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Peroneus Longus Tendon Versus Hamstring Tendon Autograft In Arthroscopic Acl Reconstruction: A Prospective Randomized Study Of Knee Function, Stability, And Donor-Site Morbidity

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ABSTRACT

Background: Arthroscopic anterior cruciate ligament reconstruction (ACLR) with hamstring tendon (HT) autografts is very popular, and could result in knee flexion weakness and harvest-related morbidity. An alternative of constant diameter, with arguably reduced donor-site morbidity, has developed in the form of the peroneus longus tendon (PLT) at the expense of ankle function.

Methods: It was a prospective randomized self-controlled study that was undertaken in a tertiary orthopaedic unit (2023-2025). The participants were randomly divided into 30 individuals with isolated unilateral ACL rupture who received ACLR with either PLT autograft (n=15) or quadrupled HT autograft (n=15). The measurement of functional outcomes was preoperative, 1.5, 3, 6 months using Modified Cincinnati Score (MCS), Lysholm score, and Subjective IKDC 2000. Donor-site complications were measured using AOFAS (PLT group), thigh circumference deficit, sensory symptoms, pain, ankle range of motion, and handheld dynamometry-based strength. Knee stability was evaluated using Anterior Drawer, Lachman, Pivot Shift and KT-1000 arthrometer at the follow-up. Independent t-tests/Mann-Whitney U tests and chi-square tests were conducted in groups (due to the independent test, 1=0.05).

Results: PLT had more mean graft diameter than HT (8.68±0.23 mm; and 7.65±0.59 mm, respectively, p<0.001). Both groups had also improved but at 12 months, PLT had better MCS (90.1±2.9 vs 86.8±2.7), Lysholm (89.9±3.8 vs 86.3±2.1) and IKDC (92.4±4.3 vs 89.1±5.2) (all p<0.05). With enduring effects, recovering the stance favoring PLT actions and dynamics with time of 3 months and above, there was less KT-1000 side-to-side difference in final follow-up (1.2±0.5 vs 1.8±0.6 mm, p<0.01). PLT had a reduced donor-site morbidity (thigh deficit 0.520.2 cm vs 1.22.04 cm, p=0.001), and comparable outcomes of the ankle near outcome normalcy at 12 months (AOFAS 97.62.4).

Conclusion: Even though PLT autograft ACLR yielded thicker grafts, faster mobilization, better 12-month stability and less donor-site morbidity and ankle functionality, it helps to support the idea that PLT is a strong alternative to HT in primary ACLR.

Keywords: *Anterior Cruciate Ligament; Peroneus Longus Tendon; Hamstring Tendon; Autograft; Arthroscopy; Ikdc; Lysholm; Donor-Site Morbidity*

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1. INTRODUCTION

ACL may be regarded as one of the most significant knee injuries in terms of their consequences to athletic activity, work performance, and the overall joint wellbeing. Despite successful due surgical reconstruction, a significant proportion of patients fail to recuperate sport performance of the preinjury standard and a subcomponent onset an irreversible instability or degeneration as time passes [1,2]. Restoring anteroposterior and rotational stability and facilitating safe resumption of functions, reducing graft failure, and minimizing donor-side morbidity are objective operative goals of ACL reconstruction (ACLR) [3].

The choice of autografts is still the focus of ACLR. Bone-patellar tendon-bone (BPTB) and hamstring tendon (HT) are most likely to be used, each with unique trade offs in terms of fixation biology, anterior knee pain, deficit of strength and risk of revision [3-5]. Huge comparative datasets and meta-analyses have demonstrated that there are widespread similarities in patient-reported outcome in graft types but that there continue to be some morbidity differences, and in certain cohorts, some difference in revision probability [4,6]. The use of HT grafts is commonly favored as they minimise anterior knee pains and kneeling pain; nevertheless, HT harvest can decrease the knee flexion, induce saphenous nerve syndrome and offer inconsistent graft diameter, which is clinically significant since in some literature, small diameter soft-tissue grafts are found to increase failure (Hebel et al, 2008).

Another autograft that has also become popular is the peroneus longus tendon (PLT). PLT has sufficient length and diameter to support single-bundle ACLR biomechanically and clinical series are reporting increasing usefulness of knee function at the lowest possible levels of ankle morbidity [8–11]. Modern comparative clinical trial and systematic review indicate that PLT autograft ACLR provides similar functional results as HT autografts and that it may have some benefits in graft size and donor-site morbidity [912].

