Magnetic resonance imaging findings of knee injury

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ABSTRACT

Background: Since its introduction to musculoskeletal imaging in the early 1980, magnetic resonance imaging (MRI) has revolutionized diagnostic imaging of the knee. It is therefore become the examination of choice in the evaluation of internal joint structures of the knee like menisci, cruciate ligaments, and articular cartilage.

Objectives: to describe the MRI finding in various knee injuries.

Patients and methods: A cross sectional study was done on 130 patients with history of knee injury in MRI unit at institute of radiology and al-Shaheed Ghazi Al-Hariri Hospital in medical city complex - Baghdad, from October 2011 to February 2013 includes 103 men, 27 women; the mean age was 33.86 years. MR imaging studies of the knee performed using a 1.5 T MR system. The sequences included coronal and sagittal PD, sagittal T2 FSE, fat suppressed T2 FSE, STIR axial and coronal. Knee MR studies were obtained to evaluate ligament, menisci, articular surface and bone pathologies of knee injuries.

Results: MR images were normal in 15 patients; it was positive for meniscal tears in 59 patients and maximum involvement was in the medial meniscus and the posterior horn. These tears were classified into grade 1 (28.8%), grade 2 (11.5%), grade 3 (53.9%) and grade 4 (5.8%). Ligament tears were seen in 70 patients. Secondary signs associated with ligament tears were also assessed.

Conclusions: MRI is an accurate, non-invasive technique for examination of the soft tissues and osseous structures of the knee. It has great capability in diagnosing meniscal tears and classifying them into grades and types, which would avoid unnecessary arthroscopic examination. It is a very good modality to diagnose complete tears of the anterior cruciate ligament (ACL).

Keywords: knee, magnetic resonance imaging, meniscus.

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The knee is one of the most commonly injured joint and MRI is currently the imaging modality of choice for nearly all clinical indications concerning the knee[1] . Normal knee joint function is essential for day-to-day life and in many popular sports. The number of patients with complaints of knee injury is quite significant and, therefore, magnetic resonance imaging of the knee is of great value to understand and diagnose the varied pathologies of knee joint[2]. Since its introduction to musculoskeletal imaging in the early 1980s, MRI has revolutionized diagnostic imaging of the knee. This innovative technology allows superior soft tissue detail with multiplanar imaging capability that provides accurate evaluation of the intra- and extra-articular structures of the knee not demonstrated with other imaging modalities[3].

The main purposes of this study were to describe the MRI findings in various forms of knee injury and to improve our standard MRI work and technique in the knee injury.

Methods. This cross sectional study applied on 130 patients in the MRI units at institute of radiology and Al-Shaheed Ghazi Al-Hariri Teaching Hospital in medical city - Baghdad, in the period from October 2011 to February 2013. All patients have history of knee injury. MRI examination carried out using Siemens Magnetom Avanto, 1.5 Tesla. For examination of knee joint, we used flex knee coil. The patient placed in supine position with the knee slightly flexed. Inclusion criteria includes all patients of knee injury, where the MRI was used as a modality of choice; while, exclusion criteria includes the patients who had no history of knee injury, Post operative patients, patient who had contraindication to MRI like pacemakers cochlear implants and MRI is also not recommended during first trimester of pregnancy and uncontrolled claustrophobia.

Once a patient satisfied the inclusion criteria for this study, he or she was administered the study proforma. The patients were briefed about the procedure; the noise due to gradient coils (heard once the patient was inside the bore of the magnet) and the need to restrict body movements during the scan time was explained to the patient.

The MRI protocols of knee joint done in our MRI unit as follow: coronal PD, sagittal T2WI FSE, sagittal PD FSE, fat suppressed T2WI FSE (axial, coronal & sagittal) and STIR FSE coronal. After MRI Findings interpretation, the meniscal tears were classified into: 1; Anterior horn or posterior horn tears by area involvement, 2; Grade 1, 2, 3 & 4 according to the signal intensity abnormality, and 3. Vertical, radial and bucket handle tear according to the type of tear.

