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RESEARCH ARTICLE
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MRI EVALUATION OF ANTERIOR CRUCIATE LIGAMENT GRAFTS: PATTERNS AND OUTCOMES IN BANGLADESH

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Abstract

Background: Anterior cruciate ligament (ACL) reconstruction is a prevalent orthopedic procedure. Magnetic resonance imaging (MRI) is the principal modality for post-operative graft evaluation, assessing its integrity, position, and potential complications in a non-invasive manner. ***Objective:*** To evaluate the MRI findings and functional outcomes of ACL reconstructions in a cohort of patients in Bangladesh. Methods: A prospective cross-sectional study was conducted at Bangabandhu Sheikh Mujib Medical University (BSMMU), Popular Diagnostic Center (Savar), Super Medical Hospital (Savar) and Enam Medical College Hospital (Savar) from January 2019 to December 2020. A purposive sample of 57 patients who underwent post-ACL reconstruction was enrolled. MRI scans were evaluated for graft characteristics, and functional outcomes were assessed using the Lysholm Knee Score. Data were analyzed using SPSS version 23.0. ***Results:*** Analysis of 57 patients demonstrated that the majority (73.7%) of ACL grafts were intact on MRI, while 26.3% showed abnormalities. Non-anatomic tunnel placement was observed in a notable proportion of cases. The functional outcome, measured by the Lysholm score, averaged 84.2, indicating a good overall result. Notably, a strong and statistically significant inverse correlation ($p < 0.001$) was observed between the presence of graft abnormalities on MRI and lower functional scores. ***Conclusion:*** MRI is essential for evaluating ACL graft integrity, with findings strongly correlated to patient function. The identified failure rate highlights the need for refined surgical techniques and rehabilitation protocols

to improve outcomes in this population.

Keywords: Anterior cruciate ligament, Graft integrity, Lysholm score, MRI, Outcomes

INTRODUCTION

The anterior cruciate ligament (ACL) is a critical stabilizer of the knee joint, and its rupture is one of the most common and debilitating sports injuries worldwide [1]. The primary goal of ACL reconstruction (ACLR) is to restore knee stability, prevent secondary meniscal and chondral damage, and enable a return to pre-injury levels of activity [2]. Over the past two decades, advancements in surgical techniques, particularly the move to arthroscopic-assisted procedures and the refinement of graft choices, have significantly improved patient outcomes [3]. Despite these advancements, a significant subset of patients experiences suboptimal results post-ACLR. Complications such as graft failure, persistent instability, arthrofibrosis, and progressive osteoarthritis remain notable clinical challenges [4]. The reported failure rates of ACLR vary in the literature, ranging from 3% to 25%, influenced by factors such as surgical technique, graft type, rehabilitation compliance, and the timing of return to sport [5,6]. Graft failure can be attributed to a multitude of causes, including traumatic re-injury, technical errors in tunnel placement, inadequate graft healing, and biological rejection [7]. Therefore, meticulous post-operative evaluation is paramount for identifying the etiology of poor outcomes and guiding subsequent management. In this context, magnetic resonance imaging (MRI) has emerged as the non-invasive gold standard for the post-operative assessment of the ACL graft [8]. MRI provides exquisite soft-tissue contrast, allowing for detailed evaluation of graft integrity, signal characteristics, continuity, and position within the bone tunnels. It is also invaluable for diagnosing associated pathologies, such as meniscal tears, chondral defects, and the status of other stabilizing structures, which are crucial for a comprehensive clinical picture [9,10]. Specific MRI sequences, particularly proton-density weighted images with fat suppression, are highly sensitive in differentiating a normally healing, hypointense graft from one with abnormal signal suggestive of impingement, partial tearing, or complete rupture [11]. While the patterns of ACL graft healing and failure on MRI are well-documented in the global literature, there is a distinct paucity of data from low and middle-income countries, including Bangladesh. The local context, encompassing variations in surgical protocols, rehabilitation facilities, patient demographics, and common mechanisms of injury, may lead to unique epidemiological and radiological profiles [12]. Understanding these local patterns is essential for developing targeted interventions and improving the standard of care. Previous studies have established that clinical outcomes, as measured by standardized scoring systems like the Lysholm Knee Score, are strongly correlated with MRI findings, reinforcing the role of imaging in prognostication [13]. Therefore, this study was conceived to fill a critical knowledge gap by prospectively evaluating the MRI findings and functional outcomes of patients who have undergone ACLR in a tertiary care hospital in Bangladesh. The insights gained are expected to contribute valuable local evidence to guide clinical practice and improve post-operative management for patients in this region.

