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Comparison of clinical outcomes after anterior cruciate ligament reconstruction of autogenous hamstring tendons and peroneus longus

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Abstract

Introduction: The anterior cruciate ligament (ACL) is crucial for maintaining knee joint stability against translational and rotational forces, causing knee instability, meniscal tears, and early osteoarthritis if untreated. Hamstring tendons have gained widespread popularity due to their favourable biomechanical properties, reduced harvest site morbidity and excellent clinical outcomes. The peroneus longus tendon has been explored as an alternative autograft.

Method: A comparative prospective study conducted in the Department of Orthopaedics, Chitwan Medical College, Nepal, from May 2021 to Apr 2023, following ethical approval. Patients with ACL injuries were alternatively allocated into two groups: hamstring and peroneus longus autograft. Standard fixation techniques for ACL reconstruction and rehabilitation protocols were applied. Postoperative assessments were done at 2 weeks, 6 weeks, 3 months, 6 months, and 1 year. Outcome measures included the Lysholm Score, knee stability tests (Anterior drawer test and Lachman test). Data were analysed using SPSS 21. Independent t-test, chi-square test and repeated measures ANOVA were used. Statistical significance was set at $p \leq 0.05$.

Result: Out of 54 patients (27 in each group), both groups demonstrated excellent functional recovery at one-year follow-up, with no statistically significant differences. Mean Lysholm scores were 95.00±6.64 in hamstring vs 95.59±2.20 peroneus longus, p=0.662. The anterior drawer test grade 0 was observed in 59.3% of hamstring vs 70.4% peroneus longus, p=0.426.

Conclusion: Peroneus longus autografts demonstrated comparable clinical outcomes to hamstring autografts in ACL reconstruction. The peroneus longus graft had predictable larger graft diameter, and better improvement in thigh muscle mass without significant ankle morbidity.

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Introduction

The anterior cruciate ligament (ACL) is crucial for maintaining knee joint stability against translational and rotational forces.[1] Sports-related ACL injuries rank as one of the most prevalent types of athletic injuries, potentially causing knee instability, meniscal tears, and accelerated joint degeneration when not addressed.[2,3] The primary goal of ACL reconstruction is to restore knee stability and enable patients to return to their pre-injury activity levels while preventing secondary injuries.

Multiple graft options exist for ACL reconstruction, broadly categorised into autografts and allografts. Among autografts, hamstring tendons (HT), semitendinosus and gracilis, have gained widespread popularity due to their favourable biomechanical properties, reduced harvest site morbidity and excellent clinical outcomes compared to bone-patellar tendon-bone grafts.[4] However, hamstring autografts are associated with certain limitations, including unpredictable graft diameter before surgery and potential weakness of the involved extremity muscles.[5]

Recent studies have explored the peroneus longus (PL) tendon as an alternative autograft for ACL reconstruction. The PL tendon offers several theoretical advantages, including predictable diameter, adequate length, minimal impact on walking mechanics, and preservation of ankle stability.[6,7] Biomechanical studies have demonstrated comparable tensile strength between PL and HT, suggesting their potential as a viable alternative for ACL reconstruction.[8]

Despite these promising characteristics, no comparative studies exist evaluating the clinical outcomes of PL versus HT autografts for ACL reconstruction in the Nepalese population. This study aims to compare the clinical outcomes of these two autograft options to provide evidence-based guidance for graft selection in ACL reconstruction.

Method

This prospective comparative study was conducted in the Department of Orthopaedics, Chitwan Medical College, Nepal, from May 2021 to April 2023. Ethical approval was obtained from the Institutional Review Committee of Chitwan Medical College (Reference number: CMC-IRC/078/079-093).

Patients presenting with ACL injuries requiring ACL reconstruction were screened for eligibility. The inclusion criteria included adults 18-50 years of age, acute or chronic ACL tears confirmed by clinical examination and MRI, patients willing to participate in the study with informed written consent and patients able to comply with follow-up protocol. The exclusion criteria were any previous knee surgery, including previous ACL surgery, concomitant posterior cruciate ligament injury, grade III collateral ligament injuries, irreparable meniscus injury, significant chondral damage (Outerbridge grade III-IV), and patients with neurological disorders affecting lower extremities.

The total enumerative sampling where all eligible patients presenting with ACL injury and meeting the inclusion criteria during the study period. Patients were allocated into two groups alternatively, where in Group A HT autograft was used, and in Group B PL autograft was used.

