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ORIGINAL ARTICLE

Long-Term Assessment of Peroneus Longus Tendon Graft Site Morbidity in Patients with Anterior Cruciate Ligament Reconstruction

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ABSTRACT

Objective: To evaluate donor-site morbidity and functional outcomes following anterior cruciate ligament reconstruction (ACLR) using the peroneus longus tendon (PLT) autograft of the ipsilateral site. The main aim of the study was to assess the ankle function, its stability, foot arch assessment, knee stability, and patient satisfaction after graft harvestion.

Methodology: A long-term observational cohort study of 42 patients (30 males and 12 females) who underwent ACLR using PLT autografts was conducted. Quantitative assessment included demographic data, ankle eversion and plantarflexion strength (measured with a handheld dynamometer), range of motion (ROM), and functional scoring using the American Orthopaedic Foot and Ankle Society (AOFAS), Foot and Ankle Disability Index (FADI), and Lysholm Knee Score. Foot arch assessment is checked by using wet foot printing method calculating the foot arch index. Qualitative evaluation was based on semi-structured patient interviews exploring perceived weakness, discomfort, cosmetic satisfaction, and return to activity. Statistical analysis was performed using paired t-tests with significance of p value set to be $p < 0.05$.

Results: The mean age of the patient was 28.9 ± 5.8 years, mean follow-up months of 36.4 ± 7.2. The mean ankle eversion and plantarflexion strength on the donor site were 94.6% ± 7.1% and 96.1% ± 6.4% of the contralateral limb, respectively, having not a significant difference in ROM ($p > 0.05$). Functional outcomes were excellent (AOFAS 95.2 ± 4.1; FADI 96.5 ± 3.2; Lysholm 91.9 ± 5.3). 42 patients' arch index data showed 0.233 ± 0.018 operated vs. 0.231 ± 0.018 non-operated with no significant differences both feet arches. Qualitative analysis revealed 88.1% reported no ankle weakness, and 90.5% were cosmetically satisfied.

Conclusion: PLT autograft use in ACLR resulted in excellent functional recovery, preserved foot arch, ankle and knee performance, and minimal donor-site morbidity. It is a safe, reliable, and effective alternative graft option.

Keywords: Anterior cruciate ligament reconstruction, peroneus longus tendon, autograft, donor-site morbidity, Functional outcome, Knee stability

Authors' Contribution:
[1,2]Conception; Literature research; manuscript design and drafting; [3,4]Critical analysis and manuscript review; [5,6]Data analysis; [78]Manuscript Editing.

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Introduction

The Anterior Cruciate Ligament (ACL) is an important ligament that connects the tibia and femur, provides stability, and helps in preventing the anterior migration of the tibia over the femur .[1] More than 50% of knee injuries include anterior cruciate

ligament injuries.[1] These injuries can disrupt the ligament's structure and function, affecting the knee's biomechanics. The most appropriate treatment is ligament reconstruction, and different methods have evolved within a short span of time.[2,3] Bone patellar tendon bone (BPTB) graft, hamstring tendon graft (semitendinosus ± gracilis), quadriceps tendon graft, and the recently discovered graft site, the peroneus longus tendon, are most widely used.[2,4] Nonetheless, such universal grafts tend to cause donor-site morbidity in the form of anterior knee pain, patellar tendon rupture, fractures of the tibia and patella, and hamstring weakness.[3-4] Because of these possible complications, another source of auto graft with minimal donor-site morbidity is being pursued. The longus peroneus tendon is also a potential option due to ease of harvesting, sufficient thickness equivalent to native ACL, and reduced graft-site morbidity .[2-5]

Most of the studies have demonstrated improved results with peroneus longus grafts over other types of grafts. A recent study done by sunil.b including 30 patients showed the outcome of 30 patients at follow-up of 6- and 2-month post-operative time. The pre- and post-operative AOFAS score was 100 and 99.67 respectively having a p value greater than 0.05 .[4]

