Results of arthroscopic-assisted retrograde fixation of the posterior cruciate ligament avulsions

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Introduction

A displaced tibial-side bony avulsion of the posterior cruciate ligament (PCL) should be anatomically reduced and fixed. Many techniques have been described for fixation of these injuries. All have been proven to be effective in the treatment of PCL avulsion fractures. The aim of this study was to assess the results and clinical outcomes of displaced tibial-side PCL avulsion fractures treated with arthroscopic retrograde screw fixation.

Settings and design

A case series study was held at Alexandria University.

Patients and methods

From 2010 to 2013, 24 patients had displaced avulsed PCL tibial-sided injury. They were all males. In all of them, the fragment was large (at least 1.5 cm). They were fixed arthroscopically using a single retrograde cannulated screw. The median age was 25.5±2.67 years. All patients were followed up clinically and radiologically for a median of 27±1.5 months.

Statistical analysis

SPSS, version 20.0, Chicago, Illinois, was used for statistical analysis.

Results

Postoperatively, the mean Lysholm score was 96±1.3 and the Tegner score was 7.7±0.4 points. The range of motion improved significantly from 97.14±5.4 to 130.7 ±2.67, with a *P* value less than 0.01. All patients achieved radiological union at a mean of 3.2±1.08 months.

Conclusion

Arthroscopic-assisted retrograde screw fixation is an effective, safe, and easy technique for fixation of these types of injury.

Keywords:
cannulated screw, posterior cruciate ligament, avulsion

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Introduction

Avulsion fractures of the tibial attachment of the posterior cruciate ligament (PCL) are rare injuries. The most commonly reported mechanism of injury for an isolated PCL disruption with or without avulsion of a bony fragment is the classic dashboard injury: a posteriorly directed force is applied to the proximal tibia of the knee in flexed position as happens in motorcycle or automobile accidents. Sudden hyperextension of the knee with an associated valgus or varus force and forced hyperflexion with the foot plantar or dorsiflexed are other mechanisms of injury [1].

There is no argument that a displaced tibial-side bony avulsion of the PCL should be anatomically reduced and fixed. Acute fixation is recommended within the first 3 weeks. Both open and arthroscopic methods of fixation have been reported with good clinical outcomes [1].

Arthroscopically assisted reduction with an appropriate fixation method is generally preferred to posterior arthrotomy for the following reasons: (a) concomitant lesions, including meniscal tears, can be treated without change in position and (b) less surgical invasion is required because of decreased exposure of the posterior capsule or muscle [2].

Arthroscopic techniques using cannulated screws, multiple wires, and sutures have been proven to be effective in treatment of PCL avulsion fractures [2]. The purpose of this study was to assess the results and clinical outcomes of arthroscopic retrograde fixation of displaced tibial-side PCL avulsion fractures using a single standard set cannulated screw.

Patients and methods

From 2010 to 2013, 24 patients were admitted to El Hadara University Hospital and the Alexandria Police

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Hospital with displaced PCL tibial-side avulsion fractures. The study was approved by the institutional ethics committee in the Orthopedic Department of Orthopaedic Surgery, Alexandria University, Alexandria, Egypt. The inclusion criteria for the study were PCL tibial-side avulsion fracture with radiographic evidence of greater than 3 mm of upward displacement and/or with grade II (5–10 mm of translation) or III (>10 mm of translation) findings on the posterior drawer test at 90° of knee flexion on clinical evaluation or examination under anesthesia. The fragment should be large and not comminuted (>1.5 cm) (Fig. 1). Associated meniscal, chondral, anterior cruciate ligament (ACL), or collateral ligament injuries were not grounds for exclusion. Cases with fractures of the proximal tibia or distal femur, open injury, or associated neurovascular injury were excluded from the study.

All avulsion injuries were confirmed with radiography and computed tomography scan. Computed tomography scans were used to assess the size, comminution, and displacement of the fracture fragment. MRI was obtained to exclude other concomitant injuries. Clinically, each patient was assessed preoperatively and under anesthesia using the Lachman and anterior and posterior drawer tests to evaluate cruciate injury, as well as varus and valgus stress tests both in extension and at 30° of flexion to assess the competence of the collateral ligaments. The dial and external rotation recurvatum tests were also performed to evaluate posterolateral corner injuries.

