Section: Orthopaedics

Original Research Article

FUNCTIONAL OUTCOMES AND DONOR-SITE MORBIDITY FOLLOWING ARTHROSCOPIC ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION USING PERONEUS LONGUS VERSUS HAMSTRING TENDON AUTOGRAFTS: A QUASI-EXPERIMENTAL COMPARATIVE STUDY

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Received *: 24/04/2026*
Received in revised form *: 30/05/2026*
Accepted *: 15/06/2026*

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DOI: 10.70034/ijmedph.2026.2.709

Source of Support: Nil,
Conflict of Interest: None declared

Int J Med Pub Health
2026; 16 (2); 4307-4312

ABSTRACT

Background: Anterior cruciate ligament (ACL) reconstruction is the standard treatment for symptomatic ACL deficiency. Hamstring tendon autografts are widely used; however, concerns regarding graft diameter variability and donor-site morbidity have prompted investigation of alternative autograft options such as the peroneus longus tendon. **Objectives:** To compare functional outcomes, graft characteristics, and donor-site morbidity between hamstring tendon and peroneus longus tendon autografts used in arthroscopic ACL reconstruction.
Materials and Methods: This hospital-based quasi-experimental comparative study included 60 patients with isolated ACL tears who underwent arthroscopic single-bundle ACL reconstruction using either hamstring tendon autografts (n = 30) or peroneus longus tendon autografts (n = 30). Functional outcomes were assessed using the International Knee Documentation Committee (IKDC) score and Lysholm Knee Score preoperatively and at 1, 3, and 6 months postoperatively. Donor-site morbidity in the peroneus longus group was evaluated using the Foot and Ankle Disability Index (FADI). Graft dimensions were recorded intraoperatively.
Results: Both groups demonstrated significant postoperative improvement. Patients in the peroneus longus group achieved significantly higher IKDC and Lysholm scores at all postoperative follow-up intervals ($p < 0.05$). Peroneus longus grafts demonstrated significantly greater tibial and femoral graft diameters, whereas hamstring grafts were longer. FADI scores showed an initial decline at one month followed by progressive recovery, indicating minimal long-term donor-site morbidity.
Conclusion: Peroneus longus tendon autografts provided superior early functional outcomes, larger graft diameters, and minimal donor-site morbidity during short-term follow-up. These findings support the peroneus longus tendon as a safe and effective alternative autograft for ACL reconstruction.
Keywords: Anterior cruciate ligament reconstruction; Peroneus longus tendon; Hamstring tendon; Functional outcome; Donor-site morbidity.

INTRODUCTION

Anterior cruciate ligament (ACL) injury is among the most common causes of knee instability in young and physically active individuals. Persistent ACL deficiency may result in recurrent episodes of giving way, impaired athletic performance, meniscal injury, chondral degeneration, and the subsequent development of early osteoarthritis. Consequently, arthroscopic ACL reconstruction has become the

preferred treatment for restoring knee stability and function in symptomatic patients.[1]

Selection of an appropriate graft remains one of the most important determinants of successful ACL reconstruction. An ideal graft should possess adequate biomechanical strength, allow secure fixation, demonstrate reliable incorporation, and cause minimal donor-site morbidity. Hamstring tendon autografts have gained widespread acceptance because of their favorable tensile strength, ease of harvest, and lower incidence of anterior knee pain compared with bone–patellar tendon–bone grafts.[2] However, hamstring grafts are associated with certain limitations, including variability in graft diameter, postoperative hamstring weakness, thigh muscle atrophy, and donor-site morbidity, which may influence postoperative rehabilitation and functional recovery.[3]

The peroneus longus tendon has emerged as a potential alternative autograft in recent years. Biomechanical studies have demonstrated that the tendon possesses sufficient strength and structural characteristics to function effectively as an ACL graft. Furthermore, harvesting the peroneus longus tendon is technically straightforward and is believed to have minimal impact on ankle function because of compensatory action by the peroneus brevis tendon.[4] Several clinical studies have reported favorable functional outcomes and low donor-site morbidity following ACL reconstruction using peroneus longus tendon autografts.[5]

Despite increasing interest in the use of the peroneus longus tendon, comparative evidence remains limited, particularly in the Indian population. Although previous studies have reported satisfactory outcomes with both hamstring and peroneus longus tendon grafts, differences in functional recovery, graft characteristics, and donor-site morbidity continue to be subjects of investigation. Additional comparative studies are required to further clarify the role of the peroneus longus tendon in routine clinical practice.

