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COMPARISON OF OUTCOMES BETWEEN HAMSTRING TENDON GRAFT VERSUS PERONEUS LONGUS TENDON GRAFT IN ANTERIOR CRUCIATE LIGAMENT (ACL) RECONSTRUCTION

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ABSTRACT
Background: Anterior Cruciate Ligament (ACL) reconstruction is one of the most common orthopaedic surgeries carried out around the world. Although HT autograft has been the preferred method for a long time, donor site morbidity has prompted a quest for alternatives. The PLT autograft is regarded as a new, promising technique for its biomechanical benefits.
Objective: To compare postoperative functional outcomes and knee stability between HT and PLT autografts in primary ACL reconstruction.
Methodology: An non- randomized comparative study was done at Ghurki Trust Teaching Hospital, Lahore, during January 2026 to May 2026. Ninety-six patients (48 in each group) between the ages of 20 and 45 years who had suffered from ACL injuries were selected using a sequential sampling method. Functional assessment was done after 3 months using the Lysholm Knee Score System, while knee joint stability was measured using the Lachman test.
Results: For the PLT group, a significant increase was observed in the mean postoperative Lysholm score (96.2±2.4 vs. 93.8±3.6; $p = 0.0002$), and there was an increased number of patients presenting Grade 0 Lachman findings (95.8% vs. 81.3%; $p = 0.02$). There was a lower rate of complications reported for the PLT group (4.2% vs. 14.6%), though not statistically significant ($p=0.08$). Stratified analyses confirmed consistent superiority of PLT across all subgroups.
Conclusion: PLT autograft demonstrates better functional results and joint stability when compared to HT autograft for primary anterior cruciate ligament reconstruction surgery. This evidence suggests that PLT is an ideal option for a primary graft choice, especially in cases where hamstrings need to be conserved.

KEYWORDS: Anterior cruciate ligament reconstruction (ACLR); Peroneus longus tendon (PLT); Hamstring tendon (HT); Lysholm score; Lachman test; Graft selection

INTRODUCTION
The most frequent ligament injury to the knee joint is to the anterior cruciate ligament (ACL), so its satisfactory re-injury is crucial. It is common practice to treat ACL deficiencies by anterior cruciate ligament reconstruction (ACLR) by means of the patient's own tendon (autograft).[1]
ACL reconstruction is a common orthopedic surgery that is conducted to restore knee stability and function in case of ligament trauma. The hamstring tendon (HT) autograft has long been the graft of choice because of its favourable biomechanical and clinical results. The issues of donor site morbidity, including thigh hypotrophy and knee pains, have, however, raised the issue of seeking alternative sources of grafts. Peroneus longus tendon (PLT) autograft is a recently discovered, promising graft with some of the possible benefits of graft diameter, harvest time, and fewer complications at the donor site. It is shallow in the posterior part of the distal leg, and it is easily harvestable. The

major roles played by PL are the plantar flexion of the ankle, eversion of the sole, transverse maintenance, and stabilization of the leg on the foot. [2,3]

Although PL has previously been used as a cause for autologous tendon grafts, its adverse effects have not been thoroughly studied. The taken PL was found to have no effect on walking or ankle stability. According to recent biomechanical assessments of complete PL grafts' characteristics, their strength and stiffness are comparable to those of knee ACL reconstruction. [2,3]

Recent comparative and meta-analytical studies have shown that the functional outcomes of both HT and PLT autografts in terms of Lysholm scores and knee stability are similar in both short- and mid-term follow-ups. [4-10] It is worth noting here that PLT autografts usually can offer a much wider graft diameter and shorter harvest duration, which can lead to better graft strength and surgical efficiency. [4,7–9] Also, there is less atrophy of thigh muscles in relation to harvesting of the PLT in comparison to HT and reduced rates of donor site morbidity. [4,5,7,9] Some literature indicates a quicker recovery from sports and rehabilitation in patients who have received PLT grafts [7,10]

Despite these encouraging findings, the long-term equivalence of PLT and HT autografts, particularly regarding graft survival and late complications, requires further investigation. PLT is a safe and efficient substitute for HT in ACL reconstruction, according to available data, especially in cases where hamstring harvest is contraindicated or when minimizing knee donor site morbidity is a priority. [4–9]

Agarwal et al. conducted a similar study, and the findings indicate that the mean Lysholm score in the Peroneus longus graft group was 97.00±0.00 and in the Hamstring tendon graft group was 96.35±1.60. [1]

Given the increasing demand for optimal functional recovery and reduced donor site morbidity in ACL reconstruction, a comparative evaluation of HT and PLT autografts is essential. This comparison will inform graft selection, enhance patient outcomes, and expand the repertoire of autograft options for individualized surgical planning. The study aimed to compare the Outcomes between the hamstring tendon (HT) graft versus the peroneus longus tendon (PLT) graft in anterior cruciate ligament (ACL) reconstruction in terms of functional outcome and knee stability.

