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ORIGINAL ARTICLE

Peroneus Longus Tendon Autograft in ACL Reconstruction – Clinical and Biomechanical Outcomes

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ABSTRACT

Background: *Anterior cruciate ligament (ACL) reconstruction aims to restore knee stability and function. While hamstring and patellar tendon autografts are standard, the peroneus longus tendon (PLT) has emerged as a strong alternative due to its biomechanical strength and easy harvest.* ***Aim:*** *To evaluate clinical, functional, and biomechanical outcomes of ACL reconstruction using ipsilateral PLT autograft at 24-month follow-up.* ***Methods & Materials:*** *This prospective study included 18 patients with isolated ACL rupture who underwent arthroscopic single-bundle ACL reconstruction using PLT autograft. Stability was assessed using Lachman and pivot shift tests, and anterior tibial translation was measured with a KT-1000 arthrometer. Functional outcomes were evaluated with IKDC, Lysholm, Tegner, and Cincinnati scores and the single-leg hop test. Biomechanical parameters were compared with the contralateral ACL. Donor site morbidity and complications were noted.* ***Results:*** *At 24 months, stability and function improved markedly. Lachman and pivot shift positivity decreased from 100% to 5.6%. Anterior tibial translation reduced from 9.4 ± 2.0 mm to 2.2 ± 0.9 mm ($p < 0.001$). Functional scores improved significantly ($p < 0.001$), and hop performance increased from 72 ± 10% to 94 ± 5%. PLT grafts showed good stiffness, high load to failure, minimal elongation, and acceptable rotational stability, comparable to native ACL. Donor site morbidity was low (11%), with no graft ruptures.* ***Conclusion:*** *PLT autograft offers strong clinical, functional, and biomechanical results with minimal morbidity, supporting its use as an effective alternative for ACL reconstruction.*

Keywords: *Anterior cruciate ligament, ACL reconstruction, peroneus longus tendon, autograft, knee stability, biomechanics, functional outcomes.*

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INTRODUCTION

Anterior cruciate ligament reconstruction (ACLR) is a surgical procedure intended to restore knee stability by replacing the torn ligament with a graft. [1]. The global incidence rate of ACL injuries lies around 0.029–0.03% per year, though this varies by age, sex, and activity level [2]. In Bangladesh, data indicate that among athletic populations with knee injuries, a substantial proportion involve anterior cruciate ligament (ACL) injuries, with 42.5% of individuals reporting knee problems identified as having ACL involvement [3]. Anterior cruciate ligament injuries are among the most common and disabling knee ligament ruptures, often resulting in joint instability, pain, and impaired mobility. The peroneus longus tendon (PLT) has more recently emerged as a promising alternative autograft source. In the ACLR context, the PLT can be harvested often with tenodesis to the peroneus brevis distal stump and used as an intra-articular ligament substitute [4]. ACL tears generally occur via non-contact mechanisms or contact sports trauma. Risk factors include female sex, neuromuscular weakness, terrain/surface, fatigue, and prior knee injury. When reconstruction is undertaken, graft choice can influence outcomes [5]. One of the main advantages of using the peroneus longus tendon as an autograft for ACL reconstruction is its reliable biomechanical strength. The PLT consistently provides an adequate graft diameter, often greater than 8 mm, which is considered optimal for long-term stability and reduced risk of graft failure. This consistency overcomes a major limitation of hamstring autografts, where unpredictable graft size can compromise surgical outcomes [6]. Patients who undergo PLT harvest generally report less post-operative knee pain and less thigh muscle weakness, which contributes to faster recovery and improved early functional outcomes. The PLT preserves more local knee anatomy, potentially minimizing long-term complications around the knee. The patients regain good functional scores, achieve stable knees, and return to their daily activities with satisfaction comparable to traditional graft choices [7]. The most commonly cited concern is donor-site morbidity at the ankle. While most patients maintain normal ankle function after surgery, some may experience temporary weakness in eversion or first-ray plantarflexion, as well as mild

