ID Design Press, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2019 Sep 15; 7(17):2791-2795.
https://doi.org/10.3889/oamjms.2019.644
eISSN: 1857-9655
Clinical Science

Clinical Outcome of Arthroscopic Posterior Cruciate Ligament Reconstruction with Adjustable-Loop Femoral Cortical Suspension Devices

Sholahuddin Rhatomy[1, 2*], Jacky Ardianto Horas[3], Asa Ibrahim Zainal Asikin[3], Riky Setyawan[3], Thomas Edison Prasetyo[3], Edi Mustamsir[4, 5]

[1]Department of Orthopaedics and Traumatology, Dr Soeradji Tirtonegoro General Hospital, Klaten, Indonesia; [2]Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia; [3]Soeradji Tirtonegoro Sport Center and Research Unit, Dr Soeradji Tirtonegoro General Hospital, Klaten, Indonesia; [4]Department of Orthopaedics and Traumatology, Dr Saiful Anwar General Hospital, Malang, Indonesia; [5]Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia

Citation: Rhatomy S, Horas JA, Asikin AIZ, Setyawan R, Prasetyo TE, Mustamsir E. Clinical Outcome of Arthroscopic Posterior Cruciate Ligament Reconstruction with Adjustable-Loop Femoral Cortical Suspension Devices. Open Access Maced J Med Sci. 2019 Sep 15; 7(17):2791-2795.
https://doi.org/10.3889/oamjms.2019.644

Keywords: PCL; PCL reconstruction; Adjustable loop femoral cortical suspension devices; Peroneus longus

***Correspondence:** Sholahuddin Rhatomy. Department of Orthopaedics and Traumatology, Dr Soeradji Tirtonegoro General Hospital, Klaten, Indonesia; Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada, Yogyakarta, Indonesia. E-mail: doktergustomrhatomy@yahoo.com

Received: 09-Jun-2019; **Revised:** 15-Jul-2019; **Accepted:** 16-Jul-2019; **Online first:** 30-Aug-2019

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Incidence of isolated posterior cruciate ligament (PCL) injury is lower than PCL rupture is associated with other knee injuries. Adjustable loop femoral cortical suspension device is commonly used for femoral graft fixation during PCL reconstruction.

AIM: This study purpose is to describe the functional outcome of PCL reconstruction using an adjustable loop femoral cortical suspension device.

METHODS: This study used prospective design with consecutive sampling. All patients underwent PCL reconstruction with adjustable loop femoral cortical suspension devices using peroneus longus tendon autograft. Patients were evaluated at 6 months after surgery using posterior drawer test and functional outcome scoring system (Lysholm knee score, Cincinnati Score and International Knee Documentation Committee (IKDC) score).

RESULTS: 20 patients were enrolled in this study with a mean age of 27.65 ± 9.78. Lysholm knee means the score was improved from 59.80 ± 18.73 pre-operative and 80.55 ± 11.72 post-operative ($p < 0.05$). Cincinnati mean score was improved from 52.01 ± 20.29 pre-operative to 72.95 ± 15.26 post-operative ($p < 0.05$). IKDC mean score was improved from 48.36 ± 13.18 at pre-operative to 72.5 ± 13.13 post-operative ($p < 0.05$).

CONCLUSION: PCL reconstruction using adjustable loop femoral cortical suspension device using peroneus longus tendon autograft showed good clinical outcome and knee functional outcome (Lysholm, Cincinnati, and IKDC score) at 6 months follow-up.

Introduction

Posterior cruciate ligament (PCL) injury is a rare case. Shelbourne et al. reported that PCL tears occurred in 1%-44% of all acute knee injuries and presented concomitant with complex knee trauma [1]. PCL reconstruction purpose is to restore knee stability and to prevent the development of osteoarthritic changes in knee joint [2]. The principles of PCL reconstruction are identifying and treating the pathology, placing tunnels accurately to produce anatomical graft insertion sites, utilising strong graft material, mechanical – tensioning of the graft, fixating the graft and giving the optimal post-operative rehabilitation program [3].

