RESEARCH ARTICLE

Peroneus Longus Tendon Autograft versus Hamstring Tendon Autograft in Anterior Cruciate Ligament Reconstruction: A Comparative Study with a Mean Follow-up of Two Years

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Abstract

Background: Peroneus longus tendon can be a suitable alternative autograft for anterior cruciate ligament reconstruction (ACLR). The present study aimed to compare the clinical outcome and donor site morbidity in ACLR using peroneus longus tendon autograft versus hamstring tendon autograft.

Methods: In a comparative cross-sectional study, ACLR was performed with quadrupled hamstring tendon autograft in 65 patients between 2017 and 2018, and in another group, peroneus longus tendon autograft was used for ACLR in 65 patients between 2018 and 2019. The same surgical technique, fixation method, and postoperative protocol were used in both groups. The knee functional outcomes were assessed according to the Lysholm score and the International Knee Documentation Committee scale at preoperative and at the end of at least 2 years after the procedure. Moreover, graft diameter was measured intraoperatively. Thigh circumference, the American Orthopedic Foot and Ankle Score (AOFAS), The Foot & Ankle Disability Index (FADI), and ankle range of motion (ROM) were used to evaluate ankle donor site morbidities.

Results: A total of 130 patients (65 patients in each group) were evaluated with a minimum follow-up of 2 years (range 24–31 months). Both groups showed no significant differences in clinical outcomes and knee stability. The peroneus longus graft diameter was significantly larger than the hamstring diameter (*P<0.001*). Assessment of AOFAS, FADI, and ankle ROM showed no apparent ankle joint dysfunction in the peroneus longus tendon group.

Conclusion: Faster knee extensions, less anteromedial knee pain, and thigh hypotrophy were observed in peroneus longus tendon patients. Peroneus longus tendon autograft can be an appropriate autograft for ACLR due to its strength, larger graft diameter, and avoiding potential complications of hamstring autograft obtained from the knee region.

Level of evidence: IV

Keywords: Anterior cruciate ligament reconstruction, Hamstring tendon autograft, Peroneus longus tendon autograft

Introduction

Anterior cruciate ligament reconstruction (ACLR) has been recognized as the standard treatment to restore knee stability and joint function after an ACL rupture. Several autograft options are currently used for ACLR, such as bone-patellar tendon-bone, hamstring tendon, and quadriceps tendon. Each of these autografts has advantages and disadvantages. Surgeons should consider the graft strength, size, and safe and easy graft harvesting with minimal donor site morbidity.

Some studies suggested peroneus longus tendon as an

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alternative autograft option for ACLR (1-3). The peroneus longus tendon has adequate size, and biomechanical evaluations of its properties revealed it has sufficient strength for knee ACLR (4-6). In a study by Rudy et al., there was no difference in tensile strength between the peroneus longus tendon and hamstring tendon (7). Rhatomy et al. reported that ACLR with the peroneus longus tendon showed better functional scores than the hamstring tendon (8).

Rhatomy et al. published another study showing that the ankle eversion and first ray plantarflexion strength at the donor site were compared with the contralateral healthy site, without any dysfunction at the donor site (9).

There are only a few comparative studies between the clinical outcome of the peroneus longus tendon and other grafts, and the incomplete evaluation of ankle morbidity after autogenous peroneus longus tendon harvesting for ACLR (8,10,11). The present study aimed to compare the functional outcome and the morbidity of the donor site between the peroneus longus and hamstring autografts, focusing on the donor site morbidity with a minimum follow-up period of 2 years after ACLR. We hypothesized that peroneus longus autograft could be used as an alternative autograft if it shows an acceptable clinical outcome and no severe side effects at the donor site.

Materials and Methods

The Ethics Committee approved this study protocol of our institute, and informed consent was obtained from all patients before participating in the study. In this cross-sectional comparative study, ACLR was performed with quadrupled hamstring tendon autograft in 65 patients between 2017 and 2018, and in another group, peroneus longus tendon autograft was used in 65 patients between 2018 and 2019. All procedures were performed by the same senior knee surgeon (S.M). The ACL ruptures were diagnosed using the patient's medical history, physical examinations (the Lachman test and the pivot shift test), and magnetic resonance imaging results. The inclusion criteria were: age 18–50 years and ACL rupture. The exclusion criteria were as follows: concomitant chondral lesions greater than grade III, previous surgery to the affected knee, revision cases, joint hypermobility syndrome, and the presence of an ankle joint problem.