Ligaments assessed in the following manner: ACL tear classified as acute if the MR examination was performed within 6 weeks of injury. This is either partial or complete. Chronic ACL tear was considered if MR examination was performed more than 6 weeks after injury. A chronic ACL tear was suggested if the ligament was focally or diffusely disrupted without evidence of significant edema. The ligament was also considered chronically torn if it appeared as a continuous band with low signal intensity that bridged

the expected origin and insertion of the ACL but demonstrated significant focal angulations. Secondary signs of associated bone bruises, fractures and segond fractures were assessed. Association of bone contusion, bone injury and segond fracture with ACL tears assessed. Segond fracture defined as avulsion fracture involving the proximal lateral tibia, immediately distal to the lateral plateau. Posterior cruciate ligament (PCL) tears evaluated and graded as complete or partial tear. Medial collateral ligament (MCL) tears were graded into grade 1, 2 & 3. Lateral collateral ligament (LCL) tears were classified as: grade 1, 2 & 3. Joint effusion classified as mild, moderate and severe. Bone marrow edema or bone contusions also reported.

Statistical analysis; All the findings of the cases studied were tabulated using Microsoft Excel hence statistical analysis was done by using Statistical packages SPSS18 (Statistical Package for Social Sciences version 18). Continuous variables presented and discrete variables presented as numbers and percentages. Chi square test for goodness of fit used to test the significance of observed distribution (observed trend). Findings with P value less than 0.05 considered significant.

Results. In this study group, which comprised of a total number of 130 patients, the age at presentation with knee injury ranged from 12 to 72 years. The mean age was 33.86 years and the maximum numbers of patients affected belong to the age group of 21 to 40 year as shown in figure 1.

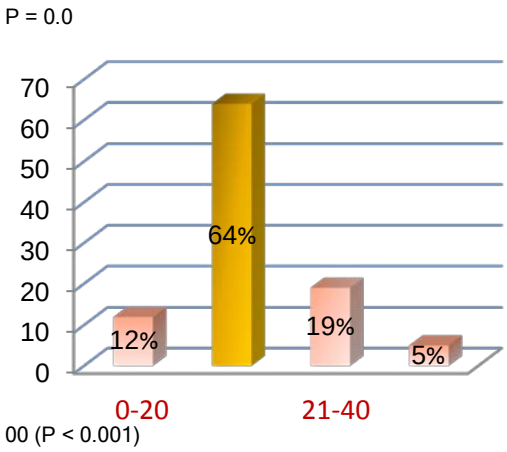
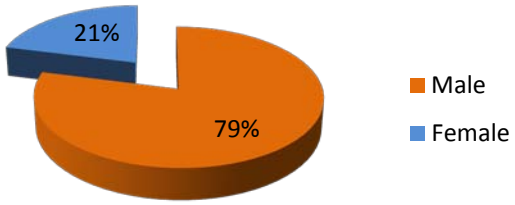


Figure1: Age distribution of the patients presenting with knee injury.

Gender distribution; there were 103 males and 27 females in the patients included in the study. Males comprised 79% of the group while the females comprised 21% as shown in figure 2.

Side of the injury; of the total 130 patients evaluated for knee injury, 56 (43%) of sample of the study involves the right knee while 74 (57%) of the patients show left knee injury as shown in table 1.

Meniscal tears: Of the 130 patients evaluated with MRI of the knee for evaluating knee injury, 59 patients (45%) had meniscal tears. Of the 59 meniscal tears, 38 (64 %) involved the medial meniscus alone, 7 (12%) involved the lateral meniscus and 14 (24 %) involved the medial as well as lateral meniscus as shown in table 2.



P = 0.000 (P < 0.001)

Figure 2: Pie chart depicting the relative percentages of male and female in the study group.

Table 1: Side distribution.

Side	Number	%	P-value
Right	56	43	P = 0.114
Left	74	57	

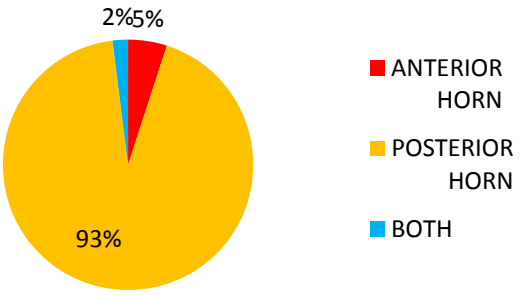
Table 2. Distribution of MRI findings of the knee injury.

MRI finding		Number total number 130	%	P value
Meniscal tear	Medial	38	29.2	
	Lateral	7	5.3	< 0.001
	Both	14	9.3	
Ligament injury	ACL	57	43.8	
	PCL	4	2.6	< 0.001
	MCL	25	16.6	
	LCL	16	10.6	
Bone injury	BM edema	38	25.3	
	Bruises	16	10.6	< 0.001
	Fracture	2	1.3	
Joint effusion		63	42	0.726
Normal		15	10	< 0.001

Of the 59 meniscal tears detected on evaluation with MRI of the knee, 55 tears (93%) of the involved the posterior horns, 3 tears (5%) involved the anterior horns while 1 (2%) involved both the anterior and posterior horns as shown in figure 3.

