CASE SERIES

A prospective evaluation of clinical and functional outcome of single bundle anatomic anterior cruciate ligament reconstruction with hamstrings autograft

Saeed Ahmed Shaikh[1], Naveed Ahmed[2], Salman Adil[3], Allah Rakhio Jamali[4]

Abstract

A case series was conducted at the Department of Orthopaedic surgery, Jinnah Postgraduate Medical Centre, Karachi, from July 2016 to June 2018, to evaluate the functional and clinical outcome of arthroscopic anatomic anterior cruciate ligament (ACL) reconstruction with hamstrings autograft. Patients aged 17 years and above with anterior cruciate ligament (ACL) injuries of duration three months or older, diagnosed on history and clinical examination and confirmed on Magnetic Resonance Imaging were prospectively recruited from outpatient department. Patients with multiligamentous injury were excluded. Information on patient's demographics such as age, duration of injury and mechanism of injury were recorded. In addition, graft length and diameter, associated injuries of lateral or medical menisci were noted peroperatively. Patients were followed for a minimum of 12 months. The functional outcomes were assessed through lysholm knee score, and Tegner activity scale. Clinical outcome was assessed with loss of motion in flexion and extension and residual laxity using Lachman test. Paired sample t-test was applied to compare mean scores pre and post-operatively.

The study findings reveal that arthroscopic anatomic Anterior Cruciate Ligament reconstruction using quadruple strand hamstring tendon autograft was an effective method of treatment for the ACL-deficient knee with improved clinical and functional status

Keywords: Anterior cruciate ligament reconstruction, arthroscopic, Hamstring tendon autograft.

DOI: https://doi.org/10.47391/JPMA.678

Introduction

The anterior cruciate ligament (ACL) is one of the most common ligament injured in the knee which requires surgical intervention.[1] ACL injuries frequently occur in athletes involved in multidirectional sports activities such as basketball and soccer because ACL is the main anterior stabiliser of the knee and prevents rotational valgus forces.[2]

[1,4]Department of Orthopedic Surgery, Jinnah Postgraduate Medical Centre, Karachi, Pakistan; [2]Aga Khan University Hospital, Karachi, Pakistan; [3]Baqai Medical University, Karachi, Pakistan.

Correspondence: Saeed Ahmed Shaikh. e-mail: drsashaikh2003@yahoo.com

When the ligament is ruptured, the injury can cause anterior and rotational laxity of the proximal tibia in relation to distal femur.[3] Patients with ACL injuries have greater risk of developing premature osteoarthritis, increased pain related to injury, lost productivity and instability of knee joint.[1]

Globally, an estimated prevalence of 0.24 to 0.34 ACL injuries per 1,000 population per year have been reported in literature;[3] however, the exact prevalence in our part of the world is not yet defined. ACL injuries mostly require reconstructive surgery and many months of rehabilitation. Approximately 300,000 reconstruction surgeries are performed annually on patients with ACL injuries to maximise the participation of an individual in activities of daily life and vocation like sports.[4] Young adults, who actively participate in contact sports as well as non-contact sports activities which require manoeuvres such as cutting and pivoting, are at high risk of ACL injuries.[3]

While, the frequency of ACL reconstructions performed each year has increased, there still remain marked differences in surgeon's preference for ligament graft choice.[3,5,6] Common techniques include bone-patellar tendon-bone (BPTB) autografts, quadruple strand semitendinosus and gracilis hamstring (HT) autografts, quadriceps tendon autografts with or without bone plug, and allografts.[7-9] Of these, most commonly used are bone-patellar tendon-bone (BPTB) autografts, quadruple strand semitendinosus and gracilis hamstring (HT) autografts.[10]

About two decades ago, the gold standard method and choice of graft for ACL reconstruction was non-anatomic single-bundle technique using bone-patellar tendon-bone graft which has the advantage of bone to bone healing.[11] However, several reports suggested that as many as 10–20% of patients experienced persistence of pain and rotational instability even after the surgery.[12] Interest in anatomic ACL reconstruction grew because of its higher potential to restore knee kinematics and improved knee stability, particularly anterior translation of the tibia and rotational stability (pivot shift).[12-15]

