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Arthroscopic anterior cruciate ligament reconstruction with semitendinosus graft versus peroneus longus tendon graft

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ABSTRACT

Background: Arthroscopic anterior cruciate ligament (ACL) reconstruction can be performed using autograft from various sources namely, bone patellar tendon graft, hamstring tendons (semitendinosus, gracilis) or peroneus longus tendon.
Methods: A prospective study of 30 patients who underwent arthroscopic ACL reconstruction using quadrupled semitendinosus tendon autograft and peroneus longus tendon autograft during the study period.
Results: Statistically, there is very little comparable difference between semitendinosus and peroneus longus when used for arthroscopic ACL reconstruction. However, peroneus longus tendon shows superior results when used in patients with grade 3 medial collateral ligament (MCL) injury combined with ACL injury.
Conclusions: Our study brings forth the superior efficacy and quality of the double stranded peroneus longus tendon especially in cases associated with complicated injuries involving the medial collateral ligament with a follow up date of about 2 years and as a healthy supplement to other choices of autografts and revision cases.

Keywords: Peroneus longus tendon, Semitendinosus, Medial collateral ligament, Arthroscopy

INTRODUCTION

Anterior cruciate ligament (ACL) injury is the controversial ligament injury and has been studied extremely all over the world for 21 years. ACL is weaker than the posterior cruciate ligament, thus it is easily torn when compared to posterior cruciate ligament.[1]

ACL injury reconstruction has been done using silver wire, fascia lata, and Iliotibial band.[2-4] Till present so many various techniques have been described for anterior cruciate ligament reconstruction from open procedure to arthroscopic procedure.[5] In 1954, the development of successful arthroscope has led to new possibilities to the field of knee surgery. Since 1982, the Anterior Cruciate ligament reconstruction is performed arthroscopically often.[7]

In ACL reconstruction bone- patellar tendon bone the most commonly used graft. But issues with the extensor mechanism of the knee joint, loss of range of motion, fracture of the patella and the chronic pain in the anterior part of the knee has lead surgeons to take different graft materials for use in reconstruction of ACL such as the semitendinosus, gracilis tendon and peroneus longus tendon are used as an alternative donor autograft materials that may be used without any problem to knee extensor.

Arthroscopic reconstruction of ACL has several advantages such as it is minimally invasive, it has higher accuracy of placement of the graft, less disturbance of normal surrounding tissue leading to faster recovery and rehabilitation, less stay in the hospital and minimum infections in the post-operative phase.

Various graft options are available for ACL reconstruction with injury specific and patient specific considerations that need to be arranged preoperatively. Most commonly used techniques are bone–patellar–bone autograft and quadrupled, or four-strand, hamstring auto-graft. However, bone–patellar–bone autograft has very long usage history, can be complicated by pain in anterior part of knee joint, mainly in patients who are in occupations requiring sitting on the knees, sports, and less commonly it can be associated with post-operative patella fracture, fat pad fibrosis, or patellar tendon contracture.[8] Hamstring harvest which is taken in the medial side can lead to injury to the saphenous nerve and can lead to knee instability in the medial side if the ACL rupture is also associated with a grade III tear of medial collateral ligament (MCL). Varus and valgus instability in post-operative phase due to collateral ligament injuries can lead to failure of the graft. Also, ACL injuries associated with MCL injuries are mostly associated with high energy trauma with larger zones of injury and studies have shown an increased prevalence of these types of injuries. Hamstring graft harvesting medially should also not be preferred in patients with skin and soft tissue injury in the area of insertion of pes anserine in order to avoid infection at surgical site. Also, additional autograft will be of benefit in revision surgeries.

An ideal graft donor should have acceptable strength, and of adequate size, and can be easily and safely harvested. literature suggests other autografts for reconstruction of ACL, like peroneus longus tendon. Zhao and Huangfu found that the anterior half of peroneus longus tendon has appropriate length and appropriate strength to be of use in reconstruction of ACL. Results after two years of follow-up when using the anterior half of the peroneus longus tendon have been found satisfactory, however there doesn't seem to be any direct comparison of the functional outcomes between anterior half of the peroneus longus tendon and hamstring tendon. Studying the bio-mechanical and kinematic aspects of removing the entire peroneus longus tendon has revealed no effect on gait or stability of the ankle.