The methods of femoral graft fixation for PCL

reconstruction are interference screw, cortical suspension devices and cross-pins [4]. There are 2 common types of cortical suspension devices; fixed loop and adjustable loop. The fixed loop cortical suspension device is a graft fixation device which the graft is attached to a continuous suture loop that is connected to a button. This device is fixed at the distal femoral cortex, and the tunnel is filled with the graft without any implants needed. The fixed loop button demonstrates desirable biomechanical properties when it fixes the hamstring graft. The newest study had shown that the use of suspensory devices in PCL reconstruction has advantaged in the length of the graft used and provided stable fixation [5], [6].

In contrast, an adjustable loop cortical suspension device has a button that is attached to the graft through the adjustable loop. Its loop is tightened to pull the graft through to the proximal of the femoral tunnel, which eliminated the additional tunnel length to flip the button [7]. Adjustable loop button allows the surgeon to adapt tunnel length difference intra-operatively. It can avoid the necessity for drilling a longer tunnel and maximise the amount of graft within the tunnel by fulfilling the bone tunnel. An additional advantage of the adjustable loop button includes the ability for graft retention on the femoral side after tibial fixation. However, the flexibility of the loop length of the adjustable loop button is the need to concern, because it can increase post-operative graft slippage [8], [9].

This study purpose is to evaluate the functional outcome after PCL reconstruction with adjustable loop cortical suspension device using peroneus longus tendon autograft at 6 months follow-up.

Methods

This study was a prospective design with consecutive sampling. Twenty patients underwent PCL reconstruction from December 2016 until August 2018. Inclusion criteria were PCL rupture patient with the age range between 18-45 years old, diagnosed with positive posterior drawer test grade 3 and confirmed with Magnetic Resonance Imaging (MRI). Exclusion criteria were chondral damage, fracture at knee region, and pathologic condition in the lower extremity. All patients underwent PCL reconstruction with peroneus longus tendon autograft using adjustable loop femoral cortical suspension device (GraftMax^{TM} Button, Conmed, USA). All patients were followed up at minimum 6 months post-operative. This study evaluated posterior drawer test and kneed functional score Lysholm knee score, Cincinnati score, and International Knee Documentation Committee (IKDC) score. JAH performed clinical outcome evaluation. This study was reviewed and approved by the Medical and Health Research Ethics Committee at the Faculty of Medicine, Public Health, and Nursing, Universitas Gadjah Mada (IRB number KE/FK/0258/EC/2019).

Surgical Technique

Under spinal anaesthesia, the patient was in the supine position, and the patient's thigh has applied the tourniquet over the cast padding. SR did all of PCL reconstruction procedure. Using a distal foot stop and lateral support, the knee was retained in 90° of flexion, varus or valgus stress manoeuvres allowed and full passive range of motion performed easily. We used standard arthroscopic examination with a 30° arthroscope using standard anteromedial (AM) and anterolateral (AL) portals to evaluate any pathology. PCL rupture was confirmed. The minimal amount of PCL remnant was excised with 4.2 mm shaver from the AM portal to improve visualisation. The arthroscope can be easier introduced into the posteromedial compartment.

By the AL portal through the intercondylar notch, the 30° arthroscope was passed between the medial femoral condyle and the PCL remnant to achieve the posteromedial compartment. A spinal needle was inserted with an arthroscopic guide to making a posteromedial (PM) portal with a number 11 blade approximately 5-10 mm above the tibial surface and posterior to the medial femoral condyle. The arthroscope was moved to the AM portal and placed in the posterolateral compartment through the intercondylar notch, lateral to ACL fibres. The knee should in 90° of flexion position during PL and PM portals creation to prevent any damage to the vessels and nerves. The distance between the PM portal and 2 branches of the saphenous nerve is approximately 17 – 20 mm and between the PL portal and common peroneal nerve is 25 mm in 90° flexion position.

Graft Preparation

The peroneus longus tendon autograft was harvested using an open tendon stripper with 1.5 cm skin incision about 2 cm above the lateral malleolus. The distal insertion of peroneus longus was sutured with the peroneus brevis tendon. The surgeon was cut the tendon above the sutured site. Peroneus longus tendon length was obtained maximal length approximately 3 fingers below the fibular head to prevent injury to the common peroneal nerve.