Morbidity of the donor sites is never a by-product, and it may dictate the rate of rehabilitation and patient satisfaction. Although possible effects of HT harvest on hamstring strength, and neurosensory symptoms surrounding the tibial incision are possible, PLT harvest causes significant questions about the strength of the ankle and knee stability as well as gait mechanics [10,13]. Recent findings that evaluate partial or anterior-half PLT harvest have assisted to judge that ankle work and ambulation may continue to be held in suitably chosen patients and surgery methods [10,13].

Given this clinical requirement of grafts with a good diameter, resilient restoration of stability, and minimal morbidity, we carried out a prospective and randomized trial between PLT and HT autografts in native arthroscopic ACLR. Our hypothesis was that with PLT, (i) larger and more stable diameter of the graft, (ii) similar or better knee functional recovery, (iii) better objective stability, and (iv) small clinically significant ankle morbidity, would be found.

2. MATERIALS AND METHODS

Study design, setting, and duration
A prospective randomized controlled study was conducted in the Department of Orthopaedics at Krishna Institute of Medical Sciences and Deemed to Be University, Karad, India, between January 2023 and December 2025.

Participants
Thirty skeletally mature adults aged 18–50 years with **isolated unilateral ACL rupture** and symptomatic knee instability were enrolled.

Inclusion criteria: age 18–50 years; isolated ACL tear; unilateral rupture diagnosed within 1 year; willingness to follow rehabilitation; ability to provide informed consent.

Exclusion criteria: associated multi-ligament injury; prior ligament surgery on the affected knee; inflammatory arthritis; open/compound injury; revision ACLR.

Randomization and allocation
Participants were randomized in a 1:1 ratio to:

- **PLT group (n=15):** tripled/quadrupled peroneus longus tendon autograft
- **HT group (n=15):** quadrupled semitendinosus–gracilis autograft

Ethics
Institutional Ethics Committee approval was obtained prior to enrollment. Written informed consent was obtained from all participants, and confidentiality was maintained.

Surgical technique
All procedures were performed arthroscopically under spinal or general anesthesia by experienced surgeons.

- **Graft harvest:** PLT was harvested from the lateral ankle region with preservation of foot function; HT harvest was performed from the medial tibial region (semitendinosus and gracilis).
- **Graft preparation:** Grafts were tripled/quadrupled based on intraoperative thickness; graft diameter and length were recorded.
- **Fixation:** Femoral and tibial tunnels were prepared and grafts were secured using interference screws and suspensory fixation devices as per standard practice.

Postoperative rehabilitation
A standardized protocol was used for both groups: brace immobilization for 2 weeks; early physiotherapy from postoperative day 2; staged strengthening and proprioception; sport-specific progression from 3–6 months; and return-to-sport progression after clinical and functional clearance.

Outcomes
Functional outcomes: Modified Cincinnati Score (MCS), Lysholm score, Subjective IKDC 2000 at baseline and 1.5, 3, 6, 12 months.

Ankle outcomes (PLT): AOFAS score; ankle range of motion; plantarflexion/eversion strength (HHD-based).

Knee stability: Anterior Drawer, Lachman, Pivot Shift at follow-ups; KT-1000 side-to-side difference at final follow-up.

Donor-site morbidity: thigh circumference deficit, sensory deficit, donor-site pain; complications.

Statistical analysis
Data were analyzed using SPSS. Continuous variables were compared using independent t-tests or Mann–Whitney U tests, and categorical variables using chi-square tests. Statistical significance was defined as $p<0.05$.

3. RESULTS

Through predetermined follow-up evaluations, thirty patients finished the program, with the same demographics and injury pattern in controls and treatment. Self-fall or sports mechanisms were the leading causes of injury and the majority of patients showed up within 3 months of injury. There was impairment of baseline knee functional scores that was corroborated by symptomatic ACL deficiency; interestingly, there was a higher baseline Lysholm score in the HT group, but there was no difference in MCS.

PLT autografts were found to be much broader and less fluctuating on intraoperative graft diameter than HT grafts (8.68±0.23 mm vs 7.65±0.59 mm; $p<0.001$). Both groups showed improvement in all functional measures as they proceeded in time though at subsequent follow-up there was a deviation in their trajectories of recovery. At 12 months, the statistically significant higher scores in MCS, Lysholm, and IKDC had been shown, indicating some but significant favorable patient-reported functional difference.

Both groups had objective stability improvements postoperatively but the PLT group had earlier and more significant improvements on manual tests starting 3 months. PLT patients, at the end of follow-up showed weaker residual anterior laxity on the KT-1000 test and reduced incidence of positive Pivot Shift against HT, which is consistent with less inconsistent restoration of rotational stability.

