

Open Repair of Posterior Cruciate Ligament Femoral Peel-Off Lesion in Multiligamentous Knee Injuries Results in Good Outcomes



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Purpose: To identify posterior cruciate ligament (PCL) peel-off lesions, to separate these lesions from more common midsubstance tears, and to evaluate patient outcomes after primary open repair. **Methods:** Patients with acute femoral-side “peel off”-type lesions associated with multiligamentous injuries who underwent PCL repair were identified. Patients with chronic PCL injuries, midsubstance PCL tears, or PCL tibial avulsions were excluded from the study. A total of 11 patients were included in this study. All patients underwent open repair using a suture pullout technique. **Results:** The mean follow-up period was 18 months. The mean Lysholm score at 12 months was 87. Mean knee range of motion (flexion) achieved at 12 months was 121°. No patient had grade 3 laxity on posterior stress testing at final follow-up. **Conclusions:** Our study showed good outcomes after primary repair of femoral PCL peel-off lesions. **Level of Evidence:** Level IV, therapeutic case series.

The posterior cruciate ligament (PCL) has been known as the central pivot point of the knee and is considered the primary restraint against posterior tibial translation. Injury to the PCL rarely occurs in isolation and is most commonly present in the setting of multiligamentous knee injuries.¹

Several patterns of PCL rupture have been reported, including midsubstance failure, tibial avulsion, femoral peel-off lesion, and femoral avulsion according to the anatomic site of the lesion.^{2,3} The so-called acute femoral peel-off tear is the subject of only a few reports in the literature.³ This separate and very specific injury type is characterized by a complete or incomplete soft-tissue disruption of the PCL at its femoral attachment

site without associated bony avulsion. Biomechanical loading studies have been unsuccessful in reproducing this type of injury; thus, the exact mechanism of injury is poorly understood.⁴

Compared with the anterior cruciate ligament (ACL), the PCL is larger and has a better blood supply to allow for primary healing, thus making this type of PCL injury more amenable to repair instead of reconstruction. Advocates argue that direct repair not only facilitates precise, anatomic reattachment of the native PCL at its natural footprint but also preserves intrinsic neural elements, crucial for proprioception and gait biomechanics.⁴ The site of this specific type of injury falls in zone I as described by Lysholm and Gillquist.⁵

One of the major concerns when treating PCL injuries associated with multiligamentous knee injuries is the availability of the graft required. Thus, performing repair rather than reconstruction whenever possible avoids the need for additional graft harvesting or the expense of an allograft when treating these injuries. The literature has been divided over open repair versus arthroscopic repair, with both repair methods showing favorable outcomes. However, all studies were either case reports or case series with limited numbers of cases. There is a paucity of literature regarding outcomes associated with open repair of this particular type of PCL injury; thus, this study was undertaken.

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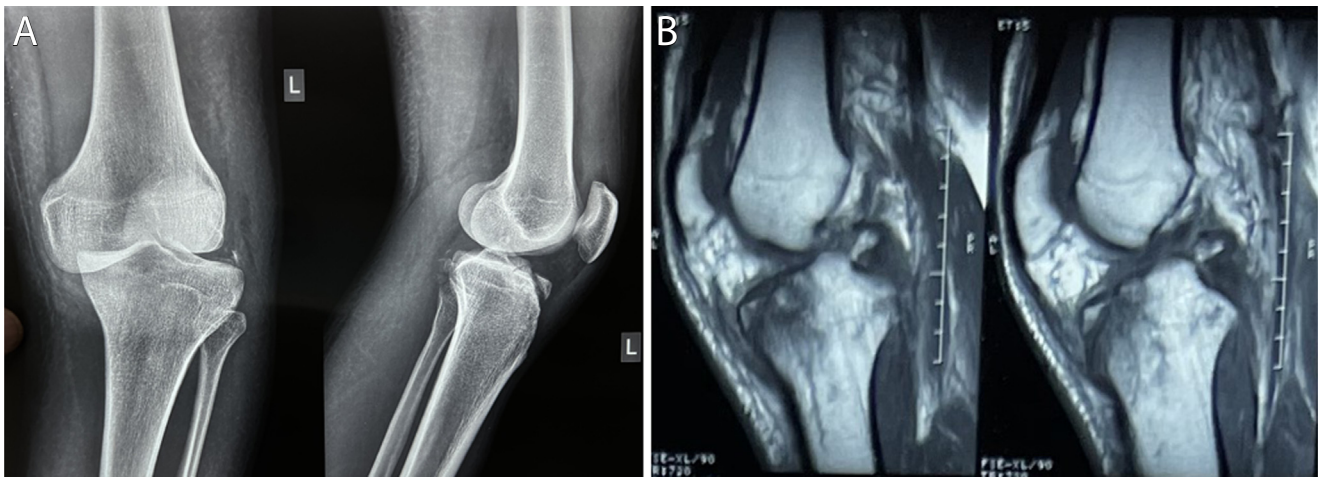