In recent times, quadruple strand hamstring (HT) autograft has gained popularity and has become the graft of choice for ACL reconstruction.[16,17] It has many advantages over bone-patellar tendon-bone graft (BPTB), such as decreased donor site morbidity, reduced anterior knee pain, smaller

skin incision, no loss of extension and less scarring.[18] The mechanical and tensile strength of four strand hamstring graft has been found to be even better than native ACL.[19]

Arthroscopic technique has revolutionised the ACL reconstruction. It has the benefits of smaller incisions, little damage to the joint tissues, better visualisation of the field for tunnel preparation, reduced pain after surgery, less joint stiffness, faster recovery and rehabilitation.[20] However, it requires skills and expensive equipment which are seldom available in low-resource settings.

A previous study, published at national level ,assessed the use of hamstring autograft technique for ACL reconstruction by open technique with short-term follow up of six months.[21] The study mainly focused on clinical parameters such as stability and range of motion. However, the minimum time required to regain normal function and clinical stability after ACL reconstruction is one year.[22] In addition, the advantages of arthroscopic ACL reconstruction are manifold.[20] Therefore, the purpose of this study was to evaluate the results of arthroscopic anatomic reconstruction of chronic ACL injury using the hamstrings as a free autogenous graft in terms of clinical stability and functional outcome.

Patients and Methods

This case series was conducted on patients who presented to Jinnah Postgraduate Medical Centre (JPMC) with anterior cruciate ligament (ACL) injuries of three months or older duration, diagnosed clinically and confirmed on Magnetic Resonance Imaging (MRI). Participants were recruited prospectively in a consecutive manner from July 2016 to June 2017 from outpatient department of orthopaedic surgery, JPMC, Karachi.

Patients with multiligamentous injury were excluded. Information on patients' demographics such as age, duration of injury and mechanism of injury were recorded. In addition, graft length and diameter, associated injuries of lateral or medical menisci were noted peroperatively. The patients were followed-up for a minimum period of 12 months. Functional outcomes were assessed through Lysholm knee score and Tegner activity scale.[23] Clinical outcomes were assessed by measuring the loss of motion (LOM) in flexion and extension, and residual laxity in terms of anteroposterior translation which is categorised according to International Knee Documentation Committee (IKDC) scores as normal, nearly normal, abnormal and severely abnormal.[24]

Data was entered in a de-identified manner and protected with password and only the research team had access to it. Data was entered and analysed using SPSS software version 19. Results were expressed in mean±SD, frequencies and proportions. Paired sample t-test was applied to compare mean score in pre-operative and post-operative conditions. A *p*-value of <0.005 was considered to be of statistical significance.

Approval to conduct the study was obtained from the JPMC ethics review committee (ERC). Informed consent was obtained from the participants and were given a unique identification number to maintain confidentiality and no personal identifiers were noted.

Surgical Procedure

The procedure was performed under general or regional anaesthesia, and a tourniquet was applied. A diagnostic arthroscopy was performed to confirm the ACL rupture, and the stumps of the ACL were debrided. The gracilis and semitendinosus tendon grafts were then harvested through a longitudinal incision 2 to 3 cm medial to the tibial tuberosity.

An arthroscopically assisted, double-loop semitendinosus and gracilis hamstring autologous ACL reconstruction was performed on each knee. The two grafts were double-looped and secured with sutures at either end, using button with looped suture at the proximal end. The combined cross-section of the four strands was measured by passing the graft through hollow cylindrical sizers. Anteromedial portal was used for femoral tunnel placement. The tibial landmark for graft placement was just posterior to the site of the remnant of the ACL. The femoral tunnel was drilled just anterior to the posterior cortex in the intercondylar notch at either the 11 o'clock or the one o'clock position for the right and left knees, respectively, leaving a 1 mm to 2 mm posterior wall. The graft was secured in the femoral tunnel with either a button with a looped suture (titanium) or bioabsorbable interference screw and in the tibial tunnel with a bioabsorbable interference screw. Graft impingement was assessed arthroscopically in full extension.

