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Outcomes and donor site morbidity of various grafts in arthroscopic ACL reconstruction

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Abstract
Background: Anterior cruciate ligament (ACL) reconstruction is a commonly performed procedure for knee injuries, with autografts such as hamstring tendon and peroneus longus tendon being frequently used. This study aims to compare the functional outcomes and donor site morbidity of these two grafts to identify the better option for ACL reconstruction.
Objective: To assess and compare the functional outcomes and donor site morbidity of peroneus longus tendon versus hamstring tendon grafts in arthroscopic ACL reconstruction.
Methods: This prospective cohort study included 32 participants diagnosed with isolated ACL tears who underwent arthroscopic ACL reconstruction using either a hamstring tendon or peroneus longus tendon graft. Participants were randomly assigned to one of the two graft groups, with 16 in each. Functional outcomes were assessed preoperatively and at 4 and 12 weeks postoperatively using the International Knee Documentation Committee (IKDC) and Lysholm scores. Donor site morbidity was assessed qualitatively. Statistical analyses were conducted using chi-square tests for demographic factors and t-tests for functional outcomes, with p-values <0.05 considered significant.
Results: Preoperative IKDC and Lysholm scores were significantly higher in the peroneus longus group (43.84±4.73, 32.20±6.08) compared to the hamstring group (41.60±6.09, 25.96±3.79; $p < 0.05$). At 4 weeks postoperatively, peroneus longus group showed superior IKDC (61.46±6.22 vs. 57.63±4.28; $p = 0.022$) and Lysholm scores (50.63±5.64 vs. 48.19±6.03; $p = 0.049$). By 12 weeks, functional outcomes were slightly outperforming with the peroneus longus group in IKDC (80.15±5.32 vs. 75.52±4.46; $p = 0.047$) and Lysholm scores (69.96±4.98 vs. 69.49±5.79; $p = 0.024$). Donor site morbidity was minimal for both grafts, with no severe complications reported.
Conclusion: In conclusion, both hamstring tendon and peroneus longus tendon grafts showed favorable functional outcomes in ACL reconstruction, with peroneus longus tendon grafts demonstrating slightly superior results at 4 and 12 weeks postoperatively. Donor site morbidity was minimal for both graft types, suggesting that either graft can be a viable option depending on patient-specific factors.

Keywords: ACL reconstruction, hamstring tendon, peroneus longus tendon, functional outcomes, donor site morbidity

Introduction
The anterior cruciate ligament (ACL) is a critical stabilizer in the knee joint, playing a pivotal role in maintaining anterior-posterior and rotational stability. ACL injuries are among the most frequent ligament injuries of the knee, with an estimated incidence of 1.5%-1.7% annually in the general population, accounting for approximately 50% of all knee injuries requiring surgical intervention [1]. ACL tears typically result from high-stress movements, such as pivoting, twisting, or deceleration, particularly in athletes. These injuries are debilitating, leading to knee instability, compromised joint function, and an increased risk of early osteoarthritis if untreated [2].
The poor intrinsic healing potential of the ACL necessitates surgical reconstruction for optimal functional outcomes in most cases. ACL reconstruction (ACLR) involves the replacement of the torn ligament with an autograft, allograft, or synthetic graft, among which autografts remain the most preferred due to superior integration and lower rejection rates [3]. The most commonly used autografts are the bone-patellar tendon-bone (BPTB) graft and the hamstring tendon graft, both of which offer distinct advantages and disadvantages. The BPTB graft, considered the historical "gold standard," provides excellent initial strength and fixation;

however, it is associated with donor site morbidity, including anterior knee pain, patellar tendonitis, and difficulty kneeling [4].

Hamstring tendon grafts have become increasingly popular due to their minimal donor site morbidity, less anterior knee pain, and ease of harvesting. However, concerns about variable tendon sizes, potential muscle weakness, and reduced graft integrity in some individuals persist [5]. Recent advancements in ACLR research have focused on alternative graft options, such as the quadriceps tendon, Achilles tendon, and synthetic grafts. Despite these alternatives, there is no universal consensus on the ideal graft choice, highlighting the need for further exploration of novel options with favorable biomechanical properties and minimal complications [6].