Fig 1. (A) Radiographs obtained immediately after injury: anteroposterior and lateral views of left knee showing lateral dislocation of tibia over femur. (B) Sagittal magnetic resonance images (T1) showing posterior cruciate ligament peel-off lesion from femur evidenced by long segment of posterior cruciate ligament attached to tibial end. (L, left.)

The purposes of this study were to identify PCL peel-off lesions, to separate these lesions from more common midsubstance tears, and to evaluate patient outcomes after primary open repair. We hypothesized that repairs of femoral peel-off lesions of the PCL would heal well and would not require reconstruction.

Methods

This study was conducted at a tertiary referral hospital with a level I trauma center. Patients who underwent PCL repair for an acute (i.e., injury < 3 weeks earlier) femoral peel off–type lesion associated with multi-ligamentous injuries (Fig 1) were retrospectively identified. Patients with chronic PCL injuries, midsubstance PCL tears, or PCL tibial avulsions were excluded from

this study. All patients underwent open repair using a suture pullout technique.

Surgical Technique

Under spinal anesthesia, the patient, with a tourniquet around the thigh, was positioned supine on the operating table. Standard anteromedial arthrotomy was performed, and the knee was hyperflexed to visualize the proximal end of the PCL. Once the peel-off lesion was found (Fig 2A), the PCL proximal end was debrided, the free end of the remnant was inspected with a tissue forceps to confirm adequate tissue quality, and a grasper was used to confirm that the stump could be reapproximated to the femoral footprint (Fig 2B). Next, the PCL footprint in the femur was debrided.

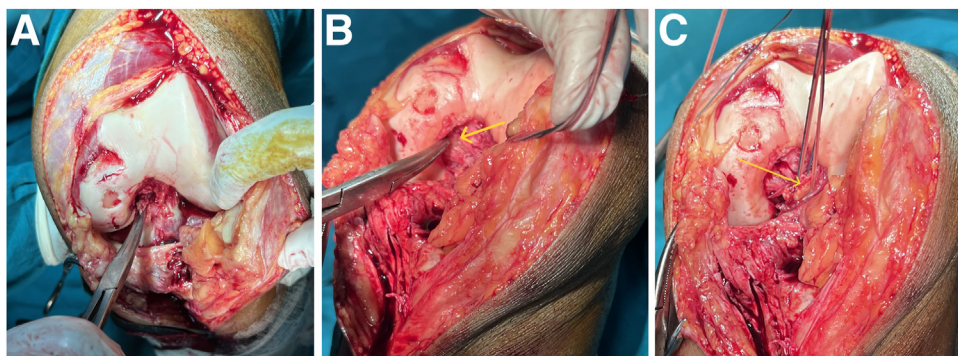
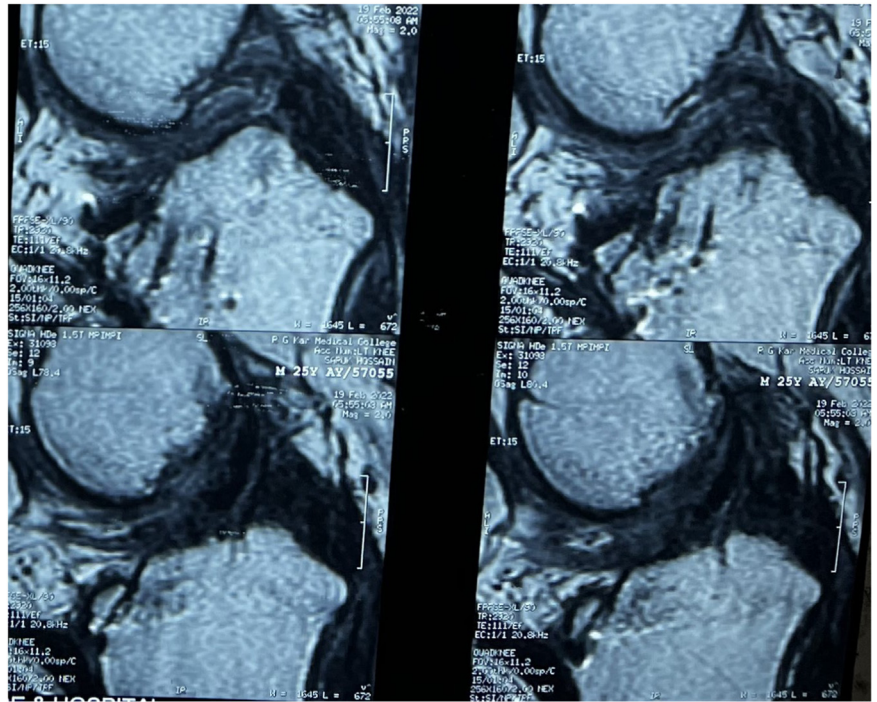


