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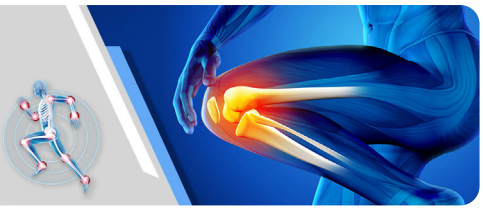

Peroneus Longus Tendon Autograft for Primary Arthroscopic Reconstruction of the Anterior Cruciate Ligament

Nabil Zunayed Sidny[1*], Mehreen Mustafiz[2], Abdullahel Wafee[3], Md Saddam Hossain[4], Arefin Iftekher Ahmed[5], Shoaib Talukder[6], Dewan Nurul Islam[7]

Abstract

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 non-sports injuries are not uncommon. Arthroscopic anterior cruciate ligament (ACL) reconstruction is the most accepted treatment for complete ACL injury worldwide. Peroneus longus tendon graft is not a popular first choice for ACL reconstruction. However, newer literature has shown good outcomes with its use.

Methods: This was a prospective cohort study conducted in Dept. of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College, Dhaka, Bangladesh from January 2022 to December 2023. This prospective cohort study involves 50 patients who underwent arthroscopic single-bundle ACLR. 25 patients each were operated on with hamstring and peroneus longus autografts. At 2 years follow-up, functional outcome was compared between groups using International Knee Documentation Committee (IKDC), Modified Cincinnati, and Tegner-Lysholm scores. Donor site morbidity in the peroneus longus group was assessed using Foot and Ankle Disability Index (FADI) and The American Orthopaedic Foot and Ankle Society (AOFAS) scores.

Results: In our study we included 50 patients who were divided subsequently into group A (hamstring) and group B (peroneus longus) of 25 each. In the hamstring group, the mean age of the patients was 32.11 ± 9.460 years of which 92% were males and 8% were females. In the peroneus longus group, the mean age of the patients was 31.74 ± 7.744 years of which 74% were males and 26% were females. Fisher's exact test revealed no significant statistical difference in age distribution between the two groups (p=0.297). The mean length of the harvested Peroneus longus graft was 28.86 ± 1.30cm and the obtained mean diameter was 8.11 ± 0.49mm. There was no statistically significant difference in the mean IKDC (77.26 vs 80.78), Modified Cincinnati (84.41 vs 89.07), and Tegner-Ly-sholm scores (85.19 vs 88.78) between the hamstring and peroneus groups respectively. Mean FADI and AOFAS scores at 2 years follow up were 96.11 and 91.67 respectively in the peroneus group suggesting no significant donor site morbidity as compared to preoperative scores.

Conclusions: Peroneus longus performs similar to hamstring grafts and can be considered as one of the first choices for arthroscopic ACL reconstruction.

Keywords: ACL Injury; Autograft; Donor Site Morbidity; Peroneus Longus Tendon

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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 non-sports injuries are not uncommon [1-3]. Arthroscopic anterior cruciate ligament (ACL) reconstruction is the most accepted treatment for complete ACL injury worldwide. The most popular autograft choices are bone-patellar tendon-bone (BPTB) and quadrupled hamstring tendon graft. Peroneus longus graft is not a popular first choice for primary ACL reconstruction at most centers, however, in the last decade or so, there has been an increasing trend for its use. 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]. Multiple studies have compared the efficacy of peroneus longus tendon graft with hamstring graft in primary ACL reconstruction [7-12]. Although many studies show comparable and good clinical outcomes, there have been persisting concerns over donor site morbidity following peroneus longus grafting such as weakness of eversion-inversion and ankle instability [13]. 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-PatellarTendon-Bone (BPTB) graft [14]. BPTB graft has the benefit of 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 [15]. 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 [16]. 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 [15,17]. However, another research did not agree with the morbidity of the donor site [18]. Rudy and his colleagues, on the other hand, found no difference in hamstring tendon and peroneus longus tensile strength in their biomechanical analysis [19].

