

Clinical and Functional Outcomes of Anterior Cruciate Ligament Reconstruction with Lateral Extra-Articular Tenodesis in Bangladeshi Patients: A Prospective Study

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ABSTRACT:

Background: Anterior cruciate ligament (ACL) injury is one of the most common causes of knee instability among young and physically active individuals. Although arthroscopic ACL reconstruction is the standard treatment, some patients continue to experience residual rotational instability. The addition of lateral extra-articular tenodesis (LET) has been proposed to enhance rotational stability and reduce graft failure. However, clinical evidence regarding the effectiveness of this combined procedure in Bangladeshi patients remains limited.

Objective: To evaluate the clinical stability and functional outcomes of anterior cruciate ligament reconstruction combined with lateral extra-articular tenodesis in Bangladeshi patients.

Methods: This prospective observational study was conducted from January 2023 to December 2025 at Enam Medical College Hospital, Comfort Hospital, and Micare Hospital, Dhaka. A total of 64 patients with ACL injuries who underwent arthroscopic ACL reconstruction with LET were included. Baseline demographic data, injury characteristics, and operative details were recorded. Clinical stability was assessed using Lachman test, pivot shift test, and anterior drawer test. Functional outcomes were evaluated using the International Knee Documentation Committee (IKDC) score, Lysholm knee score, Tegner activity scale, and Visual Analogue Scale (VAS) for pain. Patients were followed up for 12 months postoperatively, and preoperative and postoperative outcomes were compared.

Results: The mean age of the participants was 27.1 ± 6.2 years, with a predominance of males (71.9%). Sports injury was the most common mechanism of trauma (46.9%). Significant improvements in knee stability were observed after surgery. Positive Lachman test decreased from 100% preoperatively to 8.6%, while pivot shift and anterior drawer tests decreased from 81.3% and 87.5% to 6.9% and 10.3%, respectively ($p < 0.001$). Functional outcomes improved markedly, with the mean IKDC score increasing from 45.8 ± 8.4 preoperatively to 89.2 ± 5.7 at 12 months, and the Lysholm score improving from 51.9 ± 10.5 to 92.4 ± 5.2 ($p < 0.001$). Pain levels decreased significantly, with VAS scores declining from 6.3 ± 1.5 to 1.5 ± 0.9 . Approximately 90.6% of patients returned to daily activities, and 71.9% resumed sports participation. Postoperative complications were relatively low, with residual instability observed in 6.3% and graft failure in 3.1% of patients.

Conclusion: ACL reconstruction combined with lateral extra-articular tenodesis provides significant improvement in knee stability, functional outcomes, and pain reduction in Bangladeshi patients. The procedure demonstrated a high rate of return to activity and a low complication rate, suggesting that the addition of LET may enhance surgical outcomes in selected ACL-injured patients.

Key Words: Anterior cruciate ligament reconstruction; lateral extra-articular tenodesis; knee instability; functional outcome; Bangladesh; prospective study.

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Introduction

Anterior cruciate ligament (ACL) injury is one of the most common ligamentous injuries of the knee joint, particularly among young and physically active individuals. It frequently occurs during sports activities involving sudden deceleration, pivoting, or change of direction, and may also result from road traffic accidents or falls (Griffin et al., 2006). ACL rupture leads to knee instability, recurrent giving-way episodes, and difficulty in performing daily or athletic activities. If left untreated, it can predispose patients to secondary meniscal injuries and early osteoarthritis of the knee joint (Lohmander et al., 2007). Consequently, arthroscopic ACL reconstruction has become the standard surgical procedure to restore knee stability and functional performance.

Despite advances in surgical techniques and rehabilitation protocols, a proportion of patients continue to experience residual rotational instability following isolated ACL reconstruction. Persistent pivot shift and instability may compromise functional outcomes and increase the risk of graft failure (Claes et al., 2013). In recent years, there has been growing interest in augmenting ACL reconstruction with lateral extra-articular procedures, particularly lateral extra-articular tenodesis (LET), to improve rotational control of the knee joint. LET is designed to reinforce the anterolateral structures of the knee, thereby limiting excessive tibial internal rotation and enhancing overall knee stability (Sonnerly-Cottet et al., 2017).

Several clinical studies have demonstrated that combining ACL reconstruction with LET may reduce the incidence of graft failure and improve rotational stability, particularly in high-risk patients such as young athletes, individuals with high-grade pivot shift, or those undergoing revision surgery (Getgood et al., 2020). Biomechanical studies also support the role of LET in decreasing rotational laxity and protecting the reconstructed graft from excessive loads during knee movement (Inderhaug et al., 2017). As a result, the combined procedure has gained increasing acceptance in contemporary orthopedic practice.

