VOLUME - 13, ISSUE - 03, MARCH - 2024 • PRINT ISSN No. 2277 - 8160 • DOI : 10.36106/gjra

Original Research Paper

Orthopaedics

ASSESSMENT OF DONOR SITE MORBIDITY AND ANKLE STABILITY AFTER MANAGEMENT OF ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION WITH PERONEUS LONGUS AUTOGRAFT– A PROSPECTIVE STUDY IN INDIAN PATIENTS

Dr. Rounat Jadhav

Dr Vijay Bharadwaj

ABSTRACT

Background: Peroneus longus tendon (PLT) autograft has been successfully used for isolated anterior cruciate ligament (ACL) reconstruction cases. Being a powerful evertor and flexor of great toe, there can be associated ankle morbidity with this autograft option. This study aimed to assess donor site morbidity ankle strength after harvesting ipsilateral PLT autograft in ACL reconstruction. **Methods:** This was a prospective study where 100 patients with isolated ACL tear underwent ACL reconstruction using ipsilateral PLT autograft. All patients were evaluated by visual analogue scale for foot and ankle (VAS-FA), and clinical ankle joint stability was assessed by American Orthopedic Foot and Ankle Society (AOFAS) score at 3- and 6-month follow-up. Bilateral evertors, and first ray plantarflexion strength measurement using an isometer was done at 6- month follow-up for ankle strength. Donor site complications were monitored. **Results:** The mean length of PLT harvested (cm) was 26.8 (standard deviation 2.5, range 21–30), and mean diameter of the graft (mm) was 8.21 (standard deviation 0.56, range 7.2–8.6). Ankle eversion strength (p = 0.62), first ray plantarflexion strength (p = 0.52), VAS-FA (p=0.32), and AOFAS score (p = 0.29) were found to be comparable to the normal side in all patients. There were no cases of graft failure, infection or donor site scarring. **Conclusion:** ACL reconstruction using a PLT autograft revealed no muscle strength deterioration, donor site morbidity or safety concerns.

KEYWORDS : Peroneus longus autograft, Anterior cruciate ligament reconstruction, ankle stability.

INTRODUCTION

With an estimated prevalence of 1.5% to 1.7% primary anterior cruciate ligament (ACL) injury cases per year in the general population, the ACL is one of the knee joint components that sustains injuries the most commonly.[1,2] For the restoration of the ACL, bone- patellar, tendon-bone, or double-looped semitendinosus/gracilis autografts are now among the most popular graft options. The popular autograft sources used in practice are iliotibial band and fascia lata, either with or minus bone.[3] Even though there are several benefits as autogenous sources, it is impossible for these aforementioned autografts to be independent of the donor site morbidity. A change in usage of allograft as a substitute transplant has grown to lessen the risk of donor site morbidity harvested from autogenous tissue.[4] Although there are putative benefits to the patellar tendon, 40% to 60% of arthroscopic surgery patients using the patellar tendon for anterior cruciate repair autografts have issues with the anterior knee.[5]

The Peroneus Longus Tendon (PLT) is currently viewed as a potential graft that offers a secure and effective replacement for present-day grafting techniques.[6,7] PLT is being utilized in several orthopedic surgeries, including the restoration of the medial patellofemoral ligament (MPFL) and the deltoid ligament.[8,9] It has demonstrated to meet the required criteria with encouraging outcomes.[7] An ideal autograft donor must meet a number of criteria, including the right strength, size, and ease and safety of graft harvesting, and PLT meets the bulk of these requirements. PLT is also sufficiently big and robust to function as an autograft in an ACL repair.[10] Additionally, complete removal of the PLT has little impact on gait or ankle stability. PLT can be considered to be a dependable autograft choice for ACL restoration based on the strength as well as the associated donor site morbidity.[7] Nevertheless, published evidence on the donor site morbidity and ankle stability after management of Anterior cruciate ligament reconstruction with peroneus longus autograft has been seldom evaluated in Indian patients, which led to the need of this study.

METHODS

Study Participants:

The prospective study was carried out between May 2022 and April 2023 at a tertiary Orthopedic centre. The study's participants included OPD and casualty patients. A thorough clinical examination (including the pivot shift, anterior drawer, and Lachman tests) was conducted. The posterior cruciate ligament (PCL) and the postero-lateral corner (PLC) were also tested for damage, so that these patients can be excluded. Knee x-rays were used for evaluating patients, and MR imaging was used to validate the results. Excluded patients included those with multi-ligamentous injury, pre-existing flat foot, ankle deformity, paralytic conditions, poliomyelitis or previous significant injuries to ankle, underlying skin infections over knee or ankle, or chronic systemic medical diseases.

