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

Sholahuddin Rhatomy1, 2*, Jacky Ardianto Horas3, Asa Ibrahim Zainal Asikin3, Riky Setyawan3, Thomas Edison Prasetyo3, Edi Mustamsir4, 5

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

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

Posterolateral 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].


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

Competing Interests: The authors have declared that no competing interests exist.
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 peroneous 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 peroneous longus tendon autograft using adjustable loop femoral cortical suspension device (GraftMax™ Button, Conmed, USA). All patients were followed up at minimum 6 months post-operative. This study evaluated posterior drawer test and knee 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
diemenal femoral cortex (PCL femoral origin). A 4.5 mm
cannulated drill was used to create the first full-length
crossing 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
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
drive. 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 curetage 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
reflecting 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 femoral 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
(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

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

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

<table>
<thead>
<tr>
<th>Scoring assessment</th>
<th>Pre-operative</th>
<th>Post-operative</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lysholm</td>
<td>59.80</td>
<td>80.55</td>
<td>0.000</td>
</tr>
<tr>
<td>Cincinnati</td>
<td>52.01</td>
<td>72.95</td>
<td>0.000</td>
</tr>
<tr>
<td>IKDC</td>
<td>48.36</td>
<td>72.50</td>
<td>0.000</td>
</tr>
</tbody>
</table>

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 (24 versus 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


