European Journal of Molecular & Clinical Medicine

ISSN2515-8260 Volume 08,Issue 04,2021

Comparison of functional outcome of arthroscopic anterior cruciate ligament reconstruction using an autologous four-strand single semitendinosus tendon versus semitendinosus and gracilis tendon graft

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Abstract

Background: There is no consensus about the optimal graft choice for anterior cruciate ligament (ACL) reconstruction. The present study was aimed to compare the clinical and functional results of reconstruction of ACL by using an autologous four strand semitendinosus tendon versus semitendinosus and gracilis graft.

Methodology and Results: Patients were randomized to undergo ACL repair either by autologous four strand ST tendon or a ST and gracilis tendon graft. Baseline characteristics of patients in the two study groups were similar. In the present study, 58 patients were included. Mean age of the patients in the ST group was 27.34 ± 6.28 years and that in the STG group was 26.34 ± 5.19 years. Road traffic accident was the most common mode of injury and most common symptom at presentation was knee pain. It was found that among all patients included in the study, 48.3% had 4 to 8 months since the time of injury. Mean time since injury was 6.59 ± 2.7 months in the ST group and 6.42 ± 2.2 months in the STG group. LKSS and IKDC values were significantly higher in the ST group as compared to STG group at 2 and 8 weeks post-operatively. Later on, at all follow up points, the mean LKSS and IKDC were similar in the two study groups. Anterior drawer and Lachman test showed no statistical difference between the two study groups.

Conclusion: Since ACL reconstruction using quadrupled ST is more technically demanding than doubled STG and with there being no difference in outcomes, no compulsory advice should be made on the former technique.

Keywords: ACL, semitendinosus, Gracilis, LKSS, IKDC

Introduction

The anterior cruciate ligament (ACL) is an important stabilizing ligament of the knee that is frequently injured during high impact sports or violent injuries. The ACL prevents anterior

translation of the tibia and is also a secondary restraint to tibial rotation as well as varus or valgus stress[1].The ACL originates at the posteromedial aspect of the lateral femoral condyle and it courses distally in an anterior and medial fashion to the anteromedial aspect of the tibia between the condyles. The ACL is often said to be comprised of two bundles: an anteromedial bundle that is tight in flexion and a posterolateral bundle that is tight in extension[2]. ACL injuries can occur by a variety of mechanisms, including both high-energy (e.g. motor vehicle collision) and low-energy (i.e. noncontact field sports)[3].The most common mechanism involves a low-energy, noncontact injury sustained during an athletic activity. Acute management consists of rest, ice, compression of the injured knee, and elevation of the affected lower extremity. After the acute phase of the injury, ACL injuries can be managed operatively or non-operatively. Most active, younger patients and high-level athletes opt for surgical reconstruction. The decision to have surgery is based upon multiple factors, including the patient's level of activity, functional demands placed on the knee, and the presence of associated injuries to the meniscus or other knee ligaments. Other factors such as age, type of work and existing disabilities also play a role.

ACL reconstruction is generally involves replacing a graft in place of ruptured ACL. However, no consensus could be obtained on how and from where to select the most suitable graft. Native grafts may be taken from the patellar tendon, hamstring tendon (semitendinosus and gracilis), peroneus longus tendon or quadriceps tendon, or an allograft may be used. No single graft has demonstrated a superior functional and clinical outcome[4]. The three most common grafts are the patellar tendon graft, the hamstring tendon graft, and the allograft. Patellar graft may be advantageous as by providing an increased initial strength and stiffness compared with the normal ACL and potential bone-to-bone healing in the femoral and tibial tunnels made during surgery, early graft fixation is promoted[5]. Systematic reviews confirm that reconstruction using the patellar tendon graft results in greater anterior knee pain compared with other grafts [6]. Patellar tendon grafts provide greater stability than traditional hamstring grafts, but this may no longer be the case with four stranded hamstring grafts. Moreover, patellar tendon grafts may increase the long-term risk for osteoarthritis of the knee[7].

The hamstring graft has several advantages. Patellar tendon morbidity and thus primarily anterior knee pain can be avoided by using hamstring tendon. A systematic review found that hamstring donor site pain usually resolved by three months, while hamstring strength returned to normal by 12 months[8].Brown *et al*., demonstrated that the hamstring graft is stronger and stiffer when quadruple strands are used[9]. Eight-stranded tendon grafts[10], and double-bundle reconstructions[11] appear to yield greater strength and stability. As hamstring grafts need healing between a tendon and an osseous tunnel[12],initial fixation may be slower and ultimately weaker than the bone-to-bone healing of a patellar tendon graft, although techniques like endobutton have been developed to address this.