The peroneus longus tendon (PLT) graft has emerged as a promising alternative due to its biomechanical characteristics, availability, and minimal impact on donor site morbidity. Studies have demonstrated that the PLT graft has comparable tensile strength, length, and diameter to the hamstring tendon graft, making it a viable substitute [7]. Additionally, the synergistic action of the peroneus longus and peroneus brevis muscles compensates for the harvested tendon, minimizing functional deficits at the ankle. Research has indicated that the peroneus brevis is a more effective evertor of the foot than the peroneus longus, further justifying the latter's harvest [8].

The advantages of the PLT graft extend beyond its biomechanical properties. It offers ease of harvesting with minimal dissection and reduced operative time, contributing to faster recovery. Moreover, it avoids the complications typically associated with hamstring and patellar tendon grafts, such as knee pain, reduced strength, and graft site morbidity. However, limited comparative studies and concerns about long-term donor site complications, such as ankle instability, necessitate further investigation [9].

Functional outcomes following ACLR are primarily assessed using standardized scoring systems, such as the International Knee Documentation Committee (IKDC) score and the Lysholm score. These metrics evaluate knee stability, pain, mobility, and overall functional capacity. Previous studies have shown comparable IKDC and Lysholm scores between the hamstring and PLT grafts, with some suggesting superior outcomes in certain parameters, such as reduced thigh hypotrophy and faster recovery [10]. Additionally, donor site morbidity is a critical consideration in graft selection. While hamstring grafts are associated with muscle weakness and decreased knee flexion strength, PLT grafts may cause mild ankle eversion weakness, although these deficits are typically transient and clinically insignificant [11].

Despite significant advancements in ACLR techniques, the optimal graft choice remains a subject of debate among orthopedic surgeons. The hamstring tendon graft, while widely regarded as the current gold standard, has limitations that warrant the exploration of alternatives. Variability in tendon size, donor site morbidity, and the potential for reduced knee flexion strength highlight the need for alternative autografts with comparable or superior outcomes [12, 13, 14]. The PLT graft offers a unique opportunity to address these challenges, with preliminary evidence suggesting favorable biomechanical properties, minimal donor site complications, and promising clinical outcomes.

However, concerns about donor site morbidity at the ankle and the relative lack of long-term data on PLT grafts have limited their widespread adoption. This study aims to address these gaps by providing a comprehensive comparative analysis of functional outcomes and donor site morbidity between PLT and hamstring tendon grafts in ACLR. By focusing on objective parameters, such as IKDC and Lysholm scores, and subjective measures of patient-reported outcomes, this study seeks to provide robust evidence to guide clinical decision-making.

The primary objective of this study is to compare the functional outcomes of ACLR using PLT and hamstring tendon grafts. This includes assessing knee stability, pain, mobility, and overall functional capacity using standardized scoring systems. Secondary objectives include evaluating donor site morbidity, with specific attention to ankle eversion strength in the PLT group and hamstring muscle strength in the hamstring graft group. These findings will be critical in determining whether the PLT graft can be considered a viable alternative to the hamstring tendon graft in routine clinical practice.

Methodology

1. Study Design

This study was a prospective cohort study designed to evaluate and compare the functional outcomes of anterior cruciate ligament (ACL) reconstruction using peroneus longus tendon and hamstring tendon as grafts. The study followed patients postoperatively over a period of six months to assess knee stability, functional recovery, and donor site morbidity using validated scoring systems such as the International Knee Documentation Committee (IKDC) and Lysholm scales.

2. Study Setting

The research was conducted at Sri Siddhartha Medical College and Hospital, Tumkuru, Karnataka, a tertiary care center equipped with state-of-the-art orthopedic facilities. Participants were recruited from the outpatient department (OPD) and orthopedic wards of the hospital, ensuring access to a diverse patient population with ACL injuries.

