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MR Imaging of Acl Injuries and Associated Complications

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Abstract

Aim and Objective

- To examine the MRI characteristics of Anterior Cruciate Ligament (ACL) injuries,
- Investigate the indirect indicators of ACL damage.
- Assess ACL tears and their associated complications in patients undergoing MRI of the knee.

Material and methods: This prospective study was conducted at the Department of Radiodiagnosis, Basaweshwara Teaching and General Hospital, Kalaburagi. The study involved a sample size of 50 participants referred from department of orthopaedics with the history of trauma. MRI was performed using Philips Achieva 1.5 Tesla MRI machine.

Result: ACL injuries predominantly noted in male patients. However mucoid degeneration is seen most commonly in females above 50 years of age.

ACL injury may associate with secondary findings such as Bone contusion, joint effusion, popliteal cyst, hemarthrosis, also may have accompanying Meniscal and/or collateral ligament injuries.

Conclusion: MR Imaging plays a crucial role in the diagnosis and assessment of anterior cruciate ligament (ACL) injuries.

It provides detailed information about extent of the injury, associated damage to surrounding structures, and helps guide treatment decisions.

Application of MR imaging as an initial examination tool after knee trauma in the emergency department setting can potentially yield benefit to the patient and the health care system. MRI is the valuable diagnostic tool in detecting knee injuries.

Keywords: MRI, Anterior Cruciate Ligament, Knee injuries.

Introduction

Knee joint is a complex synovial joint made up of the lower end of the femur, the upper end of the tibia and the patella, which is one of the important weight bearing

joints capable of performing complex and extensive movements. It is therefore most frequently affected by traumatic and degenerative condition.

It also has supporting structures such as ligaments and menisci that play an important role in the stability and mobility, therefore injuries of ligaments and menisci are extremely common.

The ACL is the most commonly injured ligament in the entire body that most often requires surgical repair [1].

The assessment through magnetic resonance imaging (MRI) of the knee, in patients clinically suspected with ACL injury, is useful for the confirmation or disconfirmation of the ACL lesion, and also for the detection of other associated knee pathologies.

MRI is the first line investigation in suspected anterior cruciate ligament injuries and can avoid large number of unnecessary diagnostic arthroscopies. It has been reported to have a high diagnostic accuracy, non-invasive and does not involve the use of ionizing radiation[2].

To examine the MRI characteristics of Anterior Cruciate Ligament (ACL) injuries, investigate the indirect indicators of ACL damage, and assess ACL tears and their associated complications in patients undergoing MRI of the knee.

Aim and Objective

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- Investigate the indirect indicators of ACL damage.
- Assess ACL tears and their associated complications in patients undergoing MRI of the knee.

Material and Methods

This prospective study was conducted over 18 months, from August 2022 to January 2024, at the Department of Radiodiagnosis, Basaweshwara Teaching and General Hospital, affiliated with Mahadevappa Rampure Medical College in Kalaburagi. The study involved a sample size of 50 participants referred from department of orthopaedics with the history of trauma. The study started after obtaining an approval from the ethical committee and informed consent from all the study group.

MRI was performed using Philips Achieva 1.5 Tesla MRI machine after applying inclusion and exclusion criteria.

Inclusion Criteria

The MRI knee of 50 patients was performed who were referred with history of trauma and clinical suspicion of ACL injury.

Exclusion Criteria

The patients who have undergone reconstruction or repair for other ligament injuries and those with no associated knee complain, were not included in the study.

Results

The study involved a sample size of 50 participants, conducted over 18 months. Among those 50% patients are belongs to 40-60 age group (Table 1).

Right ACL injury was seen in 28 Patients and Left ACL Injury in 22 patients (Table- 2)

ACL injuries predominantly noted in male patients (84%) as compared with females (16%)

Table 1: Age distribution

Age group (years)	Number (n=50)	Percentage
<20	5	10
20-40	8	16
40-60	25	50
>60	12	24

Table 2: Side of injury

ACL injury	Number (n=50)	
Right	28	Male 16 (32%)
		Female 12 (24%)
Left	22	Male 10 (20%)
		Female 12 (24%)