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pain or numbness at the harvest site. These symptoms are generally short-lived but may affect individuals engaged in activities that demand high ankle strength, such as elite athletes in sprinting or ballet [8]. Another disadvantage is the lack of robust long-term data. Although results up to two or three years after surgery are encouraging, few studies extend beyond five years, leaving questions about graft durability, late knee stability, and the risk of osteoarthritis unresolved. Technical challenges during harvest also pose a limitation, as the procedure requires meticulous technique to avoid injury to the superficial peroneal nerve and to maintain proper tenodesis with the peroneus brevis tendon [9]. The aim of this study was to evaluate the clinical and biomechanical outcomes of anterior cruciate ligament reconstruction using the peroneus longus tendon autograft, highlighting its potential advantages, limitations, and overall viability as an alternative to traditional graft options.

METHODS & MATERIALS

A prospective comparative study on 36 patients with isolated ACL injury was conducted in the Department of Orthopaedic Surgery, BSMMU, Dhaka, from September,2022 toSeptember,2024. A total of 18 patients who underwent primary anterior cruciate ligament (ACL) reconstruction using ipsilateral Peroneus Longus Tendon (PLT) autograft were included. Ethical approval was obtained from the Institutional Review Board, and all participants provided written informed consent prior to enrollment. The study adhered to the Declaration of Helsinki guidelines.

Inclusion and Exclusion Criteria

Inclusion criteria were:

1. Age between 18 and 40 years,
2. Isolated ACL rupture confirmed by clinical examination and magnetic resonance imaging (MRI),
3. Minimum follow-up of 24 months.

Exclusion criteria included:

1. Multiligament knee injury,
2. Revision ACL reconstruction,
3. Pre-existing ankle pathology or neurological deficit,
4. Contraindication to surgery or rehabilitation protocol compliance.

Surgical Technique

All procedures were performed by the same senior orthopedic surgeon using a standardized arthroscopically assisted single-bundle ACL reconstruction technique. The Peroneus Longus tendon was harvested through a small incision posterior to the lateral malleolus using an open tendon stripper. The distal slip to the base of the first metatarsal was preserved. After harvesting, the tendon was prepared to achieve a graft diameter of 8–9 mm, doubled over and whipstitched with No. 2 nonabsorbable sutures.

Femoral and tibial tunnels were drilled through the anteromedial portal technique, and the graft was fixed using bioabsorbable interference screws on both sides. Anatomic positioning of the graft was confirmed arthroscopically before final fixation. Wound closure was performed in layers, and sterile dressing was applied.

Postoperative Rehabilitation

All patients followed a standardized postoperative rehabilitation protocol. Immediate isometric quadriceps exercises and ankle pumps were initiated on postoperative day one. Partial weight-bearing with crutches was allowed after 2 weeks and full weight-bearing after 4 weeks. Jogging was permitted at 3 months, return to pivoting sports after 9–12 months, contingent on functional recovery and quadriceps strength symmetry.

Clinical and Functional Assessment

Clinical evaluation was performed preoperatively and at the 24-month follow-up. Knee stability was assessed using Lachman and Pivot shift tests, and anterior tibial translation was quantified with a KT-1000 arthrometer. Functional outcomes were evaluated using the International Knee Documentation Committee (IKDC) subjective score, Lysholm knee score, Cincinnati Knee Rating System, and Tegner activity scale. Performance was further quantified using the single-leg hop test, expressed as a percentage of the contralateral limb.

Biomechanical Evaluation

Biomechanical properties of the reconstructed ACL were analyzed intraoperatively and postoperatively at 24 months using an instrumented arthrometer and digital motion analysis. Parameters included graft stiffness (N/mm), ultimate load to failure (N), graft elongation at 500 N (mm), and rotational stability (°). Values were compared with the contralateral normal ACL as a reference.