There was a difference in morbidity profile at the donor-site. More circumference deficit of the thigh and sensory symptoms were seen in HT patients. The reduction in ankle ROM was an early and transient event in PLT recipients which disappeared by 12 months and AOFAS scores were almost normal, which validated the functional preservation at the donor ankle of this study cohort.

Tables

Table 1. Baseline characteristics and injury profile (n=30)

Variable	PLT (n=15)	HT (n=15)
Age distribution (18–25 / 26–35 / 36–45 / >45 years)	26.7% / 33.3% / 26.7% / 13.3%	33.3% / 20.0% / 33.3% / 13.3%
Mode of injury (Sports / Self-fall / RTA / Other)	26.7% / 40.0% / 20.0% / 13.3%	20.0% / 46.7% / 20.0% / 13.3%
Presentation after injury (<1 mo / 1–3 mo / >3 mo)	33.3% / 40.0% / 26.7%	13.3% / 53.3% / 33.3%

Distribution Baseline distributions were widely similar, which reduced age and mechanism of injury confounding. The two groups represented a standard ACL epidemiology of most self-falls and sporting injury, with the majority of patients attending within 3 months. More presenters in the PLT group had fewer than 1 month (early), which might indicate an increased rapidity of care seeking, but could not be directly related to baseline functional superiority. In general, randomization was observed to give clinically comparable cohorts with which to compare downstream outcomes.

Table 2. Intraoperative graft characteristics and early milestones

Parameter	PLT (n=15)	HT (n=15)	p-value
Graft diameter (mm), mean±SD	8.68±0.23	7.65±0.59	<0.001
Harvesting time (min), mean±SD	11.5±2.1	12.39±2.3	<0.05
Time to full weight-bearing (weeks), mean±SD	3.1±0.4	3.8±0.6	<0.05
Return to sports (months), mean±SD	6.2±0.8	7.5±1.1	<0.01

PLT yielded a dependable increased graft, a viable quality considering the issue of small diameter of soft-tissue graft, and failure susceptibility noted with earlier literature [7]. Although there were minimal differences in the technical complexity rating (surgeon-perceived), the PLT harvest did not significantly increase the operative harvest time and it was even related to the achievement of earlier functional milestones, including faster full weight bearing and return to sport. Such variations are probably because of less knee flexor harvest morbidity and possibly higher early confidence due to perceived stability.

Table 3. Functional outcomes across follow-up

Outcome	Timepoint	PLT (mean±SD)	HT (mean±SD)	p-value
MCS	Pre-op	61.2±8.5	65.4±9.8	>0.05
	6 months	78.3±7.1	79.8±5.9	>0.05
	12 months	90.1±2.9	86.8±2.7	<0.05
Lysholm	Pre-op	53.1±9.2	63.2±7.5	<0.01
	6 months	70.2±8.4	76.3±6.2	<0.05
	12 months	89.9±3.8	86.3±2.1	<0.05
IKDC	6 months	85.7±5.8	82.3±6.1	>0.05
	12 months	92.4±4.3	89.1±5.2	<0.05
AOFAS (PLT)	12 months	97.6±2.4	—	—

Both grafts performed well, showing most robust functional outcome at 12 months; but PLT had a steady late benefit in MCS, Lysholm and IKDC. The initial Lysholm benefit observed in the HT group is likely to have been due to imbalance on baseline other than a real graft effect, with the trajectories moving to a point of converging and reversing by one year. Notably, the outcomes of PLT specific to the ankle normalized which is an indication that ankle disability caused by the harvest of the PLT was not permanent in this group.

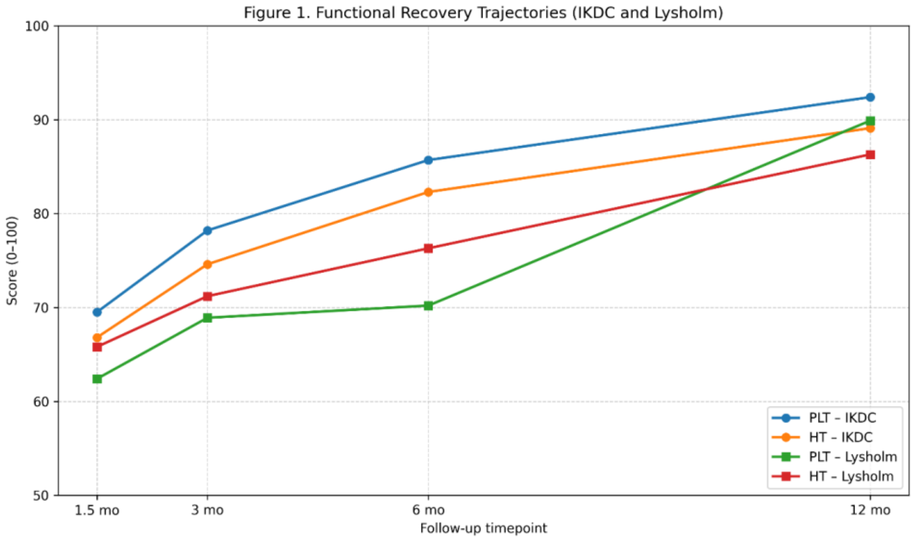
Table 4. Stability and donor-site morbidity at final follow-up

