

Original Research Article

A study on functional outcome of arthroscopic anatomical reconstruction of anterior cruciate ligament using quadrupled hamstring graft

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ABSTRACT

Background: Various techniques and graft types are now available for the reconstruction of ACL. Opinions differ among experts with regard to the ideal technique and graft type to be used. Arthroscopic anatomical ACL reconstruction using quadrupled hamstring autograft with fixation in the femoral tunnel using tightrope and in the tibial tunnel with interference screw is a relatively new technique. Purpose of this study is to analyze the postoperative outcome in our experience with this procedure.

Methods: This was a prospective study of patients with ACL injury who underwent Arthroscopic anatomical ACL reconstruction using quadrupled hamstrings autograft. All patients were operated upon by the same surgeon and had the same rehabilitation protocol. They were followed up for six months at regular intervals using IKDC, LGS scoring systems, tegner activity scale and a subjective questionnaire.

Results: About 95% of the patients had a favorable outcome as per three scoring systems. (IKDC, Lysholm score, subjective questionnaire) all three scoring system had a very high correlation around 90% of individuals were able to return to their pre injury activity level.

Conclusions: We conclude that the functional outcome of arthroscopic anatomical anterior cruciate ligament reconstruction using quadrupled hamstrings tendon autograft is excellent to good (95%). With proper patient selection and rehabilitation full occupational and recreational activities can be expected for most of the patients within four to six months of the procedure.

Keywords: Anterior cruciate ligament, Arthroscopic anatomical reconstruction, Biointerference screw

INTRODUCTION

The anterior cruciate ligament is the weaker of the two cruciate ligaments and therefore may be it tears easier than the posterior cruciate ligament.¹

Anterior knee instability associated with rupture of the ACL is a disabling clinical problem. Thus patients with knee symptoms related to ACL deficiency, may consider

ligament reconstruction as a means of stabilizing the tibio-femoral joint and restoring high level function of the knee joint.

Numerous authors have described successful reconstruction of the ACL with use of a donor autograft (patellar tendon, hamstring tendon or quadriceps tendon) and allograft (Achilles, patellar tendon, hamstring tendon or tibialis anterior) tendons. Anterior cruciate ligament reconstruction has been attempted using silver wire,

fascia lata, and iliotibial band.²⁻⁴ To date more than 400 different techniques have been described for anterior cruciate ligament reconstruction from open to arthroscopic technique.⁵ Anterior cruciate ligament (ACL) reconstruction with Hamstring tendon is becoming increasingly popular in patients with symptomatic instability and in appropriately selected patients can yield successful and satisfactory results.⁶

The present study is designed to analyze the postoperative outcome of arthroscopic anatomical ACL reconstruction with quadrupled hamstrings autograft fixed in femoral tunnel using tightrope and in the tibial tunnel using interference screws.

METHODS

Patients

Study population- the basic population of this study comprises of 110 patients who had anatomical anterior cruciate ligament reconstruction at MIOT hospitals between June 2012 and January 2014. The reconstruction techniques used were quadrupled hamstring graft with tightrope fixation arthroscopically.

Inclusion criteria

Inclusion criteria were primary ACL surgery; closed growth plates; absence of ligament injury to contra-lateral knee; agreement to participate in the study and signed informed consent prior to inclusion; a radiographic examination with normal joint status; and ACL insufficiency as determined by clinical examination (positive pivot shift and/ or positive Lachman test) and a complete ACL tear visualized on MRI.

Exclusion criteria

Exclusion criteria were degenerative tears; significant osteoarthritis; neurological deficit; secondary ACL reconstruction; associated meniscal injury.

Sample size and population

Out of 110 patients, 70 patients with isolated ACL tears who underwent ACL reconstruction with hamstring graft were selected and invited to the follow up examination. A total of 65 patients were able to attend.

Among the 65 patients were 54 men and 11 women. The clinical examination was conducted at a mean follow up of 16 weeks, 20 weeks and 24 weeks. The mean age of the patients was 28 years at the time of the operation.

Surgical technique

Initial arthroscopy

The patient receives intravenous antibiotics pre-operatively. After induction of anaesthesia, the patient is

positioned supine and a tourniquet applied on the upper thigh of the operative leg.

An examination under anaesthesia is performed. Diagnostic arthroscopy is performed through an anteromedial and anterolateral portals.

Graft harvest and preparation

A 3-4 cm incision is made anteromedially on the tibia starting approximately 4 cm distal to the joint line and 3 cm medial to the tibial tuberosity.