MATERIALS AND METHODS

A Non-randomized Trial was conducted at the Department of Orthopaedic and Spine Centre, Ghurki Trust Teaching Hospital (GTTH), Lahore, after obtaining approval from the Institutional Ethical Review Board over the period from January 2026 to May 2026. The sample size was calculated using a 95% confidence interval and 80% power of the test, considering a mean Lysholm score of 97.00 ± 0.00 in the Peroneus Longus Tendon (PLT) graft group and 96.35 ± 1.60 in the Hamstring Tendon (HT) graft group, resulting in a total sample of 96 patients, with 48 participants in each group. A non-probability consecutive sampling technique was employed for patient recruitment.[1]

Patients between 20 and 45 years of age of any gender suffering from isolated ACL injuries only were selected for inclusion in the study. Participants having ligamentous tears in conjunction with meniscus injuries, fractures near the knee joint, lower limb pathology, contralateral knee joint pathology, or those who failed to respond to further follow-ups were excluded from the study. Prior written informed consent was taken from all enrolled subjects.

All enrolled patients underwent detailed clinical evaluation, including history taking, physical examination, knee-specific stability assessment using the Lachman test, and radiological confirmation of ACL injury. The participants were allocated into two groups based on the surgeon's preference. Group A consisted of patients who underwent ACL reconstruction using hamstring tendon autografts harvested from the semitendinosus and/or gracilis tendons. Standard arthroscopic ACL reconstruction techniques were used, and graft fixation was performed using appropriate fixation devices. Group B included patients who underwent ACL reconstruction using peroneus longus tendon autografts. The tendon was harvested through a minimally invasive technique from the lateral compartment of the leg, and arthroscopic reconstruction with graft fixation was performed according to standard surgical protocols.

Following surgery, all patients received a standardized postoperative rehabilitation program comprising immobilization with a knee brace, initiation of early range-of-motion exercises, and gradual progression to weight-bearing activities as tolerated. Follow-up assessments were conducted at 6 weeks and 3 months postoperatively. Functional outcome was evaluated at 3 months using the Lysholm Knee Scoring System, which ranges from 0 to 100, with higher scores indicating better knee function. Knee stability was assessed at 3 months using the Lachman test and graded according to the standard Lachman grading system. Clinical and demographic data, including age, gender, mechanism of injury, preoperative and postoperative Lysholm scores, Lachman test grades, and postoperative complications, were recorded using a structured proforma.

Lyhslom Scoring System

All collected data were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0. Quantitative variables, including age and Lysholm scores, were expressed as mean ± standard deviation. In contrast, qualitative variables, including gender, mechanism of injury, knee stability grade, and postoperative complications, were presented as frequencies and percentages. The independent samples t-test was used to compare the mean Lysholm scores between the two groups, while the Chi-square test was applied to compare Lachman test grades and complication rates. Data were further stratified according to age, gender, and mechanism of injury to control for potential confounding variables, and post-stratification analyses were performed using the independent samples t-test and Chi-square test as appropriate. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 96 patients undergoing ACL reconstruction were included in the study, with 48 patients allocated to each group. As shown in Table I, the two groups were comparable with respect to baseline demographic and clinical characteristics. There were no statistically significant differences between the hamstring tendon (HT) and peroneus longus tendon (PLT) groups regarding mean age (29.6±5.8 vs. 30.2±6.1 years; p=0.62), gender distribution (p=0.79), mechanism of injury (p=0.91), preoperative Lachman grades (p=0.67), or preoperative Lysholm scores (58.4±5.2 vs. 59.1±5.0; p=0.50). However, the PLT group demonstrated significantly better postoperative functional outcomes, with a higher mean Lysholm score compared to the HT group (96.2±2.4 vs. 93.8±3.6; p=0.0002). Similarly, postoperative knee stability was superior in the PLT group, with a significantly greater proportion of patients achieving Grade 0 Lachman test findings (95.8% vs. 81.3%; p=0.02). Although postoperative complications were less frequent in the PLT group (4.2% vs. 14.6%), this difference did not reach statistical significance (p=0.08).

