



A STUDY OF DIFFERENT BONE BRUISING PATTERNS ON MAGNETIC RESONANCE IMAGING IN PATIENTS WITH ANTERIOR CRUCIATE LIGAMENT INJURY

Orthopaedics

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ABSTRACT

Anterior cruciate ligament (ACL) is the primary stabilizing structure of the knee which offers primary resistance to anterior tibial translation and also limits its internal rotation. Sports related injuries are the most common cause of ACL injury and non-contact type mechanism accounts for majority of these cases. Different injury mechanisms that cause ACL injuries most often also results in osseous injuries of distal femur and proximal tibia and produce different patterns of bone bruise or edema which can be well identified on MRI. The present study aims to find out the different bone bruise patterns in ACL injury and also to find the association between different mechanism of injury and the bone bruise pattern. In this cross sectional, prospective study, 40 patients fulfilling the inclusion criteria are included over a period of 18 months in a tertiary care hospital. Diagnosis of ACL injury and bone bruise is confirmed on MRI. In our study it was found that the most common bone bruise pattern was over lateral side of both femur and tibia in ACL injury. Among different mechanisms of injury, valgus component at knee and pivoting mechanisms resulted in maximum injuries. There is no statistically significant association between different mechanism of injury and bone bruise patterns in ACL injury (p -value >0.05). However, in conclusion since a particular mechanism of injury has got more tendency towards a specific bone bruise pattern it is possible that by identifying specific bone bruise pattern on MRI we can have an idea about the mechanism of injury and can also look for other associated injuries along with ACL injury caused by that particular mechanism.

KEYWORDS

Anterior cruciate ligament, bone bruises, magnetic resonance imaging, pivoting, valgus.

INTRODUCTION:

The knee joint is prone to injury because of its complexity and weight-bearing function.

The ACL is a major stabilizing structure of the knee against excessive anterior translation and internal rotation of the tibia [1].

It accounts for approximately 85% of anterior drawer test when knee is 90 degrees flexed. The overall incidence rate of ACL injury in the general population varies between 30 to 80 per 100000 persons/year [2,3]. This injury is particularly common in young individuals and it occurs approximately 70% of the time due to trauma in a sporting activity requiring pivot such as football, basketball or alpine skiing.

In the hand of an expert evaluator, clinical examination for ACL tears can be equivalent to magnetic resonance imaging (MRI) findings. Although clinical examination is most important for the diagnosis of ligament injury, painful stress examinations are not always accurate in the acute phase of injury. For that reason, MRI is indicated for early diagnosis of the acutely injured knee [4]. Selective MRI is a completely non-invasive diagnostic modality and there is no ionizing radiation [5].

Bone bruise is a very common finding in acute knee injury. Bone bruising is a result of impaction at the time of injury. Particularly in young patients who most likely have more elasticity of their ACL fibers, it is distraction and impaction, particularly of the more central rather than posterior aspects of the condyles, that can occur even in the absence of an ACL tear. Occult injuries to the bone detectable only on MRI, often referred to as bone bruises or bone contusions, occur in about 80% of patients who have sustained an acute ACL ruptures [6].

Bone bruise or contusion in the knee lesions are demonstrated as decreased signal intensity on T1-weighted images and increased signal intensity on T2-weighted images. This appearance represents areas of hemorrhage, edema or infarction secondary to trabecular micro fractures. These osseous injuries may be the results of a direct blow to the bone, compressive forces of adjacent bones impacting one another, or traction forces that occur during an avulsion injury. The most

common location of these lesions in patients with ACL injury is within the lateral compartment of the knee, on the lateral femoral condyle at the sulcus terminals and the posterolateral tibial plateau.

In acutely injured knee, bone bruise can indicate the injury pattern and mechanism and it can be very helpful in detecting associated posttraumatic internal knee lesions.

