

## The Role of Magnetic Resonance Imaging in Traumatic Knee Injury.

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## ABSTRACT

**Introduction:** Magnetic Resonance Imaging (MRI) as a non-invasive modality plays a vital role in assessment of a wide spectrum of internal knee derangements. This study focuses on the commonest anatomical derangement and reveals the importance of MRI to characterize the pattern of derangement in the assessment of the patient with knee injury.

**Methods:** This is the hospital based prospective study conducted among 65 patients referred to department of radiology with first presentation of knee injury during two years period from August, 2013 to August, 2015. Patient fulfilling the inclusion criteria underwent Magnetic Resonance Imaging knee in SIEMENS MAGNETOM C 0.35 Tesla MRI machine.

**Results:** Of the total 65 patients with knee injury, Sport injuries were the most common mode of knee injury. 63 cases with trauma had findings on MRI. Most of the cases presented with joint effusion (59 cases). Anterior Cruciate Ligament (ACL) tear is the commonest injury (37 cases) during knee trauma followed by Medial Collateral Ligament (MCL), Medial Meniscus, Posterior Cruciate Ligament (PCL), Lateral Meniscus and Lateral Collateral Ligament(LCL) injuries.

**Conclusions:** MRI as a high-contrast soft-tissue imaging technique can be used as a noninvasive modality to assess a wide spectrum of internal knee derangements in a patient with knee injury. Specific pattern of bone bruise can guide us to narrow our diagnosis.

**Key words:** Injury; knee; magnetic Resonance Imaging.

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## INTRODUCTION

The knee joint is the largest and the most superficial joint of our body which is primarily a hinge type of synovial joint that allows the flexion and extension movements combined with gliding, rolling and rotation about a vertical axis.[1, 2] It is probably the most complex and one of the most frequently injured joint within the human body. The acute injury to the knee is sustained during adolescence and adulthood and the most common factors are athletic activities and motor vehicle accidents. [3, 4] The patient with traumatic knee injury may present with pain in the knee, swelling, stiffness, locking, limping, instability and loss of function. Clinical history and physical examination are the preliminary approach for the patient with traumatic knee injury. [5] Radiological examination plays a determining role in diagnosing the various traumatic conditions involving the knee joint. [6] CT is especially useful in the evaluation of complex fractures of the distal femur, the tibial plateaus, and the patella. [4] However, its limitation in evaluation of the internal soft tissue derangement and due to its radiation hazards, CT is not the routine investigation in evaluation of the knee injury. Magnetic resonance imaging of the knee is the routinely used noninvasive modality to assess a wide spectrum of internal knee derangements and articular disorders. [3] It is highly accurate for the evaluation of the ACL, PCL, and menisci. This study identifies the commonest derangement in traumatic knee injury and evaluates the spectrum of MRI findings.

