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ORIGINAL ARTICLE

Evaluation of Ligamentous Injuries of Knee using Magnetic Resonance Imaging (MRI)

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ABSTRACT

Background and Objectives: This research aimed to assess knee injuries, which is essential for determining the appropriate therapeutic intervention and outcomes. In this study, Magnetic Resonance Imaging was employed to examine the frequency and distribution of diverse forms of damage in traumatized knee joints.

Material and Methods: Individuals referred from the Department of Orthopedic surgery in the Department of Radiology with suspected ligamentous injuries secondary to trauma after clinical evaluation were included in the study. They underwent Magnetic Resonance Imaging (MRI) of the knee as advised by the referring surgeon. The study spanned from July 2022 to June 2023. This study was conducted to assess the effectiveness of MRI in diagnosing ligamentous knee injuries because of its obvious potential.

Results: Out of the total 50 subjects, 35 (70%) were men and 15 (30%) were women. Right knee was involved in 56% of the cases. The most common ligamentous knee injury was observed to be Anterior Cruciate Ligament tear (48%) followed by medial meniscal injury (40%). Only 4 cases (8%) pf posterior cruciate ligament were identified. Magnetic Resonance Imaging (MRI) has demonstrated significant efficacy as a diagnostic tool for identifying injuries of the cruciate ligaments and menisci when compared to arthroscopic methodologies.

Conclusion: In terms of identification of the problems of menisci and cruciate ligaments, MRI is having a higher degree of sensitivity, specificity and accuracy and can be used effectively to diagnose derangements of internal soft-tissues of the knee joint including traumatic injuries of intracapsular structures.

Keywords: ligamentous knee injuries, Magnetic Resonance Imaging, Arthroscopy.

INTRODUCTION

Knee trauma can lead to injury to menisci, articular cartilage, ligaments, or bone. Due to pain and restricted movement, traumatic knee injuries are challenging to manage, making imaging an excellent diagnostic tool.[1] Despite this, arthroscopy remains the gold standard investigation for identifying different meniscal and ligamentous issues, though it requires hospitalization and anaesthesia, each with potential complications. MRI for knee evaluation was introduced after 1980. From that time, MRI has demonstrated an accuracy of 75-95% in diagnosing injuries of knee, especially those involving soft tissues. In a preponderance of medical facilities, magnetic resonance imaging (MRI) has effectively replaced diagnostic arthroscopy and arthrography in the evaluation of meniscal, ligamentous, and tendinous injuries, in addition to bone contusions and occult fractures within the knee joint.[2-5]

Inaccurate diagnosis and treatment of knee injuries may lead to premature osteoarthritis and diminished quality of life.[6] Proper treatment necessitates a precise assessment of these injuries. MRI can detect tibia plateau fractures and marrow changes, and is an exceptional modality for evaluating both the surface and internal architecture of ligaments.[7] Within the realm of knee-imaging, MRI is undoubtedly the most crucial modality and a significant advancement in guiding pain management. The advent of novel imaging sequences, along with enhancements in the signal-to-noise ratio, increased spatial resolution, reduced artefacts, decreased imaging durations, and enhanced diagnostic accuracy have revolutionized the traditional approach to diagnosing meniscal and cruciate ligament injuries. The non-invasive nature of MRI in the evaluation of traumatized knees has effectively mitigated the necessity for superfluous surgical interventions and the concomitant risks of additional morbidity.[8-10]

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MATERIALS AND METHODS

This retrospective study focuses on individuals with clinical suspicion of internal injuries of the knee joint, who presented to Orthopaedics Surgery unit of Mayo hospital, affiliated to King Edward Medical University Lahore Pakistan. A total of 50 patients were evaluated from July 2022 to June 2023 (1 year). Individual between 18 to 60 years age exhibiting clinical indications suggestive of internal derangement within the knee joint and acute traumatic internal injuries pertaining to the knee joint were included in the study. Patients having degenerative arthrosis in relation to age and those with absolute contraindication to magnetic resonance imaging were excluded from the study.

