International Journal of Research in Orthopaedics
Veeragandham P et al. Int J Res Orthop. 2017 May;3(3):423-430
http://www.ijoro.org

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20171006

Functional outcome following arthroscopic ACL reconstruction using semitendinosus graft: a prospective observational study

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Received: 01 March 2017
Accepted: 14 March 2017

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ABSTRACT

Background: Anterior cruciate ligament (ACL) injuries remain a common orthopaedic disease, particularly in young adults. The treatment of choice for ACL injuries is ACL reconstruction (ligamentoplasty). The present study was conducted to observe and evaluate the outcome results of arthroscopic ACL reconstruction by hamstring grafts using Endobutton-CL technique for femoral fixation and Bioabsorbable Intrafix Screw technique for tibial fixation in ACL injury.
Methods: This prospective comparative observational study related data were captured between January 2014 to December 2015 in a tertiary care teaching hospital, Haldia. About 36 patients with arthroscopic anatomic ACL reconstruction using hamstring tendon graft were evaluated and followed up for functional outcome. Patients were evaluated for pain, functioning and stability of knee using validated knee scoring systems which included tegner activity scale and IKDC score.
Results: Out of 36 patients 31 patients (86.11%) were male and 5 patients (13.88%) were females. About 25 patients (69.44%) had right sided ACL injury and remaining 11 patients (30.55%) had left sided ACL injury. The mean of the pre-op IKDC scoring was 42.45 with SD of 9.68 and the mean of the post-operative IKDC scoring was 81.87 with SD of 13.40, so improvement was statistically significant.
Conclusions: The technique of arthroscopic ACL reconstruction offers an excellent knee function, knee stability and restoration of preoperative functional status with minimal complications.

Keywords: Anterior cruciate ligament injuries, Arthroscopy, Anterior cruciate ligament reconstruction, Semitendinosus - gracilis graft, Tegner activity scale, International knee documentation score, Outcome

INTRODUCTION

Anterior cruciate ligament (ACL) is the major internal stabilizing ligament of the knee and its injury generates major instability. ACL injuries occur more frequently as a result of sports injuries caused by brutal deceleration movements (sudden stop, pivoting, sudden change of direction, jumping). In some cases, the patient can resume his/her activity and several hours later a major local edema appears with joint effusion caused by massive hemarthrosis.[1]

ACL injuries remain a common orthopaedic disease, particularly in young adults. The treatment of choice for ACL injuries is ACL reconstruction (ligamento-plasty). ACL reconstruction is the surgical intervention used to replace the damaged ACL with a bone-patella tendon-bone (BTB) graft or with soft parts (semitendinosus – gracilis muscles (ST-G) – a method more frequently used nowadays).[1] Arthroscopic anterior cruciate ligament reconstruction has remained a treatment of choice for anterior cruciate ligament deficient knees, since majority of non-operative procedures have resulted in functionally unacceptable outcomes.[2] The incidence of

ACL deficient knees due to trauma is reported as 1 in 3,500 people, resulting in 95,000 new ACL ruptures per year in few studies.[3-5] The ACL is the weaker of the two cruciate ligaments and therefore may be it get torn easier than the posterior cruciate ligament.[6]

The most common mechanism is that of a sudden pivoting or cutting maneuver during sporting activity, which is commonly seen in football, basketball & soccer. The ligament can also tear due to work injuries or automobile accidents. Recent studies have contributed substantially to our understanding of anterior cruciate ligament anatomy and have revealed that common techniques for anterior cruciate ligament reconstruction may fail to replicate native ligament origins or insertions.[7-13]

METHODS

This prospective comparative observational study was approved by the ethics committee of the hospital. Informed consent of each patient was obtained. Study related data were captured between January 2014 to December 2015 in a tertiary care teaching hospital, Haldia. All the cases presented with anterior cruciate ligament injury attended orthopedic OPD and emergency department were treated with arthroscopic anatomic ACL reconstruction using hamstring tendon graft were evaluated and followed up for functional outcome. About 68 patients underwent the ACL reconstruction surgery from January 2014 to December 2015, out of which 36 patients were followed up and evaluated in the present prospective, observational study.

