

Original Research Article

Clinical and functional outcome of isolated posterior cruciate ligament avulsion fractures treated by open reduction and internal fixation

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Received: 27 November 2021

Revised: 02 March 2022

Accepted: 03 March 2022

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ABSTRACT

Background: PCL ligament avulsion fracture injuries constitute about 3-20% of all the knee injuries. Isolated posterior cruciate ligament injuries are uncommon and often go undiagnosed in acutely injured knees. In the long run they cause severe functional disability of the knee joint. There is no consensus concerning the optimal surgical treatment approach for these injuries. Our study was to assess the functional and clinical outcome of isolated PCL avulsion fractures with open reduction and internal fixation.

Methods: This is a prospective study of 27 patients with isolated PCL avulsion fractures, done in the department of orthopaedics in RNT medical college over a 2-year period. All were treated with open reduction and internal fixation with 4 mm cannulated cancellous screw and washer. Postoperatively, patient leg was immobilized in posterior POP slab for 2 weeks, allowing toe touch weight bearing. All patients were regularly followed-up. 3 cases of post operative wound infection were detected.

Results: Of the 27 patients, there were 19 males and 8 females. All the cases showed good fracture union in an average of 12 weeks post operatively. In the first 6 weeks, all of them acquired an average knee flexion of 90 degrees and by 3 months, all of them had 125 degrees of free flexion possible. 2 cases showed negative posterior draw sign. The knee scoring system assessment showed 21 cases of excellent result, 4 cases of good result and 2 cases of fair result.

Conclusions: Though rare, PCL avulsion fractures are to be managed properly and treated surgically. PCL tibial avulsion fractures treated through Burk and Schaffer approach with open reduction and internal fixation produces good results.

Keywords: Posterior cruciate ligament avulsion fracture, Open reduction and internal fixation, Burk and Schaffer approach

INTRODUCTION

Isolated posterior cruciate ligament (PCL) injuries are uncommon and often go undiagnosed in acutely injured knees. PCL ligament avulsion fracture injuries constitute about 3-20% of all the knee injuries. They are less common than its counterpart ACL ligament. It's a strong ligament than ACL and 20% thicker.¹ It has two parts a

bulky anterior part, and thinner obliquely running posterior part which runs with wider insertion on to the back of the tibial plateau. A small twig of the PCL is attached to the posterior horn of the lateral meniscus. The PCL ligament gives posterior and partly rotator stability to the knee joint. It forms the axis for the knee "screw home mechanism" rotation during terminal degrees of knee extension.² Recent study reported the mechanism of

injury is similar to intrasubstance PCL tears and is associated with meniscus injuries in 16.8% and additional ligament injuries in 19% of patients.³ The ligament avulsion is most commonly occurring from the tibial side, displacing the fragment intraarticularly the PCL, being a strong ligament, presents more commonly with avulsion fractures of its tibial attachment unlike the anterior cruciate ligament whose tears commonly present as isolated lesions fracture. A rupture or avulsion of PCL leads to posterior instability of the knee joint with Posterior drawer test and Lachman's test positive on clinical examination. Avulsion injuries differ from other PCL injuries in that they are easily diagnosed on standard radiographs where a bony fragment may be visible. Traditionally, surgery of PCL injuries was deferred due to an apprehension that the approach to the posterior part of the knee is difficult.³ However, surgical fixation of avulsion injuries is recommended to avoid morbidity associated with non-union of the fracture.

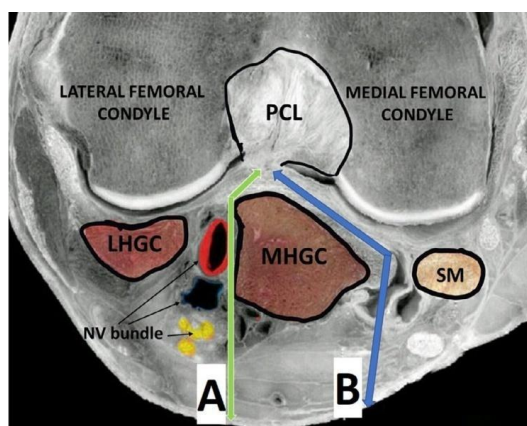


Figure 1: Anatomical axial cut demonstration at the level of the PCL showing the two main posterior approaches to the knee, the direct posterior approach (A) between the two gastrocnemius heads, and the posteromedial approach; and (B) between the medial gastrocnemius head and the semimembranosus.