Figure 1: Incision for Peroneus longus tendon exposure

100 patients fulfilling the inclusion criteria were enrolled in study, of which 75 were males and 25 were females. Prior to undergoing reconstructive surgery for an acute ACL damage, the patients received physiotherapy and knee immobilization with the aim of restoring almost complete range of motion, strengthening the symmetric quadriceps, and reducing joint effusion. After the inflammatory phase had resolved, the patients were scheduled for surgery.

Under spinal anesthesia, surgery was carried out in a supine position. In every instance, a pneumatic tourniquet was employed. For harvesting the PLT, 2-cm incision was accomplished on the posterior aspect of distal fibula, near superior peroneal retinaculum (Figure 1). Carefully cutting the fascia exposed the posterolateral aspect of the PLT through

the incision. To stop retraction, the distal cut end of the PLT was stitched to the intact Peroneus brevis muscle (Figure 2). The tendon was cut with a knife, sutured with thick non-absorbable suture No. 2, Peroneus longus tendon harvested (figure 4) using a long tendon remover (Figure 3). Staples and absorbable subcutaneous sutures were used to seal the incision. On a tendon board, the harvested graftwas pre-tensioned. After that, the graft was looped to create a triple graft. The transplant had a femoral fixation device connected to one end. To precisely match the triple graft's sizeto the required femoral and tibial tube, the graft was run through cylindrical sizers.

Figure 2: Exposure of Peroneus longus tendon

Figure 3: Peroneus Longus graft extraction

Figure 4: Harvested peroneus longus tendon

Routine anterolateral portal (viewing portal) was made, through which arthroscope introduced and diagnostic arthroscopic round was made to confirm the provisional diagnosis. Anteromedial portal (working portal) was created, through which shaver was introduced and tibial and femoral footprints were prepared leaving a stump of remnant ACL at tibial insertion site to maintain some blood supply and retain some proprioception for the new graft. With knee joint in hyperflexion Beth pin was passed through the femoral footprint using an offset drill guide and femoral tunnel drilled first with 4.5mm drill and then with drill size as per graft size up to required length. Similarly, the tibial tunnel was drilled using Beth pin with help of tibial footprint jig set at 55 degrees with knee at 90 degrees flexion. The PLT graft was passed through the tibial tunnel followed into femoral tunnel up to the marked point of femoral required tunnel length. After confirmation of endobutton flip the grafted was singed and tibial end fixed with HA screw. Graft was checked for stability and impingement on hyperflexion. A post-operative x-ray was taken to check that the tunnels and trans-fixation device were positioned correctly.

Two days of broad-spectrum IV antibiotics were administered. On the second, fifth, and tenth postoperative days, dressings were applied. In cases where an isolated ACL repair was performed, patients were instructed to bear some weight while wearing a ROM knee brace starting on the second postoperative day. The American Association of Orthopedic Surgery's (AAOS) postoperative rehabilitation protocol for ACL restoration was followed when instructing physiotherapy.

***Functional Assessment*:**

Patients were followed up regularly for a period of 6 months. 1st follow up was done at 3 months and last follow up at 6 months. The assessment of donor site morbidity (figure 5) following peroneus longus tendon grafting was assessed by clinical examination and functionally by Visual Analogue Scale for pain at foot and ankle (VAS-FA) and the American Orthopedic Foot and Ankle Society (AOFAS) score.[11,12]

The power of eversion and first ray plantar flexion were also examined comparing with the normal sides on contralateral ankles. At six months following surgery, the results of muscular strength tests were gathered. Patients' isometric muscular strength was measured using a Baseline analog hydraulic push-pull dynamometer. Bilateral ankle inversion & eversion (figure6,7) and first ray plantarflexion were examined. Each muscle's strength was measured three times, with the highest strength being noted. To eliminate any potential bias in the study, the same person measured all muscle strength assessments. Eversion was gauged while lying in the opposite decubitus posture. The patients were instructed to evert their ankles (figure 6). On the fifth metatarsal, the dynamometer was set. Patients' crural regions were gently pushed to reduce the use of other muscles, and the dynamometer was used to measure muscular strength.

Isokinetic Muscle Strength Test of Ankle

In the prone posture, first ray plantarflexion was measured. The opposing knee joint was 90 degrees flexed. To limit the movement of other muscles, the examiner's helper maintained the ipsilateral distal section of the crural area. The patients were instructed to flex their initial rays. Muscle strength was measured using a dynamometer that was attached to the first to fifth distal metatarsals of the feet.

