



Original Article

Role of Magnetic resonance imaging in the Evaluating Anterior Cruciate Ligament Injuries

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ABSTRACT

The anterior cruciate ligament (ACL) plays a crucial role in maintaining knee stability. ACL injury can lead to functional disability in the patient and long-term complications like post traumatic arthritis so the diagnosis of ACL injuries with imaging is pivotal for the accurate management of the patient. MRI has emerged as the study of choice to correctly grade the ACL injury.

Objective: This study is aimed to assess the grading and evaluation of ACL injuries using magnetic resonance imaging (MRI).

Methods: A descriptive cross-sectional study was conducted over a twelve-month period from August 2024 to August 2025 in the Department of Radiodiagnosis, GCS Medical College and Hospital, Ahmedabad. A total of 50 patients with clinical suspicion of ACL injury were included in the study and MRI examinations were performed using a 1.5-Tesla scanner using the standard MRI knee protocol sequences. Imaging findings were analysed to determine the presence of ACL injury and grade the degree of injury.

Results: The mean age of patients was 35.76 ± 16.11 years, indicating a predominance of young to middle-aged individuals. Of the 50 patients, 26 (52%) were males and 24 (48%) were females, showing near equal gender distribution. Grade - I injury - Sprain was the most common MRI finding (44%). Grade - ii injury - Partial tears accounted for 22%. Grade - iii injury - Complete tears constituted 28%. A small percentage (6%) fell under other injury descriptions.

Conclusion: MRI is a non-invasive and radiation-free imaging modality that plays a critical role in the accurate diagnosis of ACL injury, particularly in grading the injury from sprain to complete tear. MRI can significantly enhance diagnostic accuracy and guide therapeutic decision-making.

Keywords: Anterior Cruciate Ligament Injuries Magnetic Resonance Imaging Knee Joint ACL Grading.

INTRODUCTION

Ligaments are strong connective tissues that hold the bones in place and function to provide stability and control knee movements. ACL is one of the four primary ligaments that supports the knee joint. Two of these ligaments, located inside the joint, cross each other to form an "X" shape: the anterior cruciate ligament (ACL) at the front and the posterior cruciate ligament (PCL) at the back. The ACL prevents forward tibial movement, while the PCL prevents backward motion. (1)

ACL originates from the anteromedial aspect of the intercondylar region of the tibial plateau and extends poster laterally to attach to the medial aspect of the lateral femoral condyle. The ACL measures 32 mm long and is 7 to 12 mm wide and has 2200 N strength. ACL is composed of two bundles - anteromedial and a posterolateral bundle. Blood supply of ACL - middle geniculate artery. Nerve supply of ACL - posterior articular nerve which is a branch of the tibial nerve. Histologically, the ACL is composed of type I collagen (90%) and type III collagen (10%). The anteromedial band is the stronger band and is taut in flexion while the posterolateral band is lax, it is the reverse for the posterolateral bundle. Both

these bundles restrain the anterior tibial translation - with the anteromedial bundle being the primary restraint to anterior tibial translation in flexion and the posterolateral bundle serves the role in extension. (2)

Deficiency of the anteromedial bundle is tested for by the anterior drawer test, which is performed at 90 degrees of flexion and the posterolateral band deficiencies are more commonly detected by the Lachman test and pivot shift test. Approximately half of ACL injuries are associated with additional damage to structures such as the articular cartilage, meniscus, or other ligaments. (3)

The reported frequency of meniscal tears and ACL tears is between 39.6 and 73.0%. While medial meniscal tears are more likely in chronic injuries, lateral meniscal tears are more common in acute ACL tears. Meniscal tears, which account for 77% of lateral meniscal tears and 95% of medial meniscal tears, are typically found near the posterior horn. (4)

Ligament injuries are classified as sprains and graded by severity. Grade 1 involves mild stretching and sprain, and the ligament still stabilizes the joint. Grade 2 represents partial tearing with looseness and reduced strength. Grade 3 indicates a complete rupture, often causing joint instability.