Post-operatively, all patients were placed in a splint in full extension for two weeks and allowed to bear weight as tolerated. Early range of movement exercises were commenced in bed on the first post-operative day

All patients had early patellar mobilisation (manually-assisted vertical and horizontal patella movement in bed for six weeks, and at two months were allowed to progress to gentle exercises.

Postoperative Assessment and evaluation

Postoperative reviews were performed at 1.5, 3, 6 and 12 months. The patients were assessed clinically by performing Range of Movement (ROM) measured

manually using a goniometer graded in degrees. ROM was classified in flexion as normal (0-5), nearly normal (6-15), abnormal (16-25) and severely abnormal >25) and extension normal (<3), nearly normal (3-5), abnormal (6-10), and severely abnormal (>10) according to The International Knee Documentation Committee (IKDC Questionnaire) IKDC knee scoring system.[24] Loss of motion(LOM) more than 25º in flexion and more than 10º in extension compared to the non-injured knee was classified as LOM.[24] Residual laxity in terms of anteroposterior translation of both knees was examined using Lachmann Test and the data were reported according to IKDC score as normal (0-2mm), near normal (3-5mm), abnormal (6-10mm) and severely abnormal (>10mm).[24]

Patients answered two sets of Lysholm score and tegner activity scale questionnaires (pre- and post-operatively) to assess the functional outcome and were also asked to subjectively classify the outcome of the ACL reconstruction as excellent (91-100), good (84-90, fair (65-83) and poor (<64). Thus, the Lysholm score, tegner activity level scale, anteriorposterior translation of the injured knee relative to the normal knee and loss of motion in flexion and extension were considered as the outcome measures.

Results

Mean age of the patients was 23.7±4.5years. Injury to right and left knees were almost equally distributed (n=29, 53.7% versus n=25, 46.3%).Mean time interval since the patients sustained injury to surgery was 9.8 ± 4.0 months. All included patients were male and the most common cause of injury was road traffic accident(n=38, 70.4%) followed by sports (n=12, 22.2%) and domestic injuries in (n=4, 7.4%) patients. In majority of the patients the associated injury was medial meniscus (n= 23, 42.6%), while 29.6 %(n= 16) had no injury. However, patients with associated injury of lateral meniscus and combined lateral and medial meniscus were equally distributed (n=8, 14.8% versus n=7, 13%). With regards to the method of fixation on the femoral side, aperture fixation with bioabsorbable screw in 14 (25.9%) patients and suspensory fixation method with looped button in 40 (74.1%) patients was used. However, on the tibial side, aperture fixation with screw was used in all patients (n=54). Size 8mm diameter was the most common in 15 (27.8%) cases. The mean graft diameter was 8.35±1.03mm with minimum seven and maximum 10mm.(Table 1)

Mean preoperative Lysholm score was 34.5 ± 10.8 (p-value <0.005) which improved to 90.7 ± 9.1 (p-value <0.005) after surgery at the last follow up. Average pre injury Tegner activity scale was 6.2±1.1, which improved from post injury scale of 2.3 ± 0.8 (p-value <0.005) to 5.6 ± 1.0 (p-value <0.005) post-surgery as depicted in table 2. Out of 54 patients, 36 had lysholm score of 91 or more (excellent), 12 had score between 84-90, while the remaining six patients had score of less than 83 which were categorised as either fair or poor. Outcome of the patients with relation to age is mentioned in Table 3.

Average loss of range of motion in flexion and extension of 3.52+5.0350 and 1.85+2.7290 was observed respectively. Lack of motion in extension of 50 was found in 7 (13%) patients whereas maximum lack of motion in extension was 10 degrees (IKDC grade C-abnormal) found in3 (5.6%) cases. Rest of the patients regained normal extension. Maximum loss of flexion of 200(IKDC grade C, abnormal)

Table-1: Demographic characteristic of patients.

variables	n (%)
Sex	
Male	54 (100)
Age categories (years)	
17-22	26 (48.1)
23-28	18 (33.3)
29-33	10 (18.5)
Time from injury to surgery categories	
3-8 months	23 (42.6)
9-12 months	19 (35.2)
13-18 months	12 (22.2)
Mechanism of Injury	
Road Traffic Injuries (RTI)	38 (70.4)
Sports	12 (22.2)
Domestic Injuries	4 (7.5)
Meniscal Lesion Type	
Isolated Lateral	8 (14.8)
Isolated Medial	23 (42.6)
Both Medial & Lateral	7 (13)
None	16 (29.5)

Table-2: Clinical and Functional outcomes.

