

Minimally invasive open reduction and fixation of avulsed tibial insertion of posterior cruciate ligament

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Abstract

Background Surgical treatment of bony avulsions of the posterior cruciate ligament (PCL) through a classic posterior approach carries a high risk of neurovascular compromise, and arthroscopic techniques are demanding. The purpose of this study is to report results of safe, minimal invasive surgical approach using pull-out suture fixation technique.

Materials and methods This is a prospective study of 16 cases with avulsion of the posterior tibial spine, managed through minimally invasive posterior approach and fixed by pull out suture. All patients were males, of mean age 34.5 ± 5.5 years. Average follow-up period was 18 ± 4 months.

Results The average operative time was 32 ± 3.75 min. X-rays showed satisfactory reduction and good bone healing in all cases at 3 months. Functional results were excellent in 13 patients, and near normal International Knee Documentation Committee (IKDC) score in the remaining 3 patients. Average Lysholm score was 95.2 ± 2.3 , with no complications related to approach or fixation technique.

Conclusions The presented minimally invasive posterior knee approach is easy and safe with adequate exposure of PCL avulsion fracture. Fixation technique by pull-out sutures is a reliable method of fixation of this kind of fractures that avoids the complications of metal hardware and subsequent need for removal.

Keywords Avulsion PCL · Pull-out · Minimally invasive

Introduction

The posterior cruciate ligament (PCL) is the primary constraint of posterior tibial translation at both 30 and 90° of flexion thus very important in knee stability [1]. Natural history studies especially of isolated PCL injuries showed overall good results of conservative management [2]; however, PCL-deficient knees sustained increased articular contact forces [3] that may lead to patellofemoral and medial tibiofemoral degenerative changes [4].

Avulsion fractures of the PCL are rare, and treatment options depend on the type and size of the fracture, displacement, comminution, and orientation of the fragment [5, 6]. These injuries typically occur at the tibial attachment and may encompass either a small area at the posterior region of the attachment or a large area that extends anteriorly and outside of the PCL attachment to tibial plateau [5].

Surgical treatment of displaced tibial avulsions of the PCL is regarded as necessary to achieve anatomic fixation, and to regain knee stability [1, 7]. Open reduction and fixation through traditional posterior knee approach is associated with significant soft tissue damage and high risks of neurovascular compromise [8]. Arthroscopic management of these injuries is technically challenging and probably beyond the capabilities of most orthopedic surgeons (especially non-sports fellowship trained orthopedists) [9].

The purpose of the current study is to assess the results of open reduction and pull-out fixation of avulsed tibial insertion PCL using mini-invasive posterior knee approach.

Material and methods

During the period from October 2011 to December 2013, 16 patients with tibial avulsion fractures of the PCL were enrolled

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in the current study. The study was approved by the ethical committee of Benha University. All patients have signed an informative consent.

All patients were males, of mean age 34.5 years (range 23 to 45). The mode of injury was road traffic accident in ten patients, fall in three patients, and sport injury in three patients. All fractures were acute with an average of 8 days (range 5 to 13) from injury.

The inclusion criterion was PCL avulsion fracture with more than 3 mm of upward displacement of the bony fragment. Exclusion criteria were as follows: (1) minimally displaced bony fragment (<3 mm) and (2) associated tibial plateau, tibial or femoral fractures, or other knee ligamentous or meniscal injuries that required surgical repair diagnosed prior to surgery or during preliminary arthroscopy.

Diagnoses were confirmed by clinical and radiologic evaluation. Preoperative anteroposterior (AP) and lateral x-rays and CT scans were done for all patients. MRI was done for only three cases (Fig. 1). Posterior laxity was measured by manual posterior drawer test done preoperatively under anesthesia, at 3 months and 1 year follow-up in comparison to normal side.

Operative technique

All patients underwent surgery under spinal anesthesia with the use of tourniquet. Patients were placed in the supine

position and routine knee arthroscopy was done to address the intra-articular lesions and deal with them (patients required meniscal or ligamentous repair were excluded from the study). Patients were then flipped into prone position and draped again.

A vertical incision was used beginning at the knee flexion crease for about 5 cm along the medial head of gastrocnemius. Both the superficial and deep fascia were cut in line of the incision.

The medial head of gastrocnemius was split, and medial half was retracted medially with semimembranosus muscle while lateral half was retracted laterally protecting neurovascular structures until the capsule was exposed (Fig. 2a, b).

Capsulotomy with longitudinal incision was made laterally to expose the avulsed bony fragment and the fracture crater. The avulsed bony attachment of the PCL was identified and Ethibond no 5 was passed in the PCL stump three to four times.

