

## Evaluation of Traumatic Knee Joint Injuries Using Magnetic Resonance Imaging

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### Abstract

**Background:** MRI is a widely used modality for diagnosing patients with knee complaints, and it has increasingly replaced diagnostic arthroscopy in this regard. The current research aimed to study the assessment of traumatic knee injuries using MRI, to identify any correlations between the type of tissue damage and age, to determine the ligaments most frequently involved, and to compare the frequency of knee injuries in athletes to those in the general population.

**Methods and Results:** This cross-sectional study included 150 patients with a history of knee injuries who were referred for knee MRI. The study was carried out in the radiology departments of two hospitals (King Faisal Hospital and King Abdulaziz Specialist Hospital, Taif, Saudi Arabia). Medical reports were collected from March 2021 to April 2022. The largest number of affected males were in the age group of 20-30 years; the largest number of affected females were in the age groups of 51-60 years and >60 years. Most athletic patients were in the age group of 20-30 years of age. The anterior cruciate ligament (51.9%) and meniscus (43.1%) were the most affected parts of the knee joint in patients of all ages. Joint effusions and cysts were found in 74.4% and 21.6%, respectively, among all age groups. A torn disc was found in 4 cases, only in male patients aged <20 to 40 years.

**Conclusion:** A non-invasive, radiation-free procedure, MRI facilitates accurate "lesion mapping," which is important in the diagnosis and follow-up of traumatic knee injuries. (**International Journal of Biomedicine. 2023;13(1):115-119.**)

**Keywords:** knee joint • ligament • meniscus • MRI

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### Abbreviations

**ACL**, anterior cruciate ligament; **CT**, computed tomography; **FSE**, fast spin echo; **LCL**, lateral collateral ligament; **MRI**, magnetic resonance imaging; **MCL**, medial collateral ligament, **PCL**, posterior cruciate ligament.

### Introduction

The knee joint is the largest in the human body.<sup>(1)</sup> A form of synovial hinge joint allows for flexion, extension, and external and internal rotation.<sup>(2,3)</sup> The knee joint is responsible

for weight-bearing and mobility.<sup>(4)</sup> It is made up of bones (the femur, tibia, patella), ligaments (the anterior and posterior cruciate ligaments [ACL, PCL], and medial and lateral collateral ligaments [MCL, LCL]), tendons, and menisci; the medial and lateral menisci act as cushions.<sup>(4,5)</sup> Ligament and

meniscal injuries are more common, more varied, and more severe in young athletes than other types of injuries and linked with a high rate of morbidity, which necessitates surgical care and a lot of rest.<sup>(6)</sup> Joint damage has been identified as a significant risk factor for onset of osteoarthritis.<sup>(6,7)</sup>

Despite the importance of clinical evaluation in diagnosing ligament and meniscal injury, painful stress tests are not always successful in the acute phase of the injury. In the event of a knee joint injury, medical assessment, radiographs, and even a CT scan are insufficient to diagnose certain internal joint derangements. As a result of its superior soft tissue contrast resolution and multiplanar imaging capabilities,<sup>(6)</sup> MRI is a widely used modality for diagnosing patients with knee complaints, and it has increasingly replaced diagnostic arthroscopy in this regard. With the ability to examine different anatomy and pathology, ranging from ligamentous injuries to articular cartilage lesions, MRI is considered the optimal imaging and diagnostic method for the knee joint.<sup>(8,9)</sup>

The use of MRI in diagnostic imaging of the knee has revolutionized the field.<sup>(10)</sup> MRI offers superior soft tissue contrast and can analyze soft tissue and bony structures in several imaging planes, giving it a significant advantage over other imaging techniques. A non-invasive, radiation-free procedure, MRI facilitates accurate "lesion mapping," which is important in the diagnosis and follow-up of traumatic knee injuries.<sup>(7,11)</sup> In addition, MRI is a cost-effective technique as it reduces unnecessary surgical and arthroscopic interventions.<sup>(7,12,13)</sup> Early detection of knee injuries is critical for avoiding the long-term implications of delayed treatment.<sup>(14,15)</sup>

## Materials and Methods

### Study population

This study was cross-sectional in design. Medical reports of 150 patients were collected from March 2021 to April 2022. The study was carried out in the radiology departments of two hospitals (King Faisal Hospital and King Abdulaziz Hospital). Ethical approval for this study was obtained from the Research and Studies Department at the Directorate of Health Affairs at Taif City, The Ministry of Health (IRB Registration Number with KACST, KSA: HAP-02-T-067, approval number 674; on 02/02/2022). All participants provided written informed consent.

