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## Correlation of imaging findings with clinical examination: Traumatic knee

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### Abstract

Impaction and distraction injuries have different characteristic appearances on MR Images. Impaction causes bone marrow edema. On MR images, trabecular contusion has the appearance of bone marrow edema. Ligament damage is a common and important distraction injury, with numerous MRI manifestations. A prospective study consisting of 50 patients with traumatic knee joint is undertaken to study the spectrum of MRI findings in all consecutive cases of knee trauma referred from orthopaedic OPD. Out of 50 patients studied, 18 (64.3%) patients were exposed for both Lachman's test and ACL tear. In 10 (35.7%) patients ACL tear were not suspected clinically on Lachman's test but were detected on MRI.

**Keywords:** Traumatic knee, Lachman's test, MRI

### Introduction

Knee is the largest synovial joint in the body and it is a complex hinge joint. It consists of two condylar joints between the medial and lateral condyles of the femur and the corresponding condyles of the tibia, and a saddle joint between the patella and the patellar surface of the femur. Fibula is not directly involved in the joint. Stabilized is provided by various ligaments around the joint <sup>[1]</sup>.

Injuries of the ligaments and menisci in knee joints are associated with particular traumatic mechanisms. MRI findings can reveal the traumatic mechanisms in many acute knee injuries. Compression and tension are the two basic loads that commonly act on the knee.

In compressive load, bones collide leading to impaction. Compressive load causes bone marrow contusion and, if sufficient in magnitude, depressed cortical fracture.

It can also damage interposed soft tissues, most commonly the articular cartilage and meniscus, when they become entrapped between bones <sup>[2]</sup>.

In tensile load, on the other hand, bones pull apart leading to distraction across the joint and traction on stabilizing structures. Tensile load can cause ligament and tendon tears as well as avulsion fracture. Impaction and distraction injuries have different characteristic appearances on MR Images. Impaction causes bone marrow edema. On MR images, trabecular contusion has the appearance of bone marrow edema. Ligament damage is a common and important distraction injury, with numerous MRI manifestations <sup>[3]</sup>.

A sudden strong force is more likely to snap a ligament in its midsubstance.

Before Growth plates close, the immature skeleton is at increased risk of avulsion fracture.

The risk of avulsion is also increased in the elderly population because of osteoporosis.

In ACL tears, the tibia translates anteriorly and the menisci can be torn either by entrapment between the tibia and femur or by tension transmitted to them by the posterior joint capsule and menisiofemoral ligaments <sup>[4]</sup>.

The ACL and MCL develop maximum tension when internal rotation is combined with valgus force <sup>[5]</sup>. Therefore with excessive internal rotation and valgus loading, both the ACL and MCL fail, leading to anterior tibial translocation and the pivot shift pattern of bone marrow edema.

Dashboard mechanism occurring with flexed knee position puts the PCL at risk of distraction injury. Because of functional synergism, posterolateral corner structures tend to be injured in combination with the PCL <sup>[6]</sup>

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**Methodology**

A prospective study consisting of 50 patients with traumatic knee joint is undertaken to study the spectrum of MRI findings in all consecutive cases of knee trauma referred from orthopaedic OPD.

**Inclusion Criteria**

- All the patients referred with knee injuries following trauma.
- Cases of all age groups.

**Exclusion Criteria**

- Patient having history of claustrophobia
- Patient having history of cardiac pacemakers, metallic foreign body and cochlear implants insitu.

**Imaging protocol**

Technique-Imaging will be done with 1.5 Tesla Philips Achieva Machine using 8 channel SENSE knee coil.

Positioning-Imaging is done with full extension in neutral position. A small field of view (FOV) typically in the range 14-16 cm.

The following sequences will be selected as required.

- T2W axial-TE (100 MS), TR (5400 MS), FOV (160), Slice thickness (1-3 mm).
- PD fat sat sagittal-TE (30 MS), TR (2500 MS), FOV (155), Slice thickness (3 mm).
- STIR coronal-TE (60 MS), TR (3547 MS), FOV (150), Slice thickness (3 mm).
- mFFE sagittal-TE (9.2 MS), TR (934 MS), FOV (165), Slice thickness (1-3 mm).
- T1W coronal-TE (7 MS), TR (500-700 MS), FOV (150) Slice thickness (1mm).