The PES anserinus insertion is exposed with subcutaneous dissection. With the PES retracted medially, the gracilis and semitendinosus tendons are visible on the medial side. The more proximal thicker of the two tendons is the gracilis and below it is the more horizontal semitendinosus tendon. After the tendons are identified, the semitendinosus tendon is pulled forward with a curved clamp or a mixer forceps and snared with a braided suture. With Metzenbaum scissors, the dissection is carried proximally up the thigh.

Then semitendinosus tendon is released from its tibial insertion. The insertion site, including the periosteum, is widely circumscribed with a knife and undermined with a periosteal elevator.

After carefully releasing the tendon from its insertion, a double Krackow –type whipstitch with vicryl is placed near the insertion of the tendon and its fibrous extension is released.

All sides of the tendon are palpated to ensure there are no fibrous extensions before releasing it with an open end tendon stripper. The muscle should slide off the tendon as the stripper is advanced proximally.

The surgical assistant prepares the tendons on the ACL Graft master on the back table. The overall length of the tendon is measured. The tendon is cut in half to make two segments of equal length. A double Krackow-type whipstitch is placed in both ends of each tendon with No. 2 Ethibond. Each segment is looped to create a total of four strands and graft size measured with the tendon sizer. A running, interlocking no. 2-0 nonabsorbable Krackow-type whipstitch is placed in each end of the loop so that the graft can be passed as a single quadruple graft. The prepared graft is then placed under tension, covered by wet saline gauze, for 20 to 30 minutes on the graft master. If the gracilis tendon is also to be harvested, this may be found just superior to the position of the semitendinosus, as described in step one. The same technique is followed for removal of this tendon.

Femoral tunnel preparation

The stump at the femoral attachment of anterior cruciate ligament is debrided noting the footprint. Using an awl

the midpoint of the foot print is marked. The knee is hyperflexed and using the femoral offset 7 mm (arthrex) from anteromedial portal, the guide pin is passed at the previous reference point. The length of the femoral tunnel can be calculated through graduations at the guide pin (arthrex beeth pin). A cannulated reamer of appropriate diameter which is determined by sizing the hamstring graft is advanced over the guide pin

Tibial tunnel preparation

The foot print of the anterior cruciate ligament is clearly defined by debriding the ACL stump at the tibial attachment. The placement of the tibial guide pin should be at the mid-point of the foot print which is approximately 2mm medial and anterior from the anterior horn of lateral meniscus.

The graft is pretensioned and using a tightrope for femoral fixation, graft is passed from the tibia to femur. 15 to 20 cycles of complete flexion and extension is made to align the graft on the femoral cortex. On the tibial side fixation is done using bio interference screws which will be 1mm more than the tunnel size.

Wound closure

Thorough lavage of the joint is done to clear off the debris. Graft harvest site is sutured in layers with no 2-0 vicryl. Skin sutured with ethilon/skin staples. Compression bandage dressing done and long knee extension brace is applied.

Postoperative rehabilitation

All patients were initiated on postoperative ACL Protocol [adapted from Wilk et al] on postoperative day 1.

On the operative day, after patient recovers from anaesthesia, patient is taught to do foot and ankle pump movements. The next day patient is taught static quadriceps exercises. On the 2nd postoperative day, active knee bending with gradual increase of 10-20 degrees of flexion/ day was started. On the 3rd post-operative day, assisted SLRT, abduction and adduction exercises of thigh and hamstring strengthening exercises were started. By the end of 1st week, patient will be able to walk full weight bearing with long knee brace. Sutures are removed on the 10th postoperative day and patient is discharged with the advice to continue exercises as per the protocol given to them in the form of a booklet.

Patients were advised to wear long knee brace for 2 months to protect the knees from getting injured. Patients were followed up every month for the first 6 months and the progresses are assessed. Patients are subject to single hop test at 4th, 5th and 6th month of post-operative period and at the end of 6th month, the patients are subjected to IKDC, Lysholm Scoring and the subjective questionnaire.

Statistical analysis

Descriptive statistics are reported (mean, median, minimum, maximum, standard deviation). Paired sample “t” test was done to compare the group means and the p value was calculated Probability value less than 5% was considered as statistically significant. The SPSS 17.0 software package (SPSS, Inc., Chicago, Illinois) was used for the analysis. Microsoft Word and Excel were used to generate graphs and tables.

RESULTS

Age distribution

The mean age in our study was 28 years. The youngest patient was 18years and the oldest patient was 46 years old. The maximum number of patients were in the age group of 21- 25years (36.92%) followed by the age group 26-30years (24.61%) (Table 1).

Table 1: Age and sex distribution.