Activity Scales	Mean Score Difference			*p*- value
	Pre-injury	Preoperative	Post-operative	
Functional outcome				
Tegner	6.2 ± 1.1	2.3 ± 0.8	5.6 ± 1.0	<0.005
Lysholm	100 ±0	34.5 ± 10.8	90.7 ± 9.1	<0.005
Clinical outcome				
Loss of Motion	n	Mean		
Loss of motion in extension	54	1.85±2.72		
Loss of motion in flexion	54	3.52±5.03		
Anteroposterior translation	54	2.69±2.39		

Table-3: Functional outcome scores with relation to age.

Functional outcome	Mean age
Excellent	32.22 ± 4.5
Good	24.92 ± 4.9
Fair	24.80 ± 4.45
Poor	22.00 ± 0.00

was found in 2 (3.7%) patients;1 (1.9%) patient had loss of flexion of 150 whereas in the remaining patients normal to near normal flexion was observed.(table 2)

Residual laxity after surgery was assessed in terms of AP translation which was considered significant at greater than 100 according to IKDC criteria. Mean residual laxity was found 2.69+2.394mm. Residual laxity of more than 5mm was found in five patients with only one patient having laxity of 10mm. All other patients had residual laxity of <5mm. (Table 2). Out of 12 patients with sports injury, 10 regained their previous activity level whereas two patients changed their lifestyle due to fear of re-injury.

Discussion

ACL reconstruction using quadruple strand hamstring autograft has been studied vastly in recent times and the procedure has gained popularity due to less postoperative morbidities and faster rehabilitation.[25] In our study we found excellent results (lysholm score >91) in 36(66.67%) patients, good in 12 (22.22%) patients (lysholm score 84-90) and fair or poor results in six (11.11%) patients (lysholm score <83) using single bundle quadrupled strand hamstring autograft as shown in figure 1.The referencing for this grading system was done according to Mitsou A et al.[26] On the basis of the results of our study, majority of patients, (n= 48, 88.9%) with mean score of 90, achieved satisfactory outcomes under the category of good and excellent. A recent prospective study on 97 patients with primary ACL reconstruction with quadruple strand hamstring autograft showed a mean lysholm score of 90.8±9.3 and tegner scale of 6.6±2.0 at two years of postoperative follow up comparable to our results.[27]

It has been observed in literature that the graft size and age of the patient plays an important role in recovery after ACL reconstruction.[28] With every 1mm decrease in the graft size there are almost 50% chances of graft failure.[29] Mean diameter of the graft in our study was 8.35±1.03mm. All these patients had excellent outcome except one patient with graft size of 8mm. The non-compliance could have been due to other factors like young age which also affects outcome of ACL reconstruction. Magnussen et al in 2012 concluded that lower graft diameter less than 8mm and age less than 20 are important predictors; the rates of revision ACL reconstruction were higher in these cases.[30] There was a reduction in average range of motion in both flexion and extension compared to the normal side in our series which may be attributed to the severity of injury and non-compliance of the patients. However, none of our patients had extension deficit of more than 100 (IKDC grade D-severely abnormal), supported by a prospective single centre study published in 2016 where none of the patients had IKDC Grade C or D extension deficit.[31] Similarly, flexion loss of 200 was found in only two (3.7%) cases (IKDC grade C-abnormal), while there was no patient in grade D of IKDC scoring.

Although various studies aim to retain the residual laxity of ACL reconstruction with quadruple strand hamstring ranging from less than 3mm to 5mm.[31] Our aim was to retain the residual laxity of 5mm or less according to IKDC criteria. According to IKDC scoring system AP translation of more than 5mm is considered abnormal (grade-C) which was present in five (9.4%) cases only.[24] However, mean residual laxity in our study was 2.69±2.39.