**Results**

**Table 1:** Lachman’s test and ACL tear

Lachman's test	ACL tear				Total		P-value
	Absent		Present		No	%	
	No	%	No	%			
Absent	22	100.0	10	35.7	32	64.0	<0.001
Present	0	0.0	18	64.3	18	36.0	
Total	22	100.0	28	100.0	50	100.0	

There is a statistical correlation between ACL tear and Lachman’s test with p-value <0.001. Out of 50 patients studied, 18 (64.3%) patients were

exposed for both Lachman’s test and ACL tear. In 10 (35.7%) patients ACL tear were not suspected clinically on Lachman’s test but were detected on MRI.

**Table 2:** Posterior drawer test and PCL tear

Posterior drawer test	PCL tear				Total		P-value
	Absent		Present		No	%	
	No	%	No	%			
Absent	43	93.5	3	42.86	43	86.0	<0.001
Present	3	6.5	4	57.14	7	14.0	
Total	46	100.0	7	100.0	50	100.0	

There is a statistical correlation between PCL tear and posterior drawer test with p-value <0.001. Out of 50 patients studied, 4 (57.14%) patients were

exposed for both posterior drawer test and PCL tear. In 3 (42.86%) patients, PCL tear were not suspected clinically on posterior drawer test but were detected on MRI.

**Table 3:** McMurray’s test and Meniscal tears

Mc Murray's Test	Medial meniscus tear				Total		Lateral meniscus tear				Total	
	Absent		Present		No	%	Absent		Present		No	%
	No	%	No	%			No	%	No	%		
Absent	24	80.0	5	25.0	29	58.0	23	67.6	6	37.5	29	58.0
Present	6	20.0	15	75.0	21	42.0	11	32.4	10	62.5	21	42.0
Total	30	100.0	20	100.0	50	100.0	34	100.0	16	100	50	100.0
					P- value = <0.001					P-value = 0.04		

There is a statistical correlation between medial meniscus tear and Mc Murray’s test with p-value <0.001.

There is a statistical correlation between lateral meniscus tear and Mc Murray’s test with p-value (0.04).

Out of 50 patients studied, 15 (75%) patients were exposed for both medial meniscal tear and McMurray’s test.

Out of 50 patients studied, 10 (62.5%) patients were exposed for both lateral meniscus tear and McMurray’s test.

In 5 (25%) patients of total 20 medial meniscus tears and 6 (37.5%) patients of total 16 lateral meniscus tears were not suspected clinically on McMurray’s test but were detected on MRI.

**Table 4:** Valgus strain test and Medial collateral ligament tear

Valgus strain test	MCL tear				Total	
	Absent		Present			
	Number of cases	%	Number of cases	%	Number of cases	%
Absent	30	96.8	13	68.4	43	86.0
Present	1	3.2	6	31.6	7	14.0
Total	31	100.0	19	100.0	50	100.0
						P-value = 0.005

There is a statistical correlation between MCL tear and valgus strain test with p-value 0.005. Out of 50 patients studied, 6 (31.6%) patients were exposed

for both valgus strain test and medial collateral ligament tear. In 13 (68.4%) patients MCL tear were not suspected clinically on valgus strain test but were detected on MRI.

**Table 5:** Varus strain test and lateral collateral ligament

Varus strain test	LCL tear				Total	
	Absent		Present			
	Number of cases	Percentage	Number of cases	Percentage	Number of cases	Percentage
Absent	38	97.4	9	81.8	47	94.0
Present	1	2.6	2	18.2	3	6.0
Total	39	100.0	11	100.0	50	100.0
						p - value = 0.054

There is no statistical correlation between LCL tear and varus strain test with p-value 0.054. Out of 50 patients studied, 2 (18.2%) patients were exposed for both LCL tear and varus strain test. In 9 (81.8%) patients LCL tear were not suspected clinically on varus strain test but were detected on MRI.