However, hamstring graft can cause considerable decrease in knee flexion and tibial rotation strength due to the harvesting of both hamstring tendons[13]. Thus, the importance of harvesting gracilis tendons in ACL reconstruction has been debated in many research studies, doubting the role of the gracilis tendon in hamstring graft technique[14].Furthermore, previous studies indicate that harvesting the gracilis tendon autograft is not only ineffective in the motor control and stability of the knee, but also inefficacious regarding the kinetic muscle torque involved in knee flexion[15]. Some research studies, using subjective and functional evaluations, have demonstrated no significant differences between harvesting semitendinosus ten- don and semitendinosus and gracilis[16].

Therefore, this study was done to examine and compare the results of the ACL reconstruction using only semitendinosus autograft (ST) and the combined use of semitendinosus and gracilis (ST/G).

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Material and Methods

This study was conducted on patients undergoing reconstruction of ACL ligament at the Department of Orthopaedics, Bhagat Phool Singh Government Medical College for Women, Khanpur Kalan, Sonepat for a period of 18 months. This study was approved by institutional ethical committee. A separate informed consent was obtained from patients before being included in the study.

Inclusion criteria: Patients in the 20 to 45 year age group with symptomatic unilateral ACL tear confirmed with radiological diagnosis.

Exclusion criteria: Patients with bilateral anterior cruciate ligament tears, Multiligamentous injury, pre-existing knee arthritis or comorbidities.

Sampling: The sample size was calculated based on previous studies by Kyung *et al*., [17] and Witvrouw *et al*.,[18]. Using nMaster 2.0 software the calculations were done. With the power of study being 80% and alpha error at 5%, sample proportion 0.32 and with confidence interval 95% the sample size was calculated to be 29 patients in each group and total sample size was calculated as 58. Simple random sampling was used and was collected using computerized generated by simple random number table.

Study design: In this present prospective interventional study, 58 eligible patientswere included. At baseline, pre-operative clinical functional score by Lysholm Gillquist score and IKDC score were noted. The patients were then randomized to undergo ACL repair either by autologous four strand ST tendon or a ST and gracilis tendon graft. Post-operatively all patients underwent clinical functional assessment at 2 weeks, 8 weeks, 12 weeks and 24 weeks.

Surgical technique

Anesthesia: For majority of patients, spinal anesthesia was preferred, but the choice depended on patients' general condition and the preference of the patient and operating surgeon. Once the patient was anesthetized, an examination under anesthesia was performed.

Positioning: The subject was positioned in the supine position on the operation table. A tourniquet was placed, high-up on the proximal thigh of the operative extremity.

Draping: The operative leg is then thoroughly scrubbed, from the level of the tourniquet down to the foot, with 10%w/v iodine solution and then painted with ioprep 7.5w/v solution. A standard surgical drape is then placed and secured. The prepared leg is then exsanguinated by using a sterile Esmarch, from the foot upto the thigh, and then the tourniquet is inflated.

Arthroscopic portals: In all our patients, standard anterolateral, anteromedial and accessory portals were made

ACL graft preparation: An oblique incision was placed over the medial border of the proximal tibia, about one centimeter above the 'pes anserius'. The Sartorius fascia was split transversely and the semitendinosus and gracilis tendons were identified. These tendons were then separated from its tibial attachment with a #11 blade. Using a tendon stripper, doubled gracilis and semitendinosus tendons in ST/G group or quadrupled semitendinosus in ST group were harvested in patients according to their study group. The tendons were then

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cleared off their muscle fibers and then fastened together with 'whip-stich' sutures using 2 ethybond. The prepared graft was then mounted on a graft preparation board and pre-tensioned.

Femoral and tibial tunnel: Remnants of the torn ACL were carefully inspected and an attempt was made to preserve large tibial stumps and ACL fibers with intact connections from the tibia to the femur. After selecting and confirming the desired location for the ACL femoral tunnel, a microfracture awl was used to mark the location along the lateral wall of the intercondylar notch. In our study, an endobutton was used for the femoral fixation in all cases. First we used a 4 mm drill Bit to drill a tunnel through the lateral femoral cortex. The depth of drilling was calculated by deducting the preferred endobutton length from the initial tunnel length and then adding 10mm; required for the endobutton to flip. While viewing through the anterolateral portal, ACL tip aimer jig was inserted at a 55° angle through the anteromedial portal into the knee joint. Position the tip of the aimer, 2–3 mm anterior to the posterior margin of the anterior horn of the lateral meniscus and slightly medial to mid-line of the ACL footprint of tibial attachment.

