The Reliability of MRI Knee Joint Compared to Arthroscopy in Identifying Meniscal and Anterior Cruciate Ligament Tear

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Abstract

Introduction: Magnetic Resonance Imaging (MRI) is widely used as a non-invasive diagnostic tool for knee injuries, while arthroscopy remains the gold standard for definitive diagnosis. This study aimed to evaluate the reliability of MRI compared to arthroscopy in identifying meniscal and anterior cruciate ligament (ACL) tears. **Methods:** This retrospective cross-sectional study was conducted at Combined Military Hospital, Bogura from October 2024 to December 2024. Data were collected from 30 patients who underwent both MRI and arthroscopy for suspected ACL or meniscal injuries. MRI findings were reported by blinded radiologists and compared to arthroscopic findings, which were considered the gold standard. Sensitivity, specificity, positive predictive value, and negative predictive value of MRI were calculated. Statistical analysis was performed using SPSS V25.

Results: MRI identified 80% of cases as complete tears and 20% as partial tears, while arthroscopy confirmed 90% as complete tears and 10% as partial tears. Physical training was the leading cause of injuries (66.67%), followed by sporting activities (33.33%). Meniscus tears were slightly more frequent on the right side (50.00%) than the left (33.33%), and ACL tears were almost equally distributed between the right (43.33%) and left (40.00%) sides. The findings demonstrate a strong agreement between MRI and arthroscopy, with MRI being highly reliable for detecting complete tears.

Conclusion: MRI is a reliable, non-invasive diagnostic tool for identifying meniscal and ACL tears, particularly complete tears. However, arthroscopy remains indispensable for detecting partial tears and confirming ambiguous cases. The complementary use of these modalities optimizes diagnostic accuracy and treatment outcomes. Further advancements in MRI technology could reduce the need for invasive procedures.

Keywords: Magnetic Resonance Imaging, Arthroscopy, Meniscal Tear, ACL Tear, Diagnostic Accuracy, Knee Injuries, Complete Tears, Partial Tears.

I. INTRODUCTION

Knee injuries are among the most common musculoskeletal issues, significantly affecting individuals' quality of life and productivity worldwide. Anterior cruciate ligament (ACL) and meniscal tears account for a substantial proportion of these injuries, often leading to pain, instability, and restricted mobility. Their prevalence is notably high in populations engaged in sports or physically demanding occupations, contributing to substantial functional impairment and long-term disabilities such as osteoarthritis and chronic instability if left untreated. Epidemiological studies have highlighted that these injuries are particularly prevalent in young adults, where their impact on productivity and healthcare resources is profound ^{1,2}. In resource-limited settings such as Bangladesh, diagnosing and managing knee injuries pose significant challenges. The lack of advanced diagnostic tools and specialist expertise often results in delayed or incorrect diagnoses, exacerbating patient outcomes. Economic constraints further complicate access to timely and appropriate interventions, increasing the burden on individuals and healthcare systems. Studies in similar regions underscore the socioeconomic implications of untreated or mismanaged knee injuries, including prolonged recovery periods, reduced workforce participation, and escalating healthcare costs ^{3,4}. Accurate diagnosis is crucial in preventing long-term complications in differentiating between intra-articular knee pathologies, especially in ambiguous cases.

Magnetic resonance imaging (MRI) and arthroscopy have emerged as pivotal diagnostic tools in this context. MRI is a non-invasive modality that provides detailed visualization of soft tissues, enabling the identification of ligamentous and meniscal injuries with high sensitivity and specificity. Its comprehensive imaging capability is particularly valuable for pre-surgical planning, offering insights into associated