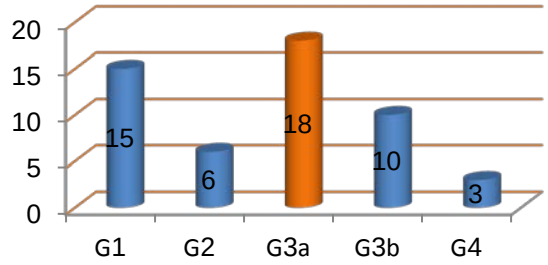
Medial meniscal tears; Of the 52 medial meniscal tears. 15 were grade 1 tears , 6 were grade 2 tears, 18 were grade 3a tears , 10 was grade 3b tears and 3 were grade 4 tears. All of the tears in the medial meniscus involved the posterior horn as shown in figure 4.

Lateral meniscal tears; Of the 21 patients with lateral



P = 0.000 [P < 0.001]

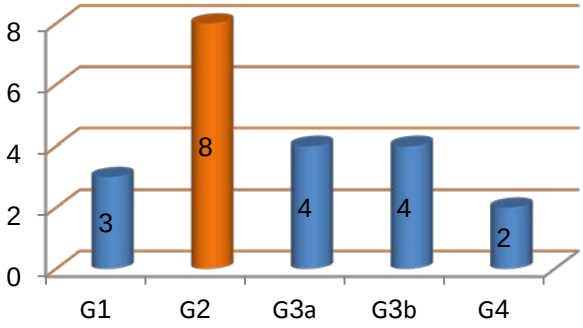
Figure 3: Distribution of meniscal tears in the anterior and posterior horns.



P = 0.002

Figure 4: Bar graph showing grades of meniscal tear in the anterior and posterior horns of medial meniscus.

meniscal tear could be graded into grade 1 (14.4%), grade 2 (38.1%), grade 3a (19%), grade 3b (19%) and grade 4 (9.5%) as shown in figure (5).

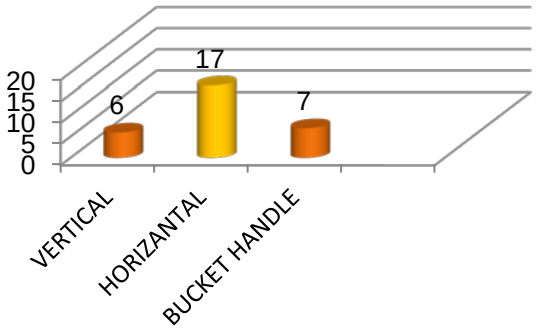


P = 0.292

Figure 5: Bar graph showing the different grades of lateral meniscal tear.

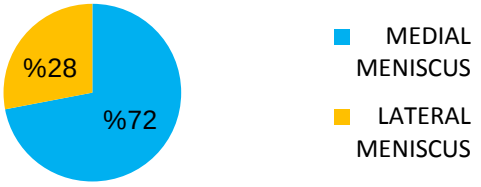
Types of meniscal tears: Of the 59 meniscal tear, 30 tears could be classified into types with 6 having vertical tears, 17 having horizontal tears and 7 having bucket - handle tears as shown in figure 6.

Bucket Handle tears; among the 7 patients with bucket handle tears, 5 (72%) had tears involving the medial meniscus and 2 (28%) had tears involving the lateral meniscus as shown in figure 7.



P = 0.025

Figure 6: Bar graph showing the distribution of the meniscal tears into types.



P = 0.257

Figure 7: Pie chart showing distribution of bucket-handle tears in the medial and lateral Meniscus.

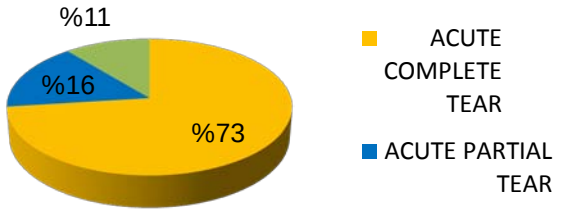
Ligament tears; Ligament tears were seen in 70 patients on evaluation of MR images of knee out of 130 patients included in the study. Of the 70 patients with ligament tears, 57 patients (80.1 %) had ACL tears, 4 patients (5.7 %) had PCL tears, 25 patients (35.5 %) had medial collateral ligament tears and 16 patients (22.8 %) had lateral collateral ligament tears.