Graft passage: Using an arthroscopic probe or grasper, we retrieved the suture loop that was left in the ACL femoral tunnel and pulled the suture out of the knee joint through the tibial tunnel. The endobutton was then flipped and tension was applied to the free end of the graft. The knee was then completely extended and the free end of the graft was attached to the proximal medial tibia with bio screw or suture disc. In case of semi T G, only suture disc was used and for semi T both bioscrew and suture disc were used.

Post-operative rehabilitation: The knee was immobilized for 3 days, followed by isometric and passive flexion exercises. Patients were allowed one-third body weight bearing 2 weeks postoperatively, increasing to full weight bearing as tolerated by the patientat 4 weeks postoperatively. Running was allowed at 6 months postoperatively.

Functional Assessment: Functional assessments of all patients included in the study was done pre-operatively for baseline scores and then post-operatively at 2 weeks, 8 weeks, 12 weeks and 24 weeks.

Lysholm Knee Scoring Scale: The purpose of the Lysholm Knee Scoring Scale is to assess the results of knee ligament surgery[19]. Evaluation on this scale is based on 8 items: limping, support, stair's climbing, walking, squatting, thigh atrophy, instability, and locking. Each response to the 8 items is assigned an arbitrary score. These scores are administered by clinicians in collaboration with the patient. Scores are assigned on an increasing scale from 0-100 with 100 being interpreted to mean no symptoms. Percentage scores are grouped into four major categories: below 64 poor, 65-85 fair, 845-94 good, and 95-100 excellent[20].

International Knee Documentation 2000 score (IKDC)[21]: The IKDC scale was evaluated by summing the scores for the individual items and then transforming the score to a scale that ranges from 0 to 100. To calculate the final subjective IKDC score simply add the score of each item and divide by the maximum possible score which was 87.

Subjective IKDC score = [Sum of items/Maximum possible score] × 100

The score is interpreted as a measure of function such that higher scores represent higher levels of function and lower levels of symptoms. A score of 100 is interpreted to mean no limitation with activities of daily living or sports activities and the absence of symptoms.

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Data Collection and Statistical analysis: Using a pre-designed, semi-structured patient related data were collected. Demographic data like age and gender were noted for all patients. Clinical information such as mode and age of injury, x-ray findings were noted. Pre-operative (baseline) and post-operatively all patients underwent clinical functional assessment at 2 weeks, 8 weeks, 12 weeks and 24 weeks. Descriptive variables were expressed as mean and standard deviation for quantitative variables and frequency and percentages for qualitative variables. The qualitative (gender and complications) variables were compared using the chi-square and Fisher's exact tests. For the nonparametric variables (Lysholm Gillquist score and IKDC score), we used the Mann-Whitney U test for comparison. The statistical analysis was done with SPSS Version 21.0 (SPSS Inc, USA) and p value less than 0.05 was taken as statistically significant.

Results

During the study period, we included 58 patients. There underwent ACL reconstruction with either by autologous four strand ST tendon or a ST and gracilis tendon graft.

Table 1: Comparing patients in the two study groups according to their age

Age (in years)	Procedure		Total
	ST	STG	
≤ 30	20	18	38
	69.00%	62.07%	65.52%
31 to 40	8	10	18
	27.60%	34.48%	31.03%
> 40	1	1	2
	3.40%	3.40%	3.40%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 0.81		
Mean age	27.34 ± 6.28	26.34 ± 5.19	
	p value = 0.67		

In the present study, 58 patients were included. Mean age of the patients in the ST group was 27.34 ± 6.28 years and that in the STG group was 26.34 ± 5.19 years, with no statistical difference between them (p value = 0.67).

Table 2: Comparing patients in the two study groups according to their gender

Gender	Procedure		Total
	ST	STG	
Females	2	4	6
	6.90%	13.79%	10.34%
Males	27	25	52
	93.10%	86.21%	89.66%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 0.72		

In the present study, 89.66% of the patients were males (n=52) and rest being females. There were 27 males in the ST group and 25 males in the STG group. The gender distribution in the two study groups was not statistically significant (p value = 0.72).

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Table 3: Comparing patients in the two study groups according to their mode of injury

Mode of injury	Procedure		Total
	ST	STG	
Road Traffic Accidents	21	18	39
	72.40%	62.07%	67.24%
Sports injury	8	11	19
	27.60%	37.93%	32.76%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 0.92		

History at the time of presentation to the hospital revealed road traffic accident was the most common mode of injury in our patients (67.24%). In the ST group 72% and in the STG group 62% had a road traffic accident. Sports injury was seen among 32.76% of the patients. The distribution of patients according to the mode of injury was not statistically significant (p value = 0.92).

