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ORIGINAL ARTICLE

Arthroscopic Single-Bundle ACL Reconstruction Using Peroneus Longus Tendon Autograft

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Abstract

Background: ***When it comes to sports and accidents involving the knee, the anterior cruciate ligament (ACL) is the most common ligament injured. ACLR helps restore stability and function to the knee. The two most common types of tendon autografts are those from the hamstring (HT) and the patellar tendon (BPTB).***

Objectives: ***To assess the function and outcome of the knee following ACLR using peroneus longus tendon (PLT) autograft.***

Patients and methods: ***This prospective study was performed on thirty males with isolated ACL tears at Al-Azhar University Hospitals between December 2021 and June 2022 and followed up for one year. These patients underwent single-bundle arthroscopic ACLR with the PLT autograft.***

Results: ***A statistically significant difference was observed regarding International Knee Documentation Committee (IKDC), Tegner-Lysholm, Modified Cincinnati and Lachman test scores from pre-operation to 6- and 12-months follow-up and as regard Knee Visual Analog Scale (VAS) score from pre-operation to 3 months follow-up (p-values < 0.0001). A low statistically significant difference regarding the American Orthopedic Foot and Ankle Society (AOFAS) and the Foot and Ankle Disability Index (FADI) scores between pre-operation and six months follow-up with p-values of (p=0.0023 and p=0.0149 respectively) and no statistically significant difference after 12 months follow-up with p-values of (p=0.0735 and p=0.0912 respectively) were observed.***

Conclusion: ***PLT full-thickness autograft provides a stable painless knee, with an excellent range of motion and improved quality of life, with no adverse effects on the ankle or gait. It can be deemed a reasonable autograft option for ACL reconstruction.***

Keywords: ACL; Peroneus longus tendon autograft; AOFAS

1. Introduction

ACL tears constitute nearly 50% of all knee joint injuries. ACLR is recommended for restoring rotatory and anterior-posterior knee laxity. [1]

There are a variety of grafts, anchoring systems, and surgical procedures available today. Preferred graft sources include HT and BPTB autografts. [2]

There are advantages to autografts, but there are also some disadvantages. The risks of the BPTB graft include increased incidence of anterior knee discomfort (in around 60% of patients), increased risk of anterior cruciate ligament (ACL) tears in the opposite knee, and eventual osteoarthritis.[3]

The risk of autograft rupture is increased while using HT autograft since it can lead to an imbalance in the knee's flexors and extensors. [4]

The expensive cost, increased risk of graft failure, and ongoing Lachman and pivot shift are some of the reasons why allo- and xenografts are used less often. [5]

Innovative surgical techniques that protect the knee's dynamic stabilizers are being sought after as our understanding of biomechanics and kinematics continues to grow. [6]

Promising features of the PLT include short harvest times, ideal graft thickness, and little effect on knee joint stabilizers, which lessens the likelihood of problems. [7]

However, the potential of using PLT autograft in arthroscopic ACLR and its impact on knee and ankle function still needs to be explored globally, necessitating further research in this area.

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2. Patients and methods

The prospective study was carried out at Al-Azhar University Hospitals on patients with isolated ACL tears between December 2021 and June 2022 and followed up for one year. These patients went through arthroscopic single-bundle ACLR using PLT autograft, which was fixed by an adjustable suspensory device at the femoral end and by a biodegradable interference screw at the tibial end.

Inclusion criteria: Torn ACL in individuals aged 18 to 45 years

Exclusion criteria: Multi-ligamentous injury, meniscal tear, significant chondral damage (greater than grade I), peri-articular knee fracture, and patients with a pre-existing pes planus, deformity of the ankle, neuromuscular conditions, or previous ankle significant injuries.

Methods:

Surgical procedure

The prophylactic antibiotic 3rd generation cephalosporin (Cefotaxime 1gm) is routinely given intravenously during the anaesthesia induction. Operations are performed under spinal anaesthesia in the supine position. Arthroscopy is achieved using anterolateral and anteromedial portals to confirm the diagnosis.

Skin incision for graft:

An incision measuring 3 cm in length is made vertically on the back of the lateral malleolus, 2 cm proximal to its tip, and proximal to the superior peroneal retinaculum. After careful excision of the fascia, the peroneal tendons are exposed. The PLT was found in posterolateral position to the peroneus brevis tendon. Both tendons were sutured together. The proximal segment of the PLT was cut and sutured; after that, a long tendon stripper was introduced proximally to a point 5 cm distal to the fibular head to protect against peroneal nerve injury. The skin was sutured using Nylon 2-0. The harvested tendon's length was obtained after it had been released from muscle tissue.