Inclusion criteria

Patients operated for ACL reconstruction surgery, both the genders above 18 years were included, patients and/or his/her legally acceptable representative willing to provide voluntary written informed consent for participation in the study.

Exclusion criteria

Immature skeleton, H/O previous operation on either knee, H/O concurrent fracture, other co-exiting significant injuries: posterior cruciate ligament, lateral collateral ligament etc, patients and/or his/her legally acceptable representative willing not to provide voluntary written informed consent for participation in the study.

Approach

The patient's clinical history and examination findings were recorded prospectively in a case record form. Detailed clinical and radiological examination was carried out. The clinical assessment involved detailed history, clinical examination, and neurological examination. The patients were asked for duration of symptoms, mode of initial treatment taken and limitation of activities of daily living. Written and oral consent was taken from the patient explaining clearly to the patient in their own language the procedure, risks and proposed benefits. Follow up of the patient is done for 6 months postoperatively. All the patients who were diagnosed clinically and radiologically with ACL tear and all who gave the consent were included in the study. Knee examination like Lachman test, pivot test, McMurray test, Varus valgus stress test etc were done.[14-16] X-ray of the knee joint was taken pre & post-op. Routine laboratory investigation like Hb, BT, CT, and urine complete examination was done. Tegner activity scale and IKDC scale scoring was noted pre & post-operatively.[17] All patients were enrolled to undergo primary arthroscopically assisted ACL reconstruction.[18]

The Lachman test is the most sensitive and the pivot shift the most specific test for the diagnosis of ACL rupture.[19] The Lachman test has become recognized as the most reliable noninvasive clinical method for determining the integrity of the anterior cruciate ligament. The original description provided for the test being reported as either positive or negative. The purpose of this study is to present a clinical grading system for positive examinations. The criteria are as follows: Grade I, proprioceptive appreciation of a positive test; Grade II, visible anterior translation of the tibia; Grade III, passive subluxation of the tibia with the patient supine; Grade IV, ability of the patient with a cruciate-deficient knee to actively sublux the proximal tibia.[19]

The McMurray's test was designed to detect tears in the posterior segment of the meniscus. It is performed by placing the knee beyond 90° of flexion and then rotating the tibia on the femur into full internal rotation to test the lateral meniscus, or full external rotation to test the medial meniscus. The same maneuvers are performed in gradually increasing degrees of knee flexion to progressively load more posterior segments of the menisci. No valgus or varus stress is applied. During the maneuver, the joint line is palpated both medially and laterally. A positive test is considered to be a thud or click that can sometimes be heard but can always be felt.[15]

Instruments and implants

Arthroscopic portal cannulas with obturators, 30º arthroscope. fiber-optic light, irrigation system, arthroscopic burr and shaver, arthroscopic grasper, arthroscopic scissors, guide wires and reamers, tendon harvesting stripper, endobutton, interference screw and digital radiography. Diagnostic arthroscopy was done using standard medial and lateral parapatellar portals. Diagnosis was confirmed.

Surgical procedure

Intravenous antibiotics were started one hour before the incision. All cases have been done under spinal

anesthesia with tourniquet control in supine position with knee flexed to 90^{o} hanging in leg holder at the edge of the OT table.

Steps of the procedure

A high anterolateral portal was made to avoid the highest part of the fat pad and for better 'look down' view of the tibial attachment site of ACL easily. Establishing the AM portal at the correct height above the medial joint line is extremely important to the success of the procedure.