Mechanism of injury and factors affecting it : -

- ACL injuries often result from sudden directional changes, abrupt stops, deceleration while running, awkward landings after jumping, or direct impacts such as tackles. These movements may stretch the ligament beyond its elastic limit, leading to sprains or tears.
- Factors for ACL injury are broadly classified into biomechanical, anatomical and physiological.
- Biomechanical factors include - axial loading, tibial translation, knee valgus, cellular Mechano- transduction mechanisms, neuromuscular deficits, collagen fibril structure.
- External factors include the type of competition, footwear, playing surface, and environmental conditions
- Anatomical factors predisposing to injury include - Narrow intercondylar notch causing impingement on the ACL, steep tibial slope leading to more anterior tibial translation, greater Q angle and the size and shape of the ACL.
- Physiological factors encompass hormonal levels, muscle strength and neuromuscular control. (5)

Magnetic resonance imaging (MRI) has become a routine and reliable tool for identifying different patterns of ACL rupture and serves as a safe, non-invasive alternative to diagnostic arthroscopy. It is commonly used to confirm meniscal or ACL injuries before recommending surgical intervention such as arthroscopy. (6)

The objective of the present study was to evaluate ACL injuries using MRI findings and to determine the frequency and diagnostic accuracy of specific MRI patterns associated with ACL rupture.

METHODS

Materials and Methodology

- Study Design: Observational cross-sectional study
- Location: Department of Radiology, GCS Medical College, Hospital & Research Centre
- Duration: August 2024–August 2025(12months)
- Inclusion Criteria: Patients of all ages and genders with suspected ACL injury referred for MRI evaluation
- Exclusion Criteria: Patients with contraindications to MRI scan such as heart pacemakers, Implantable hearing aids, neurostimulators, intracranial metal clips, metallic hip implants

A total of 50 patients were included in the study.

- MRI Brain scans were performed using a 1.5 Tesla MRI scanner, equipped with a dedicated knee coil. Standard MRI knee protocol sequences were obtained, including Sagittal PD FS (or T2 FS): Excellent for evaluating ligaments (ACL/PCL) and menisci.
- Coronal PD FS (or T2 FS): Crucial for evaluating collaterals and bone marrow edema.
- Axial PD/T2 FS
- Sagittal T1 and 3D sequences

The imaging findings were systematically assessed to determine the ACL injury and its grading, prevalence of ACL injury according to the age and gender of the patient. All data were documented in a structured format, and imaging findings were correlated with clinical presentation. Data analysis was carried out - Categorical variables were expressed as frequencies and percentages. Continuous variables were summarized using mean and standard deviation.

RESULTS

A total of 50 patients were included in the study over a 12-month period, presenting with clinical signs and symptoms suspicious of knee injuries.