	Number	Percent (%)
Age (in years)		
15-20	04	6.15
21-25	24	36.92
26-30	16	24.61
31-35	07	10.76
36-40	10	15.38
41-45	02	3.07
46-50	02	3.07
Sex	Frequency	
Male	54	83.07
Female	11	16.93

Sex distribution

In our series of 65 patients, 54 patients were males and 11 patients female, (male predominance). It may be because of the involvement of males in outdoor activities like sports, farming and road traffic accidents (Table 1).

Side of injury

Right knee was injured in 18 patients (27.69%) and left knee was injured in 47 patients (72.30%) (Table 2).

Nature of injury

Most of the ACL tears were caused by road traffic accidents followed by sports activities like football, kabbaddi and athletics like jumping, police physical training etc. Some patients (18.46%) got injured while doing daily activities like slip and fall while walking/ climbing down stairs. Twisting of the knee was noted in most of the patients (63.33%) followed by twisting in flexion (36.67%) (Table 2).

Table 2: Symptoms.

	Frequency	Percent (%)
Side of injury		
Right	18	27.69
Left	47	72.30
Nature of injury		
RTA	30	46.15
Sports	23	35.38
Fall	12	18.46
Presenting symptoms		
Pain	54	83.1
Swelling	53	81.5
Giving way	65	100
Clicking	28	43.1

Presenting symptoms

All patients presented with complaints of giving way of the knee. 81.5% cases were having swelling and 83.1% cases presented with complaint of pain. 41.1% of the patients were able to appreciate the clicking of knee (Table 2).

Table 3: Complications.

Graft site morbidity	Yes %	No %
Pain	08 12.30	57 87.69
Superficial infection	02 3.07	63 96.92
Deep infection	00 00.00	65 100
Numbness	04 6.15	61 93.84
Laxity	07 10.76	58 89.3
Click	02 3.07	63 96.92
FFD	01 1.53	64 98.46

Complications

8 patients (12.30%) had pain at the graft site at the end of 6 months. Early superficial infection of the site was present in 2 cases (3.07%) which delayed wound healing. There was no deep infection. 07 patients (10.76%) were having grade I laxity at the end of 6 months but with hard end point. 1 patient (1.53%) had FFD due to noncompliant physiotherapy. 2 patients (3.07%) complaint of click but no instability (Table 3).

Post-operative outcome- IKDC scoring

72.30% of the patients graded their post-operative recovery as normal and 23.07% as near normal, whereas 3 patients (4.6%) graded recovery as abnormal according to IKDC score. The abnormal group included 2 patients with superficial infection and one with FFD (Table 4).

Post-operative outcome- LGS scoring (Lysholm Gillquist scoring)

93.7% of the patients reported outcome as excellent and good with scores above 90 and 84-90 respectively

according to LGS scale. 3 patients (4.61%) scored >65 and <83 and were grouped as fair outcome (Table 4).

Post-operative outcome: SQ (subjective questionnaire)

At the regular follow up and at the end of 6 months, 73.8% patients graded their recovery as very satisfied and the remaining 26.2% were satisfied with the outcome (Table 4).

Table 4: Postoperative outcome.

	Frequency	Percent (%)
IKDC scoring		
Normal	47	72.30
Near normal	15	23.07
Abnormal	3	4.60
LGS scoring (Lysholm Gillquist scoring)		
Excellent	42	64.61
Good	20	30.76
Fair	3	4.61
Poor	0	0
SQ (subjective questionnaire)		
Very satisfied	48	73.80
Satisfied	17	26.20
Not satisfied	0	0.00

Single leg hop test

Limb symmetry index was calculated by the percentage of affected limb over the normal limb. The preoperative index had a mean of 46.11. Post operatively the index improved to a mean of 80.005 (Table 5).

Table 5: Single leg hop test.

Limb symmetry index	Minimum	Maximum	Mean
Preoperative	27.77	57.77	46.112
Postoperative	61.66	98.94	80.0005

Tegner activity scale

All the patients showed a significant improvement in their postoperative tegner scores pre-operative scores were between 2 and 4 whereas postoperative the scores were between 5 and 8 (Table 6).

Physiotherapy compliance

83% of the patients were complaint with the post-operative rehabilitation protocol. The percentage was higher initially but with the improvement in the daily life activities, the patients gradually decreased their physiotherapy intensity and thus the final non compliancy was 17%.

Table 6: Tegner activity scale.

Tegner	2	3	4	5	6	7	8
Pre op	2	33	30				
Post op				1	31	31	2

Return to pre injury level of activity

90.76% of the patients were able to return to their pre injury activity including competitive sports. 6 patients (9.23%) were not satisfied with physiotherapy regimen and these patients were noncompliant to the protocol.