pathologies such as bone marrow edema or cartilage damage. In contrast, arthroscopy is regarded as the gold standard for knee diagnostics, allowing direct visualization of intra-articular structures and enabling simultaneous therapeutic interventions. However, its invasive nature and associated risks, such as infection and anesthetic complications, underscore the importance of precise pre-operative imaging to minimize unnecessary surgical procedures 5-7. MRI has been demonstrated to have diagnostic accuracies of up to 97% for ACL tears and 92%-95% for meniscal injuries, depending on tear location and complexity⁸. Its ability to differentiate between partial and complete ligamentous injuries and evaluate posterior horn meniscal tears makes it indispensable in clinical practice. Nevertheless, studies have highlighted its limitations in detecting certain injury patterns, such as peripheral or posterior horn tears, necessitating careful interpretation to avoid false negatives ⁹. On the other hand, arthroscopy provides unmatched diagnostic accuracy by allowing real-time examination of intra-articular structures. Beyond diagnosis, it enables therapeutic actions such as meniscal repair or ACL reconstruction in the same setting, making it the definitive modality for cases where MRI findings are inconclusive or when surgical intervention is planned ^{10,11}. Comparative studies between MRI and arthroscopy emphasize the complementary nature of these modalities. MRI's non-invasive nature and high accuracy make it the preferred initial diagnostic tool, reducing the need for diagnostic arthroscopies. However, arthroscopy remains essential in cases where MRI findings are equivocal or where simultaneous therapeutic intervention is required. In resource-limited settings, these considerations are particularly important. The judicious use of MRI as a pre-operative tool can optimize patient management, reduce healthcare costs, and minimize the risks associated with unnecessary surgical procedures, aligning with the overarching goal of improving clinical outcomes in these settings ^{12,13}. This study aims to evaluate the reliability of MRI compared to arthroscopy in identifying meniscal and ACL injuries, particularly in the Bangladeshi population. By examining diagnostic accuracies and clinical outcomes, the study seeks to provide evidence-based insights to guide diagnostic pathways, enhance decision-making, and optimize resource utilization in healthcare systems with limited access to advanced diagnostic technologies.

II. METHODS

This retrospective cross-sectional study was conducted at CMH, Bogura from October 2024 to December 2024 to evaluate the reliability of Magnetic Resonance Imaging (MRI) compared to arthroscopy in identifying meniscal and anterior cruciate ligament (ACL) tears in patients presenting with knee injuries. Data were collected from the medical records of patients who underwent both MRI and arthroscopy for suspected meniscal or ACL injuries at Combined Military Hospital (CMH) Bogura between October 2024 and December 2024. Patients with incomplete records, prior knee surgeries, or coexisting conditions that could confound imaging findings were excluded from the study. MRI scans were performed using Achieva 1.5 T MRI, Philips with standard knee joint protocols, and the findings were reported by experienced radiologists blinded to arthroscopic results. Arthroscopy, conducted by orthopedic surgeons, was considered the gold standard for diagnosing meniscal and ACL tears. The agreement between MRI and arthroscopy findings was assessed for the medial and lateral meniscus and ACL tears, and the sensitivity, specificity, positive predictive value, and negative predictive value of MRI were calculated. Statistical analysis was performed using SPSS V.25, with results expressed as percentages, means, and 95% confidence intervals, where appropriate. Ethical approval was obtained from the institutional review board, ensuring adherence to ethical standards for retrospective data collection and analysis.

III. RESULTS

Basic Characteristics	n	%		
Age				
21-30	20	66.67%		
31-40	10	33.33%		
Sex				
Male	25	83.33%		
Female	5	16.67%		
Occupation				
Unemployed	10	33.33%		
Employed	18	60.00%		
Housewife	2	6.67%		

Table 1: Distribution of Study Population Based on Basic Characteristics (n=30)

The study population consisted of 30 participants, with the majority (66.67%) aged between 21-30 years, and the remaining 33.33% aged 31-40 years. Males predominated, accounting for 83.33% of the participants, while females comprised 16.67%. In terms of occupation, 60.00% were employed, 33.33% were unemployed, and 6.67% were housewives.

Reason of Meniscus Tear & ACL tear	n	%
Physical Training	20	66.67%
Sporting	10	33.33%

 Table 2: Distribution of Study Population Based on Reason of Meniscus Tear & ACL tear (n=30)

Among the study population, the most common cause of meniscus and ACL tears was physical training, accounting for 66.67% of cases, while sporting activities were responsible for 33.33%.

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Side of Meniscus Tear & ACL tear	n	%		
Meniscus Tear				
Right	15	50.00%		
left	10	33.33%		
ACL tear				
Right	13	43.33%		
left	12	40.00%		

 Table 3: Distribution of Study Population Based on of Meniscus Tear & ACL tear (n=30)

The distribution of meniscus and ACL tears revealed that meniscus tears occurred more frequently on the right side (50.00%) compared to the left side (33.33%). Similarly, ACL tears were slightly more common on the right side (43.33%) than on the left side (40.00%).



Figure 1: Distribution of Study Population Based on MRI findings of Meniscus Tear & ACL tear (n=30) Based on the MRI findings, 80% (n=24) of the cases were diagnosed with complete tears, while 20% (n=6) were identified as partial tears.



Figure 2: Distribution of Study Population Based on Arthroscopic finding of Meniscus Tear & ACL tear (n=30) Based on the arthroscopic findings, 90% (n=27) of the cases were identified as complete tears, while 10% (n=3) were diagnosed as partial tears.

