Case Report

ANNALS OF MEDICINE & SURGERY

OPEN

Direct posterior approach to posterior cruciate ligament bony avulsion fractures: a case series introducing a new surgical technique

Parham Talebian, S. Aref Daneshi, Mohammad Soleimani*

Background: Posterior cruciate ligament bony avulsion is one of the well-known knee injuries, which includes about 3–20% of knee ligament injuries. Failure to properly treat this injury causes instability in the knee. Although various surgical approaches have been introduced for this injury, there is controversy regarding selecting the suitable method under certain conditions.

Method: In this study, as well as introducing our new surgical technique, we reported the treatment results of our patients who underwent surgery between April 2021 and June 2022. In this approach, in a short time with about 5 cm incisions, we can directly access the fracture site and directly fix the fracture with minimal tissue damage.

Result: Results of this study showed that the operating time was about 24.2 min on average. And in the 6-month follow-up results of our patients, no complications were reported, while the results stipulate a complete recovery of knee pain, range of motion, and stability in examinations.

Conclusion: Apparently, the direct posterior approach to posterior cruciate ligament bony avulsion fractures is a safe method with minimal complications and suitable treatment results for patients.

Keywords: avulsion, case series, knee, posterior cruciate ligament

Introduction

The posterior cruciate ligament (PCL) is one of the ligamentous structures of the knee that plays a prominent role in knee stability. This structure, which is anatomically connected to the medial condyle of the femur to the posterior intercondylar area of the tibia, prevents the tibia from excessive posterior translation and rotation in the flexion of 90–120°[1,2].

The true incidence of PCL injuries has been estimated to be 3–20% of all knee ligament injuries[3].

One of the specific injuries to PCL is avulsion fractures. Treatment of these fractures is important because failure to treat them properly can lead to knee instability and osteoarthritis[4].

Although various methods such as open reduction and internal fixation (ORIF) and arthroscopic fixations with the use of sutures, wires, and screws have been introduced to treat this problem so far[4–6], with the preface of arthroscopic techniques, the trend has moved toward this type of treatments, which is less invasive, but since imperative implements for performing arthroscopic procedures are not available in all medical centers, and also using this technique needs special expertise of the surgeon, focusing on open surgery techniques is also particularly important. Until now, various open surgical approaches have been introduced to treat PCL bony avulsions, each of which has advantages and disadvantages. So far, no gold standard approach has been introduced for this surgery[7], but various methods, such as the posteromedial approach[8], limited posterior approach[9], and modified open posterior approach[10], have been introduced. In this study, our goal is to introduce a new surgical approach for ORIF of PCL avulsions in the shortest time and with the least tissue damage.

HIGHLIGHTS

- Using a comfortable and safe approach to perform posterior cruciate ligament bony avulsion surgery is one of the challenges of an orthopedic surgeon.
- Although various methods have been proposed for posterior cruciate ligament bony avulsion surgery, none of them have been recognized as the gold standard of this surgery.
- The proposed direct posterior approach has many advantages for the surgeon and the patient, which can be mentioned as short surgery time, small incision, and quick and good access to the fracture site. Also, after surgery, good treatment results have also been seen.

Orthopedic Surgery Research Centre, Tehran University of Medical Sciences, Tehran, Iran

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

**Corresponding author. Address: Orthopedic Surgery Research Centre, Sina University Hospital, Tehran University of Medical Sciences, Tehran 1136746911, Iran. Tel: +98 216 312 1294, fax: +98 216 312 1294. E-mail address: mohammad.sly72@yahoo.com (M. Soleimani).*

Annals of Medicine & Surgery (2023) 85:545–549

Received 12 October 2022; Accepted 26 January 2023

Published online 9 March 2023

http://dx.doi.org/10.1097/MS9.0000000000000265

Patients and methods

In this study was conducted as a case series, the result of the treatment of 12 patients who underwent surgery with a new surgical approach was investigated. Included patients were the people who were admitted to the emergency ward of Sina University Hospital, Tehran, Iran, with a diagnosis of PCL bony avulsion. These 12 patients were male, and all of them were transferred to the hospital after a motor vehicle accident with a complaint of knee pain.

The age range of these patients was 31 years; the oldest of them was 48 years old, and the youngest was 22 years old. X-rays and computed tomography (CT) scans were performed on these patients, and after the diagnosis was registered and the need for surgery was decided, they were candidates for screw fixation of PCL avulsion.

All patients were transferred to the operating room the next day or up to 2 days after admission.

This study has been reported in line with the PROCESS (Preferred Reporting Of CasE Series in Surgery) criteria[11].