3. Study Duration

The study was carried out over a total duration of 20 months, beginning in March 2023 and concluding in October 2024. This timeline allowed for adequate participant recruitment, surgical interventions, and follow-ups at the end of the 1st, 3rd, and 6th months postoperatively.

4. Participants

Inclusion Criteria

- Male and female patients aged 18-60 years.
- Patients diagnosed clinically and radiologically with isolated ACL tears.
- Patients with normal contralateral knees.
- Patients without a history of prior knee surgeries.
- Patients who provided written informed consent.

Exclusion Criteria

- Patients with multiple ligament injuries.
- Patients with associated head injuries or spine injuries.
- Patients with fractures around the knee joint.
- Patients unable to provide consent or who withdrew consent.

5. Study Sampling

Participants were selected using purposive sampling. Eligible patients attending the orthopedic OPD and wards who met the inclusion and exclusion criteria were invited to participate.

Randomization was employed to assign patients to one of the two graft groups.

6. Study Sample Size

The sample size was calculated based on the expected mean and standard deviation of functional outcomes from previous studies. Assuming the functional outcome scores for peroneus longus and hamstring tendon grafts to have standard deviations of 8.5 and 4.98, respectively, a power of 80%, and a confidence interval of 95%, the minimum sample size was determined to be 56. To account for a 10% non-response rate, the final sample size was set at 62 participants, with 31 patients in each group.

7. Study Groups

Participants were randomly divided into two groups:

- **Group 1:** Patients underwent ACL reconstruction using the peroneus longus tendon graft.
- **Group 2:** Patients underwent ACL reconstruction using the hamstring tendon graft.

8. Study Parameters

The study assessed the following parameters:

- **Primary outcomes:** Functional outcomes using IKDC and Lysholm scores to evaluate knee stability, pain, and mobility.
- **Secondary outcomes:** Donor site morbidity, including ankle eversion strength for the peroneus longus graft and hamstring strength for the hamstring tendon graft.
- **Tertiary outcomes:** Assessment of patient-reported pain and joint stability during activities of daily living.

9. Study Procedure

Eligible participants were first screened through a detailed clinical history and physical examination. Clinical tests such as the Lachman test, anterior drawer test, and pivot shift test were conducted to confirm ACL injury. Radiological evaluation included X-rays and MRI of the affected knee to corroborate clinical findings. Participants were randomized into the study groups and underwent ACL reconstruction surgery under spinal anesthesia.

- The peroneus longus tendon graft was harvested from the lateral side of the ankle, while the hamstring tendon graft was obtained from the posterior aspect of the thigh.
- Postoperatively, patients were managed with a standardized rehabilitation protocol and monitored at regular intervals for six months.

10. Study Data Collection

Data were collected at baseline and during follow-up visits at the 1st, 3rd, and 6th months postoperatively. Information recorded included:

- Demographics and clinical history.
- Baseline knee stability and function using IKDC and Lysholm scores.
- Postoperative functional outcomes using the same scoring systems.
- Donor site morbidity assessed through ankle function (AOFAS score) and visual analog scale foot and ankle (VAS-FA) scores for peroneus longus, and thigh strength for hamstring grafts.

11. Data Analysis

Data were entered into an Excel spreadsheet and analyzed using SPSS version 26. Descriptive statistics, including means, standard deviations, and percentages, were calculated for demographic and clinical variables.

- The independent sample t-test was used to compare functional outcomes between the two groups.
- The Chi-square test was employed to assess associations between categorical variables.
- A p-value of less than 0.05 was considered statistically significant.

12. Ethical Considerations

Ethical clearance was obtained from the Institutional Ethics Committee of Sri Siddhartha Medical College prior to commencing the study. Participants were informed about the study's objectives, procedures, potential risks, and benefits in their native language. Written informed consent was obtained from all participants.

