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Functional outcome of arthroscopic anterior cruciate ligament reconstruction using semitendinosus autograft – A prospective study

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Abstract

Introduction: Anterior cruciate ligament is most commonly injured ligament around the knee, Arthroscopic reconstruction of the Anterior cruciate ligament has many advantages over the open arthrotomy method. Autografts such as Semitendinosus and Bone Patellar tendon graft were commonly used for reconstruction.

Materials and Methods: A prospective study was done from 2013 to 2015 to analyze the post-operative outcome of Arthroscopic Anterior cruciate ligament reconstruction with Semitendinosus autograft.

Results: This study comprised of 25 patients and followed for minimum of 6 months. Success rate is 100 %, with 92% graded as excellent to good and rest 8 % with fair functional results.

Conclusion: We conclude that Anterior Cruciate Ligament reconstruction with quadrupled semitendinosus graft has good functional results and high success rate.

Keywords: Anterior cruciate ligament, Arthroscopic reconstruction, Semitendinosus tendon graft

Introduction

Anterior Cruciate Ligament (ACL) injury is the most commonly injured ligament around the knee [1]. The modern high speed vehicular accident and sporting life style has led to increased ligament injuries of the knee.

Earlier open arthrotomy and reconstruction of the Anterior Cruciate Ligament was done. However excessive soft tissue dissection led to complications like increased post-operative pain, infection, knee stiffness and prolonged duration of rehabilitation. In 1954, the development of successful arthroscope brought new possibilities to the field of knee surgery. From then Anterior Cruciate Ligament reconstruction has often been done arthroscopically [2].

Reconstruction of the Anterior Cruciate Ligament was done with a donor autograft (patellar tendon, hamstring tendon or quadriceps tendon) and allograft (Achilles, patellar tendon, hamstring tendon or tibialis anterior tendons), attempts have been made using synthetic graft, Silver wire, Fascia lata, and Iliotibial band [3]. To date more than 400 different techniques have been described for Anterior Cruciate Ligament Reconstruction from open to arthroscopic technique [4]. The bone patellar tendon bone is the most commonly used graft in Anterior Cruciate Ligament reconstruction.

The present study is designed to analyze the postoperative outcome of arthroscopic Anterior Cruciate Ligament reconstruction with quadrupled semitendinosus tendon auto graft fixed in femoral tunnel and in the tibial tunnel using interference screws.

Aims and objectives of study

1. To study the functional outcome of arthroscopic Anterior Cruciate Ligament reconstruction using semitendinosus autograft.
2. To continue the clinical study with a follow-up up to six months to evaluate improvement and record the same.

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Methodology

This was a prospective study of 25 consecutive patients who underwent arthroscopic anterior cruciate ligament (ACL) reconstruction using quadrupled semitendinosus tendon autograft during the study period, 2013 to July 2015.

Inclusion criteria

All skeletally mature patients with anterior cruciate ligament tear confirmed by Lachman test with concomitant meniscal injury that required repair were included in the study, provided that they were permitted to undergo rehabilitation after Anterior Cruciate Ligament reconstruction involving full weight – bearing gait and unrestricted non weight bearing range of motion.

Exclusion criteria

1. Patients with Anterior Cruciate(ACL) Ligament avulsion injury.
2. Anterior cruciate ligament tear with Concomitant posterior cruciate ligament, collateral ligament injuries requiring surgery or posterolateral corner injury.
3. Anterior cruciate ligament tear associated with the bony injury around the knee.
4. Patients undergoing revision anterior cruciate ligament reconstruction.

Assessment of Results: was done by using international Knee documentation knee score & single hop test.

Observations and results

Table 1: age distribution

Age in years	No. of patients	Percentage
15-25	12	48%
26-35	7	28%
36-45	6	24%
Total	25	100%

The basic population of this study comprised of all 25 patients who underwent Anterior Cruciate Ligament reconstruction with Mean of 29 yrs. The youngest patient was 19yrs and the oldest patient was 45 years old.

Table 2: nature of injury

Nature of Injury	No. Of patients	Percentage
Road Traffic Accident	12	48%
Fall	7	28%
Sport	6	24%
Total	25	100%

Most common nature of the injury causing Anterior Cruciate Ligament tears were road traffic accidents (48%). Next common cause was Fall (28%), while doing daily activities like slip and fall while climbing down stairs.6 patients (24%) injured their Anterior Cruciate Ligament while playing sports.