ACL tears; Of the 57 patients with ACL tear, 42 (73%) patients had acute complete tear, 9 (16%) patients had acute partial tear, 6 (11%) patients had chronic tears of ACL as shown in figure 8.

MCL tears; Of the 70 patients with ligament tears, 25 patients had medial collateral ligament (MCL) tears .Of these 25 patients, 11 patients (44%) had Grade 1 tear, 12 patients (48%) had grade 2 tears and 2 patients (8%) had grade 3 tears as shown in figure 9.

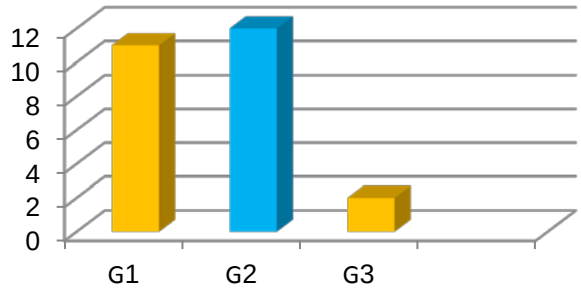
Table 3: Showing distribution of ligament tears.

Ligament tears	Number /Total	Percentage	P value
ACL tears	57/70	80.1 %	< 0.001
PCL tears	4/70	5.7 %	< 0.001
MCL tears	25/70	35.5 %	0.017
LCL tears	16/70	22.8 %	< 0.001



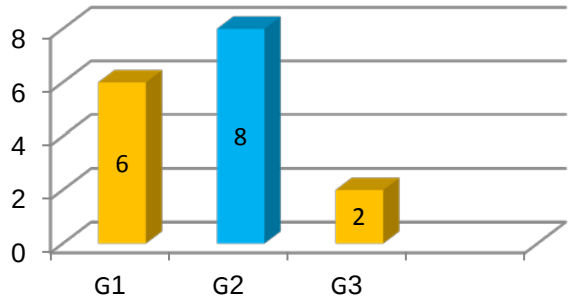
P < 0.001

Figure 8: Pie chart showing types of ACL tear.



P = 0.026

Figure 9: Bar diagram showing the different grades of medial collateral ligament tears.



P = 0.023

Figure 10: Bar diagram showing the different grades of lateral collateral ligament tears.

Discussion. The knee injuries that disrupt ligaments, menisci, articular cartilage and other structures of the knee cause painful knee that cause significant morbidity and disability. Imaging of knee, therefore, presents a special challenge because of its complex structure. A variety of imaging modalities are currently used to evaluate knee abnormalities. These modalities include standard radiography, scintigraphy, computed tomography (CT), MRI and arthrography.

MR imaging has revolutionized knee imaging. There are many reports in literature comparing magnetic resonance imaging with arthroscopic findings. These studies have helped validate the role of MR imaging in the clinical arena; especially for the evaluation of meniscal and ligamentous injuries. Also MR imaging plays a valuable role in the evaluation of a variety of acute and chronic knee injuries[4].

There are many advantages of MR imaging over other modalities. Moreover, MR imaging does not require intraarticular or intravenous injection of contrast material, does not require manipulation of the knee joint, and is painless[5].

This study included 130 patients who had history of knee injury and underwent MRI of the knee joint. The study included MRI of the knee joint of which 74 were left knee and 56 were right knee.

The study population consisted patients in the age group of 12- 72 years with a mean of 33.86 years. Maximum number of patients who underwent MRI of the knee for knee injury belonged to the age group of 21-40 years. This study also showed a male preponderance for knee injury, accounting for 79% of the caseload. These findings in agreement with results obtained by Henan et al[6].

Of the 130 patients, MRI of the knee was normal in 15 patients. In this study, 45% patients evaluated with MRI of the knee for evaluating knee injury had meniscal tears. Of these, 64% had medial meniscal tears only, 12% had lateral meniscal tears only and 24% had medial as well as lateral meniscal tears. Crues et al in their study of meniscal tears and correlation with arthroscopy in 142 patients found meniscal tears in 66% involving the medial meniscus and 33% involving the lateral meniscus[7].

Of the 59-meniscal tears noted in 130 patients, 55 tears involved (93%) the posterior horn and 3 involved (5%) the anterior horn and 1 tear (2%) involved both the anterior and posterior horns. Crues et al in their study also found meniscal tears involving the posterior horns, which accounts for 57% compared to the 16% involving the anterior horn[8]. Weiss et al also reported meniscal tears involving the posterior horn accounting for 50%-60% and tears involving the anterior horn accounting for 5%- 20%[9].