The study found that the final results of anterior cruciate ligament (ACL) reconstruction with arthroscopy using hamstrings graft were satisfactory in most of the patients. Rehabilitation after ACL reconstruction is hugely emphasised for better recovery by achieving early motion, prevention of joint stiffness and development of neuromuscular control.[32] However, many patients in the study had minimal to moderate quadriceps muscle wasting because of failure to follow rehabilitation regimen after surgery. This can be due to insufficient awareness of the importance of rehabilitation or other socioeconomic factors which needs further exploration.

Measuring tools such as KT-1000 arthrometer would provide more accurate clinical evaluation results. The other method used for ACL reconstruction is bone-patellar tendon-bone (BPTB), which could have been compared with the current technique used for comparison of outcomes in this study.

Main limitation of the study was that all the patients were males; therefore, we were unable to compare our results with female population. Secondly, long-term follow up is required to assess the complications such as graft failure and development of osteoarthritis.

Conclusion

Reconstruction of the anterior cruciate ligament with quadruple strand hamstrings autograft provides satisfactory outcome based on physical and functional evaluation. Although there are recent advances in ACL reconstruction using BPTB, allograft or other synthetic materials, reconstruction with hamstrings graft is still considered a viable option with less morbidities.

Disclaimer: None.

Conflict of Interest: None.

Funding Sources: None.

References

1. Buller LT, Best MJ, Baraga MG, Kaplan LD. Trends in anterior cruciate ligament reconstruction in the United States. Orthop J Sports Med 2014 Dec;3: 2325967114563664.
2. Gianotti SM, Marshall SW, Hume PA, Bunt L. Incidence of anterior cru-

ciate ligament injury and other knee ligament injuries: A national population-based study. J Sci Med Sport 2009; 12: 622-7.