The present study was undertaken to compare functional outcomes, graft dimensions, and donor-site morbidity between hamstring tendon and peroneus longus tendon autografts in patients undergoing arthroscopic ACL reconstruction.

MATERIALS AND METHODS

Study Design and Setting

This hospital-based quasi-experimental comparative study was conducted in the Department of Orthopaedics, PES Institute of Medical Sciences and Research (PESIMSR), Kuppam, over a period of 18 months. The study included patients presenting to the orthopaedic outpatient and emergency departments with isolated anterior cruciate ligament injuries requiring surgical reconstruction.

Study Population

A total of 60 patients diagnosed with isolated anterior cruciate ligament (ACL) tears and planned for arthroscopic ACL reconstruction were included in the study.

Sample size calculation

The sample size was calculated for comparison of mean functional outcome scores between the two graft groups. Assuming a mean difference of 8.25, a common standard deviation of 9.435, a two-sided alpha error of 5%, and a study power of 80%, the minimum required sample size was estimated to be 20 participants in each group. To enhance statistical precision and account for potential loss to follow-up, 30 patients were recruited in each group, resulting in a total sample size of 60 participants.

Inclusion Criteria

- Patients aged 18 years and above
- Clinically and radiologically confirmed isolated ACL tear
- Patients willing to undergo surgical reconstruction and provide informed consent

Exclusion Criteria

- Multiligament knee injuries
- Associated fractures around the knee
- Previous surgery on the affected knee
- Inflammatory arthritis or septic arthritis
- Neuromuscular disorders affecting lower limb function

Sampling method

Participants were recruited using a purposive sampling technique. Eligible patients who fulfilled the inclusion criteria and provided written informed consent were enrolled consecutively until the required sample size was achieved.

Study Groups

Patients were allocated into two equal groups (n = 30 each) based on graft selection after preoperative evaluation and discussion between the operating surgeon and the patient. Allocation was therefore non-randomized, consistent with the quasi-experimental design of the study.

- **Group A:** Hamstring tendon autograft (n = 30)
- **Group B:** Peroneus longus tendon autograft (n = 30)

All procedures were performed by the same surgical team using standardized operative techniques and postoperative rehabilitation protocols to minimize procedural variability.

Data collection procedure

All patients underwent detailed clinical evaluation, including history taking, physical examination, and radiological assessment. Clinical examination included Lachman test, anterior drawer test, and pivot shift test. Following preoperative counselling and anaesthetic evaluation, patients underwent arthroscopic anterior cruciate ligament reconstruction using either hamstring tendon or peroneus longus tendon autografts. The choice of graft was determined after discussion between the operating surgeon and the patient.

All procedures were performed by the same surgical team using standardized operative techniques. Intraoperative parameters including graft length and graft diameter at the tibial and femoral ends were recorded. Postoperatively, all patients followed a uniform rehabilitation protocol emphasizing early mobilization, progressive weight bearing, restoration of range of motion, and muscle strengthening exercises.

Patients were reviewed at one, three, and six months following surgery. Functional outcomes were assessed using the International Knee Documentation Committee (IKDC) score and the Lysholm Knee Scoring Scale. Donor-site morbidity among patients undergoing peroneus longus tendon harvest was evaluated using the Foot and Ankle Disability Index (FADI).

Surgical Technique

All patients underwent arthroscopic single-bundle ACL reconstruction under spinal anesthesia by the same surgical team to minimize operator bias. Standard anterolateral and anteromedial portals were used. Graft fixation on the femoral and tibial sides was performed using standardized fixation devices as per institutional protocol.

Intraoperatively, graft length and graft diameter at both tibial and femoral ends were measured and recorded.

Postoperative Rehabilitation

All patients followed a uniform postoperative rehabilitation protocol, which included early range-of-motion exercises, progressive weight-bearing, quadriceps strengthening, and gradual return to functional activities as tolerated.

