Fixation of tibial bony avulsion of the posterior cruciate ligament using the posteromedial approach

Mohamed E. Attia, Amr I. Zanfaly

Department of Orthopedic Surgery, Zagazig Faculty of Medicine, Zagazig, Egypt

Correspondence to Mohamed E. Attia, MD, Sharkia Hehia, Ahmed Oraby Street, Zagazig, Egypt
Tel: +20 122 729 9549;
e-mail: mohamedelsadek83@yahoo.com

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Background
Tibial avulsion fractures of the posterior cruciate ligament are not infrequent. Controversies exist between fixation of the fragments and their reconstruction in patients with small bony fragments. This prospective study was undertaken to study the results after fixation of the fragments using a lag screw.

Objective
This study was designed to evaluate the efficacy of the treatment of posterior cruciate ligament avulsion fractures using the posteromedial approach and fixation with navicular screws.

Study design
This was a prospective study conducted in 12 patients treated by fixation with navicular screws through the posteromedial approach.

Patients and methods
From June 2008 to March 2010, 12 patients with acute posterior cruciate ligament avulsion fracture of the tibial attachment were treated surgically at Zagazig University Hospital and Health Insurance Hospital. Nine patients were male and three were female. Navicular screw fixation was used in all 12 patients in avulsed bony fragments, with washers in eight patients and no washers in four patients.

Results
All the avulsion fractures achieved union at an average of 10–14 weeks. All patients had severe posterior instability (>10 mm) preoperatively. After union of the fracture, no case suffered severe instability. Patients were followed up for an average of 7.58 months (range 6–12 months). Of the 12 patients included in this study, four (33.3%) showed excellent results, seven (58.3%) showed good results, and one (8.3%) showed a fair result.

Conclusion
The treatment of avulsion fracture of the posterior cruciate ligament by open reduction through the posteromedial approach and internal fixation using partially threaded screws gives very good functional and radiological results. The dissection involved is minimal and risk to the neurovascular structures is negligible.

Keywords:
avulsion fracture, posterior cruciate ligament, tibial bony

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Introduction

Injuries of the posterior cruciate ligament (PCL) are rare. Chronic instability and early degenerative changes can develop as a result of delayed diagnosis. Evaluation of the PCL is notoriously difficult, both clinically and arthroscopically. Isolated PCL disruption most commonly occurs as avulsion at its tibial insertion as opposed to its femoral origin or as a midsubstance tear. On imaging, this injury appears as focal discontinuity of the posterior tibial articular surface. The mechanisms of injury of the PCL are multiple and include a direct blow to the anterior tibia with the knee flexed (as occurs with dashboard injury during a motor vehicle collision) or severe hyperextension (which commonly occurs in the setting of athletic trauma). Despite the fact that injury to the PCL may be an isolated finding, concurrent damage to the other major stabilizing structures of the knee is common. This is particularly true when the mechanism of injury involves severe rotational forces [1]. The PCL plays a major role in knee stabilization [2]. Isolated tear or avulsion of the PCL can be caused by a fall on a flexed knee or by striking of the flexed tibia on the dashboard in a motor vehicle accident [3]. The tibial insertion of the PCL is more consistent than the femoral insertion [4,5]. The two PCL fiber bundles insert without anatomic separation in a centrally located fovea, or facet, on the posterior aspect of the tibia ~1.0–1.5 cm distal to the joint line, with the posterior horn of the medial meniscus being the anterior-most extent [5]. The center of the two fiber bundles is located, medial to lateral, 48% of the mediolateral width of the tibial plateau from the medial tibial edge [4]. Moorman *et al*. [6] found that the mean distance from the anterior edge of the PCL tibial insertion to the posterior tibial cortex was 15.6 mm (range 14–18 mm). The center of the