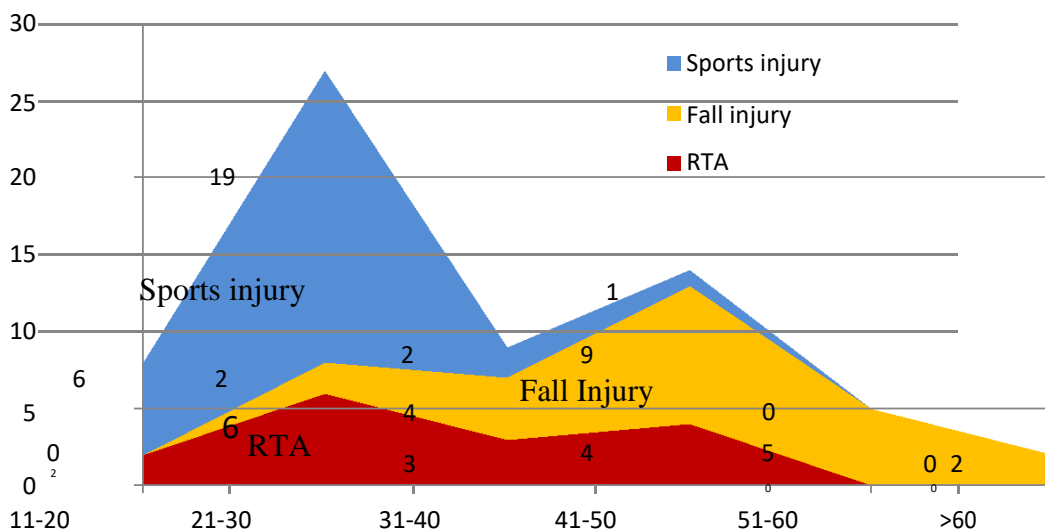
## METHODS

This was a hospital based prospective study done during the period of August 2013 to August 2015 in the department of Radiology, College of Medical Sciences Teaching Hospital, Bharatpur, Nepal. Traumatic patients which were referred for knee MRI in the department of Radiology with no history of previous knee surgery were enrolled for the study. Patient with history of knee surgery, cardiac pacemaker, claustrophobia, bone and joints prosthesis, nail, plate, patients with metallic implants, metallic shunts, coil, surgical clips, metallic suture, aneurysmal clips, electronic implants were excluded. Ethical clearance was obtained from the subject committee and Institutional Review Committee. Written informed consent from each patient was obtained. Subjects of the study underwent MRI scan in SIEMENS MAGNETOM C 0.35 Tesla MRI machine. Patient is laid supine with slightly flexed (5 degree) and externally rotated (15 degree). Sequences Used: T1- weighted Axial, Coronal (T1- 350/20, TR/TE); T2- weighted Axial, Coronal, Sagittal (T2- 4000/120, TR/TE); Proton Density Sagittal (PD- 4000/20, TR/TE); T2- Fat-Sat Coronal; Optional DESS Coronal/Sagittal. Coil: Circular polarized coil, Array coils. Collected data were analyzed using SPSS (Statistical Package for the Social Sciences) 20.0 program, Endnote X7.0.1, Microsoft Word 2013 and Microsoft Excel 20.

