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Quantifying donor site morbidity in anterior cruciate ligament reconstruction using peroneus longus tendon autograft

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ABSTRACT

Objectives: The objective of this study was to assess the donor site morbidity in patients having anterior cruciate ligament reconstruction (ACLR) using peroneus longus tendon (PLT) autograft.

Methods: A prospective cohort study was conducted at the orthopedic department of Pakistan Atomic Energy Commission General Hospital, Islamabad, from July 2021 to July 2023. A total of 150 patients aged between 20 and 40 years with an anterior cruciate ligament injury requiring ligament reconstruction were included in the study. Exclusion criteria included previous ankle ligamentous injuries, fractures or surgeries around the ankle, and high-risk sports like football. After the ACLR surgery, the patients were assessed for pain, range of motion (ROM), and muscle power in the 6th week, 3rd month, and 6th month. Return to jogging without discomfort at the ankle during 1st min of jogging was assessed at six months.

Results: Of the 150 patients, 142 (94.6%) were male and 8 (5.4%) were female. The mean age of participants was 32.53 ± 4.78 years. Pain and loss of ROM around the ankle were reduced after six months compared to three months and six weeks, that is, $P < 0.05$. Muscle power was increased after six months ($n = 152$; 94.0%) ($P < 0.001$). In the 6th month, 133 patients (88.7%) were able to jog without discomfort around the ankle joint during the 1st min of jogging, but 17 patients (11.3%) started jogging after six months without discomfort at the ankle joint during the 1st min of jogging ($P < 0.001$).

Conclusion: ACLR using the PLT autograft resulted in a good functional outcome, smooth rehabilitation with an early return to sports, and minimal complications at the donor site.

Keywords: Anterior cruciate ligament, Autograft, Donor site morbidity, Peroneus longus tendon, Reconstruction, Visual analog scale

INTRODUCTION

The anterior cruciate ligament (ACL) is commonly damaged in the knee joint, affecting approximately 1.5–1.7% of primary ACL cases annually in the population.[1] ACL injuries can

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be treated with either conservative or surgical methods. Conservative treatment, involving knee bracing and physical therapy, is typically recommended for patients with ACL sprain or incomplete tears. However, surgical intervention is usually necessary for patients with complete ACL tears and may involve reconstruction of the ligament using an allograft or autograft.[2] ACL reconstruction (ACLR) can be performed with both allografts and autografts. Allografts have the disadvantages of being more expensive, having delayed incorporation, being more likely to transmit diseases, and being more likely to have immunological reactions.[3] Reconstructive surgery involving the utilization of a frequently sourced graft from the patient's muscle (autograft) has gained widespread popularity as a procedure for treating an ACL injury, ensuring the preservation of knee function and stability.[4] ACLR aims to restore the knee's biomechanical and kinematic functions to a level similar to its native function.[5]

The current preferred option for ACLR around the globe is using a hamstring tendon autograft because it provides better tensile strength than the bone-patellar tendon-bone (BPTB) autograft. However, the inconsistent muscle diameter in different individuals can result in suboptimal outcomes or potential graft failure.[6] Alternative autograft options for ACLR consist of BPTB, quadriceps tendon, and tensor fascia lata.[7] The BPTB autograft is a gold standard in ACLR. The biomechanical strength of BPTB is comparable to that of native ACL. BPTB enables early active-safe rehabilitation without increasing graft failure risk and has a favorable long-term outcome. However, BPTB can cause morbidity at the graft harvesting site, such as patellofemoral discomfort, loss of mobility, and patellar fracture.[8] Our population faces unique functional demands because individuals in our culture and religion need to perform high-flexion knee activities such as kneeling and squatting for social and religious customs for extended periods. Hence, they need to flex the knee up to 150°–165°. At this much flexion, it exceeds the usual population by an average of 15°.[9] Hence, donor site morbidity is a very important consideration in our population, and graft sites remote from the ACLR site will address this problem better. The disadvantages of the regularly utilized autografts discussed above necessitate the search for an alternate graft material. An ideal graft would have a reasonable degree of strength, a suitable size, and be quickly and safely harvested. The peroneus longus tendon (PLT) is long and strong enough to be used as an autograft of choice to reconstruct ACL.[3] The PLT is obtained from a location near the lateral ankle, specifically proximal and posterior to it.[10]

Kartus *et al.*[11] classified donor site morbidity into three categories: General pain, specific discomfort, and late tissue reactions. Various methods exist for evaluating issues related to donor site morbidity. Valuable clinical tools include (1) evaluating strength through functional tests such as the 1-leg-hop test or dynamometers such as Cybex, assessing range of motion (ROM) loss, examining knee-walking ability, and measuring disturbance or sensory loss in the donor site area or the region innervated by nerves passing through the donor site; (2) conducting radiographic evaluations using standard radiographs, magnetic resonance imaging, computed tomography, and ultrasonography; and (3) performing histologic and biochemical analyses on samples obtained from the donor site area.[11]

The study aimed to determine the donor site morbidity in patients undergoing ACLR using PLT autograft.