Hamstring tendon graft harvation

A 2.5-3 cm skin incision was made over the pes anserine starting 1 cm medial to the tibial tubercle and heading postero-medial, starting 5 cm below the joint line. The subcutaneous fat was incised and stripped off the pes with a sponge. The superior border of the pes was identified with finger, the gracilis tendon was identified by rolling it with finger and fascia was then incised between gracilis and semitendinosus tendon. Through this incision the gracilis tendon was scooped out using Lahey's forcep. The tendons were palpated and the sartorius fascia was incised parallel to the fibers of the fascia just above the thicker and more distally inserted hamstring tendons. After the vinculae had been cut under visual control, the distal end of tendons is cut and graft is harvested with a semi-blunt, circular closed tendon stripper. The total length obtained was usually 25 cm for semitendinosus and 20 cm for gracilis tendon.

Hamstring tendon graft preparation

The tendon was prepared for quadruple graft, depending on the length of the tendon, 7 cm being the minimum accepted length for the final graft. No.2 Ethibond suture was used for preparation of proximal and distal ends of the graft by whip stitch method. Two No. 5 non absorbable Ethibond sutures were used as the lead sutures at the distal and proximal ends. The thickness of the graft is measured using a sizer.

Under arthroscopic vision the meniscal tear or cartilaginous lesion if present was first tackled by either partial menisectomy or debridment of cartilaginous lesions.

Femoral tunnel preparation

A torn ACL was usually visualized as failing to extend to its normal femoral attachment (empty lateral wall sign). Maximal possible knee flexion of the knee with the leg holder on was achieved. One assistant was used to maintain the knee flexion position while drilling the femoral tunnel. Femoral offset guide was introduced into the joint through the tibial tunnel and engaged into "over the top" position with the knee in 90° flexion. The guide was aimed at 1:30 o'clock position in the left knee and 10:30 o'clock in the right knee. The femoral aimer of appropriate offset (radius of the graft diameter+ 3) was used to avoid posterior cortex blowout. The beath pin was drilled through the aimer until it exited at the anterolateral aspect of the thigh which was held by a hemostat. Femoral tunnel was prepared with calibrated, cannulated reamers to the desired length and diameter of the graft.

Tibial tunnel preparation

The acufex tibial guide was introduced into the joint through the antero-medial portal after setting the inclination of the jig at 50-550. The aimer was placed on the centre of the tibial foot print which lies about 7 mm anterior to the PCL in the midpoint and just medial to the posterior edge of the anterior horn of lateral meniscus. The sleeve was inserted into the guide up to the tibial cortex (through the incision used for graft harvesting) at about 2 cm medial to the tibial tubercle and 4 cm below the joint line. A guide pin was drilled into the joint through the sleeve. The tunnel was then reamed with a cannulated headed reamer placed over the guide pin, starting from 8 mm size up to the size determined by graft sizer.

Graft placement and fixation

The graft was prepared with appropriate sized endo-button loop. Through the 'beath' pin one ethibond was pssed from tibial tunnel to femoral tunnel. The 'beath' pin was withdrawn from the femoral side by gentle pulling. The thick string of the endobutton was pulled and button was flipped at lateral cotex of the femur. An appropriate bio-absorbable interference screw was used to fix the graft at the tibial site in extension while giving the posterior drawer.

Closure

The sartorial fascia and subcutaneous tissue was stitched with an interrupted 2.0 vicryl suture and skin was closed with interrupted silk sutures. The portal sites were usually left open for drainage. No drains were used. A sterile dressing was applied. After applying a pressure bandage, tourniquet deflated and tourniquet time noted. Knee was subsequently placed in a brace locked in extension. The wound was closed in layer, tourniquet removed and compression bandage, knee brace was applied. Distal pulses were assessed.

Postoperative care

Patient was given intravenous antibiotics for 2 days. Postoperative knee elevation and ice compresses were used for 24 hrs. Wound inspection was done on 2nd and 10th day. Sutures were removed on 10th-12th day. Long knee brace was applied to all cases during the immediate post-operative period and was continued till 6 weeks post op. Post-operative X– rays of the operated knees were taken.