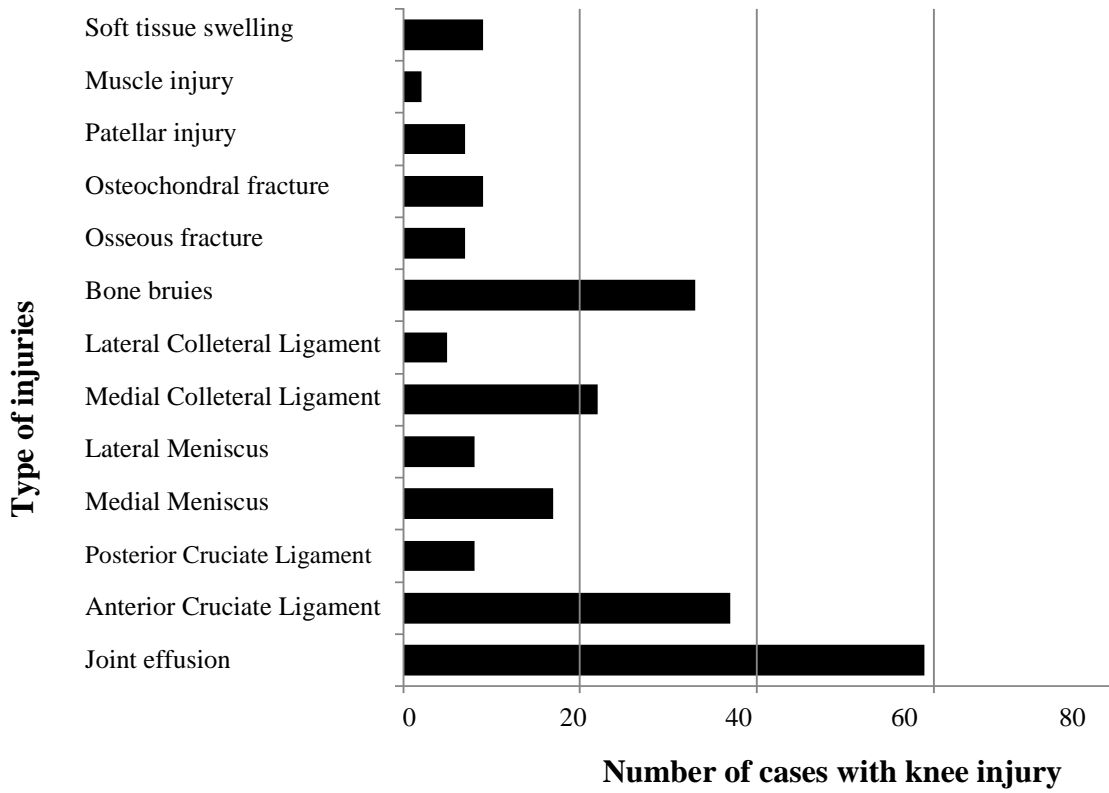
## RESULTS

There were total 65 traumatic knee injury cases, of them 48 (73.8%) were males and 17 (26.2%) were females with male to female ratio of 2.8:1. There was less significant difference on involvement on side of knee injured observed, right knee with frequency of 30 and left with frequency of 35. The study revealed that, sport injuries was the most common mode of knee injury. The second common mode of injury was fall injury 22 (33.8%) cases, male being predominance (12). 15 (23.1%) of the patient had Road Traffic Accident. The age distribution pattern among the mode of injury revealed that 28 (43.1%) had sports injury where most of them were among age group 21-30 years, 22 had fall injury where most of them were among age group 41-50 years and 15 had road traffic accidents which was common among young adults. (Figure 1)

Out of the total 65 patients, 2 patients presented with normal MRI findings without any derangement. 59 (90.8%) had joint effusion, 37 (56.9%) had ACL tear, 8 (12.3%) had PCL tear, 17 (26.2%) had medial meniscus tear, 8 (12.6%) had lateral meniscus tear, 22 (33.8%) had MCL tear, 5 (7.7%) had LCL tear, 33 (50.7%) had bone bruise, 7 (10.8%) had osseous fracture, 9 (13.8%) had osteochondral fracture, 7 (10.8%) had patellar injury, 2 (3.1%) had muscle injury and 9 (13.8%) had soft tissue swelling (Figure 2). Of the 37 ACL tear, 26 injuries were partial and 11 were complete and of the total 8 PCL tear, 7 had partial and 1 case had complete tear.



**Figure 1: Distribution of age group according to the mode of injury**



**Figure 2: Common derangement in knee injuries.**

Similarly of the 17 patients with medial meniscus tear, 7 (41.2%) had grade II which was more common, 5 (29.4%) had grade I tear and 5 (29.4%) had grade III tear. In 8 patients with lateral meniscus tear, 3 (37.5%) had posterior horn injury, 3 (37.5%) had body injury and 2 (25%) had anterior horn injury. Besides, 7 patients who presented lateral meniscus tear, 4 (57.2%) had grade I tear and 3 (42.8%) had grade II tear. There was no patient with grade III tear. Out of 65 patients with knee injury, 22 (33.8%) had MCL (MCL) tear ; of them 12 (54.5%) had Grade I injury, 9 (41%) had Grade II injury and 1 (4.5%) had Grade III injury. Similarly 5 cases (7.7%) with LCL tear presented with 3 cases (60%) with Grade I injury and 2 (40%) with Grade III injury. There were no patients with Grade II injury. Bone bruises were seen in 30 cases where 12 (18.5%) had femoral condyle and tibial plateau bruise, 11 (16.9%) had medial tibial bruise, 7 (10.8%) had lateral femur bruise, 2 (3.1%) had fibula bruise and 1 (1.5%) had medial femur bruise.

Out of 37 (56.9%) patients with ACL tear; 20 (54.5%) were associated with bone bruise whereas 8 (40%) had lateral tibia/femoral condyle bruise, 6 (30%) medial tibial plateau bruise, 4 (20%) had lateral femoral condyle bruise only, 1 (5%) had medial femoral condyle bruise and 1 (5%) had fibula head bruise as shown in table 1.