### Data collection

Patients were examined using a Philips Gyroscan ACS-NT 1.5T MRI scanner and Siemens Magnetom Skyra 3T scanner. Fast spin echo (FSE) imaging, in combination with fat suppression (FS) MRI techniques, was used to improve the sensitivity and specificity of MRI in identifying ligament damage. The sequence was as follows: axial FSE (proton density or fat-saturated T2-weighted sequence), coronal FSE (proton density and/or fat-saturated T2-weighted sequence), and sagittal FSE (proton density with/without fat saturation and fat-saturated T2-weighted ± T1-weighted sequence)

### MRI image analysis

The knee MRI scans were assessed for the presence of knee injuries. Two radiologists with more than five years of experience in musculoskeletal system imaging interpreted all

scans in consensus to decrease the inter- and intra-observer variability error/detection rate.

The MCL and LCL injuries were diagnosed in the axial and coronal FSE. The imaging features of ligament injury appeared as discontinuity of medial meniscofemoral and meniscotibial ligaments with a wavy form of the ligament.

In addition, the tears were diagnosed when the obtained signal intensity was increased on proton-density-weighted (PDw) and fat-saturated, T2-weighted images.

Finally, some imaging features appeared in some patients with knee injuries, such as bone contusion, anterior translation of the tibia, meniscal injury, and a joint effusion.

The statistical analysis was performed using the statistical software Microsoft Excel.

## Results

A total of 150 patients (121[80.7%] males and 29[19.3%] females) were examined by MRI and presented with clinically suspected knee joint abnormalities, given the presence of a knee injury history. The mean age for males and females was 35.4 and 47.7 years, respectively. The largest number of males (35.5%) were in the age group of 20-30 years; the largest number of females were in the age groups of 51-60 years and >60 years (24.1% in both cases). In contrast, the age group of >60 years was smallest for males (5.8%), and the groups of 20-30 years and <20 years were smallest for females (6.9% in both cases) (Table 1).

**Table 1.**

*Distribution of patients according to age and gender.*

Age-group (years)	Male n (%)	Female n (%)	Total n (%)
<20	10 (8.3)	2 (6.9)	12 (8.0)
20-30	43 (35.5)	2 (6.9)	45 (30.0)
31-40	35 (28.9)	6 (20.7)	41 (27.3)
41-50	17 (14.0)	5 (17.2)	22 (14.7)
51-60	9 (7.4)	7 (24.1)	16 (10.7)
>60	7 (5.8)	7 (24.1)	14 (9.3)
Total	121 (80.7)	29 (19.3)	150 (100%)

In our study, 53(35.3%) of the patients were athletes. Most athletic patients were in the age group of 20-30 years of age. The age group of >60 years was the smallest (1.9%). Most athletic patients were male (92.5%), and only 7.5% were female (Table 2).

The ACL (51.9%) and meniscus (43.1%) were the most affected parts of the knee joint in patients of all ages (Table 3). For males, the ACL (53.7%) was the most affected, followed by the meniscus (41.1%). In contrast, the meniscus was most affected for females (53.8%), followed by the ACL (42.3%) (Table 4). Joint effusions and cysts were found in 74.4% and 21.6%, respectively, among all age groups (Table 5). Joint

effusions affected 75.9% of males and 68.6% of females, followed by cysts, which were identified in 19.1% of males and 31.4% of females (Table 6). A torn disc was found in 4 cases, only in male patients aged <20 to 40 years (Table 7).

**Table 2.**

*Distribution of athletic patients (n=53) according to age*

Age group (years)	Athletic patients n (%)
<20	3 (5.7)
20-30	22 (41.5)
31-40	14 (26.4)
41-50	11 (20.8)
51-60	2 (3.8)
>60	1 (1.9)

**Table 3.**

*Distribution of patients according to the relationship between knee injuries (n=160) and age*

Age group (years)	ACL	PCL	MCL	LCL	Meniscus	Patellar
<20	5	0	0	0	0	0
20-30	31	0	1	1	17	1
31-40	25	2	0	0	20	0
41-50	11	0	0	0	13	1
51-60	3	1	0	0	8	0
>60	8	1	0	0	11	0
Total	83(51.9%)	4(2.5%)	1(0.6%)	1(0.6%)	69(43.1%)	2(1.3%)

**Table 4.**

*Distribution of patients according to the relationship between knee injury (n=160) and gender*

Gender	ACL n(%)	PCL n(%)	MCL n(%)	LCL n(%)	Meniscus n(%)	Patellar n(%)	Total n(%)
Male	72(53.7)	3(2.2)	1(0.75)	1(0.75)	55(41.0)	2(1.5)	134(83.8)
Female	11(42.3)	1(3.8)	0(0)	0(0)	14(53.8)	0(0)	26(16.2)

**Table 5.**

*Distribution of patients according to the relationship between pathology and age.*

Age-group (years)	Normal	Joint effusion	Cyst	Fusion	Fracture
<20	0	12	0	0	0
20-30	4	40	4	0	1
31-40	4	37	10	0	1
41-50	1	18	8	2	1
51-60	1	13	8	0	2
>60	1	11	8	0	0
Total	11	131	38	2	5

**Table 6.**

*Distribution of patients according to the relationship between pathology and gender.*

