injuries of knee joint, which can be diagnosed by physical examination alone in most cases. Further confirmation by MRI should be reserved for doubtful cases only.

## Significance of this study

This study recommends to conserve the principles of clinical diagnosis and to reduce the overuse of MRI, which will decrease the diagnostic pitfalls of imaging, thereby preventing unnecessary procedures and reducing healthcare costs.

## Ethical approval

This study was approved by King Abdullah International Medical Research Center under protocol No. RM17/005/M. While an institutional ethical approval was obtained before the study, patient consent was waived due to the retrospective nature of the study. However, confidentiality of all patient information was assured.

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## Declaration

Because of the retrospective nature of this study, informed consents were waived.

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Nil.

## Conflicts of interest

There are no conflicts of interest.

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