Observational Study

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A prospective study of arthroscopic primary ACL reconstruction with ipsilateral peroneus longus tendon graft

Experience of 439 cases

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Abstract

Anterior cruciate ligament (ACL) tears are frequent ligamentous injuries that necessitate reconstruction in many cases. The patellar tendon and the hamstring tendon are the most frequently utilized autografts for reconstruction. However, both have certain disadvantages. We hypothesized that the peroneus longus tendon would be an acceptable graft for arthroscopic ACL reconstruction. The aim of this study is to determine whether a peroneus Longus tendon transplant is a functionally viable option for arthroscopic ACL reconstruction without compromising donor ankle activity. In this prospective study 439 individuals aged between 18 to 45 years, who underwent ACL reconstruction using ipsilateral Peroneus longus tendon autograft were observed. The injury to the ACL was initially assessed by physical examinations and further confirmed by magnetic resonance imaging (MRI). The outcome was assessed at 6, 12, and 24 months after the surgery using Modified Cincinnati, International Knee Documentation Committee (IKDC), and Tegner-Lysholm scores. The donor ankle stability was evaluated using foot and ankle disability index (FADI) and AOFAS scores, as well as hop tests. Significant ($P < .001$) improvement in the result of the IKDC score, Modified Cincinnati, and Tegner-Lysholm score was observed at the final follow-up. The Lachman test was mildly (1+) positive only in 7.70% of cases, the anterior drawer became negative in all cases, and the pivot shift test was negative in 97.43% of cases at 24 months after the surgery. FADI and AOFAS scores for donor's ankle functional assessment were impressive, as were single hop test, triple hop test, and cross over hop test results at 2 years. None of the patients had any neurovascular deficit. However, 6 cases of superficial wound infection were observed, 4 at the port site and 2 at the donor site. All resolved after appropriate oral antibiotic therapy. The peroneus longus tendon can be considered a safe, effective, and promising graft of choice for arthroscopic primary single-bundle ACL reconstruction because it has a good functional outcome and impressive donor ankle function after surgery.

Abbreviations: ACL = anterior cruciate ligament, AOFAS = American orthopedic foot and ankle score, FADI = foot and ankle disability index, IKDC = international knee documentation committee, MRI = magnetic resonance imaging.

Keywords: ACL reconstruction, arthroscopy, peroneus longus, single-bundle

1. Introduction

An anterior cruciate ligament (ACL) is the most frequently injured ligament in the knee joint that is usually injured when engaging in sports activity, but nonsports injuries are not uncommon.[1–3] It can occur by landing from a ladder during household activities and even playing with and running after kids. ACL reconstruction aims at establishing a stable knee that will allow the patient to have normal everyday life or to return to sporting activities after surgery.[4] Throughout the past decades, ACL reconstruction has evolved considerably using various grafts.[5,6] Autografts, allografts, and synthetic grafts have all been tried with varying degrees of success.

Autografts can come from various tendon sources. The 2 most common are the hamstring tendon graft and the patellar tendon (PT) graft, commonly known as the Bone-Patellar-Tendon-Bone (BPTB) graft.[7] BPTB graft has the benefit of

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bone-to-bone healing, which allows tunnel and graft to be easily incorporated, leading to a quicker return to work and athletic activity. But, BPTB carries the potential for morbidity at the donor site, including motion loss, patellofemoral discomfort, and fracture of the patella. On the other hand, a hamstring autograft is easily harvested with little morbidity at the donor site and is similar to native ACL. Yet, it has unpredictable graft size, and the hamstring capacity can be diminished, which is important for certain athletes in need of hamstring power.[8]

Peroneus Brevis and peroneus longus have a synergistic action; hence longus can be spared as an autograft. This tendon is increasingly being used as a graft in reconstructive orthopedics, including spring or deltoid ligament reconstruction in the foot and medial patellofemoral ligament reconstruction in the knee.[9] Peroneus longus tendon has been used as the first option for ACL autograft in a few earlier studies, with favorable clinical results and low donor site morbidity.[8,10] However, another research did not agree with the morbidity of the donor site.[11] Rudy and his colleagues, on the other hand, found no difference in and hamstring tendon and peroneus longus tensile strength in their biomechanical analysis.[12] We hypothesized that, the peroneus longus tendon would be an acceptable graft for arthroscopic ACL reconstruction. Hence, it would be particularly useful for sportsmen who rely on hamstring strength or for patients who, most of the time, are kneeling during their religious or social activity. The aim of this study is to determine whether a peroneus Longus tendon transplant is a functionally viable option for arthroscopic ACL reconstruction without compromising donor ankle activity.