Outcome Measures

Functional outcomes were assessed using validated scoring systems:

- International Knee Documentation Committee (IKDC) score
- Lysholm Knee Scoring Scale

Assessments were performed:

- Preoperatively
- At 1 month, 3 months, and 6 months postoperatively

Donor-site morbidity in patients undergoing peroneus longus tendon harvest was evaluated using the Foot and Ankle Disability Index (FADI) at the same follow-up intervals.

Statistical Analysis

Data were entered into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS) version 23.0. Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages.

Baseline demographic characteristics and graft-related variables were compared using the independent Student's t-test for continuous variables and the Chi-square test for categorical variables. Functional outcome scores were analysed at predefined follow-up intervals. Intergroup comparisons were performed using the independent Student's t-test, while changes in donor-site function within the peroneus longus group were assessed using paired comparisons. A p-value less than 0.05 was considered statistically significant.

Ethical Considerations

The study was approved by the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrollment.

RESULTS

Table 1: Baseline Characteristics and Graft-Related Variables

	Group	Hamstring Graft	Peroneus Longus Graft	Chi-sq	p-value
Age	< 21	1	2	1.5905	0.662
	21–30	16	19		
	31–40	10	6		
	41–50	3	3		
Gender	Female	8	10	0.3175	0.573
	Male	22	20		
Side of Injury	Left (L)	17	9	4.343	0.037*
	Right (R)	13	21		
Mode of Injury	Road Traffic Accident	14	15	0.082	0.960
	Self-Fall	5	5		
	Sports Injury	11	10		
Graft related variables	Tibial Thickness (mm)	7.50 ± 0.51	8.53 ± 0.51	-7.878	< 0.001
	Femoral Thickness (mm)	7.37 ± 0.49	8.43 ± 0.50	-8.310	< 0.001
	Graft Length (cm)	28.33 ± 1.58	25.80 ± 1.61	6.153	< 0.001

***P<0.05 is statistically significant; **P<0.01 is statistically highly significant**

The baseline demographic characteristics, including age distribution, gender, and mode of injury, were comparable between the hamstring graft group and the peroneus longus graft group, with no statistically significant differences observed. This indicates adequate baseline homogeneity between the two groups, minimizing selection bias and allowing meaningful comparison of postoperative outcomes.

A statistically significant difference was noted with respect to the side of injury, with a higher proportion

of right-sided injuries observed in the peroneus longus graft group. However, this variable is unlikely to have influenced functional outcomes, as laterality has not been shown to affect graft performance or postoperative recovery.

Assessment of graft-related variables revealed significant differences between the two graft types. The peroneus longus graft demonstrated significantly greater tibial and femoral graft diameters compared to the hamstring graft, whereas the hamstring graft exhibited significantly greater overall graft length. The larger graft diameter observed with the peroneus longus tendon may have biomechanical relevance and could contribute to improved postoperative knee stability.

Table 2: Functional Outcomes Based on IKDC Scores

Follow-up Interval	Graft Used	Mean IKDC Score	SD	t-value	p-value
Pre-operative	Hamstring	42.50	4.90	-0.815	0.418
	Peroneus Longus	43.53	4.92		
1 Month	Hamstring	53.60	4.65	-3.33	0.0015**
	Peroneus Longus	57.50	4.42		
3 Months	Hamstring	67.27	5.25	-6.65	<0.0001
	Peroneus Longus	75.97	4.88		
6 Months	Hamstring	80.53	2.87	-11.81	<0.0001
	Peroneus Longus	89.93	3.28		
***P<0.05 is statistically significant; **P<0.01 is statistically highly significant**					

Preoperative IKDC scores were comparable between the two groups, indicating similar baseline knee function prior to surgical intervention. Postoperatively, both graft groups showed progressive improvement in IKDC scores across all follow-up intervals, reflecting successful restoration of knee function following arthroscopic ACL reconstruction.

However, patients reconstructed using the peroneus longus tendon consistently demonstrated significantly higher IKDC scores at 1 month, 3 months, and 6 months postoperatively compared to those receiving hamstring tendon grafts. The magnitude of intergroup difference increased with time, suggesting not only faster recovery but also superior mid-term functional outcomes in the peroneus longus graft group.