Statistical analysis

Overall the functional and clinical outcome following ACL reconstruction using quadrupled hamstring graft was studied by comparing the pre-operative and post-operative scores of Lysholm, Tegner activity scale, KT arthrometer and limb symmetry indices (Tables 7 and 8).

Lysholm score

The mean Lysholm score preoperatively was 70.78

whereas post operatively there was significant improvement with a mean value of 90.78.

Tegner activity scale

The mean score preoperatively was found to be 3.43 whereas post operatively the mean score obtained was 6.52 which was also statistically significant

KT 1000 arthrometer

Clinically, instability testing with KT 1000 arthrometer showed a mean preoperative score of 6.46 which decreased significantly to 1.54 following surgery.

Limb symmetry indices

As calculated from the hop test the mean limb symmetry index preoperatively was found to be 46.112 whereas postoperatively. The score improved to 80.0005. The p<0.001.

Thus postoperatively, the average scores of both subjective and measurements showed a significant improvement, implying a good outcome.

Table 7: Paired samples statistics (N =65).

Pair	Mean	Std deviation	Std error mean
Lysholm pre op	70.78	1.256	0.189
Lysholm post op	90.78	2.870	0.356
Tegner pre op	3.43	0.558	0.069
Tegner post op	6.52	0.589	0.073
KT 1000 pre op	6.46	0.502	0.062
KT 1000 post op	1.549	0.2107	0.0261
LSI pre op	46.112	6.2150	0.7709
LSI post op	80.005	9.44393	1.17138

Table 8: Paired samples test.

	Paired differences							Sig. (2 tailed)
	Mean	Std deviation	Std error mean	95% confidence interval of the difference		t	df	
				Lower	Upper			
Pair 1 Lysholm Pre op- Lysholm Post op	-20.000	3.187	0.395	-20.790	-19.210	-50.596	64	0.000*
Pair 1 Tegner Pre op- Tegner Post op	-3.092	.824	0.102	-3.296	-2.888	-30.259	64	0.000*
Pair 1 KT 1000 Pre op- KT 1000 Post op	4.9123	0.5583	0.0693	4.7740	5.0507	70.935	64	0.000*
Pair 1 LSI Pre op- LSI Post op	-33.88900	9.53219	1.18232	-36.25096	-31.52704	-28.663	64	0.000*

*p<0.001

DISCUSSION

Anterior cruciate ligament (ACL) ruptures left untreated lead to subsequent knee disability, which can be severe with potentially devastating long term consequences. Although there are many potential graft choices from which to choose for ACL reconstruction, hamstring autografts have over the past decade increasingly become more popular. Several studies have shown that multiple-strand hamstring tendon ACL reconstructions have higher strength, stiffness, and cross-sectional area compared with patellar tendon grafts.

Harvest of hamstring tendon autografts also yields fewer donors site morbidity than harvest of patellar bone-tendon- bone grafts and carries no risk of patellar fracture, however remote. New techniques focus on optimizing graft strength and stiffness.

Successful ACL reconstruction using hamstring autograft requires stable initial graft fixation and, ultimately, graft-to- bone healing. Hamstring reconstruction using femoral tightrope fixation has been shown to have excellent initial mechanical properties, including pullout strength. Tibial hybrid fixation with bio-interference screws provides excellent soft tissue to bone fixation.

Ristanis et al. showed that abnormal tibial rotation occurring while descending stairs and pivoting later confirming that traditional placement of hamstring graft would not restore normal knee joint mechanics.^{7,8}

Tashman et al. showed similar finding when investigating running in an ACL reconstructed knee.⁹ Combination of abnormal knee kinematics, clinical studies indicate a significant proportion of patients exhibiting poor clinical rotational stability and study showing a relationship between ACL injury reconstruction and development of arthritis suggested further investigation was required to reestablish normal knee joint kinematics and hopefully a more optimal physiological knee joint environment.

To improve single bundle ACL reconstruction Kato et al compared the effect of different tunnel positions for single bundle ACL reconstruction on knee biomechanics. According to their study the anatomical tunnel position is superior to non-anatomical tunnel position and that mid bundle position is the most well balanced of anatomical position.¹⁰

In our study 110 patients underwent ACL reconstruction using quadrupled hamstrings tendon autograft during the study period in MIOT Hospitals. All patients underwent graft fixation using tightrope in the femoral tunnel and bio-interference screws in the tibial tunnel. Of these 110 patients, 70 patients who had an isolated ACL tear were chosen and invited for follow up examinations. 5 patients were lost on follow up. Thus, the total number of patients in the study was limited to sixty five. 54 (83.07%) were male patients and 11 female patients (16.92%), all aged between 15 and 50 years of age. The side of injury was distributed accordingly. 47 patients (72.3%) had injured their left knee while 18 patients (27%) injured their right knee. A statistical trend towards a better outcome in all the scoring systems was seen. Arthroscopic anatomical ACL reconstruction was done by the same surgeon as an in-patient procedure in all patients under spinal anaesthesia.