Note: LHGC: lateral head of the gas-trocnemius, MHGC: medial head of the gastrocnemius, SM: semimembranosus, NV: neurovascular).

Repair of avulsion injuries can be done with an open or arthroscopic technique. Biomechanical studies have also demonstrated comparable results of screw fixation using open or arthroscopic means.^{4,5} However, arthroscopic repair is technically more challenging, requires specialized equipment and has a long learning curve. Thus, it unsuitable to perform in primary centers. Open reduction and internal fixation using screws has been considered a favorable method to manage PCL avulsion injuries producing satisfactory results.⁶

In addition, a simplified posteromedial approach described by Burks and Schaffer,⁷ which is useful for avoiding difficulties associated with previous posterior approaches to the knee, has become the standard

approach to the PCL. There is currently a wide variety of materials available for internal fixation, including lag screws, steel wires, absorbable screws, suture anchors and straddle nails.⁸ Fixation with screws has shown favorable results; however, no one technique has been considered a gold standard for avulsion fractures of the PCL. The purpose of our study was to evaluate the clinical and functional outcome after open reduction and internal fixation of tibial avulsion injuries of the PCL using cannulated cancellous screws. **RESULTS:** The outcome analysed by Lysholm scoring system showed 77.7% excellent results, 14.8% good results and 7.4% fair results.

Aims and objectives

The aim and objective of the study was to evaluate the efficacy of the treatment of posterior cruciate ligament avulsion fractures using the posteromedial approach and fixation with cannulated cancellous screws, plates, pullout suture technique.

METHODS

This was a prospective study conducted in the department of orthopedics in RNT medical college, Udaipur. Over a 2 years period from June 2019 to June 2021, we selected a total of 27 patients who presented with isolated PCL Avulsion fractures. The common cause of injury was dashboard type of road traffic accident.

Inclusion and exclusion criteria

The inclusion criteria included age between 20 -50 years, closed acute avulsion fractures and patients who gave consent. The exclusion criteria were age >50 years, compound injuries and complex ligament injuries.

Procedure

After detailed clinical and radiological examination these patients were splinted in a posterior POP slab. Further investigations like CT scan and MRI of the knee are done to assess for size, displacement of the fracture and to rule out additional ligament or Meniscus injuries. All the patients are treated by posterior-medial approach to the knee as described by Burks and Schaffer.

The patient is given spinal anesthesia and placed in prone position, with affected limb in flexion at knee joint. Under C arm, the fragment is visualised and reduced over posterior tibial plateau and sutured at the osteo ligamentous junction. Later it is provisionally stabilized with K wire. A long thin guide wire is passed from the centre of the fragment, directing posterior to anterior through the proximal tibia under C-arm guidance with knee in flexion, ensuring it makes an angle of 45° to the posterior surface of the tibia. After safely drilling over the guide wire, and measuring the length, 4 mm cannulated cancellous screw with washer is fixed.

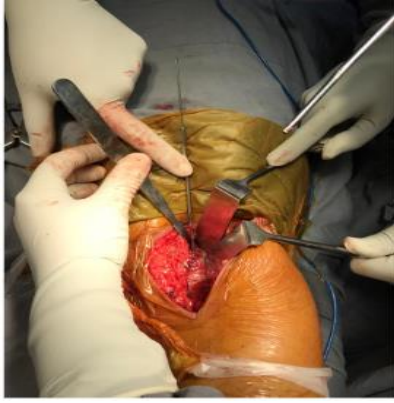


Figure 2: Intra-operative photograph showing the screw insertion technique.

