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Original Research Article

Reliability and assessment of partial or complete anterior cruciate ligament injuries with diagnostic arthroscopy

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ABSTRACT

Background: Partial tears of anterior cruciate ligament (ACL) were more commonly identified in young group with knee twisting. Partial tears are characterized by tear involvement of less than 50% of the ligament is torn. The arthroscopic evaluation is considered as gold standard in diagnostic evaluation. The comparison of findings between partial and complete tears in magnetic resonance imaging (MRI) and arthroscopy helps in finding out reliability of diagnostic modalities and consider the surgeon to establish the plan of treatment.
Methods: 2-year prospective study at the department of orthopedics, RRMCH, Bangalore, India. 40 consecutive patients with suspicion of cruciate injuries of knee were selected for the study from July 2018 to May 2021. The MR imaging of knee in selected cases were performed and the findings were obtained. The descriptive statistical analysis was prepared which includes spectrum of MRI findings in cruciate injuries of knee that were correlated with arthroscopy findings in determining the accuracy.
Results: Total 40 patients, we obtained 100% sensitivity and 66.67% specificity, 93.75% accuracy of MRI with arthroscopy in diagnosing complete ACL tears. We obtained 90.91% sensitivity and 80% specificity, 87.50% accuracy of MRI with arthroscopy in diagnosing partial ACL tears.
Conclusions: The partial tears can be missed or can be over diagnosed on MRI. These misinterpretations are more likely to happen due to intra-substance signal abnormality. Description of the status of ACL ligament in arthroscopy helped the orthopaedic surgeons in decision making as conservative approach in partial tears and reconstruction in a complete tear.

Keywords: ACL, MRI, Arthroscopy, Knee injuries, Internal derangement of knee

INTRODUCTION

Partial tears of ACL were more commonly identified in young group with knee twisting or sprain caused by direct injuries.[1] Partial tears are characterized by tear involvement of less than 50% of the ligament is torn.[2] They constitute 50-65% of knee injuries. The optimal treatment for these injuries is necessary for proprioception and prevent biomechanical demands of patient.[3] Preservation of vascularity helps during healing process. Currently it is subject of debate to preserve ACL remnant and provide additional support with new graft or debride and proceed with standard ACL reconstruction technique. It is necessary to understand the ligament kinematics based on clinical examination, Imaging, Arthroscopy. It is difficult to diagnose partial tears through clinical examination alone. So alternative modalities such as MRI and Arthroscopy evaluation are required for definitive diagnosis. Although some MRI signs and manifestations have been proposed to be helpful in diagnosis of partial ACL tears. However, the efficacy of MRI is still questionable in isolated injuries involving anteromedial

and posterolateral bundle alone.[4] The arthroscopic evaluation is considered as gold standard in diagnostic evaluation, by using traditional portals helps in assessing the remnant fibers and checking for clinical stability if preserved. The comparison of findings between partial and complete tears in MRI and arthroscopy helps in finding out reliability of diagnostic modalities and consider the surgeon to establish the plan of treatment.

Aim

Study of spectrum of MRI findings and arthroscopic findings and their reliability in assessing partial tears and complete tears of ACL injuries and their role in management.

METHODS

Source of data

Data will be collected from patients who come to OPD, department of orthopedics, Rajarajeswari medical college and hospital, Bangalore with knee joint injury posted for the arthroscopic surgery after obtaining the informed consent.

Sample size

Total 40 patients were included in the study.

Study period

Study conducted for 3 years January 2019-May 2021.

Type of study

The type of study was of the comparative prospective study.

Inclusion criteria

Patients presented cruciate ligament injuries for which, after outpatient, evaluation, there was an indication for surgical treatment, selected cases for arthroscopy, age group 18 years and above, both males and females, recent knee injury (within 3 months) and multiple ligament injuries were included in the study.

Exclusion criteria

Patients contraindicated to MRI, presence of degenerative diseases which could be inflammatory or primary (osteoarthritis) and femoropatellar degenerative conditions were excluded.

Study design

Descriptive statistical analysis and correlation evaluation study of MRI findings with arthroscopic findings in selected cases and 95% confidence interval of findings of MRI and arthroscopy.