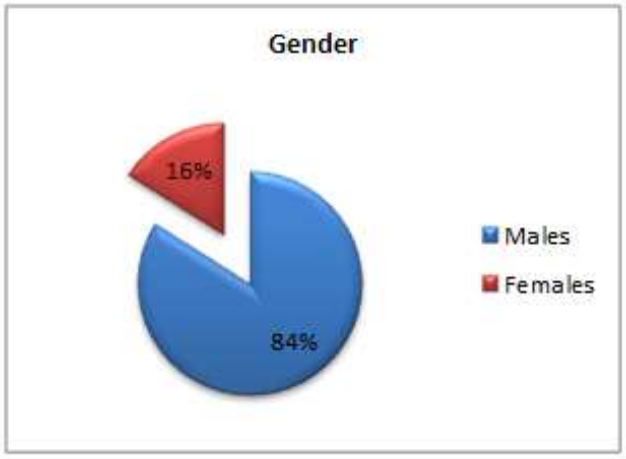

Figure 1: Gender distribution

Interstitial sprain was most commonly seen in about 55% of cases (commonly in males).

Mucoid degeneration is seen most commonly in females above 50 years of age.

Complete tear is seen in about 53% of cases more common on right side (Figure 2).

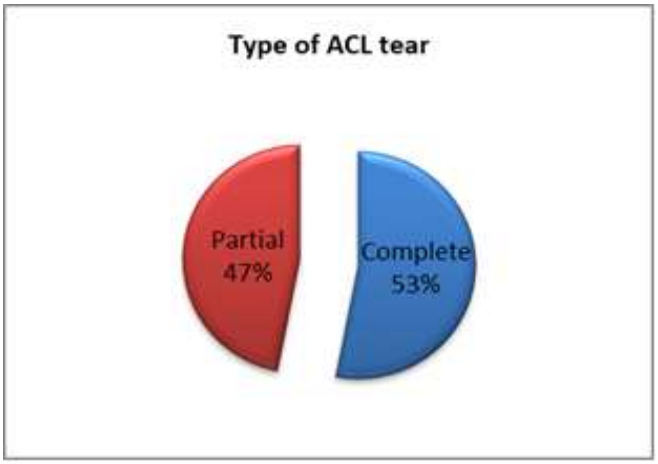

Figure 2: Types of ACL tear

ACL injury may associate with secondary findings such as Bone contusion, joint effusion, popliteal cyst, hemarthrosis, also may have accompanying Meniscal and/or collateral ligament injuries (Figure 3-5).