Preparing the triple graft:

The harvested tendon was pre-tensioned and triple-layered. The prepared graft diameter was measured. The minimal sleeve that passes the graft with minimal friction determines the tunnel diameter. During preparation, an adjustable suspensory device with an adjustable loop was passed and attached to one end.

Femoral tunnel placement:

A central transpatellar tendon portal and an anteromedial portal were used for femoral footprint visualization and instrumentation. The femoral intercondylar notch anatomy was identified using a shaver (the study group didn't need notchplasty). The femoral insertion point was marked, and a guide wire was inserted to create an anteriorly oriented tunnel, preventing posterior wall damage. After drilling the tunnel, the guide pin exited the thigh with a shuttle loop.

Tibial tunnel placement:

A guide pin was inserted into the knee using a drill guide system, angled at 55° to the tibial shaft. The pin's tip was placed behind the anterior horn of the lateral meniscus and 7 mm anterior to the posterior cruciate ligament. The tunnel was then drilled using a cannulated drill bit.

Graft passage and fixation

The passing loop was retrieved from the tibial side. Then, via the tibial tunnel, the graft was pulled until the suspensory device passed the outer femoral cortex, flipped over the cortex, and the adjustable loop was shortened to secure 25 mm of the graft inside the femoral socket. Cyclical tensioning through repetitive flexion and extension ensured proper graft alignment. Arthroscopic visualization confirmed alignment and absence of impingement. Tension was applied to Ethibond before fixing the interference screw on the tibial end.

Closure:

Following thorough irrigation, the skin incision at the insertion site of the tibial screw and portals of arthroscopy were stitched with Nylon 2-0, and an intra-articular drain was left for 24 hours.

Postoperative rehabilitation

During the initial six weeks of rehabilitation, the focus is on walking with partial weight bearing using crutches, accompanied by isometric quadriceps exercises, passive range of motion from 0 to 90 degrees and Active ankle movement. During the seventh and eighth weeks, the regimen advances to include active extension exercises against resistance, gradually increasing from 1 kg to 7 kg over 90 days. By the third month, the rehabilitation intensifies with the introduction of treadmill walking and cycling, starting at 10 minutes each and progressing to one hour daily. The fourth month marks the initiation of running on soft terrain for 10 minutes, escalating to one hour daily, along with thrice-weekly swimming sessions. Individuals can reintegrate into low-risk sports by the fifth month with sport-specific exercises. Finally, participants can safely return to team and high-risk sports by the sixth month.

Ethical Statement

This study was conducted according to international ethical standards and local regulatory restrictions. The study did not pose any physical, psychological, social, legal, economic, or other potential risks to the participants. The study maintains patients' privacy. The investigators were accountable for maintaining the confidentiality of the data. We further confirm that participants' data was not utilized in any way other than this study. To preserve the anonymity of the participants, we did not enter personal data into our data entry tool. Instead, each subject was given a special identification code.

Statistical analysis

The statistical analysis was performed with SPSS software (Statistical Package for Social Science) (Version 24.0). Pre-operative and postoperative data were compared utilizing the t-test and Chi-square test for inferential statistics. Descriptive statistics were based on the mean and standard deviation. Statistical significance was considered at P-values < 0.05.

3. Results

A total of thirty male patients (aged 18 to 38) fulfilled the inclusion criteria. Arthroscopic single-bundle ACLR was carried out using the same harvest, graft technique and arthroscopic technique by a single senior arthroscopic surgeon. The demographic analysis of this study is demonstrated in Table 1.

Table 1. Descriptive data distribution in all study populations

DEMOGRAPHIC DATA	N=30
AGE (YEARS)	25.4±5.26
HEIGHT (M^2)	1.76±0.03
WEIGHT (KG)	75.53±3.55
BMI (KG/M^2)	24.43±1.1
DURATION BEFORE SURGERY (MONTHS)	4.6±0.8
AFFECTED SIDE	
LEFT	12(40%)
RIGHT	18(60%)
DOMINANT SIDE	
LEFT	4(13.3%)
RIGHT	26(86.7%)
MODE OF TRAUMA	
FOOTBALL INJURY	27(90%)
TWISTING WHILE RUNNING	3(10%)
GRAFT DIAMETER (MM)	9.46±0.35
ORIGINAL HARVESTED TENDON LENGTH (CM)	28.43±0.79

The IKDC, Modified Cincinnati and Tegner-Lysholm scores showed a statistically significant difference (p<0.0001) at 6- and 12-months post-operative in comparison to pre-operative values (Table 2).