Measure	PLT	HT	p-value
Lachman Grade 0/1	93.3%	60.0%	<0.05
Pivot Shift negative	86.7%	60.0%	<0.05
KT-1000 side-to-side (mm), mean±SD	1.2±0.5	1.8±0.6	<0.01
Thigh circumference deficit (cm), mean±SD	0.5±0.2	1.2±0.4	<0.001
Sensory deficit	10%	26.7%	0.02
Total complications	10%	30%	0.12

It was the PLT which appeared to be favoured in final stability testing- on manual and instrumented measures, indicating that the factor restores much better both translational and rotational stability. The difference between the KT- 1000 values (0.6 mm absolute difference between the groups) is minimal but significant when combined with reduced levels of Pivot Shift positivity, which has strong associations with functional instability. PLT at the knee demonstrated a strong advantage in regards to DSM, a smaller thigh deficit, and sensory symptoms less than hamstring harvest had been witness to the morbidity disadvantage in relation to hamstring donor.

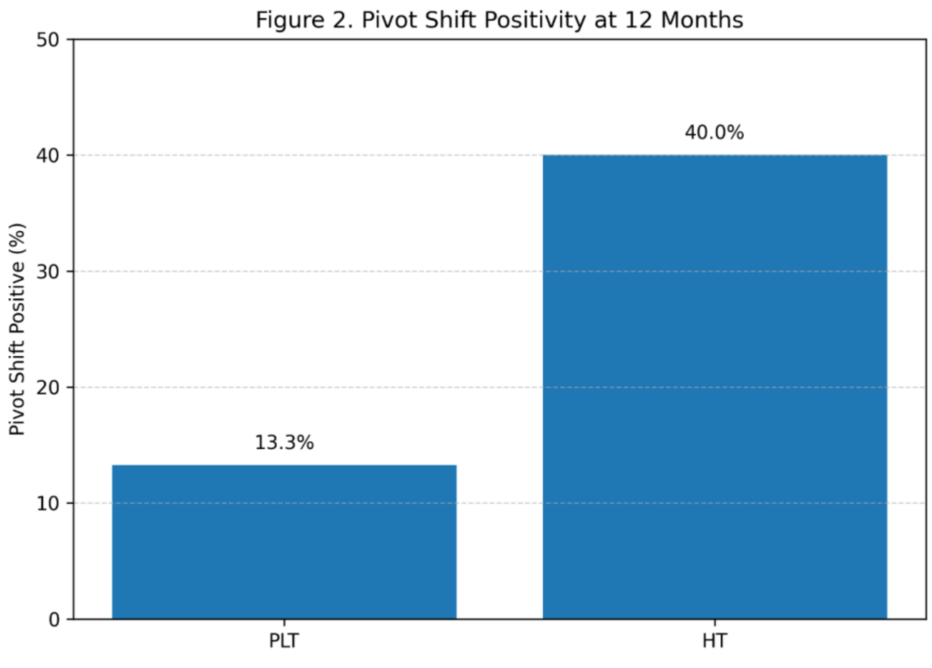
Figures

FIGURE 1. FUNCTIONAL RECOVERY TRAJECTORY (IKDC AND LYSHOLM) OVER 12 MONTHS (GROUP MEANS)



The trend indicates that conventionalized rehabilitation and correction of preoperative instability are the major factors in achieving early recovery, and in the period range of 6-12 months, subtle variations in the burden and stability of the donor site could be the determinants of elevated levels of functionality. Reduced knee flexor harvest morbidity and possibly stronger rotational control are the late PLT benefits concerned which are more evident in advanced strengthening and sport-specific exercises.