Table 4: Comparing patients in the two study groups according to their associated injuries

Associated injury	Procedure	
	ST	STG
Medial meniscus		
Yes	21	20
	72%	69%
No	8	9
	28%	31%
	p value = 0.90	
Lateral meniscus		
Yes	4	6
	14%	21%
No	25	23
	86%	79%
	p value = 0.83	

We examined the patients for any associated injuries. Medial meniscal injury was found in a total of 41 patients, while lateral meniscal injury was found in only 10 patients in the study. Among the ST group 72% had medial meniscal injury, while lateral meniscal injury was found in only 14% of the patients. Among patients in the STG group, 69% had the medial meniscal injury while only 21% had lateral meniscal injury. The distribution of these associated injuries were not statistically different between the two study groups.

Table 5: Comparing patients in the two study groups according to the time since injury

Time since injury(in months)	Procedure		Total
	ST	STG	
< 4	8	8	16
	27.60%	27.60%	27.60%
4 to 8	14	14	28
	48.30%	48.30%	48.30%
> 8	7	7	14
	24.10%	24.10%	24.10%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 1.00		

Mean time (in months)	6.59±2.7	6.42±2.2	
	p value = 0.64		

Time since injury was enquired from the patients. It was found that among all patients included in the study, 48.3% had 4 to 8 months since the time of injury. Mean time since injury was 6.59 ± 2.7 months in the ST group and 6.42 ± 2.2 months in the STG group, the difference of which was statistically not significant (p value = 0.64).

Table 6: Comparing patients in the two study groups according to their IKDC at different time points

IKDC	Procedure	Mean	Std. Deviation	Std. Error Mean	p value
Pre-operative	ST	56.814	11.9935	2.2271	0.73
	STG	56.01	3.6097	0.6703	
2 weeks	ST	38.769	4.606	0.8553	<0.001
	STG	34.338	3.4123	0.6337	
8 weeks	ST	66.107	5.8432	1.0851	<0.05
	STG	63.824	3.5893	0.6665	
12 weeks	ST	77.814	5.8147	1.0798	0.58
	STG	77.055	4.6792	0.8689	
24 weeks	ST	91.372	3.3002	0.6128	0.23
	STG	92.328	2.7422	0.5092	

IKDC was assessed in the patients pre-operatively and post-operatively at 2 weeks, 8 weeks, 12 weeks and 24 weeks. The above describes how the mean IKDC values changed over different points of follow up. We observed the mean IKDC to be similar in both the study groups at baseline (pre-operatively). At 2 weeks, we observed the mean IKDC to be significantly higher in the ST group as compared to STG group (38.76 ± 4.6 vs. 34.33 ± 3.4; p value <0.001). Similar observation was made at 8 weeks as well. Later on, at all follow up points, the mean IKDC was similar in the two study groups.

Table 7: Comparing patients in the two study groups according to their LKSS at different time points

Lysholm knee scoring scale	Procedure	Mean	Std. Deviation	Std. Error Mean	p value
Pre-operative	ST	79.21	10.506	1.951	0.43
	STG	77.59	3.551	0.659	
2 weeks	ST	40.34	5.563	1.033	<0.05
	STG	37.66	3.618	0.672	
8 weeks	ST	64.24	7.084	1.316	<0.05
	STG	61.38	5.506	1.022	
12 weeks	ST	87.62	4.17	0.774	0.07
	STG	85.79	3.559	0.661	
24 weeks	ST	93.76	2.586	0.48	0.12
	STG	93.07	3.046	0.566	

LKSS was assessed in the patients pre-operatively and post-operatively at 2 weeks, 8 weeks, 12 weeks and 24 weeks. The above describes how the mean LKSS values changed over different points of follow up. We observed the mean LKSS to be similar in both the study groups at baseline (pre-operatively). At 2 weeks, we observed the mean LKSS to be significantly higher in the ST group as compared to STG group (40.34 ± 5.5 vs. 37.66 ± 3.6; p value <0.05). Similar observation was made at 8 weeks as well. Later on, at all follow up points, the mean LKSS was similar in the two study groups.