Hence the present study was done at our tertiary care center to investigate the association between the mechanisms of injury to the type of bone bruise pattern in patients with ACL injury as seen on MRI scan and to correlate it clinically and also to assess the different types of bone bruise patterns with ACL injury.

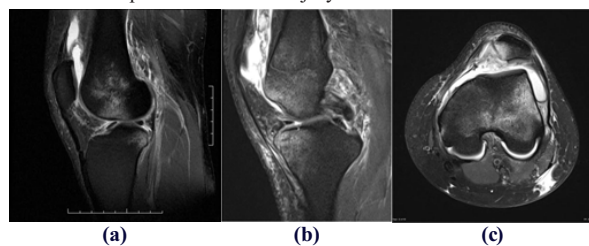


Fig 1: MRI images showing different types of bone bruise pattern; (a) pivot shift injury, (b) kissing contusions in hyperextension injury, (c) bruises in lateral patellar dislocation

Table 1: Different mechanisms of injury resulting in ACL injury (GL Strauss)

Mechanism 1	Solid foot plant with rotation of the knee.
Mechanism 2	Solid foot plant with valgus stress on the knee.
Mechanism 3	Twist of the knee without foot plant.
Mechanism 4	Hyperextension injury of the knee.
Mechanism 5	Injury during changing of direction while running or walking
Mechanism 6	None of the above mentioned specific mechanisms of injury were present.

Methodology:**Ethics approval:**

A hospital based prospective, open label, cross sectional study was conducted on 40 patients to investigate the association between the mechanisms of injury and the pathology of ACL injuries as seen on MRI scan and correlate clinically. The study was conducted after taking due permission from the Institutional Ethics Committee and Review Board and after taking Written Informed Consent from the patients.

Study design:

A hospital based prospective, open label, cross sectional study

Study Duration: 18 months

Study area: The study was done at our tertiary care center in the department of Orthopedics on attending OPD/IPD.

Study population: All the Patients attending the hospital OPD with recent knee injuries (<6weeks) with painful or unstable knee joint with or without other associated symptomatology who fulfilled the inclusion criteria.

Sample size: 40 patients

Inclusion Criteria

1. Patients of either sex
2. Age group 18 to 60 years
3. Patients with recent knee injuries (<6weeks) with painful or unstable knee joint with or without other associated symptomatology

Exclusion Criteria:

1. History of any infection, surgery or neoplasm of knee joint,
2. History of any disease having bony involvement
3. Patients having prosthetic heart valve implant, pacemaker implant, aortic stent graft, cochlear implant or any metallic orthopedic implants, any joint replacement surgery and claustrophobic patients. (Contraindications for MRI)
4. Patients not giving inform consent or not willing to undergo MRI

Study procedure:

- Written informed consent was taken.
- Detailed history regarding onset and progression of symptoms.
- History of mechanism of injury
- General physical examination and detailed knee examinations as per the standard protocol
- MRI scan of knee using 1.5 T MRI and as per the standard imaging protocol of the hospital.
- ACL tears were identified by primary signs (abnormal signal intensity, abnormal course or discontinuity) and secondary signs (bone contusions, Blumensaat's angle, anterior tibial displacement, PCL line and PCL angle).
- The sagittal plane was primarily used to evaluate the bone marrow edema which was confirmed on coronal images.
- The bone bruises pattern & suspected type/mode of injury on the basis of MRI were then correlated with detailed patient's history
- The mechanism of knee injury and clinical manifestations were correlated.

OBSERVATIONS AND RESULTS:

- Majority of the patients (62.5%) were from the age group of 21-30 years followed by 15% from 41-50 years, 10% from 31-40 years and 51-60 years and 2.5% from the age group of 18-20 years. The mean age of patients was 32.90 ± 11.98 years.
- Majority of the patients were male (57.5%) and female patients constituted 42.5%.
- 35 (87.5%) patients had noncontact type of injury while 5 (12.5%) patients had contact type injury.