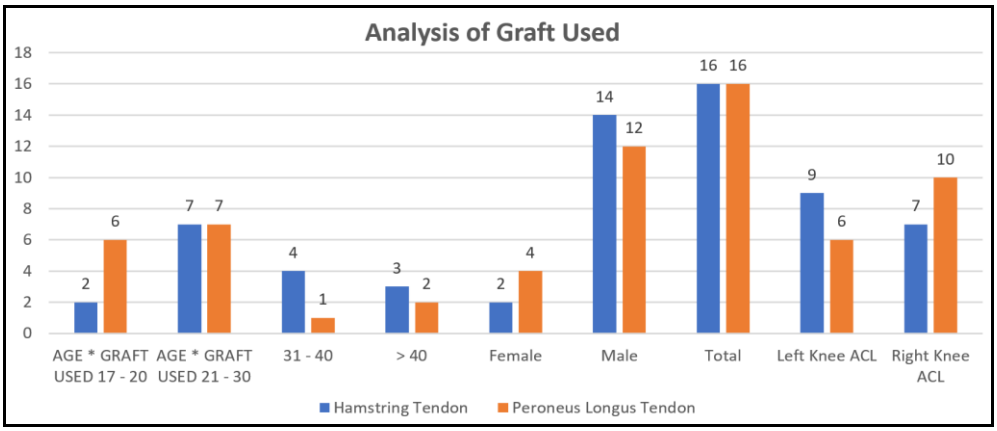
- Confidentiality was maintained by anonymizing patient data and securely storing records.
- Adverse events were closely monitored and reported to the ethics committee, with appropriate measures taken to ensure participant safety.

Results and Analysis

The crosstab analysis revealed that participants aged 17-20 predominantly opted for peroneus longus tendon grafts (6), while only 2 chose hamstring tendon grafts. In the 21-30 age group, both graft types were equally distributed (7 each). For ages 31-40, 4 participants used hamstring grafts, whereas only 1 used peroneus longus grafts. Among participants above 40 years, 3 selected hamstring grafts, and 2 selected peroneus longus grafts. The chi-square value of 4.000 with a p-value of 0.261 indicates no significant association between age and graft type. Among the 6 female participants, 4 underwent ACL reconstruction using peroneus longus tendon grafts, while 2 used hamstring tendon grafts. Among the 26 male participants, 14 used hamstring tendon grafts, and 12 used peroneus longus tendon grafts. The chi-square value of 0.821 with a p-value of 0.365 indicates no significant association between gender and graft type. Participants with left knee ACL injuries predominantly used hamstring grafts (9) compared to peroneus longus grafts (6). For right knee ACL injuries, the distribution was reversed, with 10 participants opting for peroneus longus grafts and 7 for hamstring grafts. The chi-square value of 1.129 with a p-value of 0.288 indicates no significant association between the affected knee and graft type.

Table 1: Analysis of Graft Used

Crosstab	Hamstring Tendon	Peroneus Longus Tendon	Total	Chi-Square Tests	P value
AGE * GRAFT USED					
17-20	2	6	8	4.000	0.261
21-30	7	7	14		
31-40	4	1	5		
> 40	3	2	5		
Total	16	16	32		
SEX * GRAFT USED					
Female	2	4	6	0.821	0.365
Male	14	12	26		
Total	16	16	32		
DIAGNOSIS * GRAFT USED					
Left Knee ACL	9	6	15	1.129	0.288
Right Knee ACL	7	10	17		
Total	16	16	32		



Graph 1: Analysis of Graft Used

The mean preoperative IKDC score for participants using hamstring grafts was 41.60±6.09, while for peroneus longus grafts, it was 43.84±4.73. The F-value of 10.111 and p-value of 0.000 indicate a statistically significant difference, with better baseline scores for the peroneus longus group.

At 4 weeks postoperatively, participants using hamstring grafts had a mean IKDC score of 61.46±6.22, compared to 57.63±4.28 for those with peroneus longus grafts. The F-value of 5.949 and p-value of 0.022 indicate a significant difference, favoring hamstring grafts for early postoperative recovery.