PCL insertion was, on average, 7 mm anterior to the posterior tibial cortex, with the bulk of the ligament located in the posterior half of the PCL facet. A few fibers were found to extend inferiorly 2 cm down the posterior tibial cortex. The authors recommend that, during transtibial PCL reconstruction, the center of the tibial tunnel be placed at one-quarter of the total facet length anterior to the posterior tibial cortex 7 mm anterior to the posterior cortex. PCL is fixed on the anterior half of the axial surface of the femoral internal condyle, protruding at caudal and medial directions, by the intercondylar incisure toward its tibial insertion located posterior, inferior, and juxtalateral to the midline of the tibial plateau. It acts as a major posterior knee stabilizer, limiting posterior tibial translation in relation to the femur [7,8]. PCL injuries account for 20% of knee ligament injuries. That incidence is higher especially in cases resulting from high-energy trauma, such as motorcycle and car accidents. In an athletic population, this injury is more closely associated with contact sports [9,10]. In treating a PCL injury, different techniques such as tendon graft and fixation methods are applied; in the presence of PCL bone avulsion in its tibial insertion surgical intervention is considered the most favorable method from treatment and secondary healing perspectives [2]. The surgical technique consists of a posterior medial knee approach, involving reinsertion and fixation of the PCL bone fragment into its anatomical bed located on the posterior tibial surface, which is reported as sufficient for re-establishing ligament integrity and function [11].

Patients and methods

From June 2008 to March 2010, 12 patients with PCL tibial avulsion injuries presented at Zagazig University Hospital and Health Insurance Hospitals. Nine were male and three were female; seven patients had affection of the right knee and five patients had affection of the left knee; their ages ranged from 24 to 36 years, with an average of 29.2 years. Associated injuries were present in three patients in the form of contralateral-sided fractured femur, fractured ribs, and ipsilateral fractured leg bones; the cause of injury was motor vehicle accident in six patients, sports injury in two, bicycle injury in two, falling from a height in one, and road traffic accident in one. At the time of presentation, all patients were evaluated by clinical tests such as drawer test, Lachman's test, pivot shift test, and test for integrity of the medial and lateral collateral ligament by valgus and varus methods (preoperative and intraoperative). Radiography films of the knee (posteroanterior and lateral views) showed avulsion fracture of the PCL tibial attachments. MRI was performed in all patients. Patients were operated upon at an average 5 days after trauma (varying from 3 to 10 days). All patients were treated using the posteromedial approach and the bony fragment was fixed with navicular lag screws. The Lysholm knee score was used to evaluate the outcome of the patients and radiological union on follow-up (Table 1).

Surgical technique

After administering anesthesia the patient is positioned in the prone position and the lower extremity is held in 30° of flexion at the knee joint over a bolster. An inverted L incision is made over the posteromedial corner of the knee joint. Transverse limb incision is begun in mid-popliteal space, 1–2 cm below the popliteal crease and slightly medial to the midline of the knee (Fig. 1a). The incision is then extended and curved distally following the posteromedial aspect of the upper leg, ending 4–5 cm distally. The skin and subcutaneous flap are inferolaterally reflected. This area is devoid of subcutaneous neurovascular elements, but the posterior cutaneous nerve of the calf and short saphenous vein are located superficially to the fascia and should be preserved at lateral extension of the incision. The fascia overlying the medial head of the gastrocnemius is identified and opened in line with the longitudinal limb that is incised (Fig. 1b). The dissection is continued by longitudinal splitting of the fibers of the medial head. Medial and lateral divisions of the medial head are held separate to expose the posterior capsule of the knee joint; then capsulotomy with a longitudinal incision is made to expose the avulsed bony fragment. If there is more than one bony fragment or lateral extension of the bony fragment, pulling the lateral half of the medial head could improve the exposure (Fig. 1c). The middle geniculate artery may be encountered near the midposterior capsule and can be ligated if necessary. After cleaning the crater and the avulsed fragment, the bony fragment is reduced into its bed and fixed with a navicular screw [12].