MCL tear of more than or equal to grade II is an independent risk factor for instability of the knee joint in postoperative phase after ACL reconstruction. Given the possible difficulties and possible complications associated with harvesting the hamstring in grade III MCL injury associated with ACL tear. The main purpose of this study is to present an alternative autograft option. After establishing the peroneus longus graft as a feasible option, this study then aimed to show data in vivo to demonstrate the safety and effectiveness of the peroneus longus tendon in ACL reconstruction with associated MCL repair can be compared to the already accepted gold standard (Hamstring tendon).

Objective

The aim and objective of this research is to study the arthroscopic anterior cruciate ligament reconstruction using semintendinosus tendon vs peroneus longus tendon, to study pathophysiology of ACL tear, to study arthroscopic ACL reconstruction using semitendinous graft and to study arthroscopic ACL reconstruction using longus peroneus graft.

METHODS

This was a prospective study of 30 consecutive patients who underwent arthroscopic ACL reconstruction using quadrupled semitendinosus tendon autograft and peroneus longus tendon autograft during the study period, from November 2017 to October 2019, in Dr. DY Patil Medical College and Hospital, Pimpri, Pune. The source of data was obtained from Orthopaedic ward of the hospital. Data was collected according to a proforma. Ethical committee clearance was obtained before the start of study.

Source of funding

All investigations and procedures will be done if clinically indicated. No specific or additional investigation will be done for the purpose of study. Most of the investigatons/procedures are done free of cost, any investigation/procedure/implant if indicated clinically will be borne by the patient as per hospitals policy.

Inclusion criteria

All skeletally mature patients with ACL tear confirmed by Lachman test with concomitant meniscal injuries and/or collateral ligament injuruies that required repair were included in the study, provided that they were permitted to undergo rehabilitation after ACL reconstruction involving full weight – bearing gait and unrestricted non weight bearing range of motion. And age group between 15 to 25 years.

Exclusion criteria

Patients with ACL avulsion injury. Anterior cruciate ligament tear with concomitant posterior cruciate ligament, collateral ligament injuries requiring surgery or posterolateral corner injury. Anterior cruciate ligament tear associated with the bony injury around the knee. Patients undergoing revision ACL reconstruction. Concurrent musculoskeletal condition, e.g., back, hip, or ankle injury on either extremity. Age >25 years, tear <4 weeks old, pathological ACL tear, pregnancy, septic and rheumatoid arthritis, professional athletes.

Surgical technique

Graft harvest and preparation

Semitendinosus graft harvesting: After the tendons have been positively identified, semitendinosus tendon is released from its tibial insertion. Release the tendon proximally by controlled tension on the tendon, while

advancing the stripper proximally, followed by graft preparation.

Peroneus longus graft harvesting: To harvest the graft, the involved lower limb was put in a supine position. Autogenous peroneus longus tendon was harvested by taking an incision along the posterior border of the distal fibula, just above the superior peroneal retinaculum.

The peroneus longus tendon was exposed on its posterolateral surface through the incision after incising the fascia. Tendon was pulled forward with a curved clamp.

The release of proximal tendon was then performed with a tendon stripper, and it was passed through the fascial tunnel to harvest graft and skin closed, followed by graft preparation.

Tibial and femoral tunnel preparation

After preparation of tibial and femoral tunnels, the harvested graft is placed and femoral side fixed using endobutton. Under arthroscopic visualization in the joint, the threads of the endobutton is pulled using the principle of flipping the endobutton. The femoral fixation is confirmed by togging of the endobutton. The tibial side of the graft is fixed with an interference screw.

Statistical analysis

Descriptive statistics are reported (mean, median, minimum, maximum, standard deviation). The calculations between the differences of means were done by analysis of variance. Association between two variables were found using chi square test. Independent t test was done to compare the group means. Probability value less than 5% was considered significant statistically.