Table 8: Comparing patients in the two study groups according to the Anterior Drawer test pre- and post-operatively

Anterior drawer test			
	Procedure		**Total**
Pre-operative	ST	STG	
Grade 0	0	0	0
	0%	0%	0%
Grade 1	0	0	0
	0.00%	0.00%	0.00%
Grade 2	24	25	49
	82.80%	86.20%	84.50%
Grade 3	5	4	9
	17.20%	13.80%	15.50%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 1.00		
Post-operative			
Grade 0	24	23	47
	82.80%	79.30%	81.00%
Grade 1	4	5	9
	13.80%	17.20%	15.50%
Grade 2	1	1	2
	3.40%	3.40%	3.40%
Grade 3	0	0	0
	0%	0%	0%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 0.98		

Anterior Drawer test was assessed in the patients pre-operatively and post-operatively. The above compared proportion of patients in various grades pre- and post-operatively in the two study groups. Pre-operatively, in the ST group, 17.2% of the patients were in Grade 3, 82.8% were in Grade 2, while in the STG group, 13.8% were in Grade 3 and 86.2% were in Grade 2. The difference in proportions was not statistically significant (p value = 1.00). Post-operatively, in the ST group 3.4% were in Grade 2, 13.8% in Grade 1 and 82.8% in Grade 0. In the STG group, 3.4% were in Grade 2, 17.2% were in Grade 1 and 79.3% were in Grade 0. The difference in the proportion of patients in various grades in the two study groups was not statistically significant (p value = 0.98).

Table 9: Comparing patients in the two study groups according to the Lachman test pre- and post-operatively

Lachman test			
	Procedure		**Total**
Pre-operative	**ST**	**STG**	
Grade 0	0	0	0
	0%	0%	0%
Grade 1	2	2	4
	6.90%	6.90%	6.90%
Grade 2	23	21	44
	79.30%	72.41%	75.86%
Grade 3	4	6	10
	13.80%	20.69%	17.24%
	29	29	58

	100.00%	100.00%	100.00%
	p value = 0.63		
Post-operative			
Grade 0	12	10	22
	41.40%	34.48%	37.93%
Grade 1	15	16	31
	51.70%	55.17%	53.45%
Grade 2	2	3	5
	6.90%	10.34%	8.62%
Grade 3	0	0	0
	0%	0%	0%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 0.78		

Lachman test was assessed in the patients pre-operatively and post-operatively. The above compared proportion of patients in various grades pre-and post-operatively in the two study groups. Pre-operatively, in the ST group, 13.8% of the patients were in Grade 3, 79.3% were in Grade 2, 6.9% in Grade 1 and none in Grade 0 while in the STG group, 20.6% were in Grade 3 and 72.4% were in Grade 2, 6.9% were in Grade 1 and none in Grade 0. The difference in proportions was not statistically significant (p value = 0.63). Post-operatively, in the ST group 6.9% were in Grade 2, 51.7% in Grade 1 and 41.4% in Grade 0. In the STG group, 10.34%% were in Grade 2, 55.17% were in Grade 1 and 34.48% were in Grade 0. The difference in the proportion of patients in various grades in the two study groups was not statistically significant (p value =0.78).

Table 10: Comparing patients in the two study groups according to the Pivot test pre- and post-operatively

Pivot test			
	Procedure		**Total**
Pre-operative	**ST**	**STG**	
Grade 0	3	3	6
	10.30%	10.30%	10.30%
Grade 1	21	19	40
	72.40%	65.52%	68.97%
Grade 2	5	7	12
	17.20%	24.14%	20.69%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 0.77		
Post-operative			
Grade 0	23	20	46
	79.30%	68.97%	79.31%
Grade 1	6	8	12
	20.70%	27.59%	20.69%
Grade 2	0	1	0
	0%	3.44%	0%
	29	29	58
	100.00%	100.00%	100.00%
	p value = 0.71		

Pivot test was assessed in the patients pre-operatively and post-operatively. The above compared proportion of patients in various grades pre-and post-operatively in the two study

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groups. Pre-operatively, in the ST group, 17.2% of the patients were in Grade 2, 72.4% were in Grade 1, 10.3% in Grade 0 while in the STG group, 24.14% were in Grade 2 and 65.52% were in Grade 1, 10.3% were in Grade 0. The difference in proportions was not statistically significant (p value = 0.77).Post-operatively, in the ST group none were in Grade 2, 20.7% in Grade 1 and 79.3% in Grade 0. In the STG group, one patient was in Grade 2, 27% were in Grade 1 and 68.97% were in Grade 0. The difference in the proportion of patients in various grades in the two study groups was not statistically significant (p value =0.71).