Zhao et al. [6] conducted a study to assess the correlation between the peroneus longus and foot arch graft. In this work, the foot shapes of the operated side and the contralateral healthy side were measured in 20 patients using a 3D scanner. The non-weight-bearing and weight-bearing foot lengths were reported as 234.29 ± 9.15 mm and 234.09 ± 9.08 mm for the operated side, and 237.38 ± 9.53 mm and 237.38 ± 9.04 mm for the healthy side. Similarly, the non-weight-bearing arch index was 0.22 ± 0.06 on the operated side and 0.22 ± 0.06 on the healthy side, whereas the weight-bearing arch index values were 0.24 ± 0.04 and 0.25 ± 0.04, respectively. The non-weight-bearing arch volumes were 21,704 ± 6880 mm³ and 22,585 ± 6931 mm³, while the weight-bearing arch volumes were 17,096 ± 5560 mm³ and 17,579 ± 5387 mm³, for the operated and healthy sides, respectively. The corresponding arch volume indices were 0.21 ± 0.12 and 0.21 ± 0.11. The AOFAS score calculated in the healthy foot was 98.30 ± 1.66 and in the operated site was 98.05 ± 1.73. No significant differences were observed in the bilateral comparison of these parameters ($P > 0.05$). Despite these findings, the authors highlighted that long-term follow-up studies are still needed to quantify anatomical and biomechanical function, particularly concerning ankle joint morbidity and the role of the peroneus longus in maintaining foot arch support.[5-7]

Methodology

This study was conducted as a long-term observational cohort study in the patients of cruciate ligament reconstruction (ACLR) analysing use of the peroneus longus tendon (PLT) graft ,evaluating the donor site morbidity .Patients who had undergone ACLR using ipsilateral PLT grafts with post-operative time period of minimum 2 year at Pakistan Atomic Energy Commission Hospital. The patients were identified from surgical records. Ethical approval obtained from the ethical review board of the hospital with ERB Id "PGHI-IRB(DMC)-RC-06-063"written informed consent obtained from all participants of this study.

Sample technique used, was the Non-probability consecutive sampling .The sample size was calculated by using the weight bearing foot arch index of operated and non -operated feet of 0.24 ± 0.04 and 0.25 ± 0.04 respectively, referencing from the study of Zhao et al [6].Paired comparison formula was used with (α) 0.05,statistical power of 80% and estimated within subject correlation coefficient of 0.83 between the two feet .The sample size calculated to be 42 with total duration of the study was 6 months.

Inclusion criteria comprised skeletally mature individuals with isolated ACL injuries treated with PLT autograft and a minimum follow-up of two

years. Patients with previous lower limb surgeries, concurrent ligamentous injuries, neuromuscular disorders, or systemic diseases affecting rehabilitation were excluded from the study.

The primary objectives of this study were to evaluate ankle stability and foot arch assessment while secondary objectives were to assess the knee functional status, patient satisfaction and cosmetic evaluation of donor site. Ankle stability was assessed by using AOFAS and AFDI score. Foot arch of both feets were assessed by using wet foot printing technique, analyzed through foot arch index method. Knee functional status through Lysholm Knee Scoring Scale. Semi-structured interviews conducted to explore any perceived weakness, discomfort, cosmetic satisfaction, and return to activity. Quantitative data included demographic characteristics (age, sex, and body mass index), time since surgery, and objective functional outcomes. Ankle and knee joint range of motion were measured with a goniometer, while ankle plantarflexion and eversion strength were assessed using a handheld dynamometer. Functional recovery was quantified using the American Orthopaedic Foot and Ankle Society (AOFAS) score, the Foot and Ankle Disability Index (FADI), and the Lysholm Knee Scoring Scale. Foot Arch of both feet were assessed using the wet foot printing method. Foot arch index of both feet wet footprints were assessed and foot arch index calculated and compared using paired comparison test. Limb symmetry indices were calculated to compare the operated and contralateral sides. Qualitative variables were sum of patient-reported perceptions of donor site discomfort, ankle instability, foot arch preservation, cosmetic appearance, and satisfaction with overall surgical outcomes. Semi-structured interviews were conducted to explore subjective experiences of functional limitation, gait alteration, and return-to-activity confidence.

Data analysis was performed using both quantitative and qualitative approaches. Ddescriptive statistics (mean, standard deviation, and range) and inferential tests, including paired t-tests was used to analyze the quantitative variables, to determine differences and associations between operated and non-operated limbs. Categorical data evaluation was done using chi-square tests. For qualitative variables, interview transcripts were thematically analysed to identify recurrent patterns and subjective experiences of morbidity, which were then triangulated with quantitative results to enhance validity. Statistical significance was set at $p < 0.05$, and all analyses were performed using SPSS version27.0.

The study was conducted after obtaining ethical approval from the Ethical Review Committee of Pakistan Atomic Energy General Hospital with ERB Id "PGHI-IRB(DMC)-RC-06-063.