Materials and Methods

This was a prospective cohort study conducted in Dept. of Orthopaedic and Trauma Surgery, Shaheed Monsur Ali Medical College, Dhaka, Bangladesh from January 2022 to December 2023. The sample size of 50 patients was selected with reference to a study by Rhatomy et al. [8] in which they studied a total of 48 patients, (80% power at 5% level of significance) [8]. The study population was divided into two groups of 25 each. Patients between the age of 18 to 50 years who were diagnosed to be having isolated complete ACL tear based on clinical and MRI evaluation and who under- went arthroscopic ACL reconstruction were included in the study by purposive (non-random) sampling. Patients who had a multiligamentous knee injury, intra-articular fractures, chondral injuries, meniscal injuries, arthritic changes or previous ankle lesions were excluded. Patients in group A received hamstring autograft and those in group B received peroneus longus autograft. To avoid selection bias, every consecutive patient was allotted alter-natively between the two groups. Informed consent was taken from all the subjects in this study and the rights of participants were protected. Demographic data (age and gender) was collected from all patients. Preoperative anterior drawer and Lachman test results were documented for each patient. Preoperative American Orthopaedic Foot and Ankle Society (AOFAS) Ankle hindfoot score [20] and Foot and Ankle Disability Index (FADI) [21] were assessed in the peroneus longus group to be able to compare them postoperatively.

Surgical technique of single-bundle ACL reconstruction

All patients in both groups were operated on by the same surgical team. Surgery was done under spinal anesthesia and a high groin tourniquet was used in all patients. Initially, a thorough diagnostic arthroscopy was performed through standard anteromedial and anterolateral portals [22]. After confirmation of ACL tear, autografts were harvested.

Harvesting peroneus longus graft

A longitudinal incision was made over the posterolateral aspect of the distal leg, just posterior to the lateral malleolus. After subcutaneous dissection, peroneus longus and brevis tendons were identified and tagged. Sural nerve was not encountered in the approach. Lesser saphenous vein and its tributaries were protected. Tenodesis was performed at their distal most aspect with polyester non absorbable braided suture. Following this, the peroneus longus tendon was whip stitched, cut distally, and harvested using an open tendon stripper. Stripper was carefully maintained just superficial fibula, while not extending into proximal 1/3rd of leg, in order to prevent injury to superficial and deep peroneal nerves. While harvesting the peroneus tendon graft, the ankle is maintained in plantar flexion to minimize the risk of sural

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nerve injury [23]. The harvested graft was consistently between 24- 26 cm in length and after tripling had a diameter between 7.5 to 9 mm (Figure 1).

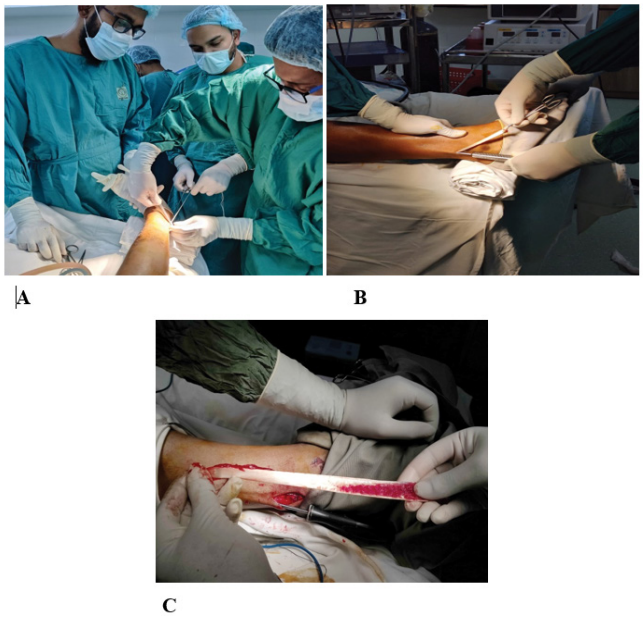

Figure 1(A-C): Harvesting.