The clinical data was collected and examined as per the guidelines given in the International Knee Documentation Committee (IKDC) knee form 2000 and Tegner Activity Score. Patients were followed up for 6 months and functional outcome of the patients will be checked with IKDC scoring and Tegner Activity Score.[17,18] The Subjective 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.[18]

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.[18]

The objective IKDC scale has total 7 domains related to the knee, reflecting both impairment and disability.[18] The worst grading for first 3 key domains – presence of effusion, knee range of motion and ligament stability– determines the eventual IKDC grade. Patients are graded in 4 different grades – A, B, C and D – normal, nearly normal, abnormal and severely abnormal respectively. The worst group grade determines the final evaluation for acute and sub-acute patients. For chronic patients compare preoperative and postoperative evaluations.

RESULTS

This prospective study of ACL reconstruction using four fold hamstring auto graft was conducted in the Department of Orthopaedics in a tertiary care teaching hospital, Haldia. About 68 patients underwent the ACL reconstruction surgery from February 2014 to December 2015, out of which 36 patients were followed up and evaluated. Out of 36 patients 31 patients (86.11%) were male and 5 patients (13.88%) were females. About 25 patients (69.44%) had right sided ACL injury and remaining 11 patients (30.55%) had left sided ACL injury as shown in Table 1. If we compare the patients on the basis of the mode of injury, 19 patients (52.77%) had RTA, 10 patients (27.77%) had sports injury and 07 patients (19.44%) had other mode of injury like fall from ladder or slip as shown in Table 1. On comparing the patients according to the associated injury 25 (69.44%) patients had isolated ACL injury, 8 (22.22%) patients had ACL+MCL injury and 03 (8.33%) patients had ACL+PCL injury as shown in Table 1. The average age of ACL injuries patients was 38.68 years (SD 10.23) as shown in Table 1.

Most of the patients i.e. 24 (66.6%) were in the age group of 20-30 years. Age of patients ranged from 18 to 48 years with mean age of 38.68 years as shown in Table 1.

Majority of the patients were reported as male i.e. 31 (86.11%) cases and 5 (13.88%) cases were females. The ratio of right knee to left knee involved in ACL injury was 2.27:1. In 25 (69.44%) cases right knee was involved and in 11 (30.55%) cases left knee was involved. There were no bilateral cases in the study. Isolated ACL injury was observed in 25 (69.44%). Remaining cases it was associated with either MCL injury (22.22%) or PCL (8.33%) as shown in Table 1. About 19 (69.44%) cases of ACL injury were due to road side accidents which was followed by 10 (27.77%) cases were due to Sports injury and another 07 (19.44%) cases were due to slipping on floor/missing stairs etc. The pivoting stress that is a twisting force over the knee where the body rotates and pivots on a firmly fixed foot placed on ground, was found to be the most common cause of ACL rupture.

Table 1: Demographic and clinical characteristics of the ACL injury patients [n=36].

Characteristics	N (%) or mean±SD
Male	31 (86.11%)
Female	05 (13.88%)
M:F ratio	6.2:1
Age (years)	38.68 ± 10.23
Rt. sided ACL injury	25 (69.44%)
Lt. sided ACL injury	11 (30.55%)
Rt. Sided: Lt. Sided	2.27:1
Mode of injury	
RTA	19 (52.77%)
Sports injury	10 (27.77%)
Others	07 (19.44%)
Types of injury	
Isolated ACL injury	25 (69.44%)
ACL+MCL injury	08 (22.22%)
ACL+PCL injury	03 (8.33%)

Table 2: Injury-surgery interval for ACL reconstruction surgery [n=36].

S. No.	Time in months	No. of patients	Percentage
1	0-2	16	44.44
2	2-4	09	25
3	4-6	07	19.44
4	6-12	03	8.33
5	>12	01	2.77
	Total	36	100

Most of the patients presented for surgery within 6 months of injury 32 (88.88%) as shown in Table 2. Only very few cases repaired after 12 months 01 [2.77%]. Interestingly, patients who underwent reconstruction between 2 and 4 weeks from injury and underwent an accelerated rehabilitation program had a decreased incidence of arthrofibrosis as compared to those who underwent a conventional rehabilitation program.