Table 3: presenting symptoms

Symptoms	Pain	Swelling	Locking	Giving away
Present	15	15	11	25
Absent	10	10	14	0
Percentage	60%	60%	44%	100%

All patients presented with complaints of giving way of the knee. 15 (60%) patients presented with complaint of pain and swelling. 11 patients (44%) gave history of locking of knee which was correlated with associated injuries in the knee.

Table 4: delay in surgery (acl reconstruction)

Delay in surgery(in months)	No. Of patients	Percentage
2-4 months	8	32%
4-6 months	4	16%
6-12 months	9	36%
More than 12 months	4	16%
Total	25	100%

In our study the time period elapsed between the injury and the Anterior Cruciate Ligament reconstruction ranged from 2 months to 2 years with a mean value of 6.8 months.

Table 5: frequency of associated injuries on mri

Mri associated injuries	No. Of patients	Percentage
Medial meniscus(mm)	10	40%
Lateral meniscus(lm)	3	12%
Lm +mm	1	4%
Medial collateral ligament(mcl)	1	4%
Negative	10	40%
Total	25	100%

Medial meniscal tear was the commonest associated injury in 10 patients (40%) and Lateral meniscus detected in 3 patients, medial collateral injury in 1 patient. There was no lateral collateral ligament and Posterior Cruciate Ligament injury.

Table 6: clinical evaluations in outpatient department

Clinical test	No. Of patients	
	Positive	Negative
Anterior drawer test	25(100%)	0(0%)
Lachman test	24(96%)	1(04%)
Pivot shift test	18(72%)	07(28%)

Anterior Drawer test was found to be 100% positive, with majority of them in grade 3. Lachman test was positive in 96% of patient. pivot shift test was found to be positive in 18 patients (72%) by evaluation under Outpatient department.

Table 7: results of associated injuries on arthroscopy

Arthroscope associated injuries	No. of patients	Percentage
Lateral meniscus(lm)	3	12%
Medial meniscus(mm)	9	36%
Negative	13	52%
Total	25	100%

Diagnostic arthroscopy prior to Anterior Cruciate Ligament reconstruction confirms the medial meniscal tear in 9 cases and 3 cases lateral meniscal tear. There was no Posterior Cruciate Ligament injury in our study.

Table 8: results of clinical evaluation of laxity under anesthesia

Clinical test	No. Of patients	
	Positive	Negative
Anterior drawer test	25(100%)	0(100%)
Lachman test	25(100%)	0(100%)
Pivot shift test	23(92%)	2(08%)

Lachman test was found to be 100% positive, with grade 3 in 92% and grade 2 in 8%, Anterior drawer test was 100% positive with grade 3 in all patients pivot shift test was found to be positive in 23 patients(92%) by evaluation under anesthesia.

Table 9: post-operative lysholm and gillquist score

Lysholm gillquist score	No. Of patients	Percentage
Excellent	14	56%
Good	9	36%
Fair	2	8%
Total	25	100%

56% of the patients reported outcome as excellent with scores above 95 and 36% of patient reported good with scores above 84-94 according to LGS scale. 2 patients (8%) scored >65 &<83 and were grouped as fair outcome.

Table 11: preoperative & postoperative mean limb symmetry indices.

Limb symmetry index(lsi)	Mean	No. Of patient	Std. Deviation	Std. Error mean	P valve
Pre operative	45.468	25	9.6771	1.9354	0.00
Post operative	80.916	25	8.1714	1.6343	

Paired T- test between Limb Symmetry Index score preoperative score and LSI score post operative showed that significant correlation with p valve less than 0.05 and mean LSI Pre op score was 45.468 with improved mean LSI post op of 80.916 after Anterior Cruciate Ligament reconstruction

Table 12: post operative anterior drawer test.

Post op anterior drawer test	No. Of patients	Percentage
Negative	17	68%
Grade 1	8	32%
Total	25	100%

Majority of the patients (68%) were having no laxity at the end of 6 months, rest of the patients (32%) have grade 1 laxity with hard end point

Table 13: post-operative pivot shift test

Post op pivot shift test	No. Of patients	Percentage
Negative	23	92%
Positive	2	8%
Total	25	100%

Table 16: comparison of single hop test with lgs and ikdc score

Comparison of single hop test with LGS and IKDC score		No. of patient	Mean hop test	Std. Deviation	Minimum	Maximum	P VALUE
LGS	Excellent	14	83.321	5.2812	75.5	93.2	0.042
	Good	9	79.944	10.229	62.7	93.1	
	Fair	2	68.45	1.6263	67.3	69.6	
IKDC	Normal	17	82.129	5.5054	75.2	93.2	0.072
	N-normal	6	81.633	12.458	62.7	93.1	
	Abnormal	2	68.45	1.6263	67.3	69.6	

On Comparison of single hop test with LGS and IKDC score, found to have statistical correlation with LGS Score with p value less than 0.05.