Technique

The cases that were included were patients with acute PCL injuries with large fragment PCL bony avulsions whose treatment plan was ORIF, which was based on the proposed treatment algorithm's study by Veltri and Warren[12].

Before surgery, the diagnosis was confirmed by X-ray and CT scan, and informed consent was obtained from all patients by explaining the surgery.

The patient was anesthetized at the discretion of the anesthesia service as general or spinal. We used the tourniquet for the patients. Patient position was placed in the prone with the knee flexed 15–20°.

First, we draw a horizontal line in the middle of the popliteal fossa (which is the middle crease behind the knee) (Fig. 1A). A parallel line is drawn 2 cm below the first line (Fig. 1B). The medial head of the gastrocnemius was determined, and the intersection of these two lines was defined as the beginning of the incision line (Fig. 1C). A 5 cm vertical incision was made below the mentioned point, which can be more or less based on the surgeon's skill and the amount of need for exposure (Fig. 1D). After opening the skin, subcutaneus tissue and fascia when the medial head of gastrocnemius was observed under it the lateral head of gastrocnemius and neurovascular retracted to lateral. A longitudinal incision is made through the medial head of the gastrocnemius muscle, and by opening it and finally shaving the posterior part of the tibia, the fracture site becomes obvious (Fig. 1E).

At this time, the action is done under the direct view to get the separated part reduced and got fixation by 3.5 or 4.5 screws along with a washer.

After ensuring reliable reduction by C-arm, a drain is inserted, the medial head of the gastrocnemius muscle is repaired with absorbable sutures (Fig. 1F), then the fascia and subcutaneous tissue are sutured with absorbable sutures, and finally the skin is sutured with a nonabsorbable suture (Fig. 1G).

At the end of the surgery and after dressing, the cylindric splint is applied at 5–10° of flexion for the patient.

Postoperative care

On the first day after surgery, the drain was removed, and the patient was advised to start nonweight bearing with a cane or a walker. After training the quadriceps strengthening movements, the patient is discharged and recommended to visit 2 weeks later. The only medicine prescribed for them is analgesics.

Two weeks later, the stitches are removed at the next visit, but the patient is still not allowed to weigh.

At the 6-week postoperative visit, after taking an anteroposterior view and lateral knee X-ray and ensuring no problem in the union process, the patient recommended leaving the splint or brace aside and starting partial weight bearing and knee range of motion (ROM) with physical therapy. The patient was allowed to start ROM in a passive and limited way but was advised to reach full ROM and full weight bearing in physical therapy exercises until the next visit, which was in 12 weeks' time.

After the next visit in the 12 weeks and radiographic assessment for union approval, the patient was permitted to perform everyday activities without restriction.

The patient's last visit is at 6 months, after which the treatment is completed.

Results

The operating time was 24.2 min on average (range 16–40 min). The PCL avulsed fragment was fixed by one screw (4.5 mm screw) and a washer. There were no neurovascular complications.

All patients were followed for 6 months after the initial operation. All patients demonstrated a full ROM of operated knees after the surgery.

The posterior drawer test was negative in 12 patients. A positive reversed pivot shift sign was negative in all patients. Radiographic examination at the last follow-up showed complete healing without any displacement of the fractures in all cases. No patient had significant hardware-related complaints, and implants were not removed.

Case presentation

A 43-year-old man presented with a complaint of left knee injury from a motor vehicle accident. He had no past medical, surgical, or drug history. Physical examination indicated a swollen knee and limited ROM. The diagnosis of PCL bony avulsion was confirmed by an anteroposterior view, and lateral knee X-rays, and CT scan (Fig. 2A–C).

The operation was performed the next days after the injury with the introduced approach; the surgery was done by a postgraduate year 3 resident under the supervision of a master. The length of surgery was approximately 28 min. The patient was discharged with a cylindric splint and advised 2 weeks later follow-up. He achieved normal knee ROM 4 weeks postoperation; union was achieved after ~12 weeks postoperatively. The patient returned to his usual activities after 3 months of surgery, and he was allowed to do sports 6 months after surgery.