Fareed et al reported the results of a retrospective study on patients who underwent arthroscopic ACL reconstruction.¹¹ The purpose of their study was to evaluate their initial experience with this procedure.. All patients underwent the same rehabilitative program. Patients were evaluated using the IKDC ligament evaluation system. The average follow up was 25.4 months.

Similarly Button K and others, in 2005, evaluated the outcome of ACL reconstruction with semitendinosus tendon autograft with same rehabilitation protocol in 48 patients at 20 months.¹² The results of these studies were compared to our study (Table 9).

Table 9: Comparison of no. of participants and IKDC values with previous studies.

	Fareed et al (2003) ¹¹	Button et al (2005) ¹²	Present study
Number of patients	25	48	65
Average follow up	25.4 weeks	20 weeks	24 weeks
IKDC			
Normal	12 (48%)	26 (54%)	47 (72.3%)
Near Normal	12 (48%)	18 (38%)	15 (23.07%)
Abnormal	01 (4%)	04 (8%)	03 (4.6%)

In their study, a satisfactory outcome was seen in 96% & 92% respectively while it was 95.4% in our study. In the LGS system 42 patients (64.61%) had an excellent outcome while 20 patients (30.76%) had good and 3 patients (4.61%) had a fair outcome. Quite similarly, 48 patients (73.8%) were very satisfied as per the subjective questionnaire and 17 patients (26.2%) were satisfied. No

patient was dissatisfied. This was probably due to the fact that most of the patients were keen on normal day to day activities than return to sports. 59 patients (90.76%) were able to return to the pre- injury activity level.

All patients performed the hop test in the postoperative four to six months period. The mean limb symmetry

index of the single hop test was 80.0005%. Statistically the hop test was more of a trend with regards to IKDC and LGS, whereas it was significant with SQ.

Reid et al in March 2007, published their results of a series of hop tests on 42 patients, 15–45 years of age who had undergone ACL reconstruction.¹³

The mean limb symmetry index in above study was calculated at the 22nd postoperative week against at 24th postoperative week in our study. The mean values of above study were all above 85%. In our study the mean value is around 80%. This could be due to some patients; especially the ones with a poorer outcome had much lower limb symmetry indices which was skewing the mean to the lower side. Moreover, many patients were quite apprehensive in performing the hop test, thereby

increasing the disparity between the normal and the operated limb scores.

Time period elapsed between the injury and the ACL reconstruction ranged from 1 1/2 months to 2 1/2 years with a mean value of 6.6 months. The duration of surgery ranged from 95 minutes to 140 minutes with a mean of 109.5 minutes. 8 patients (12.30%) had pain at the graft donor site. Four patients (6.15%) had numbness around the graft donor site which gradually resolved completely. 7 patients (10.76%) had laxity of up to grade 1. In spite of this, Lachman test was hard end and it is the reason for the success of the surgery.

Two patients (6.67%) had superficial skin infection resulting in delayed wound healing and thus resulting in decreased post-operative scores.

Table 10: Comparison of our results with Andrea reid et al and Gulick et al studies.

	Andrea reid et al. study, 2007 ¹³	Gulick TD Study, 2002 ¹⁴	Present study
Number of patients	42	57	65
Average age	26 years	27 years	28 years
Rehabilitation protocol	4–6 months	4–6 months	4–6 months
Hop test- mean	88.2±9.5 (63.8–103.2)	-	80.005±3.65 (61.66–
Limb symmetry	At 22 weeks	-	98.94) at 24 weeks
Return to prior level of function	-	84%	90.76%

Gulick and others in 2002 studied on 57 patients and concluded that 84% of their patients returned to pre injury level of function.¹⁴ In our study 90.76% patients returned to their previous level of function with 63% of the patients compliant with the physiotherapy regimen (Table 10).

CONCLUSION

Anterior cruciate ligament reconstruction has gone through an evolutionary process over the last century. Initial anatomical reconstruction gave way to non-anatomical reconstruction. However over the past decade anatomical reconstruction has enjoyed resurgence in popularity.

Anatomical and bio mechanical studies provide compelling evidence that anatomical insertion site restoration is the future of ACL reconstruction. However more comparative clinical studies with greater number of patients and a long term follow up are awaited to a certain whether anatomical single bundle reconstruction will provide any clinical benefit over conventional techniques.

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