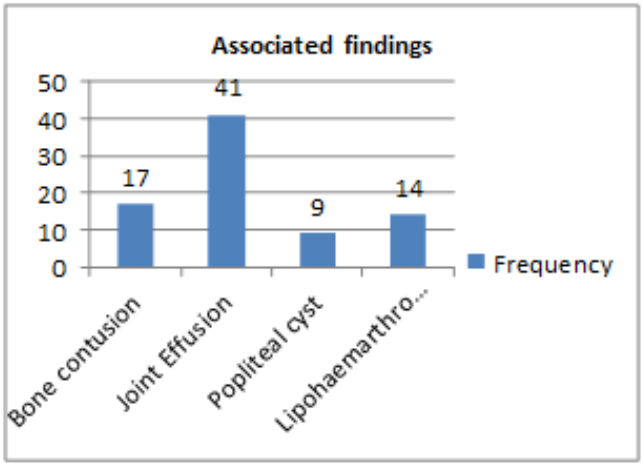

Figure 3: Associated findings

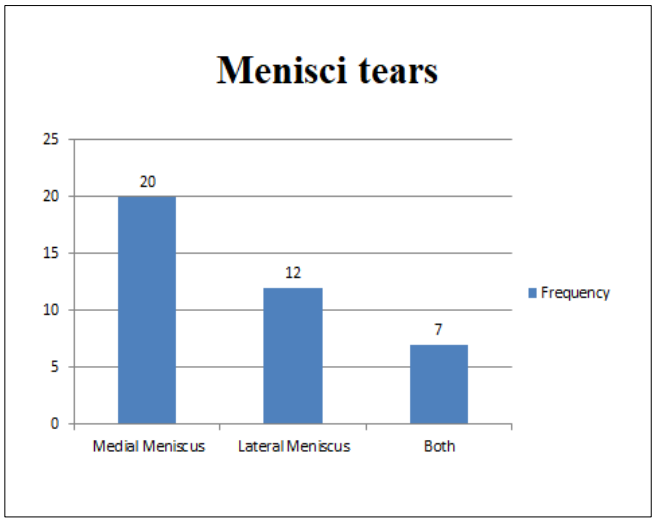

Figure 4: Meniscal tear

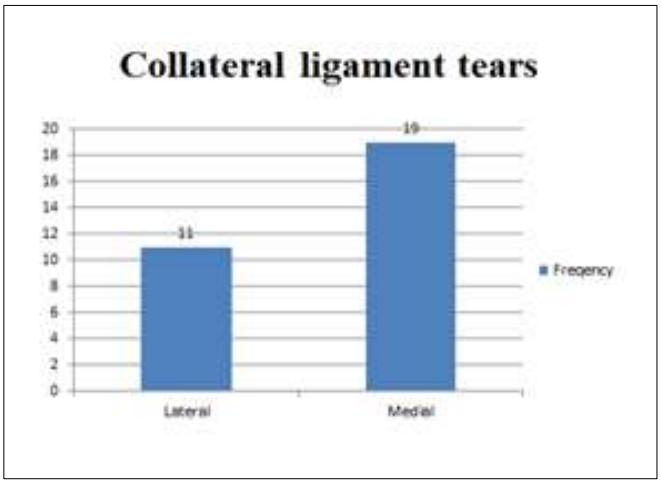

Figure 5: Collateral ligament tears

Discussion

The anterior cruciate ligament (ACL) runs in an oblique course from the tibia to the lateral femoral condyle.

It is an intra-articular extra synovial ligament composed of fibers running from the anterior inter condylar region of the proximal tibia to the medial aspect of the lateral femoral condyle within the intercondylar groove.

The fibers of the ACL are arranged into two bundles known as the anteromedial and posterolateral bundle according to their tibial insertion.

The anterio -medial inserts at a more medial and superior aspect of the lateral femoral condyle, while the postero-lateral bundle inserts at a more lateral and distal aspect of the lateral femoral condyle.[3]

The ACL is usually seen on sagittal fat saturated MRI images as a longitudinally striated band.

Normally the ACL should have a low to intermediate signal intensity, with continuous fibers in all planes and MRI sequences. The postero-lateral band normally has higher signal intensity than the antero-medial band.

The mechanism of the ACL injury includes:

1. Internal rotation of the tibia relative to the femur.
2. Hyperextension such as occurs during jumping or high kick maneuvers and will lead to contra-coup bone contusion on the anterior tibia and femoral condyle.
3. External rotation of the tibia relative to the femur with varus stress leading to impaction and bone edema medially and distraction laterally resulting in Segond fracture and tear of the lateral collateral ligament.

ACL Lesion - MRI Signs:[4]

Primary signs

- Swelling
- Increased signal on T2 or PD FS (proton density weighted with fat saturation)
- Fibre discontinuity
- Change in the expected course of ACL

Expected course can be evaluated by comparing the trajectory of ACL with that of Blumensaat line. The Blumensaat line is the line drawn along the roof of the intercondylar notch (posterior surface) of the femur as seen on lateral radiograph of the knee joint (Figure 6).

Figure 6: Blumensaat line

When ACL has a normal trajectory, it forms together with the Blumensaat line an arrow which points backwards (or upwards) When ACL has an abnormal trajectory, then it forms together with the Blumensaat line an arrow which points forwards (or downwards).

Complete ACL tear (Figure 7)

The primary signs of ACL tear are:

- Ligament discontinuity of ACL.
- Diffuse or focal abnormal signal intensity

- Abnormal orientation or ligament course (abnormal Blumensaat angle)
- A mass-like appearance in the expected location of the ACL
- Non-visualization of the ACL.
- Empty notch sign.

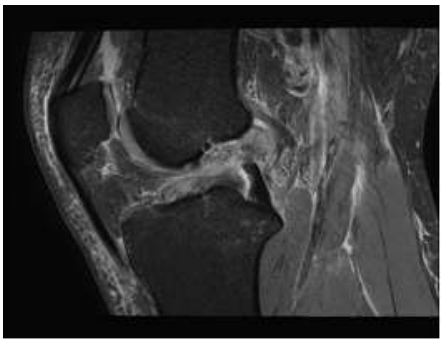

Figure 7: Sagittal PDFS demonstrate complete ACL tear

Secondary signs:

- Bone contusion in lateral femoral condyle and posterolateral tibial plateau (Figure 8).
- >5 mm of anterior tibial translation (anterior tibial translation sign; anterior drawer sign) distance between two parallel lines drawn tangential to the posterior lateral femoral condyle and posterior lateral tibial plateau (Figure 9).
- Angulation of the posterior cruciate ligament (buckling).
- Meniscal injury (Figure 8).
- Collateral ligaments injury.
- Articular effusion/hemarthrosis (Figure 10).
- Segond fracture (avulsion fracture of lateral tibial rim)[5].