Majority of the patients 27 (75%) cases presented with a feeling of giving way of the knee during routine work and guarded walking with pain with or without locking while 09 (25%) cases had the feeling of giving way only during sporting activity/heavy labor usually with pain with or without locking as shown in Table 3.

Table 3: Presenting complaints of the study participants [n=36].

Sr. No.	Presenting complaints	No. of patients	Percentage
1	Giving way, guarded walking and pain during normal work with locking	19	52.77
2	Giving way, guarded walking and pain during normal work without locking	08	22.22
3	Giving way and pain during sporting activities/heavy labor with locking	05	13.88
4	Giving way and pain during sporting activities/heavy labor without locking	04	11.11
	Total	36	100

We assessed functional outcome of the patients through pre-operative and post-operative IKDC scoring. The mean of the pre-op IKDC scoring was 42.45 with SD of 9.68 and the mean of the post-operative IKDC scoring was 81.87 with SD of 13.40 as shown in Table 4. We analyzed the data through SPSS software and applied paired t test. The P value came out to be 0.0001 which is highly statistically significant.

Table 4: Comparison of pre and postoperative result of validated knee scoring systems [n=36].

Validated Knee Scoring Systems	Preoperative (Mean ± SD)	Postoperative (Mean ± SD)	p value
IKDC Score	42.45±9.68	81.87±13.40	0.0001

In present study of evaluation of patients with ACL injury, majority 23 (63.88%) of cases were in group C (abnormal), followed by 09 (25%) in group B (severe abnormal) and 04 (11.11%) cases were in group D (near abnormal) as shown in Table 5.

Twenty seven (74.99%) cases reported their knees as normal or nearly normal after ACL reconstruction as shown in Table 7. About 07 (19.44%) cases described their knee as abnormal and 02 (5.55%) cases described his knee as severely abnormal.

Table 5: Preoperative objective IKDC knee ligament standard evaluation form of patients with ACL injury [n=36].

Sr. No.	IKDC grade	No. of patients	Percentage
1	Group A (normal)	0	0
2	Group B (Nearly normal)	04	11.11
3	Group C (Abnormal)	23	63.88
4	Group D (Severe abnormal)	09	25
	Total	36	100

Table 6: Preoperative objective IKDC grade of patients with ACL injury [n=36].

Sr. No.	IKDC grade	No. of patients	Percentage
1	Group A (normal)	0	0
2	Group B (Nearly normal)	04	11.11
3	Group C (Abnormal)	23	63.88
4	Group D (Severe abnormal)	09	25
	Total	36	100

Table 7: Objective IKDC grade after ACL reconstruction [n=36].

Sr. No.	IKDC grade	No. of patients	Percentage
1	Group A (normal)	17	47.22
2	Group B (Nearly normal)	10	27.77
3	Group C (Abnormal)	07	19.44
4	Group D (Severe abnormal)	02	5.55
	Total	36	100

Table 8: Tegner activity before injury and after ACL reconstruction.

	Range	Mean
Tegner activity before injury	5-9	7.3
Tegner activity after operation	3-8	6.4

Table 9: Postoperative range of motion after ACL reconstruction.

	No Flexion Contracture	Flexion Contracture Present
Full Flexion Possible	26 (72.22%)	02 (5.55%)
Full Flexion Not Possible	06 (16.66%)	02 (5.55%)

Almost 26 (72.22%) patients regained almost full range of motion (no flexion contracture i.e. full extension and full flexion). About 04 (11.11%) case had both restriction of flexion and extension as shown in Table 9.