RESULTS

In our study of 30 patients, peroneus longus graft was used in 15 patients, out of which, 4 patients (26.7%) of age group 16-17 years, 3 patients (20%) of age group 18-20 years and 8 patients (53.3%) of age group 21-25 years.

Semitendinosus graft was used in 15 patients, out of which, 2 patients (13.3%) were in the age group of 16-17 years, 5 patients (33.3%) of age group 18-20 years and 8 patients (53.3%) of age group 21-25 years.

Distribution of patients according to nature of injury

Most of the ACL tears were caused by road traffic accidents (43.33%). Next common cause was activities like football, kabaddi and athletics like jumping, police physical training, etc (33.33%). Few patients (23.33%) had injury while performing routine activities like slip and fall while walking/ climbing down stairs.

In our study of 30 patients, peroneus longus graft was used in 15 patients, out of which, 3 patients (20%) were sedentary workers, 5 patients (33.3%) were daily workers, 7 patients (46.7%) were sports persons.

Semitendinosus graft was used in 15 patients, out of which, 4 patients (26.7%) were sedentary workers, 4 patients (26.7%) were daily workers, 7 patients (46.7%) were sports persons.

Distribution of patients according to presenting symptoms

All patients presented with complaints of giving way of the knee. 90% of the patients were able to appreciate the clicking of knee. 66.7% cases were having swelling and 50% cases presented with complaint of pain. 46.7% gave history of locking of knee which was correlated with associated injuries in the knee.

Medial meniscal tear was the commonest associated injury (46.67%) detected by MRI followed by grade 1 medical collateral ligament (20%) and medial meniscus tear (10%) not requiring surgery. There was no lateral collateral ligament and PCL injury.

3 patients (10%) had pain at the graft site at the end of 6 months. Early superficial infection of the site was present in 1 case (3.33%) which delayed wound healing. There was no deep infection. Majority of the patients (66.67%) were having grade I laxity at the end of 6 months but with hard end point. 1 patient (3.33%) had FFD due to noncompliant physiotherapy. 2 patients (6.67%) complaint of click but no instability.

60% of the patients graded their post-operative recovery as normal and 33.3% as near normal whereas 6.7% graded recovery as abnormal according to IKDC score. The abnormal group included one patient with superficial infection and one with FFD.

In around 96.7% of the patients, outcome was reported as excellent and good with scores more than 95 and 84-94 respectively according to LGS scale. 1 patient (3.3%) scored >65 and <83 and were grouped as fair outcome.

At the regular follow up and at the end of 6 months, 73.3% patients graded their recovery as very satisfied and the remaining 26.7% were satisfied with the outcome.

Limb symmetry index was calculated by the percentage of affected limb over the normal limb. The preoperative index for peroneus longus ranges from 41.78 to 48.02 with a mean of 44.9. The preoperative index for semitendinosus ranges from 38.7 to 52.9 with a mean of 45.8. Post-operatively the index for peroneus longus improved to a mean of 89.9 ranging from 86.78 to 93.02. Post-operatively the index for semitendinosus improved to a mean of 86.5 ranging from 82.2 to 90.8.

Distribution of patients according to return to pre-injury level of activity and graft material used

90% of the patients returned to their levels of activities in pre injury status including farming and to competitive sports. 3 patients (10%) were not satisfied with physiotherapy regimen and these patients did not comply to the protocol.

Table 1: Distribution of patients according to age and graft material used.

Age group (yrs)	Graft used	
	Peroneus longus (%)	Semitendinosus (%)
<18	4 (26.7)	2 (13.3)
18-20	3 (20)	5 (33.3)
>20	8 (53.3)	8 (53.3)
Total	15	15

Chi square test=1.167, p value=0.558 (not significant).

Table 2: Distribution of patients according to occupation and graft material used.

Occupation	Graft used		
	Peroneus longus (%)	Semitendinosus (%)	Total (%)
Sedentary	3 (20)	4 (26.7)	7 (23.3)
Daily worker	5 (33.3)	4 (26.7)	9 (30)
Competitive (sports)	7 (46.7)	7 (46.7)	14 (46.7)
Total	15	15	30 (100)

Chi square test=0.254, p value=0.881 (not significant).