Femoral Tunnel Preparation

The femoral footprint was visualised and cartilage border was identified with the radiofrequency probe. The knee was flexed 90°. The femoral PCL guide was positioned at the condyle's articular surface using 2.4 mm guide passing pin until penetrate the

medial femoral cortex (PCL femoral origin). A 4.5 mm cannulated drill was used to create the first full-length passing tunnel. Cannulated drill which matches the diameter of the harvested graft was made through that tunnel. The depth of the socket was calculated based on the length of the prepared graft (usually 25-30 mm). The free end of number 2 Vicryl suture loop is advanced out the AM thigh using the guide passing pin. The arthroscope was moved to the AL portal, and the femoral blue Vicryl was taken from the AM portal.

Tibial Tunnel Preparation

The surgeon made an accessory portal with needle guide at medial to the lateral part of the medial femoral condyle (usually passed through the patellar tendon). The surgeon cleaned this side to make a better visualisation of PCL remnant. PM portal was made with transillumination guide, and the needle was kept in line with posterior plateau. The shoulder trochar was put in PM portal. The PCL tibial guide that was set at 65 was placed through the AM portal at the anatomic position of the PCL insertion (middle of the PCL remnant). The surgeon made an incision about 2 cm at the proximal medial tibia and placed the drill sleeve. With the 30 arthroscopes in the PM portal, the surgeon drilled a 2.4 mm guide pin carefully into the tibia to avoid the posterior neurovascular structures damage. To confirm sagittal plane of guidewire placement was right, the surgeon used assisted fluoroscopy. The protection curettage was inserted from the AM portal and placed over the 2.4 mm guidewire. A cannulated reamer that matches to graft diameter is used for the final tibial tunnel preparation. Soft tissue remnant was removed at the posterior end of the tibial tunnel by shaver or radiofrequency probe through the tibial tunnel. By keeping the arthroscope in the PM portal, a looped number 3 nonabsorbable suture was inserted into the tibial tunnel using a suture passer with an eyelet. This suture was retrieved from the AM portal through the intercondylar notch with an arthroscopic grasper. The suture was tied with the femoral tunnel suture and was pulled through the tibial tunnel. The knot between the sutures was opened and removed (tibial tunnel suture).

Graft Passage and Fixation

The graft was passed through the tibial tunnel. The difficult part of the procedure was passing the graft gradually through both the tibial and femoral tunnel, which was in the opposite direction. The surgeon tried to reduce as much as possible of excessive friction between the graft and the tunnel that may lead to entrapment or even rupture of the graft. For this reason, we divided the procedure into 2 steps: first, the sutures of the normal pull-up (femoral side of the graft) was shuttled through the tibial tunnel and was taken through the AM portal by the number 3 nonabsorbable (green) Mersuture. The killer turn angle at the posterior exit of the tibial tunnel was the most dangerous step because of the severity of the reflexing angle and the difficulty of controlling the graft progression of the hidden and narrow compartment, especially when used anterior viewing portal. Therefore, the arthroscope can be placed in the PM portal. While the assistant was pulling the sutures of the pull-up through the AM portal, the surgeon was using the switching stick from the PL portal as a pulley to help the progressive graft passage until the tibial side mark appeared posteriorly (a 2 cm length was left in the tibial tunnel). Second, the loop of the number 3 non-absorbable Mersuture (tibial tunnel) was passed through the loop of the number 2 Vicryl (femoral tunnel).

Consequently, the traction sutures of the normal-sized pull-up were passed through the number 2 Vicryl suture and shuttled directly through the femoral tunnel. The femoral pull-up was flipped over the medial femoral cortex and was secured into the prepared socket by pulling its adjustable loop suture the graft. The surgeon performed full ROM. Final PCL tensioning was performed by pulling the sutures and securing the suture with a bio-absorbable screw at the tibial side. During final fixation, the knee is retained in 70° of flexion, and an anterior drawer was applied.