- Mean age: 35.76 years
- Standard deviation: 16.11 years

Age range: 17–83 years

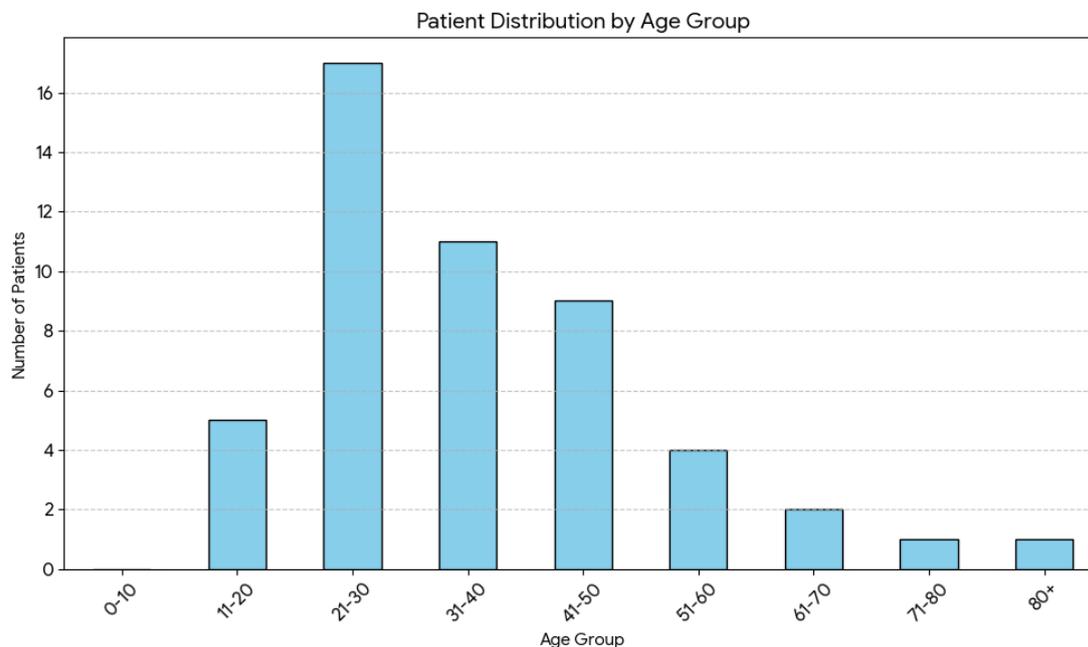


Figure 1 - showing Age group wise distribution of patients with ACL injuries categorized into 10-year age groups, has been generated.

Gender Distribution

Table 1: Gender distribution of patients

	Frequency	Percentage
Male	26	52
Female	24	48
Total	50	100.0

MRI Grading of ACL Injury

Table 2: Frequency of Grade 1, Grade 2 and Grade 3 Injury in patients

	Frequency	Percentage
Grade 1 ACL Injury - Sprain	22	44
Grade 2 ACL Injury (Partial Tear)	14	28
Grade 3 ACL Injury (Complete Tear)	11	22