**Discussion**

Imaging of knee 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, magnetic resonance imaging and arthrography.

MR imaging has revolutionized knee imaging. It has been compared by various studies between magnetic resonance and arthroscopic findings. These studies validate the role of MR imaging in the clinical arena especially for the evaluation of ligamentous injuries. There are many advantages of MR imaging over other modalities.

This study included 50 patients who were clinically suspected as having some form of internal derangement of knee.

The subjects of this study belonged to the age group of 15 to 55 years with mean age of 33.52 years. Maximum were young patients in the age group of 15-30 years (48%). 84% of patients of this study were male and male outnumbered females in all age groups in this study. Majewski *et al* [7] study showed, acute traumatic injuries of knee were common in age group 20-29 and 70% were male. In our study, traumatic injury to knee were found in 84% males. So young adult males were predominantly imaged for clinically suspected ligamentous or meniscal injuries. In our study 28 patients (56%) had ACL tears, 7 patients (14%) had PCL tears, 19 patients (38%) had medial collateral ligament tears and 11 patients (22%) had lateral collateral ligament tears. Therefore ACL tear was identified as commonest injury among ligamentous tears around the knee joint.

Singh JP *et al* [8] in their series of 173 patients, 78 patients (45.08%) showed ACL tears, among these 52 (66.67%) are partial, 16 (20.51%) are complete and 10 (12.82%) cases showed non visualization of ACL. The authors concluded

that ACL tears are more common than other ligamentous injuries with partial tears being commoner. However in our study, out of 28 patients with ACL tears, 13 patients (46.4%) were having partial tears and 15 patients (53.6%) were having complete tears. Complete tears were common in our study which can be attributable to the severity of trauma involved in young adults. The indirect signs of ACL tears were analyzed in the form of objective criteria such as sagittal ACL tibial angle, PCL angle and anterior tibial translation were used. The mean sagittal ACL-tibial angle was 47° in case of partial ACL tears, while the mean angle was only 28.13° in complete tears. The mean PCL angle was 124.38° in partial ACL and more acute angle with mean angle of 101.53° in complete ACL tears. The mean anterior translation measured 2.31 mm in partial ACL tears and 9.93 mm in complete ACL tears.

Amilcare Gentili *et al* [9] performed a retrospective study to establish the sensitivity and specificity of indirect signs of ACL tears on MR. They reported a sensitivity and specificity were as follows; 90%, 97% for ACL angle <45°; 52%, 94% for PCL angle <107° and 41%, 91% for anterior displacement of tibia >7mm. Presence of these indirect signs corroborated the presence of ACL tear in our study. In our study, out of 50 patients, only 18 patients (64.3%) were exposed for both Lachman’s test and ACL tear. In 10 patients (35.7%), ACL tear were not suspected clinically on Lachman’s test but were detected on MRI. Study done by Malanga *et al* [10] on physical examination of knee demonstrated that the Lachman’s test is sensitive and specific for the detection of anterior cruciate ligament tears. Similar results were found in our study also.

In our study injury to PCL was noted in 7 patients (14%). All these patients had increased intrasubstance signal intensity of ligament. In all patients continuity of the ligament was maintained but showed increased thickness in anteroposterior diameter. The mean PCL thickness was 9.1 mm in these cases. These results are comparable to the study done by William Rodriguez *et al* [11] on 34 patients with surgically proven PCL tear, which showed mean PCL thickness of 9.6 mm in case of torn ligament. Bone contusion was found in 5 patients (71.42%) of PCL tears. Sonin *et al* [12] reported high incidence of bone bruise in

association with PCL tear ranging from 32 to 83%. Similar results were found in our study.

### Conclusion

In our study, out of 50 patients, only 4 (57.14%) patients were exposed for both posterior drawer test and PCL tear. In 3 patients (42.86%) PCL tear were not suspected clinically on posterior drawer test but were detected on MRI.

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