FIGURE 2. ROTATIONAL STABILITY AT 12 MONTHS: PIVOT SHIFT POSITIVITY (%)



Superior Pivot Shift Addiction suggests left behind rotational laxity, potentially affecting the cutting and pivoting locutionary results in spite of robust patient-administered measurements. The reduced rate of positivity in PLT indicates a better recovery in rotational stability which could possibly be translated to higher rates of confidence, subjective giving-way, and return-to-sport. This agrees with the previous results of KT-1000, concurrently with a coherent signal of stability in the modalities of measurements.

4. DISCUSSION

To evaluate this, this prospective randomized study established that PLT autograft ACLR yielded larger graft diameter, earlier mobilization, better stability in 3 months and better functional outcomes at 12 months than HT autograft, and yet near-normal ankle function at one year. These data are in line with the accumulating body of evidence that demonstrates that PLT is a clinically viable alternative to HT, especially in cases where the size of grafts is sufficient and the donor-site of the knee is of primary importance.

Our results in graft diameter are similar to comparative clinical literature [9,10] indicating much thicker PLT grafts over HT grafts. The foregoing clinical implication of the graft diameter can be supported through the literature that documented smaller diameter of grafts on risk of graft failure, which encourages the development of methods that enhance uniformity and size relative to soft-tissue grafting [7]. Although our study did not quantify the graft rupture rates owing to the sizes of samples and length of follow up, increasing graft geometry could partially contribute to the high-quality stability profiles in especially in PLT patients.

Our 12-month outcomes are functional, similar to recent comparative literature that demonstrates that PLT can deliver patient reported outcomes equal to or sometimes superior to HT, with little ankle non-function [9-12]. A 2025 systematic review and meta-analysis in Journal of Orthopaedic Surgery and Research found that PLT is probably non-inferior to HT on the short- to mid-term outcomes and that it is clinically interchangeable in suitable selected cases [11]. Identically, a prospective randomized comparative study of 2025 found that PLT yielded similar IKDC and Lysholm outcomes at 18 months and had no significant ankle dysfunction as assessed by AOFAS [9]. These observations are further expanded by our data that show not only equivalence but also a one-year more advantage in terms of stability and a number of functional scores that were chosen.

The clinical implications of the stability advantage that we observed, particularly the differences of Pivot Shifts are significant. Rotatory laxity is closely correlated with functional instability and the inability to resume pivoting sporting activities. Before graft literature Previous graft studies focus on the fact that graft choice and harvest morbidity can interact with neuromuscular outcome development; hamstring harvesting can affect dynamic stabilization due to the hamstring contribution to the resistance to anterior tibial translation and tibial rotation control, especially when facing high-demand tasks [3,5]. Compared to the early flexor recovery patterns, HT patients in our cohort had stronger knee flexion strength at 6 months, however, their residual laxity remained higher at 12 months. This paradox indicates that passive mechanical stability and dynamic strength are not ideally coupled- and that the location of the tunnel, the graft diameter, fixation, and biologic incorporation could play an important role in eventual late stability results.

There was clinical significance in differences of donor-site morbidity. We also noted higher deficit of thigh circumference and sensory symptoms in HT patients-which has been reported to cause morbidity in medial tibial tissue and the accepted morbidity profile of medial tibial cuts is known to cause saphenous nerve irritation during hamstring harvest procedures [3,5]. On the other hand, PLT harvest resulted in transient ankle stiffness with full ROM by the 12 months and high AOFAS scores, which are comparable to the studies that analyzed the effects of the PLT harvest on the gait and ankle functionality [13]. A 2024 study investigating anterior-half PLT harvest and gait parameters confirms the biological plausibility of the idea of ankle mechanics and how they could be maintained in such a way that the harvest technique is carefully performed and rehabilitation is guided [13].

Limitations are small sample size (n=30), single-centre design and inadequate follow-up on long-term outcome as graft rupture, contralateral injury and osteoarthritis. Even though several stability endpoints were employed, imaging-based tunnel positioning analysis and objective biomechanics were not included. Further studies ought to have multi-centered adequately powered RCTs, longer follow-ups, standardized return-to-sport testing batteries, and cost-effectiveness analyses.

5. CONCLUSION

Peroneus longus tendon autograft was found to result in significantly greater graft diameter, faster mobilization, objective stability, and better patient-reported knee function at 12 months follow-up, and prove superior in primary arthroscopic ACL reconstruction compared to hamstring tendon autograft, in this randomized prospective study. Notably, and of significance is that, PLT harvest was linked with minimal donor-site morbidity and maintained ankle functionality by one year. Although hamstring grafting also works, PLT is a valid option to consider, specifically, when the graft diameter sufficiency, minimization of knee donor-site morbidity, and stability re-establishment are valued more. Greater multi-center trials should be performed to verify long-term results and profiles of failure.

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