Table 3: Frequency of associated injuries on MRI.

Injuries	Yes		No	
	N	%	N	%
MM	14	46.67	16	53.33
LM	03	10	27	90
MCL	06	20	24	80
LCL	-	-	30	100
PCL	-	-	30	100

Table 4: Complications.

Graft site morbidity	Yes	%	No	%
Pain	03	10.00	27	90.00
Superficial infection	01	3.33	29	96.67
Deep infection	00	00.00	30	100
Numbness	01	3.33	29	96.67
Laxity	20	66.67	10	33.33
Click	02	6.67	28	93.33
FFD	01	3.33	29	96.67

Table 5: Distribution of patients according to post-operative IKDC score and graft material used

Post-op IKDC scoring	Graft used		
	Peroneus longus (%)	Semitendinosus (%)	Total (%)
Normal	10 (66.7)	8 (53.3)	18 (60)
Near normal	4 (26.7)	6 (40)	10 (33.3)
Abnormal	1 (6.6)	1 (6.7)	2 (6.7)
Total	15	15	30 (100)

Chi square test=0.622, p value=0.7326 (not significant).

Table 6: Distribution of patients according to post-operative LGS score and graft material used.

Post-op LGS scoring	Graft used		
	Peroneus longus (%)	Semitendinosus (%)	Total (%)
Excellent	9 (60)	8 (53.3)	17 (56.7)
Good	6 (40)	6 (40)	12 (40)
Fair	0	1 (6.7)	1 (3.3)
Poor	0	0	0
Total	15	15	30 (100)

Chi square test=1.059, p value=0.589 (not significant).

Table 7: Distribution of patients according to post-operative SQ score and graft material used.

Post op SQ scoring	Graft used		
	Peroneus longus (%)	Semitendinosus (%)	Total (%)
Very satisfied	12 (80)	10 (66.7)	22 (73.3)
Satisfied	3 (20)	5 (33.3)	8 (26.7)
Not satisfied	00	00	0
Total	15	15	30 (100)

Chi square test=0.242, p value=0.622 (not significant).

Table 8: Single hop test.

Limb symmetry	Graft material	Score (Mean±SD)	T test
Pre-operative	Peroneus longus	44.9±3.12	0.670
	Semitendinosus	45.8±7.10	
Post-operative	Peroneus longus	89.9±3.12	0.020
	Semitendinosus	86.5±4.30	

Table 9: Comparison of IKDC, SQ and LGS and single hop test.

	Hop test			P value
IKDC	Normal	Near normal	Abnormal	<0.05
	90.56±2.89	84.90±2.89	84.00	
LGS	Excellent	Good	Fair	<0.05
	90.29±3.37	85.50±3.50	86.00	
SQ	Very satisfied	Satisfied		<0.05
	89.59±3.59	84.50±2.93		

Table 10: Comparison of graft diameter.

Graft material	Graft length (mm)	T test
	Mean±SD	
Peroneus longus	9.00±0.42	P=0.000
Semitendinosus	8.38±0.41	

DISCUSSION

Semitendinosus tendon has been widely used as an autograft in ACL reconstruction. However, there is a lot of variation in semitendinosus tendon diameter and a short graft length has been recognised as a major risk factor for failure of ACL reconstruction surgeries. 8 mm has been noted as the minimum cross-sectional diameter of the graft which can be difficult with Semitendinosus tendon alone as appropriate length also has to be maintained. There is an increased chance of wound complication and infection with semitendinosus graft harvest in a patient who has ACL injury associated with grade III medial collateral ligament injury of the same side. And also there is a chance of instability of the medial knee joint, although it has not been proved completely. Finally, if the patient has a high-energy injury to the medial side of the knee leading to grade III medial collateral ligament injury should raise a question about the reliability of the medial hamstrings. Also, sources of adequate autograft can be scarce in cases of multi-ligament injuries and pediatric knee reconstructions. there are other studies which have

recognised the use of peroneus longus tendon graft as an alternative to semitendinosus tendon.