Complication Assessment

Postoperative complications were recorded, including donor site morbidity (ankle weakness or numbness), infection, knee stiffness requiring manipulation, and graft rupture. Ankle function was evaluated using the American Orthopaedic Foot and Ankle Society (AOFAS) scoring system to monitor donor site integrity.

Statistical Analysis

Data were analyzed using SPSS software (version 26.0, IBM Corp., Armonk, NY, USA). Quantitative variables were expressed as mean ± standard deviation (SD) or median (interquartile range, IQR) where appropriate. Categorical variables were presented as frequencies and percentages. Comparisons between preoperative and postoperative values were performed using the paired Student's t-test. A p-value < 0.05 was considered statistically significant.

RESULT

As shown in Table I the mean age of the study population was 27.39 ± 5.17 years, with a predominance of males 72.22%. The mean body mass index (BMI) was 24.32 ± 1.77 kg/m^2. ACL reconstruction was performed on the right knee in 10 patients 55.56% and on the left in 8 patients 44.44%. The median time interval between injury and surgery was 5 months where interquartile range: 3–7 months. The mean preoperative Tegner activity score was 5.1 ± 1.2. The mechanism of injury is illustrated showing that most injuries occurred during sports activities (55.56%), followed by road traffic accidents (38.89%) and domestic accidents (5.56%) (Figure 1). The proportion of patients with a positive Lachman test decreased from 100% preoperatively to 5.56% postoperatively ($p < 0.001$). Similarly, the pivot shift test was positive in all patients preoperatively but in only one patient (5.56%) after surgery ($p < 0.001$). The mean anterior tibial translation improved markedly from 9.4 ± 2.0 mm to 2.2 ± 0.9 mm ($p < 0.001$). Functional scores also showed substantial enhancement, with the mean IKDC subjective score increasing from 47.9 ± 6.8 to 88.5 ± 5.9 and the Lysholm score improving from 51.2 ± 7.5 to 91.7 ± 6.1 (both $p < 0.001$) (Table II). Table III illustrates the mean Tegner activity score increased from 5.1 ± 1.2 preoperatively to 7.6 ± 1.1 postoperatively. The Cincinnati

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Knee Rating System score improved markedly from 54.8 ± 6.1 to 89.3 ± 5.5. The single-leg hop distance also increased substantially, from 72 ± 10 to 94 ± 5 of the contralateral limb ($p < 0.001$) (Table III). The reconstructed ACL had comparable properties to the contralateral native ligament, with slight but significant differences in stiffness ($p = 0.02$), ultimate load to failure ($p = 0.03$), elongation ($p = 0.04$), and rotational stability ($p = 0.05$) (Table IV). Postoperative complications were minimal, including donor site morbidity in 2 patients 11.11%, superficial infection in 1 patient 5.56%, and knee stiffness requiring manipulation in 1 patient 5.56%, resulting in an overall complication rate of 22.22% (Table V).

Table – I: Baseline demographic and clinical characteristics of the study population (*n*=18)

Variables	Frequency (n)	Percentage (%)
Age (years)		
Mean ± SD	27.39 ±5.17	
Gender		
Male	13	72.22
Female	5	27.78
BMI (kg/m²)		
Mean ± SD	24.32 ±1.77	
Side of ACL reconstruction		
Right	10	55.56
Left	8	44.44
Time from injury to surgery (months)		
median (IQR)	5 (3–7)	
Preoperative Tegner activity score		
Mean ± SD	5.1 ± 1.2	