Results

The total number of participants was 42(30 males and 12 females) who underwent anterior cruciate ligament reconstruction (ACLR) surgery, Iipsilateral peroneus longus tendon (PLT) autograft was used in all the patients who were included in the study. The participants mean age was 28.9 ± 5.8 years, having a mean follow-up period of 36.4 ± 7.2 months. The mean body Mass index (BMI) was 24.8 ± 3.1 kg/m². All patients achieved complete wound healing without infection or neurovascular complications. No donor-site re-rupture or significant ankle instability was observed. Quantitative assessment demonstrated that the mean Arch Index of the operated foot was 0.233 (SD 0.018, range 0.20–0.27), compared with 0.231 (SD 0.018, range 0.20–0.27) for the non-operated foot

Table I: Foot Arch Index operated vs healthy feet (n = 42)

Foot	Mean AI	SD	Range
Operated	0.233	0.018	0.20–0.27
Non-operated	0.231	0.018	0.20–0.27

Table II: Normality and Comparative Statistical Tests		
Test	**Statistic**	**p-value**
Shapiro-Wilk (Operated AI)	W = 0.938	0.030
Shapiro-Wilk (Non-operated AI)	W = 0.913	0.005
Wilcoxon signed-rank test	W = 87.0	0.063

Table III: Quantitative Functional Outcomes and Limb Comparison (n = 42)				
Parameter	**Operated Limb (Mean ± SD)**	**Contralateral Limb (Mean ± SD)**	**Limb Symmetry Index (%)**	***p*-value**
Ankle eversion strength (N)	69.2 ± 7.8	73.2 ± 8.1	94.6	0.076
Ankle plantarflexion strength (N)	94.8 ± 9.6	98.6 ± 8.9	96.1	0.108
Ankle ROM (degrees)	58.9 ± 5.9	59.7 ± 6.2	98.7	0.219
AOFAS score	95.2 ± 4.1	—	—	—
FADI score	96.5 ± 3.2	—	—	—
Lysholm Knee Score	91.9 ± 5.3	—	—	—

*Note: Data analyzed using paired t-tests: significance threshold $p < 0.05$.

The Shapiro Wilk Test indicated that Arch Index values were not normally distributed for either the operated ($p = 0.030$) or non-operated ($p = 0.005$) foot; For the paired comparison non, parametric Wilcoxon Signed-rank test was performed. And in preference to the paired sample t-test originally specified. The difference was found not to be statistically significant between the operated and non-operated Arch Index (Wilcoxon signed-rank test, $p = 0.063$), clearly showing that there was no statistically significant or detectable difference. The paired t-test result is reported as a reference ($p = 0.067$), though the non-parametric result should be considered primary given the normality violation.

The mean ankle eversion strength on the donor side was 94.6% ± 7.1% compared to the contralateral limb, while plantar flexion strength was 96.1% ± 6.4%. Differences in range of motion (ROM) between limbs were not statistically significant ($p > 0.05$). Functional scores revealed excellent outcomes, with mean AOFAS score of 95.2 ± 4.1, FADI score of 96.5 ± 3.2, and Lysholm Knee Score of 91.9 ± 5.3. Paired t-tests showed no significant reduction in functional capacity between the operated and non-operated limbs, indicating preserved ankle and knee performance following graft harvest.

Table IV: Qualitative Patient-Reported Outcomes		
Variable	**Frequency (n)**	**Percentage (%)**
No perceived ankle weakness	37	88.1
Mild discomfort on exertion	5	11.9
Cosmetic satisfaction (Likert ≥ 4/5)	38	90.5
Reported gait alteration	3	7.1
Full return to pre-injury activity	36	85.7
Overall satisfaction with surgery	40	95.2

Qualitative analysis from semi-structured interviews showed that most patients experienced minimal or no donor site morbidity. A majority (88.1%) reported no noticeable ankle weakness, while 90.5% expressed satisfaction with the cosmetic appearance of the harvest site. Mild discomfort during high-intensity activity was noted in 11.9% of cases but did not limit functional participation. Thematic analysis revealed three dominant themes: functional adaptation, aesthetic satisfaction, and confidence in limb performance. The qualitative findings corresponded with quantitative results, collectively indicating minimal long-term morbidity associated with PLT harvesting.

Above mentioned statistical results indicates the use of Peroneus Longus tendon in patients of Anterior cruciate ligament reconstruction led to excellent long-term knee and ankle function and no gross donor site morbidity. Both quantitative and qualitative analyses demonstrated that PLT autograft use preserved ankle strength and motion, maintained high patient satisfaction, and resulted in no clinically significant functional deficits.

