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# Functional Outcome in Arthroscopic Anterior Cruciate Ligament Reconstruction Using an Autologous Quadrupled Hamstring Tendon Versus Peroneus Longus Tendon Graft: A Comparative Study

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**Learning Point of the Article:**

Peroneus longus tendon can serve as an effective alternative autologous graft for anterior cruciate ligament reconstruction. Despite a transient reduction in ankle eversion strength after graft harvesting, patients achieve comparable knee function and clinical outcomes to those receiving quadrupled hamstring grafts by 6 months. Its larger graft dimensions make it a useful option when a larger graft is required.

## Abstract

**Introduction:** The knee is the largest and most complex synovial hinge joint, stabilized by primary ligaments (anterior cruciate ligament [ACL], posterior cruciate ligament, medial collateral ligament, lateral collateral ligament) and secondary structures, such as the hamstrings and quadriceps. The ACL is vital for preventing anterior tibial translation and maintaining rotational stability.

**Aim of the Study:** (1) To perform arthroscopic ACL reconstruction using autologous quadrupled Hamstring Tendon (HT) or peroneus longus tendon (PLT) grafts. (2) To compare the functional outcomes of ACL reconstruction with these two grafts.

**Materials and Methods:** This study was conducted at the Department of Orthopedics, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, over 24 months and included 30 patients aged 18–45 years with symptomatic ACL insufficiency confirmed clinically and through magnetic resonance imaging. Patients with additional ligament injuries, osteoarthritis, or systemic conditions were excluded. Participants were randomized into two groups for arthroscopic ACL reconstruction with either a hamstring or PLT graft. Surgical procedures included femoral and tibial tunnel creation and graft fixation with adjustable loop endobuttons and bioabsorbable screws. Post-operative care included immobilization, antibiotics, structured rehabilitation, and follow-up assessments at 2, 12, and 24 weeks. Functional outcomes were assessed using International Knee Documentation Committee (IKDC) scores, while donor site morbidity was evaluated using American Orthopaedic Foot and Ankle Society scores. Data were analyzed with the Statistical Package for the Social Sciences v26 using Chi-square tests, t-tests, and repeated measures Analysis of Variance; significance was set at $P < 0.05$.

**Results:** Both groups were demographically similar (60% males; mean age 32 years). Sports-related trauma was the most common cause of ACL injury. Group B (peroneus longus) had significantly larger graft diameters and lengths ($P < 0.01$). No surgical site infections occurred. Group A initially showed more graft-site paresthesia, which resolved by 24 weeks, while Group B experienced a temporary reduction in ankle eversion strength at 12 weeks, which normalized by 24 weeks. Functional outcomes, including IKDC scores and range of motion, were comparable between groups at 12 and 24 weeks.

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**Conclusion:** Arthroscopic ACL reconstruction using either hamstring or peroneus longus grafts results in similar clinical and functional outcomes at 6 months. The peroneus longus graft, despite a temporary impact on ankle eversion, is an effective and viable alternative to the HT graft.

**Keywords:** Anterior cruciate ligament, anterior cruciate ligament reconstruction, hamstring tendon graft, peroneus longus tendon graft, arthroscopic surgery, functional outcome, knee stability, donor site morbidity.

## Introduction

The knee is the largest and one of the most intricate synovial joints in the human body, functioning primarily as a hinge joint while permitting a degree of rotation. Its stability depends on a combination of bony anatomy, intra-articular structures, and a complex network of static and dynamic stabilizers [1].

The primary stabilizing ligaments include the anterior cruciate ligament (ACL), posterior cruciate ligament (PCL), and the medial collateral ligament (MCL) and lateral collateral ligament (LCL). These structures are vital for maintaining anteroposterior and coronal plane stability, as well as controlling rotational forces. Among them, the ACL is especially critical – it prevents anterior translation of the tibia and provides essential control during pivoting movements [2].

Dynamic support is further provided by the surrounding musculature, including the quadriceps and hamstrings, though their stabilizing capacity is secondary and less effective in the absence of intact ligamentous structures.

ACL injuries are some of the most common ligamentous injuries encountered in orthopedic practice, particularly among athletes involved in high-demand pivoting and cutting sports. Most often, these injuries occur through non-contact mechanisms, such as sudden deceleration, hyperextension, or directional changes, though contact-related trauma can also be involved. Patients typically present with a sudden "pop," joint effusion, and instability [3].