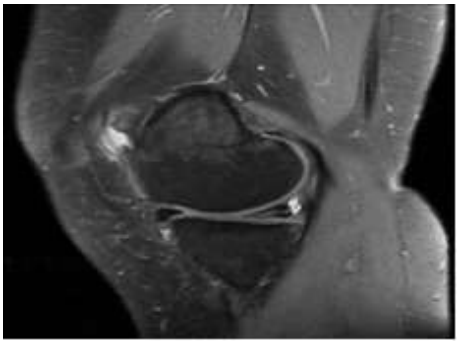

Figure 11: Sagittal PDFS demonstrate Horizontal tear of posterior horn of medial meniscus.

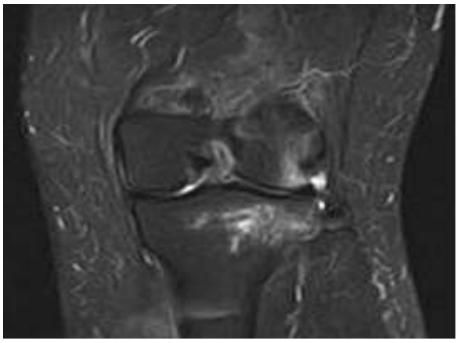

Figure 12: Coronal plane STIR demonstates bone contusions which are diffuse ill define areas of high signal intensity in lateral femoral condyle and posterior aspect of tibial plateau- **“kissing contusions”.**

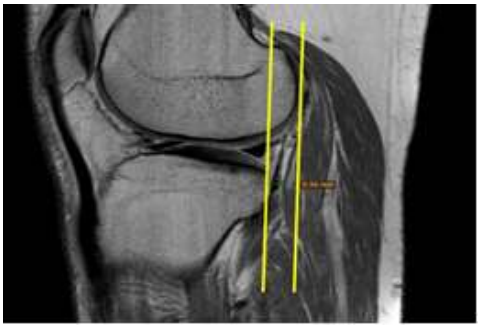

Figure 13: Sagittal T1W image demonstates anterior tibial translation of more than 5mm in a patient with ACL lesion.

Figure 14: Sagital PDFS image demonstrates bone edema and joint effusion joint effusion

Partial ACL tear:

The anteromedial bundle (AMB) is most commonly involved in incomplete or partial ACL tears. However specific commitment of AMB versus posterolateral bundle (PLB) tears is not possible most of the time.

Assessment of partial ligamentous tears is difficult than of complete tear.

The signs or appearance that indicates partial tear are:-

- Discrete focus of increased signal within ACL with a normal ACL course and with identification of intact fibers.
- Non-visualization of the ACL on one MRI sequence with visualization of the fibers on other sequences.
- Bowing or undulating course of otherwise intact ACL.

Chronic tear

- In chronic tears of the ACL, there is no edema and synovitis nor there irregularity of the free concave edge of Hoffa's fat pad.
- There can be small chronic joint effusion.
- The ACL may not be visualized on sagittal or coronal images.
- Absence of ACL in the lateral intercondylar notch on coronal MR images is termed as empty notch sign (empty lateral wall).
- The ACL may also appear attenuated or small in chronic tears.
- The chronically teared ACL can be scarred to the surrounding adjacent structures.

Figure 15: Sagittal PDFS image demonstrate fragmentation of ACL which is horizontally oriented and scarred on PCL.

Majewski et al, study showed, acute traumatic injuries of knee were common in age group 20-29 and 70% were male which correlates with the present study[6].

Singh JP et al, 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 which states that ACL tear is most common[7].

Conclusion

MR Imaging plays a crucial role in the diagnosis and assessment of anterior cruciate ligament (ACL) injuries.

It provides detailed information about extent of the injury, associated damage to surrounding structures, and helps guide treatment decisions.

Early and accurate diagnosis through MRI can lead to better outcomes for individuals and appropriate interventions such as surgery or rehabilitation.

However it's important to interpret MRI findings in conjunction with clinical assessment for a comprehensive understanding of the injury and the most suitable treatment plan.

Application of MR imaging as an initial examination tool after knee trauma in the emergency department setting can potentially yield benefit to the patient and the health care system. MRI is the valuable diagnostic tool in detecting knee injuries.

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