2. Methods

2.1. General information

This prospective study held between January 2015 to June 2019, observed patients who underwent single-bundle arthroscopic ACL reconstruction by the same operating surgeon at a tertiary care orthopedic teaching hospital situated in the nation's capital. Using consecutive sampling technique 456 patients were identified at the emergency and casualty department, 17 were excluded following exclusion criteria and finally 439 patients were analyzed (Fig. 1). Patients were recruited after a comprehensive clinical evaluation such as an anterior drawer test, Lachman test, and pivot shift test. Further, a clinical examination was performed to rule out any injuries to the Posterior Cruciate Ligament or the Posterolateral Corner. Anteroposterior and lateral view radiographs of the afflicted joint were taken, and the case was subsequently confirmed using magnetic resonance imaging (MRI). Inclusion criteria were clinically diagnosed and MRI-confirmed cases with only ACL injury and ages between 16 and 45 years. Patients with a pathological condition in the lower extremity and fracture around the knee or associated ligament injury, meniscal injury, chondral damage, and any abnormality of the contralateral knee joint were excluded. Revision cases and patients who refused to provide consent were also excluded. The study was approved by the tertiary care center's Institutional Review Board and informed written consent as per the Declaration of Helsinki was obtained from all the participants.

2.2. Pre operative rehabilitation program

Prior to surgery, subjects were enrolled in a pre operative rehabilitation program. Pre operative rehabilitation consisted of progressive exercise and perturbation training in order to restore quadriceps muscle strength. Subjects were systematically progressed through the rehabilitation process based on the protocol used by Eitzen and his colleague.[13]

2.3. Arthroscopic surgery

A single senior arthroscopic surgeon performed all the surgery, and graft preparation and measurement were done by the same assistant. Every patient had the surgery in the supine position while under spinal anesthesia, with a pneumatic tourniquet being used to control bleeding. To harvest the peroneus longus

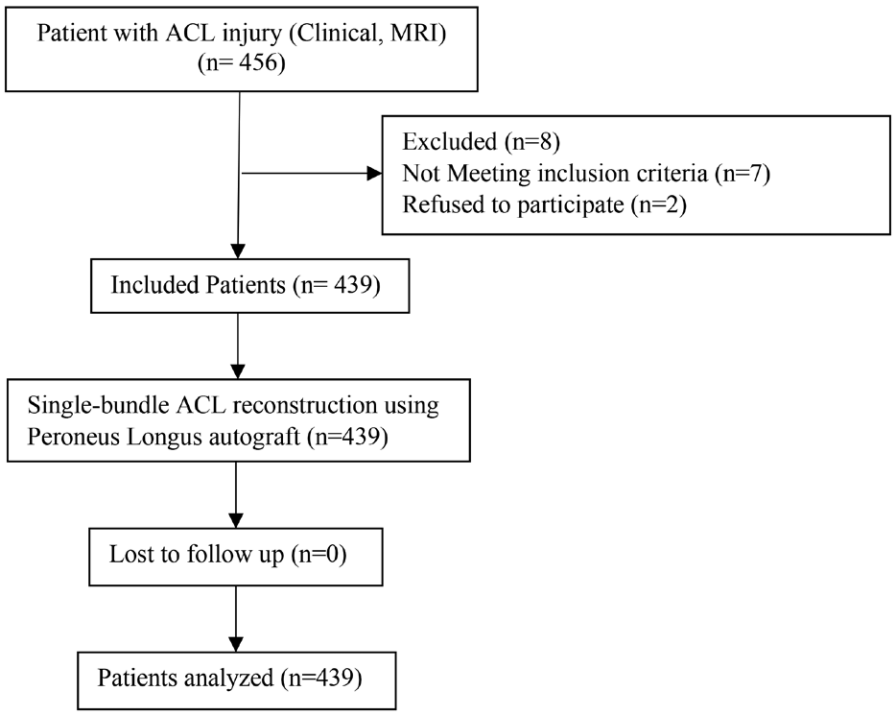

Figure 1. Flow diagram of patients excluded from the study.