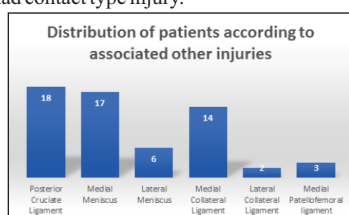


Figure 2: Distribution of patients according to associated other injuries

Fig: 2

In our study it was found that the other associated injuries were Posterior Cruciate ligament injury (45%), followed by Medial Meniscus injury (42.5%), Lateral Meniscus injury (15%), Medial collateral ligament (35%) and Lateral collateral ligament (5%), Medial Patellofemoral ligament (7.5%)

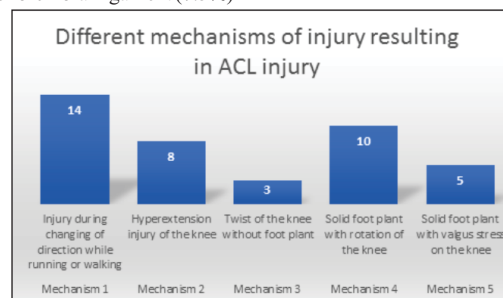


Figure 3: Distribution of patients with ACL injury associated with different mechanisms of Injury

Fig:3

The most common mechanism causing Anterior Cruciate Ligament injury was found to be injury during change of direction while running or walking (35%) followed by solid foot plant with rotation of the knee (25%), hyperextension injury of the knee (20%) solid foot plant with valgus stress on the knee (12.5%) and twist of the knee without foot plant (7.5%).

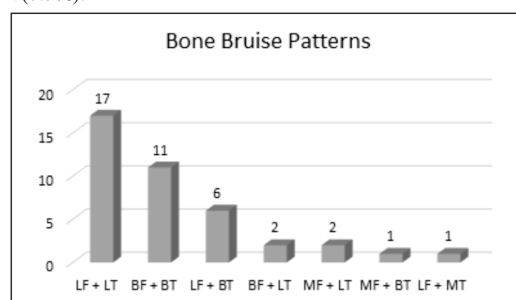


Figure 4: Distribution of patients according to Bone Bruise Patterns

Fig: 4

LF – Lateral Femur; MF – Medial Femur; BF – Bilateral Femur; LT – Lateral Tibia; MT – Medial Tibia; BT – Bilateral Tibia;

The most common bone bruise pattern observed among the patients was Lateral Femur + Lateral Tibia (LF + LT) (42.5%) followed by Bilateral Femur + Bilateral Tibia (BF + BT) (27.5%), Lateral Femur + Bilateral Tibia (LF + BT) (15%), Bilateral Femur + Lateral Tibia (BF + LT) (5%), Medial Femur + Lateral Tibia (MF + LT) (5%), Medial Femur + Bilateral Tibia (MF + BT) (2.5%) and Lateral Femur + Medial Tibia (LF + MT) (2.5%).

Table 2: Association between Mechanism of injury and different types of Bone bruise pattern

Bone bruise pattern	Injury during changing of direction while running or walking	Hyperextension of Knee	Twist of the knee without foot plant.	Solid foot plant with rotation of the knee.	Solid foot plant with valgus stress on the knee.	Total
LF+LT	7	5	1	3	1	17
BF+BT	5	0	0	4	2	11
LF+BT	1	3	1	0	1	6
BF+LT	0	0	0	2	0	2
MF+LT	0	0	1	1	0	2
MF+BT	1	0	0	0	0	1
LF+MT	0	0	0	0	1	1
Total	14	8	3	10	5	40

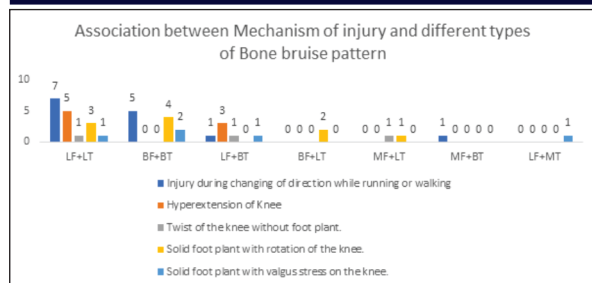


Figure 5: Association between Mechanism of injury and different Bone bruise patterns