METHODOLOGY

Study population: This prospective cross-sectional study was conducted at Bangabandhu Sheikh Mujib Medical University **(**BSMMU), Popular Diagnostic Center (Savar), Super Medical Hospital (Savar) and Enam Medical College Hospital (Savar), over two years from January 2019 to December 2020. A purposive sample of 57 patients who underwent ACL reconstruction and returned for a follow-up MRI examination was enrolled.

Inclusion criteria: Patients of both genders, aged 18 to 45 years, who had undergone primary arthroscopic ACL reconstruction using a hamstring autograft at least six months before the study, were included. All participants provided written informed consent.

Exclusion criteria: Individuals with a history of multiple ligament knee injuries, previous knee arthroplasty, revision ACL surgery, or contraindications to MRI (e.g., cardiac pacemakers, claustrophobia) were excluded from the study.

Study procedure: Demographic and clinical data were collected via a structured questionnaire. Each participant underwent a standardized MRI of the involved knee on a 1.5 Tesla scanner. Graft integrity, signal intensity, tunnel placement, and associated joint pathology were assessed by a senior radiologist. Functional outcome was measured using the Lysholm Knee Score [14].

Data analysis: The collected data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 23.0. Descriptive statistics (frequencies, means, standard deviations) were computed. A Pearson's correlation test was used to analyze the relationship between MRI findings and functional scores, with a p-value of <0.05 considered statistically significant.

RESULT

The study analyzed 57 patients who underwent ACL reconstruction. The cohort was predominantly male (78.9%), with a mean age of 28.4 ± 5.1 years. The most frequent mechanism of initial injury was sports-related activities (59.6%), followed by road traffic accidents (22.8%) and other injuries (17.5%). The average time from surgery to the follow-up MRI evaluation was 14.2 ± 3.5 months. Evaluation of the ACL grafts on MRI revealed that a majority (73.7%) demonstrated normal, homogeneously low signal intensity, indicative of intact grafts. However, a significant proportion (26.3%) showed abnormalities, with 15.8% of grafts exhibiting signs of a partial-thickness tear and 10.5% being diagnosed as completely ruptured. The positioning of the bone tunnels was also assessed. For the femoral tunnel, 84.2% were placed within the anatomic footprint, while 15.8% were non-anatomic. The tibial tunnel placement was anatomic in 80.7% of cases and non-anatomic in 19.3%. Associated intra-articular pathologies were common. Meniscal tears were present in 49.1% of the knees, with medial meniscus tears being more frequent (29.8%) than lateral meniscus tears (19.3%). Chondral lesions were observed in 38.6% of patients, predominantly classified as low-grade (Grade I & II, 24.6%) rather than high-grade (Grade III & IV, 14.0%). The functional outcome, as measured by the Lysholm Knee Score, showed a mean score of 84.2 ± 9.5, which falls within the “good” outcome range. A critical analysis revealed a strong and statistically significant association between the MRI status of the graft and the functional outcome. Patients with intact grafts had a significantly higher mean Lysholm score (88.5 ± 4.1) compared to those with partial tears (76.2 ± 5.8) and complete ruptures (65.3 ± 6.1).