MATERIALS AND METHODS

This prospective cohort study was performed at the orthopedic department of Pakistan Atomic Energy Commission General Hospital, Islamabad, from July 2021 to July 2023 after obtaining approval from the Institutional Review Board (IRB), vide reference number PGHI-IRB (Dme)-RCD-06-024. A total of 150 patients gave consent to enroll in this study after ACLR surgery using PLT autograft.

Inclusion criteria

To be eligible for this study, patients must satisfy the following criteria: they must be between the ages of 20 and 40, have an ACL injury requiring ligament reconstruction, and have no substantial previous ankle injury or instability.

Exclusion criteria

Patients, who refused to participate, had a pathological ailment around the ankle, played ankle-demanding sports such as football, or had previous surgery around the ankle and foot were excluded from the study.

Written consent was obtained before enrolling all patients, and their confidentiality was ensured at all levels. Approval from the Institutional Ethical Committee was also obtained before starting the project. A knee surgeon with extensive experience conducted the surgeries on all patients. After the surgical procedure, the patients were assessed for pain, ROM, and muscle power in the 6th week, 3rd month, and 6th month. The ability to jog was assessed at six months. The visual analog scale was used to quantify pain severity. It comprises a 10 cm line with numbers 0 ("absence of pain") and 10 ("highest potential pain") at opposite ends. The patients were instructed to draw a line to reflect their current pain level. ROM was assessed using the American Orthopedic Foot and Ankle Society (AOFAS) ankle-hindfoot score, in which we categorized the ankle according to the degree of angle to which the ankle can bend as compared to the contralateral side in sagittal motion (flexion and extension) if the ROM

was 75–100% or more as compared to contralateral side than its motion was considered normal or mildly restricted. However, if the ROM was between 25% and 75%, it was considered moderately restricted; if the ROM was <25%, it was considered severely restricted. In the case of hindfoot motion (inversion and eversion), if the ROM was between 75% and 100% compared to the contralateral side, then the motion was considered normal or mildly restricted. However, if the ROM was between 25% and 75%, it was considered moderately restricted; if the ROM was <25%, it was considered markedly restricted.

The assessment of muscle power was done using the Medical Research Council (MRC) muscle power scale. The MRC strength scale uses a range from 0 (absence of muscle contraction) to 5 (normal power) to assess the strength of a particular muscle group. For the assessment of the fourth parameter, we divided the patients into two groups: No discomfort at the ankle during the first minute of jogging and discomfort at the ankle during the first minute of jogging, which is the component of the ACL-return to sports after injury scale.

Descriptive statistics were used to present the relevant sociodemographic and other variables generated during the study. Pearson Chi-square analysis and Fischer's exact test were used to establish statistically significant differences among study variables. The Statistics Package for the Social Sciences version 24.0 was used for all the above-mentioned analyses. $P \leq 0.05$ were considered significant for establishing the comparison between variables within the time duration.

RESULTS

A total of 150 patients enrolled in this study after ACLR surgery using PLT autograft. Of the patients, 142 (94.6%) were male and 8 (5.4%) were female. The mean age of the patients was 32.53 ± 4.78 years.

Pain and loss of ROM around the ankle were reduced after six months [Table 1] as compared to three months and six weeks, that is, $P < 0.05$. Muscle power of the patients was increased after six months ($n = 152$; 94.0%), followed by three months (127 (84.7%) and six weeks ($n = 120$; 80.0%) with significant $P < 0.001$.

In the 6th month, 133 patients (88.7%) were able to jog without any discomfort around the ankle joint during the 1st min of jogging, but 17 patients (11.3%) started jogging after six months without any discomfort at the ankle joint during the 1st min of jogging ($P < 0.001$).

DISCUSSION

This study used the PLT as an autograft for ACLR in patients with acute ACL rupture. Various experiments have shown that the PLT offers the highest tensile strength. Shi *et al.*[12] discovered that the anterior half of the PLT possesses sufficient length and strength to be a viable autograft option for ACLR. Restoring joint stability and alleviating symptoms are the immediate objectives of ACLR. In the long run, the ultimate goals involve enabling individuals to resume their previous level of activities and mitigating the risk of future onset of osteoarthritis.[13,14] Many studies indicate that the results of ACLR surgeries are frequently below expectations. Instability after the surgery can continue, potentially resulting in additional harm to the meniscus or cartilage. Over time, this can lead to the development of knee arthritis. Recent research findings highlight that just 37% of patients who had ACLR attained full recovery of their knee's normal function.[15] Only 65–70% of individuals return to the pre-injury level of sports activity after ACLR.[16] Common signs after ACLR include discomfort in a specific area, reduced sensation, and difficulty kneeling or walking on the knees. As stated in available sources, anterior knee pain could be associated with three factors: Decreased mobility, limited hyperextension post-ACLR, and damage to the infrapatellar nerve caused by the skin incision.[17,18]

