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Clinical outcomes in anterior cruciate ligament reconstruction using peroneus longus tendon autograft versus hamstring tendon autograft

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ABSTRACT

Objectives: The objective of this study was to compare the clinical outcomes in anterior cruciate ligament reconstruction (ACLR) using peroneus longus tendon (PLT) autograft and hamstring tendon (HT) autograft.

Methods: A quasi-experimental study design was utilized. This study was done at the Orthopedic Department of Pakistan Atomic Energy Commission, General Hospital, Islamabad, from July 2021 to July 2023. Patients were split into two groups, and they received either PLT or HT autograft. Pain, range of motion (ROM), muscle power, and return to jogging were assessed using the visual analog scale, goniometer scale, and anterior cruciate ligament-return to sports after injury scale at six weeks, three months, and six months post-surgery.

Results: A total of 61 patients, out of which 26 patients received an HT (quadrupled gracilis and semitendinosus) graft and 35 received a PLT autograft. The patient's mean age was 26.51 ± 6.78 years. The HT group had more pain at six weeks and three months, while the PLT group had lesser pain ($P < 0.05$). Both groups had mild pain after six months ($P = 0.337$). At six and three months, there was a significant difference in ROM ($P = 0.05$), but no significant change in the Medical Research Council power of muscles was identified. Thirty-four patients from the PLT group could jog without discomfort before six months. Overall, every patient was satisfied with the treatment that they received.

Conclusion: Patients who had ACLR with a PLT autograft had significantly better clinical and functional outcomes compared to those who received an HT autograft.

Keywords: Anterior cruciate ligament reconstruction, Autograft, Hamstring tendon, Peroneus longus tendon, Visual analog scale

INTRODUCTION

The anterior cruciate ligament (ACL) is one of the knee's most commonly injured components. ACL injuries lead to enduring and significant impairments due to their vital role in knee function.[1] Each year, over 200,000 people in the USA suffer ACL tears, which account for

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more than 50% of all knee injuries.[2] At present, ACL reconstruction (ACLR) is the most widely accepted and effective approach to restoring knee stability and reducing the likelihood of future meniscal tears and clinical osteoarthritis. This procedure necessitates using one of three options: an allograft, synthetic graft, or autograft.[3] Several autograft options are currently utilized in ACLR, which include the quadriceps tendon, bone-patellar tendon-bone, and hamstring tendon (HT). These autografts each have positive and negative aspects. Surgeons consider graft strength and dimensions, as well as the ease and safety of graft retrieval, all while minimizing complications at the donor site.[4,5]

Based on the latest research, bone-patellar tendon-bone stands out as the optimal graft choice due to its bone-to-bone healing, which enables efficient tunnel and graft assimilation, resulting in a faster return to functionality and athletic activity. However, due to the invasive method, defined length, large incision, and weaker than natural ACL, it entails a risk of patellar fracture, which is not suited for the double-bundle reconstruction and has a high incidence of anterior knee discomfort.[6] A HT autograft has the same strength as a native ACL, and it is easy to take with minor donor site morbidity. Since it has an unknown graft diameter and may cause the loss of hamstring power, it is crucial for certain athletes who need significant hamstring strength[7] or are affected negatively by other disadvantages such as quadriceps-hamstring imbalance, knee laxity, and various ligament injuries.

Considering the disadvantages of the autografts**,** an alternative graft material is needed. The peroneus longus tendon (PLT) is of an appropriate size, and biomechanical analysis of its characteristics showed that it has enough strength for knee ACLR.[8] PLT autografts are frequently employed in several orthopedic procedures, such as repairing the medial patellofemoral ligament, the spring ligament, and the deltoid ligament.[9] This is feasible due to peroneus brevis and PLT, each having a distinct function. According to some studies, the peroneus brevis is an even more potent ankle evertor, rationalizing the possibility of using PLT as an autograft when needed.[10]

Only a few comparative studies have been conducted between the PLT autograft and the other grafts. The main purpose of this study was to evaluate the clinical results of patients who had ACLR using HT autograft against patients who had ACLR using PLT autograft.

MATERIALS AND METHODS

This quasi-experimental study was performed at the Orthopedic Department of Pakistan Atomic Energy Commission, General Hospital, Islamabad, from July 2021 to July 2023. Sampling was done using a non-probability consecutive sampling technique. All the available samples during the study duration fulfilling inclusion criteria were included in the study.

Inclusion criteria

Patients between the ages of 20 and 35 with an isolated ACL rupture were included in the study.