Discussion

We included 58 patients, without pre-existing arthritis, with symptomatic unilateral anterior cruciate ligament tear, with clinical or radiological evidence of anterior cruciate ligament tear.In the present study, mean age of the patients in either of the study groups was similar, with the most common age group being less than 30 years of age (65%). Also, 89.66% of the patients were males (n=52) and rest being females. Karimi-Mobarake *et al*., [**Error! Bookmark not defined.**] included patients with mean age of 28.8 ± 8.2 years and 29.7 ± 7.9 years in the ST and STG group respectively. A recent meta-analysis comparing patient-reported outcomes and functional knee parameters of ACL reconstruction surgery with ST and ST-gracilis grafts found that mean patient age ranged from 20 to 31 years, with vast majority of studies reporting more numbers of male than female patients[22]. Furthermore, in our study, road traffic accident was the most common mode of injury in our patients (67.24%) and rest having sports injury. The etiology underlying ACL injury varies significantly by country, with the vast majority being related to sporting injury in the USA, Western Europe and Scandanavia[23] where 58% were associated with a sporting injury, 26% with an RTA, and 16% were related to other nonsporting injuries in an Indian cohort[24].

We examined the patients for any associated injuries. Medial meniscal injury was found in a total of 41 patients, while lateral meniscal injury was found in only 10 patients in the study. Among the ST group 72% had medial meniscal injury, while lateral meniscal injury was found in only 14% of the patients. Among patients in the STG group, 69% had the medial meniscal injury while only 21% had lateral meniscal injury. Kyung *et al*., [**Error! Bookmark not defined.**] found that there were 27 cases of meniscus injury and six cases of MCL injury in the ST group and 21 cases of meniscus injury and two cases of MCL injury in the ST/G group. Partial meniscectomy and meniscus repair was performed in 13 and 14 cases, respectively, in the ST group, and they were performed in 15 and six cases, respectively, in the ST/ G group. MCL injuries were treated conservatively in both groups.

Time since injury was enquired from all our patients, mean time since injury was 6.59 ± 2.7 months in the ST group and 6.42 ± 2.2 months in the STG group, the difference of which was statistically not significant (p value = 0.64). Kyung *et al*., found that the mean time from injury to index surgery in the ST and ST/G groups were 5.8 and 6.0 months, respectively. Karimi-Mobarakeh *et al*., found that the time between injury and surgery was 2. 7 ± 1.9 and 2.8 ± 1.6 months.

We assessed the functional outcome of our patients in the two study groups using IKDC and LKSS pre-operatively and post-operatively at 2, 8, 12 and 24 weeks. We observed the mean IKDC to be similar in both the study groups at baseline (pre-operatively). At 2 weeks and 8 weeks, we observed the mean IKDC to be significantly higher in the ST group as compared to STG group. Later on, at all follow up points, the mean IKDC was similar in the two study groups. Karimi-Mobarakeh *et al*., [**Error! Bookmark not defined.**] found no significant differences in the IKDC subjective score side-to-side between the two groups (80.8 ± 6.8 vs 83.5 ± 6.3, p value = not significant). Similarly, Arden *et al*., found that the outcome measures of the IKDC, knee laxity, isokinetic knee flexor peak torque and range of motion were not significantly different in ST and ST/G groups. Gracilis harvest had no positive or negative effect on the outcome

measures of ACLR according to the findings of Barenius *et al*., [**Error! Bookmark not defined.**]. Niki *et al*., [**Error! Bookmark not defined.**] demonstrated that the IKDC improved in patients

ISSN2515-8260 Volume 08,Issue 04,2021

undergoing either ST or STG grafting but there was no significant difference among the patients in the two groups. Inagaki *et al*., **Error! Bookmark not defined.** also found that after 2 years of follow-up, no significant differences in the functional outcome as assessed by IKDC in patients undergoing ST or STG grafting. In addition, we observed the mean LKSS to be similar in both the study groups at baseline (pre-operatively). At 2 weeks, and 8 weeks we observed the mean LKSS to be significantly higher in the ST group as compared to STG group. Later on, at all follow up points, the mean LKSS was similar in the two study groups. Similar results were reported by Kyung *et al*., [**Error! Bookmark not defined.**] also found that LKSS was not significantly different among either ST or STG group of patients. Inagaki and colleagues also demonstrated similar functional outcomes.