All patients were followed up for a minimum of 2 years (range 24-31 months), and a single examiner recorded the results. The functional scores include the International Knee Documentation Committee (IKDC), Lysholm score, and knee range of motion (ROM) assessed before and 2 years after surgery. The postoperative graft harvesting problem was evaluated using the measuring thigh circumference (15 cm proximal to the upper pole of the patella) compared with the contralateral healthy side in both groups. The conditions of the ankle donor site in the peroneus longus tendon group were assessed by American Orthopedic Foot and Ankle Score (AOFAS), the Foot & Ankle Disability Index (FADI) Score, and ankle ROM.

Operation procedures

Patients laid supine under spinal or general anesthesia, and a tourniquet was applied to the thigh. At first anterior portals were used, then diagnostic arthroscopy of the knee was performed, and graft harvesting (hamstring or peroneus longus) was done. All other joint procedures and passing the meniscus repair suture were carried out, and a partial meniscectomy was performed if needed.

Peroneus longus tendon harvesting

Peroneus tendon harvesting was done in the ipsilateral leg. The peroneus longus tendon was harvested with a 2 cm longitudinal skin incision at the posterolateral side of the fibula just over the peroneus tendon, 2-3 cm proximal to the posterior border of the lateral malleolus. After exposing the distal peroneus longus, a stripper was used to harvest the tendon to about 4–5 cm below the fibular head to avoid peroneal nerve injury. Then both peroneus tendons were sutured distally [video]. The superficial fascia and fat of the harvested tendon were removed, and the rough edge was trimmed carefully. The tendon was doubled up longitudinally through the middle to obtain a 2-strand autograft, and its ends were whip-stitched with a No. 2 polyester suture (Ethibond, Arthrex, Naples, Florida, USA).

Hamstring tendon harvesting

In the hamstring group, a 3 cm oblique skin incision was made over the anteromedial aspect of the proximal tibia over the pes anserinus. Both the semitendinosus and gracilis tendons were harvested using an open tendon stripper. The tendons were then folded to form a 4-strand hamstring graft, and both ends were secured with whip-stitch suture using a No. 2 polyester suture (Ethibond, Arthrex, Naples, Florida, USA).

Autograft fixation

The intraarticular surgical technique was identical: The femoral tunnel and the tibial tunnel were drilled independently in anatomical position, and implantation of the tendon was performed. The prepared autograft tendon was implanted, and femoral fixation was achieved with TightRope (Arthrex, Naples, Florida, USA), while tibial side fixation was achieved with a BioScrew (Arthrex, Naples, Florida, USA) one size bigger than the tibial tunnel diameter.

Rehabilitation

Patients were discharged with the knee immobilizer the day after the surgery. Both groups were treated with the standard postoperative protocol for ACLR. Knee extension and ankle pump exercises began immediately after surgery. The first two weeks allowed partial weight-bearing and a motion range of 0 to 90 degrees. Full flexion was obtained within 5 to 6 weeks, and the full weight-bearing exercise was allowed at least 3 to 4 weeks after the surgery. Running was permitted after 3 to 4 months, and returning to sports activity was recommended after completing functional outcome tests 6 to 9 months after the operation.

Statistical analysis

The sample size was estimated according to the results of a study conducted by Rhatomy et al. (8), based on Standard deviatiov1 (SD1) = 15.1 and Standard deviatiov2 (SD2) = 11.8 of the IKDC score, with 95% CI and 95% test strength, Actual Difference (D) = 2, Equivalence Margin (E) = -6 (20% of mean) and considering the equal ratio of samples in the peroneus longus and hamstring groups. The estimated sample size was at least 65 patients in each group.

$$n = \frac{(r+1)(z_{1-\beta}+z_{1-\alpha})^2\,\delta^2}{r((\mu_A-\mu_B)-d_{NI})^2} = \frac{(1+1)\,(1.65+1.65)^2\times(15.1+11.8)/2)^2}{1(2-(-6))^2} \cong 65$$

Descriptive data (range, mean and standard deviation) were used in the present study. An Independent T-Test was used to compare quantitative variables with normal distribution in the two groups. The normal distribution of quantitative variables was checked by the normal Q-Q Plot and Shapiro-Wilk test. A *P*-value less than 0.05 was considered statistically significant, and all statistical analyses were performed using SPSS software (version 23.0, SPSS Inc., Chicago, Illinois).

Results

During the present study, 130 patients who underwent ACLR in two groups of hamstring tendon (n=65) and peroneus longus tendon (n=65) were followed up for at least 2 years (range 24–31 months). There were no significant differences in demographic data and injuries between the two groups (*P>0.05*) [Tables 1; 2].