If left untreated, ACL tears can result in chronic knee instability, recurrent giving way, and increased risk of secondary damage, such as meniscal tears and articular cartilage degeneration, ultimately contributing to early-onset osteoarthritis. As a result, accurate diagnosis, thorough evaluation of associated injuries, and timely intervention are essential.

Surgical reconstruction remains the standard of care for symptomatic individuals, particularly those with high functional demands. Advancements in graft selection, surgical techniques, and rehabilitation protocols continue to evolve, intending to restore native knee kinematics and optimize long-term outcomes [4].

## Materials and Methods

### Study setting and period

The study was conducted at the Department of Orthopaedics, Maharishi Markandeshwar Institute of Medical Sciences and Research, Mullana, over a period of 24 months to evaluate the functional outcomes of arthroscopic ACL reconstruction using autografts from the hamstring and peroneus longus tendons (PLTs) after taking clearance from the institute'' ethics committee IEC NO.-2760 on date December 13, 2023.

### Sample size and sampling technique

A total of 30 patients, aged 18–45 years, who underwent ACL reconstruction with either hamstring or PLT autografts, were included. Participants were selected using randomized sampling.

### Inclusion and exclusion criteria

#### Inclusion criteria

Symptomatic ACL insufficiency confirmed clinically or through magnetic resonance imaging, age 18–45 years, and no history of prior knee surgery.

#### Exclusion criteria



**Figure 1:** Skin incision for hamstring tendon graft harvesting.



**Figure 2:** Hamstring graft harvesting from pes anserine.



**Figure 3:** Skin incision site for peroneus longus graft.

Asymptomatic individuals, patients below 18 or above 45 years, systemic conditions affecting pre-anesthetic fitness, presence of PCL, MCL, or LCL injuries, osteoarthritis or tibial plateau fractures, active skin infections, or axial malalignment, such as varus deformity.

### Clinical confirmation of ACL tear

Diagnosis of ACL tears was confirmed through a combination of detailed patient history, physical examination, and imaging studies to ensure accurate selection of suitable candidates for the study.

### Preoperative workup

Patients admitted with confirmed ACL tears underwent routine laboratory and imaging investigations, along with an anesthetic assessment to determine suitability for regional or general anesthesia.

### Preoperative rehabilitation

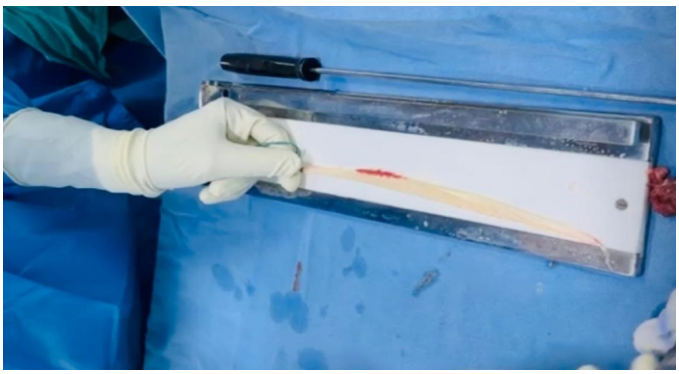


**Figure 5:** Harvested graft.



**Figure 4:** Tagged peroneus longus graft with suture for harvesting

Knee joint strength and range of motion (ROM) were assessed and recorded before surgery. Patients were instructed in static and dynamic quadriceps exercises to maintain muscle conditioning, and all participants received detailed education regarding the post-operative rehabilitation protocol to optimize recovery.

### Surgical technique and ACL reconstruction

### Preparation and anesthesia

All procedures were performed in a sterile orthopedic operating theatre with prophylactic antibiotics. Spinal or epidural anesthesia was administered to all patients.