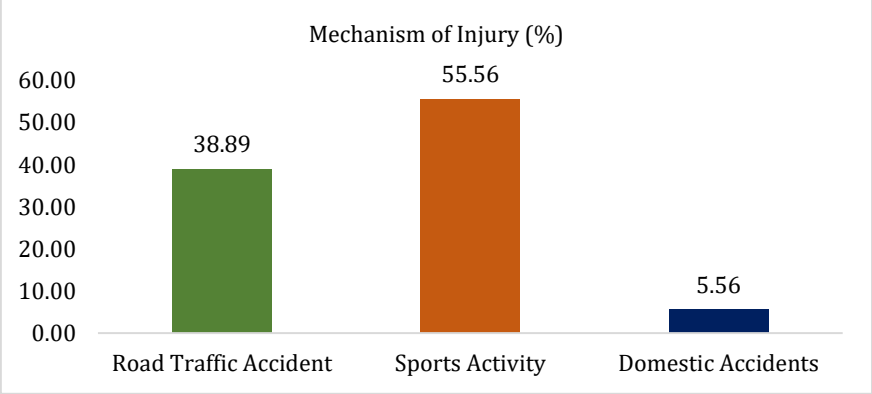

Figure – 1: Mechanism of injury among patients undergoing ACL reconstruction with Peroneus Longus tendon autograft

Table – II: Clinical outcomes at 24-month follow-up

Outcome Measure	Preoperative	Postoperative	p-value*
Lachman test positive, n (%)	18 (100.00)	1 (5.56)	<0.001
Pivot shift test positive, n (%)	18 (100.00)	1 (5.56)	<0.001
Anterior tibial translation (mm), mean ± SD	9.4 ± 2.0	2.2 ± 0.9	<0.001
IKDC subjective score, mean ± SD	47.9 ± 6.8	88.5 ± 5.9	<0.001
Lysholm score, mean ± SD	51.2 ± 7.5	91.7 ± 6.1	<0.001

Table – III: Improvement in functional performance and activity scores at 24-month follow-up after ACL reconstruction using peroneus longus tendon autograft

Score/Scale	Preoperative	Postoperative	Mean Change ± SD	p-value*
Tegner activity score	5.1 ± 1.2	7.6 ± 1.1	2.5 ± 0.7	<0.001
Cincinnati Knee Rating System	54.8 ± 6.1	89.3 ± 5.5	34.5 ± 5.8	<0.001
Single-leg hop distance (% of contralateral)	72 ± 10	94 ± 5	22 ± 8	<0.001

Table – IV: Biomechanical properties of reconstructed ACL

Parameter	Reconstructed ACL (Mean ± SD)	Normal Contralateral ACL Reference	p-value*
Graft stiffness (N/mm)	315 ± 28	340 ± 25	0.02
Ultimate load to failure (N)	2050 ± 150	2250 ± 140	0.03
Graft elongation at 500 N (mm)	4.3 ± 0.5	3.9 ± 0.4	0.04
Rotational stability (°)	3.6 ± 1.0	3.0 ± 0.8	0.05

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Table – V: Postoperative complications

Complication	Frequency (n)	Percentage (%)
Donor site morbidity (ankle weakness, numbness)	2	11.11
Graft rupture	0	0.00
Infection	1	5.56
Knee stiffness requiring manipulation	1	5.56
Overall complication rate	4	22.22