Clinical evaluation

Specific history and relevant clinical examination of injured knee was done in all patients and a clinical diagnosis was established. A detailed physical examination was under taken by a surgeon with more than five years of experience of treating pathological conditions of the knee. In order to evaluate ACL injuries, the Lachman test and Anterior drawer test were used. All selected patients will be subjected to MR imaging.

MRI technique

MR scan Magnetom Avanto 18 channel 1.5 Tesla MR machine by Siemens India ltd was used in all patients. Patient was positioned supine and feet-first in the MR imager, with the knee in 100-150-degree external rotation to obtain imaging of ACL in the sagittal plane. A 170-mm field of view and a 256×192 matrix with 1 signal average was used with 4 mm slice thickness. The MR images consisted of fat-suppressed PD (TE 45, TR 2800) in axial, sagittal, and coronal planes, T2W (TE 80, TR 4000) and T1W (TE 11, TR 495) in sagittal plane. MRI evaluation is followed by therapeutic arthroscopy procedure conducted by orthopedic surgeon at operating room.

Diagnostic arthroscopy

By establishing the anterolateral viewing portal, the advanced into the patellofemoral joint for tracking patellar surface. Later the scope is advanced into the intercondylar notch, and the anterior and posterior cruciate ligaments are examined and probed along their length. The ACL femoral attachment site, which is the site of 80% of ACL tears, with the empty lateral wall sign serving as an indicator of complete tear. Both the findings will be analyzed and by using interpretation of data (Table 1), the sensitivity, specificity, accuracy, positive predictive value, negative predictive value was evaluated.

Statistical analysis

The data was entered in a Microsoft excel spreadsheet and statistical package for social sciences (SPSS) software version 17 was used for analysis. The socio-demographic data were expressed in terms of means and proportions. Test of significance was done using a chi-square test for association. A $p<0.05$ was considered significant.

Ethical clearance

Study was conducted after obtaining institutional ethics committee clearance and approval from respective authorities.

RESULTS

In our study the age group ranging from 18 to 50 years. Males are mostly to suffer knee injuries compared to females. The right knee was more frequently injured than

left knee (Figure 1). Total 40 patients were evaluated and ACL tear was found in 36 (95%) patients among these 10 (25%) were partial tears and 26 (65%) were complete (Table 2 and 3). The altered signal intensity in the ligament was seen in 16 patients (40%), 8 (20%) cases showed discontinuity, 6 (15%) cases show hyper intense signals and 6(15%) cases showed non-visualization of ACL. In complete ACL tears, true positive 26, false positive 2, false negative 0, true negative 4. In partial tears ACL true positive 10, false positive 1, false negative 1, True negative 4 (Table 4). We obtained 100% sensitivity and 66.67% specificity, 93.75% accuracy of MRI with respect to fair correlation with arthroscopy in diagnosing complete ACL tears, with positive predictive value is 92.86%, negative predictive value is 100%. We obtained 90.91% sensitivity and 80.00% specificity, 87.50% accuracy of MRI with respect to fair correlation with arthroscopy in diagnosing partial ACL tears, with Positive predictive value is 90.91%, negative predictive value is 80% (Table 5).

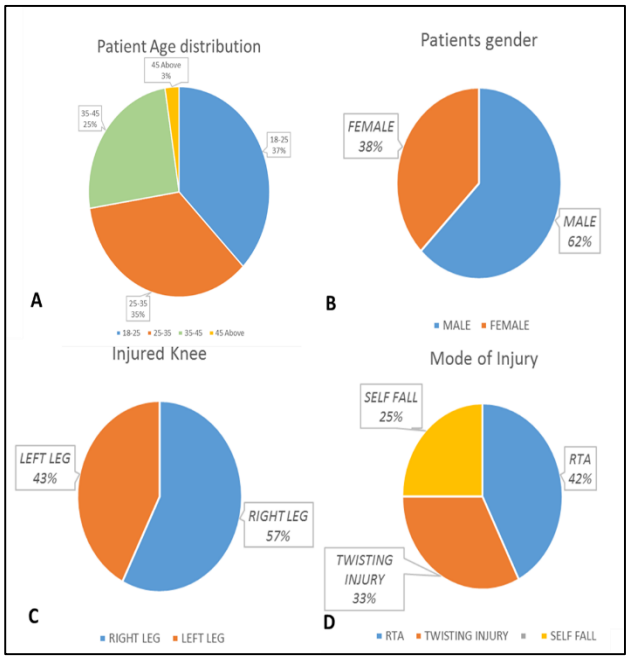

Figure 1: Demographic data.