One major concern regarding ACL reconstruction with hamstring tendon is loss of knee flexion strength. Gifstad *et al*., in a 7-year follow-up study of the patients who had undergone ACL reconstruction, found that total flexion work decreased more among the patients in the ST/ G group than those in bone–patellar tendon–bone (BPTB); however, anterior knee pain was observed in BPTB more than with the ST/G[25]. This was observed especially during the first few years following the operation. Conversely, two other review articles suggest that semitendinosus and gracilis tendons regenerated among a significant number of patients who had undergone ACL reconstruction with the ST/G technique[26]. However, there is doubt as to whether the regeneration occurs at the anatomic site and whether or not this affects knee flexion strength. Janssen *et al*., observed 22 patients who had undergone ACL reconstruction with 4S-HT for 1 year and used an MRI to assess tendon regeneration[27]. They reported the regeneration of gracilis tendons in all the patients and the regeneration of semitendinosus tendons in 14 of the 22 patients. This regeneration of tendons had no significant effect on the scores of IKDC, Tegner, Lysholm, KT-1000, or the isometric and isokinetic tests of hamstring muscles.

Even though both the patient related outcomes (IKDC and LKSS) were comparable in both the study groups in our study and shown previously as well, side-to-side differences in flexor peak torque have been shown to be significantly higher in the ST-G graft at lower angular velocities, indicating that the gracilis muscle plays a greater role on knee flexion torque at lower angular velocities[28]. This has been validated by the presence of higher surface electromyogram signals at slower velocities during isokinetic test[29]. While multiple studies highlighted that ST alone appears to have an added advantage over ST-G grafts with respect to rotational weakness, they too concluded a lack of clinical differences. Still, these statistical differences have not translated into clinical significance as the patient related outcomes have consistently been reported to be similar between the two surgical procedures.

Limitations

Selection bias may have affected our study results because we included only patients who had unilateral ACL tear and reconstruction. The maximum follow-up period of 24 weeks of the patients might not be enough to assess functional outcomes and long term assessment of quality of life. Objective assessment methods like K-1000 were not utilized in the study.

Conclusion

Our results show that patients who underwent ST graft had significantly higher IKDC and LKSS at only 2 and 8 weeks post-operatively, further assessments showed no difference. Other than this no other assessment method could identify superiority of one surgical technique over the other.

References

1. Markolf KL, Mensch JS, Amstutz HC. Stiffness and laxity of the knee-the contributions of the supporting structures. A quantitative *in vitro* study. J Bone Joint Surg. Am. 1976;58:583.
2. Kennedy JC, Alexander IJ, Hayes KC. Nerve supply of the human knee and its functional importance. Am J Sports Med. 1982;10:329.
3. Mountcastle SB, Posner M, Kragh JF Jr, Taylor DC. Gender differences in anterior cruciate ligament injury vary with activity: epidemiology of anterior cruciate ligament injuries in a young, athletic population. Am J Sports Med. 2007;35:1635.
4. Foster TE, Wolfe BL, Ryan S, *et al*. Does the graft source really matter in the outcome of patients undergoing anterior cruciate ligament reconstruction? An evaluation of autograft versus allograft reconstruction results: a systematic review. Am J Sports Med. 2010;38:189.
5. Miller SL, Gladstone JN. Graft selection in anterior cruciate ligament reconstruction. Orthop Clin North Am. 2002;33:675.
6. Li S, Su W, Zhao J, *et al*. A meta-analysis of hamstring autografts versus bone-patellar tendon-bone autografts for reconstruction of the anterior cruciate ligament. Knee. 2011;18:287.
7. Pinczewski LA, Lyman J, Salmon LJ, *et al*. A 10-year comparison of anterior cruciate ligament reconstructions with hamstring tendon and patellar tendon autograft: a controlled, prospective trial. Am J Sports Med. 2007;35:564.
8. Poolman RW, Farrokhyar F, Bhandari M. Hamstring tendon autograft better than bone patellar-tendon bone autograft in ACL reconstruction: a cumulative meta-analysis and clinically relevant sensitivity analysis applied to a previously published analysis. Acta Orthop. 2007;78:350.
9. Brown CH Jr, Steiner ME, Carson EW. The use of hamstring tendons for anterior cruciate ligament reconstruction. Technique and results. Clin Sports Med. 1993;12:723.
10. Zhao J, He Y, Wang J. Double-bundle anterior cruciate ligament reconstruction: four versus eight strands of hamstring tendon graft. Arthroscopy. 2007;23:766.
11. Schreiber VM, van Eck CF, Fu FH. Anatomic Double-bundle ACL Reconstruction. Sports Med Arthrosc. 2010;18:27.
12. Poolman RW, Abouali JA, Conter HJ, Bhandari M. Overlapping systematic reviews of anterior cruciate ligament reconstruction comparing hamstring autograft with bone-patellar tendon-bone autograft: why are they different? J Bone Joint Surg. Am. 2007;89:1542.
13. Kim JG, Yang SJ, Lee YS, Shim JC, Ra HJ, Choi JY. The effects of hamstring harvesting on outcomes in anterior cruciate ligament-reconstructed patients: a comparative study between hamstring-harvested and-unharvested patients. Arthroscopy.2011;27(9):1226-1234
14. Gobbi A, Domzalski M, Pascual J, Zanazzo M. Hamstring anterior cruciate ligament reconstruction: Is it necessary to sac-rifice the gracilis? Arthroscopy.2005;21(3):275-280.
15. Yosmaoglu HB, Baltaci G, Ozer H, Atay A. Effects of additional gracilis tendon harvest on muscle torque, motor coordination, and knee laxity in ACL reconstruction. Knee Surg. Sports Traumatol Arthrosc.2011;19(8):1287-1292
16. Barenius B, Webster WK, McClelland J, Feller J. Ham-string tendon anterior cruciate ligament reconstruction: Does gracilis tendon harvest matter? Int. Orthop.2013;37(2):207-212.
17. Kyung HS, Lee HJ, Oh CW, Hong HP. Comparison of results after anterior cruciate ligament reconstruction using a four-strand single semitendinosus or a semitendinosus and gracilis tendon. Knee Surgery, Sports Traumatology, Arthroscopy. 2015