Operative approach

A simplified posterior approach first described by Burks and Schaffer in 1990 has become the standard open approach to the PCL avulsion fracture.²² The patient is placed in the prone position with the knee flexed to 30°. A gentle, inverted L incision is made along the flexion crease, continuing toward the medial gastrocnemius through skin and fascia.



Figure 3: CT sagittal cut showing comminuted displaced PCL avulsion fracture. The proximal fragment is attached to the PCL, the distal fragment is attached to the medial meniscus root. A non absorbable suture was placed into the meniscus root and the suture placed into a knotless anchor on the posterior tibial cortex. The PCL fragment was ultimately secured with screw and washer.

The interval between the medial gastrocnemius and semimembranosus is bluntly dissected, exposing the capsule, which is vertically incised. The tibial attachment of the PCL is now exposed while the neurovascular bundle is protected by the medial gastrocnemius, which is retracted laterally. Alternatively, the gastrocnemius may be split to allow more access laterally, or a midline incision can be utilized.²³⁻²⁵ Fixation may be obtained

with screws with or without washers, wire fixation, small plates or pull-out suture fixation. The posterior knee capsule is then exposed and incised to reveal the avulsed PCL tibial insertion fragment, the fracture hematoma is removed and in cases of old injuries, any fibrous tissue is debrided from the avulsed fragment or from its bed, the fragment is reduced under direct vision to its bed (this could be facilitated by slight knee flexion), the fragment is held gently in place using a spike pusher, then it is provisionally fixed using a K-wire, the position of the reduced fragment can be checked by fluoroscopy. More recently, Gavaskar et al described a minimally invasive approach utilizing the interval between the two heads of the gastrocnemius.²⁶ In their cohort of 22 patients, they reported stable fixation and no complications utilizing a minimally invasive approach centered over the intersection of the tibial eminence and a transverse line 1 cm proximal to the tibial articular surface obtained using fluoroscopy. Following the approach, one to two cannulated screws and washers were placed.



Figure 4: Fluoroscopic post-operative image showing anatomic reduction of PCL facet fracture using screw and washer.



Figure 5: Screw insertion under C arm guidance.

Post-operatively, the limb was immobilised in long knee brace for 2 weeks. ROM and quadriceps strengthening exercises started after 2 weeks, partial weight bearing

started from 6 weeks and total weight bearing from 12 weeks. The patients were followed every 2 weeks for 3 months later every month for 9 months clinically and radiologically. Stability was assessed by drawer test and radiologically by stress X-ray. Final functional outcome was assessed using Lysholm knee score.

Post-operative and follow up protocol

Postoperatively during the hospital stay, patients were given low molecular weight heparin 40 mg for venous thromboembolic prophylaxis once daily, which was changed after discharge to 75 mg aspirin once daily for three weeks postoperative. The drain was removed 24 h postoperative, a plain radiograph of the knee (AP and lateral views) was obtained to confirm reduction and implants position.



Figure 6: PCL fixation through pullout suture technique using ACL ZIG and Ethibond number 5.0.

After patient discharge, the knee was kept immobilized for six weeks in a long knee brace. Quadriceps strengthening was started by the time of drain removal; passive knee flexion was allowed up to 90° for the first four weeks, then active knee motion exercises under the guidance of a physiotherapist were started, toe-touch weight-bearing was allowed for all patients from the second postoperative day while putting the brace; however, strict no weight-bearing till six weeks was advised for patients presented late (where a screw was not possible to be placed through the avulsed PCL fragment). A gradual increase in weight-bearing is started gradually

from the fourth week, and full weight bearing should be achieved by 12 weeks only after confirmation of full union of the PCL tibial insertion. Return to sports activities was allowed after 6-9 months.