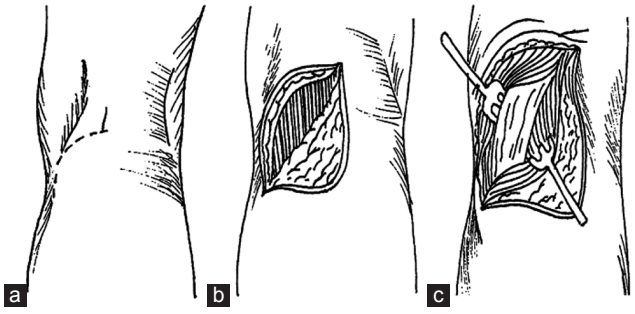
Postoperative care

The knee was immobilized in a plaster cast at 30° flexion for 6 weeks, followed by placement of the limb in a long leg hinged knee brace while wearing the brace, patients are encouraged to start quadriceps muscle-strengthening exercises and gradual guarded flexion and extension. Also walking with partial weight bearing is allowed using crutches at 3 weeks. The brace is locked in full extension during walking. At 9 weeks, the brace is unlocked to allow motion and full weight bearing is permitted. At 12 weeks, the brace is removed and patients are encouraged to increase activity gradually.

Table 1 Patient's data Lysholm knee score

Case nos	Age (years)	Sex	Side	Mechanism of injury	Associated injury	Days before fixation	Fixation	Follow-up (months)	Lysholm knee score	Complications
1	32	Male	Right	Motorcycle	—	5	Navicular screw	6	Excellent	—
2	26	Male	Right	Motorcycle	—	3	Navicular screw	8	Good	Superficial infection
3	24	Female	Right	Motorcycle	Contra lateral fracture femur	4	Navicular screw and washer	12	Excellent	—
4	31	Male	Left	Falling from a height	—	6	Navicular screw	8	Good	—
5	24	Male	Left	Motorcycle	—	4	Navicular screw	6	Good	—
6	36	Male	Right	Bicycle le	—	5	Navicular screw and washer	6	Excellent	—
7	28	Female	Left	Road traffic accident	Ipsilatral leg fracture	6	Navicular screw	12	Fair	Stiffness knee
8	30	Male	Left	Bicycle le	—	10	Navicular screw	6	Good	—
9	24	Male	Right	Motorcycle	—	7	Navicular screw and washer	8	Excellent	—
10	26	Male	Right	Sports injury	—	6	Navicular screw	6	Good	—
11	30	Female	Left	Sports injury	Fracture clavicle	5	Navicular screw	6	Good	—
12	31	Male	Right	Motorcycle	—	3	Navicular screw and washer	7	Good	—
Average	29.2					5.25		7.58		

Figure 1



Posteromedial incision of the right proximal tibia [12]. (a) Line of incision. (b) Superficial dissection, medial head of the gastrocnemius. (c) Reflection of two parts of the medial head of the gastrocnemius, posterior capsule.

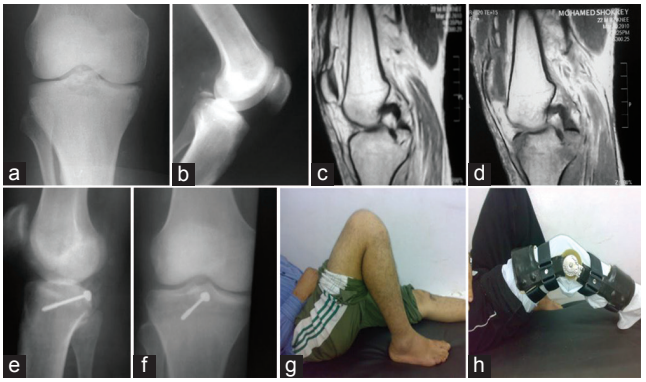
Results

The Lysholm knee score is a condition-specific outcome measure that contains eight domains: limp, locking, pain, stair climbing, use of supports, instability, swelling, and squatting. An overall score of 0–100 is calculated, with 95–100 indicating an excellent outcome, 84–94 indicating a good outcome, 65–83 indicating a fair outcome, and less than 65 indicating a poor outcome. There were nine male and three female patients. The mean age at the time of injury was 29.2 years (range 24–36 years). There were six motorcycle injuries; two sports injuries, two bicycle injuries, one road traffic accident, and one injury from a fall. The mean Lysholm score in this study was 91. Following the Lysholm scoring system, of the 12 patients in this study, four (33.3%) showed excellent results, seven (58.3%) showed good results, and one (8.3%) showed a fair result. One patient had superficial skin infection treated with antibiotics and daily dressing. One patient had knee stiffness. The results for ipsilateral leg fractures were fair. No neurovascular complications occurred (Fig. 2).