The HT Group: The semitendinosus and gracilis tendons were harvested through a 3-4 cm incision over the anteromedial aspect of the proximal tibia. Tendons were prepared as quadruple-strand/triplicate grafts. The ACL reconstruction was performed using a standard arthroscopic technique with anatomical tunnel placement.

The PL Group: The tendon was harvested through a 2-3 cm incision, posterolateral aspect of fibula, which is 2 to 3 cm above lateral malleolus. The tendon was prepared as a doubled graft. ACL reconstruction was performed using the same arthroscopic technique with anatomical tunnel placement.

Both groups underwent identical fixation methods using suspensory fixation (endobutton system) on the femoral side and aperture fixation (interference screws) on the tibial side.

All patients followed a standardised rehabilitation protocol that included knee immobilisation in an extension brace immediately postoperatively, passive range of motion exercises during weeks 1 to 2, active range of motion and strengthening exercises from weeks 3 to 6, progressive weight-bearing and functional exercises during weeks 6 to 12, and a return to sports-specific activities between months 6 to 9 based on individual progress.

Outcome measures included clinical assessments at 2 weeks, 6 weeks, 3 months, 6 months, and 1 year postoperatively. Sutures were removed in 2-week after surgery. We compared pre-operative clinical parameters like Lysholm Score, knee stability tests like Anterior drawer test and Lachman test and other secondary outcomes with 6 months and 1 year follow-up among two groups.[9]

The primary outcomes included the Lysholm Score, a functional knee assessment score ranging from 0 to 100 points, and knee stability tests such as the Anterior Drawer test and Lachman test, both graded from 0 to 3. The secondary outcomes comprised the AOFAS (American Orthopaedic Foot and Ankle Society) score,[6] thigh circumference measured 15 cm proximal to the superior pole of the patella and difference noted from the normal side, graft characteristics including diameter and any complications such as infection, graft failure, or donor site morbidity.

Statistical analysis included data entry into Microsoft Excel and analysis using SPSS version 21. Parametric tests (independent t-test, repeated measures ANOVA) were used under the assumption of approximate normality of the data. Mean and Standard Deviation were used to describe continuous variables. Independent t-tests were used for comparing continuous variables between groups, while chi-square tests were used for categorical variables. Repeated measures ANOVA was used to analyse changes over time within groups. Statistical significance was set at $p \leq 0.05$.

Result

Out of a total of 54 patients (27 in each group), mean age was 31.40±9.68 years in the HT group and 35.22±8.67 years in the PL group. In graft characteristics, the mean graft size diameter was 7.90±0.43 mm in the HT group and 8.51±0.44 mm in the PL group, Table 1.

Repeated measures ANOVA used to analyse changes in thigh circumference (within each group) across three time points: pre-operative, 6 months, and 1 year, showed thigh circumference improved significantly over time in both groups ($p=0.006$, $\eta^2=0.136$). The effect size ($\eta^2=0.136$) suggests a moderate effect of time on thigh circumference, Table 2.

Independent t-test used to compare thigh circumference differences between the two groups (HT vs. PL) at each time point showed no significant difference at baseline ($p=0.50$), but a significant difference at 6 months ($p=0.002$) and 1 year ($p<0.001$), with the PL group showing better improvement (less thigh hypotrophy) compared to the HT group, Table 2.

Repeated measures ANOVA used to assess changes over time within groups, as the same participants were followed at multiple time points (pre-operative, 6 months, and 1 year), showed no significant time effect ($p=0.468$), i.e. both groups improved similarly over time. An independent t-test used to compare Lysholm scores between the two groups at each time point showed no significant differences at any time point (pre-operative: $p=0.178$; 6 months: $p=0.789$; 1 year: $p=0.662$), i.e. both grafts provided comparable functional recovery (Lysholm scores) post-ACL reconstruction, Table 3.

Between-group comparisons revealed no significant differences in Anterior Drawer Test score distributions at any time point (pre-operative: $p=0.757$, 6 months: $p=0.555$, 1 year: $p=0.426$), indicating comparable functional outcomes between graft types, Table 4.

Between-group comparisons revealed no significant differences in Lachman's grading at any time point (pre-operative: $p=0.50$, 6 months: $p=0.59$, 1 year: $p=0.57$), indicating comparable functional outcomes between graft types, Table 5.