Table 3: Functional Outcomes Based on Lysholm Knee Scores

Follow-up Interval	Graft Used	Mean Lysholm Score	SD	t-value	p-value
Pre-operative	Hamstring	47.37	4.43	0.997	0.323
	Peroneus Longus	46.17	4.89		
1 Month	Hamstring	60.93	3.18	-5.33	<0.0001
	Peroneus Longus	64.97	2.66		
3 Months	Hamstring	75.63	2.97	-12.12	<0.0001
	Peroneus Longus	84.67	2.81		
6 Months	Hamstring	89.30	2.25	-10.84	<0.0001
	Peroneus Longus	95.40	2.11		
***P<0.05 is statistically significant; **P<0.01 is statistically highly significant**					

Similar to IKDC outcomes, preoperative Lysholm scores did not differ significantly between the two groups, confirming baseline comparability. Postoperative evaluation demonstrated significant improvement in Lysholm scores in both groups, indicating overall effectiveness of ACL reconstruction.

Nevertheless, the peroneus longus graft group exhibited significantly higher Lysholm scores at all postoperative follow-up intervals when compared with the hamstring graft group. These findings suggest better subjective knee function, improved stability, and enhanced ability to perform daily and sporting activities among patients receiving the peroneus longus tendon graft.

Table 4: Donor-Site Morbidity Assessment Using FADI Scores

Comparison Interval	Time Point	Mean FADI Score	SD	t-value	p-value
Pre-op vs 1 Month	Pre-operative	91.60	4.11	7.12	<0.0001
	1 Month	84.73	2.77		
1 Month vs 3 Months	1 Month	84.73	2.77	-12.28	<0.0001
	3 Months	92.33	2.22		
3 Months vs 6 Months	3 Months	92.33	2.22	-9.46	<0.0001
	6 Months	97.60	2.16		
***P<0.05 is statistically significant; **P<0.01 is statistically highly significant**					

Evaluation of donor-site morbidity in the peroneus longus graft group using the Foot and Ankle Disability Index revealed a significant but transient reduction in ankle function at the 1-month

postoperative follow-up. This early decline likely reflects postoperative pain and temporary functional limitation following tendon harvest.

Subsequent assessments demonstrated significant improvement in FADI scores at 3 months and further improvement at 6 months, with scores exceeding preoperative levels by the final follow-up. These findings indicate excellent recovery of ankle function and minimal long-term donor-site morbidity associated with peroneus longus tendon harvest.

In addition to demonstrating statistically significant improvements in postoperative functional scores, the findings suggest that patients receiving peroneus longus tendon autografts experienced faster recovery and superior early functional restoration compared with those receiving hamstring tendon grafts. The larger graft diameter observed in the peroneus longus group may have contributed to improved biomechanical stability and enhanced functional outcomes during the rehabilitation period.

DISCUSSION

The present study compared functional outcomes, graft characteristics, and donor-site morbidity following arthroscopic ACL reconstruction using hamstring tendon (HT) and peroneus longus tendon (PLT) autografts. Both grafts resulted in significant postoperative improvement; however, patients reconstructed with PLT autografts demonstrated superior functional outcomes throughout the six-month follow-up period.

Baseline demographic characteristics and preoperative functional scores were comparable between groups, indicating adequate baseline homogeneity. This minimizes the influence of confounding factors and strengthens the validity of postoperative comparisons.

A notable finding of the present study was the significantly larger graft diameter obtained with PLT autografts. Previous biomechanical and clinical investigations have suggested that larger graft diameters may provide greater tensile strength and improved resistance to graft failure. Keyhani et al. reported significantly larger graft diameters in patients undergoing ACL reconstruction with PLT grafts while maintaining satisfactory functional outcomes. Similarly, Rhatomy et al. observed that PLT autografts consistently provided greater graft thickness than hamstring grafts, potentially contributing to improved graft biomechanics. The larger tibial and femoral graft diameters observed in our study may therefore have contributed to the superior postoperative functional outcomes demonstrated in the PLT group.

Functional recovery assessed using IKDC and Lysholm scoring systems improved significantly in both groups following reconstruction. However, patients receiving PLT grafts consistently achieved significantly higher scores at one, three, and six months postoperatively. These findings suggest more rapid restoration of knee stability and earlier return to functional activities among patients undergoing reconstruction with PLT autografts.

