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Research Paper

Magnetic Resonance Imaging Evaluation of Knee Joint: A Retrospective Study in Duhok City, Kurdistan Region of Iraq

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ABSTRACT: BACKGROUND:

Knee joint pain is considered one of the leading causes of morbidity and disability throughout all age groups. Its variable pathogenesis, ranging from minor injuries to various disease processes, necessitates precise evaluation.

OBJECTIVE:

Evaluation of knee joint lesions using magnetic resonance imaging to characterize various types of traumatic and non-traumatic conditions leading to the joint pain.

PATIENTS AND METHODS:

This retrospective cross-sectional study was conducted among 900 patients referred to the radiology departments of major medical centers in Duhok city over a period of 26 months. MRI scans were performed on patients of different age groups and both sexes using Samsung 1.5 Tesla MRI scanners. The evaluation of different causes of knee joint pain was performed by the referring specialists, examined by the globally proved gold standard radiological method (MRI), data from the resulting investigations collected and analysed.

RESULTS:

The age group most affected by knee pathology was between 21-30 years for both genders. The most common knee pathologies observed were synovial fluid effusion, meniscal injury, bone lesions, and ACL injuries. Horizontal tears were the most frequent type of tears observed in both menisci. Grade 3 tears were more prevalent in the medial menisci, while grade 2 tears were more prevalent in the lateral menisci. Partial tears were the frequent findings in the cruciate and collateral ligaments. Degenerative joint changes were the most common additional MRI findings, followed by joint infectious changes. Baker's cysts were the most frequent cystic lesions followed by parameniscal cysts. Bony enchondroma was the more frequently observed joint related tumor, followed by chondroblastoma.

CONCLUSION:

Magnetic Resonance Imaging is an extremely useful imaging modality for evaluating changes in the knee joint. It provides valuable information to the referring orthopedic surgeon for planning the course of treatment, whether it is conservative management or surgery.

KEYWORDS: Knee joint, Ligaments, Menisci, MRI

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INTRODUCTION:

Painful knee joints account for a considerable number of emergency department visits and primary care outpatient visits each year. Variable disease processes and injuries that disrupt the ligaments, menisci, articular cartilage, bones, and other structures of the knee joint all contribute to knee joint pain. Its main causes have been attributed to various acute or chronic factors.⁽¹⁾ Meniscal and cruciate ligament injuries are common issues encountered by orthopedic surgeons due to the anatomical structure and functional demands of these ligaments. The failure of regular activities of the knee joint, Issues such as stability and weight-bearing can result from an injury involving these components. It will have an impact on one's physical well-being and disrupt

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everyday activities, which will harm the sufferer both physically and financially. $^{(2)}$

Chronic problems arise from the overuse of the joint and often involve the surrounding ligaments or tendons. A phenomenon which likely happens when pain develops gradually or when discomfort recurs in a prolonged period of time. Chronic problems are often triggered by prior injuries, especially if the original injury was not allowed to heal. ^(1,2)

Magnetic Resonance imaging allows visualization of all joint components, including articular cartilage, menisci, intra-articular ligaments and the intra-articular bony structural disruptions, which may not be detectable by other imaging methods. It can visualize various relevant tissues in addition to its important role in providing a detailed structural composition. ⁽³⁾

An excellent soft tissue detail with multi-planar imaging capabilities provides an excellent method for evaluating joints. Fast spin echo and fat suppression MRI techniques have improved the sensitivity and specificity of MRI in detecting injuries to articular cartilage, menisci, and cruciate ligaments ⁽⁴⁾. Menisci and the anterior cruciate ligament (ACL) are frequently injured in knee trauma, particularly in road traffic accidents and among young males participating in sports. The medial meniscus (MM) is more commonly injured than the lateral meniscus (LM) and is sometimes associated with an anterior cruciate ligament tear $^{\rm (5)}$

Magnetic Resonance Imaging Considerations:

Meniscal tears are classified as simple tears, complex tears, and displaced tears.