Exclusion criteria

The criteria for exclusion were a potential injury to the collateral ligament, a fracture in the vicinity of the knee, the existence of a pathological ailment in the lower extremity, and previous surgery to the affected knee and ligamentous laxity (Beighton score).

Sixty-one patients underwent ACLR surgery from July 2021 to June 2023. From July 2021 to June 2022, 26 patients received ACLR using an HT (quadrupled gracilis and semitendinosus). However, in light of the most recent research and taking into account the ease of harvest and minimal donor site morbidity, we decided to use the PLT as a graft in accordance with the literature and for the patient's benefit, hence from July 2022 to June 2023, in 35 patients, the PLT was utilized. Proper post-operative monitoring was carried out for both groups throughout the study period. A team of three orthopedic surgeons specialized in arthroscopic surgeries performed all the surgeries. The patients were positioned supine and received regional anesthesia. A tourniquet was placed on the thigh and inflated without raising or draining blood. The standard anterolateral and anteromedial portals were utilized. An arthroscopic examination was performed to diagnose ACL rupture, and subsequently, the tendon was harvested for grafting.

Parameters that were evaluated in the study included power, range of motion (ROM), pain, and patient satisfaction. After the surgeries, these parameters will be evaluated in both groups in the sixth week, third month, and sixth month. At six months, the ability to jog without discomfort around the knee joint was evaluated. A visual analog scale was used to determine the pain parameters. Scores were obtained by scribbling an indication on a 10-cm line indicating a continuum from "no pain" to "worst pain." Knee joint flexion and extension were used to evaluate the ROM in both groups of patients. A goniometer scale was used to measure the ROM. The degree of motion compared to the contralateral side was considered. A ROM between (75° and 100°) was denoted mild to no restriction. If the ROM was between (25° and 75°), it indicated moderate restriction in movement. A ROM between (0° and 25°) demonstrated severe restriction as compared to the contralateral side.[11] The power of the quadriceps and hamstring muscle groups was measured by the Medical Research Council (MRC) muscle

power scale.[12] The MRC strength scale ranges from 0 (No muscle contraction) to 5 (normal contraction). The patient's degree of satisfaction was rated using a five-point Likert scale ranging from highly satisfied to highly dissatisfied based on the study by Sullivan and Artino.[13] The time patients took to jog comfortably without discomfort in their knees was compared between the two groups. It was divided into two categories: patients who could do jogging without discomfort within six months after ACLR surgery and those who took more than six months.

The Statistical Package for the Social Sciences version 26 was used to analyze the data. Standard deviation and mean were computed for all quantitative variables. Qualitative data was recorded, frequency and percentages were calculated, and the Chi-square test/Fischer exact test was employed for significance testing, with $P \leq 0.05$ deemed significant.

RESULTS

Sixty-one patients who underwent ACLR surgery were enrolled in this study; 26 received ACLR using the HT (quadrupled gracilis and semitendinosus), whereas 35 received a PLT. Of the total patients, 55 (90.1%) were male, and 6 (9.9%) were female. The mean age of the patients was 26.51 ± 6.78 years. The HT group had severe pain at six weeks and three months compared to the PLT group ($P < 0.05$). After six months, patients of both groups had mild pain with $P = 0.337$. A comparison of the patient's pain around the knee in the sixth week, third month, and sixth month is shown in Table 1.

There was a statistically significant difference in the ROM between both groups at knee joints at six weeks, three months, and six months, that is, $P < 0.05$. The comparison of the knee joint ROM (flexion and extension) to a contralateral side at the sixth week, third month, and sixth month is shown in Table 2.

A statistically significant difference was found among the groups in MRC muscle power at the knee joint in the sixth week, third month, and sixth month as $P < 0.05$ shown in Table 3.

In the sixth month, 21 (80.8%) patients from the HT group and 34 (97.1%) patients from the PLT group could jog without discomfort. After six months, 5 (19.2%) from the HT group and only 1 (2.9%) from the PLT group were able to jog without discomfort ($P = 0.034$), shown in Table 4.

Furthermore, most patients were satisfied with the treatment; yet, the PLT group patients were more satisfied than the HT group, that is, $P = 0.003$. The details of patient satisfaction at six months for both groups are shown in Table 5.

Table 1: Comparison of patient's pain around knee at 6th week, 3rd month, and 6th month (*n*=61).