Repeated measures ANOVA used to analyse changes in AOFAS scores within each group across three time points: pre-operative, 6 months, and 1 year showed no significant time effect (p=0.659), i.e. AOFAS scores improved similarly over time in both groups, Table 6.

An independent t-test used to compare AOFAS scores between the two groups (HT vs. PL) at each time point showed no significant differences at any time point, i.e. no ankle morbidity in the PL graft (harvested from the ankle) compared to the HT graft. Gradual improvement in both groups showed similar improvements in AOFAS scores over time, suggesting that harvesting the PL tendon does not negatively impact ankle stability or function, which has clinical implications that PL graft is a safe alternative without worrying about donor-site ankle complications, Table 6.

Table 1. Clinical and demographic of patients with anterior cruciate ligament (ACL) reconstruction using hamstring tendons (HT) and peroneus longus tendon (PT) graft, n=54

Variables	n(%)
Age(years), Mean±SD	33.31±9.30
Gender, n(%)	
Male	32(59.3)
Female	22(40.7)
Injured side, n(%)	
Right	33(61.1)
Left	21(38.9)
Duration of injury (months), Mean±SD	5.37±4.62
Graft type, n(%)	
HT	27(50)
PT	27(50)
Graft size, Mean±SD	8.21±0.53

Table 2. Difference in thigh circumference between normal and injured limb over time after ACL reconstruction, n=54

Group	Thigh circumference (cm), Mean±SD			p-value, repeated measures ANOVA
	Pre-op	6 months	1 year	
HT (27)	1.78±0.46	1.76±0.37	1.15±0.28	0.006
PL (27)	1.86±0.41	1.44±0.33	0.78±0.22	
p-value (t-test, between gr compare)	0.50	0.002*	0.000*	--

Table3. Lysholm scores by graft type and time point after ACL reconstruction, n=54

Graft type	Lysholm scores, Mean±SD			p-value ANOVA
	Pre-op	6 months	1 year	
HT (n=27)	55.22±6.91	89.40±2.80	95.00±6.64	0.468
PL (n=27)	57.85±7.24	89.62±3.23	95.59±2.20	
p-value (t-test, between gr compare)	0.178	0.789	0.662	NA

Table 4. Anterior Drawer Test (ADT) score by graft type and graft point after ACL reconstruction, n=54

Graft type	baseline score	Pre-operative n(%)	6 months n(%)	1 year n(%)
HT				
	Score 0	0	6(22.2)	16(59.3)
	Score 1	0	21(77.8)	10(37)
	Score 2	8(29.6)	0	0
	Score 3	19(70.4)	0	1(3.7)
PL				
	Score 0	0	7(25.9)	19(70.4)
	Score 1	0	19(70.4)	7(25.9)
	Score 2	6(22.2)	1(3.7)	1(3.7)
	Score 3	21(77.8)	0	0
Between-group comparisons, p (Chi-square or Fisher's exact)		0.757	0.555	0.426

Table 5. Lachman grading distribution by graft type and time point after ACL reconstruction, n=54

Time point	Graft type	Grade 0 n(%)	Grade 1 n(%)	Grade 2 n(%)	Grade 3 n(%)	p-value Chi-square, Fisher
Pre-operative	HT	0	0	9(33.3)	18(66.7)	0.50
	PL	0	0	8(29.6)	19(70.4)	
6 months	HT	10(37)	17(63)	0	0	0.59
	PL	10(37)	16(59.3)	1(3.7)	0	
1 year	HT	18(66.7)	8(29.6)	0	1(3.7)	0.57
	PL	18(66.7)	8(29.6)	1(3.7)	0	

Chi-square test or Fisher's exact test for between-group comparison at each time point

Table 6. American Orthopaedic Foot and Ankle Society (AOFAS) scores by graft type and time point after ACL reconstruction, n=54

Graft type	AOFAS scores, Mean±SD Pre-operative	6 months	1 year	p-value (ANOVA)
HT (27)	90.48±3.04	92.81±2.51	95.44±2.85	0.659
PL (27)	91.62±3.48	92.51±2.72	95.48±2.81	
p-value (t-test, between gr compare)	0.203	0.679	0.962	--

Discussion

This prospective comparative study evaluated the clinical outcomes of ACL reconstruction using HT versus PL autografts in 54 patients over a one-year follow-up period. Our findings demonstrate that both graft types provide comparable functional outcomes.

