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Original Article

Physiotherapy Section

Evaluation of Donor Ankle Function after Harvesting Peroneus Longus Tendon Graft for Anterior Cruciate Ligament Reconstruction- A Prospective Cohort Study

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ABSTRACT

Introduction: Primary full thickness Peroneus Longus Tendon Graft (PLTG) for Anterior Cruciate Ligament Reconstruction (ACLR) has been used with good clinical outcome. Recently, it is designated as a promising graft option for ACLR. The effect of harvesting PLTG on donor ankle function is still not completely understood. Peroneus Longus Tendon (PLT) is thought to play a major role in proprioceptive regulation of the ankle joint. All the studies till date did cross-sectional assessments of ankle and foot function at or after 6 months that might have overlooked the timely detection of donor site morbidities.

Aim: To evaluate the ankle function and compare the affected and sound limb function in subjects with an ACLR with autologous PLTG starting at an early postoperative visit upto six months.

Materials and Methods: A prospective cohort study was conducted at a tertiary rehabilitation centre from March 2019 to March 2021 including the follow-up evaluation. As per the inclusion criteria, 63 participants after ACLR with PLTG were considered for assessment using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle and hind foot scale and Foot and Ankle Ability Measure (FAAM) scale at 6 weeks, 3 months and 6 months post-ACLR follow-up. Comparison between sound and affected limbs was done during all follow-ups. The statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 18.0. Both FAAM and AOFAS ankle and foot scores were analysed with non parametric tests.

Results: Mean age of 63 participants were 29.25 years. Median of AOFAS and FAAM score at 6 week, 3 month, and 6 month post-ACLR follow-ups were (88, 98 and 100) and (97.22, 98.80 and 100), respectively. Statistically significant increase in AOFAS and FAAM scores were observed at 3 month and 6 month as compared to 6 week follow-ups with p=0.001 and p-value=0.001 respectively. The group comparison between the affected and sound side functional scores at different study visits showed statistically significant greater values for the sound ankle than the affected ankle (FAAM: 6 week: p-value=0.001; 3 month: p-value=0.001; 6 month: p-value=0.001 and AOFAS p-value=0.001; p-value=0.001; p-value=0.001, respectively).

Conclusion: The evaluation of functional outcomes showed gradual and linear improvement at subsequent postoperative visits and restores fully to 100% at 6 month indicating a near-normal to normal donor ankle function following ACLR with PLTG by 6 months. The group comparison showed only marginal but significant difference between affected and sound ankle function.

Keywords: Autograft, Bone-patellar, Functional score, Morbidity, Musculoskeletal dysfunctions, Proprioceptive regulation

INTRODUCTION

Anterior Cruciate Ligament (ACL) is the most common ligament, injured around knee, the incidence being one in 3000 [1] and noted as 86.5% of knee injury in India [2]. Many autograft options exist for ACL reconstruction but Bone-Patellar Tendon-bone (BPTB) and hamstrings autografts are usually preferred by the surgeons in India [3]. Extensive studies have been done world wide to prove the suitability of these grafts but disagreement has still been persisted [4,5]. Peroneus Longus Tendon Graft (PLTG) has been used as a graft choice in various reconstructive surgeries [6,7] and is evolving as a primary autologous graft option for ACLR [8,9]. Biomechanically also, it is suitable [10,11]. Many researchers have been using primary full thickness PLTG for ACLR with good clinical outcome [12-14]. Recently, it is designated as a promising graft option for ACLR [15,16] and even superior to the hamstring graft [17].

However, some studies reported donor ankle impairments after harvesting the Peroneus Longus Tendon (PLT) graft such as instability, depletion of Range Of Motion (ROM), reduced peroneal strength etc., at least for the first year of surgery [18-20]. Moreover, a simple question could be arisen. When the knee is already affected what is the necessity of involving the same side ankle too? Although justifications in favour of PLT graft are many folded such as the dynamic support supplied from intact agonist hamstring muscles to the reconstructed ligament are protected, no extension or flexion loss in knee joint is expected in the postoperative patients and accelerated rehabilitation protocol can be used as both hamstring and quadriceps are intact in patients after ACL reconstruction with PLT graft. But controversies continue to exist regarding the donor ankle morbidity after harvesting PLTG and researchers could not strongly recommend PLT as a primary graft option in ACLR especially for sports persons because of inadequate literature assessing the donor ankle and limited reviews in this field [11,18]. Probably, this is the reason why most of the available studies are from the eastern parts of the globe only [21].