Others	3	6
Total	50	100

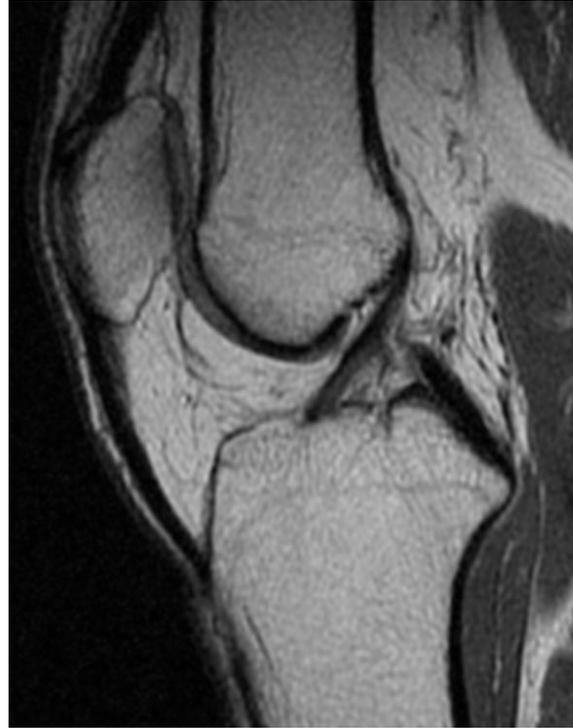


Figure 2 - ACL Sprain



Figure 3 - ACL Sprain with partial tear

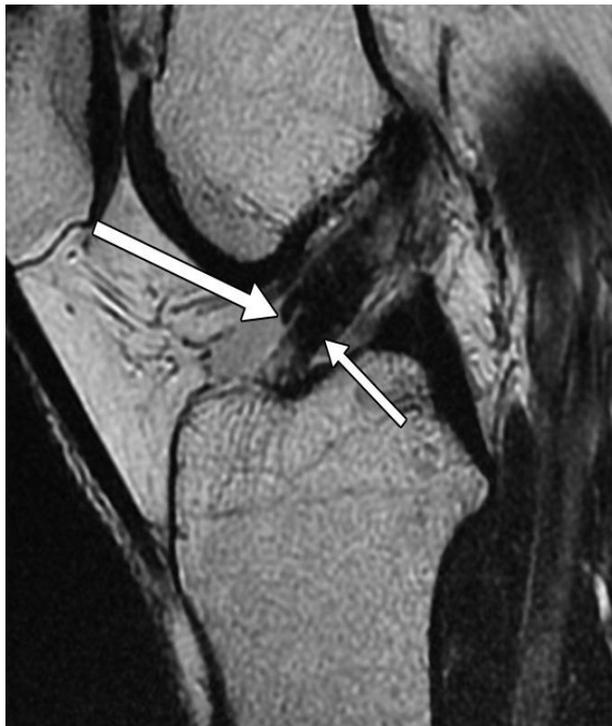


Figure 4 - Anteromedial fibres disruption with intact posterolateral bundle



Figure 5 - Complete Tear of ACL at its femoral attachment



Figure 6 - ACL tear with bone marrow edema in the proximal tibial condyle

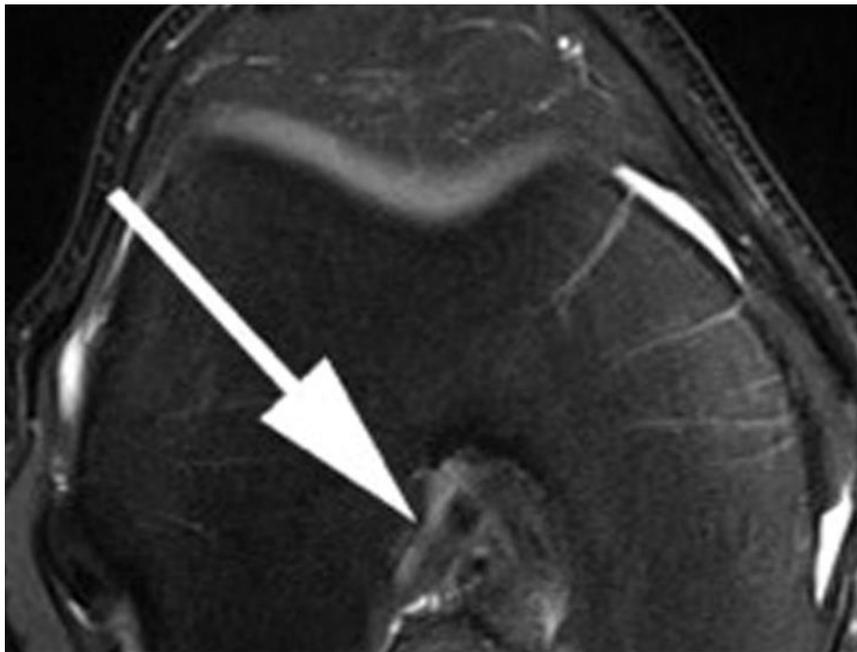


Figure 7 - Axial image showing Posterolateral bundle tear

MRI findings further classified ACL injuries into three grades from Grade - I (sprain) to complete tear - grade – III