IV. DISCUSSION

The findings of this study highlight the diagnostic reliability of Magnetic Resonance Imaging (MRI) compared to arthroscopy for identifying meniscal and anterior cruciate ligament (ACL) tears, emphasizing the complementary nature of these modalities. Our results showed that MRI identified 80% of cases as complete tears and 20% as partial tears, while arthroscopy confirmed 90% as complete tears and 10% as partial tears. These findings align with prior studies that report high sensitivity and specificity for MRI in diagnosing complete tears, though with some limitations in detecting partial tears ¹⁴. Arthroscopy, as the gold standard, demonstrated superior diagnostic accuracy, particularly for complex or subtle tears that might be missed on MRI ^{2,15}. The predominance of complete tears in our study population is consistent with other findings. For example, Bucha et al. (2018) reported that MRI reliably detects complete ACL tears with high sensitivity and specificity but may underestimate partial injuries, a limitation also observed in our study ⁶. In this regard, our study reinforces the critical role of arthroscopy in confirming partial tears and guiding therapeutic decisions, as also highlighted by Tolani et al. (2023), who emphasized the necessity of arthroscopy when MRI findings are ambiguous ¹⁶. Interestingly, the causes of ACL and meniscus tears in our population were predominantly attributed to physical training (66.67%), with sporting injuries accounting for 33.33%. This distribution mirrors findings from Bucha et al. (2018), who also identified physical training as a significant contributor to knee injuries in active populations ⁶. Tandoğan et al. (2004) similarly reported that 87% of ACL and meniscus tears occurred in individuals engaged in regular physical activities, highlighting the heightened risk in such populations ¹⁴. This reinforces the importance of preventive strategies in high-risk groups, particularly those involved in intensive physical training or sports. The laterality of injuries observed in this study revealed a nearequal distribution of ACL tears between the right (43.33%) and left (40.00%) sides, with a slight predominance of right-sided meniscal tears (50.00%). These findings are consistent with other studies, such as those by Sharifah et al. (2015), which found no significant laterality differences but noted higher diagnostic challenges in posterior horn meniscal tears, particularly on the left side ². This emphasizes the need for meticulous imaging and arthroscopic evaluation to ensure accurate diagnosis. The comparative analysis of MRI and arthroscopy underscores their complementary roles in clinical practice. While MRI provides a non-invasive, highly sensitive screening tool for pre-surgical planning, its limitations in detecting certain injury patterns necessitate arthroscopic confirmation. Thomas et al. (2007) reported that MRI has a high negative predictive value, making it a valuable initial diagnostic tool, though arthroscopy remains indispensable for definitive diagnosis¹³. In our study, MRI's underestimation of complete tears (80% vs. 90% confirmed by arthroscopy) is consistent with findings from Tolani et al. (2023), who noted reduced sensitivity for posterior horn tears and partial injuries ¹⁶. The observed diagnostic agreement between MRI and arthroscopy in this study supports the use of MRI as a reliable first-line diagnostic tool, particularly in resource-limited settings where routine arthroscopy may not be feasible. However, the lower detection rate for partial tears suggests that MRI findings should be interpreted cautiously, especially in cases with subtle or equivocal findings. The systematic review by Phelan et al. (2016) similarly concluded that MRI is highly accurate for ACL tears but slightly less reliable for lateral meniscal tears, further corroborating our observations ¹⁷. In conclusion, while MRI is an excellent non-invasive diagnostic modality for meniscal and ACL injuries, arthroscopy remains the gold standard for definitive diagnosis. The integration of these two modalities, with MRI as the initial diagnostic tool and arthroscopy as the confirmatory and therapeutic approach, ensures optimal patient outcomes. Future advancements in MRI technology, such as the incorporation of higher-resolution imaging and machine learning algorithms, hold promise for improving the detection of subtle tears and enhancing its diagnostic utility.

Limitations of the study

It was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

V. CONCLUSION

This study highlights the reliability of Magnetic Resonance Imaging (MRI) compared to arthroscopy in identifying meniscal and anterior cruciate ligament (ACL) tears. While MRI demonstrated high sensitivity and specificity for diagnosing complete tears, arthroscopy confirmed its role as the gold standard, particularly for detecting partial tears and ambiguous findings. The predominance of complete tears and the higher contribution of physical training as a causative factor emphasize the need for effective diagnostic tools and preventive strategies in active populations. The complementary roles of MRI and arthroscopy, with MRI as a non-invasive initial diagnostic tool and arthroscopy as the definitive confirmatory and therapeutic approach, underline their importance in optimizing patient outcomes. Future advancements in MRI technology could further enhance its diagnostic utility, potentially reducing the need for invasive procedures in certain cases.

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