Fig 2. Right knee exposed through medial parapatellar approach showing posterior cruciate ligament femoral end grasped with hemostat (A), bare femoral attachment site (arrow) on medial femoral condyle shown by tip of hemostat (B), and nonabsorbable sutures (arrow) passed through intact peeled off posterior cruciate ligament from femoral end (C). There is also a depressed subchondral lesion on the anteromedial condyle of the femur.

Fig 3. Magnetic resonance images 12 months after repair showing complete healing of posterior cruciate ligament after posterior cruciate ligament femoral peel-off lesion repair.



Nonabsorbable sutures were then passed in the PCL stump (Fig 2C). Two tunnels were drilled in a parallel manner using a Beath pin, and the 2 ends of the sutures were retrieved through the respective tunnels. Both the sutures were then tied to each other while the anterior drawer maneuver and 90° of knee flexion were applied. In cases with multiligamentous injuries, associated ligament injuries were dealt with accordingly.

Postoperative Regimen

A long leg brace was used for 3 weeks, and weight bearing was allowed as tolerated. At 3 weeks, a hinged knee brace and progressive range-of-motion (ROM) exercises were allowed. Follow-up visits were scheduled at 1, 4, 8, 12, and 24 weeks postoperatively. Outcomes at 12 months of follow-up were objectively

evaluated based on knee ROM and knee posterior stress films.⁶ In addition, follow-up magnetic resonance imaging was performed at 1 year to assess healing (Fig 3).

Results

A total of 11 patients were included in this study. The mean age of the study population was 28.5 years. The mean follow-up period was 18 months. Knee dislocation (KD) type 3 was the most encountered type of injury (55%), followed by KD type 2 (27%). KD type 5 (fracture-dislocation) was the least common injury pattern seen in the study population (18%). Most of the knee injuries encountered were multiligamentous. Isolated PCL injury was not reported in any case. Mean knee ROM (flexion) achieved at 12 months was 121° (Figs 4 and 5). In 2 patients, 10° of flexion

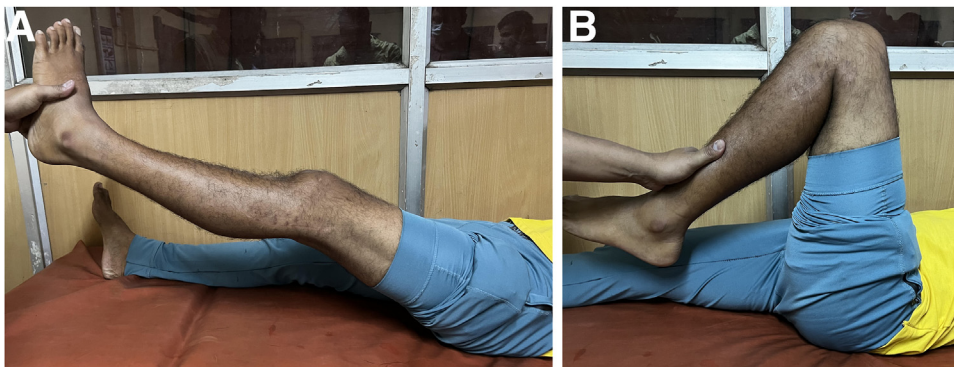


Fig 4. (A, B) Knee range of motion at 12 months after posterior cruciate ligament femoral peel-off lesion repair.



Fig 5. (A, B) Full range of motion at 12 months after posterior cruciate ligament femoral peel-off lesion repair in knee with type 5 injury.

deformity—extension lag was observed at final follow-up. Mean posterior translation on stress testing was less than 5 mm at 12 months' follow-up (Fig 6). No patient had grade 3 laxity on posterior stress testing at final follow-up. No case of infection was reported. Demographic details and outcomes of each patient are shown in Table 1.