Discussion

Anterior cruciate ligament (ACL) ruptures left untreated lead to knee instability, which can lead to potentially devastating long term consequences. The advantages of arthroscopically assisted Anterior Cruciate Ligament reconstruction are that

Table 10: post-operative international knee documentation knee score (ikdc)

International knee documentation score(ikdc)	No. Of patients	Percentage
Normal	17	68%
Near normal	6	24%
Abnormal	2	8%
Total	25	100%

92% of the patients graded their post-operative recovery as normal and near normal whereas 2 patients (8%) graded recovery as abnormal according to IKDC score. The abnormal group included two patients; one had superficial infection and the other with abnormal Limb Symmetrical Index score and decreased Range OfMotion. Both of them are incompetent to physiotherapy and had low LGS score

Post op pivot’s test was positive in 2 patients post operatively but majority of the patient had negative pivot.

Table 14: return to pre injury level of activity

Return to pre injury level	No. Of patients	Percentage
Yes	21	84%
No	4	16%
Total	25	100%

84% of the patients were able to return to their pre injury activity including farming and to competitive sports.

Table 15: comparisons of international knee documentation score (ikdc) and lysholm gillquist score (LGS)

Comparison of ikdc and lgs scores		Lgs		
		Excellent	Good	Fair
Ikdc	Normal	14	3	0
	Near normal	0	6	0
	Abnormal	0	0	2

there is negligible injury to the synovial membrane of the knee joint and it can achieve better results than accomplished by open operative technique.

Although there are many potential graft choices from which to choose for Anterior Cruciate Ligament reconstruction, Hamstring autograft have become more popular, from the last decade. The advantages of Hamstring autograft include it is easier to harvest and donor site morbidity is less when compared to Bone-Pateller Tendon-Bone graft [5].

Several studies have shown that multiple-strand hamstring tendon Anterior Cruciate Ligament reconstructions have higher strength, stiffness, and cross-sectional area compared with patellar tendon grafts, and additionally, the extensor mechanism is preserved and intact and no post operative knee pain. In a long term follow-up study^[6], by Mohtadi in 2011 concluded that hamstrings autograft was found to have better International Knee Documentation, less knee pain, and better leg hop test compared to Bone-Tendon-Bone autograft. This study found no difference in range of motion, KT-1000 arthometric measurement, or pivot test examination. Harvest of hamstring tendon autograft also yields less donor site morbidity than harvest of patellar bone- tendon- bone grafts and carries no risk of patellar fracture^[7], however remote.

In our study we used small medial incision over proximal tibia to obtain semitendinosus graft and same incision was extended to drill tibial tunnel. Quadrupled graft was prepared from obtained graft.

Earlier technical factors, specifically the absence of adequate fixation techniques, initially limited the use of hamstring grafts for Anterior Cruciate Ligament reconstruction. New techniques are developed which focus on optimizing graft strength and stiffness. Successful Anterior Cruciate Ligament reconstruction using hamstring autograft requires stable initial graft fixation and ultimately graft to bone healing. Hamstring reconstruction using interference screw has been shown to have excellent initial mechanical properties, including pullout strength. Extra-articular soft tissue graft fixation constructs have been accused of allowing motion of the tendons and the access of synovial fluid within the bone tunnel, both of which may impair graft healing and ultimately result in increased knee laxity^[8]. In contrast the resulting, short graft fixation construct in interference fixation has been shown to increase anterior knee stability.

In the present study 24 male and 1 female patients underwent Anterior Cruciate Ligament reconstruction using quadrupled semitendinosus tendon autograft during the study period. All patients underwent graft fixation using interference screw in the femoral tunnel and in the tibial tunnel. None of our patient had graft laceration or failure of fixation during rehabilitation. All patients underwent "anatomical" single bundle Anterior Cruciate Ligament reconstruction using semitendinosus or gracilis tendon, these included visualization of the native Anterior Cruciate Ligament, insertion sites, placing the tunnels in the footprint, knee flexion angle during femoral tunnel drilling, use of an accessory anteromedial portal for femoral tunnel. Gavriilidis *et al.*^[9] 2008 in their cadaveric study found that drilling through accessory anteromedial portal found to have accurate anatomic femoral positioning of the Anterior Cruciate Ligament attachment when compared with transtibial technique. Single Bundle Anterior Cruciate Ligament graft placed at the centre of the native Anterior Cruciate Ligament attachment sites is more effective at controlling anterior tibial translation and the pivot shift phenomena, and more closely reproduces normal knee kinematics, whereas in isometric non-anatomical tunnel placement resulted in the combination of a posterior tibial tunnel position and a high, deep femoral tunnel position often produced a vertical Anterior Cruciate Ligament graft^[10, 11].

