Magnetic Resonance Imaging (MRI) Based Diagnosis of Anterior Cruciate Ligament (ACL) TEARS in Patients with Internal Derangements of Knee

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ABSTRACT

Objective: To assess the role of magnetic resonance imaging (MRI) in diagnosing anterior cruciate ligament (ACL) tears in patients with knee internal derangements.

Study Design: Prospective longitudinal study.

Place and Duration of Study: Department of Radiology, Combined Military Hospital, Kharian Pakistan, from Sep 2019 Aug 2020.

Methodology: 40 patients of any age and gender were part of the study with painful or unstable knee joints. A clinical examination was performed after recording demographic data. In addition, MRI was performed, and primary and secondary signs were noted for each case.

Results: The range of patients was 15 to 63, with a mean age of 36.3 ± 12.62 years. Most of the patients were male (n=29; 72.5%), whereas only 11 (27.5%) were females. In total, 27 (67.5%) complete and 13 (32.5%) partial Anterior cruciate ligament (ACL) tears were present. Blumensaat's angle >15 degree was present in 10 (37.03%) complete tear cases and 2 (15.38%) partial tear cases. Anterior tibial displacement was evident in 4 (14.81%) complete tear cases and 3 (23.07%) partial tear cases. Posterior cruciate line (PCL) angle was apparent in 21 (77.77%) complete tear cases and 12 (92.30 %) partial tear cases.

Conclusion: The use of MRI is advocated for diagnosing Anterior cruciate ligament (ACL) tears in patients with knee internal derangements.

Keywords: Anterior cruciate ligament (ACL), Knee injuries, Magnetic resonance imaging (MRI).

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INTRODUCTION

The injury to cartilage, bone, ligaments or menisci can result in trauma to the knee. The pain and restricted movements associated with traumatic knee suppress quality of life for the patient.[1] Thus, the assessment of knee trauma is very important. Consequently, many modalities have been in use for this purpose. Arthroscopy is used as a gold standard for the diagnosis of knee-related trauma. However, for arthroscopic investigation, the patient must be hospita-lised and operated on under anesthesia.[2] Hospitalisa-tion is sometimes inconvenient for the patient, whereas operation under anaesthesia is associated with certain complications. Thus, the use of arthroscopic evaluation is limited.[3]

Imaging is considered an efficient modality for the assessment of the injury. Therefore, magnetic resonance imaging (MRI) was utilized in the 1980s. The accuracy of MRI in diagnosing a knee injury has been estimated to be 75-95%.[4] The high accuracy of MRI in assessing knee trauma, especially soft tissue, has made it highly applicable and reliable. Thus, an MRI of the knee is considered the diagnostic method for accurately assessing injuries to tendons, ligaments, menisci, occult fractures, bone contusions, marrow changes, tibial plateau fractures and bone bruises. Consequently, it has gradually substituted arthroscopy and arthrography.[5]

Adverse outcomes such as premature osteoarthritis, distorted lifestyle, and wastage of time are highly associated with the inability to properly diagnose and manage knee injuries. In order to acquire adequate therapy, accurate evaluation of the nature of such injuries is mandatory.[6] MRI has a high capacity to assess the internal structure and ligament surfaces. Therefore, it can be said that MRI is an important attribute of knee imaging.[7] It can be highly helpful in the proper management of knee pain. This is why MRI is considered the primary tool for knee imaging.

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On the other hand, beneficial aspects of enhanced resolution, improved signal to noise ratio, initiation of new sequences, shorter imaging times, decreased artefacts, and better accuracy has made MRI more desirable.[8] MRI has changed the invasive approach toward knee pain management. It has replaced the old procedures that were associated with high morbidity. Due to MRI, visualisation of the injured knee is possible without any invasiveness.[9]

The present study is an effort toward understanding the contribution of MRI in a better way.

METHODOLOGY

This prospective longitudinal study was performed at the Department of Radiology, Combined Military Hospital, Kharian Pakistan. The study was conducted from September 2019 to August 2020, including patients being referred from the Orthopedics Department during this time. The consecutive sampling method was used. The sample size was calculated per the previous work of Qayyum *et al*,[10] and 40 patients were made part of the study with inclusion criteria of painful or unstable knee joint, which was symptomatic or asymptomatic.

Inclusion Criteria: Patient of any age group and gender, with the clinical suspicion of internal derangement of the knee joint and acute traumatic internal derangement of the knee joint were included.

Exclusion Criteria: Patients with the previous history of surgery of the same knee, age-associated degenerative arthrosis of the knee joint and any contraindication for MRI were excluded from the study.