Table I: Demographic and Clinical Characteristics of Patients Undergoing ACL Reconstruction

Variables	Hamstring Tendon Group (n=48)	Peroneus Longus Group (n=48)	p-value
Age (years), Mean ± SD	29.6 ± 5.8	30.2 ± 6.1	0.62
Gender			0.79
Male, n (%)	40 (83.3)	39 (81.3)	
Female, n (%)	8 (16.7)	9 (18.7)	
Mechanism of Injury			0.91
Sports, n (%)	26 (54.2)	28 (58.3)	
RTA, n (%)	14 (29.2)	13 (27.1)	
Domestic/Others, n (%)	8 (16.6)	7 (14.6)	
Preoperative Lachman Test			0.67
Grade II, n (%)	17 (35.4)	19 (39.6)	
Grade III, n (%)	31 (64.6)	29 (60.4)	
Preoperative Lysholm Score, Mean ± SD	58.4 ± 5.2	59.1 ± 5.0	0.50
Postoperative Lysholm Score, Mean ± SD	93.8 ± 3.6	96.2 ± 2.4	0.0002
Postoperative Lachman Test			0.02
Grade 0, n (%)	39 (81.3)	46 (95.8)	
Grade I, n (%)	9 (18.7)	2 (4.2)	
Complications			0.08
Present, n (%)	7 (14.6)	2 (4.2)	
Absent, n (%)	41 (85.4)	46 (95.8)	

The stratified analysis of postoperative Lysholm score showed consistent superior functional outcomes for the ACL reconstruction procedure performed with the peroneus longus tendon graft. Patients from the PLT group had a significant difference in their postoperative Lysholm score for each age category, each gender, and each mechanism of injury (all p<0.05). For those in the age category of 20-30 years old, there is a significant difference between the mean of postoperative Lysholm scores in patients from the PLT group compared to the HT group (97.0±2.0 vs. 94.1±3.2; p=0.0001). The same trend was noticed for those in the age group of 31-45 years old (95.4±2.6 vs. 93.5±3.8; p=0.005). Moreover, both male and female patients in the PLT group scored significantly better than those in the HT group in the postoperative Lysholm score.

Table II: Stratification of Functional Outcome (Postoperative Lysholm Score) with Respect to Effect Modifiers

Variable	**Hamstring Tendon Group Mean ± SD**	**Peroneus Longus Group Mean ± SD**	**p-value**
Age Group			
20–30 years	94.1 ± 3.2	97.0 ± 2.0	0.0001
31–45 years	93.5 ± 3.8	95.4 ± 2.6	0.005
Gender			
Male	93.9 ± 3.5	96.3 ± 2.3	0.0001
Female	93.1 ± 3.9	95.8 ± 2.7	0.0002
Mechanism of Injury			
Sports	94.2 ± 3.1	96.9 ± 2.1	0.0001
RTA	93.5 ± 3.7	95.8 ± 2.5	0.0006
Domestic/Others	92.8 ± 4.0	95.0 ± 2.8	0.002

The results from the post-stratification analyses regarding postoperative complications revealed that there was a tendency for fewer complications in the peroneus longus tendon group than in the HT group in all subgroups studied. Nevertheless, none of the comparisons were statistically significant after stratification. Complications between HT and PLT patients did not differ statistically by stratifying by age, gender, or injury mode (all $p>0.05$).