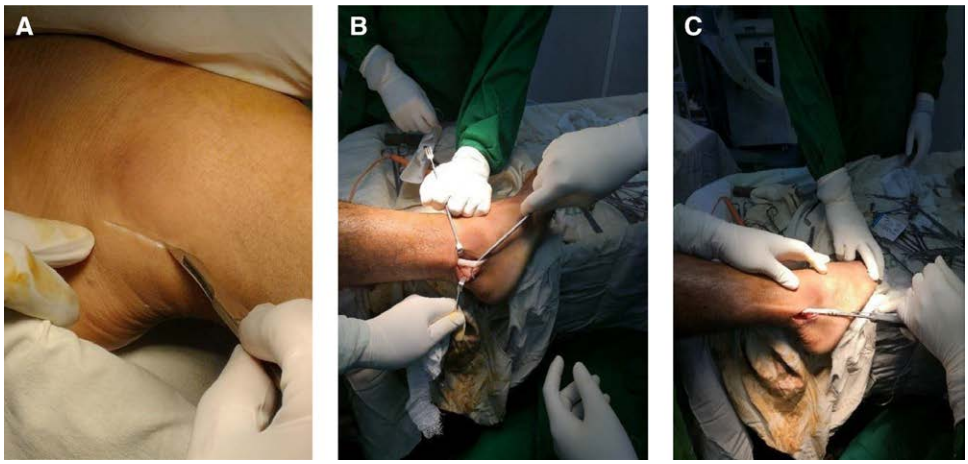

Figure 2. Incision to harvest the tendon (a), Tendon exposed by layer (b), Tendon being stripped by tendon stripper (c).

Table 1

Clinical features of the patients in the study (n = 439).

Characteristics	Group	Mean ± SD	Min	Max	n
Age [in yrs]		27.10 ± 7.41	18	45	
Sex					
	Male				348 (79.27)
	Female				91 (20.72)
Injury mechanism	Sports				258 (58.76)
	MVA				101 (23.00)
	Domestics				80 (18.22)
Length of peroneus longus tendon graft [in cm]	27.5–28.5				123 (28.01)
	28.6–29.5	28.86 ± 1.30	27.5	30.3	191 (43.50)
	29.6–30.5				90 (20.50)
	>30.5				35 (07.97)
Diameter of peroneus longus tendon graft (after folded over once) [in mm]	7.0–7.5				76 (17.31)
	7.6–8.0				103 (23.46)
	8.1–8.5	8.11 ± 0.49	7.0	8.8	207 (47.15)
	8.6–9.0				53 (12.07)
Complication after surgery					
Superficial wound	Yes				6 (1.37)
infection	No				433 (98.63)

Values are presented as frequency, mean or percentage.

MVA = motor vehicle accident, SD = standard deviation. Percentage in the parenthesis.

Table 2

Clinical examination of the knee before surgery and at final follow up.

Test grade	Before surgery	At the final follow up
Lachman test		
Negative	33 (7.51)	405 (92.25)
1 + (mild: 0 to 5 mm laxity)	213 (48.51)	34 (7.74)
2 + (moderate: 6 to 10 mm laxity)	168 (38.26)	00 (00)
3 + (severe: 11 to 15 mm laxity)	25 (5.69)	00 (00)
Pivot shift test		
Negative	157 (35.76)	427 (97.26)
Glide (grade I)	236 (53.75)	12 (2.73)
Clunk (grade II)	33 (7.51)	00 (00)
Gross (grade III)	13 (2.96)	00 (00)
Drawer test		
Negative	(00)	439 (100)
Positive	439(100)	(00)

Values are presented as frequency and percentage. Percentage in the parenthesis.

tendon, a 2 cm incision was made along the posterior edge of the distal fibula, just above the superior peroneal retinaculum (Fig. 2a). The tendon is exposed by deepening the incision (Fig. 2b). Distal cut end of Peroneus longus tendon sutured with intact peroneus Brevis muscle to prevent retraction. Using number 2 nonabsorbable suture, the tendon was sutured and cut with a scalpel, finally harvested with a long tendon stripper (Fig. 2c). The wound was closed using absorbable subcuticular sutures and staples or nonabsorbable sutures for the skin. On a tendon board, the harvested graft was pretensioned, and its length was measured. The graft was folded once to create a double-stranded graft and to determine the graft diameter, subsequently passed through the cylindrical sizers. Calibration was taken by the same assistant in all cases.