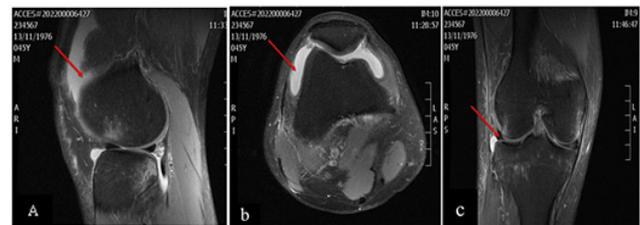
Gender	Joint effusion	Cyst	Fusion	Fracture	Total
Male	107 (75.9%)	27 (19.1%)	2 (1.4%)	5 (3.5%)	141(80.1%)
Female	24 (68.6%)	11 (31.4%)	0	0	35 (19.9%)

**Table 7.**

*Distribution of patients according to the relationship between a torn disc and age.*

Ages (years)	Torn disc
<20	1 (25%)
20-30	1 (25%)
31-40	2 (50%)
41-50	0
51-60	0
>60	0
Total	4 (100%)

Figure 1 presents MRI images of the knee of a 45-year-old male who presented with pain and swelling in his left knee after a twisting injury.



**Fig. 1.** MRI images of the knee for a 45-year-old male who presented with pain and swelling in his left knee after a twisting injury:

A): Sagittal FS PD-FSE image demonstrates moderate to severe joint effusion (red arrow); (B): Axial FS PD-FSE image indicates moderate to severe joint effusion (red arrow); (C): Coronal FS PD-FSE image shows a lateral meniscus posterior horn tear (red arrow).

## Discussion

The increased resolution and precision of MRI have caused it to become recognized as the optimal method for imaging patients with trauma to the knee.<sup>(16)</sup> Its diagnostic performance has been demonstrated to be superior to physical investigations for recognizing damage to the menisci and ligaments.<sup>(17)</sup>

The current research aimed to study the assessment of traumatic knee injuries using MRI, to identify any correlations between the type of tissue damage and age, to determine the ligaments most frequently involved, and to compare the frequency of knee injuries in athletes to those in the general population.

In our study, the male-to-female ratio was 4:1. The mean age for males and females was 35.4 and 47.7 years, respectively. Our gender/age findings were in accordance with a study by Umap et al.,<sup>(6)</sup> which aimed at evaluating traumatic knee joint injuries with MRI. In a study by Yawn et al.,<sup>(18)</sup> injured men were younger than injured women and more likely to have an injury during a sports activity, whereas women's injuries were more likely to result from non-sports-related falls. Knee sprain or strain was the most common final diagnosis (36%) among 664 patients with an isolated acute knee injury.

In the current study, the ACL (51.9%) and meniscus (43.1%) were the most affected in patients of all ages. In a study by Hetta et al.,<sup>(19)</sup> among 25 patients who had sports-related knee injuries, 15(60%) had ACL injuries, 2(8%) had PCL injuries, 10(40%) had meniscal injuries, 8(32%) had collateral ligament injuries, 5(20%) had bone injuries, and 2(8%) had muscular injuries. Comparing the results from MRI findings of sport-related knee injuries with arthroscopic or surgical findings, Lazarova and Gligorievski<sup>(20)</sup> found that the accuracy of MRI in detecting the meniscal lesion was 66.7% for the complete meniscal lesion and 85.7% for the incomplete meniscal lesion. In detecting the ACL lesion, the accuracy of MRI was 85.7% for the complete ACL lesion and 80.8% for the partial ACL lesion.

In our study, the joint effusion (74.4%) and cysts (21.6%) were the most common pathologies among all age groups. Mahmoud et al.<sup>(21)</sup> found that joint effusion was found on MRI in 63.8% of cases among 58 patients with knee joint pain. Our results align with those of Nasir,<sup>(22)</sup> in that males are more likely than females to present with joint effusion. However, the studies disagree in that, in the present work, cysts were more commonly identified in women.

Previous studies evaluated the spinal factors and the development of knee osteoarthritis. Tsuji et al.<sup>(23)</sup> reported that the presence of patella-femoral pain correlated well with the sacral inclination and knee flexion position and with changes in lumbar kyphosis. They called this correlation the "knee-spine syndrome." Murata et al.<sup>(24)</sup> suggested that degenerative changes in the knee might be a factor in the development of loss of lordosis. Tauchi et al.<sup>(25)</sup> showed that an increase in spinal inclination angle (OR=1.073,  $P<0.05$ ) was significantly associated with knee osteoarthritis. In the current study population, a torn disc was noted in males aged <20-40 years.

Our study had several limitations. First, the number of subjects was relatively small. Second, the data collected also had no information about the sporting discipline. Thus, it is necessary to conduct further research, considering these limitations.

**In conclusion**, MRI is one of the imaging modality choices for rapidly diagnosing the knee joint injury and evaluating its condition. MRI can also be used instead of more invasive modalities in patients with traumatic knee injuries.

## Competing Interests

The authors declare that they have no competing interests.

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