### Positioning and limb preparation



**Figure 6:** Graft size measurement.

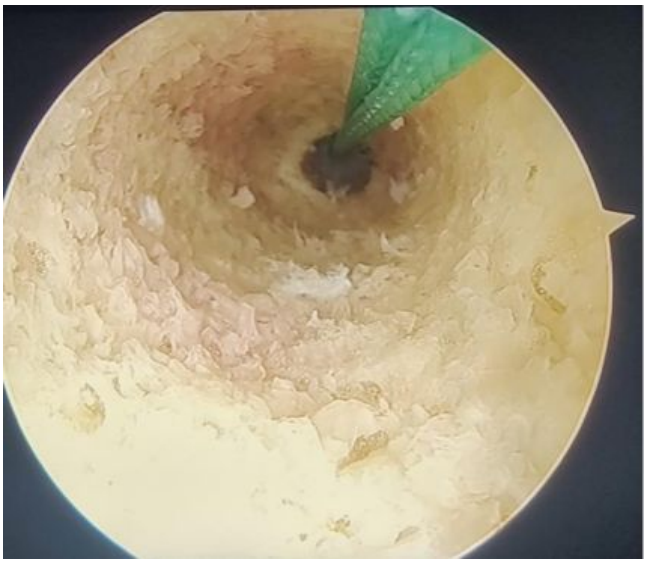


**Figure 7:** Femoral tunnel.

The operative leg was secured with a leg holder and lateral support post, and a tourniquet was applied. The limb was thoroughly cleaned using aseptic techniques, draped, and positioned supine with the knee flexed at 90°. Sterile gowns were worn by the surgical team to maintain a clean environment.

### Arthroscopic portal creation and diagnostic arthroscopy

Standard anterolateral and anteromedial arthroscopic portals were established. The anterolateral portal was used for visualization with a 4 mm, 30° arthroscope, while the anteromedial portal served as the primary working portal. Diagnostic arthroscopy assessed menisci, cruciate ligaments, cartilage, and other intra-articular structures, with joint distension maintained using normal saline.

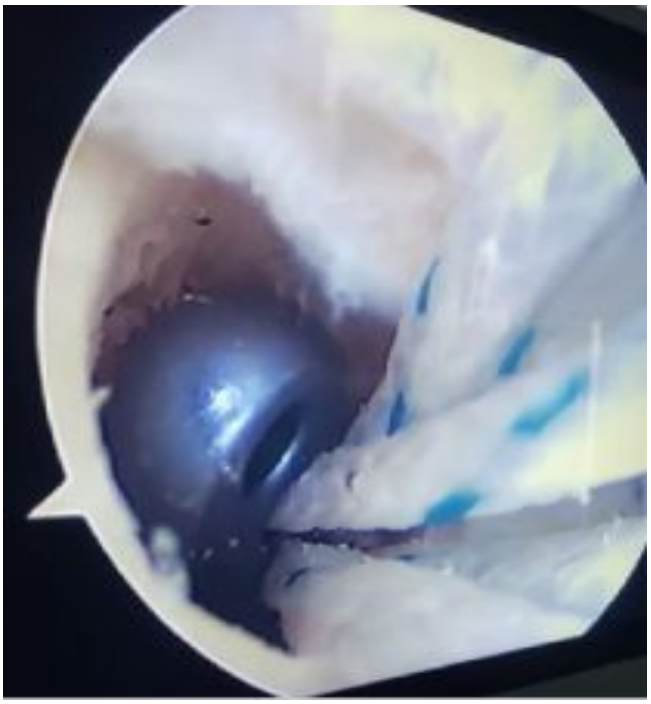


**Figure 9:** Graft fixation with adjustable loop endobutton.

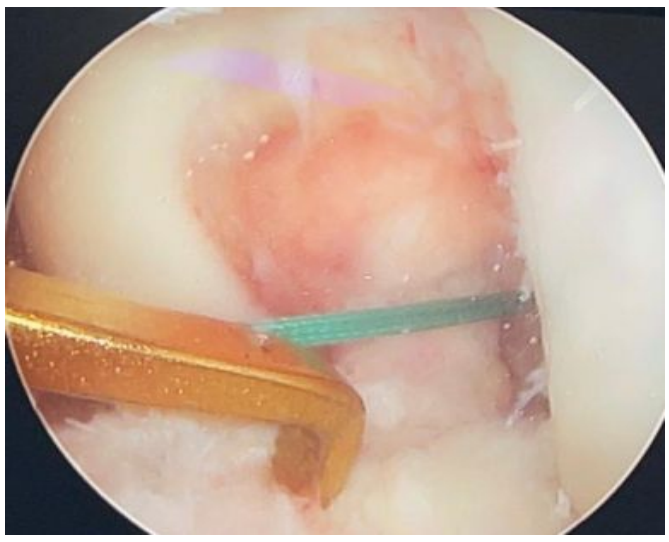


**Figure 8:** Tibial tunnel.

### Graft harvesting and preparation

#### Hamstring graft

A 4 cm anteromedial tibial incision exposed the gracilis and semitendinosus tendons, which were dissected, released, measured, and folded into a quadrupled graft using Krackow sutures (Fig. 1 and 2).