Table III: Stratification of Postoperative Complications with Respect to Effect Modifiers

Variable	**HT Group Complications (%)**	**PLT Group Complications (%)**	**p-value**
Age Group			
20–30 years	4/28 (14.3)	1/26 (3.8)	0.23
31–45 years	3/20 (15.0)	1/22 (4.5)	0.30
Gender			
Male	6/40 (15.0)	2/39 (5.1)	0.19
Female	1/8 (12.5)	0/9 (0.0)	0.30*
Mechanism of Injury			
Sports	3/26 (11.5)	1/28 (3.6)	0.30
RTA	2/14 (14.3)	1/13 (7.7)	0.63
Domestic/Others	2/8 (25.0)	0/7 (0.0)	0.21*

***Fisher's Exact Test applied due to small cell frequencies.**

DISCUSSION

The present study demonstrates that PLT autografts provide superior short-term functional outcomes and objective knee stability compared with HT autografts in primary single-bundle ACL reconstruction. In a cohort of 96 well-matched patients, the PLT group achieved significantly higher mean postoperative Lysholm scores (96.2±2.4 vs. 93.8±3.6; p=0.0002) and a greater proportion of Grade 0 Lachman findings (95.8% vs. 81.3%; p=0.02) at 3 months. The PLT group also exhibited lower complication rates (4.2% vs. 14.6%), though this did not reach statistical significance (p=0.08). Stratified analyses confirmed consistent functional superiority of PLT across all age groups, genders, and injury mechanisms, strengthening the generalisability of these findings.

These findings are consistent with the growing body of recent literature supporting PLT as a viable and potentially superior alternative to HT. Multiple systematic reviews published between 2021 and 2025 have reported comparable or favourable outcomes with PLT.[10-15] He et al. performed a meta-analysis of 12 studies involving 910 patients. They confirmed that PLT autografts produce functional outcomes comparable to HT grafts, with the added benefit of larger graft diameters and reduced thigh morbidity.[5] Non-inferiority of PLT regarding the Lysholm score and IKDC was also shown by Park et al. based on data from six RCTs with 683 patients. In contrast, the rate of donor-site morbidity in the PLT group was found to be significantly lower.[6]

In a systematic review conducted by Kumar et al. in 2025, which analyzed a total of 10 studies obtained through searches in databases such as PubMed, Cochrane CENTRAL, and Scopus, based on PRISMA guidelines, the same conclusion was drawn that there is no difference between PLT and HT autografts with regards to patient-reported outcomes, supporting the idea that PLT autografts are non-inferior to HT autografts.[11] In more recent times, Opoku et al. performed an updated meta-analysis, analyzing various criteria like Lysholm, IKDC, Tegner, AOFAS score, graft diameter, thigh circumference, harvest time, and knee laxity.[4]

The superior objective knee stability observed in the PLT group of our study is likely attributable to consistently larger graft diameters achievable with PLT harvest. Grafts exceeding 8 mm in diameter are associated with lower re-rupture rates and enhanced biomechanical stability. Butt et al. reported a significantly larger PLT graft diameter (8.9±0.2 mm vs. 7.9±0.4 mm; $p<0.001$) in a 5-year RCT with no significant difference in IKDC or Lysholm scores, confirming minimal ankle donor site impact.[12] Similarly, Gök et al. documented significantly larger PLT graft diameters (8.56±0.93 vs. 7.44±0.6 mm; $p<0.001$) alongside faster harvest times, less thigh hypotrophy, and lower donor-site morbidity—findings that closely mirror those of the present study. Also showed significant improvement in functional outcome. For the Lysholm scores, the peroneus longus group had a preoperative mean score of 62.85±3.7, which improved to 91.42±4.7 at the last follow-up, with a score change of 28.9 ($P<0.001$).The hamstring group had a preoperative mean score of 62.07±3.6, which increased to 91.02±5.4 at the last follow-up, resulting in a score change of 28.6 ($P<0.001$)[13]

Vijay et al. (2024) also noted slightly better functional knee scores with PLT, reinforcing its potential superiority in select metrics.[14] Regarding complications, the trend toward fewer events in the PLT group mirrors the literature emphasizing reduced donor-site morbidity. HT harvesting is often associated with hamstring weakness, damage to the saphenous nerve, and imbalance between the quadriceps and hamstrings. On the other hand, PLT harvesting shows little effect on ankle eversion strength and low morbidity rates. Sari et al. (2025), along with other researchers, found similar results regarding overall outcomes but noted superior results concerning graft diameter and preservation of knee flexion strength using PLTs. From a mechanical perspective, PLT autografts provide strong tensile properties, predictability in terms of anatomical features, and relatively easy extraction from the donor site, thus overcoming the major drawbacks of HT autografts. Moreover, our subgroup analysis proves that these advantages can be generalized regardless of age, gender, or cause of injury.[15]