Two slotted 2.4-mm ACL guide pins drilled in the medial and lateral sides of the bottom of the fracture crater were used to pass the pull-out sutures to the anteromedial surface of the tibia. The fracture fragment(s) is pushed in the fracture crater while the sutures were pulled. The sutures were then tied with the knee held in 90° flexion while applying anterior drawer force by assistant (Fig. 2c).

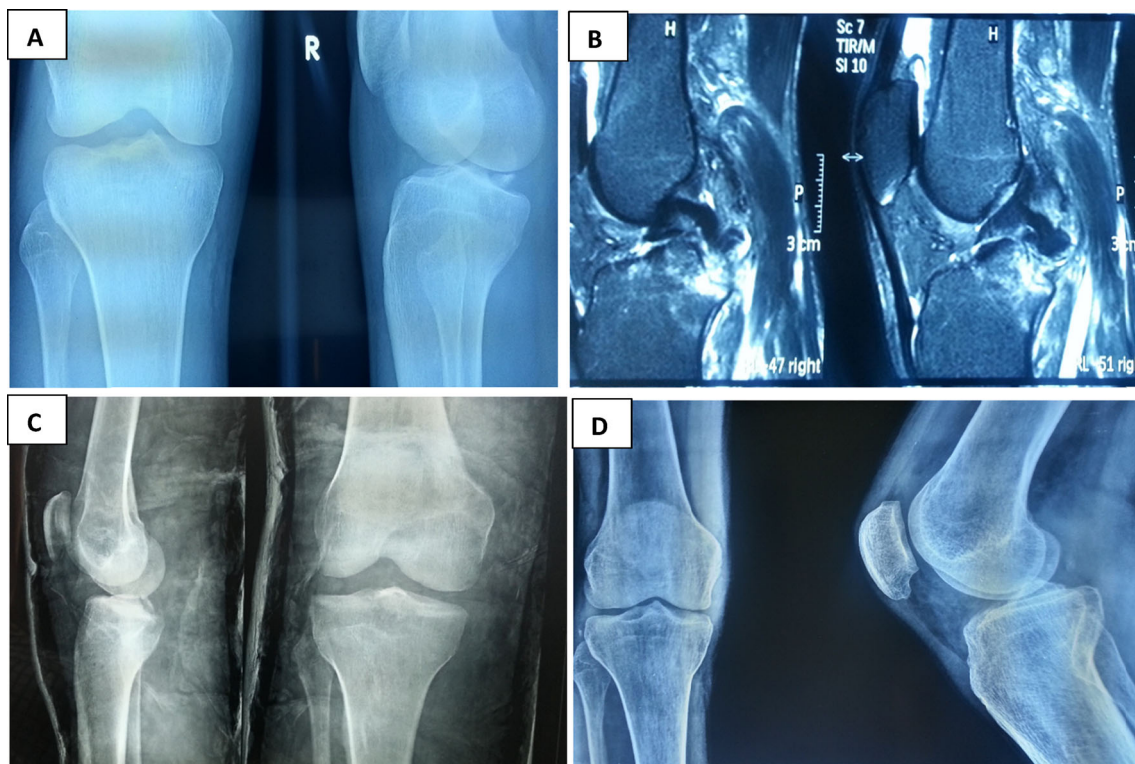
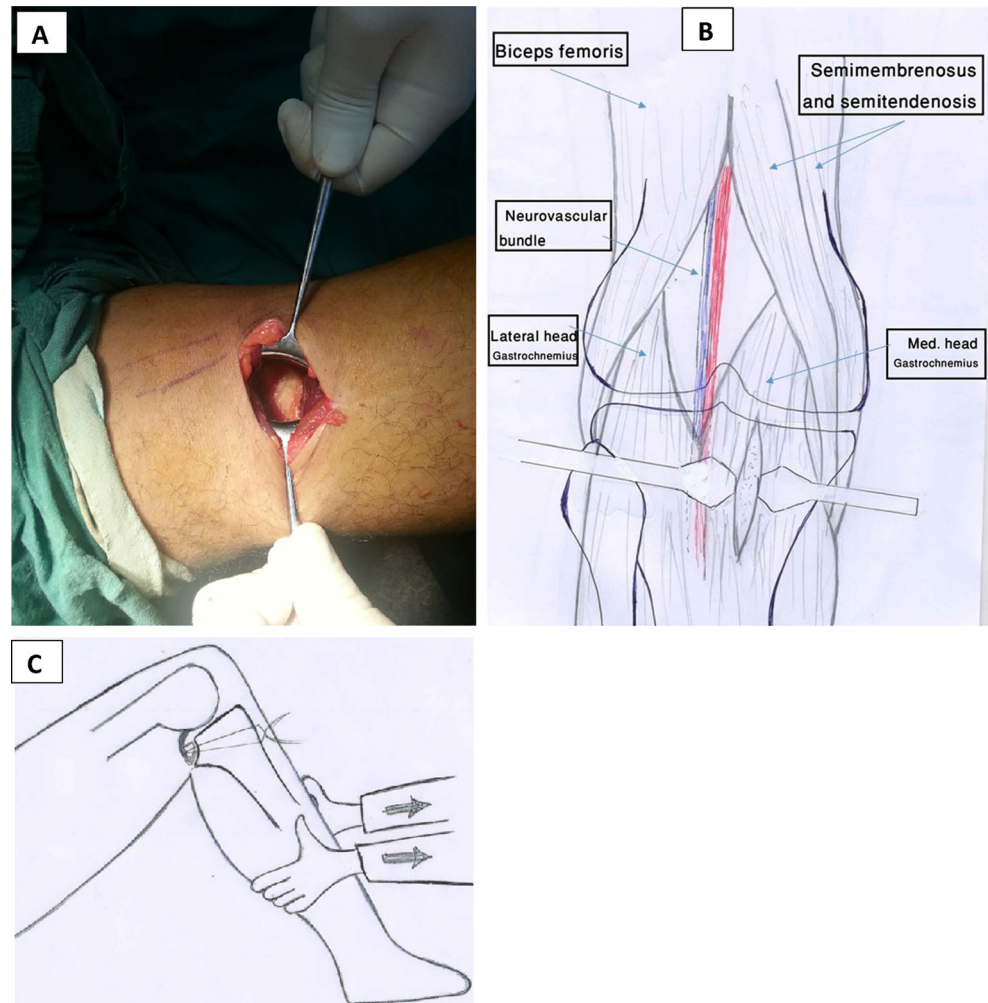