Patient reported outcome measures have been used to document the functional outcome of ankle in musculoskeletal conditions. However, the researchers have also commonly used clinician-rated outcome measures like AOFAS scale for recording the ankle function. A systematic review of all original clinical articles reporting on foot and/or ankle topics in six orthopaedics journals over a ten-year period (2002 to 2011) was conducted. The reviewers found that out of 139 unique clinical outcome scales, AOFAS scale (55.9%, as a percentage of foot/ankle outcome articles) was the most popular one [22,23]. Subsequent studies demonstrated the limitation of AOFAS scoring system in evaluating the patient from his own perspective. Later, the use of the AOFAS clinical rating systems as the sole instrument was discouraged by many [24,25].

After an extensive literature search authors found a paucity of literature on evaluation of donor ankle morbidities during the early postoperative phases following ACLR with PLTG. All the studies till date, did cross-sectional assessments of ankle and foot function at or after 6 months that might have overlooked the timely detection of donor site impairments [12,15,24]. By examining the functional outcome at an early postoperative visit and repeating it over a period of time, we would be able to detect any decrement in the donor ankle function. This information might be useful in planning the postoperative management for the patients following ACLR with PLTG. Authors also aimed to measure the current level of functioning of donor ankle after harvesting the whole PLT, from the patient's as well as clinicians' perspectives. So, the objective of the study was to report the functional outcome of the donor ankle via the holistic evaluations using both clinician rated as well as patient reported functional scales periodically after harvesting PLT autograft from ipsilateral ankle. Author hypothesised that donor ankle function would be influenced by the peroneus longus autologous graft harvest for ACL reconstruction.

MATERIALS AND METHODS

The study was a prospective observational research design conducted for a period of 24 months from March 2019 to March 2021. It was a part of an ongoing research project, approved by the Institutional Ethics Committee (IECJREH/A17/2020). The study has followed all ethical standards in accordance with the revised Declaration of Helsinki 2013. Voluntary informed consent was obtained from each subject for authorising their participation in the study. A total of 63 postoperative patients after ACLR with PLTG reported to the Physiotherapy Outpatient Department of a National Rehabilitation Hospital, from March 2019 to March 2021 including the 6 month follow-up evaluation and met the inclusion and exclusion criteria, were recruited for the study.

Inclusion criteria: 1) postoperative patients after ACLR with PLTG; 2) within the age-group of 18-50 years; 3) should be comprehensive, mentally stable, and co-operative; 4) having bilateral healthy ankle before surgery.

Exclusion criteria: 1) patients who were not willing to participate in the study; 2) having any general systemic illness.

Study Procedure

The principal investigator did a baseline assessment at 6 week, and follow-up measurements at 3 month and 6 month post-ACLR visit respectively to find out the functional morbidities around the donor ankle. Outcome measures were evaluation of functional impairments of donor ankle by the FAAM Scale, a patient reported outcome measure and AOFAS ankle and hind foot scale, a clinician rated scoring system. Both the scales have been used for evaluation of different clinical conditions around ankle with their own advantages and disadvantages [24,26,27]. FAAM is comprised of a questionnaire with 21 items of Activities of Daily Living (ADL) and 8 items of sports subscales. It is a reliable, responsive, and valid assessment tool to evaluate musculoskeletal dysfunctions of lower leg ankle and foot [28,29]. The sports subscale was not included in the present study data collection sheet because of the mix subjects (sports persons, recreational players as well as non players together) we had chosen for this study. The ADL subscale score of FAAM range from 0-84, which are converted into percentages with greater score indicating higher functioning. AOFAS ankle and hind foot Scale was introduced by a subcommittee of the AOFAS Research Committee [30]. It is a 100-point scale with subjective and objective questions. The higher score indicates good outcome. It evaluates patients' pain, gait, movement and alignment, based upon clinicians' observations, and function, based on patient's perception. So, it is reliable [30-33] and remained widely used till date [21,34].