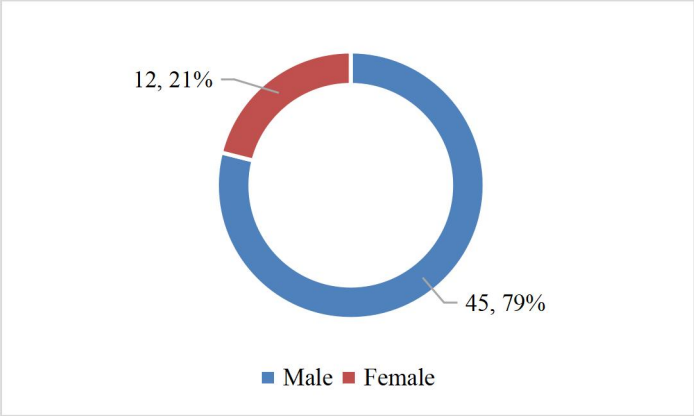

Figure 1: Gender distribution (N=57)

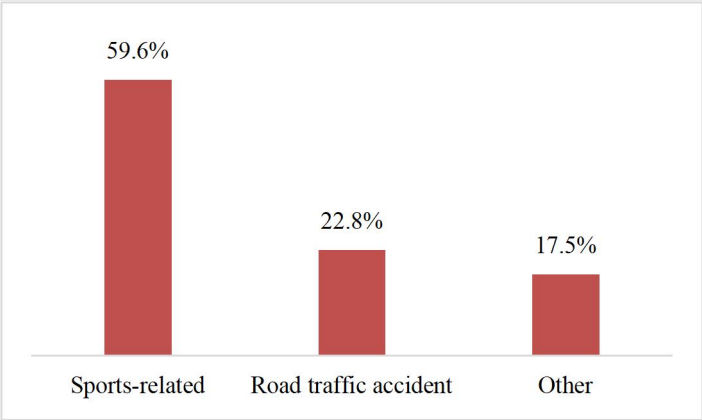

Figure 2: Mechanism of injury

Table 1: MRI evaluation of ACL graft status

Graft status	n	%
Intact (Normal signal)	42	73.7%
Partial thickness tear	9	15.8%
Complete rupture	6	10.5%

Table 2: Evaluation of femoral and tibial tunnel placement

Tunnel position	Tunnel type	
	Femoral (n=57)	Tibial (n=57)
Anatomic	48 (84.2%)	46 (80.7%)
Non-anatomic	9 (15.8%)	11 (19.3%)

A. Signal-to-Noise Quotient (SNQ) measurement. B. Femoral tunnel placement measurement.
Figure 3: ACL graft assessment on MRI

Table 3: Associated intra-articular pathologies on MRI

Pathology	n	%
Meniscal tear (n=28)		
Medial meniscus	17	29.8%
Lateral meniscus	11	19.3%
Chondral lesion (n=22)		
Low grade (I & II)	14	24.6%
High grade (III & IV)	8	14.0%

Table 4: Functional outcome (Lysholm score) by graft status

Graft status on MRI	n	Lysholm score
		Mean ±SD
Intact	42	88.5 ± 4.1
Partial tear	9	76.2 ± 5.8
Complete rupture	6	65.3 ± 6.1
p-value	<0.001	

One-way Analysis of Variance (ANOVA) was used

Table 5: Association between chondral lesions and functional outcome

Lesion grade	n	Lysholm score
		Mean ±SD
None	35	87.1 ± 5.2
Low grade (I & II)	14	82.5 ± 4.8
High grade (III & IV)	8	73.6 ± 7.9
p-value	<0.001	