The mean diameter of the 2-strand peroneus longus tendon was 8.71 ± 0.4 (range 8-9 mm), and the mean diameter of the four-strand hamstring tendon autograft was 7.65 ± 0.6 (range 6.5-8.5 mm) that showed significant difference (*P<0.001*) [Table 3]. In the second group, a five-strand hamstring autograft was used for some patients with an autograft diameter of 7 mm.

Clinical outcomes

Based on the obtained results, most patients had acceptable functional outcomes after ACLR operation in each group (*P<0.001*); however, no significant differences between the two groups were observed in functional scores [Table 4].

Lachman and pivot shift tests were performed to evaluate the knee laxity and stability. Any grade III Lachman or positive pivot shift test was defined as a failure. No significant differences were witnessed between both groups. The Lachman test assessment showed normal findings in 109 patients, while 6 patients (4 patients in the hamstring group and 2 patients in the peroneus longus group) had small laxity with a firm endpoint. Moreover, 8 patients in the hamstring group and 7 patients in the peroneus longus group had re-tear [Table 5].

Donor site morbidity and Ankle joint function

Objective measurements of the ankle ROM, FADI score, and AOFAS score were used to evaluate donor ankle morbidity after peroneus longus harvesting. No patient experienced ankle joint dysfunction or difficulty in sports activities due to peroneus longus autograft transfer. There was no significant difference in ankle ROM for all movements between the peroneus longus harvested compared to the contralateral side [Table 6].

The mean AOFAS score for the donor's ankle was 93.42 ± 1.7 (range 84-100; Excellent=90-100 points, Good=75-89 points, Fair=60-74 points, and Poor<60 points) at the last follow-up, and there was no difference between both sides. The mean FADI score was 92.78 ± 0.57 (range 94-102) at the donor site and 98.91 ± 0.62 at the contralateral healthy side. No significant difference was found in the

Table 1. Demographic data of the two groups' patients

	Peroneus longus Tendon (n= 65)	Hamstring Tendon (n= 65)
Gender (m/f)	(58 / 7)	(61 / 4)
Age (year)	29.80 ±7.5 years (18-47)	27.60 ± 8.1 years (20-50)
BMI (kg/cm²)	26.6 ± 3.2	27.9 ± 1.9
Follow-up (month)	26.7 ± 2.4	33.2 ± 4.6

Table 2. Anterior cruciate ligament injury of the two groups' patients

	Isolated Acl injury	Associated injuries		
		medial meniscus tear (repair)	meniscus tear (Partial meniscectomy)	Lateral meniscus tear repair
Peroneus longus group (n=65)	32	23	7	3
Hamstring group (n=65)	36	22	5	2

ACL: Anterior cruciate ligament

Table 3. Comparison of graft diameter

Graft	Diameter (mm)	*P-value*
Peroneus longus	8.71 ± 0.4 (range 8-9 mm)	*P<0.001*
Hamstring	7.65 ± 0.6 (range 6.5-8.5 mm)	

Table 4. Functional outcomes of the hamstring and peroneus longus groups

		Preoperative	Last follow-up	Score change (percent)	*P-value*
IKDC	Peroneus longus	55.2±2.4	92.5±9.8	37.3 (67)	<0.001
	Hamstring	54.8±8.5	93.4±6.2	38.6 (70)	<0.001
	P-value	0.96 (n.s)	0. 589 (n.s)		
Lysholm	Peroneus longus	63.5±11.2	95.1±6.2	31.6 (49)	<0.001
	Hamstring	62.2±7.3	94.9±10.5	32.7 (52)	<0.001
	P-value	0.490 (n.s)	0.522 (n.s)		

FADI score between the donor and the contralateral side (*P>0.0001*). No pain or complaint about the weakness of the ankle joint, vascular and neurological complications, or other discomforts over the donor site of the ankle was noted.

No serious instability or complication was found in both groups. Thigh hypotrophy was considerably more significant in the hamstring tendon group compared to the peroneus longus group at a minimum of 2 years of follow-up (12.2±4.5 mm mean thigh hypotrophy in the hamstring group and 4.9±2.4 mm mean thigh hypotrophy in the peroneus longus group; *P<0.001*).

Although there was just 2-3 mm calf hypotrophy in the peroneus longus group, there was no thigh hypotrophy in this group. Two patients complained of mild to moderate pressure pain, paresthesia, and dysesthesia at the donor site of the peroneus longus group, and there were two patients with mild wound discharge from ankle incision during the first two weeks with daily dressing changes and oral antibiotics they were treated.