The Institutional Ethical Review Board permission was obtained from Institutional Ethical Committee (Reference No. 541). The patients were explained the purpose of the study and were asked to sign written informed consent. After clinical examination, patients were administered imaging with the help of 0.35 Tesla Semen MRI. The sequences used were T1, Proton Density, T2 & Short Tou Inversion Recovery sagittal, axial, and coronal. The primary signs and secondary signs were used to identify ACL tears. The primary signs included abnormal course and abnormal signal intensity, as secondary signs included PCL line, PCL angle, bone contusions, anterior tibial displacements and Blumensaat's angle >15 degrees.

Blumensaat's angle is the angle between the anterior margin of ACL on sagittal view and a line drawn with the edge of the intercondylar roof.[11] Anterior tibial displacement is assessed through the position of the lateral tibial plateau about lateral femoral condyle > 5mm. The PCL angle lies between the line linking the start of PCL on the femur to a point, present at the directional change region of PCL. Another line connects this point to the distal part of the PCL insertion region on the tibia. PCL angle <105 degrees is indicative of ACL injury. The posterior cruciate line, a line tangent to the upper border of the posterior cruciate ligament, normally intersects the medullary cavity of the femur. If not PCL line sign is present indicative of ACL injury

Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Quantitative variables were summarized as Mean ± SD and qualitative variables were summarized as frequency and percentages

RESULTS

The majority of the patients were male (n=29; 72.5%), whereas only 11 (27.5%) females were included. The range of patients was 15 to 63, with a mean age of 36.3 ± 12.62 years. From the data, it is evident that primarily young males underwent MRI for ACL tears. This indicates more likeability of occurrence of ACL injury among young males.

Table-I showed the distribution of types of an ACL tears. 27 (67.5%) complete and 13 (32.5%) partial ACL tears were part of the study. Table-II showed indirect signs of an ACL tear. ACL angle was evident in 8 (29.62%) complete cases and 12 (92.30%) partial cases. Blumensaat's angle was present in 10 (37.03%) complete cases and 2 (15.38%) cases. Anterior tibial displacement was evident in 4 (14.81%) complete cases and 3 (23.07%) partial cases. PCL angle was apparent in 21 (77.77%) complete cases and 12 (92.30%) partial cases.

Table-I: Distribution of type of anterior cruciate ligament (ACL) tear.

Distribution of ACL Type	n (%)
Complete	27 (67.5)
Partial	13 (32.5)

Table-II: Indirect signs of anterior cruciate ligament (ACL) tear.

Signs n (%)	Complete (n=27)	Partial (n=13)
Anterior Cruciate Ligament angle	8 (29.62)	12 (92.30)
Blumensaat's Angle	10 (37.03)	2 (15.38)
Anterior Tibial Displacement	4 (14.81)	3 (23.07)
Posterior Cruciate Line Angle	21 (77.77)	12 (92.30)

The angle of 40° was found to be the mean sagittal ACL-tibial angle for a partial ACL tear. On the other hand, 24° was estimated to mean sagittal ACL-tibial

angle for a complete ACL tear. The angle of 2° was found to be the mean Blumensaat's line-ACL angle for a partial ACL tear, whereas 26° was estimated to be the mean Blumensaat's line-ACL angle for a complete ACL tear. The angle of 122° was calculated to be the mean PCL angle for a partial ACL tear, whereas 105° was estimated to be the mean PCL angle for a complete ACL tear. The mean anterior tibial displacement was calculated as 5mm for a partial ACL tear, whereas 8mm was evident as the mean anterior tibial displacement for complete ACL tears.

Table-III showed clinical examinations for internal derangement of the knee. Lachman's test was positive for 32 (80%) ACL cases, the posterior drawer test was evident for 19 (47.5%) cases, Mcmurray's test was positive for 22 (55%) cases, the valgus strain was apparent for 28 (70%) patients, and Varus strain was affirmative for 30 (75%) cases.

Table-III: Clinical examination for internal derangement of knee.

Clinical examination	n (%) (n=40)
Lachman's test	32 (80)
Posterior drawer test	19 (47.5)
Mcmurray's test	22 (55)
Valgus strain	28 (70)
Varus strain	30 (75)

DISCUSSION

The knee is one of the most important joints. Consequently, it is highly involved in kinesis and highly associated with morbidity. By getting involved in knee-related mobility, an individual moves towards instability.[11] The leading cause of knee-related injuries can be attributed to sports-related activities. With increased activities among youth, this age group is highly prone to knee injuries. Moreover, it is also evident that these young people have many life-related responsibilities, due to which they are inclined towards early diagnosis and proper management of knee injury.[12] However, with an increase in knee injuries, it has become necessary and challenging to diagnose and manage them within constricted time properly.[13]

The increasing trend among young individuals toward sports activities has drastically increased knee-related injuries. Distortion of ligaments and cartilage in regions near the knee joint has become common.[1] On the other hand, such a condition is associated with high morbidity and low quality of life. The busy schedules of young people demand speedy and efficient recovery. Researchers have been investigating better solutions to this problem. Imaging has remained eminent for the visualisation of complex synovial joint.[9] It has enabled the practitioners to identify pathologies related to knee injuries efficiently. Conse-quently, the introduction of MRI has been recognised as one of the most important steps toward under-standing such pathologies.[14]