The tensile strength of four stranded semitendinosus graft (4090N) and double stranded peroneus longus tendon (4268N) are more or less comparable and they are superior to the tensile strength of the ACL (2160N).

Strictly speaking in biomechanical sense, the double strand peroneus longus tendon as mentioned above proves to be healthy option as a source for grafting which provides great strength for ACL reconstruction.

The therapeutic effects of ACL reconstruction surgery using both the above-mentioned grafts (viz peroneus longus and semitendinosus with four and two strands respectively) are almost similar. there was a case of a patient who was treated with the four-strand hamstring tendon graft came with a gross positive anterior drawer test 6 months after surgery and he gives no history of any strenuous exercise or any other injury. Graft resorption was seen in the MRI There was no such complication in the peroneus longus tendon graft, because the diameter of four strand semitendinous is consistently smaller than double stranded peroneus longus tendon.

Earlier studies have suggested that harvesting the peroneus longus tendon has minimal to no effect on foot and ankle function. Our study results support this. The main function of peroneus longus is to evert the foot and plantar flex the first ray. The only disadvantage of harvesting peroneus longus would be the ankle instability due to reduction in the strength of eversion and plantar flexion.

The study done shows minimal reduction in ankle range of motion and strength before and after the surgery. The peroneus longus tendon has minimal effect on maintenance of the arch of the foot. Medial longitudinal arch is maintained by abductor hallucis, posterior tibial tendon, and flexor pollicis longus. Lateral longitudinal arch is maintained by peroneus brevis, and abductor digiti minimi. The foot transverse arch is maintained by the posterior tibial tendon and adductor pollicis

Therefore, one can infer from studies that the stability of the foot will not be much affected by using a peroneus longus graft.

Due to the easy and safe harvesting techniques peroneus longus tendon can be considered as one of the most ideal candidate for reconstruction of the anterior cruciate ligament. Firstly, as it superficially located, the peroneus longus tendon can be exposed quickly as to the semitendinosus tendons. Also, there aren't many complications related to the structures around the peroneus longus tendon as compared to the hamstring tendons which makes it easier for one to harvest the graft. The biomechanical properties of peroneus longus tendon are superior.

In Huangfus and Zhao's study, the results showed that the failure cases of reconstructions done with semitendinosus tendon and peroneus longus tendon were similar and much better than that of the reconstruction done using the gracilis tendon. The length of the peroneus longus tendon which is used for the reconstruction is more ideal as to that of the gracilis and semitendinous although morbidity of the donor should be kept in mind with respect to the graft harvesting site.[9]

In Angthong et al clinical study involving the peroneus longus which involved 24 cases ankle stability and function were significantly affected when both the normal and affected sites were compared.[10] However, studies conducted by Kerimoğlu et al reported that there was no problem with stability and ankle function.[11] Even though the reports of the studies and sample size done previously (for example Angthong et al) were not convincing enough to draw conclusions from, related to functional loss at the ankle joint, surgeons are reluctant to harvest the peroneus longus tendon until better and biomechanically preferable study reports are obtained for the same.

In our study, the diameter of a double-strand peroneus longus tendon was found be around to 8 to 9 mm and the actual length of it is around 30 cm from the myotendinous junction to the insertion, which makes it very effective and reliable as a graft. There was not much change in the ankle stability and function before and after the surgery

There has been a healthy debate on the selection of appropriate graft material for complicated cases involving ACL tears for instance those associated with MCL injury. The short-term results of our study done shows that double stranded peroneus longus tendon of the same side proves to be an excellent graft without much complications especially those related to the ankle strength and functions.

CONCLUSION

In conclusion our study brings forth the superior efficacy and quality of the double stranded peroneus longus tendon especially in cases associated with complicated injuries involving the medial collateral ligament with a follow up date of about 2 years and as a healthy supplement to other choices of autografts and revision cases. Familiarizing oneself with the anatomy and functions of the graft site and the peroneus longus tendon as such is a healthy addition to the surgeon's abilities and armamentarium.

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