DISCUSSION

Development in arthroscopic techniques and improvement in technology and research have allowed anterior cruciate reconstruction to become one of the most successful surgical techniques in sports medicine.[20,21] Injury to the anterior cruciate ligament (ACL) is the most common ligamentous injury, ranging up to 200,000 injuries per year in the United States.[22] Sports such as soccer, football, and skiing have been reported to be high-risk sports and individuals who participate in these sports are 10 times more likely to rupture the ACL when compared to other sport activities.[23]

Even though reconstruction is the most common treatment for ACL rupture, there remains debate in the literature regarding the optimal timing of surgery.[24]

Smith et al concluded from their systematic review that there were no differences in clinical outcomes between early (less than 3 weeks) and delayed (greater than 6 weeks) ACL reconstruction (ACLR); however, their conclusion is based on present literature that has limitations, such as non-randomization and lack of appropriate blinding.[25] Mayr et al studied the effect of timing as well as preoperative knee status on ACLR outcomes.[26] The authors documented the irritability of the knee before surgery (i.e. swelling, effusion, hyperthermia), ROM, and additional injuries. Timing of surgical intervention may only be one factor that should be considered when determining optimal timing of surgery. The decision of when to undergo ACLR is likely multifactorial and may include factors such as pre-operative status of the knee, family, school or work obligations, as well as mental preparation. More research is needed in order to identify a multifactorial objective algorithm that could be used to assist the surgeon and patient in determining when surgical interventions should occur in order to yield optimal clinical results.[26, 27]

The two most commonly used autografts for intra-articular reconstruction of ACL are the central one third of patellar tendon and combined semitendinosus and gracilis tendon.[28,29] We used four fold hamstring graft (semi-tendinosus plus gracilis) in this study to reconstruct the torn ACL using transfix/endobutton and bioscrew for graft fixation on femoral and tibial side respectively.

In the present study age of patients ranged from 18 to 42 years with mean age of 38.68 years which may slightly higher than with the mean age (27 years) of Specchiulli et al, Jomha et al (26 years) and Siebold et al mean age (29 years).[30-32] This may be because of small sample size in the present study.

The observations clearly demonstrate that majority of ACL tear occur during sports injuries. In the present study the subjective IKDC score is 88.87 points which is in accordance with the 90 points of Siebold et al using Hamstring autograft and Endobutton and 85 and 82 points of Aglietti et al using double strand hamstirng autograft.[32,33] In the present study 74.99% cases of ACL tear reported their knees as normal or near normal (group A & B) after reconstruction which is in accordance with the 94% of Jomha et al at 5 years follow up using either hamstring or BPTB graft, and 92% of Siebold et al using Endobutton.[31,32]