Harvesting hamstring graft

An oblique 5 cm long incision was made over the anteromedial surface of the proximal third of the leg overlying the pes anserinus insertion. After subcutaneous dissection, sartorius fascia was identified and divided, following which semitendinosus was identified and tagged (Figure 2). The tendon was whip stitched, cut distally, and harvested using an open tendon strip- per. In 20 out of 27 cases, semitendinosus alone was insufficient for the desired graft thickness. Hence gracilis tendon was additionally harvested and the graft was quadrupled or tripled to attain optimal dimensions (8 cm ± 0.5 cm length and 8.5 mm ± 1 mm diameter). In both groups, the graft was wrapped with vancomycin-soaked gauze [24] and tensioned.

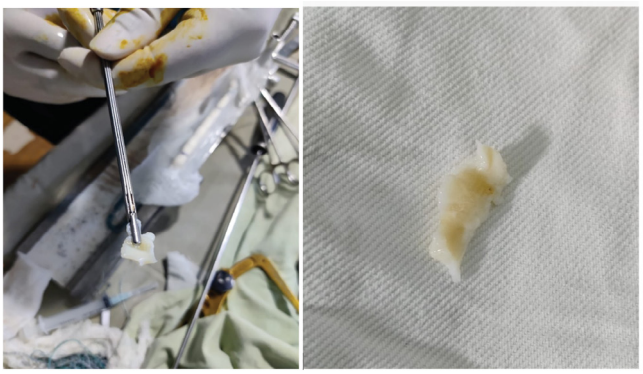

Figure 3 (A-B): Meniscectomy.

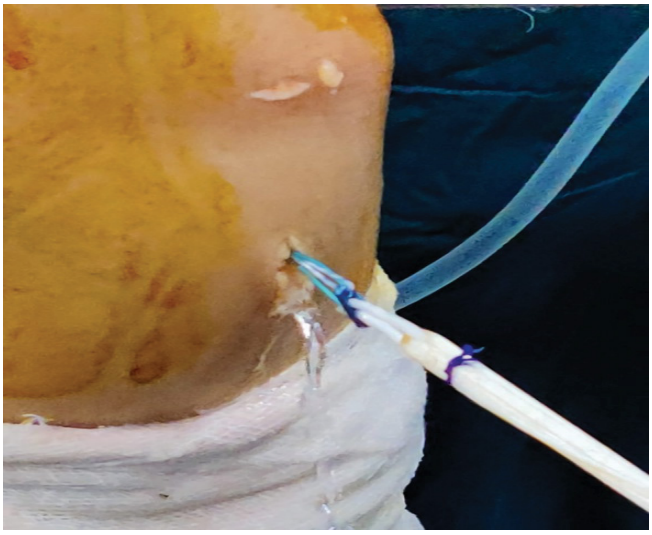

Figure 4: Prepared Graft with Endobutton Insertion.

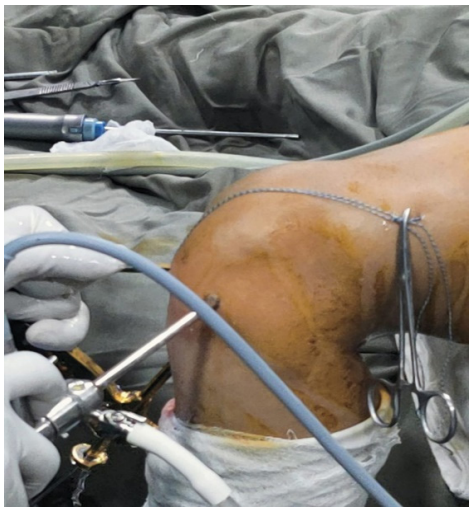

Figure 2: Arthroscopic Evaluation.

