



## MAGNETIC RESONANCE IMAGING BASED EVALUATION OF PATIENTS WITH KNEE TRAUMA

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### ABSTRACT

**Aim:** Magnetic Resonance Imaging based evaluation of patients with knee trauma. **Objective:** To define the spectrum of findings in patients with knee trauma and correlate the findings with the mode of injury. To segregate the findings of various structures involved in knee injury and correlate with different mode of injuries. **Material and methods:** This study was carried out in Department of Radiodiagnosis, Dr. R.P.G.M.C. Kangra at Tanda, Himachal Pradesh, after approval by institutional ethics committee. The present study was conducted on patients referred to department of radio-diagnosis from department of orthopaedics for MRI evaluation of knee trauma. **Results:** The study was done among 91 patients with knee injuries. Maximum of the study participants had injury associated with hyperextension and Anterior cruciate ligament involved, the study also found that grade III medial meniscus injury on the posterior horn is common among the patients with knee trauma.

**KEYWORDS:** Knee trauma, Magnetic resonance imaging(MRI), Anterior cruciate ligament, posterior cruciate ligament, medial collateral ligament, lateral collateral ligament,

### INTRODUCTION

The knee can be conceptualized as 2 joints—a tibiofemoral and a patellofemoral joint. The tibiofemoral joint allows transmission of body weight from the femur to the tibia while providing hinge-like, sagittal plane joint rotation along with a small degree of tibial axial rotation. Functionally, the quadriceps muscle group and patellofemoral articulation—along with the tibialis anterior and ankle joint—act to dissipate forward momentum as the body enters the stance phase of the gait cycle.<sup>[1]</sup>

The knee is stabilised by both primary stabilisers and secondary stabilisers. Primary knee stabilisation is achieved through knee ligaments, while muscles around the knee play a secondary role, although both work congruently to help the knee function reliably. Ligaments are fibrous bands of tissue that connect bone to bone and provide support to joints. The knee is reinforced by two collateral ligaments, one on the medial side and another on the lateral side, as well as two stronger ligaments (the cruciate ligaments) that prevent excessive anterior, posterior, varus and valgus displacement of the tibia in

relation to the femur. The patellar ligament attaches proximally to the apex of the patella and distally to the tibial tuberosity and is the inferior continuation of the quadriceps femoris tendon. Other ligaments, such as the transverse, arcuate popliteal, oblique popliteal, anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), medial collateral ligament (MCL), lateral collateral ligament (LCL), and popliteofibular ligament all act as knee stabilisers.

Knee trauma has a high incidence rate and has been extensively studied over the last decade. For example, one prospective cohort study conducted over seven consecutive professional football seasons found that injuries due to knee instability was second only to thigh strains (23%), and 18% of all injuries were sustained at the knee joint.<sup>[2]</sup> However, it is not only professional athletes at risk of these injuries, as Loes, Dahlstedt and Thomée<sup>[3]</sup> reported that knee injury accounted for 15% to 50% of injuries related to 12 different sports during a longitudinal seven year trial of recreational male and female exercisers. Knee instability is a problem affecting both young and old individuals, as those aged over 65

years have been reported to suffer from one to three incidences of falls due to several factors, including self-reported knee instability.<sup>[4]</sup> It affects a varied population, including professional athletes,<sup>[5]</sup> older adults, and recreational exercisers.<sup>[6]</sup> The impact of knee instability can be severe, and may lead to an increased risk of falls<sup>[4]</sup> and a long period of rehabilitation.<sup>[7]</sup> These consequences of knee instability increase the cost to health care systems.<sup>[8]</sup> Loes, Dahlstedt, and Thomée<sup>[3]</sup> concluded that knee injuries accounted for a high proportion of the costs in the medical treatment of sport injuries. Many countries have health care systems focused on value-based care, which are systems focused on understanding the cost drivers, implementing high-value therapies,<sup>[9]</sup> and improving methods and/or techniques to assess knee instability and rehabilitation therapies that could potentially reduce the health care costs associated with knee injury.<sup>[10]</sup>

In acute knee injuries, a working diagnosis usually can be made on the basis of the clinical examination.<sup>[11]</sup> Plain radiographs (anterior-posterior [AP] and lateral views) usually are obtained if fractures are suspected. MR imaging enables the most comprehensive imaging assessment of the knee and when performed early after injury, MR imaging is both cost-effective<sup>[12]</sup> and can aid in predicting which patients require further treatment.<sup>[13]</sup> Radiographs may demonstrate an acute fracture but commonly are either negative or may demonstrate indirect signs of an acute soft-tissue injury. Computed tomography (CT) is usually reserved for diagnosis of suspected fractures or assessment of complex fractures.