CONCLUSION

The present study was done to evaluate the clinical & functional outcome of arthroscopic reconstruction using semitendinosus autograft in patients with ACL tear. Standard arthroscopic technique was used for ACL reconstruction. Twenty seven (74.99%) cases reported their knees as normal or nearly normal after ACL reconstruction. About 07 (19.44%) cases described their knee as abnormal and 02 (5.55%) cases described his knee as severely abnormal. The mean Tegner activity before injury and after operation at most recent follow up was 7.3 (5-9 range) and 6.4 (3-8) respectively. The mean of the pre-op IKDC scoring was 42.45 with SD of 9.68 and the mean of the post-operative IKDC scoring was 81.87 with SD of 13.40. Arthroscopic reconstruction of ACL tear using four fold hamstring auto graft fixed with transfix/endobutton and bioscrew is a reliable, effective and reproducible technique. The earlier the ACL is repaired the better is the functional outcome because delay in surgery can cause secondary meniscal and cartilage damage leading to poorer functional outcome. Knee pain and difficulty in regaining full range of movement were the main complications. This study concludes that the reconstruction of ACL with hamstring autograft fixed with transfixes/endobutton and bioscrew technique is reasonably safe with less complications and good functional outcome. The accurate placement of graft in the tunnel and preparation of graft are important to obtain optimal results. Further studies with reference to long term follow up; radiological parameters including MRI, relevant subjective scores, and double-blind prospective trials comparing the effectiveness of different methods of graft fixation are however required to provide more clarity on the use of femoral fixation systems.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. Cirstoiu C, Circota G, Panaitescu C, Niculaita R. The Advantage of Arthroscopic Anterior Cruciate Ligament Reconstruction with Autograft from the Tendons of the Semitendinosus – Gracilis Muscles for the Recovery of the Stability of the Knee. Mædica. 2011;6(2):109-13.
2. Fu FH, Bennet CH, Latterman C, Ma CB. Current trends in anterior cruciate ligament reconstruction. Part 1: Biology and biomechanics of reconstruction. Current concepts. Am J Sports Med. 1999;27(6):821-30.
3. Lyman S, Koulouvaris P, Sherman S, Do H, Mandl LA, Marx RG. Epidemiology of anterior cruciate ligament reconstruction: trends, readmissions, and subsequent knee surgery. J Bone Joint Surg Am. 2009;91(10):2321-8.
4. Frank CB, Jackson DW. Current concepts review. J Bone Joint Surg Am. 1998;79(10);1556-75.
5. Shervegar S, Nagaraj P, Grover A, Niranthara Ganesh DJ N, Abdul Ravoof A. Functional outcome following arthroscopic ACL reconstruction with rigid fix: A retrospective observational study. Arch Bone Jt Surg. 2015;3(4):264-8.
6. Moore KL. The Knee Joint In: Clinically oriented anatomy. 2nd ed. Williams & Wilkins. 1985;523-41.
7. Colombet P, Robinson J, Christel P, Franceschi JP, Djian P, Bellier G, et al. Morphology of anterior cruciate ligament attachments for anatomic reconstruction: a cadaveric dissection and radiographic study. Arthroscopy. 2006;22:984-92.
8. Ferretti M, Ekdahl M, Shen W, Fu FH. Osseous landmarks of the femoral at tachment of the anterior cruciate ligament: an anatomic study. Arthroscopy. 2007;11:1218-25.
9. Purnell ML, Larson AI, Clancy W. Anterior cruciate ligament insertions on the tibia and femur and their relationships to critical bony landmarks using high-resolution volume-rendering computed tomography. Am J Sports Med. 2008;36:2083-90.
10. Siebold R, Ellert T, Metz S, Metz J. Tibial insertions of the anteromedial and posterolateral bundles of the anterior cruciate ligament: morphometry, arthroscopic landmarks, and orientation model for bone tunnel placement. Arthroscopy 2008;24:154-61.
11. Siebold R, Ellert T, Metz S, Metz J. Femoral insertions of the anteromedial and posterolateral bundles of the anterior cruciate ligament: morphometry and arthroscopic orientation models for double-bundle bone tunnel placement—a cadaver study. Arthroscopy. 2008;24:585-92.
12. Takahashi M, Doi M, Abe M, Suzuki D, Nagano A. Anatomical study of the femoral and tibial insertions of the anteromedial and posterolateral bundles of human anterior cruciate ligament. Am J Sports Med. 2006;34:787-92.
13. Tantuway V, Mustafa Johar SA, Patel V, Nagla A, Gupta R, Bhambani P. Assessment of foot print of femoral tunnel placement with commercially available off set guide in arthroscopic ACL reconstruction. Int J Res Orthop. 2017;3:43-9.
14. Prins M. The Lachman test is the most sensitive and the pivot shift the most specific test for the diagnosis of ACL rupture. Aust J Physiother. 2006;52(1):66.
15. Hing W, White S, Reid D, Marshall R. Validity of the McMurray's Test and Modified Versions of the Test: A Systematic Literature Review. The Journal of Manual & Manipulative Therapy. 2009;17(1):22-35.
16. Miller RH III, Azar FM. Knee injuries. In: Canala ST, Beaty JH, editors. Campbell's Operative Orthopaedics. 11th ed. Philadelphia: Mosby Elsevier; 2008: 2395-2575.
17. Tegner Y, Lysolm JL. Rating systems in the evaluation of knee ligament injuries. Cin Orthop Rel Res. 1985;198:43-9.
18. 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 & Res. 2011;63(11):208-28.
19. Gurtler RA, Stine R, Torg JS. Lachman test revisited. Contemp Orthop. 1990;20(2):145-54.
20. Frank CB, Jackson DW. Current concepts review. The science of reconstruction of the anterior cruciate ligament. Bone Joint Surg Am 1997; 79:1556-76.
21. Robindro P, Latchumi NVK, Kanthimathi BD. To study the functional outcome of arthroscopic ACL reconstruction using hamstring graft fixed with endobutton for femur and interference screw and suture post for tibial fixation. Int J Med Dent Sci. 2016;5(1):978-83.
22. Centers for Disease Control & Prevention, National Center for Health Statistics. National hospital discharge survey: annual summary, 1996 [monograph on the Atlanta, GA: Centers for Disease Control and Prevention; 1996.
23. Dragoo JL, Bruan HJ, Durham JL, Chen MR, Harris AHS. Incidence and risk factors for injuries to the anterior cruciate ligament in National Collegiate Athletic Association football: data from 2004-2005 through 2008-2009 national collegiate athletic