Standard arthroscopic portals were made, and an arthroscopic survey was performed. A guidewire was inserted into the posteromedial corner of the lateral femoral condyle using a femoral offset aimer for all cases according to the harvested graft diameter. A femoral tunnel was created using an adequately sized reamer. Flexing the knee to 70° to 90°, through the anteromedial portal, the tip of the tibial drill guide was placed into position; finally, the angle of the drill guide was adjusted to 45° to 55°. After placing the drill sleeve on the medial cortex of the tibia, the guidewire was drilled into position, coming out at the tibial plateau. The tibial tunnel was created using a cannulated tibial reamer of the size dictated by the thickness of the harvested graft. The graft was marked appropriately and moved via the tibial

tunnel into the femoral tunnel under arthroscopic supervision. After applying stable traction to the graft and passing a guidewire through it, the graft was fixed with a biodegradable screw in both the femoral and tibial tunnels. Aperture fixation with biodegradable screws on both sides is commonly practiced in our center. The goal of this study was not to evaluate various fixation methods, rather to evaluate graft effectiveness. Hence, to remove the influence of diverse fixation methods, we employed a single strategy in all instances, which is commonly used by our surgeons. The patient was given antibiotics, analgesics and the knee was immobilized. A postoperative radiograph was taken to check that the tunnels and fixation device were properly placed.

2.4. Postoperative follow-up, rehabilitation, and return to activity

For all of the cases, the same person among the coauthors recorded functional results and donor site morbidity at 6, 12, and 24 months following the surgery. As a functional assessment, the Tegner-Lysholm, IKDC (International Knee Documentation Committee), and Modified Cincinnati scores were used. The serial hop test, AOFAS (American orthopedic foot and ankle score), and FADI (Foot and Ankle Disability Index) score were used to assess donor site morbidity.

All patients were treated with the same postoperative ACL rehabilitation program.[8] Patients were trained to exercise the injury site leg using partial weight-bearing until 3-weeks post-surgical procedure followed by full weight-bearing. Knee extension started immediately after surgery. Knee flexion was steadily increased from 0° to 90° until 3 weeks following surgery when complete flexion was achieved. Despite the fact that jogging was permitted after 2 months, resumption to sports activity was postponed until the functional outcome test and serial hop test at 6 months.

3. Result

The patients in the current research had an average age of 27.10 ± 7.41 years. Sports injuries were the leading cause of 258 (58.76%) injuries, followed by motor vehicle accidents (MVA). The mean length of the harvested Peroneus longus graft was 28.86 ± 1.30 cm and the obtained mean diameter was 8.11 ± 0.49 mm. Superficial wound infection was observed in 6 cases, 4 at the port site and 2 at the donor site. None of the patients had any neurovascular deficit (Table 1). At final follow-up Lachman test was normal in 405 cases (92.25%), while 34 patients (7.74%) had 1 + laxity, and pivot shift tests were negative in 427 (97.26%) cases. The drawer test was negative in all cases (Table 2). The majority of patients experienced an improvement in their IKDC, modified Cincinnati, and Lysholm scores with a mean difference of 32.9 ± 11.7, 27.3 ± 13.9 and, 24.7 ± 10.6, respectively, at 24 months after the procedure. A significant difference (P = .001) was found in the IKDC, modified Cincinnati, and Lysholm scores between the preoperative and final follow-up assessments (2-year postoperatively) (Table 3). For the evaluation of donor site morbidity, functional assessments at all the follow-up for the ankle using AOFAS and FADI scores showed good results. The mean AOFAS score for the donor's ankle was 97.63 ± 3.20 (range 89.00–100.00), and the FADI score was 98.46 ± 2.31 (range 86.20–100). The mean score of the single hop test was 92.31 ± 4.45. The mean score of the triple hop test was 93.26 ± 3.61. The mean score of the cross over hop test was 94.20 ± 2.51. The mean score of the timed hop test was 94.18 ± 3.25 (Table 4).

4. Discussion

The most commonly used autografts for ACL reconstruction were the patellar tendon and the hamstring tendon. Knee discomfort can complicate the use of the former autograft, especially in individuals who spend a lot of time on their knees for religious, cultural, or sporting activities. If the ACL rupture is accompanied by medial collateral ligament rupture, hamstring harvesting can cause medial knee joint instability, and injure the saphenous nerve is also another possibility. Peroneus longus is one of the main ankle evertors. So, the primary concern about using Peroneus longus tendon graft is ankle instability. The study would evaluate how a single-bundle ACL reconstruction using ipsilateral peroneus longus tendon autograft affects functional outcome and donor site morbidity in primary cases.