A) Pie chart showing patient's age distribution, B) Pie chart showing patient's gender C) Pie chart showing patient's injured knee involved, D) Pie chart showing patient's mode of injury.

Table 1: MRI findings and arthroscopy findings of ACL interpretation of data.

Ligament status	Intact/ lax	
Tear	Present/ absent	
Site	Femoral attachment Mid substance Tibia/fibula attachment	If present-grade of tear: Grade i Grade ii Grade iii
Avulsion	Present/absent	

Table 2: Results for MRI in diagnosing internal derangements of knee.

MRI ACL		N	Percent (%)	Valid percent (%)
Valid	Intact and appear normal	4	10	10
	Complete tear	26	65	65
	Partial tear	10	25	25
	Total	40	100	100

Table 3: Results for arthroscopy in diagnosing internal derangements of knee.

Arthroscopic ACL		N	Percent (%)	Valid percent (%)
Valid	Intact and appear normal	7	17.5	17.5
	Complete tear	24	60	60
	Partial tear	9	22.5	22.5
	Total	40	100	100

Table 4: MRI findings of ACL and their correlation with findings of arthroscopy.

ACL	TP	FP	FN	TN
Complete tear	26	2	0	4
Partial tear	10	1	1	4

Table 5: Correlation findings of ACL.

Test	Partial tear ACL (%)	Complete ACL (%)
Sensitivity	90.91	100
Specificity	80	66.67
Positive predictive value	90.91	92.86
Negative predictive value	80	100
Accuracy	87.50	93.75

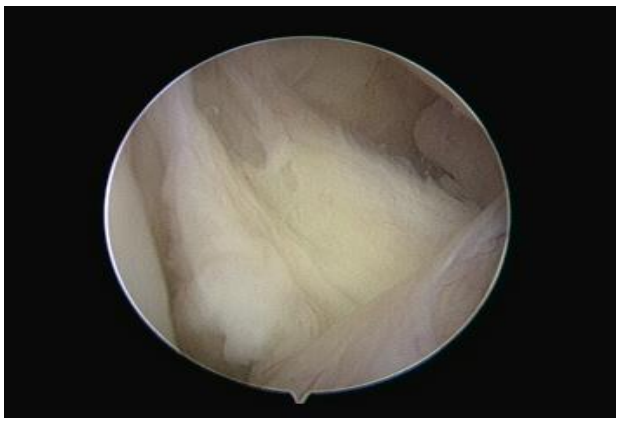

Figure 2: Arthroscopic view of complete tear of ACL with empty notch sign.

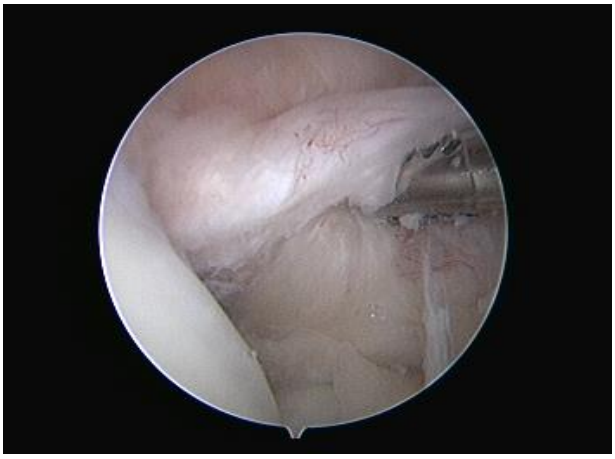

Figure 3: Arthroscopic view of complete tear of ACL at femoral attachment with complete laxity.