Single bundle arthroscopic PCL reconstruction with adjustable femoral cortical suspension device

The graft was passed through the tibial tunnel, killer turn angle and femoral tunnel with suture guide. The suture guide was pulled until all the graft suture had passed the femoral skin. The grey suture (the button suture) was pulled until slipped with the blue Vicryl. The blue-white suture was pulled until it had passed the femoral tunnel. The graft was fastened with bio-absorbable screw in the tibial tunnel with 90° knee flexion and anterior drawer of the tibia. The remaining graft was sutured with the fascia. The surgeon closed the skin, and the operation was done.

Results

During the period of the study, twenty patients fulfilled the inclusion criteria and underwent PCL reconstruction with adjustable loop cortical suspension device using peroneus longus tendon. There were twenty patients which consist of 15 males and 5 females. The patient's mean age was 27.65 ± 9.78 range from 16 until 55 years old. Site of injury was 13 at the right knee and 7 in the left knee. Injury mechanism occurred 6 in sport, 9 in a vehicle accident and 5 in another injury mechanism. Peroneus longus tendon means diameter was 8.35 ± 0.58 ranges from

7.50 to 10.00. Subjects' characteristics were shown in Table 1.

Follow-up evaluation using posterior drawer test at 6 months post-operative showed positive drawer test grade 1.

Table 1: Subjects' characteristics

Characteristics	Mean	SD	Min	Max	N (%)
Age	27.65	9.78	16.00	55.00	
Sex					
Male					15(75.0)
Female					5(25.0)
Injury site					
Right					13 (65.0)
Left					7 (35.0)
Injury mechanism					
Sport					6 (30.0)
Vehicle accident					9 (45.0)
Others					5 (25.0)
Graft diameter	8.35	0.58	7.50	10.00	

Abbreviations: SD: Standard Deviation; Min: Minimum; Max: Maximum; N: Number of Subjects

There were significant differences between the preoperative and 2-year postoperative score in Lysholm knee score, Cincinnati score, and IKDC score ($p < 0.05$), as shown in Table 2. Lysholm knee means the score was improved from 59.80 ± 18.73 pre-operatively to 80.55 ± 11.72 at 6 months follow-up. Cincinnati mean score was improved from 52.01 ± 20.29 pre-operatively to 72.95 ± 15.26 at 6 months follow-up. IKDC mean score was improved from 48.36 ± 13.18 pre-operatively to 72.5 ± 13.13 at 6 months follow-up.

Table 2: Functional outcome

Scoring assessment	Pre-operative		Post-operative		Significance
	Mean	SD	Mean	SD	
Lysholm	59.80	18.73	80.55	11.72	0.000
Cincinnati	52.01	20.29	72.95	15.26	0.000
Ikdc	48.36	13.18	72.50	13.13	0.000

Abbreviations: SD: standard deviation.

Discussion

Our main finding in this study was that PCL reconstruction using adjustable loop femoral cortical suspension had satisfactory clinical outcomes. There were only two studies which reported clinical outcomes of PCL reconstruction with adjustable loop suspension device (Freychet et al., and Setyawan et al.,). Our study emphasised their findings that the PCL reconstruction technique would yield favourable results [10], [11].

Freychet et al. found that the mean postoperative IKDC and Lysholm score were 85.0 (SD 13.5) and 87.4 (SD 13.1), respectively, meanwhile, in our study, the mean was 72.5 and 80.55. These differences might not be significant. It might cause by the different duration of the follow-up (24versus 6 months), different operation technique (double-bundle versus single-bundle technique). Setyawan et al. found that the mean postoperative IKDC, Cincinnati, and Lysholm scores were 78.17, 79.00 and 80.20, respectively, and the scores were improved significantly in 2 years follow-up. These findings may be attributable to the difference in the duration of follow-up (2 years versus 6 months), but might not be significant statistically [10], [11].

Peroneus longus tendon autograft has several advantages, including no anterior knee pain, no kneeling pain, and reduce the incidence of postoperative thigh hypotrophy [11]. Setyawan et al. explained that the usage of peroneus longus tendon gave excellent ankle functional score based on FADI and AOFAS score [11]. However, some disadvantages of peroneus longus usage are still debatable. A biomechanical study that explained tensile strength comparison between peroneus longus tendon, hamstring tendon, patellar tendon, and quadriceps tendon showed that the tensile strength of peroneus longus was comparable to hamstring tendon, and was significantly stronger than patellar tendon and quadriceps tendon [12].