Fig: 5

In our study it was found that there is no statistically significant association between different mechanisms of ACL injury and the types of bone bruise or edema pattern. [p-value >0.05 (not significant) Chi square test used]

- Data analysis performed by using SPSS (Statistical Package for social science) Version 25:0
- Qualitative data variables expressed by using frequency and Percentage (%).
- Quantitative data variables expressed by using Mean, SD, Median etc.
- Chi-square test used to find the association between ESR level CRP levels with various qualitative data variables.

p-value < 0.05 considered as significant.

DISCUSSION:

A hospital based prospective, open label, cross sectional study was conducted on 40 patients to investigate the association between the mechanisms of ACL injuries to the different bone bruise patterns as seen on MRI scan and correlate clinically. The study also investigated on the frequency of different bone bruise patterns and different pathologies associated with ACL injuries. In the present study it was found that the other associated injuries were Posterior Cruciate ligament injury (45%), followed by Medial Meniscus injury (42.5%), Lateral Meniscus injury (15%), Medial collateral ligament (35%) and Lateral collateral ligament (5%), Medial Patellofemoral ligament (7.5%). The study conducted by Strauss GL et al [7]. cross-sectional analytical study to determine whether there is an association between the mechanism of injury and the pathology seen on a MRI scan in ACL injuries found MRI scans of ACL injuries also shows similar results. The study showed that medial meniscal injuries were found in 77% cases, lateral meniscal injuries in 54% cases, medial collateral ligament injuries in 41% cases and femoral bone bruising in 62% cases.

The most common bone bruise pattern observed in our study among the patients was Lateral Femur + Lateral Tibia (LF + LT) (42.5%) followed by Bilateral Femur + Bilateral Tibia (BF + BT) (27.5%), Lateral Femur + Bilateral Tibia (LF + BT) (15%), Bilateral Femur + Lateral Tibia (BF + LT) (5%), Medial Femur + Lateral Tibia (MF + LT) (5%), Medial Femur + Bilateral Tibia (MF + BT) (2.5%) and Lateral Femur + Medial Tibia (LF + MT) (2.5%). Similar observations were noted in a study done by Aravindh P et al [9], Song G et al [10] and Shi H et al [8].

Shi H et al [8] study investigating the common bone bruise patterns after an ACL injury found that the most common relative bone bruise pattern was located on only the lateral side of both the femur and the tibia (44.4%), followed by the lateral and medial sides of both the femur and tibia (29.0%). For the pattern found on the lateral and medial sides of both the femur and tibia, the bone bruises on only the lateral side of both the tibia and femur were more severe and more anterior than those on only the medial side.

Further in our study it was found that the most common mechanism causing ACL injury was injury during change of direction while running or walking (35%) followed by solid foot plant with rotation of the knee (25%), hyperextension injury of the knee (20%), solid foot plant with valgus stress on the knee (12.5%) and twist of the knee without foot plant (7.5%).

We also found that there is no statistically significant association between different mechanisms of ACL injury and the types of bone bruise or edema pattern.

CONCLUSION:

In conclusion the results of the study suggested that in ACL injuries the most common bone bruise pattern is located on the lateral side of both tibia and femur. Among the different mechanisms of injury, valgus component at the knee and the pivoting mechanism play a significant role in causing ACL injuries.

Though there is no statistically significant association between mechanism of injury and bone bruise pattern in ACL injury, it can be observed that a particular mechanism of injury has got more tendency towards a specific bone bruise pattern. So, by identifying specific bone bruise pattern on MRI we can have an idea about the mechanism of injury and thus can look for other associated injuries along with ACL injury caused by that particular mechanism.

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