Primary functional outcomes, in both HT and PL autograft groups, showed excellent functional recovery, as evidenced by similar Lysholm scores at 6 months (89.40±2.80 vs 89.62±3.23) and 1 year (95.00±6.64 vs 95.59±2.20) postoperatively. These findings are similar to other studies.[9]

The lack of significant differences in functional scores suggests that both graft types are equally effective in restoring knee function. However, some literature has reported a better functional score in PL group, suggesting knee function may be better with a peroneus graft than an HT graft.[10]

Knee stability assessment using anterior drawer test and Lachman test demonstrated comparable results in both groups. There was a significant improvement in knee stability in both groups, and this was comparable in every follow-up, with no statistically significant difference. At one year, both groups achieved comparable rates of grade 0 (59.3% HT vs 70.4% PL for ADT; 66.7% for both groups in Lachman test). This finding is consistent with other studies which demonstrated comparable knee stability between the PL and HT tendons.[11] The similar stability outcomes suggest that both grafts provide adequate mechanical properties for ACL reconstruction.

In terms of graft characteristics, the PL group demonstrated a larger mean graft diameter (8.51±0.44 mm vs 7.90±0.43 mm), which may contribute to improved graft incorporation and long-term stability. Other studies have also highlighted the advantage of predictable graft diameter with PL tendons, which addresses one of the limitations of HT grafts, where diameter variability can affect surgical planning and outcomes.[12]

Difference in thigh circumference was significant to injured between the two groups compared to the normal limb in all subsequent follow-ups. The PL group had better improvement in thigh muscle hypotrophy in both 6 months (1.44±0.33 cm vs 1.76±0.37 cm) and 1 year (0.78±0.22 cm vs 1.15±0.28 cm) compared to the HT group. Thigh hypotrophy due to HT (semitendinosus and gracilis) tendon harvest results in decreased strength, resulting in quadriceps-hamstring asymmetry, which results in an imbalance in dynamic knee stability.[13] Our findings were similar to other studies,[14] therefore, the patients in PL group had better recovery with significantly improved thigh hypotrophy.

Donor site morbidity (AOFAS Scores), showed gradual improvement over time in both groups, with no significant differences between graft types. The PL group maintained excellent ankle function throughout the follow-up period, supporting the safety of PL harvest with minimal impact on ankle biomechanics, as previously reported.[8]

The primary concern of the PL donor site (ankle) is the deficit of eversion while the patient is in the stance phase of gait and ankle instability.[15] None of our patients had such complaints. This can be attributed to the role of peroneus brevis in ankle eversion. We can infer that harvesting the PT graft does not cause ankle morbidity and does-not significantly impact ankle joint function.

There was one case with superficial infection of the donor site in PL group which improved with oral antibiotics and regular dressing. One case of HT group had Anterior Drawer and Lachman test grade 3 after 6 months follow-up. The patient had history of twist injury while riding bike.

Limitation of this study include, first, the sample size was relatively small, with only 54 patients (27 per group), which may have limited the statistical power to detect subtle differences between the two graft types. Second, the follow-up period was restricted to 1-year post-surgery, thereby missing important long-term outcomes such as graft durability, the development of osteoarthritis, or late-onset complications. Third, the absence of randomisation and the use of alternate allocation could have introduced selection bias. Fourth, as a single-centre study conducted at a tertiary care teaching hospital in Nepal, the findings may not be generalizable to other populations or surgical settings. Fifth, the study relied on subjective outcome measures, including functional scores such as Lysholm and AOFAS, and manual stability tests like the Lachman and Anterior Drawer tests, which are susceptible to examiner bias.

Conclusion

This study demonstrates that peroneus longus autografts provide comparable clinical outcomes to hamstring autografts in anterior cruciate ligament reconstruction. Both graft types achieved excellent functional recovery and knee stability restoration. The peroneus longus tendon had advantages of a predictable, larger graft diameter and is potentially better at improving thigh wasting, making it a valuable alternative for ACL reconstruction.

Author contribution

Concept design: SK, GN; Literature search: BDS, TPD, SR; Data collection: SK, GN, SR; Data analysis: SK, BDS; Draft manuscript: All; Final manuscript and accountability: All

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Conflict of interest

None

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Supplementary material

The data and supplementary material that support the findings of this study are available from the corresponding author upon reasonable request.

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