Table 5. Comparison of knee laxity and stability

	stable	Mild to moderate laxity	re-tear
Hamstring group (n=65)	53	4	8
Peroneus longus group (n=65)	56	2	7

Table 6. Ankle Range of Motion in peroneus longus group

Motion (degree)	peroneus longus harvested	contralateral side	*P-value*
Dorsiflexion	20.5±7.6	20.8±6.1	0.826
Plantarflexion	36.8±7.2	37.4±2.1	0.575
Inversion	30.9±4.5	30±5.1	0.352
Eversion	24.7±9.2	25.8±4.7	0.453

Discussion

The most crucial finding of this study was that the peroneus longus tendon seemed to be an appropriate autograft option for ACLR, provided good functional results, prevented potential complications of the autograft harvested from the knee region, and did not significantly affect the ankle joint.

The type of harvested graft often depends on the surgeon's preferences. Autograft size, strength, donor site morbidity, availability, patient activity level, and lifestyle should be considered in preoperative autograft selection (5, 10, 12, 13). An appropriate alternative autograft source can shorten the surgical time and reduce

the morbidity of the harvest side and postoperative pain. In a biomechanical study by Rudy et al., no significant difference between the peroneus longus and hamstring tendon tensile strength was found (7). Wiradiputra et al. concluded that the peroneus longus tendon could be considered the first option graft in ACLR because there was no significant postoperative morbidity associated with biomechanical inconveniency to the donor site (14). As a result of this comparative study, knee laxity for peroneus longus tendon autograft was similar to hamstring tendon autograft, and no significant differences were found between the two groups in terms of functional scales and ROM of the knee joint after ACLR. In a systematic review by He et al., patients with peroneus longus tendon autograft ACLR reported equal functional outcomes (Lysholm score, IKDC subjective score) compared with hamstring tendon (15).

According to the related literature, autograft diameter has an essential effect on the re-rupture and revision rate (4). Recent studies argued that a less than 8mm graft diameter is not acceptable (16-18). In the current study, the mean diameter of the peroneus longus tendon was more than 8 mm [Table 3]. Despite the larger diameter in the peroneus longus group, the percentage of re-rupture is almost similar to the hamstring group, which may indicate that the peroneus longus graft is less stable than the hamstring graft.

Patients weighing less than 55 kg, height less than 150 cm, with a thigh circumference of less than 37 cm and a body mass index less than 18 should be considered at increased risk of unqualified hamstring tendon (19). A study by Song et al. found that the height, weight, and duration of injury were associated with the diameter of the peroneus longus tendon (10). Snaebjornsson et al., in a large cohort study of patients, reported that a 0.5 mm increase in graft diameter reduced the likelihood of revision surgery by 0.86 times (20). This study showed that the diameter of the peroneus longus tendon was larger than that of the hamstring tendon.

Hypoesthesia due to injury to the infrapatellar branch of the saphenous nerve, is a donor site morbidity in hamstring tendon harvesting that may reduce the quality of life (21). Present study reported significant differences in thigh hypotrophy between the two groups.

Reduced peak torque eversion, inversion, and decreased ankle function and stability have been identified as possible complications at the donor site after harvesting the peroneus longus tendon (11). Present study found no significant pain or donor site complications close to lateral malleolus after harvesting peroneus longus tendon. Additionally, no significant differences were found in the ROM of the ankle (flexion/extension, inversion/eversion, and angle of rotation) at the donor site compared to the contralateral healthy ankle side. Rathomy et al. reported that the peroneus longus tendon autograft harvesting had little effect on foot and ankle function (22). A systematic review study by Marín Fermín et al. showed that ACLR's clinical and stability results with peroneus longus tendon autograft were similar to hamstring tendon at short-term follow-up. However, more substantial evidence is needed before recommending its routine use after peroneus longus tendon harvesting (23). Bi et al. were reluctant to completely remove the peroneus longus tendon for fear of causing irreversible functional impairment (24).

The present study has some limitations. Because the follow-up period was relatively short, we could not evaluate the long-term clinical efficacy or long-term complications. Due to the small sample size, the results might not be generalizable to a larger population.

The clinical relevance of the current study is that the peroneus longus as an alternative graft in ACLR can be recommended because it shows good functional results compared to the hamstring tendon with less donor site morbidity.

The present study demonstrated that peroneus longus tendon autograft might be considered a safe and practical autograft source for arthroscopic anterior cruciate ligament reconstruction with respect to its strength, larger graft diameter, satisfactory ankle function, and prevention of potential complications of hamstring autograft obtained from the knee region.

Conflict of interest: All authors declare that they have no conflict of interest related to this study.

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Informed consent: Informed consent was obtained from all individual participants included in the study.

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