More , of the 8 (12.3%) patients with PCL tear; 6 (75%) were associated with bone bruise where 3 (50%) had medial tibial plateau bruise and 3 of them had single bruise on lateral femoral condyle (16.6%), medial femoral condyle only (16.6%) and lateral femor/tibial plateau (16.6%) respectively as illustrated in table 1.

**Table 1. Bone bruise and association with ACL and PCL tear**

Bone bruise	ACL injury		PCL injury	
	Complete	Partial	Complete	Partial
<b>Femoral condyle and Tibial plateau</b>	<b>4</b>	<b>4</b>	<b>0</b>	<b>1</b>
<b>Medial tibia</b>	<b>2</b>	<b>4</b>	<b>0</b>	<b>3</b>
<b>Lateral femur</b>	<b>1</b>	<b>3</b>	<b>1</b>	<b>0</b>
<b>Medial femur</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>
<b>Fibula</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>0</b>
<b>Total</b>	<b>7</b>	<b>13</b>	<b>1</b>	<b>5</b>

Similarly, 17 patients had multiple structures injuries (at least 3 structures including ACL, MCL, MM, PCL, LM, LCL and fracture) illustrated in table 2.

**Table 2: Internal derangement in patients following knee injury involving at least 3 structures**

<b>7 Patient with multiple structure injuries came to MRI within week</b>							
ACL	MM	MCL	PCL	LM	LCL	Fracture	Ptn. no
Partial	-	Gr I	Partial	-	-	Present	3
-	-	-	-	A. horn	Gr I	Present	2
Complete	P. horn	-	-	-	Gr I	Present	1
-	-	Gr I	Partial	-	-	Present	1
<b>3 Patients with multiple structure injuries came to MRI between 1-2 weeks</b>							
ACL	MM	MCL	PCL	LM	LCL	Fracture	Ptn. no
Partial	P. horn	Gr I	-	-	-	-	2
Complete	P. horn	Gr III	-	-	-	-	1
<b>5 Patients with multiple structure injuries came to MRI between 2 wks- 1mnth</b>							
ACL	MM	MCL	PCL	LM	LCL	Fracture	Ptn. no
-	P. horn	Gr II	Partial	-	-	-	2
Partial	P. horn	Gr I	-	-	-	-	2
-	-	Gr I	Partial	Body	-	-	1
<b>2 Patients with multiple structure injuries came to MRI between 1-3 month</b>							
ACL	MM	MCL	PCL	LM	LCL	Fracture	Ptn. no
Complete	P. horn	Gr II	-	-	-	-	1
Partial	P. horn	-	Partial	-	-	-	1

## DISCUSSION

A study among 6.6 million knee injury presented to United States emergency departments from 1999 through 2008 found that the burden of knee injury was 2.29 injuries per 1,000 populations. [7] . MRI as a non-invasive modality plays a vital role in assessment of a wide spectrum of internal knee derangements. The purpose of this study was to reveal the importance of MRI in the assessment of the patients with knee injuries and to study the pattern of the lesion seen in the MRI and find the commonest derangement in knee injury. This study is similar to the study conducted by Manoj et al. (2014) [8] among 80 patients with knee trauma where age range was 15-61 years with mean age of 30 years and the largest group of patients were in the range of 21-40 years.

**Mode of knee injury:** Sports injury was the most common mode of injury followed by fall injury and road traffic accident which is similar to the study conducted by Jah et al. (2005) [9]

**Time period of presentation to doctor after knee injury:** Most of the patients 25 (38.5%) presented to doctor within 14-30 days following acute knee injury. Similar time period was found by a study conducted by Bollen et al. (2000) [10] where he found that the mean delay from injury to the diagnosis was 22 days. Patient who presented early were found to have more severe injury than the patient who came later because the disability was more among severe injured patients.

**Pattern of derangement in knee injury:** Out of 65 patients two patients were found normal without any derangement, 59 (90.8%) had joint effusion, 37 (56.9%) had ACL tear, 8 (12.3%) had PCL tear, 17 (26.2%) had medial meniscus tear, 8 (12.6%) had lateral meniscus tear, 22 (33.8%) had MCL tear, 5 (7.7%) had LCL tear, 33 (50.7%) had bone bruise; 7 (10.8%) had osseous fracture, 9 (13.8%) had osteochondral fracture, 7 (10.8%) had patellar injury, 2 (3.1%) had muscle injury and 9 (13.8%) had soft tissue swelling.