Out of 150 patients, 113 (975.35%) patients had mild pain around the ankle, 30 (20%) patients had moderate pain, and 7 (4.7%) had severe pain in the 6th week. In the 3rd month, the number of patients with severe pain decreased to 5 (3.3%), patients with moderate pain were 19 (12.7%), and the patients with mild pain were 126 (84.0%). In the 6th month after ACLR, only 3 (2%) patients had severe pain, 12 (8.0%) had moderate pain, and 135 (90.0%) had mild pain. The 2nd parameter ROM was accessed using the AOFAS ankle hindfoot scale in which out of 150 patients, 83 (55.3%) patients had a mild loss, 44 (29.3%) had a moderate loss, and 23 (15.4%) had severe loss of ankle joint (plantar flexion and dorsiflexion) motion at the 6th week after the ACLR surgery. In the 3rd month, 117 (78.0%) patients had a mild loss of motion, 27 (18.0%) had a moderate loss, and 6 (4.0%) had severe loss of motion. However, at the 6th month after the ACLR, only 4 (2.7%) patients were having severe loss of motion, 6 (4.0%) patients were having moderate loss, and 140 (93.3%) patients were having mild loss of motion. Similarly, the loss of range of hind foot (eversion and inversion) motion also decreases in the 6th month compared to 3rd month and 6th week.

The third parameter, muscle power, was measured using the MRC muscle power scale. The muscle power was increased in the patients after the 6th month ($n = 152$; 94.0%), followed by the 3rd month ($n = 127$; 84.7%) and 6th week ($n = 120$; 80%). In the fourth parameter, we assessed the patients based on the ACL RSI scale, in which 133 (88.7%) patients returned to jogging without discomfort around the ankle joint during the 1st min of jogging before six months, and 17 (11.3%) returned

Table 1: Comparison of patients' pain, ROM, and muscle power around ankle joint at 6th week, 3rd month, and 6th month (*n*=150).

Parameters	6th week (%)	3rd month (%)	6th month (%)	*P*-value
Pain at the donor site				
Mild	113 (75.3)	126 (84.0)	135 (90.0)	<0.020
Moderate	30 (20.0)	19 (12.7)	12 (8.0)	
Severe	7 (4.7)	5 (3.3)	3 (2.0)	
ROM of the ankle joint (plantar flexion and dorsiflexion)				
No or mild loss	83 (55.3)	117 (78.0)	140 (93.3)	<0.001
Moderate loss	44 (29.3)	27 (18.0)	6 (4.0)	
Severe loss	23 (15.4)	6 (4.0)	4 (2.7)	
ROM of the hindfoot (eversion and inversion)				
No or mild loss	91 (60.7)	119 (79.3)	142 (94.6)	<0.001
Moderate loss	40 (26.7)	24 (16.0)	5 (3.3)	
Severe loss	19 (12.6)	7 (4.7)	3 (2.0)	
Muscle power				
No contraction	0 (0)	0 (0)	0 (0)	<0.001
Flicker or trace of contraction	0 (0)	0 (0)	0 (0)	
Active movement, with gravity eliminated	10 (6.6)	8 (5.3)	2 (1.3)	
Active movement, with against gravity and resistance	20 (13.4)	15 (10.0)	6 (4.0)	
Normal power	120 (80.0)	127 (84.7)	142 (94.7)	

ROM: Range of motion

to jogging without discomfort around ankle joint during the 1st min of jogging after 6th month.

Based on previous studies, removing the PLT is not expected to affect the foot and ankle function substantially.[19] Our findings support this assertion. The main function of the peroneus longus muscle is to rotate the foot outward and flex the first metatarsal bone downward.[20,21] There are concerns that removing this tendon may not only decrease eversion strength and plantar flexion but also result in greater ankle instability. However, our research showed that ankle strength and ROM were similar before and after the PLT extraction.

Limitations of the study

There are some limitations to this study. First, the cohort size is small. Consequently, it becomes challenging to make an objective evaluation. Nevertheless, efforts were made to minimize bias by involving a single surgeon, implementing the same rehabilitation protocol, and using a consistent operative technique. One drawback of this study is the relatively short two-year follow-up. To address this, further research could focus on thoroughly assessing ACLR with the PLT autograft. In addition, it would be valuable to objectively measure the strength of ankle eversion to evaluate the potential adverse effects of harvesting the PLT as a donor site, including its impact on ankle functional score.

CONCLUSION

ACLR using the PLT autograft resulted in a superb functional outcome, smooth rehabilitation with the early return to sports, and minimal complications at the donor site. This highlights the PLT as a viable option primary option for grafting in ACLR surgeries in non-athletic population.

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AUTHOR'S CONTRIBUTIONS

MNK contributed to manuscript preparation, manuscript editing and review. SNJ was involved in conception and design. SM contributed to literature research. SK contributed to data acquisition, data analysis, and statistical analysis. QMG was involved in clinical and experimental studies and UUS contributed to the definition of intellectual content. 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-06-024, 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 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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