Table 3 - showing Gender Distribution by ACL injury Grade

Injury Grade	Male ()*	Female ()*	Total
Sprain	13 (59.1%)	9 (40.9%)	22

Partial Tear	7 (58.3%)	5 (41.7%)	12
Complete Tear	8 (57.1%)	6 (42.9%)	14

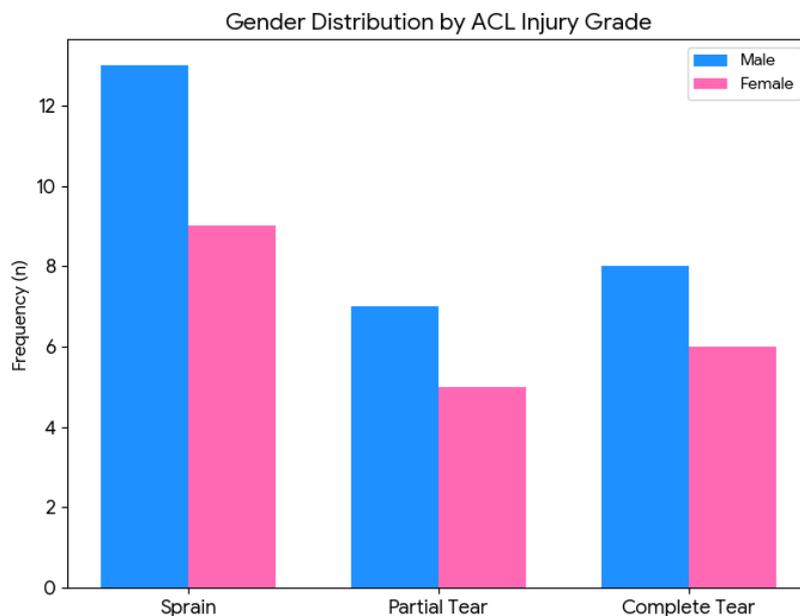


Figure – 8

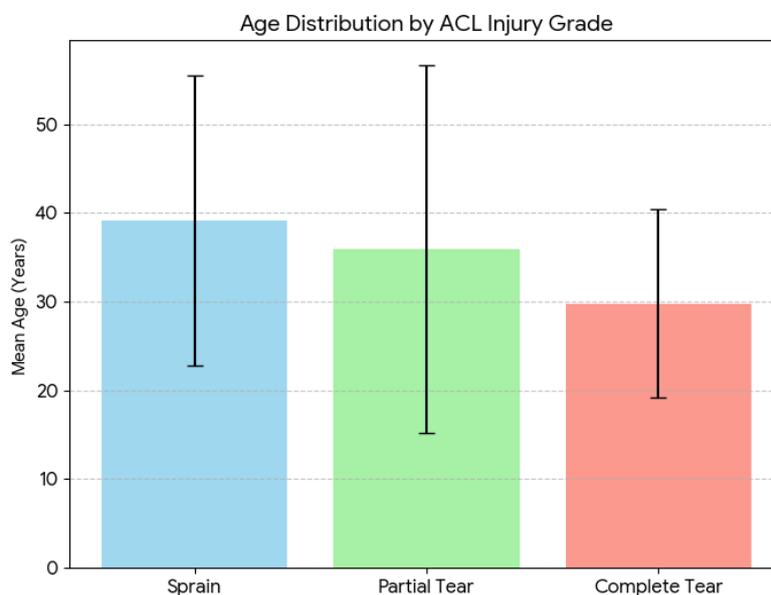


Figure – 9

DISCUSSION

MRI plays a crucial role in evaluating ligament injuries including ACL and to accurately grade the injury from sprain to complete ligament tear.

Age distribution of the patients: -

Based on the analysis of the 50 patients:

- The mean age of patients with ACL injury was 35.76 years.

- The largest age group is 21-30 years, with 17 patients (34%)
- This is followed by the 31-40 years group (11 patients - 22%) and the 41-50 years group (9 patients).
- Younger (0-20 years) and older (60+ years) populations represent a smaller portion of the dataset.

Nearly 56% of all patients fall between the ages of 21 and 40, which typically correlates with higher physical activity levels.

So, in the present study, the study population shows a wide age distribution with a predominance of young and middle-aged adults.

These findings are consistent with previous research. Faustine F. Dufka (2016) (7) evaluated MRI features of ACL injuries in relation to skeletal maturity and reported that ACL injuries are more frequent in young adults with relatively weaker bone structures. Younger patients commonly exhibited tibial avulsion fractures and partial tears, while complete ACL ruptures and associated injuries increased with age, eventually resembling adult injury patterns.

Gender analysis of the data: - revealed a slight male predominance, but overall distribution was nearly equal. Of the 50 patients, 26 (52%) were males and 24 (48%) were females, showing near equal gender distribution.

These findings supported those of Stracciolini A (2015), (8) in which the incidence of ACL injury in males and females shows no significant difference in >12 years old patients.

Signs of ACL tear -

Primary signs of ACL tear -

Direct signs include failure to visualize the ACL fibres on images taken in any plane or discontinuity of the ligament (interruption of the ACL fibres seen on two different imaging planes). Another sign is the presence of irregular or wavy contour of the ACL or an abnormal orientation of the ACL fibres.

Secondary signs of ACL injury - anterior tibial subluxation, the posterior horn of the lateral meniscus may be unveiled, complete visualization of the lateral collateral ligament (LCL) on a single coronal image, deep femoral notch sign, PCL buckling, presence of bony contusion increased signal intensity on T2 and PD weighted images) in the mid-to-anterior portion of the lateral femoral condyle and posterolateral aspect of the tibial plateau.(9)

MRI grading of ACL injuries: -

MRI accurately graded the ACL injuries into three categories -

- Grade 1 injuries (Sprain) representing the least severe form characterized by mild stretching with an intact and functional ligament as evident by PDFS hyperintensity without obvious disruption of fibers were observed in 22 patients (44%).
- Grade 2 injuries, (partial tear) indicating partial disruption of fibers with increased laxity, were identified in 14 patients (28%).
- Grade 3 injuries (complete tear), the most severe category involving complete ligament rupture confirmed on MRI, were detected in 11 patients (22%) and others (6%) fell under other injury descriptions.

Among the 50 patients, 13 males and 9 females presented with sprain, thus stating that in both genders sprain was the most commonly encountered finding.

Grading of ACL injury in association with the age of the patient revealed that complete tears to be more prevalent in the younger age groups (20 - 30), while sprain was more common in middle aged adults.