#### Peroneus longus graft

A 2–3 cm lateral distal leg incision exposed the PLT, which was harvested, cleaned, measured, and folded into a double-loop graft suitable for ACL reconstruction (Fig. 3 and 4). Figs. 5 and 6 show graft size measurement and preparation.

### ACL reconstruction and tunnel creation

The femoral footprint was identified arthroscopically, and a femoral tunnel was drilled using a guidewire and cannulated reamer to match the graft diameter (Fig. 7). The tibial tunnel was created using a tibial guide and reamer aligned with the anatomical footprint (Fig. 8).

### Graft fixation

The graft was passed through the tibial and femoral tunnels and

**Table 1: Pre-operative functional assessment of patients in Group A, that is, hamstring tendon graft, and Group B (peroneus longus tendon graft)**

| Parameter | Group A Graft ($n$=15) (%) | Group B ($n$=15) (%) | $P$-value |
|---|---|---|---|
| Anterior drawer test (Grade) | | | 0.28[a] |
| Grade 2 | 5 (33.3) | 4 (26.7) | |
| Grade 3 | 10 (66.7) | 11 (73.3) | |
| Lachman test (Grade) | | | 0.28 [a] |
| Grade 2 | 5 (33.3) | 4 (26.7) | |
| Grade 3 | 10 (66.7) | 11 (73.3) | |
| IKDC score (Mean±SD) | 46.1±2.9 | 47.6±3.47 | 0.21[b] |
| Range of motion (°) | 99.3±9.6 | 101±9.15 | 0.16[b] |

IKDC: International Knee Documentation Committee, SD: Standard deviation
a = chi square test, b = student t - test

secured proximally with a suspensory fixation device (EndoButton) and distally with a bioabsorbable or titanium interference screw. Graft cycling was performed to distribute tension and prevent slack, and final arthroscopic inspection ensured proper orientation and impingement-free motion (Fig. 9).

### Post-fixation and wound management

Post-operative imaging confirmed tunnel and fixation placement. Wounds were closed with subcutaneous and skin sutures, a sterile dressing applied, and a knee brace fitted.

### Post-operative protocol and evaluation

The limb was immobilized, elevated, and IV antibiotics were administered for 5 days. Wounds were inspected on post-operative days 2 and 7, and sutures removed on day 14. Early rehabilitation commenced under physiotherapist supervision. Follow-up evaluations occurred at 2, 6, 12, and 24 weeks, with radiographs assessing tunnel and fixation positions and functional outcomes measured using standardized scoring systems for knee stability, ROM, and patient-reported outcomes.

### Scoring and statistical analysis

Functional outcomes were evaluated using the International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, an ordinal scoring system where higher scores indicate better knee function and fewer symptoms. Activities were graded from 0 (unable to perform due to knee pain) to 4 (very strenuous activities, such as jumping or pivoting), and pain frequency was scored from 0 (constant) to 10 (never). The total score from individual items was transformed to a scale of 0–100, with 100 indicating full knee function without restrictions. A valid IKDC score required responses to at least 90% of items. Donor site morbidity was assessed pre- and post-operatively using the American Orthopaedic Foot and Ankle Society (AOFAS) score to evaluate ankle function after grafts harvesting.

For statistical analysis, data were recorded in a pre-designed case record form and entered into Microsoft Excel, then analyzed using the Statistical Package for the Social Sciences version 26. Continuous variables, such as age or graft

**Table 2: Post-operative functional assessment of patients in Group A, that is, hamstring tendon graft, and Group B (Peroneus longus tendon graft) at 12 weeks**

| Parameter | Group A hamstring tendon graft ($n$=15) (%) | Group B Peroneus longus tendon graft ($n$=15) (%) | $P$-value |
|---|---|---|---|
| Anterior drawer test (Grade) | | | 0.66[a] |
| Grade 0 | 11 (73.3) | 12 (80) | |
| Grade 1 | 4 (26.7) | 3 (20) | |
| Lachman test (Grade) | | | 0.65[a] |
| Grade 0 | 11 (73.3) | 12 (80) | |
| Grade 1 | 4 (26.7) | 3 (20) | |
| IKDC score (Mean±SD) | 82±1.05 | 82.2±1.23 | 0.66[b] |
| Range of motion (°) | 113.7±4.8 | 116.3±3.99 | 0.11[b] |