Pain around the knee	Study groups		*P*-value
	Hamstring (*n*=26) (%)	Peroneus longus (*n*=35) (%)	
6th week			
Mild	7 (26.9)	31 (88.6)	<0.001
Moderate	10 (38.5)	3 (8.6)	
Severe	9 (34.6)	1 (2.9)	
3rd month			
Mild	16 (61.5)	32 (91.4)	0.017
Moderate	5 (19.2)	2 (5.7)	
Severe	5 (19.2)	1 (2.9)	
6th month			
Mild	23 (88.5)	34 (97.1)	0.337
Moderate	2 (7.7)	1 (2.9)	
Severe	1 (3.8)	0 (0)	

Table 2: Comparison of ROM at the knee joint (flexion and extension) compared to the contralateral side at the 6th week, 3rd month, and 6th month (*n*=61).

ROM	Study groups		*P*-value
	Hamstring (*n*=26) (%)	Peroneus longus (*n*=35) (%)	
6th week (Flexion only)			
Mild loss	12 (46.2)	28 (80.0)	0.022
Moderate loss	7 (26.9)	4 (11.4)	
Severe loss	7 (26.9)	3 (8.6)	
3rd month (Flexion and extension)			
Mild loss	9 (34.6)	30 (85.7)	<0.001
Moderate loss	11 (42.3)	3 (8.6)	
Severe loss	6 (23.1)	2 (5.7)	
6th month (Flexion and extension)			
Mild loss	19 (73.1)	33 (94.3)	0.044
Moderate loss	4 (15.4)	2 (5.7)	
Severe loss	3 (11.5)	0 (0)	

ROM: Range of motion

DISCUSSION

Knee injuries are often caused by ACL damage, which requires careful reconstruction. Autografts are frequently used because they have a minimal chance of causing negative reactions and zero risk of transmitting diseases. When used as a biological graft, an autograft experiences a process of recollagenation and revascularization, which can result in a 50% loss of strength in the initial stages of implantation.[14] When considering a replacement for the ACL, choosing a stronger graft substitute than the ACL itself is important. This is due to the native ACL's maximal tensile load of 2020 ± 264 N.[15] Over the past few years, the HT has become a popular choice as an autograft for ACLR. However, there is

Table 3: Comparison of MRC muscle power at knee joint at 6th week, 3rd month, and 6th month (*n*=61).

MRC muscle power	Study groups		*P*-value
	Hamstring (*n*=26) (%)	Peroneus longus (*n*=35) (%)	
6th week			
No contraction	0 (0)	0 (0)	0.011
Contraction trace or flicker	0 (0)	0 (0)	
Active movement with gravity eliminated	9 (34.6)	5 (14.3)	
Active movement against gravity and resistance	10 (38.5)	7 (20.0)	
Normal power	7 (26.9)	23 (65.7)	
3rd month			
No contraction	0 (0)	0 (0)	<0.001
Contraction trace or flicker	0 (0)	0 (0)	
Active movement with gravity eliminated	4 (15.4)	1 (2.9)	
Active movement against gravity and resistance	12 (46.2)	3 (8.6)	
Normal power	10 (38.5)	31 (88.6)	
6th month			
No contraction	0 (0)	0 (0)	0.001
Contraction trace or flicker	0 (0)	0 (0)	
Active movement with gravity eliminated	4 (15.4)	0 (0)	
Active movement against gravity and resistance	8 (30.8)	2 (5.7)	
Normal power	14 (53.8)	33 (94.3)	

MRC: Medical research council

Table 4: Comparison of the ability to jog without discomfort at the knee (ACL-RSI) (*n*=61).

Jogging without discomfort at the knee joint	Study groups		*P*-value
	Hamstring (*n*=26) (%)	Peroneus longus (*n*=35) (%)	
Before the 6th month	21 (80.8)	34 (97.1)	0.034
After the 6th month	5 (19.2)	1 (2.9)	

RSI: Return to sports after injury, ACL: Anterior cruciate ligament

a considerable range in HT diameter, and using a very small graft could increase the risk of failure in ACLR.[16]

According to previous research, functional outcomes and knee stability have been reported as positive outcomes following ACLR using PLT autograft.[17,18] In terms of knee function evaluation, the outcomes of ACLR utilizing PLT were considered satisfactory by Angthong *et al.*[19] However, clinical examinations conducted at an average follow-up time of 13 months showed that 8.4% of all patients had laxity in the varus talar tilt tests. In addition, 16.7% of patients had grade IV deterioration in eversion and first-ray plantar flexion, and 100% had grade IV+ deterioration in these areas. This study's American Orthopedic Foot and Ankle Society (AOFAS) Hindfoot Score and the Foot and Ankle Disability Index score shows that the donor's ankle functioned perfectly after removing the PLT.