3. van der Hart CP, van den Bekerom MP, Patt TW. The occurrence of osteoarthritis at a minimum of ten years after reconstruction of the anterior cruciate ligament. J Orthop Surg Res 2008; 3: 24.
4. Vundelinckx B, Herman B, Getgood A, Litchfield R. Surgical Indications and Technique for Anterior Cruciate Ligament Reconstruction Combined with Lateral Extra-articular Tenodesis or Anterolateral Ligament Reconstruction. Clin Sports Med 2017; 36: 135-53.
5. Chang CB, Choi JY, Koh IJ, Lee KJ, Lee KH, Kim TK. Comparisons of femoral tunnel position and length in anterior cruciate ligament reconstruction: modified transtibial versus anteromedial portal techniques. Arthroscopy 2011; 27: 1389-94.
6. Macaulay AA, Perfetti DC, Levine WN. Anterior cruciate ligament graft choices. Sports Health 2012 ; 4: 63–8.
7. Xerogeanes JW. Quadriceps Tendon Graft for Anterior Cruciate Ligament Reconstruction: THE GRAFT OF THE FUTURE!Arthroscopy 2019; 35: 696-7.
8. Wagner M, Kääb MJ, Schallock J, Haas NP, Weiler A. Hamstring tendon versus patellar tendon anterior cruciate ligament reconstruction using biodegradable interference fit fixation: a prospective matched-group analysis. Am J Sports Med 2005 ; 33: 1327-36.
9. Reinhardt KR, Hetsroni I, Marx RG. Graft selection for anterior cruciate ligament reconstruction: a level I systematic review comparing failure rates and functional outcomes. Orthop Clin North Am 2010; 41: 249-62.
10. Todor A, Nistor DV, Caterev S. Clinical outcomes after ACL reconstruction with free quadriceps tendon autograft versus hamstring tendons autograft. A retrospective study with a minimal follow-up two years. Acta Orthop Traumatol Turc 2019; 53:180-3.
11. Grassi A, Carulli C, Innocenti M, Mosca M, Zaffagnini S, Bait C, et al. New Trends in Anterior Cruciate Ligament Reconstruction: ASystematic Review of National Surveys of the Last 5 years. Joints 2018; 6: 177–87.
12. Abebe ES, Utturkar G, Taylor D, Spritzer C, Kim J, Moorman CT 3rd, et al. The effects of femoral graft placement on in vivo knee kinematics after anterior cruciate ligament reconstruction. J Biomech 2011; 44: 924-9.
13. Bedi A, Maak T, Musahl V, O'Loughlin P, Choi D, Citak M, et al. Effect of tunnel position and graft size in single-bundle anterior cruciate ligament reconstruction: an evaluation of time-zero knee stability. Arthroscopy 2011; 27: 1543-51.
14. Carson EW, Anisko EM, Restrepo C, Panariello RA, O'brien SJ, Warren RF. Revision anterior cruciate ligament reconstruction: etiology of failures and clinical results. J Knee Surg 2004; 17: 127-32.
15. Ohsawa T, Kimura M, Hagiwara K, Yorifuji H, Takagishi K. Clinical and second-look arthroscopic study comparing 2 tibial landmarks for tunnel insertions during double-bundle ACL reconstruction with a minimum 2-year follow-up. Am J Sports Med 2012; 40: 2479-86.
16. Chechik O, Amar E, Khashan M, Lador R, Eyal G, Gold A. An international survey on anterior cruciate ligament reconstruction practices. Int Orthop 2013; 37: 201–6.
17. Pinczewski LA, Lyman J, Salmon LJ, Russell VJ, Roe J, Linklater J. 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: 564-74.
18. Goldblatt JP, Fitzsimmons SE, Balk E, Richmond JC. Reconstruction of the anterior cruciate ligament: meta-analysis of patellar tendon versus hamstring tendon autograft. Arthroscopy 2005; 21: 791-803.
19. Cerulli G, Placella G, Sebastiani E, Tei MM, Speziali A, Manfreda F. ACL Reconstruction: Choosing the Graft. Joints 2013; 1: 18–24.
20. 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. Maedica (Buchar) 2011; 6: 109–13.
21. Khan RDA, Hassan SMT, Saeed UB, Yasin A. Postoperative range of motion and stability after anterior cruciate ligament reconstruction using quadrupled hamstring autograft. J Pak Med Assoc 2015; 65: S215-9.
22. Gohil S, Annear P, Breidahl W. Anterior cruciate ligament reconstruction using autologous double hamstrings: A comparison of standard versus minimal debridement techniques using MRI to assess revascularisation: a randomised prospective study with a one-year follow-up. J Bone Joint Surg Br 2007; 89: 1165-71.
23. Tegner Y, Lysholm J. Rating systems in the evaluation of knee ligament injuries. Clin Orthop Relat Res 1985; (198): 43-9.
24. Hefti E, Müller W, Jakob R, Stäubli HU. Evaluation of knee ligament injuries with the IKDC form. Knee Surg Sports Traumatol Arthrosc 1993; 1: 226-34.
25. Almangoush A, Herrington L. Functional performance testing and patient reported outcomes following ACL reconstruction: A systematic scoping review. Int Sch Res Notices 2014; 2014: 613034.
26. Mitsou A, Vallianatos P, Piskopakis N, Maheras S. Anterior cruciate ligament reconstruction by over-the-top repair combined with popliteus tendon plasty. J Bone Joint Surg Br 1990; 72: 398-404.
27. Colombet P, Saffarini M, Bouguennec N. Clinical and Functional Outcomes of Anterior Cruciate Ligament Reconstruction at a Minimum of 2 Years Using Adjustable Suspensory Fixation in Both the Femur and Tibia: A Prospective Study. Orthop J Sports Med 2018; 6: 2325967118804128
28. Figueroa F, Figueroa D, Espregueira-Mendes J. Hamstring autograft size importance in anterior cruciate ligament repair surgery. EFORT Open Rev 2018; 3: 93-7.
29. Clatworthy M. Graft Diameter matters in Hamstring ACL reconstruction. Orthop J Sports Med 2016; 4: 2325967116S00082
30. Magnussen RA, Lawrence JTR, West RL, Toth AP, Taylor DC, Garrett WE. Graft size and patient age are predictors of early revision after anterior cruciate ligament reconstruction with hamstring autograft. Arthroscopy 2012; 28: 526-31.
31. 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 Surg Sports Traumatol Arthrosc 2015; 23: 3238-43.
32. Yabroudi MA, Irrgang JJ. Rehabilitation and return to play after anatomic anterior cruciate ligament reconstruction. Clin sports Med 2013; 32:165-75.