Nov;23(11):3238-43.

18. Witvrouw E, Bellemans J, Verdonk R, Cambier D, Coorevits P, Almqvist F. Patellar tendon vs. doubled semitendinosus and gracilis tendon for anterior cruciate ligament reconstruction. International orthopaedics. 2001 Oct;25(5):308-11.
19. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. The American journal of sports medicine. 1982 May;10(3):150-4.
20. Collins NJ, Misra D, Felson DT, Crossley KM, Roos EM. Measures of knee function: International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Knee Injury and Osteoarthritis Outcome Score (KOOS), Knee Injury and Osteoarthritis Outcome Score Physical Function Short Form (KOOS- PS), Knee Outcome Survey Activities of Daily Living Scale (KOS- ADL), Lysholm Knee Scoring Scale, Oxford Knee Score (OKS), Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), Activity Rating Scale (ARS), and Tegner Activity Score (TAS). Arthritis care & research. 2011 Nov;63(S11):S208-28.
21. Irrgang JJ, Anderson AF, Boland AL, Harner CD, Kurosaka M, Neyret P, Richmond JC, Shelborne KD. Development and validation of the international knee documentation committee subjective knee form. The American journal of sports medicine. 2001 Sep;29(5):600-13.
22. Chin BZ, Wee IJ, Syn NL, Krishna L. Arthroscopic anterior cruciate ligament reconstruction: a meta-analysis comparing semitendinosus alone and semitendinosus with gracilis tendon autografts. The journal of knee surgery. 2019 Aug;32(08):796-803.
23. Englund M, Eriksson K, Forssbland M, Frobell R, Kvist J, Herbertsson P. Swedish ACL Register. Annual Report;The Swedish National Knee Ligament Register. X Base, 2014.
24. Jacob KM, Oommen AT. A retrospective analysis of risk factors for meniscal co-morbidities in anterior cruciate ligament injuries. Indian J Orthop. 2012;46:566-9.
25. Gifstad T, Sole A, Strand T, Uppheim G, Grontvedt T, Drogset JO. Long-term follow-up of patellar tendon grafts or hamstring tendon grafts in endoscopic ACL reconstructions. Knee Surg. Sports Traumatol Arthrosc.2013;21(3):576-583.
26. Nikolaou VS, Efstathopoulos N, Wredmark T. Hamstring tendons regeneration after ACL reconstruction: an overview. Knee Surg. Sports Traumatol Arthrosc.2007;15(2):153-160.
27. Janssen RP, van der Velden MJ, Pasmans HL, Sala HA. Regeneration of hamstring tendons after anterior cruciate ligament reconstruction. Knee Surg. Sports Traumatol Arthrosc.2013;21(4):898-905.
28. Yosmaoglu HB, Baltaci G, Ozer H, Atay A. Effects of additional gracilis tendon harvest on muscle torque, motor coordinationand knee laxity in ACL reconstruction. Knee Surg. Sports Trauma-tol Arthrosc. 2011;19(08):1287-1292.
29. Croce RVMJ, Miller JP. Angle- and velocity-specific alterations in torque and semg. activity of the quadriceps and hamstrings during isokinetic extension-flexion movements. Electromyogr Clin Neurophysiol. 2006;46(02):83-100.