Fig. 1 a Preoperative x-ray showing the fracture, b Preoperative MRI showing the fracture, c Immediate postoperative x-ray, d 6 months postoperative radiograph showing complete union

Fig. 2 **a** Intraoperative photos of right knee with the patient prone showing posterior knee capsule well exposed. **b** Illustrative drawing of the approach showing split in medial head gastrocnemius. **c** Illustrative drawing demonstrating pull-out suturing while applying anterior drawer stress over tibia



After thorough lavage, the capsule split was sutured back, and the wound was closed without a drain. An above knee cast was applied with the knee in 5 to 10° of flexion.

Postoperative care and follow-up

Patients were encouraged to start isometric strengthening exercises of the quadriceps immediately after surgery. After 2 weeks of non-weight bearing, partial weight bearing was allowed for another 4 weeks. The plaster cast was removed after 4 weeks, and range of motion exercises were started to reach 120° flexion by the end of the sixth week. Follow-up x-rays were done at 6 weeks, 3 and 6 months. Sport activities were allowed after 6 months. At 12 months postoperatively, Lysholm and International Knee Documentation Committee (IKDC) score were collected.

Results

Average time of open surgery was 32 min (25–40 min). Mean follow-up period was 18 months (12–28 months). X-rays

taken 3 months postoperatively showed that bony union was achieved in all 16 patients.

At final follow-up, the knee ranges of flexion reached or exceeded 125° in all patients. Before surgery, ten patients had grade II positive posterior drawer test and six had grade III. Postoperatively at final follow-up, all patients had a negative posterior drawer test except one patient who had a grade I positive test with firm end-point.

At final follow-up, average Lysholm score was 95.2±2.3 (range 92–100). According to the IKDC scale, normal knee function (grade A) was reported by 13 patients who returned to their former type of work. The remaining three patients were graded as near normal (grade B).

No neurovascular complications were met in the current series.

Discussion

Early diagnosis of isolated PCL tears may be difficult, and the treatment remains controversial. On the contrary, bony PCL

avulsion injuries are easy to diagnose with universally standard treatment protocol [7, 10]. However, some orthopedic surgeons are apprehensive about treating tibial avulsions of the PCL because of their unfamiliarity with the standard posterior approach to the knee.

Very few series [11–13] discussing PCL injuries have used the posterior approach through the popliteal fossa as described by Abbott [14] because of the complexity of the approach and the need for dissection of the neurovascular bundle in the popliteal fossa. Similarly, the posterolateral approach is limited by potential injury to the common peroneal nerve [15].