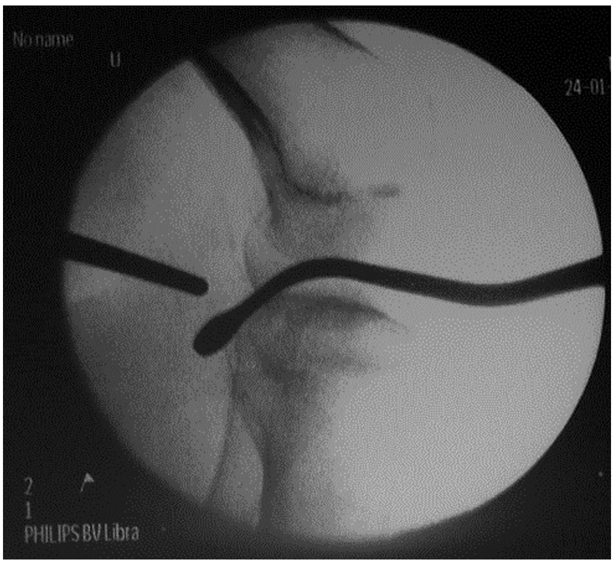
The patient was placed in supine position with the affected limb hanged from the table. A single 2 g dose of intravenous cephazolin was administered before inflation of a high thigh tourniquet at 300 mmHg. Examination under anesthesia confirmed a posterior sag with positive posterior drawer test with a soft end point. After a thorough physical examination under general anesthesia, the affected lower extremity was prepared and draped. A routine knee arthroscopic evaluation was done through the usual anterolateral portal. The parapatellar anteromedial portal was located just medial to the medial border of the patellar tendon and adjacent to the patella. The high posteromedial portal was located under vision with the use of spinal needle approximately adjacent to the posteromedial femoral condyle and 3 cm above the joint line.

A 30° arthroscope was introduced through a parapatellar anteromedial portal and advanced between the ACL and the PCL on medial femoral condyle to visualize the posteromedial compartment. The proximal posteromedial portal is prepared under direct vision, and a blunt trocar and a sheath were placed. The arthroscope was switched to posteromedial portal to visualize the posteromedial compartment (Fig. 2). The PCL bony fragment was debrided with a motorized shaver. The size of the fracture fragment was measured using the 5-mm tip of the arthroscopic

Figure 1

Preoperative lateral radiograph showing avulsed PCL tibial large fragment. PCL, posterior cruciate ligament.

Figure 2

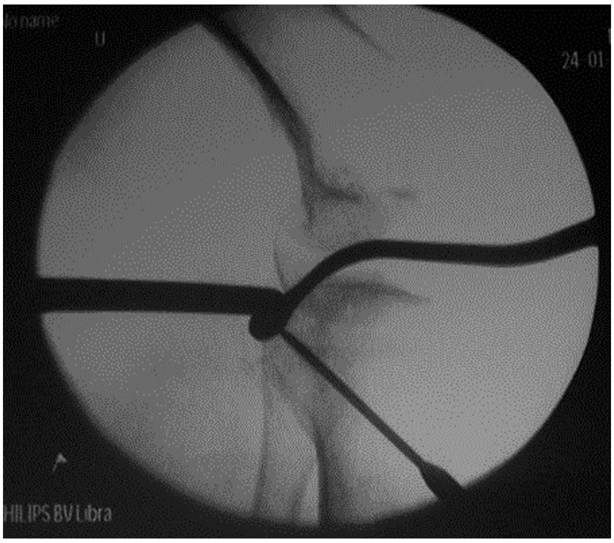


Intraoperative fluoroscopic view showing 30° arthroscopy through posteromedial portal and PCL guide inserted through anterior portals reducing the fragment. PCL, posterior cruciate ligament.

probe. The fracture fragment was manipulated with the probe and temporarily reduced into the anatomic position.

The PCL guide was then introduced through the anteromedial portal and used to reduce the fragment into its anatomical position (Fig. 2). The reduction was temporarily fixed with a transtibial guidewire (2.4 mm). To avoid displacement and rotation of the fragment during fixation, another guidewire was introduced centrally inside the fragment (Fig. 3). A small stab incision was made on the anterior aspect of the proximal leg, and the anterior tibial cortex was exposed. A partially threaded cannulated screw with a washer was then introduced over the central guidewire while maintaining the reduction with the PCL guide (Fig. 4). The fragment was fixed while applying an anterior drawer to the knee flexed at an angle of 70–90°. With tightening of the screw, the fragment was gradually compressed to its anatomical position. The screw was introduced till good compression of the fragment was obtained. Firm fixation was confirmed using a fluoroscopic control before closure of the wounds (Figs 5 and 6).