Figure 5: Graft with Endobutton Insertion.

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Rehabilitation

Postoperatively patients in both the groups underwent accelerated rehabilitation in 5 phases as described by Shelbourne et al. [25]. Postoperative bracing was not used. Rehabilitation emphasized full knee extension on the first postoperative day and immediate weight-bearing as per the patient's tolerance. Patients were regularly followed up and periodic clinical and radiological assessments were done. The functional outcome of both groups of patients was assessed at two-year follow-up along with donor site morbidity in the peroneal longus group. The functional outcome was quantified by questionnaire-based scoring systems like International Knee Documentation Committee (IKDC) [26], Modified Cincinnati [27], and Tegner-Lysholm [28] scores. Anterior drawer and Lachman tests were performed in both groups by the same team of surgeons. Donor site morbidity in the peroneus longus group was quantified using AOFAS Ankle hindfoot score and FADI.

Statistical analysis

The collected data were analyzed by descriptive and inferential statistical methods. Descriptive methods such as frequency and percentage were calculated to summarize categorical data. Mean and standard deviation (SD) were calculated to summarize the IKDC, Modified Cincinnati, Tegner-Lysholm, AOFAS, and FADI scores. Unpaired t-test was used to compare scores between the groups at two-year follow-up. The Chi-square test and Fisher's exact test were used to compare categorical parameters between the groups. Analysis was done using SPSS 23.0 software. The level of significance in this study was 5% (P-value less than 0.05).

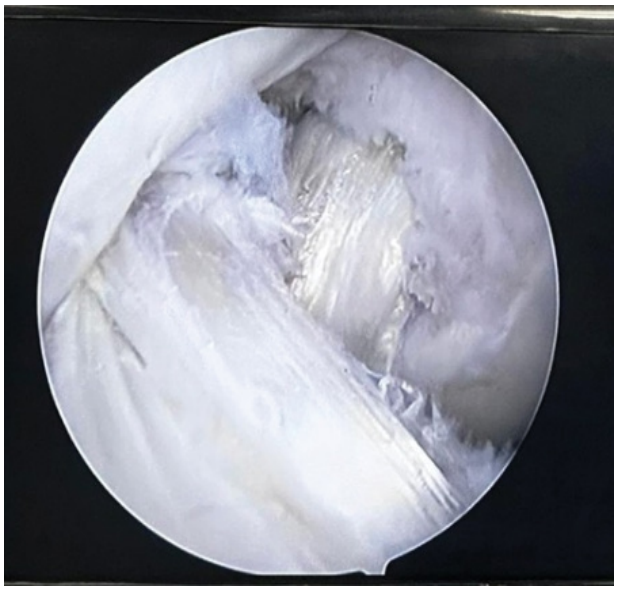

Figure 6: Both grafted ACL and PCL (ACL- Autologous Peroneus Longus Graft, PCL- Autologous Quadruple Hamstring Graft).

Figure 7: Biodegradable Screw Insertion.