IKDC: International Knee Documentation Committee, SD: Standard deviation, a = chi square test, b = student t - test

**Table 3: Post-operative functional assessment of patients in Group A, that is, hamstring tendon graft, and Group B (peroneus longus tendon graft) at 24 weeks**

| Parameter | Group A Hamstring Tendon graft ($n$=15) (%) | Group B Peroneus longus tendon graft ($n$=15) (%) | $P$-value |
|---|---|---|---|
| Anterior drawer test (Grade) | | | 0.62[a] |
| Grade 0 | 12 (80) | 13 (86.7) | |
| Grade 1 | 3 (20) | 2 (13.3) | |
| Lachman test (Grade) | | | 0.62[a] |
| Grade 0 | 12 (80) | 13 (86.7) | |
| Grade 1 | 3 (20) | 2 (13.3) | |
| IKDC score (Mean±SD) | 90.7±1.75 | 90.8±2.19 | 0.94[b] |
| Range of motion (°) | 122.1±4.1 | 124±2.91 | 0.103[b] |

IKDC: International Knee Documentation Committee, SD: Standard deviation
a = chi square test, b = student t - test

**Table 4 : Pre- and post-operative functional scoring of patients in Group A (Hamstring Tendon Graft). (*n*=15)**

| Test | Pre-operative | Post-operative (3 months) | Post-operative (6 months) | *P*-value* |
|---|---|---|---|---|
| IKDC score (Mean±SD) | 46.1±2.9 | 82±1.05 | 90.7±1.75 | <0.01 |
| Range of motion (°) | 99.3±9.6 | 113.7±4.8 | 122.1±4.1 | <0.01 |

**IKDC: International Knee Documentation Committee, SD: Standard deviation * repeated measures ANOVA**

measurements, were expressed as mean ± standard deviation, while categorical variables, such as gender or type of graft, were presented as counts and percentages. Differences between the hamstring and peroneus longus graft groups were analyzed using the Chi-square test for categorical data and the Student's t-test for continuous data. Repeated measures Analysis of Variance was employed to assess within-group changes over multiple follow-up time points. A $P < 0.05$ was considered statistically significant.

## Results

### Demographic characteristics

The study included 30 patients with complete ACL tears, equally divided into Group A (Hamstring Tendon [HT] Graft) and Group B (PLT Graft). Both groups had similar demographics, with 60% males and 40% females. The majority of patients were aged 31–40 years (66.7% in Group A, 73.3% in Group B), with mean ages of 32.17 ± 4.71 years and 32.83 ± 4.42 years, respectively. The distribution of affected knees was nearly equal, with left and right knees involved in roughly half of the patients in each group.

### Mode and timing of injury

Sports injuries were the predominant cause of ACL tears (66.7% in Group A, 60% in Group B), followed by road traffic accidents and trauma. Most patients underwent ACL reconstruction within 1 month of injury (46.7% in both groups), while a smaller proportion had surgery between 1 and 2 months, 2 and 3 months, or after 3 months.

### Functional outcomes

Preoperatively, both groups had comparable IKDC scores (Group A: 46.1 ± 2.9; Group B: 47.6 ± 3.47) and ROM (99.3° vs. 101°) (Table 1). Post-operative assessments at 12 and 24 weeks showed significant improvement in both groups, with no statistically significant differences between them (Table 2). At 24 weeks, IKDC scores reached 90.7 ± 1.75 in Group A and 91.7 ± 1.56 in Group B, and mean ROM increased to 122.1° and 124°, respectively ($P > 0.05$) (Table 3). pre and post operative functional scoring in hamstring group [group A][Table 4]. pre and post operative functional scoring in Peroneus longus group [group B][Table 5].