Although a substantial body of literature exists regarding ACL reconstruction and LET in Western populations, evidence from South Asian countries, including Bangladesh, remains limited. Differences in injury mechanisms,

activity levels, rehabilitation access, and healthcare infrastructure may influence postoperative outcomes in this region. Evaluating clinical and functional outcomes in the local population is therefore important for guiding surgical decision-making and optimizing patient care.

Therefore, the present study aimed to evaluate the clinical stability and functional outcomes of anterior cruciate ligament reconstruction combined with lateral extra-articular tenodesis in Bangladeshi patients treated in selected tertiary care hospitals in Dhaka. The study assessed postoperative knee stability, functional scores, return to activity, and complication rates in order to determine the effectiveness of this combined surgical approach.

Materials and Methods

This prospective observational study was conducted from January 2023 to December 2025 at three tertiary care centers in Dhaka, Bangladesh: Enam Medical College Hospital, Comfort Hospital, and Micare Hospital. The study included 64 patients diagnosed with anterior cruciate ligament (ACL) injury who underwent arthroscopic ACL reconstruction combined with lateral extra-articular tenodesis (LET). Patients aged between 18 and 45 years with symptomatic ACL rupture confirmed by clinical examination and magnetic resonance imaging (MRI) were eligible for inclusion. Patients with previous knee surgery, multi-ligament knee injuries, advanced osteoarthritis, or systemic musculoskeletal disorders were excluded from the study.

All patients underwent arthroscopic ACL reconstruction using either hamstring tendon autograft or patellar tendon graft, followed by lateral extra-articular tenodesis using the modified Lemaire technique. Concomitant procedures such as meniscal repair or partial meniscectomy were performed when indicated. Standardized postoperative rehabilitation protocols were followed for all patients.

Baseline demographic characteristics, injury mechanism, associated injuries, and operative details were recorded using a structured data collection form. Clinical evaluation was performed using Lachman test, pivot shift test, and anterior drawer test to assess knee stability. Functional outcomes were measured using validated scoring systems including the International Knee Documentation Committee (IKDC) score, Lysholm knee score, Tegner

activity scale, and Visual Analogue Scale (VAS) for pain. Patients were followed at regular intervals postoperatively, including 6 weeks, 3 months, 6 months, and 12 months. Preoperative and postoperative clinical and functional outcomes were compared to evaluate surgical effectiveness.

Data analysis:

Statistical analysis was performed using appropriate descriptive and inferential methods. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were presented as frequency and percentage. A p-value < 0.05 was considered statistically significant.

Results:

The gender distribution of the study population is presented in Figure. Among the 64 patients included, the majority were male (46, 71.9%), while female patients accounted for (18, 28.1%) of the total sample. This predominance of male participants reflects the higher incidence of ACL injuries among physically active males.

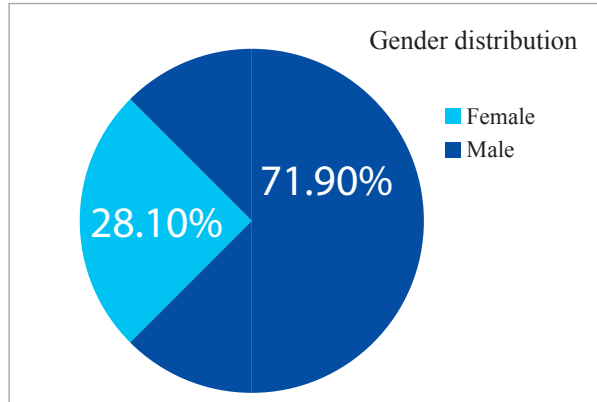
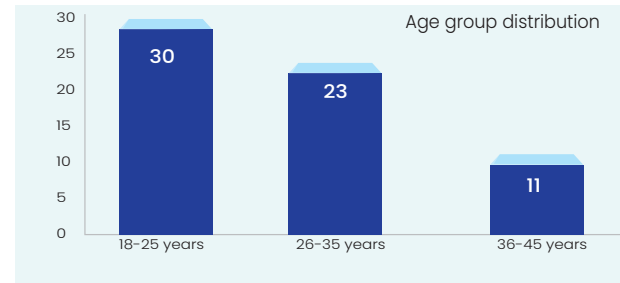


Figure 1: Gender distribution of the study population (n=64)

Figure shows the age group distribution of the study participants. The majority of patients belonged to the 18–25 years age group (n = 30), followed by 26–35 years (n = 23) and 36–45 years (n = 11). The mean age of the participants was 27.1 ± 6.2 years, indicating that ACL injuries were more common among young adults. This pattern reflects the higher exposure of younger individuals to sports and physically demanding activities.