The basic tears are further classified as longitudinally oriented tears, horizontal (cleavage) tears, radial tears, root tears, flap tears, bucket-handle tears, and parrot beak tears $^{(6,7,8)}$ (Figure 1).

Grading of meniscal tears according to pathological and Magnetic Resonance Imaging is as followed ⁸:

Grade 1: Observed as focal, globular intrasubstance increased signal; no extension to the articular surface

Grade 2: Detected as horizontal, linear intrasubstance increased signal; no extension to the articular surface

Grade 3: Meniscal tear; increased signal extends to or communicates with at least one articular surface. Grade 4: Complex tear/macerated meniscus

The anterior and posterior cruciate ligaments (ACL and PCL) are considered normal if they appear as a continuous low signal intensity band on both coronal and sagittal images.

Cruciate ligament injuries are classified as sprains, partial tears, interstitial tears, and complete tears. Injuries to the collateral ligaments are classified into sprains , partial tears, complete tears, and ruptures ⁽⁹⁾ (Figure 2)



Figure 1: Illustration of the meniscal tear types ⁸.

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Figure 2: Sagittal T2-weighted fat-suppressed MR image confirms a complete tear of the ACL ¹⁰

PATIENT AND METHODS:

A retrospective cross-sectional study in which 900 patients presented with painful knee joints participated. The study was approved by the ethical committee of the Ministry of Higher Education and the College of Medicine at the University of Duhok, conducted in two large private hospitals in Duhok city over a period of 26 months, from April 2021 to June 2023. The patients included in the study experienced knee joint pain, whether due to traumatic or non-traumatic reasons. Patients with cardiac pacemakers, metallic implants, post-operative complications, technical imaging issues, motion disorders, and claustrophobia were excluded from this study.

MRI scans of the knee in this study were performed using a Siemens Magnetom Essenza (A Tim+Dot system) MR machine with a 1.5 tesla field strength magnet. The scans were conducted using a flex coil, a small field of view (14-16cm), and a slice thickness of 4-5mm.

Multiple axial, coronal, and sagittal planes were obtained. The imaging protocols included proton density and T1-weighted sequences in sagittal and coronal planes T1 and T2weighted sequences in the axial, coronal, and sagittal planes, as well as sagittal and coronal STIR images. Radiologists reviewed all images. In cases where the diagnosis was uncertain, two radiologists reached a consensus on the diagnosis. The data collected from these images included age, sex, and the distribution of various knee pathologies, such as bone abnormalities, fluid effusion, meniscal issues, ligament problems, cysts, and bony lesions. This data was analyzed and presented in the form of tables and figures.

Statistical Analysis:

After thorough verification, the data was analyzed using the SPSS 21.0 software package (Statistical Package for the Social Sciences). The variables were expressed in terms of numbers and percentages.

RESULTS:

Regarding the age and sex distribution of the patients, the most affected age group was between 21-30 years in both genders, accounting for 42.2% of the total number. This was followed by an age group between 31-40 years, which accounted for 32.2% of the total number. Males accounted for 515 cases, while females accounted for 385 cases, making up 57% and 43% of the total cases, respectively(table 1).

Table 1: Demographic Distri	ibution of Patients No.	(900) and	nercentages%
Table 1. Demographic Distri	button of 1 attents 140.	(200) and	percentages /0.

<20	Male 49	% 5.4	Female 13	% 1.4	Total 62	% 6.8
21-30	236	26.2	144	16	380	42.2
31-40	178	19.7	112	12.4	290	32.2
41-50	23	2.5	82	9.1	105	11.6
>50	29	3.2	34	3.7	63	7

The most common knee pathology observed was synovial fluid effusion, which accounted for 90% of the total cases. This was followed by meniscal injury, with combined medial and lateral meniscal injuries accounting for 88% of the cases. Bone and ACL ligament injuries each accounted for 70% of the total cases, while PCL injury accounted for 46%. The least common was collateral ligament injury, which accounted for 24% of the cases (Table 2).