**Table 5: Pre- and post-operative functional scoring of patients in Group B (peroneus longus tendon graft). (*n*=15)**

| Test | Pre-operative | Post- operative (3 months) | Post-operative (6 months) | *P*-value* |
|---|---|---|---|---|
| IKDC score (Mean±SD) | 47.6±3.47 | 82.2±1.23 | 91.7±1.56 | <0.01 |
| Range of motion (°) | 101±9.15 | 116±4.81 | 124±2.91 | <0.01 |

**IKDC: International Knee Documentation Committee, SD: Standard deviation, * repeated measures ANOVA**

**Table 6: Assessment of eversion and plantar flexion muscle strength of donor ankle by MRC scale in group B**

| Ankle function | Pre-operative (%) | Post-operative (12 weeks) (%) | Post-operative (24 weeks) (%) |
|---|---|---|---|
| Eversion power | | | |
| Grade 4 | 0 | 1 (6.7) | 0 |
| Grade 5 | 15 (100) | 14 (93.3) | 15 (100) |
| Plantar flexion | | | |
| Grade 5 | 15 (100) | 15 (100) | 15 (100) |

**MRC: Medical Research Council**

### Graft characteristics

The Peroneus Longus graft (Group B) had a significantly larger mean diameter (8.70 ± 0.25 mm) and length (270 ± 7.19 mm) compared to the Hamstring graft (Group A: 8.27 ± 0.32 mm, 255 ± 12.02 mm; $P < 0.01$) (Table 6).

### Post-operative complications

No surgical site infections were reported in either group at 12 or 24 weeks. Graft-site paresthesia was initially higher in Group A (20% at 12 weeks) but resolved by 24 weeks; only 1 patient in Group B had transient paresthesia at 12 weeks. Donor-site ankle morbidity in Group B showed a temporary reduction in AOFAS scores at 12 weeks (94.13), which improved by 24 weeks (98.4, $P < 0.01$). Eversion strength

**Table 7: Graft characteristics**

| Parameter | Group A | Group B | *P*-value* |
|---|---|---|---|
| | Hamstring tendon graft (*n*=15) | Peroneus longus tendon graft (*n*=15) | |
| | (Mean±SD) | (Mean±SD) | |
| Graft diameter (mm) | 8.27±0.32 | 8.70±0.25 | <0.01 |
| Graft length (mm) | 255±12.02 | 270±7.19 | <0.01 |

**SD: Standard deviation, *- repeated measures ANOVA**

showed a slight decrease at 12 weeks in 1 patient but fully recovered by 24 weeks, while plantar flexion remained intact throughout.[Table 7].

### Summary

Both grafts provided excellent functional recovery, with significant improvements in IKDC scores and knee ROM over 6 months. While the Peroneus Longus graft had larger dimensions, it caused only a temporary reduction in ankle eversion strength, which fully recovered by 24 weeks, indicating it as a viable alternative to the HT graft for ACL reconstruction.

## Discussion

### Overview of ACL injuries and graft options

ACL injuries are among the most common sports-related and trauma-associated knee injuries, especially in active and physically demanding populations [5]. Arthroscopic ACL reconstruction is well established as the gold-standard treatment to restore knee stability and function. While the HT autograft has traditionally been favored due to its favorable strength, consistent graft size, and relatively low donor site morbidity , alternative grafts, such as bone-patellar tendon-bone, quadriceps tendon grafts, allografts, and synthetics (e.g., ligament augmentation and reconstruction system) have also been explored. Recently, the PLT has gained interest as a viable alternative, with several studies suggesting comparable functional outcomes, larger graft dimensions, and limited knee donor site morbidity [6].

### Participant characteristics

#### Sex distribution

In this study, both graft groups had an equal sex distribution (60% male and 40% female), consistent with published cohorts reporting male predominance in ACL injuries due to higher participation of males in high-impact sports. Nazem et al. also noted a male majority in their cohort of 375 ACL reconstructions, aligning with findings from Reddy et al. where males predominated in a 50-patient ACLR series with road traffic injuries[7]. However, studies by Agarwal et al. and Asif et al. reported more balanced sex ratios, possibly reflecting increased female engagement in competitive sports [8,11].

#### Age distribution

The majority of participants in both groups were aged 31–40 years, with mean ages of approximately 32 years, aligning with other studies that suggest ACL tears are most prevalent in the third and fourth decades due to higher physical activity and occupational strain. Younger patients (21–30 years) constituted a smaller proportion in this study, comparable to Agarwal et al.'s findings of fewer injuries in younger cohorts [8].