Results

In our study we included 50 patients who were divided subsequently into group A (hamstring) and group B (peroneus longus) of 25 each. In the hamstring group, the mean age of the patients was 32.11±9.460 years of which 92% were males and 8% were females. In the peroneus longus group, the mean age of the patients was 31.74±7.744 years of which 74% were males and 26% were females. Fisher's exact test revealed no significant statistical difference in age distribution between the two groups (p=0.297). The mean length of the harvested Peroneus longus graft was 28.86±1.30cm and the obtained mean diameter was 8.11±0.49mm. The Chi-square test revealed no statistical difference in gender distribution between the two groups (p =0.067). The anterior drawer test and Lachman test preoperatively in all the patients in both groups were positive (grade 3 translation with a soft endpoint). At two-year postoperative follow-up, none of the patients showed clinical instability and all the patients showed Lachman grade 0 or 1 with a firm endpoint. On comparison of two-year follow-up scores of both groups, there was no statistically significant difference noted in IKDC (p = 0.085), Modified Cincinnati (p=0.169), and Tegner-Lysholm (p = 0.186) scores, implying that the peroneus longus group had an equally good functional outcome (Table 1). To assess donor site morbidity in the peroneus longus group, the mean AOFAS ankle hind foot score assessed at two-year follow-up was noted to be 95.67 ± 6.367 with a mean difference of 4.333 ± 6.367 from the preoperative scores. These differences were statistically not significant (p = 0.198). The mean FADI score at a two-year follow-up was 99.11 ± 3.446 with a mean difference of 4.889 ± 3.446 from preoperative scores which was also statistically not significant (p = 0.180) (Table 2). This implies there was no significant donor site morbidity in patients who underwent ACL reconstruction with peroneus longus autograft. No patients in the peroneus longus group showed adverse complications such as sural nerve injury.

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Table 1: Comparison of functional outcome at two-year follow-up in both groups of patients.

Scores (post-op)	Graft used	Sample size (n)	Mean ±SD	P-value
IKDC	Hamstring	25	77.26±7.209	0.085
	Peroneus longus	25	80.78±7.526	
Modified Cincinnati	Hamstring	25	84.41±15.445	0.169
	Peroneus longus	25	89.07±7.961	
Tegner-Lysholm	Hamstring	25	85.19±11.806	0.186
	Peroneus longus	25	88.78±7.418	

Table 2: Comparison of donor site morbidity in the peroneus longus group.

Scores	Sample size (n)	Mean ±SD	Mean difference	Standard deviation of the difference	P-value
AOFAS Pre-op	25	100.00±0.000	4.333	6.367	NS
AOFAS Post-op	25	95.67±6.367			
FADI Pre-op	25	104.00±0.000	4.889	3.446	NS
FADI Post-op	25	99.11±3.446			

Table 3: Result of serial hop test.

Test	Mean ± SD	Range	Normality
AOFAS	97.63 ± 3.20	89.00-100.00	0
FADI	98.46 ± 2.31	86.20-100.00	0
Hop (single)	92.31 ± 4.45	87.00-96.00	0
Hop (triple)	93.26 ± 3.61	88.00-98.00	0
Hop (cross over)	94.20 ± 2.51	90.00-98.00	0
Hop (timed)	94.18 ± 3.25	89.00-98.00	0

Values are presented as mean ± standard deviation and range.

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 3).

Discussion

Arthroscopic ACL reconstruction is a commonly performed surgery and has gained tremendous popularity in recent times, especially with the increasing exposure to contact sports. Currently, graft choices for primary ACL reconstruction (ACLR) are autologous hamstring semitendinosus gracilis (ST-G), quadriceps tendon, bone-patellar tendon bone (BPTB), peroneus longus autograft, allografts, and carbon filament-based synthetic grafts [29,30]. 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. Allografts, on the contrary, have a higher risk of disease transmission, poor biocompatibility, poor graft incorporation, and face issues of unavailability in developing countries. However, they offer advantages over autografts such as reduced surgical time, no donor site morbidity, and abundance of graft material in multi-ligament reconstruction or revision cases [31,32]. Hamstrings being dynamic stabilizers on the medial side, there is a concern while choosing hamstring graft in patients with multi ligamentous injury, especially those with medial collateral ligament injury [33]. Moreover, semitendinosus tendon is often found to have inadequate diameter as noticed in our study, thus requiring concomitant gracilis harvest with tripling or quadrupling of grafts. In females and chronic ACL deficient knees, one can anticipate further attenuation of hamstring tendons thus potentially compromising graft diameter. Lesser diameter of graft, especially below 7.5mm is