Discussion

A total of 42 patients (30 males and 12 females) who underwent anterior cruciate ligament reconstruction (ACLR) surgery using autografts of ipsilateral Peroneus longus tendon were included in the study. The participants mean age was 28.9 ± 5.8 years, with a mean follow-up period of 36.4 ± 7.2 months. Another study (2021) reported that the peroneus longus tendon may be considered as a first-choice graft in ACL reconstruction, as it demonstrated the absence of significant postoperative morbidity.[11] The mean body mass index (BMI) in our study was 24.8 ± 3.1 kg/m². All patients achieved complete wound healing without infection or neurovascular complications. No donor-site re-rupture or significant ankle instability was observed. A study published in 2025 found that harvesting the PLT is relatively easier and faster, providing a consistently adequate graft size compared to hamstring tendons (HTs). Both graft types showed comparable patient-reported outcomes over a 2-year follow-up, with no graft failures in either group. The authors concluded that for primary ACLR surgery the PLTs perform similarly to HT autografts, without any associated ankle-site morbidity.[12] Quantitative analysis in our study showed that mean ankle eversion strength on the donor side was 94.6% ± 7.1% compared to the contralateral limb, while plantar flexion strength was 96.1% ± 6.4%.no statistically difference in R.O.M was appreciated as $p > 0.05$). Functional outcomes were excellent, with mean AOFAS score of 95.2 ± 4.1, FADI score of 96.5 ± 3.2, and Lysholm Knee Score of 91.9 ± 5.3.A study done to see the relationship between the PLT graft harvest and foot arch. In this study the foot arch of the operated side and the contralateral healthy side were assessed in 20 patients using a 3D foot scanner.The foot length of non-weight-bearing and weight-bearing feet were reported as 234.29 ± 9.15 mm and 234.09 ± 9.08 mm for the operated side, and 237.38 ± 9.53 mm and 237.38 ± 9.04 mm for the healthy side. The non-weight-bearing arch index of the operated side was 0.22 ± 0.06 and on the healthy side was 0.22 ± 0.06. Whereas the weight-bearing arch index values of the operated and non-operative side were 0.24 ± 0.04 and 0.25 ± 0.04, respectively.[6] Paired t-tests indicated no significant reduction in functional capacity between the operated and non-operated limbs, suggesting preserved ankle and knee performance following graft harvest. Similarly, a 2022 study reported that the PLT autograft provided a painless, stable knee with a good range of motion and no adverse effects on ankle function or gait. Thus, the PLT autograft was considered a suitable graft in terms of strength, safety, and minimal donor-site morbidity.[13] Qualitative analysis from semi-structured interviews in our study revealed that most patients experienced minimal or no donor-site morbidity. The majority (88.1%) reported no noticeable ankle weakness, and 90.5% were satisfied with the cosmetic appearance of the harvest site. Mild discomfort during high-intensity activity was reported by 11.9% of participants but did not limit functional performance. Thematic analysis identified three key themes: functional adaptation, aesthetic satisfaction, and confidence in limb performance. These qualitative findings corresponded with the quantitative results, collectively indicating minimal long-term morbidity associated with PLT harvesting. In another latest study conducted in 2025 showed the excellent clinically and functional outcomes with non-significant complications. It had emerged as an excellent option. However, larger comparative studies were still deficit and need evidence base findings to support the study and evaluate long-term graft durability.[14] Our study results indicated that harvesting the peroneus longus tendon for ACL reconstruction led to excellent long-term ankle and knee function with minimal donor-site morbidity. Similarly, a 2024 study reported that PLT autograft used in ACLR resulted not only in good functional outcomesbut also smooth rehabilitation and recovery with early return to sports, .it also had a

very minimal donor-site complications.[15] Overall, both quantitative and qualitative analyses in our study demonstrated that PLT autograft use preserved ankle strength and motion, maintained high patient satisfaction, and resulted in no clinically significant functional deficits. In agreement, a 2025 study concluded that in appropriately selected patients, ACLR using PLT autograft can achieve excellent clinical success based on patient-reported outcomes, clinical performance measures, and low graft failure rates.[16]

Conclusion

In ACLR, use of Peroneus Longus Graft demonstrated excellent ankle and knee function with no or minimal morbidity and no effect over the foot arch anatomy and. Both ankle and knee performance were well preserved, and patients reported high satisfaction with cosmetic and functional recovery. These findings evident and support PLT graft as a reliable, effective and safe graft option for ACL reconstruction.

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