Biomechanical studies have demonstrated that a vertical Anterior Cruciate Ligament graft may resist anterior tibial translation, but often fails to resist the combined motions of anterior tibial translation and internal tibial rotation which occur during the pivot-shift phenomenon. Hong-Chul Lim *et al.*^[12] and several meta-analysis in their study concluded that

Anatomical single bundle Anterior Cruciate Ligament reconstruction restored the initial stability closer to the native Anterior Cruciate Ligament under combined anterior and internal rotational forces when compared to non-anatomical Anterior Cruciate Ligament single bundle reconstruction. Data summarized from the results of five panels on anatomic Anterior Cruciate Ligament reconstruction found that most popular graft choice among surgeons for primary Anterior Cruciate Ligament reconstructions is hamstring tendon autograft, there was unanimous support among surgeons for the use of "anatomic" reconstructions using bony and soft tissue remnant Landmarks^[13].

In our study the time period elapsed between the injury and the Anterior Cruciate Ligament reconstruction ranged from 2 months to 2 years with a mean value of 6.8 months. It comes under delayed reconstruction and patients were kept on early mobilization protocol, which was supported by Zhu *et al.*^[14] Zhu *et al.*^[14] had concluded that early rehabilitation in Moderate manner is better than accelerated procedure. In our study the surgery patients were kept under rehabilitation, patients were followed according to Wilk *et al.* rehabilitation protocol for 6 months during immediate post operative and follow up period, it was observed that adherence to physiotherapy gradually waned in most of the patients, as observed in other studies.

Lysholm and Gillquist subjective score First published in 1982^[15]. It was revised in 1985 and again in 2001. The revised scale includes 8 items: 1) limp, 2) support, 3) locking, 4) instability, 5) pain, 6) swelling, 7) stair climbing, and 8) squatting with maximum score of 100. In the present study 56% of the patients reported outcome as excellent with scores above 95 and 36% of patient reported good with scores above 84-94 according to LGS scale. 2 patients (8%) scored >65 & <83 and were grouped as fair outcome.

In the present study 92% of the patients graded their post operative recovery as normal and near normal whereas 2 patients (8%) graded recovery as abnormal according to International Knee Documentation Committee knee score. In the abnormal group one patient had superficial wound infection which was controlled with oral antibiotics and had low post-op limb symmetry index and the other patient presented to surgery after one and half year after initial injury and had low post-op limb symmetry index. Both of the patients were in compliant to physiotherapy and have fair outcome on Lysholm and Gillquist scale.

The single-legged hop test to the anterior cruciate ligament reconstructed knee is specifically related to knee muscle strength recovery and residual anterior laxity^[16]. All patients performed the hop test in the postoperative upto six months period. The mean limb symmetry index of the single hop test was 80.916. These values gradually reduced when the outcome became poorer on the two scoring systems. Statistically the hop test was much more significant with Lysholm and Gillquist Score with P value <0.05.

Andrea Reid *et al.* published results of a series of hop tests on 42 patients, 15-45 years of age who had undergone anterior cruciate ligament reconstruction^[17]. The mean limb symmetry index in above study was calculated at the 23rd 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 81%. This could be due to some patients, especially the ones with a poor outcome had much lower limb symmetry indices values which skewed 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. In 2013, Lao ML^[19] and Chen *et al* reported the results of a comparative study on patients who underwent arthroscopic anterior cruciate ligament reconstruction with single and double bundle reconstruction with hamstring tendon retrospectively. In their study 26 underwent single bundle anterior cruciate ligament reconstruction and were available for follow up. All patients underwent the same rehabilitative program. Patients were evaluated using the International Knee Documentation, ligament evaluation system, Lysholm and Gillquist score, Tegner activity score and radiological feature. The average follow up was 25.4 months. Lao ML *et al.*, found patient who underwent single bundle Anterior Cruciate Ligament reconstruction found to have good International Knee Documentation score in 96.3% patients and grade I laxity of less than 5mm in 13% and moderate laxity between 5-10mm in 2 patients (9%). None of the patient had post op positive pivot's test. As compared to our study 92% patients have normal to near normal International Knee Documentation score and grade I laxity in 32% patient and none of patient had moderate laxity, post-op pivot positive in 8% (2 patients).