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known to increase risk of graft rupture and increases revision rate [34]. Every 0.5 mm increase in graft diameter from 7 mm to 9 mm has been found to reduce revision rate by 0.82 times and also has a positive correlation with IKDC scores [35]. They noted the excellent functional outcome of the knee at 1 year follow-up without any significant ankle or foot disability [8]. Cao et al. [7] conducted a study on 35 patients using peroneus longus as a graft [7]. At 15-months of follow-up, their Lysholm score was excellent in 25 patients, good in 6 patients, fair in 3 patients, and poor in 1 patient with an average score of 97.2 (range 60-100). Using the peroneus longus tendon as the first choice for primary arthroscopic ACL reconstruction has also attracted skepticism regarding donor site morbidity and it's in vivo biomechanical performance when compared to hamstring tendon graft. Angthon et al. [13] in their study involving 24 patients, reported a significant decrease in isokinetic muscle strength (eversion and inversion) at 7-months follow-up as compared to the contralateral side. They reported the association of ankle instability in the early postoperative period and concluded that peroneus longus autograft is unfavorable for primary use [13]. Few studies have performed biomechanical tests to compare in vitro tensile strengths of hamstring vs peroneus longus tendons [10,36]. They have found no significant difference in strengths between the two graft options. Fu Dong Shi et al. [10] in 2019 compared the biomechanical properties and functional outcome in patients undergoing arthroscopic ACL reconstruction with doubled peroneus longus tendon and quadrupled hamstring tendon [10]. Concerns regarding the thickness of peroneus longus graft have been assessed in studies that have concluded satisfactory dimensions of graft on doubling or tripling [8,10]. In such selected studies which compare the grafts, peroneus longus has found to give statistically higher scores of IKDC and Lysholm as compared to hamstring graft. Tegner activity scale has given statistically similar results. These meta-analyses have looked at donor morbidity to foot and ankle in terms of various parameters like AOFAS scores, FADI scores, strength assessment and hop tests. These have concluded that despite some biomechanical studies showing a reduced peak eversion torque, clinical parameters suggest no significant morbidity to foot and ankle [33]. While these conclusions project non-inferiority of peroneus longus tendon, they also highlight the need for better studies to generate stronger evidence [37]. Most studies have low sample size, lack of appropriate comparison, different grafting techniques (full thickness graft, anterior or posterior partial thickness graft), heterogenous surgical techniques (single bundle vs double bundle, anatomical vs non anatomical) and varied postop rehab. This heterogeneity potentially creates murkiness in the interpretation of results [33]. We compared the difference in the functional outcome of peroneus longus graft to the hamstring graft in 50 subjects over two years, along with the assessment of any donor site morbidity in the peroneus longus group. Our results show comparable functional outcomes in the three scoring systems (IKDC, Modified Cincinnati, and Tegner Lysholm scores) with no statistically significant difference between both groups. This implies that the in vivo biomechanical performance of the peroneus longus autograft was comparable to hamstring autograft. The donor site morbidity in the peroneus longus group as assessed using AOFAS and FADI scores, showed that at two-year follow-up patients had excellent ankle function with no residual weakness or functional limitations. None of the patients had any adverse outcomes such as ankle instability, loss of movement, weakness, nerve injury. All patients had resumed back to their pre-injury activities satisfactorily. In addition to this, we made few other important observations in favor of peroneus longus autograft. Firstly, the peroneus longus tendon was technically easier to identify and harvest. Peroneus brevis is deeper and muscular around the region, thus easily differentiating itself from superficial and tendinous peroneus longus. Secondly, the surgical time for harvest of peroneus longus graft was lesser than hamstring graft, which is beneficial economically and otherwise. Lack of fibrous attachments and vincula makes the harvest easier and reliably faster. Thirdly, we found peroneus longus to have a consistently thicker diameter and adequate length in all our cases (harvested graft was consistently between 24- 26 cm in length and after tripling had a diameter between 7.5 to 9 mm).

Conclusion

The results of our study suggest that peroneus longus can be used as one of the first choices of autografts for primary arthroscopic 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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