Adjustable loop suspension device has an advantage including reducing tunnel widening because it can reduce the distance between the button and the proximal end of the graft [7]. However, there were still few studies that described the usage of adjustable loop suspension in PCL reconstruction.

Recent systematic review and meta-analysis by Lee et al. concluded that biomechanically double-bundle is more superior to single-bundle PCL reconstruction in terms of anteroposterior stability [13]. A recent systematic review by Qi et al., and Chahla et al., found no differences in patient-reported outcomes [14], [15]. Following recent evidence, we would prefer using single-bundle PCL reconstruction due to simpler surgical techniques and similar outcomes.

In our study, we only included patients with isolated PCL injuries, excluding multi ligamentous knee injury. Interestingly, Freychet et al., found that there was no significant difference in outcome scores when the injury was stratified by Knee Dislocation classification in 2 years of follow-up [10]. Mygind-Klavsen et al. found that patients with a multi ligamentous knee injury and isolated PCL injury would have identical functional and objective outcomes with a mean follow-up of 5.9 years [16]. Spiridonov et al., also reported that there was increased significantly in Cincinnati and IKDC score in both isolated and multi ligamentous knee injury [17].

PCL reconstruction is rare and technically challenging than ACL reconstruction. Limitation to visualise posterior compartment with standard AM and AL portals and the risk of neurovascular injuries may lead to limb-threatening complication. Adjustable loop suspension device may accomplish a satisfactory size of PCL graft, and the peroneus longus tendon length restriction can be avoided. This study has several limitations. There is no long-term result and no control group. We also used prospective design and limited

sample size, which was because of a small number of isolated PCL injuries. We would recommend more extensive studies with bigger sample size, control group and randomised controlled trial study design usage. Despite these limitations, the procedure was shown favourable results.

In conclusion, PCL reconstruction with adjustable loop femoral fixation device using peroneus longus tendon autograft was shown good knee functional outcome score at 6 months follow-up.

References

1. Shelbourne KD, Davis TJ, Patel D V. The natural history of acute, isolated, nonoperatively treated isolated posterior cruciate ligament injuries: a prospective study. Am J Sports Med. 1999; 27(3):276-83. https://doi.org/10.1177/03635465990270030201 PMid:10352760

2. Voos JE, Mauro CS, Wente T, Warren RF, Wickiewicz TL. Posterior cruciate ligament: anatomy, biomechanics, and outcomes. Am J Sports Med. 2012; 40(1):222-31. https://doi.org/10.1177/0363546511416316 PMid:21803977

3. Dennis MG, Fox JA, Alford J winslow, Hayden JK, Bach BR. Posterior cruciate ligament reconstruction: current trends. J Knee Surg. 2004; 17(4):133-9. https://doi.org/10.1055/s-0030-1248211 PMid:15366267

4. Kamelger FS, Onder U, Schmoelz W, Tecklenburg K, Arora R, Fink C. Suspensory fixation of grafts in anterior cruciate ligament reconstruction: a biomechanical comparison of 3 implants. Arthrosc - J Arthrosc Relat Surg. 2009; 25(7):767-76. https://doi.org/10.1016/j.arthro.2009.01.021 PMid:19560641

5. Brossard P, Boutsiadis A, Panisset J-C, Mauris F, Barth J. Adjustable button devices for all-arthroscopic posterior cruciate ligament reconstruction using the hamstrings tendons and the "forgotten" transseptal approach. Arthrosc Tech. 2017; 6(4):e979-85. https://doi.org/10.1016/j.eats.2017.03.010 PMid:28970981 PMCid:PMC5621138

6. Lee YS, Wang JH, Bae JH, Lim HC, Park JH, Ahn JH, et al. Biomechanical evaluation of cross-pin versus interference screw tibial fixation using a soft-tissue graft during transtibial posterior cruciate ligament reconstruction. Arthrosc - J Arthrosc Relat Surg. 2009; 25(9):989-95. https://doi.org/10.1016/j.arthro.2009.02.006 PMid:19732637