Figure 3

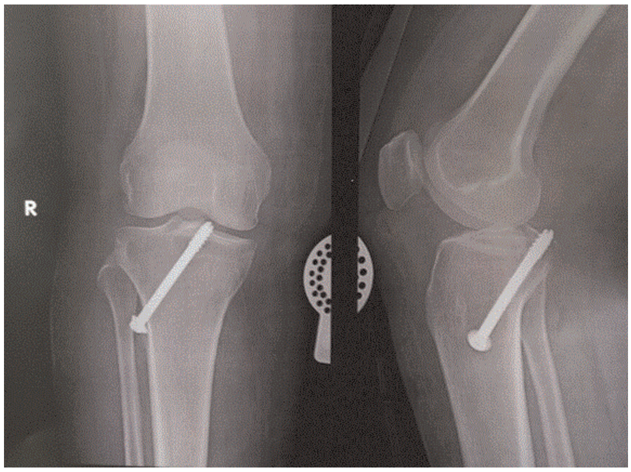


Inserting a guidewire for preliminary fixation of the fragment.

Figure 4

Retrograde screw insertion.

Figure 5



Immediate postoperative radiograph.

Figure 6

1.5 month after ORIF showing complete healing of the fragment 6 months postoperatively.

All the patients were followed up and evaluated by clinical and radiographic assessment at monthly intervals until fracture union occurred and then at the end of 2 years of follow-up. Bony union was defined as the absence of a visible fracture line on plain radiographs. The Lysholm scoring system, Tegner activity score, and International Knee Documentation Committee knee ligament examination form were used for follow-up assessment to document symptoms. Knee radiographs in the standing anteroposterior and lateral views were examined for alignment, joint space narrowing, and degenerative changes.

Statistical analysis

The evaluation data at 2 years of follow-up were gathered and statistically analyzed with SPSS software (version 20.0; SPSS Inc., Chicago, Illinois, USA). The results were analyzed using the appropriate statistical test. Comparison between preoperative and postoperative results was done using Wilcoxon signed test. Fisher exact test was used for nominal data. A *P* value of 0.05 was considered statistically significant.

Postoperative rehabilitation

The operative extremity was placed in a long leg hinged brace that is locked to permit only 20° of flexion for 2 weeks postoperatively. With the brace, patients were encouraged to start quadriceps muscle strengthening exercises and to begin partial weight bearing (15 kg) using crutches. However, full weight bearing was not permitted during the first 6 weeks. After 2 weeks, protected range-of-motion exercises were started. The brace was locked in full extension during ambulation. At 6 weeks, the brace was unlocked and full weight bearing was permitted. At 8 weeks, the brace was removed, and the patients were encouraged to increase activity gradually.

Results

A total of 24 cases of displaced PCL tibial-side avulsion injuries were fixed with all arthroscopic retrograde cannulated screw. The median age was 25.5±2.67 years. They were all males. Eleven of them sustained road traffic accidents, two in a quarrel, and rest sustained sports injury. The mean time elapsed between injury and surgery was 18±5.17 days (minimum 7 days and maximum 21 days). All patients were followed up clinically and radiologically for a median of 27±1.5 months (minimum 18 months, maximum 36 months). Five patients had medial meniscal tears and two of them had medial collateral ligament injury.

All patients had positive drawer test preoperatively (13 patients GII and 11 patients had GIII). These values improved significantly, with *P* value less than 0.05. At 18 months, 12 patients had GI and only two patients had GII. The Lysholm score postoperative mean was 96±1.3 (range, 94–99; confidence interval 95.89–97.1). The mean Tegner score was 7.7±0.4 points postoperatively. Regarding International Knee Documentation Committee postoperative score, all patients were classified as normal except two patients who were classified as near normal.

The range of flexion improved significantly from 97.14 ±5.4° (range, 90–115°) to 130.7±2.67° (range, 125–135°), with a *P* value less than 0.01. Eight patients had transient flexion deformity of their affected knees with a median of 7.1±1.3° (range, 5–15°), which was improved after three months of intensive physiotherapy. All patients achieved radiological union at a mean of 3.2±1.08 months (range, 2.5–4 months, confidence interval, 2.38–3.69).