**Type of ACL injury:** Out of 65 patients with knee injury, 56.9% had ACL tear. Of these 37 patients with ACL tear, 26 (70.2%) had partial tear and 11 (29.8%) had complete tear. This study shows that the partial tear is more common than the full-thickness tear. Similar study conducted by Nenezic et al. (2013) [11] among 149 patients showed slightly higher incidence of ACL tear 134 (89.9%). Other similar studies conducted by Bollen et al. (2000) [10] Gupta et al. (2014) [12], Singh et al. (2004) [13] also found ACL tear as a most common finding where partial tear was most common than the full-thickness tear.

**Type of PCL injury:** Out of 65 patients with knee injury, 8 (12.3%) had PCL tear. Of these 8 patients with PCL tear 7 (87.5%) had partial tear and 1 (12.5%) had complete tear. Esmaili et al. (2005) [14] in their study among 71 patient with knee injury also found similar incidence of PCL tear 11 (15.4%). Other study conducted by Singh et al. (2004) [13] found that the incidence of PCL was less than that of ACL with ACL: PCL ratio of 7.8:1 which is similar to this study where ACL: PCL ratio is 4.6:1. PCL is less injured than that of ACL because of the fact that PCL is stronger than ACL.

**Medial Meniscus injury:** Of the total cases 17 (26.2%) had medial meniscus tear where all of them were in the posterior horn. Similar study

was conducted by Manoj et al. (2014) [8] and found similar incidence of medial meniscus injury (29%). Other similar study conducted by Singh et al. (2004) [13] also found posterior horn injury to be most common (78.95%). **Lateral Meniscus injury:** Out of 65 patients with knee injury, 8 (12.6%) had lateral meniscus tear where 3 (4.6%) had posterior horn injury, 3 (4.6%) had body injury and 2 (3.1%) had anterior horn injury which was quite similar to the study conducted by Manoj et al. (2014) [8] and Singh et al. (2004). [13] **Grade of Medial Collateral Ligament injury:** In this study out of 65 patients with knee injury, 22 (33.8%) had MCL tear, where 12 (54.5%) had Grade I injury, 9 (41.8%) had Grade II injury and 1 (4.5%) had Grade III injury which was similar to the study conducted by Bollen et al. (2000) [10] where 29% had MCL tear. **Grade of Lateral Collateral Ligament injury:** In this study out of 65 patients with knee injury, 5 (7.7%) had LCL tear where 3 (4.6%) had Grade I injury and 2 (3.1%) had Grade III injury. Other study conducted by Manoj et al. (2014) [8] and Bollen et al. (2000) [10] also found decreased incidence of LCL compare to that of MCL tear which is similar to this study where Medial collateral ligament is common than that of LCL with MCL:LCL ratio of 4.4:1 which is due to the fact that LCL is superficially located and is not attached to lateral meniscus. **Pattern of bone bruise in knee injury:** Out of 65 patients with knee injury, 33 (50.7%) had bone bruise. Of these 33 bone bruises, lateral femoral condyle and tibial plateau bruise was the commonest 12 (36.3%), followed by medial tibial bruise 11 (33.33%). Most of the patients ACL tear (54.05%) were 8 (43%) lateral femoral condyle/ tibial plateau bruise followed by 6 (30%) medial tibial plateau bruise. This showed that patient with ACL tear had lateral tibial/femoral condyle bruise which is the result of pivot shift injury or the medial tibial plateau bruise as a result of dashboard injury. Most of the patients with PCL tear 6 (75%) had medial femur bruise which is the commonest mechanism of PCL injury as a result of dashboard injury.

## CONCLUSION

Knee injury is more common among with sports injury being the most common mode of injury. MRI can be used as a noninvasive modality to assess a wide spectrum of internal knee derangements. Specific pattern of bone bruise can guide us to narrow our diagnosis.

## CONFLICT OF INTEREST

None

## SOURCES OF FUNDING

None



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