MRI without contrast is approximately 90 percent accurate in identifying surgically confirmed ACL and meniscal injuries in adults and children. When used judiciously, knee MRI should decrease the number of surgical procedures performed, resulting in better patient outcomes and significantly decreased costs. A superior soft tissue detail with multiplanar imaging capability, provides a distant advantage for MRI over other imaging modalities in addition to its non-invasive, non-operator dependent, and cost effective nature.

Extensive PubMed research did not reveal a study on MRI evaluation of knee trauma peculiar to the present study area so, the study was carried out with an aim to define the spectrum of findings in patients with knee trauma and correlate the findings with the mode of injury.

## METHODS

The present study was carried out in Department of Radiodiagnosis, Dr. R.P.G.M.C. Kangra at Tanda, Himachal Pradesh, after approval by institutional ethics committee. The present study was conducted on patients referred to department of radio-diagnosis from department of orthopaedics for MRI evaluation of knee trauma. The study was undertaken as a cross sectional study among patients with knee injuries. Number of

patients done over the span of one year fulfilling our inclusion and exclusion criteria were included in the study. All the patients reporting to the department of radio diagnosis with knee injuries, fulfilling the eligibility criteria for the study were included, hence no sampling technique was employed. The present study was undertaken during the period July 2018 to July 2019. Inclusion Criteria: Patients with history of knee trauma. Exclusion Criteria: Patients with-

- Cardiac pacemakers.
- Metallic foreign body.
- Implanted electrodes.
- Metallic ear prosthesis.
- Claustrophobia.
- Refusal for study.
- History of knee surgery.
- Malignancy involving knee joint

Detailed history including duration, mode of injury were collected and documented. Patient's physical examination was carried out and A pre-informed written consent was taken. Plain radiographs of knee were obtained, and subsequently the patient was screened before entry into scanning room for ferromagnetic objects, pacemaker and aneurysm clips etc. Then patient was taken up for MRI scan. MRI of the knee was done on 1.5 Tesla MRI machine (Signa Excite, GE Healthcare), with the patient in supine position. Multi-planar images were obtained in the axial, coronal and sagittal planes. Characterization of the lesions were done subsequently. All patients were evaluated clinically and then they underwent MRI of the knee in Department of Radiodiagnosis at Dr. R.P.G.M.C. Kangra at Tanda using 1.5 Tesla MRI scanner GE healthcare (Signa Excite). The patient was placed supine, feet first with the leg in full extension. The knee was placed in 10 to 15° of external rotation in an extremity coil (8 Channel Coil). Initial localizer for each plane was obtained. The following parameters were used, 28\*28 field of view and a matrix of 256\*128. Following sequences as per requirement, depending on case to case were obtained.

- Sag T1
- Sag PD FatSat
- Sag T2 FSE
- Sag T2\*GRE
- Sag SPGR
- Cor STIR
- Cor PD frFSEFatSat
- Cor T1
- Cor GRE
- Axial T1 FSE
- Axial T2 FSE

## Statistical analysis

Means and proportions were calculated for continuous and categorical variables respectively. Chi square test was used to test statistical difference between two proportions. A p value <0.05 was considered statistically significant.

## RESULTS

- The present study was carried out with an aim to define the spectrum of findings in patients with knee trauma and correlate the findings with the mode of injury.
- The study was undertaken as a cross sectional study among 91 patients with knee injuries during the period July 2018 to June 2019.
- Maximum of the study participants were in the age group of 41-50 years (25.3%). The mean age of the study participants was observed to be  $39.2 \pm 13.4$  years. Majority of the study participants were males (61.5%).
- Maximum of the study participants had injury associated with hyperextension (25.3%) followed by direct trauma to the knee (24.2%).
- Maximum number of study participants had their Anterior cruciate ligament involved (50.5%) followed by Medical Meniscus (31.9%).
- Among the study participants with anterior cruciate ligament injury, about 61 % of the participants had partial injury while the rest had complete injury (39.1%). Fifty percent of the study participants with anterior cruciate ligament injury had Femoral as the site of injury followed by tibial (28.3%). MRI revealed hyper intensity among 63 % and non-visualization among 21.7% of the participants with ACL injury.
- Maximum of the study participants had grade III (37.9 %) medial meniscus injury followed by grade II (34.5%). Among the study participants with medial meniscus injury, about 62 % of the participants had injury on the posterior horn followed by anterior horn (24.1 %).
- Bone contusion was present in 38.5 % of the study participants and only 4.4 % of the study participants had thickening and enhancement of the synovium in MRI.
- Around 10 % of the study participants had buckling of the PCL and 3.3 % of the participants had both buckling of PCL and Anterior translation of tibia.

## DISCUSSION

The present study was carried out with an aim to define the spectrum of findings in patients with knee trauma and correlate the findings with the mode of injury. The study was undertaken as a cross sectional study among 91 patients with knee injuries during the period July 2018 to June 2019.