Data collection method: Initially, consent was obtained from patients or their attendants for magnetic resonance imaging (MRI), followed by collection of relevant medical history. Patients were assessed using a 1.5 Tesla MRI machine with various appropriate sequences. MRI slices were scrutinized for the presence of tears in the meniscii, cruciate ligaments, and collateral ligaments, as well as for fluid accumulations within and adjacent to the joint, in addition to any signal alterations observed in the surrounding bones, muscles, and tendons. Subsequently, arthroscopy was performed on these cases.

Data analysis method: The collected data was tabulated and graphs were used to present it. Sensitivity, specificity, and predictive values were determined. Kappa statistics were employed to analyze the data for significant correlations between observed values of MRI and arthroscopy of the knee.

Sensitivity: The classification of sensitivity was deemed Excellent when it ranged from 0.9 to 1, Very Good for values between 0.8 and 0.9, Good for those falling within the interval of 0.7 to 0.8, Average when it spanned from 0.6 to 0.7, and Poor for any value below 0.6.

Kappa Statistics: Less than 0.20 indicating a poor level of concordance, 0.21 – 0.4 suggesting a fair level of concordance, 0.4 – 0.6 denoting a moderate level of concordance, 0.61 – 0.8 reflecting a good level of concordance while 0.81 – 1.0 signifying a

very good level of concordance.

p value: P value less than 0.05 was taken as statistically significant, less than 0.01 as highly significant and more than 0.05 as not significant.

Imaging protocol: The diagnostic accuracy, encompassing both sensitivity and specificity, of certain imaging techniques can be enhanced for particular knee pathologies; thus, a concise clinical history is essential for refining the diagnostic protocol to attain the utmost evaluative insights.

Equipment: All the patients was evaluated through a 1.5 Tesla MRI machine using different sequences as needed.

RESULTS

A total of 50 patients (comprising of 35 males and 15 females) were evaluated. The mean age was 30.5 ± 8.4 years (21-44 years). The highest incidence of knee injuries was observed in 21-30 years age-group comprising 34% of the patient population followed in prevalence by the age brackets of 31-40, 11-20, 41-50, and 51-60 years, which accounted for 31%, 9%, 19%, and 7% respectively as depicted in figure 1.

Table 1 demonstrates frequencies and percentages of the injuries as observed on magnetic Resonance Imaging.

The proportion of internal derangements detected on Magnetic Resonance Imaging is illustrated in Figure. 2.

Injuries of the medial meniscus are tabulated in table 2.

Magnetic Resonance Imaging serves as an effective modality for the identification of medial meniscus injuries, exhibiting a sensitivity of 100% and a specificity of 96.67%, respectively, in comparison to diagnostic arthroscopy. Given that grade I injuries might not be detected through arthroscopic examination, magnetic resonance imaging demonstrated an enhanced capability to reveal a greater frequency of occurrences compared to arthroscopy.

All injuries of the lateral menisci are encased in table 3.

MRI demonstrates excellent performance in identifying lateral meniscus injuries, with a sensitivity of 100% and specificity of 94.87% when compared to arthroscopy. MRI detected a higher number of cases than arthroscopy, as the latter may not identify grade I and grade II injuries.

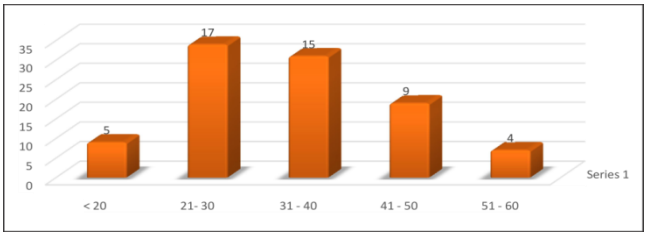

Figure 1: Age distribution of the patients.