STATISTICAL ANALYSIS

The statistical analysis was done using Statistical Package for the Social Sciences (SPSS) version 18.0. Both FAAM and AOFAS ankle and foot scores were analysed with non parametric tests. Mann-Whitney test for group comparison between sound and affected leg, Friedman test to compare study groups at various study visits and Wilcoxon rank test for pair-wise comparisons between studies visits were done after Bonferroni adjustment for multiple comparisons. A p-value <0.05 was considered significant for all statistical inferences.

RESULTS

Total 63 subjects participated in the study. Detail demographic data is given in [Table/Fig-1]. Median with Inter Quartile Range (IQR) of FAAM score at 6 week, 3 month, and 6 month post-ACLR follow-ups were 97.22 (94.44-98.68), 98.80 (97.50-100) and 100 (100-100), respectively. Statistically significant difference was observed in the FAAM scores at 3 month and 6 month as compared to 6 week follow-ups with Chi-square (2)=67.698, p-value <0.001 [Table/Fig-2].

Variable	Mean	Standard deviation	Standard error
Age (years)	29.25	8.731	1.100
Height (cm)	1.66	0.077	0.009
Weight (kg)	69.40	11.767	1.483
BMI (kg/m^2)	25.012	4.341	0.547
	Category	**Frequency**	**Percentage**
Gender	Female	11	17.47
	Male	52	82.53
Affected side	Left	31	49.20
	Right	32	50.80
Dominant side	Left	0	0
	Right	63	100

[Table/Fig-1]: Demographic details of study participants.

Variable	Mean	Std. dev	Percentiles			Chi-square (df=2)*	p-value
			25th	50th (Median)	75th		
FAAM 6 weeks	95.11	6.333	94.44	97.22	98.68	67.698	<0.001
FAAM 3 months	97.26	6.265	97.50	98.80	100		
FAAM 6 months	99.52	1.233	100	100	100		
AOFAS 6 weeks	89.05	6.590	87	88	90	95.542	<0.001
AOFAS 3 months	95.87	5.402	90	98	100		
AOFAS 6 months	99.37	2.323	100	100	100		

[Table/Fig-2]: Comparison between various study visits at 6 weeks, 3 months, 6 months of FAAM and AOFAS by Friedman test.
*df: Degrees of freedom

Post-hoc analysis was conducted with a Bonferroni correction applied resulting in a significance level set at p-value <0.017. There were significant differences in the FAAM score between the study visits such as 6 week and 3 month (p-value <0.001); 6 week and 6 month (p-value <0.001) and 3 month and 6 month (p-value <0.001) [Table/Fig-3].

Median (IQR) for AOFAS ankle and foot score at 6 week, 3 month, and 6 month post-ACLR follow-ups were 88 (87-90), 98 (90-100) and 100 (100-100), respectively. Statistically significant differences were observed in the AOFAS score at 3 month and 6 month as compared to baseline 6 week value with Chi-square (2)=95.542, p-value <0.001 [Table/Fig-2].

Post-hoc analysis with Bonferroni adjustment showed significant differences between all pair-wise comparisons such as 6 week and

Variable	Z*	p (2-tailed)
FAAM 3 months-FAAM 6 weeks	-4.069	<0.001
FAAM 6 month-FAAM 6 weeks	-6.000	<0.001
FAAM 6 months-FAAM 3 months	-4.548	<0.001
AOFAS 3 months-AOFAS 6 weeks	-6.020	<0.001
AOFAS 6 months-AOFAS 6 weeks	-6.550	<0.001
AOFAS 6 months-AOFAS 3 months	-4.993	<0.001

[Table/Fig-3]: Wilcoxon Signed Rank (post hoc) test (pair-wise comparison).
*Based on negative ranks

3 month (p-value <0.001); 6 week and 6 month, (p-value <0.001) and 3 month and 6 month (p-value <0.001) [Table/Fig-3].

The group comparison between the affected and sound side FAAM score at different study visits showed statistically significant greater values for the sound ankle than the affected ankle [Table/Fig-4].