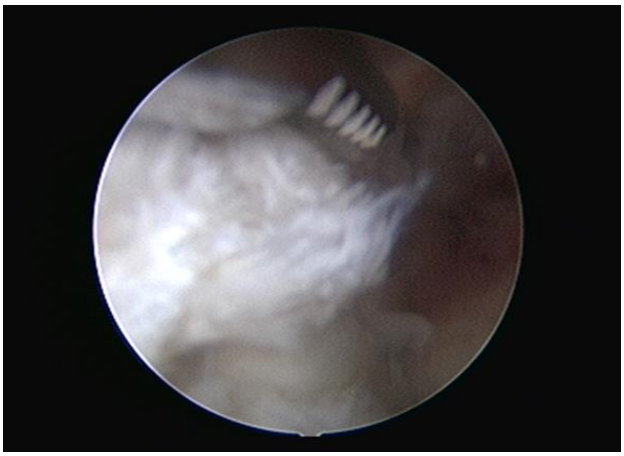

Figure 4: Arthroscopic view of partial tear of ACL at mid substance.

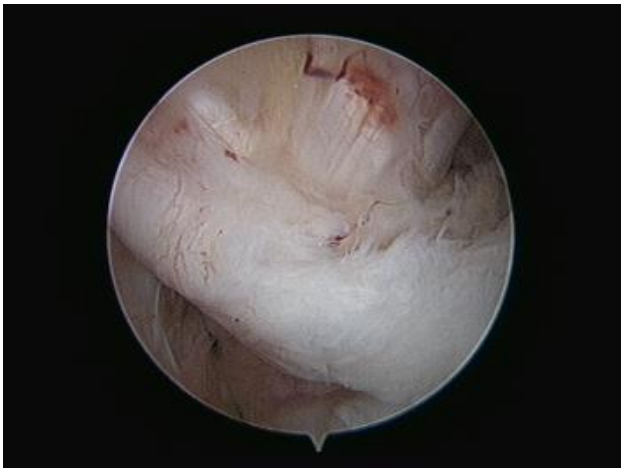

Figure 5: Arthroscopic view of partial tear of ACL at AM bundle.

DISCUSSION

The ACL is an intra-articular ligament, running from the femur to the tibia in an anterior-medial direction.[5] The ACL controls anterior movement of the tibia and inhibits extreme ranges of tibial rotation, also functions as a secondary restraint on tibial rotation and varus-valgus angulation at full extension.[6] It consists of 2 major bundles, the posterolateral bundle (PL) and the anteromedial bundle (AM) which originate on the posteromedial side of the lateral femoral condyle and insert on a region just anterior to the intercondylar tibial eminence.[7] Mean length of the AM bundle is 33 mm and is 18 mm for the PL bundle. The overall width of the ACL ranged from 7 to 17 mm, with the average being 11 mm. Partial ACL tear is considered when significant portion of at least one bundle was in continuity and was potentially functional anterior drawer testing; the Lachman test scored 0 or 1+ (<5 mm); and the pivot shift was negative or only trace-positive.[8] Nilton et al showed that physical examination has a higher sensitivity than MRI on diagnosing ACL tear.[9] De Havens et al in his study comparing physical examination with arthroscopic findings showed that Lachman test alone has an accuracy of 100% when patient is under anesthesia.[10] MR anatomy of ACL appear as a solid band or separate low signal intensity bands on sagittal and as a curvilinear fan like structure on coronal.[11] The ACL tibial attachment is usually better visualized than the femoral. Noha et al in his study evaluated reliability and value of MRI in ACL and meniscal tear diagnosis and found MRI to have higher overall accuracy in diagnosing them as compared to physical examination.[12] Axial images show ACL as flat low signal band that over the lateral femoral condyle. Pathogenesis appearances of ACL fiber has abnormal contour with increased T2-weighted image. The full-thickness tears fluid can fill the gap between the fibers.[13] The location of the tear can be described as proximal, mid substance, distal, or involving the femoral or tibial attachment.[14] Discontinuity of the fibers of ACL and an abnormal contour of ACL appear as direct signs.[15] Anterior tibial translation exceeding 6 mm, overhanging posterior horn of the lateral meniscus by 2.5 mm, Deep lateral femoral notch exceeding 2 mm in depth., Segond fracture of the lateral tibia involving the middle portion of the lateral fibrous capsule at the meniscofemoral attachment appear as indirect signs.[15] The "double PCL" sign classically is seen during this phase with the distal end of the torn ACL anterior and parallel to the PCL. Chan at al., in his study described the presence of torn ACL by measuring the lateral tibial plateau position relative to the lateral femoral condyle on a sagittal image.[16] Chronic ACL tears are completely atrophied, and will not be visualized.