association injury surveillance system. Am J Sports Med. 2012;40(5):990-5.
24. Bottoni CR, Liddell TR, Trainor TJ, Freccero DM, Lindell KK. Postoperative range of motion following anterior cruciate ligament reconstruction using autograft hamstrings. A Prospective, Randomized Clinical Trial of Early Versus Delayed Reconstructions. Am J Sports Med. 2008;36(4):656-62.
25. Smith TO, Davies L, Hing CB. Early versus delayed surgery for anterior cruciate ligament reconstruction: a systematic review and metaanalysis. Knee Surg Sports Traumatol Arthrosc. 2010;18:304-11.
26. Mayr HO, Weig TG, Plitz W. Arthrofi brosis following ACL reconstruction- reasons and outcomes. Arch Orthop Trauma Surg. 2004;124:518-22.
27. Evans S, Shaginaw J, Bartolozzi A. ACL reconstruction - it's all about timing. Int J Sports Phys Ther. 2014;9(2):268-73.
28. Amiel D, Kleiner JB, Akeson WH. The natural history of the anterior cruciate ligament autograft of patellar tendon origin. Am J Sports Med. 1986;14:449-62.
29. Johnson RJ, Beynnon BD, Nichols CE, Renstrom PA. Current concepts review: the treatment of injuries of the anterior cruciate ligament. J Bone Joint Surg (Am). 1992;74:140-51.
30. Specchiuli F, Laforgia, Mocci, Miotta Scialpi, Solaring. Anterior cruciate ligament reconstruction: A comparison of 2 techniques. Clin Orthop. 1995;311:142-7.
31. Jomha NM, Pinczewski LA, Clingelffer AJ, Otto DD. Arthroscopic reconstruction of the anterior cruciate ligament with pateller-tendon autograft and interference screw fixation. J Bone Joint Surg Br. 1999;81:775-9.
32. Siebold R, Dehler C, Ellert T. Prospective randomized comparison of double-bundle versus single bundle anterior cruciate ligament reconstruction. J Arth Related Surg. 2008;24:137-45.
33. Aglietti P, Giron F, Buzzi R, Biddau F, Sasso F. Anterior cruciate ligament reconstruction: bone–patellar tendon–bone compared with double semitendinosus and gracilis tendon grafts. J Bone Joint Surg Am. 2004;86:2143–55.

Cite this article as: Veeragandham P, Raghavan V, Chattopadhyay A, Banerjee U, Kothari S. Functional outcome following arthroscopic ACL reconstruction using semitendinosus graft: a prospective observational study. Int J Res Orthop 2017;3:423-30.