Numerous authors have reported positive results of PLT autografts and recommended its use as a substitute for other autografts. Yu *et al.*[20] conducted a study involving 35 participants with an average age of 43.4 years. These individuals underwent a procedure where an ipsilateral PLT autograft was administered. Following a 14.2-month follow-up period, it was observed that all patients displayed negative outcomes in the anterior drawer test, Lachman test, and pivot shift test. Evaluating the functional outcome through the Knee Injury and Osteoarthritis Score, International Knee Documents Committee (IKDC), and Lysholm score, a notable improvement ($P < 0.05$) was observed in the 3rd, 6th, and 12th months in comparison of pre-surgical condition.

According to the study conducted by Kerimoglu *et al.*,[17] PLT can serve as a suitable autograft source for ACLR, thereby avoiding potential complications that may arise from autografts obtained from the knee region. Importantly, no patients reported experiencing ankle joint dysfunction or difficulty in sports activities following PLT graft transfer. These results are similar to our study.

Phatama *et al.*[21] examined the outcomes of 15 recipients with PLT and 16 individuals with HT. At a 2-year follow-up, the two groups had no significant difference in pain and crepitus. However, according to Phatama *et al.*[21] score, the functional outcome was significantly better ($P < 0.0001$) in the PLT group than in the HT group. These findings are inconsistent with the results of our own study. Cao *et al.*[22] demonstrated that PLT autograft was used on 35 patients with a mean age of 31.8 years. After 15 months, the mean Lysholm score was found to be 97.2, with 25 patients having excellent scores. Most patients (88.6%) had outstanding acceptable KT-3000

Table 5: Patient satisfaction at six months of both groups (*n*=61).

Patient satisfaction	Study groups		*P*-value
	Hamstring (*n*=26) (%)	Peroneus longus (*n*=35) (%)	
Very dissatisfied	3 (11.5)	0 (0)	0.003
Dissatisfied.	5 (19.2)	0 (0)	
Neutral (neither dissatisfied nor satisfied)	2 (7.7)	2 (5.7)	
Satisfied	5 (19.2)	3 (8.6)	
Very satisfied	11 (42.3)	30 (85.7)	

arthrometer assessments, with a mean AOFAS score of 96.3. Based on the results, the authors recommended PLT as a safe and effective method substitute for ACL without having any donor site morbidity. Kumar *et al.*[23] used PLT as an autograft method for ACLR in 25 patients, having a mean graft thickness of 8.74 mm. Post-surgery evaluations showed a mean IKDC score of 98.53 and an MRC grading of 5. Results indicated excellent functional outcomes without adverse effects on ankle stability or movement.

Limitations of the study

It is worth noting that the study had some limitations. For instance, the assessment of knee function was based on the MRC grading of muscle power, which is a subjective method. Modern instruments such as arthrometers and dynamometers were employed to measure ROM and muscle strength objectively but were not used. With only 61 patients, the study might not fully capture the variability and potential complications associated with each graft type, potentially limiting the generalizability of the findings. Assessments were conducted up to six months post-surgery, which may not capture long-term outcomes, complications, or the durability of each graft type. The study's design does not account for potential confounding factors that could influence outcomes, such as the patient's activity levels or physiotherapy adherence. The study's findings provide a basis for further research, including long-term follow-up and a larger sample size, to draw more conclusive observations and results.

CONCLUSION

According to the study results, patients who underwent ACLR with a PLT autograft had significantly better clinical and functional outcomes than those who received an HT autograft. Therefore, the study suggests that the PLT autograft could be considered an appropriate alternative graft choice outside the knee for patients undergoing ACLR.

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AUTHORS' CONTRIBUTIONS

MNK contributed to manuscript preparation, manuscript editing, and review. SNJ was involved in conception and design. SM contributed to the definition of intellectual content. SK contributed to data acquisition, data analysis, and statistical analysis. QMG was involved in clinical and experimental studies, and UUS contributed to literature research. All authors have critically reviewed and approved the final draft and are responsible for the manuscript's content and similarity index.

ETHICAL APPROVAL

The Institutional Review Board approved the research at the Department of Orthopedics, Pakistan Atomic Energy Commission, General Hospital, Islamabad, reference number PGHI-IRB (Dme)-RCD-06-025 dated October 28, 2023.

DECLARATION OF PATIENT CONSENT

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patients consented to their images and other clinical information being reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY FOR MANUSCRIPT PREPARATION

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

CONFLICTS OF INTEREST

There are no conflicting relationships or activities.

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