### Age

Maximum of the study participants were in the age group of 41-50 years (25.3%). The mean age of the study participants was observed to be  $39.2 \pm 13.4$  years. The mean age was 36.6 years in a study done by Odile Fernande Zeh *et al.*<sup>[14]</sup> Tapouh *et al.*<sup>[15]</sup> who found a mean age of 35.36 years in Cameroonian population found similar results. Similar mean age was found by Tomas Fernandez-Jae *et al.*<sup>[16]</sup> in a study population with ACL rupture in Spain.

### Gender

Majority of the study participants were males (61.5%). In a study done by Odile Fernande Zeh *et al.*<sup>[14]</sup> 65% of the study population were males, with a higher ratio in the case group than in the control group. Apart from gender-balanced studies of Sonnery-Cottet *et al.*<sup>[17]</sup> in France and Helen C. Smith *et al.*<sup>[18]</sup> in USA who in contrast to our study have a majority of female, the male is more represented in most studies.

### Mode of Injury

Maximum of the study participants had injury associated with hyperextension (25.3%) followed by direct trauma to the knee (24.2%). These results are not supported by the study done by Sahoo *et al.* where hyperextension injury was found in only 2.9% of the study participants and commonest type of injury was sports injury.<sup>[19]</sup> In a study done by Shaohua Liu *et al.*, the most common causes of PCL tear are traffic accident and sports injury.<sup>[20]</sup> Major NM *et al.* found in their study about sports injury stated that during the course of a basketball season, a player's knees are subject to repetitive trauma and his study found 74% of the players had at least on abnormal findings that was presumably asymptomatic.<sup>[21]</sup>

### Anterior Cruciate ligament

Maximum number of study participants had their Anterior cruciate ligament involved (50.5%) followed by Medical Meniscus (31.9%). Among the study participants with anterior cruciate ligament injury, about 61 % of the participants had partial injury while the rest had complete injury (39.1%). Higher proportion of ACL was found with Buckling of PCL (66.7%).

Similar results were found in the study done by Singh JP *et al.* and Odile fernande Zeh *et al.*, Singh JP *et al.* 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.<sup>[22]</sup> In a study done by Odile Fernande Zeh *et al.*<sup>[14]</sup> in 53% of the cases, the ACL rupture was a partial rupture. In contrary to the result obtained by Tapouh *et al.*, who found a predominance of full-thickness rupture (81%).<sup>[15]</sup> Partial ruptures represented 10% - 35% of lesions according to Donell ST *et al.*<sup>[23]</sup>

Fifty percent of the study participants with anterior cruciate ligament injury had femoral attachment site as the site of injury followed by tibial attachment site (28.3%). MRI revealed hyper intensity among 63 % and non-visualization among 21.7% of the participants with ACL injury. These findings were correlated with findings described by Thomas H Berquist.<sup>[24]</sup>

### Posterior Cruciate Ligament

In our study 7.7 % of the total injuries were involving posterior cruciate ligament in which around 85 % of the

participants had partial tear while the rest had complete tear (14.3%) and about 57 % of the Posterior cruciate ligament injury had Femoral attachment (57.1%) as the site of injury while the rest had Tibial attachment (42.9%) as the site of injury. Around 10 % of the present study participants had buckling of the PCL and 3.3 % of the participants had both buckling of PCL and Anterior translation of tibia. MRI revealed hyper intensity among 71 % and discontinuity among the rest (28.6%) of the participants with PCL injury, similar findings were seen in a study done by Sonnin et al where they found the incidence of PCL tear to be 3 percent; in a series of study analyzing 350 cases of knee injury only 10 patients had PCL tear.<sup>[19]</sup>

Likewise in a study by Grover et al where they analyzed findings of 510 consecutive MRI of knee joints with an emphasis on PCL tear; 11 (2%) patients had different grades of tear on MRI which was confirmed correctly by arthroscopy. On the other 202 patients who had undergone MRI as well as arthroscopy for internal derangement of knee none of the patients had any PCL injury as predicted correctly by MRI.<sup>[21]</sup>

#### Collateral ligaments

In the present study, 6.6% of injuries involved medial collateral ligament and 20.9% were involving the lateral collateral ligament. Maximum of the study participants had grade II (50 %) medial collateral ligament injury followed by grade I (33.3%). Fifty percent of the study participants with Medial collateral ligament injury had tibial as the site of injury followed by tibial and mid substance (33.4%).

Maximum of the study participants with Lateral collateral ligament injury had grade I injury (52.6 %) followed by grade II injury (31.6%). Around 69 % of the study participants with Lateral Collateral ligament injury had Fibular attachment as the site of injury followed by mid substance and fibular & mid substance (15.7 %). MRI revealed hyper intensity among 84.2 % and discontinuity among the rest (15.8 %) of the participants with LCL injury. Mink JH et al,<sup>25</sup> in their study observed MRI and arthroscopy of 11 patients who had tear of LCL, 7 patients had tear of MCL which supports our results.