Finally Lao ML *et al.*, found no difference in International Knee Documentation score, Lysholm and Gillquist score, TEGNER activity score and radiological feature when compared with double bundle reconstruction. However none of patient with double bundle reconstruction had moderate laxity.

Similarly Button K and others, in 2005, evaluated the outcome of Anterior Cruciate Ligament reconstruction with semitendinosus tendon auto graft with same rehabilitation protocol in 48 patients at 20 months.

In their study, a satisfactory outcome was seen in 92% according to International Knee documentation score while it was same in our study. In the Lysholm Gillquist Score system 56.67% (17 patients) had an excellent outcome while 36.67% (11 patients) had a good and 06.67% (2 patients) had a fair outcome. In Our study 56 % (14 patients) of them reported outcome as excellent, 36 % (9 patients) of them reported good and 8% (2 patients) reported as fair according to Lysholm and Gillquist scale. 92% of the patients graded their post operative recovery as normal and near normal whereas 2 patients (8%) graded recovery as abnormal according to International Knee Documentation score. 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. Our study is comparable with both studies discussed above.

Post-operative laxity for Anterior Cruciate Ligament reconstruction was evaluated with manual lachman test and pivot shift test. One of the primary goals of Anterior Cruciate Ligament reconstruction is to restore knee laxity and provide the patient with a stable knee without giving-way episodes to promote long-term knee health. In our study 68% of the patients have negative anterior laxity and 32% of the patients have grade 1 laxity with hard end point. The most important evaluation of this Study is that Anterior Cruciate Ligament reconstruction displayed no increase in anterior laxity over time at the 6 months follow-up. In the literature, long-term follow-ups of Antero-posterior laxity over time after Anterior Cruciate Ligament reconstruction are rare however Recently, Bourke *et al.*^[20] reported the outcome after Anterior Cruciate Ligament reconstruction using HS autografts at a 15-year follow-up, there was no associated increased Antero-posterior laxity after 15 years postoperatively.

The pivot-shift test is a clinical dynamic knee laxity test

which evaluates a combination of translational and rotatory stability. Evaluation of post-op pivot's test is a essential part of our study. In the present study pre-operatively under anesthesia 92% of the patient had positive pivot's test which was reduced to 8% post operatively which was significant improvement seen when compared with the preoperative values. Hussein *et al.*^[21] reported that the anatomic Double Bundle technique was superior to the anatomic Single Bundle techniques and significant differences were found in terms of pivot-shift test and Range Of Motion. But meta-analysis comparing Double Bundle with Single Bundle reconstruction was performed by Meredick *et al.*^[22] Their meta-analysis included 4 Randomized Controlled Trails and revealed no difference in terms of the pivot-shift test. In the present study pivot shift test is negative in 92% cases at last follow-up.

In the present study 84% of the patients were able to return to the pre-injury activity level. Majority of the subjects in our study are occasional sports players and farmers, none of them are aggressive athletic players. Most of the subjects were able to do activities in daily living without difficulty and able to participate in occasional sports. Gulick TD and others in 2002 studied on 57 patients and concluded that 84% of their patients returned to pre injury level of function. However, reconstructive knee surgery is not a guarantee that all subjects will return to their pre-injury level of function. A recent meta-analysis including 48 studies showed that, 82% of participants had returned to some kind of athletic activity but only 63% returned to their pre-injury level of participation. The reasons why some athletes have been unsuccessful in returning to previous levels of activity are vast. The importance of psychological factors has recently been emphasized, kinesiophobia, or fear of reinjury, may play a significant role in some patients' inability to successfully return to their previous level of sports. Clare L. Ardern *et al.*^[23] 2015, concluded that Lower fear of re-injury, greater psychological readiness to return to sport and a more positive subjective assessment of knee function like International Knee Documentation score Lysholm Gilquist score favored return to the preinjury level after surgery in the meta-analysis.

Conclusion

In our study we have conducted Anterior Cruciate Ligament reconstruction in 25 cases and followed up for minimum of 6 months in all cases. Success rate is 100 %, with 92% graded as excellent to good and rest 8 % with fair functional results.

We conclude that Anterior Cruciate Ligament reconstruction with quadrupled semitendinosus graft has good functional results and high success rate. Our sample group is small study is for short term and there is need for long term studies with more number of patients in sample and randomized controlled studies to further establish this.

Conflict of interests

The authors declare no conflicts of interest.

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