7. Choi N-H, Yang B-S, Victoroff BN. Clinical and radiological outcomes after hamstring anterior cruciate ligament reconstructions: comparison between fixed-loop and adjustable-loop cortical suspension devices. Am J Sports Med. 2016; 45(4):826-31. https://doi.org/10.1177/0363546516674183 PMid:27881383

8. Eguchi A, Ochi M, Adachi N, Deie M, Nakamae A, Andry M. The Knee Mechanical properties of suspensory fi xation devices for anterior cruciate ligament reconstruction : Comparison of the fi xed-length loop device versus the adjustable-length loop device. j.knee. 2014; 30:1-6. https://doi.org/10.1016/j.knee.2014.02.009 PMid:24613584

9. Barrow AE, Pilia M, Guda T, Kadrmas WR, Burns TC. Femoral Suspension Devices for Anterior Cruciate Ligament Reconstruction: Do Adjustable Loops Lengthen? Am J Sports Med. 2014; 42:343-9. https://doi.org/10.1177/0363546513507769 PMid:24158183

10. Freychet B, Desai VS, Sanders TL, Kennedy NI, Krych AJ, Stuart MJ, et al. All-inside posterior cruciate ligament reconstruction: surgical technique and outcome. Clin Sports Med [Internet]. 2019; 38(2):285-95. https://doi.org/10.1016/j.csm.2018.11.005 PMid:30878050

11. Setyawan R, Soekarno NR, Asikin AIZ, Rhatomy S. Posterior Cruciate Ligament reconstruction with peroneus longus tendon graft: 2-Years follow-up. Ann Med Surg. 2019; 43:38-43. https://doi.org/10.1016/j.amsu.2019.05.009 PMid:31194056 PMCid:PMC6551477

12. Phatama KY, Hidayat M, Mustamsir E, Pradana AS, Dhananjaya B, Muhammad SI. Tensile strength comparison between hamstring tendon, patellar tendon, quadriceps tendon and peroneus longus tendon: A cadaver research. J Arthrosc Jt Surg. 2019; (xxxx):10-2. https://doi.org/10.1016/j.jajs.2019.02.003

13. Lee D-Y, Kim D-H, Kim H-J, Nam D-C, Park J-S, Hwang S-C. Biomechanical Comparison of Single-Bundle and Double-Bundle Posterior Cruciate Ligament Reconstruction. JBJS Rev. 2017; 5(10):e6. https://doi.org/10.2106/JBJS.RVW.17.00008 PMid:29040171

14. Qi YS, Wang HJ, Wang SJ, Zhang ZZ, Huang AB, Yu JK. A systematic review of double-bundle versus single-bundle posterior cruciate ligament reconstruction. BMC Musculoskelet Disord. 2016; 17(1):1-9. https://doi.org/10.1186/s12891-016-0896-z PMid:26818255 PMCid:PMC4730768

15. Chahla J, Moatshe G, Cinque ME, Dornan GJ, Mitchell JJ, Ridley TJ, et al. Single-Bundle and Double-Bundle Posterior Cruciate Ligament Reconstructions: A Systematic Review and Meta-analysis of 441 Patients at a Minimum 2 Years' Follow-up. Arthrosc - J Arthrosc Relat Surg. 2017; 33(11):2066-80. https://doi.org/10.1016/j.arthro.2017.06.049 PMid:28866340

16. Mygind-Klavsen B, Nielsen TG, Lind MC. Outcomes after posterior cruciate ligament (PCL) reconstruction in patients with isolated and combined PCL tears. Orthop J Sport Med. 2017; 5(4):10-2. https://doi.org/10.1177/2325967117700077 PMid:28451615 PMCid:PMC5400213

17. Spiridonov S, Slinkard N, LaPrade R. Isolated and Combined Grade-III Posterior Cruciate Ligament Tears Treated with Double-Bundle Reconstruction with Use of Endoscopically. J Bone Jt Surg Am. 2011; 93(19):1773-80. https://doi.org/10.2106/JBJS.J.01638 PMid:22005862