On the other hand, arthroscopic fixation that has become popular in last decade [16–18] is challenging and technically demanding, which is not feasible to all orthopedic surgeons, and anatomic reduction and reliable fixation are difficult to achieve. Moreover, due to the close proximity of the popliteal neurovascular bundle, this procedure may be dangerous [19].

The open technique could be performed using mini-invasive approach providing satisfactory exposure of the fracture site through safe, simple, less time-consuming approach. Burks and Schaffer [8] described a posteromedial approach for treatment of PCL injuries through the interval between the medial gastrocnemius muscle and the semimembranosus tendon. This approach avoids dissecting the neurovascular structures in the popliteal fossa as well, but sometimes the mass of the retracted medial gastrocnemius head does not provide adequate exposure to the lateral part of the fracture bed especially in muscular persons and after mild edema following arthroscopy. Some authors reported skin necrosis along the incision line in many cases due to overzealous retraction during surgery [12].

In the current series, we have used mini-invasive (trans-gastrocnemius) posterior approach for fixation of tibial avulsions of PCL and present our experience with this safe and easy exposure with overall results comparable to arthroscopic

or other open and min-invasive posteromedial approaches (Table 1).

The average operative time was 32 ± 3.75 minutes which is similar to average time reported by Zhang et al. [20] using posteromedial approach but about half the time of Gui et al. [18] using arthroscopic fixation (67 ± 11.25 min). The postoperative flexion range was 134 ± 4.6 which is similar to that of Gui et al. [18] but better than that of Zhang et al. [20] (average was 120). All 16 cases in our current series passed without any intraoperative or postoperative approach complications, demonstrating the safety of the approach.

Many fixation techniques have been used for fixation of avulsion fractures, such as k wires [16], screws [13, 21], pull-out sutures [18, 22], and suture anchors [20]. Screws fixation is recommended if the fracture fragment is large. However, 50 % of these fractures are comminuted [5], and there is always a high risk of screw cut-out and bony fragment destruction by the screw [23]. Moreover, screws may cause irritation and pain after healing which require removal [24]. Eggers et al. [25] in their biomechanical study concluded that “under cyclic loading conditions, suture fixation of tibial eminence fractures provides more fixation strength than screw fixation.”

In one case, sutures cut through bone tunnels (probably due to very close tunnels exit), so sutures were tied and tensioned over a distal screw.

The operative technique presented in the current study has many advantages. First, the approach is easy, simple, and safe. Second, the fixation technique by pull-out sutures is a simple and reliable method of fixation that is suitable in comminuted fractures and avoids the complications of metal hardware and subsequent need for removal. One more advantage is that it allow for tensioning the PCL that may show some laxity from interstitial damage. The limitation of the current study is the lack of objective instrumental posterior knee laxity measurement (by KT-1000 or stress x-rays).

Table 1 Postoperative results of current study and similar studies using other open and arthroscopic techniques

	Current study	Gui et al. [18]	Nikiforidis et al. [13]	Zhang et al.[20]
Number of patients	16	28	23	16
Approach	Mini-open	Arthroscopic	Posterior approach	Posteromedial approach
Fixation technique	Pull-out sutures	Single tunnel pull-out suture	4 mm screws in 17 cases and pull out in 6 cases	Suture anchors
Average follow-up	18 months (12–28)	40 months (33–45)	7.4 years (2–14)	18 months (4–36)
Mean operation time	32 min (25–40)	67 min (45–90)	–	28 min (20–40)
Posterior drawer test	1 grade I, 15 negative	23 negative and 1 grade 1	–	–
Knee ROM	134.3 ± 4.6 (range 126–142°)	135.3 ± 6.3 ° (range 125–150°)	Full ROM	120°
Lysholm knee score	95.2 ± 2.3 (range 92–100)	95.2 ± 2.3 (range 92–100)	–	94 (79–100)
IKDC score	13 normal, 3 near normal	20 normal and 4 near normal	18 normal 5 near normal	–
Average time to union	3 months	2.8 months	6 weeks	4 months

Conclusion

The presented minimally invasive posterior knee approach is easy and safe with adequate exposure of PCL avulsion fracture. Fixation technique by pull-out sutures is a reliable method of fixation of this kind of fractures that avoids the complications of metal hardware and subsequent need for removal.

Compliance with ethical standards

Conflict of interest Both authors have no conflict of interest to disclose and did not receive any fund or research grants.

Ethical approval The study was approved by ethical committee of Banha University and was in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed consent All patients signed an informed consent after clear explanation of the surgical procedure.

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