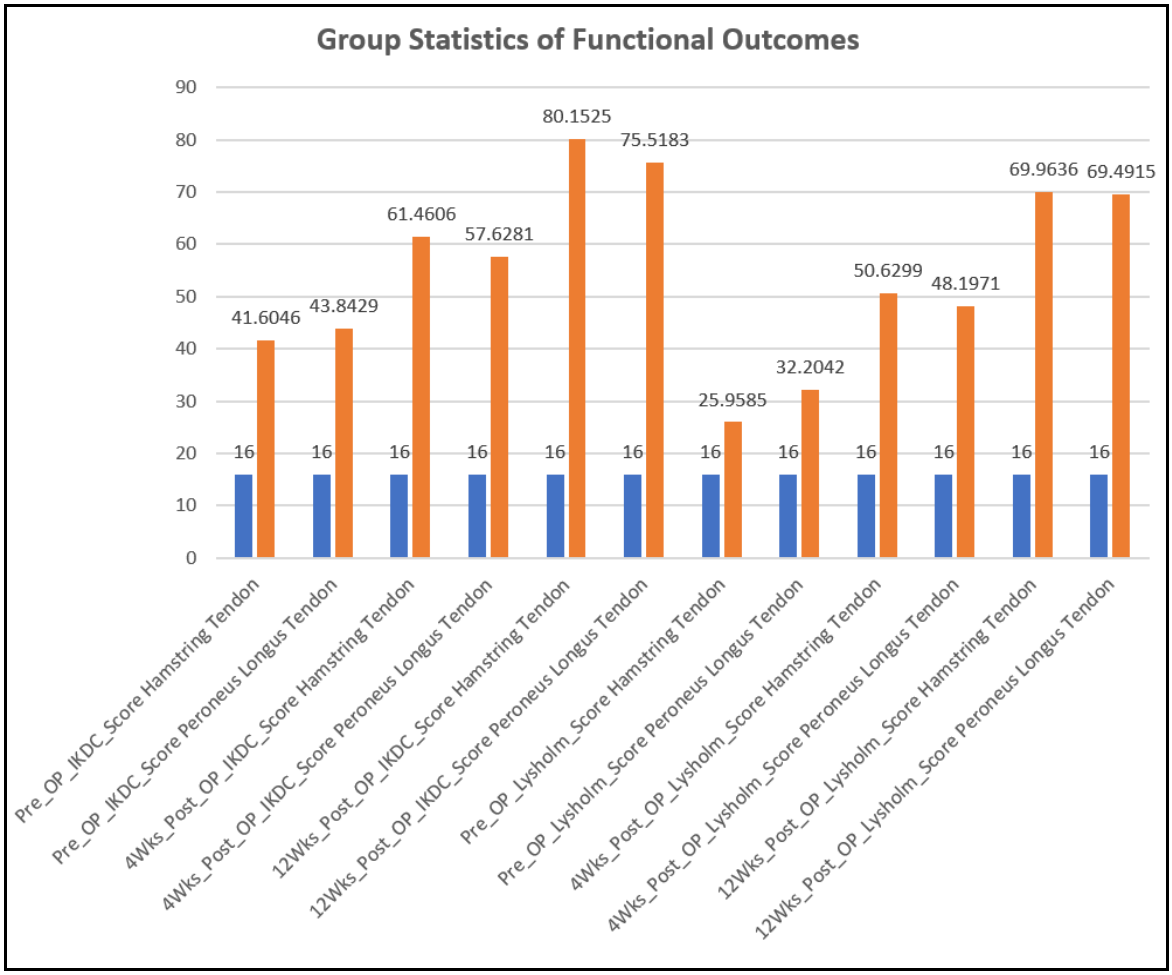
Twelve weeks postoperatively, hamstring grafts again showed higher mean IKDC scores (80.15±5.32) compared to peroneus longus grafts (75.52±4.46). The F-value of 4.005 and p-value of 0.047 confirm a significant difference, suggesting better short-term recovery with hamstring grafts.