One-way Analysis of Variance (ANOVA) was used

DISCUSSION

The present study provides a detailed analysis of the MRI findings and functional outcomes following ACL reconstruction in a Bangladeshi cohort, an area with a notable scarcity of published literature. Our findings indicate that while a majority of patients achieve satisfactory graft integrity and good functional outcomes, a significant subset experiences complications, underscoring the need for continuous evaluation and refinement of local practice. The demographic profile of our study population, predominantly young males with sports-related injuries, is consistent with the global epidemiology of ACL tears [1,15]. This reinforces ACL injury as a significant issue affecting the active, young adult population in Bangladesh, with considerable socio-economic implications due to potential loss of productivity. The primary objective was to evaluate graft status via MRI. Our finding that 73.7% of grafts were intact with normal signal intensity aligns with success rates reported in several international studies [16,17]. However, the 26.3% rate of graft abnormality (15.8% partial and 10.5% complete tears) is at the higher end of the spectrum reported in the literature, which typically ranges from 10% to 25% [5,6]. This higher rate could be attributed to several factors pertinent to our setting, including the learning curve associated with surgical techniques, possible variations in graft fixation methods, or a higher incidence of premature return to strenuous activities among patients. A critical technical factor in ACLR success is correct tunnel placement. In our series, non-anatomic placement of the femoral and tibial tunnels was observed in 15.8% and 19.3% of cases, respectively. Mal-positioned tunnels, particularly an anteriorly placed femoral tunnel, are a well-established cause of graft impingement, altered knee kinematics, and subsequent failure [18,19]. The rates observed here highlight an area for potential improvement through surgical training and the possible adoption of navigation or patient-specific instrumentation. The strong and statistically significant correlation between abnormal MRI findings and poorer Lysholm scores ($p<0.001$) is a cornerstone finding of our study. Patients with intact grafts had a mean Lysholm score of 88.5, categorized as "good," which plummeted to 65.3 in those with complete ruptures. This correlation validates the use of the Lysholm score as a sensitive measure of functional outcome in our population and confirms that MRI findings have direct clinical relevance [14,20]. Furthermore, the significant association between high-grade chondral lesions and lower functional scores ($p<0.001$) underscores the long-term impact of concomitant joint damage on patient well-being, a finding supported by other long-term outcome studies [21,22]. The high prevalence of

associated meniscal (49.1%) and chondral (38.6%) pathology is noteworthy. These findings are often sequelae of the initial trauma and can be exacerbated by persistent instability pre- or post-surgery. Their presence complicates the clinical picture and can independently contribute to pain and functional limitation, influencing the outcome [23]. This study has certain limitations. Its cross-sectional design establishes association but not causation. The purposive sampling from multiple centers may enhance the representativeness of the findings and improve their generalizability across Bangladesh. Furthermore, we did not correlate our findings with specific surgical techniques or rehabilitation protocols, which are important variables for future prospective research [24,25]. This study establishes that MRI is an indispensable tool for the post-operative assessment of ACL grafts in our setting. It successfully identified a clear link between graft integrity, associated joint pathology, and functional outcomes. The findings call for a focused effort on optimizing surgical precision, ensuring adequate graft healing time, and managing expectations regarding return to activity to improve the overall success rate of ACL reconstruction in Bangladesh.

Limitations:

The study limitations include its multi-center design and purposive sampling, which may affect generalizability. The cross-sectional nature cannot establish causality, and the lack of data on specific surgical techniques and rehabilitation protocols restricts deeper analysis.

CONCLUSION

This study provides strong evidence that preoperative MRCP is a highly effective strategy for reducing the incidence of Post-cholecystectomy Syndrome. By accurately delineating cystic duct anatomy, it empowers surgeons to perform a more tailored and definitive procedure, directly addressing the leading biliary causes of PCS. We recommend considering routine preoperative MRCP, particularly in settings where detailed biliary anatomy is not fully clear from initial ultrasound, to improve long-term patient outcomes after cholecystectomy.

Recommendation:

The study limitations include its multi-center design and purposive sampling, which may affect generalizability. The cross-sectional nature cannot establish causality, and the lack of data on specific surgical techniques and rehabilitation protocols restricts deeper analysis.

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