Table 1: Frequencies and percentages of Internal Derangements as Observed On MRI

Type of derangement	Number (n)	Percentage (%)
Anterior Cruciate Ligament (ACL)	24	48
Posterior Cruciate Ligament (PCL)	4	8
Medial Meniscus (MM)	20	40
Lateral Meniscus (LM)	11	22
Medial Collateral Ligament (MCL)	3	6
Lateral Collateral Ligament (LCL)	9	18
Edema of Bone Marrow	14	28
Joint Effusion	49	98

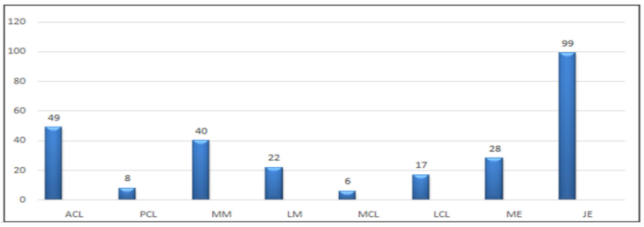

Figure 2: Proportion of internal derangements

Table 2: Details of injuries of the medial menisci (MM).

	Magnetic Resonance Imaging	Diagnostic Arthroscopy
Possitive	20	19
Negative	30	31
Total	50	50

Sensitivity = 100%
Specificity – 96.67%
Positive predictive value (PPV) = 95.4%
Negative predictive value (NPV) = 100%
Kappa = 0.95 (Very good)
p value = <0.001 (Highly Significant)

Table 3: Injuries of the lateral menisci (LM).

	Magnetic Resonance Imaging	Diagnostic Arthroscopy
Possitive	13	12
Negative	37	38
Total	50	50

Sensitivity = 85.51%
Specificity = 100%
Positive predictive value (PPV) = 100%
Negative predictive value (NPV) = 93.92%,
Kappa = 0.51 (Moderate)
P < 0.0001 (Highly Significant)

DISCUSSION

Out of the 50 individuals, about two-thirds were males and one-third females. Maniar et al.[11] reported that men are more susceptible to knee injuries than women due to their higher participation in sports related activities. They also reported that right knee injuries occur more frequently than left knee injuries. Previous studies also reported male and right knee predominance.[12-15] In this study, the majority of knee injury patients were males involved in sports such as football. The pathologies of knee were observed more frequently in younger patients with age between 20 and 40 years. Among the 50 study individuals with knee issues, 28 had right knee injuries and 22 had left knee injuries, indicating a higher involvement of the right knee.

All the individuals underwent 1.5 Tesla MR imaging and had visited the orthopaedic surgery unit of Mayo Hospital Lahore previously due to knee pathologies. Subsequently, these patients underwent both diagnostic and therapeutic arthroscopy. MRI scans were analyzed for indications of non-bony pathologies around the knee, including cysts of menisci, damage to joint-surface cartilage, cruciate and collateral ligaments injuries and loose bodies. Arthroscopy was performed to examine cysts of menisci, damage to joint-surface cartilage, cruciate and collateral ligaments injuries, injuries of menisci and loose bodies. The same sequence is also reported in the literature by del et al[16], Nakagawa et al[17]. Ali et al[18] and Chen et al[19].