Variable	Mann-whitney U	Z*	p (2-tailed)
FAAM# 6 weeks	346.500	-8.955	<0.001
FAAM 3 months	913.500	-6.689	<0.001
FAAM 6 months	1638.000	-3.453	0.001
AOFAS$ 6 weeks	220.500	-9.488	<0.001
AOFAS 3 months	882.000	-6.829	<0.001
AOFAS 6 months	1764.000	-2.710	0.007

[Table/Fig-4]: Mann-Whitney test for group comparison between affected and sound side at different study visits.
#FAAM: Foot ankle ability measure; $AOFAS: American orthopaedics foot ankle society

DISCUSSION

Peroneus longus muscle is attached to medial-plantar aspect of medial cuneiform and base of 1st metatarsal bone. Being a peronei group muscle, it everts the foot, maintains the foot arches, helps in the gait pattern and also maintains ankle and foot balance. PLTG harvest could lead to deterioration of push off at the terminal stance phase and loss of 1st ray plantar flexion [18]. As both peronei act together, overall eversion force and power is expected to be reduced, after harvesting PLTG [19]. Thus, the altered foot biomechanics during stance phase, may lead to the joint's inability to adapt to changes in surface, resulting in imbalance of the body by predisposing the foot to an inversion moment [35,36]. Moreover, the roll of PLT as a passive stabiliser of ankle joint is also evident [37]. This current study highlights the observation of expected functional morbidities around the donor ankle after harvesting PLT autologous graft for ACLR.

Previous literature emphasised that removal of PLT had little or no effect on ankle functioning [8,14,15,34]. Our findings also support this assertion. In the present study, the Median of FAAM score of the affected side ranged from 97.22 at 6 week to 98.80 and 100 at 3 month and 6 month, respectively. The sound side score being '100' at all visits, a very minimal reduction in the affected leg score was observed at 6 week and 3 month follow-ups, whereas at 6 month, the score became almost normal. FAAM-ADL subscale could reliably detect the deficits associated with chronic ankle instability [35]. Authors also emphasised that for the detection of any abnormality around ankle and foot, the minimally clinically important differences that patients perceived for the FAAM-ADL subscale was 8% [29,35]. In this study, authors observed the differences were less than 3%. This could explain the exclusion of a gross functional deficit of the donor ankle after harvesting PLT graft for ACLR. Authors observed the same with AOFAS score analysis. It also showed a decrement in the score i.e., 88 at 6 week, whereas at 3 months and 6 months, the scores became 98 and 100, respectively. Thus, clinically the functional scores became equal for both the ankle at 6 months follow-up. However, the group comparison of both FAAM and AOFAS score between affected and sound side showed significant difference during all three post-ACLR follow-up visits. Hence, authors inferenced that even-though a visible difference persisted between both the ankles initially after harvesting peroneus longus tenon graft, the function of affected ankle improved continuously with time and restored completely to normal at par with sound limb within 6 months. A study by Cao H et al., got an AOFAS score of 96.3 (range: 84-100) and showed no difference when compared to contralateral ankle. (p-value >0.05) at 6 month follow-up [38].

In this research, both AOFAS and FAAM scale showed statistically significant improvement at 3 month and 6 month as compared to 6 week post-ACLR follow-up visit. This indicated towards a gradual and linear improvement of the donor ankle function with time and full recovery at 6 month. So, we inferenced that even though the ankle function is deteriorated after ACLR with PLTG, it could be regained back to an optimal level in the due course of follow-ups. The perceptible reduction in the scores for both the functional scales during the early postoperative period could be due to multiple factors. Along with donor site morbidity, the other expected causes could be prescribed restrictions after graft harvest, non weight bearing ambulation, usual postoperative signs and symptoms, decrease ROM, scar related deficits, and protective attitude during initial postoperative weeks etc. All these factors together could influence the result at 6 week and improve later with time gradually with proper therapeutic management. If at all, we assume any morbidity at donor site existed after harvesting the PLT, then also we observed the significant improvement in the ankle function up to the optimal level by 6 months.