Table 2. Knee scoring assessment at 6 and 12 months

Parameter	Pre-operation	6 months	P value	Significance	12 months	P value	Significance
IKDC	53.95±3.65	84.12±3.75	p<0.0001	Sig.	95.38±1.29	p<0.0001	Sig.
Tegner-Lysholm	52.73±5.19	85.93±2.36			98.5±1.63		
Modified Cincinnati	56.43±3.54	83.9±1.69			96.1±1.54		

The Lachman test was used for post-operative knee stability assessment, which was normal in 22 patients, and a grade 1 anteroposterior laxity in 8 patients at 6 months and normal in 29 patients, and 1 patient had grade 1 anteroposterior laxity at the end of follow-up. (Table 3).

Table 3. Lachman test score during the follow-up

PARAMETER	*LACHMAN TEST PRE*	*LACHMAN TEST 6 MONTHS*	P VALUE	*LACHMAN TEST 12 MONTHS*	P VALUE
NORMAL	0(0)	22(73.33%)	p<0.00001	29(96.67%)	p<0.00001
GRADE 1	0(0)	8(26.67%)		1(3.33%)	
GRADE 2	23(76.67%)	0(0)		0(0)	
GRADE 3	7(23.33%)	0(0)		0(0)	

Knee pain was assessed using VAS pre-operation and at 3 months post-operative. VAS showed a highly statistically significant difference (p-value < 0.0001) among the studied individuals at 3-months follow-up (Table 4)

Table 4. Knee VAS score and duration of follow-up

PARAMETER	*PRE-OPERATIVE*	3 *MONTHS*	P VALUE	STATISTICAL SIGNIFICANCE
KNEE VAS	2.47±0.51	0.03±0.18	p<0.0001	Sig.

The mean pre-operative AOFAS and FADI scores were 98.73±0.73 and 98.83±0.74 respectively. A low statistically significant difference is observed among the studied individuals as regards AOFAS and FADI scores from pre-operation to 6 months follow-up with p-values of (p=0.0023 and p=0.0149 respectively) while at 12 months follow-up there was no statistically significant difference with p-values of (p=0.0735 and p=0.0912 respectively)

Table 5. AOFAS and FADI scores during the follow-up

PARAMETER	PRE-OPERATION	6 MONTHS	P VALUE	SIGNIFICANCE	12 MONTHS	P VALUE	SIGNIFICANCE
AOFAS	98.73±0.73	97.93±1.31	P=0.0023	Sig.	98.33±1.18	P=0.0735	N S
FADI	98.83±0.74	98.23±1.27	P=0.0149	Sig.	98.46±1.16	P=0.0912	N S

Case Presentation

An active twenty-three-year-old male driver presented with a swollen left knee after trauma while playing football, 4 months before. X-ray scan revealed no knee osteoarthritis and an MRI scan showed a full-thickness ACL tear. The posterior cruciate, menisci and collateral ligaments, were normal. The patient experienced occasional pain and symptomatic instability. Clinically, the knee showed antero-posterior laxity. The pre-operative tests revealed positive Lachman, anterior drawer tests. The pre-operative scores were as follows: IKDC was 57.5, Tegner-Lysholm was 54, Modified Cincinnati was 55, VAS was 2, AOFAS was 98, and FADI was 99. The arthroscopic procedure was done. Standard physiotherapy protocols were followed.

The post-operative scores were as follows: at 6 months (IKDC was 89.7, Tegner-Lysholm was 88, Modified Cincinnati was 84, Knee VAS was 0, AOFAS was 94, FADI was 94 and at 12 months (IKDC was 95.4, Tegner-Lysholm was 99, Modified Cincinnati was 96, Knee VAS was 0, AOFAS was 97 and FADI was 99). At 12-months follow-up period, the Lachman test was normal.