Figure 5 Postoperative assessment of Donor site(Ankle Joint)

Figure 6: Postoperative Ankle Inversion

Figure 7: Postoperative Ankle Eversion

Statistical Analysis

SPSS (Statistical Package for Social Science; version 25.0) software was used for the statistical analysis. Utilizing inferential statistics, the Paired Student t-test and Chi-square test were used to compare preoperative and postoperative data. The VAS-FA and AOFAS scores and isometric muscular strength (eversion strength, first ray plantarflexion strength) on the contralateral ankles were also compared with the normal sides using an unpaired t test. For descriptive statistics, the terms mean, standard deviation, frequency, and percentages were employed. P-values under 0.05 were noted to be significant findings.

RESULTS

In the present study, a total of 100 patients who satisfied the inclusion criteria were enrolled. Majority of the enrolled patients were males (75%). The commonest involved side was right in 58 cases. Road traffic accidents were the most common mode of injury in 74 cases. Patient characteristics are described in detail in table 1 below.

The mean length of PLT harvested (cm) was 26.8 (standard deviation 2.5, range 21–30), and mean diameter of the graft (mm) was 8.21 (standard deviation 0.56, range 7.2–8.6).

Post operatively at 6-month follow-up, knee joint stability was evaluated using Lachman test which showed normal finding in 93 cases while 7 cases showed 1+ laxity.

Mean AOFAS scores at preoperative time-point was 100+0.0, which did not significantly reduce postoperatively at any of the time-point assessed (p>0.05). A similar trend was noted when the VAS-FA was evaluated, and comparison was done between pre-operative and post- operative time-points (p>0.05). On comparison between affected knee and contralateral knee, both mean VAS-FA and mean AOFAS were noted to be statistically comparable at all time-points of assessment. Table 2 describes the mean VAS-FA and AOFAS values at assessed time points, along with figures 8 and 9 respectively.

At the donor site, the mean eversion strength was 63.72 ± 6.65 units, while it was 64.94 ± 8.11 units at the normal site on the other side. The donor site's mean first ray plantarflexion strength was 152.02 ± 9.13 units, whereas the healthy site on the other side was 154.07 ± 8.35 units. Mean eversion strength (p=0.62) and first ray plantarflexion strength (p=0.52) between the donor side and the healthy contralateral site were statistically comparable.

After surgery, none of the patients experienced a superficial infection at the location where the transplant was harvested. There was no paraesthesia, numbness, ROM restriction, scarring or any discomfort or difficulties felt over the ankle's donor site.

Table 1: Baseline Characteristics Of Enrolled Patients (n=100)

Characteristics	*Calculated value*
Age details	
Mean age (years)	31.25 ± 5.35
Median age with range (years)	30 (19-37)
Gender	
Number of Males	75
Number of Females	25
Mean Body mass index (kg/m2)	23.71 ± 3.5
Laterality of ACL tear	
Number of patients with right ACL involvement	58
Number of patients with left ACL involvement	42
Mode of injury by frequency	
Road traffic accident	74
Sports related injury	16
Fall from height	10

Table 2: Intergroup Comparison Of Mean AOFAS And VAS-FA Score Between Affected Sideand Contralateral Side At Various Time-points

Time of assessment	**Affected (n=100)**	**knee**	**Contralateral (n=100)**	**knee**	**P value (intergroup)**
Mean AOFAS score					
Pre-operative	100±0.0		100±0.0		1
Post-operative 3 months	95.31±3.34		100±0.0		0.21
Post-operative 6 months	98.54±1.12		100±0.0		0.34
Mean VAS-FA score					
Pre-operative	100±0.0		100±0.0		1
Post-operative 3 months	97.12±2.26		100±0.0		0.35
Post-operative 6 months	99.54±0.44		100±0.0		0.64

Intergroup p value assessed by Unpaired t test, p>0.05 considered NOT significant.