Several previous studies have compared PLT and HT autografts in ACL reconstruction. Keyhani et al. demonstrated comparable long-term functional outcomes between the two grafts while highlighting the structural advantages of the PLT graft. Likewise, Rhatomy et al. reported similar knee stability and patient-reported outcomes between PLT and HT grafts, concluding that PLT represents a viable alternative autograft option. Agarwal et al. also observed equivalent clinical outcomes with favorable graft dimensions in the PLT group. Our findings are consistent with these studies regarding graft characteristics but additionally demonstrate significantly better early and mid-term functional recovery in the PLT group.

More recent evidence supports these observations. Bilal et al. reported superior postoperative functional scores and excellent patient satisfaction among individuals receiving PLT autografts. Similarly, Dwidmuthe et al., in a randomized comparative study, demonstrated better early functional recovery and comparable graft safety profiles with PLT reconstruction. Furthermore, the systematic review and meta-analysis conducted by He et al. concluded that PLT grafts provide outcomes comparable or superior to hamstring grafts while maintaining low donor-site morbidity. Park et al., in their meta-analysis of randomized controlled trials, also reported favorable functional outcomes and reduced donor-site complications associated with PLT autografts. The findings of the present study further strengthen this growing body of evidence supporting PLT as an effective graft choice for ACL reconstruction.

An important concern regarding PLT harvest is potential impairment of ankle function. In the present study, donor-site morbidity assessed using the Foot and Ankle Disability Index demonstrated a transient reduction in ankle function during the early postoperative period, followed by progressive recovery. By six months, FADI scores exceeded preoperative values, indicating excellent adaptation and minimal long-term functional compromise. Similar findings were reported by Budhiparama et al., who emphasized preservation of ankle biomechanics following PLT harvest due to compensatory action of the peroneus brevis tendon. Rhatomy et al. likewise demonstrated negligible long-term ankle dysfunction following PLT harvest, supporting its safety profile.

The present study contributes to the growing evidence supporting the use of peroneus longus tendon autografts in ACL reconstruction, particularly within the Indian population where comparative clinical data remain relatively limited. Unlike several earlier studies by Keyhani et al., Rhatomy et al., and Agarwal et al., which primarily reported equivalent outcomes between grafts, our findings demonstrated significantly better early and mid-term functional recovery in the PLT group. The combination of larger graft diameter and minimal donor-site morbidity

further supports the feasibility of PLT autografts as an effective alternative to hamstring tendon grafts in routine clinical practice.

The findings of this study should be interpreted in light of certain limitations. First, the study was conducted at a single tertiary care centre with a relatively modest sample size, which may limit the generalisability of the findings. Second, the quasi-experimental design and non-randomized allocation of graft type introduce the possibility of selection bias. Third, follow-up was limited to six months and therefore did not permit assessment of long-term graft survival, return-to-sport rates, graft rupture, or degenerative changes. Fourth, objective measurements of knee laxity using instrumented testing and imaging-based assessment of graft incorporation were not performed. Finally, repeated outcome assessments were analysed using interval-wise comparisons rather than repeated-measures modelling, which may have limited the ability to evaluate longitudinal trends comprehensively. Future multicentric randomized controlled trials with larger sample sizes and longer follow-up durations are required to validate these findings.

The findings of the present study suggest that peroneus longus tendon autografts may provide advantages during the early postoperative rehabilitation period owing to larger graft diameter and favorable functional recovery. The minimal donor-site morbidity observed further supports its use as a practical alternative to hamstring tendon autografts in appropriately selected patients.

CONCLUSION

Both hamstring tendon and peroneus longus tendon autografts resulted in substantial functional improvement following arthroscopic anterior cruciate ligament reconstruction. Patients receiving peroneus longus tendon autografts demonstrated superior short-term functional outcomes, larger graft diameters, and minimal donor-site morbidity during the six-month follow-up period. Although a transient decline in ankle function was observed following tendon harvest, recovery was progressive and complete by the final follow-up assessment. These findings suggest that the peroneus longus tendon is a safe and effective alternative autograft for ACL reconstruction. Nevertheless, larger randomized studies with extended follow-up are required before definitive conclusions regarding graft superiority can be established.

Declarations: Ethics Approval and Consent to Participate: Approved by the Institutional Ethics Committee, PES Institute of Medical Sciences and Research, Kuppam.

Consent: Written informed consent was obtained from all participants.

Funding: The authors received no specific funding for this work.

Conflict of Interest: The authors declare no conflict of interest.

Availability of Data: The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

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