Mean Age= 27.1 ± 6.2

Figure 2: Age group distribution of the study population (n=64)

The mean body mass index (BMI) of the study participants was 24.6 ± 3.1 kg/m², indicating that most patients were within the normal to slightly overweight range. A history of smoking was reported in 14 patients (21.9%). The majority of participants were therefore non-smokers. These baseline characteristics provide an overview of important lifestyle-related factors in the study population.

Table 1: BMI and Smoking history of patients (n = 64)

BMI (kg/m ²)	Mean 24.6 ± 3.1	—
Smoking history	14	21.9%

Figure 3 shows the occupational distribution of the study participants. The largest proportion of patients were students (34.4%), followed by service holders (29.7%) and manual workers (23.4%), while 12.5% belonged to other occupations. This distribution indicates that ACL injuries were more frequent among individuals engaged in physically active or routine work-related activities. The higher proportion of students may reflect greater participation in sports and recreational activities.

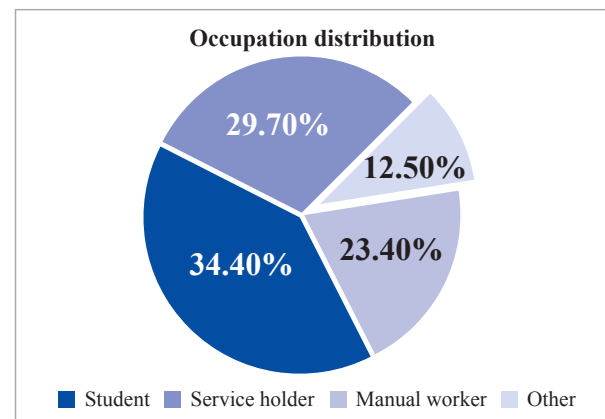


Figure 3: Occupational distribution of the study population (n=64)

Right knee injuries were slightly more common than left-sided injuries. Sports-related trauma was the most frequent mechanism of injury, followed by road traffic accidents and falls. Associated meniscal injuries were present in nearly half of the patients, while chondral injuries were less frequent. The average duration between injury and surgery was 8.7 ± 4.5 months. Preoperative functional scores demonstrated substantial knee dysfunction and pain prior to surgical intervention.

Table 2: Baseline Injury and Preoperative Knee Status

Variable	Frequency	Percentage (%)
Side of injury		
Right knee	37	57.8
Left knee	27	42.2
Mechanism of injury		
Sports injury	30	46.9
Road traffic accident	22	34.4
Fall	12	18.7
Meniscal injury present	28	43.8
Chondral injury	10	15.6
Time from injury to surgery	Mean 8.7 ± 4.5 months	—

Preoperative scores:

Score	Mean $\pm$ SD
IKDC	45.8 ± 8.4
Lysholm	51.9 ± 10.5
Tegner	3.0 ± 1.3
VAS Pain	6.3 ± 1.5

Most ACL reconstructions were performed using hamstring tendon autografts, which remain the preferred graft option in many centers. The mean graft diameter was 8.5 ± 0.6 mm, indicating adequate graft size for reconstruction. All patients underwent lateral extra-articular tenodesis using the modified Lemaire technique. Concomitant meniscal procedures were performed in patients with associated meniscal injuries. The average operative duration was 96 ± 15 minutes, and no major intraoperative complications were reported.

Table 3: Operative and Surgical Characteristics

Variable	Frequency	Percentage
Graft type		
Hamstring autograft	52	81.3
Patellar tendon graft	12	18.7
Mean graft diameter	8.5 ± 0.6 mm	—
LET technique	Modified Lemaire	64
Concomitant procedure		
Meniscal repair	16	25.0
Partial meniscectomy	12	18.8
None	36	56.2
Mean operative time	96 ± 15 minutes	—

All 64 patients were initially enrolled and operated during the study period. Follow-up compliance remained high throughout the observation period. At 6 weeks, 62 patients (96.9%) attended follow-up visits. The number of patients available at 3 months and 6 months remained above 90%. The final 12-month follow-up was completed by 58 patients (90.6%), while 6 patients were lost to follow-up due to relocation or non-compliance.