Discussion

In this study, good outcomes were seen after primary repair of PCL peel-off lesions. PCL femoral peel-off lesions are rare. PCL healing especially in these lesions is doubtful per the available literature; thus, PCL reconstruction has been the gold-standard treatment for many of these injuries. While healing, due to the effect of gravity, PCL heals in a lengthened state and failure is anticipated. Thus, reconstruction remained the standard treatment for a long time.

Until the past decade, it was also thought that the ACL was not able to heal because it is an intra-articular structure. Thus, historically repair has been abandoned in favor of reconstruction by most authors. It was commonly thought that the ACL was unable to heal and restore knee stability until Costa-Paz et al.⁷ and Steadman et al.⁸ documented healing of the ACL in indicated cases. With an increased understanding of anatomy, it was found that ACL repair was better because it preserved the native ACL ligament and its proprioceptors, which provides feedback on position and dynamic stability of the knee, thus reducing the rehabilitation period.⁹ Supporting studies were performed by Pang et al.,¹⁰ who concluded that compared with autograft ACL reconstruction, arthroscopic ACL repair showed similar clinical outcomes and even better functional performance in the treatment of proximal ACL ruptures. However, recent studies have shown a higher cumulative retear rate in the long term among patients undergoing ACL repair, particularly adolescents; hence, we need to keep in mind that long-term follow-up is necessary.¹¹



Fig 6. Postoperative radiographs of knee with type 5 injury in which posterior cruciate ligament peel-off lesion was also found and repaired by pullout suture: anteroposterior and lateral views.

Table 1. Demographic Details and Outcomes of Each Patient

Patient No.	Age, yr	KD Classification	Injury Pattern	Surgical Intervention	Follow-up, mo	Knee ROM, °	Posterior Translation on Stress, mm
1	22	Type 2	PCL and ACL	PCL repair and ACL reconstruction with hamstring graft	14	0-110	3
2	38	Type 3	PCL, ACL, and MCL	PCL repair, ACL reconstruction with hamstring graft, and MCL repair with augmentation	15	0-125	2
3	25	Type 3	PCL, ACL, and PLC	PCL repair, PLC reconstruction and ACL reconstruction with hamstring graft	17	0-122	4
4	19	Type 5	PCL and tibial plateau	PCL repair and ORIF of tibial plateau	18	10-110	8
5	33	Type 2	PCL and ACL	PCL repair and ACL reconstruction with hamstring graft	20	0-130	2
6	30	Type 3	PCL, ACL, and PLC	PCL repair, PLC reconstruction ACL reconstruction with hamstring graft	17	0-125	7
7	27	Type 2	PCL and ACL	PCL repair and ACL reconstruction with hamstring graft	22	15-120	3
8	20	Type 5	PCL and tibial plateau	PCL repair and ORIF of tibial plateau	15	0-115	4
9	33	Type 3	PCL, ACL, and MCL	PCL repair, ACL reconstruction with hamstring graft, and MCL repair with augmentation	24	0-120	3
10	42	Type 3	PCL, ACL, and MCL	PCL repair, ACL reconstruction with hamstring graft, and MCL repair with augmentation	17	0-127	2
11	25	Type 3	PCL, ACL, and LCL	PCL repair, ACL reconstruction with hamstring graft, and LCL repair with augmentation	16	0-130	2

ACL, anterior cruciate ligament; KD, knee dislocation; LCL, lateral collateral ligament; ORIF, open reduction–internal fixation; PCL, posterior cruciate ligament; PLC, posterolateral corner; ROM, range of motion.

With an increasing number of studies showing favorable outcomes of ACL repair, PCL repair has also gained increasing interest. The PCL is the more vascular of the two ligaments; hence, it should have higher success rates with repair. Favorable outcomes have been reported in case reports by Drucker and Wynne,¹² Mayer and Micheli,¹³ and Ross et al.¹⁴ Apart from case reports, case series on PCL repair have been reported. DiFelice et al.¹⁵ retrospectively reviewed 3 patients with PCL peel-off lesions associated with a multiligament-injured knee who were treated with arthroscopic ligament repair. The authors concluded that repair rather than reconstruction is helpful to the surgeon in treating PCL soft-tissue peel-off lesions.¹⁴ Giordano et al.¹⁶ conducted a study on 3 patients with acute femoral peel-off injuries of the PCL with associated multiligamentous injuries who were treated with arthroscopic repair. The authors found that successful arthroscopic repair of the PCL to its native anatomic footprint was achieved in all cases. Vermeijden et al.¹⁷ similarly showed that PCL repair yields good results both with femoral attachment and with tibial attachment.