#### Medial Meniscus and Lateral Meniscus

In our study, 31.9% injuries were in the medial meniscus and 12.1% injuries affected the lateral meniscus. Association between Medial meniscus, Lateral meniscus and Mechanism of injury was found to be significant among the study population (p value < 0.05).

Maximum of the study participants had grade III (37.9 %) medial meniscus injury followed by grade II (34.5%). Among the study participants with medial meniscus injury, about 62 % of the participants had injury on the posterior horn followed by anterior horn (24.1 %). Among these, 43 % of the participants had horizontal

tear followed by Vertical tear and Complex tear (28.5 %).

In our study among the lateral meniscus injury, 63.6 % of the participants had anterior horn injury while the rest had posterior horn injury (36.4%). Maximum of the study participants had grade III (45.5 %) lateral meniscus injury followed by grade I (36.4%). Among these lateral meniscus injury, 63.6 % of the participants had anterior horn injury while the rest had posterior horn injury (36.4%). In the present study, 43 % of the participants with lateral meniscus injury had Vertical tear followed by Horizontal and Complex tear (28.5 %).

Similar results are noted by Singh JP et al, in a series of 173 cases of which they found 57 (38.23%) patients showed MM tear and 28(29.41%) patients showed LM tear. Out of 173 patients, Grade 3 tear of MM was seen in 57(32.95%) patients, Grade 2 in 16(9.25%) patients & Grade 1 in 20(11.56%). In LM, Grade 3 tears were seen in 28(16.18%) patients, Gr 2 in 12 (6.94%) patients & Gr I in 14(8.1%) patients.<sup>[22]</sup>

In a study done by Odile Fernande Zeh et al<sup>[14]</sup> the lesions of the medial meniscus were the most frequent meniscal lesions (34.2% versus 10.5% for the lateral meniscus). This result is similar to that obtained by Tapouhet al,<sup>[15]</sup> who found predominance of medial meniscal lesions being 22%. This is contrary to the description made by Guenoun et al. in France, who found a predominance of the lateral meniscal lesions.<sup>[26]</sup>

Bone contusion was present in 38.5 % of the study participants and only 4.4 % of the study participants had thickening and enhancement of the synovium in MRI. In their study, Odile Fernande Zeh et al<sup>[14]</sup> described bone contusions of the lateral tibial and medial femoral compartments were the most frequent, found in 47.3% of cases and in 71% of cases, intra-articular effusion was found in the case group.

#### Other findings

Based on findings on MRI, 67 % of the present study participants had Joint effusion/haemarthrosis, 7.7 % had articular cartilage injury, 4.4% of the study participants had fractures and 2.2 % of the participants had Bakers cyst and 3.3% of the participants had Posterolateral corner injury. About 35 % of the study participants had bone contusion at Femoral and tibial regions followed by bone contusion at femoral region (32.3 %) and only 4.4 % of the study participants had Thickening and enhancement of the synovium in MRI. Similar findings were described by Thomas H.Berquist.<sup>[24]</sup>

#### CONCLUSION

This study was carried out with an aim to define the spectrum of findings in patients with knee trauma and correlate the findings with the mode of injury. The study was done among 91 patients with knee injuries. Maximum of the study participants had injury associated

with hyperextension and Anterior cruciate ligament involved, the study also found that grade III medial meniscus injury on the posterior horn is common among the participants with knee trauma. Association between Medial meniscus, Lateral meniscus and Mechanism of injury was found to be significant among the study population (p value < 0.05).

MRI has made it possible to look into the injured knee non-invasively, thereby avoiding invasive procedures and further morbidity. The knee joint is a compound type of synovial joint and due to the lack of bony support, stability of the joint is highly dependent on its supporting ligamentous structures, and therefore injuries of ligaments and menisci are extremely common. MRI is an excellent, noninvasive, radiation free imaging modality with multiplane capabilities and excellent soft tissue delineation. It can accurately detect, localize and characterize various internal derangements of the knee joint and help in arriving at a correct anatomical diagnosis thereby guiding further management of the patient.

Magnetic resonance imaging (MRI) is the best imaging modality for non-invasive evaluation of knee injuries. It has been reported to have a high diagnostic accuracy and does not involve the use of ionizing radiation. MRI has proved reliable and safe. In the context of trauma, post-traumatic limited range of motion and mechanical knee symptoms MRI is generally considered a valuable diagnostic tool.

#### RECOMMENDATION

We would recommend all the cases with knee trauma to undergo MRI investigation to increase the spectrum of findings through a non-invasive and safe method of investigation.

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