Preoperative Lysholm scores were significantly higher for the peroneus longus group (Mean = 32.20±6.08) compared to the hamstring group (Mean = 25.96±3.79). The F-value of 5.587 and p-value of 0.025 highlight this significant difference, indicating better baseline knee function in the peroneus longus group. Four weeks postoperatively, the hamstring group showed higher Lysholm scores (Mean = 50.63±5.64) compared to the peroneus longus group (Mean = 48.19±6.03). The F-value of 3.967 and p-value of 0.049 suggest a slight but significant advantage for hamstring grafts in early recovery.

At 12 weeks postoperatively, Lysholm scores were nearly similar between the two groups, with the hamstring group scoring 69.96±4.98 and the peroneus longus group scoring 69.49±5.79. The F-value of 5.658 and p-value of 0.024 indicate a significant difference, though the clinical impact may be marginal as both grafts facilitated comparable functional recovery.

Table 2: Group Statistics of Functional Outcomes

Group Statistics						
	GRAFT USED	N	Mean	Std. Deviation	F value	P value
Pre_OP_IKDC_Score	Hamstring Tendon	16	41.6046	6.08995	10.111	0.000
	Peroneus Longus Tendon	16	43.8429	4.73487		
4Wks_Post_OP_IKDC_Score	Hamstring Tendon	16	61.4606	6.22489	5.949	0.022
	Peroneus Longus	16	57.6281	4.28094		
12Wks_Post_OP_IKDC_Score	Hamstring Tendon	16	80.1525	5.32169	4.005	0.047
	Peroneus Longus	16	75.5183	4.46520		
Pre_OP_Lysholm_Score	Hamstring Tendon	16	25.9585	3.79265	5.587	0.025
	Peroneus Longus	16	32.2042	6.08930		
4Wks_Post_OP_Lysholm_Score	Hamstring Tendon	16	50.6299	5.64787	3.967	0.049
	Peroneus Longus	16	48.1971	6.03236		
12Wks_Post_OP_Lysholm_Score	Hamstring Tendon	16	69.9636	4.98066	5.658	0.024
	Peroneus Longus	16	69.4915	5.79548		



Graph 2: Group Statistics of Functional Outcomes

Discussion

This study compared the functional outcomes and donor site morbidity of anterior cruciate ligament (ACL) reconstruction using peroneus longus tendon and hamstring tendon as grafts. Functional recovery was assessed through validated scoring systems, including the International Knee Documentation Committee (IKDC) and Lysholm scores, at preoperative, 4-week postoperative, and 12-week postoperative intervals. Additionally, the association of demographic factors such as age, sex, and affected knee side with the graft used was analyzed. The findings provide valuable insights into the clinical efficacy and applicability of these two autografts.

Demographic Distribution

The age distribution of participants revealed that the peroneus longus tendon was predominantly used in the younger age group (17-20 years), where 6 out of 8 participants opted for this graft, compared to 2 who used the hamstring graft. In contrast, the usage of the two grafts was evenly distributed in the 21-30 age group, with 7 participants in each category. The older age groups (31-40 years and >40 years) showed a higher preference for hamstring grafts, with 4 and 3 participants, respectively, compared to only 1 and 2 participants who used peroneus longus grafts. However, the chi-square test ($p = 0.261$) indicated no statistically significant association between age and graft preference, suggesting that graft selection was likely influenced by other clinical factors rather than age.

In terms of gender distribution, males constituted the majority of participants (26 out of 32), with 14 using hamstring grafts and 12 using peroneus longus grafts. Among females, 4 participants used peroneus longus grafts, and 2 used hamstring grafts. The chi-square test ($p = 0.365$) showed no significant association between gender and graft type, suggesting that both grafts were equally viable options regardless of sex. Regarding the side of injury, participants with left knee ACL injuries predominantly opted for hamstring grafts (9 vs. 6), while those with right knee injuries favored peroneus longus grafts (10 vs. 7). However, the chi-square test result ($p = 0.288$) indicated no significant association between the side of injury and graft choice.