Discussion

Surgical treatment of acute PCL injuries includes arthroscopic or open reduction and internal fixation. Arthroscopic surgery is less invasive; however, because the posterior insertion of the posterior cruciate ligament is located distal on the posterior part of the tibial plateau, an arthroscopic operation would be relatively difficult [3].

The posterior cruciate ligament is one of the most important structures for knee joint stability, and its main role is to prevent tibial posterior displacement as well as external rotation and varus of the tibia [4].

Avulsion fracture of the posterior cruciate ligament is more common in sports-related injuries, which account for ∼40% of these injuries [5]. The mechanism of injury is mainly caused by direct impact of the tibial tuberosity and posterior tibial displacement, during which the posterior cruciate ligament is tensed. If anatomical reduction of the displaced fracture is not achieved, proper fracture union will not occur [6,7].

Nicandri *et al.* [8], believed that, regardless of the size of the displacement, an operation is necessary for the treatment of avulsion fractures of the posterior cruciate ligament owing to the serious outcomes of nonoperative treatment.

Inoue *et al.* [9] found that ∼60% of the operated knees had a mild (3 mm) but significant posterior instability, which was found at the final follow-up examination even though the bony fragment had been anatomically reduced and rigidly fixed since the time of surgery. The authors attributed that to hidden or 'occult' injuries inside the PCL midsubstance that may cause some type of PCL dysfunction on the long run [9].

The open posterior approach described by Trickey [10], which is generally recommended to fix these injuries, does not permit exploration of the knee for any additional injuries.

Arthroscopic surgery technique has improved quickly over the past 20 years. Moreover, it has little trauma and can effectively suture and fix posterior cruciate ligament avulsion fractures [2]. Arthroscopic reduction of a posterior cruciate avulsion allows also for simultaneous detection and management of any associated injuries [11].

Various arthroscopic techniques were used in the literature for PCL fragment fixation. Camara-Arrigunaga *et al.* [12] used anchor fixation. However, the use of these techniques requires more than one posterior arthroscopic portals, which is not the case with retrograde cannulated screws.

Shino *et al.* [13] reported on the use of cannulated screws for major avulsions (30 mm), and this technique was also described by Espejo-Baena *et al* [14] with similar results. This procedure, which requires keeping the avulsion reduced while the guidewire is introduced, has the disadvantage of not being able to visualize its exit, thus risking damage to the posterior structures. In addition, keeping the reduction and performing countertraction is technically demanding, so that the placement of the screw can lead to displacement of the avulsed fragment, limiting the interfragmentary compression principle with a high risk of nonunion [12].

In 2001, Kim *et al.* [15] postulated different ways for fixing fragments of different sizes. They suggested cannulated screws for large bony fragments (20 mm), multiple pins for medium-sized fragments (10–20 mm), and wire sutures and multiple sutures for small fractures (10 mm) without and with comminution.

Martinez-Moreno and Blanco-Blanco [16] experimentally demonstrated the possibility of percutaneous fixation under arthroscopic control in cadaveric knees. Clinically, Littlejohn and Geissler [17] first reported percutaneous fixation of an exceptionally large bony fragment including PCL attachment under arthroscopic control using three cannulated screws. They recommended this technique when the fragment size is large enough to allow easier fragment reduction and fixation using arthroscopy. They used PCL tibial guide through a central patellar tendon portal. Three 4.5-mm cannulated screws were used to fix the fragment. Immediate ROM was initiated with quadriceps rehabilitation. Partial weight bearing has begun at 6 weeks. Postoperative ROM was from 0 to 135° [17].

Choi and Kim [18] succeeded in rigid fixation of a large avulsed fragment, which is commonly seen, using two screws. These authors used a PCL guide to temporarily fix the fragment with pins and then rigidly fixed it using multiple cannulated screws. More recently, Espejo-Baena *et al.* [14] described the technique to reduce the large fragment using an ACL aimer and fixation with two screws, while viewing via the posteromedial portal. Incidentally, all these cases describe a relatively large size of fragments (3 cm or greater in width), which were suitable for multiple screw fixation [13].

Domnick *et al.* [19] compared the biomechanical properties of different fixation techniques for the PCL avulsion fractures. They found that the cortical suspension button and retrograde screw fixation techniques showed comparable structural properties to the direct screw fixation technique. They concluded that all techniques appear to constitute a biomechanically stable alternative to traditional anterograde screw fixation. In contrast to anterograde screw fixation, these techniques can be performed less invasively [19].

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Conflicts of interest
There are no conflicts of interest.

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