Table 4: Follow-up and Participant Retention

Follow-up Time	Patients Available	Percentage (%)
Immediate postoperative	64	100
6 weeks	62	96.9
3 months	61	95.3
6 months	59	92.2
12 months	58	90.6

Marked improvements in clinical knee stability were observed after surgery. All patients demonstrated a positive Lachman test preoperatively, which decreased dramatically at final follow-up. Similarly, the prevalence of positive pivot shift and anterior drawer tests decreased significantly following reconstruction. Knee effusion also reduced substantially. These findings indicate that ACL reconstruction with LET effectively restored knee stability.

Table 5: Preoperative vs Postoperative Clinical Examination Findings

Clinical Test	Preoperative	12 Months	p-value
Positive Lachman	64 (100%)	5 (8.6%)	<0.001
Positive Pivot shift	52 (81.3%)	4 (6.9%)	<0.001
Positive Anterior drawer	56 (87.5%)	6 (10.3%)	<0.001
Knee effusion	28 (43.8%)	5 (8.6%)	<0.001

Significant improvement was observed in all functional outcome measures during follow-up. The mean IKDC score increased from 45.8 preoperatively to 89.2 at 12 months. Similarly, the Lysholm score improved from 51.9 to 92.4, indicating excellent knee function. Tegner activity levels increased steadily over time, reflecting improved physical activity capacity. Pain levels measured using VAS decreased substantially during the postoperative period.

Table 6: Functional Outcome Scores

Score	Preoperative	3 months	6 months	12 months	p-value
IKDC	45.8 ± 8.4	69.1 ± 7.6	80.4 ± 6.5	89.2 ± 5.7	<0.001
Lysholm	51.9 ± 10.5	73.4 ± 8.6	84.7 ± 6.9	92.4 ± 5.2	<0.001
Tegner	3.0 ± 1.3	4.3 ± 1.2	5.5 ± 1.1	6.3 ± 1.0	<0.001
VAS Pain	6.3 ± 1.5	3.9 ± 1.3	2.4 ± 1.1	1.5 ± 0.9	<0.001

Most patients successfully resumed daily activities and occupational work after surgery. Approximately 90% of patients returned to their routine daily activities, while 84.4% resumed occupational duties. Return to sports was achieved in 71.9% of the participants, although slightly fewer patients returned to their pre-injury level of sports performance. The mean time required to return to sports activities was 8.4 ± 2.2 months.

Table 7: Return to Activity and Sports

Outcome	Frequency	Percentage (%)
Return to daily activities	58	90.6
Return to work	54	84.4
Return to sports	46	71.9
Return to pre-injury level	38	59.4
Mean time to return to sports	8.4 ± 2.2 months	—

The incidence of postoperative complications was relatively low. Persistent knee pain was the most commonly reported complication, followed by knee stiffness. Superficial infection occurred in a small number of patients and resolved with conservative treatment. Residual instability and graft failure were rare events. Only one patient required revision surgery during the follow-up period.

Table 8: Postoperative Complications

Complication	Frequency	Percentage (%)
Knee stiffness	5	7.8
Superficial infection	2	3.1
Persistent pain	6	9.4
Residual instability	4	6.3
Graft failure	2	3.1
Reoperation	1	1.6

Patients who achieved good functional outcomes tended to be younger and underwent earlier surgical intervention. The mean age in the good outcome group was significantly lower compared to the poor outcome group. Surgery performed within six months of injury was also associated with improved postoperative functional scores. However, sex and meniscal injury status did not show a statistically significant association with final outcomes.

Table 9: Predictors of Good Functional Outcome

Variable	Good Outcome (n=40)	Poor Outcome (n=24)	p-value
Age	25.8 ± 5.7	29.6 ± 6.4	0.02
Male	30	16	0.45
Meniscal injury	16	12	0.30
Surgery <6 months	25	8	0.01

Residual postoperative instability was observed in a small subset of patients. Meniscal injury and chronic ACL tears were associated with increased risk of postoperative instability. Patients with poor adherence to rehabilitation protocols demonstrated the highest risk of instability. These findings highlight the importance of timely surgery and structured rehabilitation.

Table 10: Predictors of Residual Instability

Variable	Instability (n=7)	Stable (n=57)	p-value
Meniscal injury	5	23	0.04
Chronic injury >12 months	4	12	0.05
High activity level	4	20	0.07
Poor rehab compliance	5	15	0.01

Patients without associated meniscal injuries demonstrated slightly better functional outcomes compared to those with meniscal involvement. The mean final IKDC score was higher in the non-meniscal injury group. Although return to sports was more frequent among patients without meniscal injury, the difference was not statistically significant. Residual instability was somewhat more common in patients with meniscal pathology.