MRI in musculoskeletal imaging has been on boost for the past many years. The combination of multiplanar capability and superior soft tissue characterization makes MRI highly recommendable for diagnosing Anterior Cruciate ligament (ACL) tears in patients with internal derangements of the knee.[15] MRI has already proved its efficiency by replacing other available methods such as CT and radiography. It omits the risks associated with radiation and is non-operator dependent. This shows the importance and applicability of MRI in the field of orthopaedics as well as radiology.[2] MRI has drastically substituted radio-graphs and CT in assessing meniscal and ligamentous pathologies. The reason can be attributed to its non-invasive and non-operator dependent nature. Moreover, it does not require contrast administration, which is also desirable.[16]

MRI can explore traumatic mechanisms associated with acute knee injuries. It can easily depict the basic loads such as compression and tension that may have caused the injury of the knee. MRI is also efficient in depicting the most common type of injury, ligament damage.[17] Thapa *et al*,[18] assessed the specificity and sensitivity of MRI in identifying knee injuries and found sensitivity to be 91% and specificity to be 94% for the ACL related pathologies. These figures depict the high efficiency of MRI in diagnosing knee injuries.

The present study comprised 40 patients who were clinically suspected of having internal derangement of the knee. The age range of patients was 15 to 63, with a mean age of 36.3 ± 12.62 years. The majority of the patients were male (n=29; 72.5%), whereas only 11 (27.5%) females were included in the study.[8] Moreover, the data shows a high prevalence of the disorder in young males. The work of Naganna *et al*,[6] justifies these findings. According to which, 74% of acute traumatic injuries to the knee were present in males. The most common age range for the disorder was 20-29 years, indicating the disorder's occurrence among youth. However, the mean age was 33.2 ± 0.3 years, which is somewhat near to the one found in the present study.

The ACL tear may be complete or partial. Present study found 27 (67.5%) complete and 13 (32.5%) partial ACL tears. Again, this is per the study of Nagaganna *et*

al,[6] which found 66% of ACL tears to be complete. The ACL tear is identified through primary or secondary signs on imaging. The primary signs used in the present study included Blumensaat's angle of more than 9.5°. In contrast, secondary signs utilised included anterior tibial displacement with more than 5mm, and PCL angle less than 114.8°.

The angle of 40° was found to be the mean sagittal ACL-tibial angle for a partial ACL tear, whereas 24° was estimated for a complete ACL tear. The angle of 2° was found to mean Blumensaat's line-ACL angle for a partial ACL tear, whereas 26° was estimated for a complete ACL tear.[19] The angle of 122° was calculated to be the mean PCL angle for a partial ACL tear, whereas 105° was estimated for a complete ACL tear.[15] The mean anterior tibial displacement was calculated as 5mm for a partial ACL tear, whereas 8mm was evident for complete ACL tears. These findings coincide with Naganna *et al*,[6] which found the mean ACL angle to be 23° incomplete and 41° in partial tears. Blumensaat's angle was 27° for complete and 3° for partial tear. The mean PCL angle was 123° in partial and 106° in complete tears. Mean anterior tibial displacement was 9mm for complete and 6mm for par-tial tears. Although indirect signs of ACL tear have high specificity, they are associated with low sensitivity. However, these signs are considered extremely important in identifying ACL tear and its type.[19]

The clinical examinations for internal derangement of the knee further confirmed the ACL tear. In the present study, Lachman's test was positive for 32 (80%) ACL cases, the posterior drawer test was evident for 19 (47.5%) cases, Mcmurray's test was positive for 22 (55%) cases, the valgus strain was apparent for 28 (70%) patients, and Varus strain was affirmative for 30 (75%) cases. In Naganna *et al*,[9] 86% of cases were confirmed by Lachman's test. This indicates that MRI has higher diagnostic potential than clinical examination as many cases not confirmed by clinical examination are already identified through MRI. Further research can be done with a greater sample size to validate the findings of the present study.

CONCLUSION

MRI is useful in diagnosing Anterior Cruciate Ligament (ACL)tears in patients with internal derangements of the knee. Injuries to the ACL can be reliably diagnosed. The diagnosis can be based on the primary signs and secondary signs**.** MRI should be encouraged in clinically suspected patients of ACL tear following knee trauma. It has beneficial aspects of being non-invasive and cost-effective.

Conflict of Interest: None.

Author's Contribution

RR: Data collection, Literature Search/drafting, SB:, MUK: Drafting Literature Search, SARSB: Study design and literature search, KMBH: Data analysis, MUSN: Literature search and questionnaire design.

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