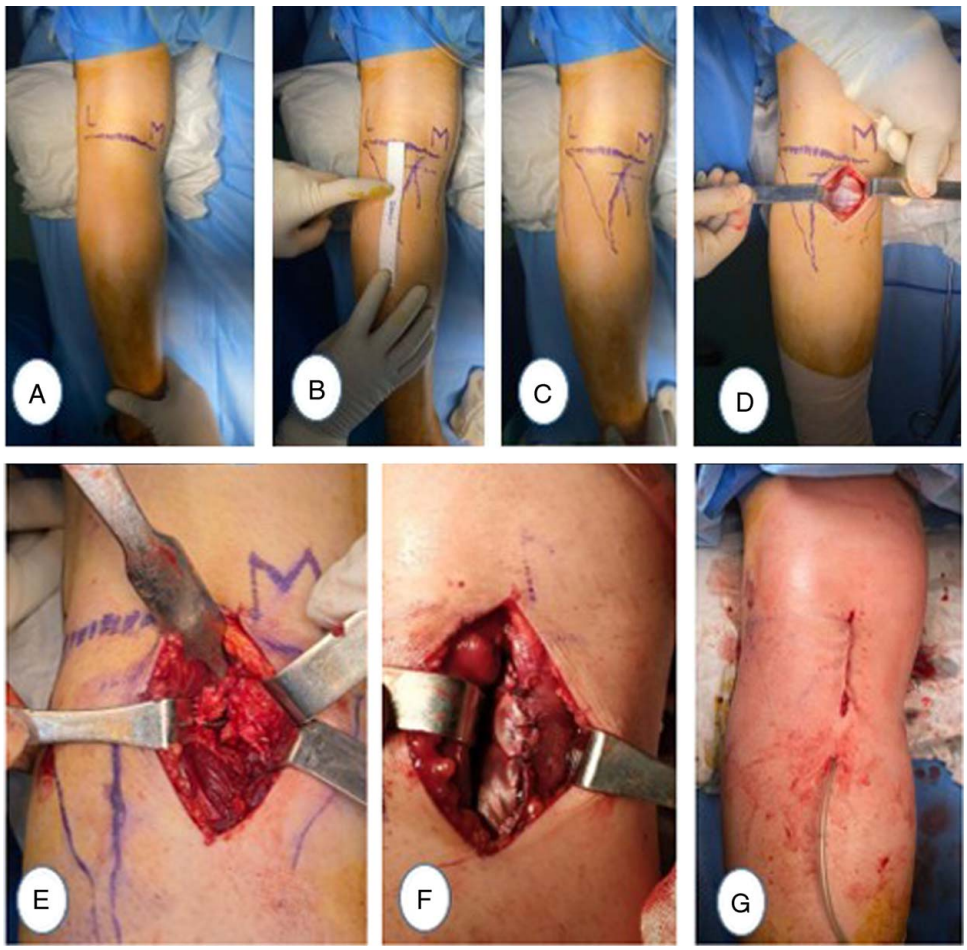

Figure 1. Horizontal line in the middle of the popliteal fossa (A). A parallel line 2 cm below the first line (B), the medial head of the gastrocnemius, and the intersection of two lines are defined as the beginning of the incision line (C). Vertical incision below the mentioned point (D). Fracture site (E). The medial head of the gastrocnemius muscle was repaired with absorbable sutures (F). Skin is sutured with a nonabsorbable suture after repairing subcutaneous tissue with an absorbable suture (G).

Discussion

Currently, various open and arthroscopic methods have been introduced to treat PCL bony avulsions, and different approaches have been used to open reduction of PCL bony avulsions[13]. What surgeons have considered in introducing new methods is that it is simpler from a technical point of view and also with fewer complications for the patient[14]. We also focused on these principles in our chosen technique to treat our patients. In our method, with an incision of about 5 cm and retracting neurovascular on the way to the fracture site, it is possible to perform surgery in the shortest possible time, while the ease of learning and using this method also provided us with the conditions that our residents treat patients using this approach.

Among the methods that have already been introduced for the treatment of PCL avulsions in the approach of Abbott and Carpenter, an incision is made in the shape of an S, and it is a time-consuming approach considering that the vessels and nerves are on the way, to the fracture site. Another approach that is used is the Burks and Schaffer approach. In this L-shaped approach, a plane was created posteromedially between the medial head of the gastrocnemius, and the semimembranosus and medial head were reflected laterally. The posterior capsule was incised over the avulsed fragment.

Although previously demonstrated suitable patient functional scores after using these methods, the problem that has always been discussed in these two approaches is that they take a lot of time[15,16].

Another approach described by Ogata and McCarthy[17] in this approach was the osteotomy of the fibular neck, which increased the complexity of the procedure[18]. Although the use of arthroscopic methods has been discussed recently[13], what should be noted is that the use of arthroscopic methods is not always and everywhere available and requires its own tools and conditions. Finally, what can differentiate our introduced method from previously introduced methods is the approach to fracture through a small incision in a short period which can be easily transferred and taught to orthopedic surgeons at different levels. In this study, this method was introduced, and the results of 12 patients were also reported; all of them returned to their usual lives suitably. One of the limitations of this study is the lack of comparison of the results of this method with other techniques, which is due to the fact that in this study, the attempt was made to introduce this technique as a new technique with appropriate results. It seems that it would be better to design studies comparing this technique with other techniques to better compare the results of this treatment method.