DISCUSSION

Anterior cruciate ligament (ACL) injuries remain a significant concern in orthopedic practice due to their impact on knee stability and long-term joint health [10]. While autografts from the hamstring tendons and patellar tendon have been standard choices for ACL reconstruction, there is growing interest in alternative grafts that may offer comparable or superior outcomes [11]. The peroneus longus tendon (PLT), a robust and readily accessible tendon, has emerged as a promising candidate for ACL reconstruction [12]. In the present study of 18 patients who underwent arthroscopic anterior cruciate ligament reconstruction (ACLR) with peroneus longus tendon (PLT) autograft, we observed marked and clinically meaningful improvements in objective stability, patient-reported outcomes and functional performance at 24 months. Lachman and pivot-shift positivity fell from 100% preoperatively to 5.6% at final follow-up, anterior tibial translation improved from 9.4 ± 2.0 mm to 2.2 ± 0.9 mm, and IKDC and Lysholm scores increased by 40.6 and 40.5 points, respectively (all $p < 0.001$). Functional indices (Tegner, Cincinnati, single-leg hop) likewise showed substantial recovery. These findings indicate that PLT autograft can reliably restore knee stability and function in the short-to-midterm, with a low incidence of major complications. These findings are consistent with previous reports in the literature. Velayudham et al. observed significant improvement in IKDC scores from 65.8 preoperatively to 92.6 postoperatively in patients undergoing PLT autograft ACL reconstruction, alongside marked improvement in Lysholm scores, with minimal donor site morbidity [13]. Similarly, Opoku et al., in a systematic review and meta-analysis, concluded that PLT autografts provide comparable functional outcomes to hamstring tendon grafts, with reduced donor-site complications [14]. Biomechanically, the reconstructed grafts in our study approximated—but did not fully equal—contralateral native ACL properties: graft stiffness and ultimate load were modestly lower (315 ± 28 N/mm and 2050 ± 150 N vs contralateral references; $p = 0.02$ and 0.03). This small deficit likely reflects biologic remodelling and incorporation rather than an intrinsic mechanical shortcoming of the PLT. Several cadaveric and tensile-testing studies report that PLT has substantial tensile strength and stiffness comparable to hamstring graft constructs and sufficient load capacity for ACL function, supporting the plausibility of our in vivo mechanical findings [15]. Importantly, the modest differences observed did not translate into clinical instability or graft failure within the 24-month window; no graft ruptures were recorded in our study. In our study, biomechanical analysis demonstrated that the peroneus longus tendon (PLT) autograft exhibited a graft stiffness of 315 N/mm, an ultimate load to failure of 2050 N, elongation at 500 N of 4.3 mm, and rotational stability of 3.6°. These parameters are comparable to those reported for the native anterior cruciate ligament (ACL) and indicate that the PLT possesses sufficient strength and stiffness to function effectively as an ACL substitute. Our biomechanical findings are in close agreement with those of previous experimental and clinical investigations. Abdelkader et al. (2023) reported an ultimate tensile strength of the PLT graft ranging from 2122 N to 2483 N, which is comparable to the native ACL (approximately 2160 N) [16]. Similarly, Saeed et al. (2023) demonstrated that a doubled PLT graft had an ultimate load of 4268 ± 285 N, significantly exceeding that of the hamstring tendon graft and comparable to the patellar tendon [17]. In another biomechanical comparison, Rhatomyet al. (2021) observed that the PLT graft exhibited greater tensile strength and lower displacement under loading than the hamstring graft, further confirming its superior load-bearing capability [18]. The stiffness recorded in the present study (315 N/mm) also aligns closely with or exceeds the reported stiffness of the native ACL (242 N/mm) and previously tested PLT grafts [19]. A principal concern with PLT harvest is potential donor-site morbidity related to peroneal function and first-ray support. In our series donor-site complaints were infrequent (11.1% reporting transient ankle weakness or numbness) and no major ankle instability events were observed. This low morbidity aligns with recent systematic and comparative reports that document minimal clinically meaningful ankle dysfunction after PLT harvest when careful surgical technique and rehabilitation are employed [20].

Limitations of the study: This study is limited by its single-center design and relatively small sample size, which may affect the generalizability of the findings. The absence of a comparative control group using alternative autografts restricts direct assessment of relative efficacy. Additionally, follow-up was limited to 24 months, precluding evaluation of long-term graft durability and potential degenerative changes. Future multicenter, randomized studies with extended follow-up are warranted to validate these results.

CONCLUSION AND RECOMMENDATIONS

The present study demonstrates that anterior cruciate ligament reconstruction using ipsilateral peroneus longus tendon autograft yields excellent clinical, functional, and biomechanical outcomes at 24 months postoperatively. Patients experienced significant improvements in knee stability, objective functional scores, and return-to-activity measures, with graft properties closely approximating the native ACL. Importantly, donor site morbidity was minimal, and no graft ruptures occurred, highlighting the safety and reliability of this technique. These findings support the peroneus longus tendon as a viable alternative to traditional autografts, offering an effective option for ACL reconstruction with favorable long-term knee function and structural integrity.

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