Pathology	No. of patients	Percentage %
MM	552	61.3
LM	240	26.6
ACL	632	70.2
PCL	416	46.2
Collateral ligaments	218	24.2
Bone	635	70.5
Joint effusion	811	90

 Table 2: Distribution of the studied sample in accordance with the common knee pathology, each patient may have more than one pathology.

From the total number of meniscal injuries, horizontal tears were the most commonly observed, accounting for 35% of medial meniscal injuries and 11.8% of lateral meniscal injuries. Vertical tears were found in 15% of medial menisci and 8.6% of lateral menisci. The study concluded

that complex tears were more common than vertical tears in the lateral menisci, accounting for 9.5% of all meniscal injuries.

Bucket handle tears were observed in 6% of the medial meniscal tears and 1.6% of the lateral meniscal tears (Table 3).

 Table 3: Distribution of patients according to the types of meniscal tears, patients may have isolated or combined meniscal pathology (total number = 792).

	MM		LM	
	No. of patients	Percentage	No. of patients	Percentage
Horizontal	278	35.1	94	11.8
Vertical	119	15	68	8.6
Radial	34	4.3	32	4
Bucket	48	6	13	1.6
handle				
Complex	79	10	76	9.5
Total	558	70.4	283	35.7

According to the grading of meniscal tears, grade 3 was the most common in the MM, accounting for 33.7% of the total number, while grade 2 was the most common in the LM, and accounting for 13% of all meniscal tears.

Grade 2 tears were seen in 23.8% of the MM tears. Grade 1 was less commonly seen in 12% of the MM tears and approximately 6% of the LM tears (table 4).

 Table 4: Distribution of severity of meniscal tears (No.792)

	MM		LM	
	No .of patients	Percentage %	No. of patients	Percentage %
Grade 1	96	12	47	5.9
Grade 2	189	23.8	104	13
Grade 3	267	33.7	89	11.2
Total	552	69.6	240	30.3

According to studies on cruciate ligament injuries, partial tears were found to be the most common type of injury in both the anterior cruciate ligament (ACL) and the posterior cruciate ligament (PCL),

accounting for 65.4% and 58.5% respectively. Complete tears were observed in 34.6% of ACL injuries and 41.5% of PCL injuries(table 5).

Anterior cruciate ligament Posterior cruciate ligament							
	No. of patients	Percentage %	No. of patients	Percentage %			
Partial Tear	413	65.4	243	58.5			
Complete tear	219	34.6	173	41.5			
Total	632	100	416	100			

Table 5: Distribution of patients according to cruciate ligaments pathology

In the collateral ligaments, partial tears were equally common in both ligaments.

Table 6: Distribution in accordance with collateral ligaments pathology (218)

Medial collateral ligament Lateral collateral ligament						
	No. of patients	Percentage %	No. of patients	Percentage %		
Partial Tear	94	67.6	53	67		
Complete tear	45	32.4	26	33		
Total	139	100	79	100		

According to the additional knee joint structural lesions, degenerative joint changes were more commonly observed, forming 28%. This was followed by traumatic bone contusion at 25%, and joint infective changes at 20%.

Cystic lesions were observed in 14.2% of the total cases that exhibited additional knee joint lesions. Among these, Baker's cysts were the most prevalent, accounting for 58% of the total

cystic lesions, followed by para-meniscal cysts at 39%.

Bony tumors were observed in 8.6% of the total cases, which also showed additional knee joint lesions. Among these bony tumors, bony enchondroma was the most common, accounting for 64% of the total cases, followed by chondroblastomas at 29% and giant cell tumors at 17% (table 7).