In our study the age group ranging from 18 to 50 years. The youngest male patient was aged 18 years and the oldest female was 47 years. Males are mostly to suffer knee injuries since they are active in sports and the right knee was more frequently injured than left knee. Among the ligamentous injuries, ACL tear is most common, seen in 36 patients (90%), to be followed by the medial meniscal injuries seen in 26 patients (65%). In our study ACL tear was found in 36 patients (90%) among these 10 (25%) were partial tears and 26 (65%) were complete. Singh JP et al in their series of 173 patients concluded that

ACL tears are more common than other ligamentous injuries.[17] However, we found altered signal intensity in the ligament as the most common sign which was seen in 16 patients (40%), 8(20%) cases showed discontinuity, 6(15%) cases show hyper intense signals and 6 (15%) cases showed non-visualization of ACL. We obtained 100.00% sensitivity and 66.67% specificity of MRI with respect to fair correlation with arthroscopy in diagnosing Complete ACL tears. Barronian et al in their study of 22 patients showed results similar to ours.[18]

Identification of ACL partial tears in our study was presented with 87.5% accuracy, partial tears of ACL may be identified as an altered signal alone and imaging may not be accurate due to the overlying synovial reaction.[19] The MR imaging in this patient demonstrated a linear band of intact fibers normally oriented in expected location of the ACL. Umans et al in his study reported sensitivity of MRI to be 0.4 to 0.75 and the specificity 0.62 to 0.89 and found that MRI is not sensitive enough to accurately diagnose partial ACL tears.[20] The results of two large studies showed that MR imaging has relatively low sensitivity (40%-75%) but moderate to high specificity (62%-94%) in diagnosis of partial tears.[21] We obtained 90.91% sensitivity and 80.00% specificity of MRI with respect to fair correlation with arthroscopy in diagnosing Partial ACL tears. MRI when compared with arthroscopy, diagnosed only 1 of 9 partial ACL tears in study conducted by Lawrance et al.[22] In an attempt to identify and explain the errors in interpretation, we undertook a critical review of our false positive and false negative findings at MRI examination. The possible causes for two false positive findings in complete tear could be due to ACL crosses the knee joint at a slightly oblique angle, the complete ligament being rarely captured in its length by a single MRI scan in the true sagittal plane leading to non-visualization of the ACL and in partial tear it is due to physiologic ligamentous laxity.[23] There were no false negative cases, which were misinterpreted as normal.

However, this study has its own limitations which include limited number of patients and lack of control groups for direct comparison of outcomes.

CONCLUSION

ACL injuries occur frequently in patients with twisting injuries of the knee. The clinical examination is one of the most important in evaluation of ACL injuries. The clinical examination which is accurately performed by an experienced examiner, the positive signs alone can be taken into consideration and justified. The MRI functions as an accurate diagnostic modality of choice and is advantageous for surgeon to understand and plan for the surgery. On comparing the results in our study the MRI shows high sensitive and accuracy in identification of both partial and complete ACL tears. MRI reports with few false results can be seen in specific knee pathologies. The partial tears can be missed or can be over diagnosed on MRI. These misinterpretations are more likely to happen due to intra-substance signal abnormality. Description of the status of ACL ligament in arthroscopy as intact or lax, site, grade helped the orthopaedic surgeons in decision making as conservative approach in partial tears and reconstruction in a complete tear.

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