The use of FAAM scale for functional assessment after ACLR with PLTG is the novelty of our study. It is the modified version of Foot Ankle Disability Index (FADI) scale and the ADL subscale remains same for both. The scores are comparable for both the scale. Based on this, our research results are consistent with other recent studies. A prospective cohort study observed the mean of AOFAS and FADI were 98.93±3.10 and 99.79±0.59 at 2-years follow-up with excellent ankle function [15]. Another study had evaluated 31 subjects (22 males and nine females), with age ranging from 18-45 years and got AOFAS and FADI score of 98.71±3.03 and 99.71±0.57, respectively, which they considered as excellent function at the donor site [13]. One more recent study also observed a mean score of AOFAS and FADI were 98.93±3.11 and 99.80±0.59 at six months post-ACLR [16]. Some researchers evaluated patients following isolated, single bundle ACLR with PLT autograft and at one-year postoperative, they observed the mean of AOFAS and FADI were 98.93±3.10 and 99.79±0.59 [17]. Others stated that the mean 6 months and 1 year follow-up AOFAS scores were 97.7 and 100, respectively and it remained unchanged thereafter till their study period up to 2 years. The mean FADI scores also showed similar results [34]. The very first researchers of PLTG in ACLR, KerImoGlu S et al., also reported that there was no obvious ankle joint dysfunction after harvesting PLT [39]. Although he had not done any objective evaluation, he claimed his patients did not experience any ankle joint dysfunction during their sports activities [39]. From all these literature, we observed that the functional score of the affected ankle remained within 97-100 after the PLTG harvest, which is quite consistent with the present study results.

However, Angthong C et al., evaluated clinical and biomechanical changes around the ankle with a follow-up period of 12.8 months [18]. Average prepost AOFAS score were 97.7±1.1 and 95.4±12 points without any significant difference between the two (p=0.09), but they also observed significantly less stability score in the transverse plain of donor ankle compared to the contralateral side. So, they recommended peroneus longus graft, to be selected for reconstruction of ACL, only when other tendons would not be available [18] or inconvenient to use [40]. Whereas others stated that removing the PLT has no effect on gait parameters and does not lead to instability of the ankle [19,41]. Trung DT et al., have conducted a prepost comparison study and found the mean

AOFAS scores were 97.3±1.67, 97.3±1.54 respectively without any significant difference between them [42]. They concluded with that PLT might be considered as a promising alternative graft for ligament reconstruction in order to avoid potential donor site morbidities of harvested autograft from the knee region [42]. The only systematic review by He J et al., compared multiple dimensions of ACLR with PLTG [21]. Even they did not observe any significant difference in FADI score between donor and sound ankle, but AOFAS was slightly decreased at postoperative follow-up as compared with the pre-operative scores (mean difference of 0.31, p-value=0.01). Overall, they concluded with that PLT autograft showed comparable functional outcomes than Hamstring tendon for ACLR. However, a slight decrease in AOFAS score should be considered during surgical planning. They recommended PLT as a suitable autograft harvested outside the knee for ACL reconstruction to avoid the complication of quadriceps-hamstring imbalance which could occur by taking autografts from the knee [21]. Moreover, few MRI studies, also observed the regenerative potential of PLT at one year follow-up after its removal [12]. Peroneus Brevis muscle is still intact in the present study subjects and probably the synergistic function of this muscle restores the donor ankle function [9,17,21]. Otis JC et al., found that peroneus brevis is comparatively dominant evertor of the ankle, justifying the PLT harvest [43].

Limitation(s)

A small number of female participants limited comparing gender effect on donor ankle function following ACLR with PLTG. Unavailability of the pre ACLR scores did not let the researchers to predict whether the functional morbidities in the early phases were due to decrement in knee function after ACLR or loss of tendon at donor ankle. Lastly, as this study focussed only on functional evaluation, other morbidities such as balance, ROM around the donor site has been overlooked.

CONCLUSION(S)

The evaluation of functional outcomes showed gradual and linear improvement at subsequent postoperative visits and restores fully to 100% at six month indicating a near-normal to normal donor ankle function following ACLR with PLTG by six months. The group comparison showed only marginal but significant difference between affected and sound ankle function.

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