DISCUSSION

The ligaments around the knee joint, particularly the cruciate ligaments (anterior and posterior cruciate), play a major role in stabilizing the joint. The most frequent mechanisms for anterior cruciate ligament injury in motor vehicle accidents and sports involve a strong valgus and external rotation of the knee. ACL injuries are now arthroscopically repaired with autografts and allografts. There are several graft alternatives available, including the hamstring tendon autograft, bone-patellar tendon-bone complex, and allografts. However, there is disagreement over the best graft for ACL reconstruction.[13,14] Patellar tendon rupture, fracture of patella or tibia, quadriceps feebleness, loss of complete extension, knee soreness, kneeling issues, and numbness brought on by damage to the infra-patellar branch of the saphenous nerve are difficulties associated with bone patella tendon bone graft. The strength of the hamstring muscles can significantly vary when the hamstring tendon is used. The Peroneus longus tendon is just as robust as the natural ACL biomechanically. The original ACL can withstand a tensile stress of 1725 N, but Kerimoglu et al.'s study found that the single strand Peroneus longus tendon could withstand a tensile load of 1950 N.[10] The primary function of the Peroneus longus is to plantar flex the first ray of the foot, with the additional functions being plantar flexion and ankle eversion. When a patient is at the stance phase of gait, the main issue with a donor ankle is the deficiency of first ray plantar flexion, while ankle instability is the other issue.[15] The lack of published data on donor site morbidity and ankle stability following ACL repair with PLT autograft in India prompted the design of the current study.

The average graft thickness in this research was 8.21 mm, which was significantly higher than the average hamstring graft thickness. The PLT diameter was similar to other identical studies by Rahaman et al.[16] (mean PLT diameter: 8.2 mm) and Song et al.[17] (mean PLT diameter: 8.3 mm).

Knee joint stability, evaluated using Lachman test, showed normal finding in 93 cases while 7 cases showed 1 + laxity at 6-month follow-up. This indicated no impact on knee stability after ACL reconstruction. Identical findings have been noted in other similar studies, like the one by Rahaman et al. which noted that at 6-month follow-up, 92.2% of the respondents graded 0 by Lachman test, followed by 7.8% at grade I.

There was no significant difference between pre-operative and post-operative AOFAS as well as VAS-FA scores, which suggests that harvesting PLT autograft did not affect ankle functions and ankle functions were well preserved. Comparison between affected and contralateral ankles also showed no significant difference in the mean AOFAS and VAS-FA scores, indicating similar functioning. These findings were identical noted by Rhatomy et al.[18] and Angthong et al.[19] in similar studies.

Eversion plus first ray plantarflexion muscle strength between the donor site and the contralateral healthy area did not significantly differ in our study. Karanikas et al.[20] reported no change in the isokinetic strength for first ray plantar flexion of the donor vs normal ankle between 3rd and 6th month, and between 6- and 12-months following ACL repair.

After the peroneus longus tendons are harvested, patients do not suffer from any foot and ankle issues, according to Zhao and Huangfu.[21] Together with the peroneus brevis tendon, the peroneus longus tendon functions synergistically.[22] The peroneus longus and peroneus brevis tendons both exhibited equivalent strength at the same force levels. According to this study, it made no difference whether the peroneus longus tendon was extracted. Six months after surgery, the first ray plantarflexion as well as eversion were assessed to account for muscle growth as well as regeneration through the rehabilitation process.

The patients also didn't report any femoral or patella discomfort. Regarding aesthetic considerations, the tendon harvesting scar behind the lateral malleolus and the scar around the tibial tunnel were both covered by the harvesting of a PLT graft. Thus, it gives sportsmen who frequently must display their legs for work an aesthetic edge as well. No patient's donor site showed signs of scarring or a superficial infection during our investigation.

The study had a few limitations. The sample size was limited, and the study was conducted at one Indian hospital, so the overgeneralization of results for Indian population should be done with caution. Future Indian studies with larger sample size and multicentre study design can help in validating our study findings.

CONCLUSION

ACL reconstruction with the help of a PLT autograft showed no muscle strength decline during eversion as well as first ray plantarflexion of the ankle joint. No donor site morbidity was noted at harvest site assessed in terms of VAS-FA as well as AOFAS scores. The functional outcomes were also noted to be comparable to the normal contralateral side.

There were no safety or aesthetic concerns associated with the PLT autograft usage.