CONCLUSION

Clinical diagnosis of ACL injuries relies on focused physical examination, which often raises strong suspicion. Although radiographs are useful for excluding associated bony abnormalities, magnetic resonance imaging remains the gold standard diagnostic modality due to its high sensitivity and accuracy in detecting ligamentous injuries including ACL and enabling early detection, appropriate management, and timely treatment planning.

This is in congruence with the study in 2009 by Behairy (10) et al. stating that MRI is an accurate, on-invasive tool for diagnosing knee injuries, showing high sensitivity for ACL tears (77.8%), 100% specificity, 94% accuracy.

REFERENCES

1. Ferretti A, Monaco E, Redler A, Argento G, De Carli A, Saithna A, et al. High prevalence of anterolateral ligament abnormalities on MRI in knees with acute anterior cruciate ligament injuries: a case-control series

- from the SANTI Study Group. *Orthopaedic journal of sports medicine*. 2019; 7(6):2325-967119852916. doi: 10.1177/2325967119852916(1)
2. Evans J, Mabrouk A, Nielson JI. Anterior Cruciate Ligament Knee Injury. [Updated 2023 Nov 17]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: [https://www.ncbi.nlm.nih.gov/books/NBK499848/\(2\)](https://www.ncbi.nlm.nih.gov/books/NBK499848/)
 3. Rodriguez K, Soni M, Joshi PK, Patel SC, Shreya D, Zamora DI, Patel GS, Grossmann I, Sange I. Anterior Cruciate Ligament Injury: Conservative Versus Surgical Treatment. *Cureus*. 2021 Dec 6;13(12):e20206. doi: 10.7759/cureus.20206. PMID: 35004026; PMCID: PMC8730351.(3)
 4. Kang, Y., Dianat, S., & Bencardino, J. T. (2023). Anterior Cruciate Ligament Injuries: MR Imaging Diagnosis with Surgical Implications. *www.jscimedcentral.com*. [https://doi.org/10.47739/2379-0571/1207\(4\)](https://doi.org/10.47739/2379-0571/1207(4))
 5. Kacprzak, B., Stańczak, M., Surmacz, J., & Hagner-Derengowska, M. (2024). Biophysics of ACL Injuries. *Orthopedic reviews*, 16, 126041. <https://doi.org/10.52965/001c.126041> (5)
 6. Bin Abd Razak, H. R., Sayampanathan, A. A., Koh, T. H., & Tan, H. C. (2015). Diagnosis of ligamentous and meniscal pathologies in patients with anterior cruciate ligament injury: comparison of magnetic resonance imaging and arthroscopic findings. *Annals of translational medicine*, 3(17), 243. [https://doi.org/10.3978/j.issn.2305-5839.2015.10.05\(6\)](https://doi.org/10.3978/j.issn.2305-5839.2015.10.05(6))
 7. Dufka FL, Lansdown DA, Zhang AL, Allen CR, Ma CB, Feeley BT. Accuracy of MRI evaluation of meniscus tears in the setting of ACL injuries. *The Knee*. 2016;23(3):460-464. doi: 10.1016/j.knee.2016.01.018.(7)
 8. Stracciolini A, Stein CJ, Zurakowski D, Meehan WP 3rd, Myer GD, Micheli LJ. Anterior cruciate ligament injuries in pediatric athletes presenting to sports medicine clinic: a comparison of males and females through growth and development. *Sports Health*. 2015 Mar;7(2):130-6. doi: 10.1177/1941738114554768. PMID: 25984258; PMCID: PMC4332643(8)
 9. Al Mohammad, B., & Gharaibeh, M. A. (2024). Magnetic Resonance Imaging of Anterior Cruciate Ligament Injury. *Orthopedic research and reviews*, 16, 233–242. [https://doi.org/10.2147/ORR.S450336\(9\)](https://doi.org/10.2147/ORR.S450336(9))
 10. Behairy, N. H., Dorgham, M. A., & Khaled, S. A. (2009). Accuracy of routine magnetic resonance imaging in meniscal and ligamentous injuries of the knee: comparison with arthroscopy. *International orthopaedics*, 33(4), 961–967. [https://doi.org/10.1007/s00264-008-0580-5\(10\)](https://doi.org/10.1007/s00264-008-0580-5(10))