The association of a decreasing rate of complications with PLT is supported by existing evidence in the literature on the donor site characteristics of the two graft types. HT removal is typically linked to hamstring weakness, saphenous nerve damage, anterior knee pain, and quadriceps-to-hamstring strength discrepancy, factors that can potentially impair knee stability and subsequent rehabilitation.[2,3,14] On the other hand, PLT removal is invariably accompanied by little effect on ankle function. In their systematic review and meta-analysis of studies up to March 2025 in five databases, Soleymanha et al. assessed ankle function after PLT removal and found no decrease in eversion strength and good functional outcome scores.[16]

Furthermore, long-term results have shown the safety of PLT harvesting. In a retrospective analysis of follow-up times of 12 to 23 years, it was found that PLT harvesting did not affect the normal development and evolution of the foot and ankle anatomy, as the foot arch position remained intact without any abnormal deformation.[17]

According to the mechanistic theory, PLT demonstrates good tensile strength, predictability of anatomy, and is easier to harvest, overcoming the shortcomings of HT while retaining excellent ankle function. According to a 24-month RCT by Asif et al., which included 120 participants, PLT patients had a shorter time to return to playing sports and a higher IKDC score. They improved Tegner-Lysholm scores compared to HT patients within 24 months, while also having a lower incidence of donor site morbidity. [10] Likewise, Punnoose et al. found greater PLT graft diameter, lower incidence of donor site morbidity, and better muscle recovery in the PLT group.[8]

Altun et al. also emphasized in a revised ACLR study that the diameter of the graft, rather than the graft itself, was a crucial determinant of stability after surgery, which implies that the ability to create a more substantial diameter graft using PLT provides a mechanical superiority over others. [18]

With respect to the secondary objective of knee stability, the significantly higher proportion of Grade 0 Lachman test findings in the PLT group (95.8% vs. 81.3%; $p=0.02$) represents an important objective clinical finding directly aligned with the study's primary aims. The Lachman test is widely accepted as the most sensitive and specific clinical test for anterior tibial translation and residual ACL laxity following reconstruction. A negative (Grade 0) Lachman test at 3 months post-operatively reflects satisfactory graft incorporation, tunnel placement, and restoration of anteroposterior stability. Kumar et al. (2025), in their PRISMA-compliant systematic review and meta-analysis of 10 studies encompassing 178 reconstructions with Lachman data, reported comparable Lachman test (Grade 0 or 1) results between PLT and HT groups (OR 1.03; 95% CI 0.14–7.45; $I^2=0\%$; $p=0.97$), establishing statistical equivalence across the pooled literature.[11] The superior Grade 0 Lachman rate in the PLT group of the present study exceeds pooled estimates and may reflect the consistently larger graft diameters achievable with PLT harvest. Agarwal et al. similarly reported negative post-operative Lachman findings in the majority of PLT recipients, consistent with robust graft stability.[1] Altun et al. (2026) further demonstrated that in revision ACLR, graft diameter was the strongest independent predictor of postoperative Lachman grade and return to sport, supporting the mechanistic link between PLT's larger diameter and superior knee stability outcomes observed in the present study.[18]

The present study has several limitations. Its single-centre, non-randomised design may introduce selection bias, and the 3-month follow-up period prevents evaluation of long-term outcomes such as graft survival, re-rupture, or osteoarthritis. Ankle-specific functional outcomes were not quantified in the current study, although the available literature consistently confirms minimal ankle morbidity following PLT harvest.[19-21] The sample size, while adequate for primary endpoints, may be underpowered for the subgroup complication analyses. Multicentric studies with a long-term follow-up, objective measurement of ankle biomechanics, and failure rates of grafts would be helpful to prove the superiority of PLT autografts in terms of better clinical outcomes and decreased risk of reoperations.

CONCLUSION

It is concluded that PLT autografts give significantly better short-term functional results and knee stability than HT autografts in primary ACL reconstructions, along with a tendency for fewer complications. Taking into consideration consistently better functional results in all age groups, gender, and trauma mechanism, and well-founded evidence from recently published literature on the benefits of using larger diameter grafts and low ankle morbidity from harvesting, PLT seems to be an excellent primary graft choice, especially in athletes, younger population, or patients where hamstring muscles should be preserved. These findings are justified for wider clinical application of PLT autograft in ACL reconstruction, after confirmation in future randomized controlled studies.

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