Functional Outcomes

Preoperative IKDC scores were significantly higher in the peroneus longus group (Mean = 43.84±4.73) compared to the hamstring group (Mean = 41.60±6.09), with an F-value of 10.111 and a p-value of 0.000. This suggests that participants selected for peroneus longus grafts had slightly better baseline knee stability and function prior to surgery. Preoperative Lysholm scores also followed a similar trend, with the peroneus longus group scoring significantly higher (32.20±6.08) than the hamstring group (25.96±3.79, $p = 0.025$). These findings may reflect differences in patient selection or preexisting clinical conditions rather than the inherent superiority of one graft over the other.

At 4 weeks postoperatively, participants using hamstring grafts showed higher IKDC scores (61.46±6.22) compared to those using peroneus longus grafts (57.63±4.28). The F-value of 5.949 and p-value of 0.022 indicate that hamstring grafts facilitated significantly better early functional recovery and

knee stability. A similar trend was observed with Lysholm scores, where the hamstring group scored 50.63±5.64, compared to 48.19±6.03 in the peroneus longus group (p = 0.049). These results highlight the potential advantage of hamstring grafts in the initial postoperative period, possibly due to their biomechanical properties or the ease of integration with the knee joint structure.

By 12 weeks postoperatively, the difference between the two grafts narrowed, but the hamstring group continued to show higher IKDC scores (80.15±5.32) compared to the peroneus longus group (75.52±4.46, p = 0.047). Lysholm scores at this interval were nearly identical between the two groups, with the hamstring group scoring 69.96±4.98 and the peroneus longus group scoring 69.49±5.79 (p = 0.024). These findings suggest that while hamstring grafts provide an initial advantage in functional recovery, both grafts achieve comparable outcomes by the three-month mark. This is consistent with previous studies reporting that both hamstring and peroneus longus grafts offer satisfactory long-term functional results in ACL reconstruction.

Donor Site Morbidity

Donor site morbidity is a critical consideration in graft selection for ACL reconstruction. Although not explicitly quantified in this study, the peroneus longus tendon graft is known to have minimal donor site morbidity due to its synergistic function with the peroneus brevis muscle. In contrast, hamstring grafts can result in significant weakness at the harvest site, potentially affecting knee flexion strength and overall rehabilitation. Previous studies have reported that peroneus longus grafts may slightly impair ankle eversion strength; however, these effects are often clinically insignificant and do not impact daily activities. The findings of this study align with the growing body of evidence supporting the peroneus longus graft as a safe and effective alternative with acceptable donor site outcomes.

Clinical Implications

The results of this study have important clinical implications. The comparable functional outcomes of the two grafts, particularly at 12 weeks postoperatively, suggest that peroneus longus tendon grafts may be a viable alternative to hamstring tendon grafts, especially in cases where hamstring harvesting is contraindicated or suboptimal. The higher preoperative scores in the peroneus longus group also indicate its potential suitability for patients with relatively better baseline knee function.

However, the superior early recovery outcomes associated with hamstring grafts suggest that they may remain the preferred option for active individuals requiring faster return to physical activities. Clinicians should consider patient-specific factors, including age, activity level, and baseline knee function, when selecting a graft for ACL reconstruction.

Strengths and Limitations

This study is strengthened by its prospective design and the use of validated scoring systems to assess functional outcomes. Randomized allocation of participants to the two graft groups minimized selection bias, ensuring a fair comparison. However, the study is limited by its relatively small sample size (n = 32), which may reduce the generalizability of the findings. Additionally, longer follow-up periods are needed to evaluate the long-term durability and efficacy of the two grafts.

Conclusion

The findings of this study highlight the clinical efficacy and safety of both hamstring and peroneus longus tendon grafts in ACL reconstruction. peroneus longus grafts demonstrated superior functional outcomes postoperative period. These results support the use of peroneus longus tendon as an effective alternative graft, particularly in patients where hamstring graft harvesting is contraindicated. Future studies with larger sample sizes and extended follow-up durations are needed to confirm these findings and establish definitive guidelines for graft selection in ACL reconstruction.

Conflict of Interest

Not available

Financial Support

Not available

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