Table	7: 5	ample	distribution	in	accordance	with	the	additional	MRI	criteria (674).
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	No. of patients	Percentage%
Joint degenerative changes	189	28
Joint infective changes	134	19.9
Cystic lesions	96	14.2
Bony Contusion	169	25
Bony tumors	58	8.6
Synovial pathology	28	4.1

DISCUSSION:

The knee is one of the largest and most complex joints in the body. Disease processes and injuries that disrupt ligaments, menisci, articular cartilage, and other joint compartments can result in significant morbidity and disability. Several studies have reported that magnetic resonance imaging (MRI) of the painful knee joint is a superior radiological technique for evaluation compared to X-ray and CT scan. Magnetic Resonance imaging offers superior soft tissue detail and multi-planar imaging capabilities, providing a distinct advantage over other imaging modalities. ⁽⁴⁾

In the present study, the analysis of patient demographics revealed that the condition had

the highest prevalence among individuals aged 21 to 30, regardless of gender. This age group accounted for 42.2% of the total number of patients. This was followed by an age group between 31 and 40 years, which accounted for 32.2% of the total number. Males were more prevalent, accounting for 515 cases, which represents 57% of the total. Females accounted for 385 cases, which represents 43% of the total. Until now, the present study was the only study of this kind conducted in the Kurdistan Region of Iraq. However, similar findings have been observed in three other studies conducted in Saudi Arabia, Egypt, and Sudan. These studies found that

the age group most affected was between 30 and 49 years, with males being more commonly affected than females $^{(5,11,12)}$ In another similar study conducted in India, the mean age of the study participants was 38.48 ± 14.53 . Males were more prevalent than females $^{(4)}$, which aligns with the findings of the present study. This similarity was also observed in another study conducted in Bengaluru. $^{(13)}$

In the present study, the most prevalent knee pathology observed was synovial fluid effusion, which accounted for 90% of the total cases. This was followed by meniscal injury, with combined MM and LM injuries accounting for 88% of the cases. Bone and ACL ligament injuries each accounted for 70% of the total cases, while PCL injuries accounted for 46%. The least common type of injury was collateral ligament injury, which accounted for 24%.

Joint effusion was found to be the most common knee joint lesion in a study conducted in Egypt, accounting for 80% of the total number of cases. This was followed by a meniscal injury, which accounted for $56.7\%^{(5)}$

Comparable findings were also observed in another study conducted in Saudi Arabia. They found fluid effusion, meniscal tears, and that synovial accounted the highest ACL tears for percentages in their sample study ⁽¹¹⁾. In a separate study conducted in Sudan, fluid effusion was present in 65% of the cases $^{(12)}$, while meniscal injuries accounted for 4.8% of the study sample. Comparable findings were also observed in two studies conducted in India. They found that the most common knee pathology observed was fluid effusion, followed by meniscal tears ^(2,14). In a study conducted in Bengaluru, meniscal injury was observed in 54% of the total cases ¹³ In another recent study conducted in India, joint effusion accounted for 88% of the cases, followed by meniscal tears at 37% and ACL injury at 33%. ⁽⁴⁾.

In another study conducted in India, the most common knee joint pathology observed was ACL injuries, followed by joint effusion and bony contusion. ⁽¹⁵⁾

From the total number of meniscal injuries observed in this study, horizontal tears were the most commonly observed, accounting for 35% of the MM injuries and 11.8% of the LM injuries. Vertical tears were found in 15% of the MM and 8.6% of the LM. The study concluded that complex tears were more prevalent in the LM than

in the MM, comprising 9.5% of all meniscal injuries.