RESULTS

Out of 27 patients, there were 19 males and 8 females. All the cases showed good fracture union in an average of 12 weeks post operatively. In the first 6 weeks, all of them acquired an average knee flexion of 90 degrees and by 3 months, all of them had 125 degrees of free flexion possible. 2 cases showed negative posterior draw sign. The knee scoring system assessment showed 21 cases of excellent result, 4 cases of good result and 2 cases of fair result. The most common post operative complication was wound infection seen in 3 cases. Lysholm scoring index in our study as analysed statistically and showed significant results with a $p < 0.001$.



Figure 7: Open PCL fixation through spring plate or one third semitubular plate

DISCUSSION

PCL injuries account for approximately 20% of total ligament injuries of the knee.¹⁴ The incidence is especially high in cases of high-energy trauma (motorcycle and car accidents), and athletic population involved in contact sports is especially vulnerable to PCL injuries.⁴ The most common mechanism underlying PCL avulsion fractures of the tibia in road traffic accidents is dashboard collision in which a direct force is applied to the proximal part of the tibia in an anterior-to-posterior direction, with the knee in flexion.⁸ In our series, most of the injuries resulted from motorcycle accidents because the majority of people commute by two-wheelers in India.

In the current study, we obtained acceptable clinical and radiological outcomes after utilizing the modified direct posterior approach to the knee for PCL tibial avulsion fixation using small set plates and screws with considerable short operative time and low incidence of

complications compared with recent studies reported on management of this injury using different approaches and variable tools for fixation as shown in (Table 2).

There are various surgical approaches described for the fixation of PCL avulsion fractures. The classical posterior approach described by Abbott was risky to the posterior neurovascular structures and delays recovery.⁶ Later, Burks and Schaffer simplified the procedure by approaching the fracture postero-medially. There was no necessity of splitting the gastrocnemius muscle, neither exposing the popliteal neurovascular structures. The post-operative rehabilitation was accelerated and good functional results were obtained. We had used this approach in the management of all the cases of PCL tibial avulsion injury.⁹ In this study, we performed open reduction and internal fixation of isolated PCL avulsion injuries using cannulated cancellous screws, plates, pullout suture technique, assuming to attain good functional and clinical outcome. In our study, all the cases showed good fracture union in an average of 12 weeks post operatively by all different methods of fixation. The outcome analysed by Lysholm scoring system showed 77.7% excellent results, 14.8% good results and 7.4% fair results. These results were superior to those reported in previous studies. In a study by Attia and Zanfaly among 12 patients treated using navicular screws, excellent results were obtained in 33.3%, good results in 58.3% and fair results in 8.3%.¹⁰ Similarly, Piedade and Mischan showed excellent results in 53% and good in 47% of their cases where screws or polyester no. 5 were used to fix the fracture. Khatri et al used the same approach and technique, which resulted in a postoperative Lysholm score of 90.85 ± 5.58 .¹¹ In the present study, all patients attained fair to good ROM with an average flexion of 125° by 12 weeks. Khatri et al achieved normal to nearly normal ROM in 96% of the patients where as 64.3% of the patients achieved results similar to our study.

The technique we used in this study resulted in significant improvement in functional and clinical outcome; however it is difficult to conclude that it should be the go to technique for PCL avulsion fractures due to the small sample size. Further studies with a larger sample size or case-control studies comparing different techniques are necessary to confirm our results. Nevertheless, the significance of this study is that we explored a novel and simple technique and added to the available literature on the management of PCL avulsion fractures.

CONCLUSION

Avulsion injuries of the PCL, though rare, should not be ignored. These injuries can be easily managed using an open reduction and internal fixation by Burks and Schaffer approach and cancellous screw fixation with early controlled knee mobilization provides excellent to good functional results.

Funding: No funding sources

Conflict of interest: None declared

Ethical approval: The study was approved by the institutional ethics committee

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Cite this article as: Juneja J, Asiger M, Kumar D, Sharma A, Jain MP, Talesra A, et al. Clinical and functional outcome of isolated posterior cruciate ligament avulsion fractures treated by open reduction and internal fixation *Int J Res Orthop* 2022;8:325-30.