REFERENCES

1. Dargel J, Gotter M, Mader K, Pennig D, Koebke J, Schmidt-Wiethoff R. Biomechanics of the anterior cruciate ligament and implications for surgical reconstruction. Strategies Trauma Limb Reconstr. 2007;2(1):1-12.
2. Raines BT, Naclerio E, Sherman SL. Management of Anterior Cruciate Ligament Injury: What's In and What's Out?. Indian J Orthop. 2017;51(5):563-75.
3. Miller SL, Gladstone JN. Graft selection in anterior cruciate ligament reconstruction. Orthop Clin North Am 2002;33:675-83.
4. Siebold R, Buelow JU, Bos L, Ellermann A. Primary ACL reconstruction with fresh-frozen patellar versus Achilles tendon allografts. Arch Orthop Trauma Surg 2003;123:180-5.
5. Kartus J, Movin T, Karlsson J. Donor-site morbidity and anterior knee problems after anterior cruciate ligament reconstruction using autografts. Arthroscopy 2001;17:971- 80.
6. Cao HB, Liang J, Xin JY. Treatment of anterior cruciate ligament injury with peroneus longus tendon. Zhonghua Yi Xue Za Zhi. 2012;92: 2460-2.
7. Nazem K, Barzegar M, Hosseini A. Can we use peroneus longus in addition to hamstring tendons for anterior cruciate ligament reconstruction? Adv Biomed Res 2014;3:115.
8. Ellis SJ, Williams BR, Wagshul AD, Pavlov H, Deland JT. Deltoid ligament reconstruction with peroneus longus autograft in flatfoot deformity. Foot Ankle Int. 2010;31(9):781- 9.
9. Xu C, Zhao J, Xie G. Medial patella-femoral ligament reconstruction using the anterior half of the peroneus longus tendon as a combined procedure for recurrent patellar instability. Asia Pac J Sports Med Arthrosc Rehabil Technol. 2016;4:21-6.
10. Kerimoğlu S, Aynaci O, Saraçoğlu M, Aydin H, Turhan AU. Peroneus longus tendonu ile ön çapraz bağ rekonstrüksiyonu [Anterior cruciate ligament reconstruction with the peroneus longus tendon]. Acta Orthop Traumatol Turc. 2008;42(1):38-43.
11. Angthong C, Chernchujit B, Suntharapa T, Harnroongroj T. Visual analogue scale foot and ankle: validity and reliability of Thai version of the new outcome score in subjective form. J Med Assoc Thai 2011;94:952-7.
12. Kitaoka HB, Alexander IJ, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. Foot Ankle Int 1994;15:349-53.
13. Pearsall IV AW, Hollis JM, Russell Jr GV, Scheer Z. A biomechanical comparison of three lower extremity tendons for ligamentous reconstruction about the knee. Arthroscopy: J Arthroscop Related Surg. 2003;19(10):1091-6.
14. Gohil S, Annear PO, Breidahl W. Anterior cruciate ligament reconstruction using autologous double hamstrings: a comparison of standard versus minimal debridement techniques using MRI to assess revascularisation: a randomised prospective study with a one-year follow-up. J Bone Joint Surg. 2007;89(9):1165-71.
15. Shi FD, Hess DE, Zuo JZ, Liu SJ, Wang XC, Zhang Y, et al. Peroneus longus tendon autograft is a safe and effective alternative for anterior cruciate ligament reconstruction. J Knee Surg. 2019;32(08):804-11.
16. Rahaman SK, Halder RC, Tayaba T, Mamun MBA, Islam MS, Khan MMR, et al. Peroneus Longus Tendon Autograft for Anterior Cruciate Ligament Reconstruction: A Safe and Effective Alternative in Nonathletic Patients. Journal of Orthopedics and Sports Medicine. 2023;5:133-8.
17. Song X, Li Q, Wu Z. Predicting the graft diameter of the peroneus longus tendon for anterior cruciate ligament reconstruction, Medicine 2018;97:e12672.
18. Rhatomy S, Wicaksono FH, Soekarno NR, Setyawan R, Primasara S, Budhiparama NC. Eversion and First Ray Plantarflexion Muscle Strength in Anterior Cruciate Ligament Reconstruction Using a Peroneus Longus Tendon Graft. Orthop J Sports Med. 2019;7(9):2325967119872462.
19. Angthong C, Chernchujit B, Apivatgaroon A, Chaijenkit K, Nualon P, Suchao-

In K. The anterior cruciate ligament reconstruction with the peroneus longus tendon: a biomechanical and clinical evaluation of the donor ankle morbidity. J Med Assoc Thai. 2015;98(6):555–60.
20. Karanikas K, Arampatzis A, Bruggemann G-P. Motor task and muscle strength followed different adaptation patterns after anterior cruciate ligament reconstruction. Eur J Phys Rehabil Med. 2009;45:37–45.
21. Zhao J, Huangfu X. The biomechanical and clinical application of using the anterior half of the peroneus longus tendon as an autograft source. Am J Sports Med. 2012;40(3):662–71.
22. Otis JC, Deland JT, Lee S, Gordon J. Peroneus brevis is a more effective evertor than peroneus longus. Foot Ankle Int. 2004;25(4):242–46.