The Peroneus longus graft obtained in this study had a mean diameter of 8.15 mm and a mean length of 28.17 cm. In about 60% (260 cases) cases, a graft harvesting with a diameter of > 8 mm was possible indicating a criteria of acceptable graft. This type of graft characteristic has similarities with others reported cases.[8,14] At the final follow-up, the anterior drawer was found to be negative in all patients, and the Lachman test showed substantial improvement in all except 7.7% of cases with mild laxity. The pivot shift test became negative in 97.43% of patients 24 months following the surgery, with the remaining cases having just a Grade-I positive result. Other

Table 3

Functional outcome at 6, 12, and 24 months after surgery.

Scoring system	Follow-up time	Score (Mean ± SD)	Mean difference	95% CI	*P* value
IKDC	Preoperative	57.6 ± 10.9			
	06 mo after surgery	89.6 ± 2.31			
	12 mo after surgery	90.1 ± 4.11			
	24 mo after surgery	91.8 ± 6.01	32.9 ± 11.7	(– 38.8)–(– 29.1)	<.001
Modified Cincinnati	Preoperative	65.8 ± 12.90			
	06 mo after surgery	87.9 ± 4.75			
	12 mo after surgery	91.8 ± 2.40			
	24 mo after surgery	92.9 ± 6.0	27.3 ± 13.9	(– 31.8)–(– 18.9)	<.001
Lysholm	Preoperative	69.9 ± 11.0			
	06 mo after surgery	90.4 ± 4.12			
	12 mo after surgery	93.5 ± 5.5			
	24 mo after surgery	93.8 ± 6.1	24.7 ± 10.6	(– 28.9)–(– 17.9)	<.001

Paired *t* test was employed to see the level of significance at final follow-up (24 mo after surgery) in comparison to the preoperative score.

Table 4

Result of serial hop test.

Test	Mean ± SD	Range	Normality
AOFAS	97.63 ± 3.20	89.00-100.00	0.000
FADI	98.46 ± 2.31	86.20-100.00	0.000
Hop (single)	92.31 ± 4.45	87.00-96.00	0.000
Hop (triple)	93.26 ± 3.61	88.00-98.00	0.000
Hop (cross over)	94.20 ± 2.51	90.00-98.00	0.000
Hop (timed)	94.18 ± 3.25	89.00-98.00	0.000

Values are presented as mean ± standard deviation and range.

studies have found similar good results with extremely few occurrences of residual Lachman test or Grade-I pivot shift test.[15,16]

Our study showed significant improvement in the result of IKDC score, Modified Cincinnati, and Tegner-Lysholm score. At 1 year following surgery, Rhatomy et al reported substantial improvements in the IKDC, Modified Cincinnati and Lysholm score.[8] Other studies have shown that using the peroneus longus tendon as a graft improved IKDC and Lysholm score significantly.[11,17] According to the results of the ankle function assessment based on FADI and AOFAS score, the donor ankle function was excellent after harvesting the peroneus longus tendon. Most likely, this is due to the fact that the donor ankle has an intact peroneus Brevis. Following the harvesting of the peroneus longus tendon, the function of ankle eversion by more powerful peroneus Brevis will be retained, as shown by several previous research.[18,19] The current study showed good performance in the single hop test, triple hop test, cross over hop test, and timed hop test. In patients with ACL injuries, a predictive test such as the serial hop test has been used to assess their fitness to return to sport in previous study.[20,21]

In addition to the above finding, another factor that makes the peroneus longus tendon an ideal candidate for ACL reconstruction is its safe and easy harvesting technique. The peroneus longus tendon is superficially placed, and its position is not complicated to access by accompanying structures like hamstring tendons.[22] Moreover, the biomechanical properties of the peroneus longus tendon are superior, as proposed by another research.[23] Our study had several limitations, one of which was that no preoperative activity level and quadriceps strength matching among the cohort. But the study used a systematic preoperative rehabilitation program to increase the quadriceps muscle strength for all participants.[13] Other limitations include, lack of using the newer equipment that objectively assesses isokinetic ankle strength, as well as the 2-year follow-up period. Further, MRI evaluation of the operated knee or donor site has not been reported. However, prior research revealed no statistically significant differences between hop test performance and isokinetic strength assessment; again, another study confirmed hop testing as a viable and accurate outcome measure during rehabilitation following ACL reconstruction.[21,24]

5. Conclusion

In summary, favorable functional outcome (IKDC, Modified Cincinnati, Tegner-Lysholm score) was achieved by the use of the peroneus longus tendon autograft in single-bundle ACL reconstruction. FADI and AOFAS scores for donor ankle functional test were impressive, as were single hop test, triple hop test, and cross over hop test proves that peroneus longus can be considered as a safe, effective, and promising graft of choice for arthroscopic primary ACL reconstruction.

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