Discussion

Injury to the PCL is not common. Avulsion of the tibial attachment of the PCL is less frequent and found more often in the older age group [13]. The so-called 'isolated' PCL is often overlooked; the presence of ecchymoses and abrasions on the anterior surface of the proximal tibia are suggestive of PCL injury. Clinical examination confirmed a posterior sag and a positive posterior drawer test. Radiographs showed a fragment of bone detached from the back of the intercondylar space of the tibial plateau, slightly displaced, or pulled upward and rotated. Although surgical indications for midsubstance tear of the PCL remains controversial, surgical fixation of the PCL avulsed fragment is

Figure 2



(a, b) Male patient with preoperative posterior cruciate ligament (PCL) avulsion fracture on anteroposterior and lateral radiographic views. (c, d) MRI with bony fragment and retracted PCL. (e, f) Postoperative radiograph 12 weeks after fixation. (g, h) Knee flexion postoperatively aided with a knee brace.

the accepted treatment of choice in PCL avulsion fractures [14,15]. Piedade and Mischan [16] reported 20 out of 21 patients after surgical treatment of avulsion fracture of the PCL from tibial attachment as having posterior laxity of at least 5–10 mm. In our study, seven patients were rated good (58.3%), four were rated excellent (33.3%), and one (8.3%) was rated fair in a subjective evaluation (Lysholm).

Inoue *et al*. [17] conducted a prospective study to evaluate the clinical prognosis of open reduction and PCL avulsion fracture fixation. In this study ~60% of the 31 studied patients showed a certain degree of posterior instability on operated knees when compared with intact knees, even after anatomical reduction and stiff fixation of the bone fragment. Trickey [18] described a technique using the posterior approach to the knee, involving open reduction and fragment fixation. Burks and Schaffer [19] adopted a simplified access for a posterior knee approach. In this study, a safe posteromedial approach was used in all patients resulting in less surgical trauma. In a study conducted on 36 patients with bone avulsion of the PCL in its tibial insertion, Torisu [20] found that the injury was secondary to a motorcycle accident in 47% of cases, and identified the presence of the injury on the anterior tibial surface in 47% of patients. Seitz *et al*. [21,22] retrospectively assessed 26 patients and found a similar mechanism of injury in 87% of cases, and injury on the anterior leg surface in 100%. In this study, 50% of injuries were the result of motorcycle accidents, and 8.3% were caused by car accidents, while the presence of injury on the anterior leg surface was found in 65% of cases.

Conclusion

Avulsion fractures of the PCL tibial insertion usually constitute only a small subgroup of PCL injuries. Although several fixation techniques have been reported in the literature, surgical fixation is usually recommended. The dissection involved is very minimal, and risk to the neurovascular structures is remote. Despite mild laxity in the injured knee, the functional outcomes after fixation of the PCL avulsion fracture using partially threaded screws were good to excellent. Surgical treatment of avulsion fractures of the PCL of the knee provides satisfactory outcomes according to subjective analysis.

Acknowledgements

Conflicts of interest

There are no conflicts of interest.

References

1 Goettsegen CJ, Eyer BA, White EA, Learch TJ, Forrester D. Avulsion fractures of the knee: imaging findings and clinical significance. Radiographics 2008; 28:1755–1770.

2 Trickey EL. Injuries to the posterior cruciate ligament: diagnosis and treatment of early injuries and reconstruction of late instability. Clin Orthop Relat Res 1980; 147:76–82.