#### Side distribution

This study showed near-equal left and right knee involvement in both groups, consistent with previous literature suggesting no strong side predilection in ACL injuries. Limb dominance, external forces, and biomechanical factors likely contribute to the multifactorial nature of injury laterality, as discussed by Vijay et al. [9].

#### Mode of injury

Sportsrelated activities were the predominant cause of ACL injuries in both groups, accounting for 66.7% and 60% in the HT and PLT groups, respectively, supported by similar findings in studies involving younger, active populations. Mechanical forces during pivoting or jumping significantly increase ACL load. Road traffic accidents and direct trauma accounted for the remainder, similar to patterns described by Keyhani et al. [10].

### Surgical parameters and graft characteristics

PLT grafts in this study had significantly larger diameters (mean 8.70 mm) and lengths (mean 270 mm) compared with HT grafts (mean diameter 8.27 mm, length 255 mm; $P < 0.01$). These findings are consistent with prior evidence indicating that PLT grafts generally provide larger cross-sectional area and length, which may confer biomechanical advantages and potential reductions in graft failure risk. Larger grafts also necessitated slightly wider tibial screw diameters in the PLT group, as reported in Keyhani et al. and Asif et al. [10, 11].

### Post-operative complications

#### Surgical site infections

No surgical site infections were observed in either group at 12 and 24 weeks, echoing the low infection rates documented in ACL reconstruction cohorts when aseptic technique and prophylactic antibiotic protocols are followed.

### Paresthesia

Graft-site paresthesia was more frequent in the HT group at 12 weeks (20%) compared with the PLT group (6.7%), but declined by 24 weeks. This trend aligns with studies linking nerve irritation at hamstring harvest sites with early sensory disturbances. Lower donor site paresthesia in the PLT group may result from its harvest location outside the knee joint capsule [12].

### Donor site morbidity (PLT group)

PLT donor site assessment showed a temporary decline in AOFAS scores at 12 weeks with significant recovery by 24 weeks, demonstrating minimal long-term functional impairment. Similarly, transient reduction in ankle eversion strength was noted at 12 weeks but fully resolved by 24 weeks, and plantar flexion remained unaffected throughout. These outcomes align with reports of minimal donor site morbidity and recovery of ankle strength following PLT harvest, reinforcing the PLT graft's safety in preserving ankle function (Table 6) [13].

### Functional outcomes

### Pre- and post-operative knee function

Preoperative functional assessments indicated similar baseline knee stability and IKDC scores between groups, consistent with prior comparisons of ACL graft cohorts. Both groups showed significant improvements at 12 and 24 weeks in Anterior Drawer and Lachman tests, IKDC scores, and ROM, with no statistically significant differences between graft types at any post-operative time point. These findings corroborate a growing body of evidence demonstrating comparable functional recovery between HT and PLT grafts [14, 15].

Studies by He et al. and Keyhani et al. reported analogous functional outcomes and graft survivorship between PLT and HT, including slightly better subjective scores in PLT groups [16]. Reddy et al. found similar knee stability outcomes with both grafts at mid-term follow-up [7]. Agarwal et al. reported equivalent IKDC and Lysholm scores at 6–12 months, further supporting the equivalence of these grafts. Vijay et al. and Asif et al. also highlighted early return to activity and larger graft dimensions with PLT without increased morbidity [9].

## Conclusion

This study demonstrates that both HT and PLT grafts provide effective, comparable functional and clinical outcomes following arthroscopic ACL reconstruction. The PLT graft offers larger graft size and minimal donor site morbidity with transient, non-impactful ankle strength changes and no compromise in long-term ankle or knee function. These findings support the PLT graft as a reliable alternative to the conventional HT graft, particularly in cases where preserving hamstring integrity or attaining a larger graft diameter is clinically desirable.

**Clinical Message**

Peroneus longus tendon is a viable autologous graft option for arthroscopic ACL reconstruction, providing larger graft dimensions and comparable 6-month functional outcomes to quadrupled HT grafts. Although temporary reduction in ankle eversion strength may occur following peroneus longus tendon harvest, it appears to resolve during rehabilitation. Thus, the peroneus longus tendon can be considered an alternative graft, particularly when a larger graft diameter is required.

**Declaration of patient consent:** The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

**Conflict of interest:** Nil **Source of support:** None

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