Bucket handle tears were observed in 6% of the MM tears and 1.6% of the LM tears. A comparable study on meniscal tears conducted in Dukok city in 2017 found that 80% of the total 80 cases in their sample study were affected by tears in the MM, while only 20% were affected in the LM. Horizontal tears were the most common type of meniscal tears found in their study, accounting for 41% of the total MM tears and 12.5% of the LM tears. Complex tears and bucket handle tears were observed. ⁽¹⁶⁾

Similar findings were also observed in another study conducted in Bengaluru, where horizontal tears were the most commonly found, followed by vertical and complex tears. Similar to the present study, they found that complex tears were more common in the LM than in the MM. ⁽¹³⁾

In this study, the most common grade of meniscal tears in the MM was grade 3, accounting for 33.7% of the total number. In contrast, grade 2 was the most common grade for LM , accounting for 13% of all meniscal tears. Grade 2 tears were observed in 23.8% of the MM tears. Grade 1 tears were less common, occurring in 12% of the MM tears and approximately 6% of the LM tears.

Similar findings were seen in another Indian study, where Grade 3 was the most common, followed by Grade 2 and then Grade 1 ⁽¹⁷⁾.Different results were observed in a study on meniscal lesions conducted in Kufa city, Iraq. Grade 1 was the most frequently observed, followed by grade 2 and then grade 3 ⁽¹⁸⁾. This difference in findings may be attributed to the smaller sample size of their study (80 patients) compared to the present study's sample size (900 patients). In the present study, the most common type of ligamentous injury was a partial tear, accounting for 65.4% in the ACL and 58.5% in the PCL.

Complete tears were less commonly observed in ACL injuries, accounting for 34.6% of the total ACL injuries, compared to PCL injuries, which accounted for 41.5%. In the case of collateral ligaments, partial tears were also prevalent, occurring equally in both collateral ligaments.

Similar findings were found in other studies conducted in Egypt, Saudi Arabia, and India. These studies reported a larger number of ACL ligament sprains compared to PCL injuries. Additionally, they found that medial collateral ligament injuries were more common than lateral ligament injuries^(5,11,14). However, in another study

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conducted in India, they found that lateral collateral ligament sprains were more common than medial collateral ligament sprains, but their findings regarding cruciate ligaments were similar to the present study ⁽¹⁵⁾. In a recent study conducted in India, it was discovered that partial ACL tears were more common than complete ACL tear. ⁽¹⁹⁾

According to the additional knee joint structural lesions observed in the present study, degenerative joint changes were the most commonly observed at 28%, followed by traumatic bone contusion at 25%, and joint infective changes at 20%.

Cystic lesions were observed in 14.2% of the total cases that exhibited additional knee joint lesions. Among these, Baker's cysts were the most prevalent, accounting for 58% of the total cystic lesions, followed by para-meniscal cysts at 39%.

Bony tumors were observed in 8.6% of the total cases, which also showed additional knee joint lesions. Among these bony tumors, bony enchondroma was the most common, accounting for 64% of the total cases, followed by chondroblastomas at 29% and giant cell tumors at 17%.

Comparable results were observed in a study conducted in India⁴. The study found that bony contusion and degenerative joint changes were the most common knee pathologies. Additionally, Baker's cysts and parameniscal cysts were the most prevalent cystic lesions. According to their study, the most common bony tumor identified was giant cell tumor, followed by chondroblastoma and enchondroma.

Comparable findings to these results were found in a study conducted in India. The study reported a higher incidence of bony contusion, followed by degenerative joint changes. The most common cystic lesions observed were Baker cysts, followed by parameniscal cysts. Synovial chondromatosis was seen in a small percentage of cases (0.8%) ⁽¹⁷⁾. Backer cyst was also the most common cystic lesion observed in two studies conducted in Sudan and Pakistan. ^(12,20) In the last study conducted in Pakistan, a high percentage of bony osteoarthritic changes and bony contusion were found among the studied sample. ⁽²⁰⁾

CONCLUSIONS AND RECOMMENDATIONS:

MRI is of vital importance in the evaluation of the knee joint, as it can accurately demonstrate the nature and extent of all joint compartments. This allows for more detailed information to be provided to orthopedic surgeons and physicians who are concerned about knee joint pathologies. Further imaging evaluations are recommended to expand this study to more specific knee pathologies.

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