Of the 21 meniscal tears involving the lateral meniscus, 3 tears were classified as grade 1 tear, 8 tears as grade 2, 4 tears as grade 3a , 4 tears as grade 3b and 2 tears as grade 4 with maximum number of tears belonging to grade 2 and 3.This is in similar to the study done by Ismael Silva et al who in their study of 44 patients with meniscal tears graded them, with the maximum number of tears belonging to grade 3 and minimum number of tears belonging to grade 1[10].

Of the 52 meniscal tears involving the medial meniscus, 15 tears were classified as grade 1, 6 tears as grade 2, 18 tears as grade 3a , 10 tears as grade 3b and 3 tears as grade 4.A study done by Ismael Silva et al, also showed that maximum number of tears involving the medial meniscus were of grade 3[10].

Of the 59-meniscal tears, 30 tears could be classified into types with 6 vertical tears, 17 were horizontal tears and 7 were of the bucket handle type of tear. The number of patients with bucket handle tears were 7 of which 5 (72%) involved the medial meniscus and 2 (28%) involved the lateral meniscus. Wright et al in their study of 46 patients with bucket handle tear found that the medial meniscus (72%) is involved more than the lateral meniscus[11].

Of the 57 patients of 130 who had anterior cruciate

ligament tears, 42 patients (73%) had acute tear (complete), 9 (16%) had acute tear (partial) and 6 (11%) had chronic tears. An ACL tear was considered acute if the MR examination was performed within 6 weeks of injury and chronic if MR examination was performed more than 6 weeks after injury as Vahey et al[12].

Vahey et al in his study of 81 patients with ACL tear correlated with arthroscopy findings had a sensitivity of 100 % specificity of 93% and an accuracy of 96% for the diagnosis of acute complete tear and a sensitivity of 87%, specificity of 93% and an accuracy of 90% with a diagnosis of chronic ACL tear[12].

Acute ACL tears were usually associated with bone bruise with 21 having associated posteroateral tibial bruise and 16 having associated lateral femoral bruise. All the acute tears were usually associated with moderate to significant joint effusion. 16 patients with ACL tears did not have associated bone bruise. Buckling of PCL was seen in 1 patient with no bruise which is suggestive of instability.

The bone fractures associated with ACL tear were lateral femoral condyle in one patient. Only 1 patient had associated Segond fracture (avulsion fracture involving the proximal lateral tibia, immediately distal to the lateral plateau). Robertson et al in their study of multiple signs of anterior cruciate ligament on MR imaging in 103 patients found that the most accurate and reliable sign of an ACL tear was discontinuity of the ACL in the sagittal and axial planes[13].

Medial collateral ligament tear was seen in 25 of 130 patients. Of the 25 patients, 11(44%) had grade 1 tear, 12 (48%) had grade 2 tear and 2 (8%) had grade 3 tears. The association of bone bruise with medial collateral ligament tears were assessed to identify those bruises that were possibly unique to MCL injury. Bone bruises were quite common (64%) and, were usually seen in the tibia. Mark E. Schweitzer et al evaluated multiple signs, prevalence and location of associated bone bruises associated with MCL tears on MR imaging. A study was conducted on 76 patients found that maximum number of patients with knee pain who had MCL tears belonged to grade 2. Bone bruises were seen in 24% with more located medially in the femur rather than laterally which was in contradistinction to this study[14].

Posterior cruciate ligament tear was seen in 4 patients with 1 patient having complete tear and 3 patients having partial tear. The incidence of PCL tear in the study group of 130 patients was 3%. The PCL being a stronger ligament, therefore, has low incidence of tears[1].

Lateral collateral ligament tears were seen in 16 patients with 6 tears belonging to grade 1, 8 tears belonging to grade 2 and 2 tears belonging to grade 3. O'Donoghue's triad (anterior cruciate ligament with medial meniscal and medial collateral ligament tear) was seen in 4 patients. No intra-articular loose body detected and no para-articular hematoma is seen.

In conclusion, knee injury common among young age group, male affected than female. Medial meniscus affected more than lateral and posterior horns more than the anterior horns. Horizontal tear is the commonest type of meniscal tear. Bucket handle tear commonly affected the medial meniscus. Maximum numbers of tears are involving the medial meniscus was of grade 3. ACL tears occur much more than the PCL tears. In the knee injury, the MCL affected more than LCL. Sagittal plane is more valuable in assessment of the cruciate ligaments injuries while the coronal plane is more helpful in the evaluation of the collateral ligaments injuries. T2 STIR acquisition is more valuable in evaluation of bone contusion.

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