ACL injuries were the most prevalent, with MRI detecting 24 cases (48%), while arthroscopy identified only 11 cases. MRI is a very efficient diagnostic modality for detecting injuries of ACL, demonstrating a sensitivity of 100% and specificity of 84.31% when compared to arthroscopy. The positive predictive value (PPV) of Magnetic Resonance Imaging was observed as 85.96%, while its negative predictive value (NPV) is 100%.[20,21] MRI and arthroscopy both identified 4 cases of PCL injuries out of 50 cases. MRI showed perfect correlation with arthroscopy in detecting PCL injuries, with 100% sensitivity, specificity, and positive and negative predictive values. Chip fractures in the tibial attachment area are the most common cause of PCL injuries.[22] For ACL tears, the observed sensitivity was 100%, specificity was 85% and accuracy was 87%, aligning with Afaq et al.'s study.[23] MRI can accurately identify ACL tears with a 93% to 97% accuracy rate. Various studies have shown sensitivity ranging from 61% to 100% and specificity from 82% to 97%.[24] This research provided a PPV of 85.96 and an NPV of 100. The ranges for positive and negative predictive values are 70% to 76% and 70% to 100%, respectively. An extensive study by Banjar et al. revealed that MRI can identify partial injuries with specificity of moderate to high degree (62%–94%) but the sensitivity was relatively lower (40–75%).[25] The moderation in signal-intensity related to these injuries were clearly

visible on T2 weighted images, as the normal decreased signal-intensity of ligaments gives a stark contrast. The efficacy of Magnetic Resonance Imaging in identifying Posterior Cruciate Ligament tears has been established. This is unsurprising, given that the PCL is typically observed without any difficulty as a homogeneous, continuous low-signal structure.

Injuries of the Medial meniscus (MM), occurring in 20 cases (40%), is the second most prevalent knee pathology. Whilst MRI detected 20 instances of medial meniscus damage, arthroscopy identified only 19. MRI demonstrated 100% sensitivity and 96.67% specificity in comparison to arthroscopy. MRI proves to be an excellent tool for diagnosing medial meniscal damage. The sensitivity, specificity, and accuracy of medial meniscal tear detection in our study aligned with those reported by Kim et al.[26] who reported that MRI had a 90% accuracy rate in detecting meniscal tears compared to arthroscopy. Their study also noted for injuries of medial meniscus, MRI revealed a sensitivity of 100%, specificity of 77%, PPV of 71% and NPV of 100%. These findings correlate with the current study's results of 100%, 96.67%, 95.4%, and 100% respectively. For lateral meniscus injury, MRI exhibits a PPV of 100% and an NPV of 93.92%. When examined the likelihood of identifying an injury using diagnostic arthroscopy for each MRI signal grade, the risk of an injury was roughly 5% in grade I, 17 to 20% in grade II, and 80 to 95% in grade III. Previous research has demonstrated that MRI can falsely detect meniscal tears.[27-28]

MRI sensitivity surpasses that of diagnostic arthroscopy because grade I and grade II tears often may not be detectable by arthroscopy. In contrary, grade III tears can easily be identified with arthroscopy. Consequently, MRI is more beneficial in detecting grade I and grade II tears, making it more precise in diagnosing meniscal tears overall. In 50 cases of knee injury, MRI identified seven instances of articular cartilage damage, while arthroscopy detected eight. For diagnosing injuries of joint-surface cartilage, MRI shows an average correlation with diagnostic arthroscopy of 60% sensitivity and 100% specificity. MRI demonstrates a 100% PPV and a 92.59% NPV. MRI sensitivity can be enhanced by employing newer sequences specifically designed for articular cartilage imaging. Beyond detecting pathologies and injuries of menisci, cruciates and collateral ligaments, MRI can also detect non-bony (soft tissue) and bony injuries around the knee joint.

CONCLUSION

Magnetic Resonance Imaging is a valuable non-invasive imaging technique without any risk to radiation exposure that can differentiate soft tissues very distinctly in multiple planes. It can accurately detect, pinpoint, and gives details of a wide range of inner pathologies including traumatic injuries of the knee joint and helps in accurately diagnosing the lesion or injury, which in turn improves patient's care. Knee joint is commonly at risk to injuries. Precisely evaluating these injuries is crucial for effective management and rehabilitation otherwise affected individuals may switch to a lifelong and irreversible impairment. Later on, diagnostic arthroscopy may be utilized both diagnostically and therapeutically.

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Conflict of interest: All the authors declare that there was no conflict of interest during this research.

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