Table 11: Outcomes by Meniscal Injury Status

Variable	With Meniscal Injury (n=28)	Without Meniscal Injury (n=36)	p-value
Final IKDC	86.7 ± 6.2	90.4 ± 5.1	0.01
Return to sports	18	28	0.17
Residual instability	4	2	0.18

Functional outcomes improved progressively during the postoperative follow-up period. Both IKDC and Lysholm scores showed continuous improvement between the 6-month and 12-month assessments. Tegner activity levels also increased over time, indicating gradual return to higher levels of physical activity. These results demonstrate that functional recovery after ACL reconstruction continues throughout the first postoperative year.

Table 12: Outcome by Follow-up Duration

Outcome	6 months	12 months	p-value
IKDC	80.4 ± 6.5	89.2 ± 5.7	<0.001
Lysholm	84.7 ± 6.9	92.4 ± 5.2	<0.001
Tegner	5.5 ± 1.1	6.3 ± 1.0	0.02

Patients who adhered to regular physiotherapy demonstrated significantly better functional recovery compared to those with irregular rehabilitation attendance. The mean IKDC score was notably higher among patients who followed structured rehabilitation protocols. Return to sports was also significantly more frequent in this group. Conversely, residual instability was more common among patients with poor rehabilitation compliance.

Table 13: Rehabilitation Compliance and Outcome

Variable	Regular Physio (n=42)	Irregular Physio (n=22)	p-value
Final IKDC	91.2 ± 5.2	85.3 ± 6.4	<0.001
Return to sports	34	12	0.01
Residual instability	2	5	0.02

Discussion

The present study evaluated the clinical stability and functional outcomes of anterior cruciate ligament (ACL) reconstruction combined with lateral extra-articular tenodesis (LET) in Bangladeshi patients. The findings demonstrated significant improvement in knee stability, functional scores, and pain reduction following surgery. A marked decrease in positive Lachman, pivot shift, and anterior drawer tests at final follow-up indicated effective restoration of knee stability. These findings are consistent with previous research suggesting that the addition of LET enhances rotational stability and improves overall surgical outcomes after ACL reconstruction (Helito et al., 2015).

In the present study, functional outcomes improved significantly over the follow-up period, as reflected by substantial increases in IKDC and Lysholm scores and a progressive improvement in Tegner activity levels. Similar improvements in functional outcomes following combined ACL reconstruction and LET have been reported in previous clinical studies (Bonanzinga et al., 2017). These improvements may be attributed to enhanced rotational control provided by LET, which reduces excessive tibial internal rotation and improves

joint biomechanics during movement (Kennedy et al., 2015).

Return to activity and sports participation is an important indicator of successful ACL reconstruction. In this study, the majority of patients were able to return to daily activities and occupational duties, while a substantial proportion resumed sports participation. These findings align with previous reports indicating that combined ACL reconstruction and lateral extra-articular procedures may facilitate a safe return to physical activity while minimizing the risk of graft failure (Monaco et al., 2014). Moreover, the relatively low complication rate observed in this study further supports the safety of the combined surgical approach.

Residual instability and graft failure were observed in a small number of patients, which is comparable to findings reported in other clinical studies (Alm et al., 2020). Factors such as delayed surgery, associated meniscal injury, and inadequate rehabilitation may contribute to less favorable outcomes. Previous studies have highlighted the importance of appropriate patient selection and postoperative rehabilitation in optimizing surgical success (Ferretti et al., 2016).

Despite the encouraging findings, several limitations should be considered. The study was conducted in a limited number of hospitals and included a relatively moderate sample size. In addition, the follow-up duration was limited to one year, which may not fully capture long-term complications such as graft failure or degenerative changes. Future multicenter studies with larger sample sizes and longer follow-up periods are recommended to further validate these findings. Nevertheless, the present study provides valuable insight into the effectiveness of ACL reconstruction combined with LET in the Bangladeshi population.

Conclusion:

Anterior cruciate ligament reconstruction combined with lateral extra-articular tenodesis demonstrated significant improvement in knee stability and functional outcomes in this study population. Postoperative clinical tests showed marked reduction in instability, while functional scores such as IKDC and Lysholm improved substantially during follow-up. Most patients were able to return to daily activities and a considerable proportion resumed

sports participation. The overall complication rate was low, indicating that the combined procedure is relatively safe. These findings suggest that the addition of LET may enhance rotational stability and improve surgical outcomes in selected ACL-injured patients. Further studies with larger sample sizes and longer follow-up periods are recommended to confirm these results.

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