Figure 1: Photos of the case presentation

4. Discussion

ACL injuries are common and require satisfactory reconstruction, often using autografts due to their safety and biocompatibility. Autografts undergo a process of revascularization and recollagenation, losing some strength initially. Ideal substitutes for ACL should possess greater strength than the native ACL. While BPTB autografts offer 2300 N and quadruple hamstring grafts provide 4090 ± 265 N, double PLT grafts boast an impressive ultimate tensile load of 4268 ± 285 N, making them a promising alternative. [8]

Post-surgery, the biomechanical implications of using stabilizers in autograft harvesting are uncertain. There is concern that this approach may negatively impact knee function and lower limb strength, potentially leading to reduced functional parameters during knee joint recovery. Graft failure is also a worry. While anatomical considerations and thorough rehabilitation can help mitigate risks, exploring alternative autograft options may potentially reduce postoperative complications related to knee joint biomechanics. [9]

BPTB autografts are linked to reports of kneeling pain and anterior knee pain after surgery. In addition, a higher prevalence of osteoarthritis in individuals who have ACL reconstruction using a BPTB autograft is reported in meta-analyses. Research has shown that this autograft is more likely to cause adhesions, resulting in limited knee extension. [10]

Using an HT autograft for ACLR may lead to weakness in knee flexors and delay electromechanical response. This approach could hinder postoperative rehabilitation by compromising the protection of the reconstructed ACL from anterior drawer force and impeding active knee flexion. [10]

The PLT has advantages due to the avoidance of knee extension or flexion deficit and not having any patellofemoral pain in patients. [10]

The autograft size in ACLR surgery significantly influences the likelihood of failure. In this study, the mean graft diameter was 9.46 mm. Xu et al. observed that clinical outcomes were improved in the autograft group when graft diameters exceeded 8.5 mm. [11]

Spragg et al. reported that the risk of a revision ACLR was 0.82 times lower for every 0.5 mm increase in graft diameter between 7.0 and 9.0 mm. [12]

Figueroa et al. recommend increasing graft size by 0.5 mm up to 10 mm for benefit. A study comparing quadruple hamstring and peroneus graft thickness showed an average difference of 0.6 mm in the direction of the PLT graft. [7]

The accessibility and straightforward identification of the PLT graft make it easier for less experienced surgeons to harvest than other graft options like BPTB and HT. This simplicity increases the surgeon's confidence and reduces the risk of errors during the procedure. [10]

Previous research indicates that utilizing the PLT graft positively impacts knee stability and functional outcomes. [7]

This study assessed the stability and functional outcome of the knee joint following ACLR using PLT, demonstrating outcomes comparable to Kerimoglu et al. [14]

The study significantly improved IKDC, Modified Cincinnati, and Tegner-Lysholm scores. Khajotia et al. reported an increase in IKDC score six months after ACLR using PLT, with a mean score of 83.53.[15]

Kerimoglu et al. reported a positive outcome in ACLR using PLT with a mean Lysholm score of 83.7. [15]

This study assessed ankle functions using the AOFAS-Hindfoot Scale and FADI score. The AOFAS mean score was 98.33±1.18, while the FADI mean score was 98.46±1.16 at 12 months follow-up, considered excellent results. This is consistent with findings from similar studies in the field, which found that one year after surgery, the mean AOFAS and FADI scores were 97.3 and 98, respectively. [7]

According to our findings, the donor's ankle functions were excellent after the PLT harvesting. This is likely due to the peroneus brevis muscle still intact. Previous studies suggested that the peroneus brevis is a more effective ankle evertor, which helps to sustain ankle eversion function following the harvest of the PLT.[7]

Limitations: There are limitations in this study. The cohort is small, and there is no assessment of ankle stability. Therefore, it is not easy to assess objectively. However, the bias has been minimized because of a single surgeon, the same rehabilitation protocol, and the operating procedure. The one-year follow-up is a limitation, and future research could focus on further assessing ACLR with PLT autograft for longer periods. An objective assessment of ankle evertor strength could be utilized to assess the complications at the donor site, and its correlation with ankle functional score can be examined.

4. Conclusion

The PLT full-thickness autograft provides a stable, painless knee with an excellent range of motion and improved quality of life, with no adverse effects on the ankle or gait. According to the findings of this study, it can also be deemed a promising alternative to avoid potential donor site morbidities of harvested autografts from the knee region (hamstring and BPTB graft).

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

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All authors have a substantial contribution to the article

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There are no conflicts of interest.

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