3 Shino K, Nakata K, Mae T, Yamada Y, Shiozaki Y, Toritsuka Y. Arthroscopic fixation of tibial bony avulsion of the posterior cruciate ligament. Arthroscopy 2003; 19:E12.

4 Edwards A, Bull AM, Amis AA. The attachments of the fiber bundles of the posterior cruciate ligament: an anatomic study. Arthroscopy 2007; 23:284–290.

5 Dargel J, Pohl P, Tzikaras P, Koebke J. Morphometric side-to-side differences in human cruciate ligament insertions. Surg Radiol Anat 2006; 28:398–402.

6 Moorman CTIII, Murphy Zane MS, Bansai S, *et al*. Tibial insertion of the posterior cruciate ligament: a sagittal plane analysis using gross, histologic, and radiographic methods. Arthroscopy 2008; 24:269–275.

7 Van Dommelen BA, Fowler PJ. Anatomy of posterior cruciate ligament. A review. Am J Sports Med 1989; 17:24–29.

8 de Abreu MR, Kim HJ, Ching CB, Jesus JM, Cho J, Trudell D, *et al*. Posterior cruciate ligament recess and normal posterior capsular insertional anatomy: MR imaging of cadaveric knees. Radiology 2005; 236:968–973.

9 Wind WM Jr, Bergefeld JA, Parker RD. Evaluation and treatment of posterior cruciate injuries. Revisited. Am J Sports Med 2004; 32:1765–1775.

10 Deeham DJ, Pinczewski LA. Arthroscopic reattachment for an avulsion fracture of the tibial insertion of the posterior cruciate ligament. Arthroscopy 2001; 17:422–425.

11 Torisu, T. Isolated avulsion fractures to the tibial attachment of the posterior cruciate ligament. J Bone Joint Surg Am 1977; 59:68–72.

12 Jazayeri SM, Esmaili Jah AA, Karami M. A safe postero-medial approach to posterior cruciate ligament avulsion fracture. Knee Surg Sports Traumatol Arthrosc 2009; 17:244–247.

13 Griffith JF, Antonio GE, Tong CW, Ming CK. Cruciate ligament avulsion fractures. Arthroscopy 2004; 20:803–812.

14 Torg JS, Barton TM, Pavlov H, Stine R. Natural history of the posterior cruciate ligament-deficient knee. Clin Orthop Relat Res 1989; 246:208–216.

15 Shelbourne KD, Davis TJ, Patel DV. The natural history of acute, isolated, nonoperatively treated posterior cruciate ligament injuries. A prospective study. Am J Sports Med 1999; 27:276–283.

16 Piedade SR, Mischan MM. Surgical treatment of avulsion fractures of the knee PCL tibial insertion: experience with 21 cases. Acta Orthop Bras 2007; 15:272–275.

17 Inoue M, Yasuda K, Kondo E, Saito K, Ishibe M. Primary repair of posterior cruciate ligament avulsion fracture. The effect of occult injury in the midsubstance on postoperative instability. Am J Sports Med 2004; 32:1230–1237.

18 Trickey EL. Rupture of the posterior cruciate ligament of the knee. J Bone Joint Surg Br 1968; 50:334–341.

19 Burks RT, Schaffer JJ. A simplified approach to the tibial attachment of the posterior cruciate ligament. Clin Orthop Relat Res 1990; 254:216–219.

20 Torisu, T. Avulsion fractures to the tibial attachment of the posterior cruciate ligament: indications and results of delayed repair. Clin Orthop Relat Res 1979; 143:107–114.

21 Seitz H, Schlenz I, Pajenda G, Vecsei V. Tibial avulsion fracture of the posterior cruciate ligament: K-wire or screw fixation? A retrospective study of 26 patients. Arch Orthop Trauma Surg 1997; 116:275–278.

22 Chiu FY, Wu JJ, Hsu HC, Lin L, Lo WH. Management of avulsion injury of the PCL with reattachment. Injury 1994; 25:293–295.