The mechanism of injury of peel-off lesions is still under debate, and the exact mechanism remains unclear.⁴ We have observed that these injuries are mainly associated with hyperextension of the knee that results

in forward translation of the tibia compared with the femur, thus tearing the PCL attachment from posterior to anterior.

We did not countersink the PCL because it reduces the effective length of the PCL stump and makes bone-to-ligament repair difficult. Thus, in our study, only the femoral footprint was debrided to raw bone and repair was carried out, which was also the technique used by Giordano et al.¹⁶

Despite the advent of modern arthroscopic repair techniques, we opted for open repair because many patients had multiligamentous injuries and capsular tears, which increased the chances of compartment syndrome. Two cases had associated tibial plateau fractures (KD type 5), which made an arthroscopic approach quite challenging. We believe that precise restoration of the anatomy and the surgical technique matter more than the approach itself (open vs arthroscopic). We were also in favor of this method because multiple lesions could be dealt with by a single incision and the surgical time and tourniquet time were reduced significantly.

Limitations

This study is not without limitations. The small number of cases is the main limitation of this study.

Conclusions

Our study showed good outcomes after primary repair of femoral PCL peel-off lesions.

References

1. Howells NR, Brunton LR, Robinson J, Porteus AJ, Eldridge JD, Murray JR. Acute knee dislocation: An evidence based approach to the management of the multi-ligament injured knee. *Injury* 2011;42:1198-1204.
2. Petrie RS, Harner CD. Evaluation and management of the posterior cruciate injured knee. *Oper Tech Sports Med* 1999;7:93-103.
3. Ross G, Driscoll J, McDevitt E, Scheller A Jr. Arthroscopic posterior cruciate ligament repair for acute femoral "peel off" tears. *Arthroscopy* 2003;19:431-435.
4. Kennedy JC, Grainger RW. The posterior cruciate ligament. *J Trauma* 1967;7:367-377.
5. Lysholm J, Gillquist J. Arthroscopic examination of the posterior cruciate ligament. *J Bone Joint Surg Am* 1981;63:363-366.
6. Lysholm J, Gillquist J. Evaluation of knee ligament surgery results with special emphasis on use of a scoring scale. *Am J Sports Med* 1982;10:150-154.
7. Costa-Paz M, Ayerza MA, Tanoira I, Astoul J, Muscolo DL. Spontaneous healing in complete ACL ruptures: A clinical and MRI study. *Clin Orthop Relat Res* 2012;470:979-985.
8. Steadman JR, Matheny LM, Briggs KK, Rodkey WG, Carreira DS. Outcomes following healing response in older, active patients: A primary anterior cruciate ligament repair technique. *J Knee Surg* 2012;25:255-260.
9. Denti M, Monteleone M, Berardi A, Panni AS. Anterior cruciate ligament mechanoreceptors. Histologic studies on lesions and reconstruction. *Clin Orthop Relat Res* 1994;308:29-32.
10. Pang L, Li P, Li T, Li Y, Zhu J, Tang X. Arthroscopic anterior cruciate ligament repair versus autograft anterior cruciate ligament reconstruction: A meta-analysis of comparative studies. *Front Surg* 2022;9:887522.
11. Gagliardi A, Carry P, Parikh H, Traver J, Howell D, Albright J. ACL repair with suture ligament augmentation is associated with a high failure rate among adolescent patients. *Am J Sports Med* 2019;47:560-566.
12. Drucker MM, Wynne GF. Avulsion of the posterior cruciate ligament from its femoral attachment: An isolated ligamentous injury. *J Trauma* 1975;15:616-617.
13. Mayer PJ, Micheli LJ. Avulsion of the femoral attachment of the posterior cruciate ligament in an eleven-year-old boy. Case report. *J Bone Joint Surg Am* 1979;61:431-432.
14. Rosso F, Bisicchia S, Amendola A. Arthroscopic repair of "peel-off" lesion of the posterior cruciate ligament at the femoral condyle. *Arthrosc Tech* 2014;3:e149-e154.
15. DiFelice GS, Lissy M, Haynes P. Surgical technique: When to arthroscopically repair the torn posterior cruciate ligament. *Clin Orthop Relat Res* 2012;470:861-868.
16. Giordano BD, Dehaven KE, Maloney MD. Acute femoral "peel-off" tears of the posterior cruciate ligament: Technique for arthroscopic anatomical repair. *Am J Orthop (Belle Mead NJ)* 2011;40:226-232.
17. Vermeijden HD, van der List JP, DiFelice GS. Arthroscopic primary repair of the posterior cruciate ligament. *J Knee Surg* 2021;34:478-485.