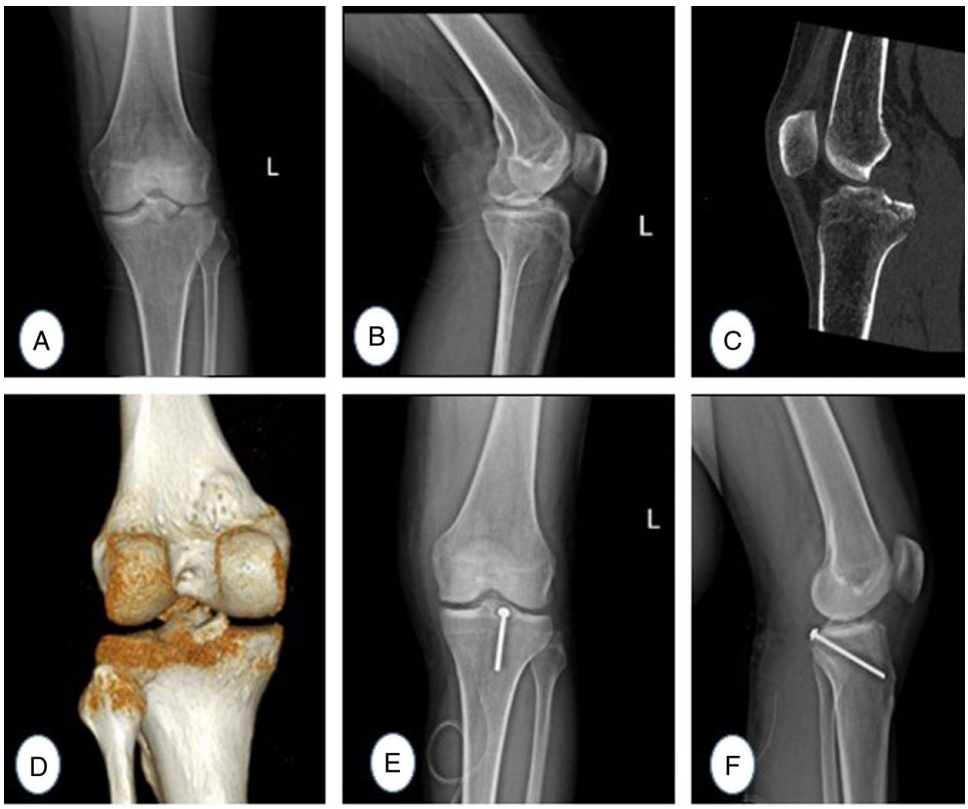

Figure 2. Preoperative X-rays (A, B), preoperative computed scan (C, D), and early postoperative X-rays (E, F).

Conclusion

Finally, it seems that the direct posterior approach to PCL bony avulsion fractures is a safe method with minimal complications and suitable treatment results for patients.

Ethical approval

This study was approved by the ethics committee of the Tehran University of Medical Sciences.

Patient consent

Consent was obtained from all patients participating in this study.

Source of funding

This research was not funded by any organization.

Author contribution

P.T.: concepts and design; S.A.D.: surgeon; M.S.: data collection, analysis, and writing.

Conflicts of interest disclosure

The authors declare that they have no conflicts of interest.

Research registration unique identifying number (UIN)

1. Name of the registry: NA.
2. Unique Identifying number or registration ID: NA.
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): Due to the state of financial sanctions in our country and the impossibility of financial payment to register the study in the mentioned registries, we could not register our study in these registries.

Guarantor

Dr Parham Talebian as the first author and Dr Mohammad Soleimani as the corresponding author.

Provence and peer review

Not commissioned, externally peer-reviewed.

Acknowledgments

We thank the orthopedic ward staff for their cooperation in the implementation of this study.

References

[1] Cosgarea AJ, Jay PR. Posterior cruciate ligament injuries: evaluation and management. J Am Acad Orthop Surg 2001;9:297–307.

[2] Logan M, Williams A, Lavelle J, *et al*. The effect of posterior cruciate ligament deficiency on knee kinematics. Am J Sports Med 2004;32: 1915–92.
[3] Bin S-I, Nam T-S. Surgical outcome of 2-stage management of multiple knee ligament injuries after knee dislocation. Arthroscopy 2007;23:1066–72.
[4] Zhang X, Cai G, Xu J, *et al*. A minimally invasive postero-medial approach with suture anchors for isolated tibial avulsion fracture of the posterior cruciate ligament. Knee 2013;20:96–9.
[5] Horas U, Meissner SA, Heiss C, *et al*. Arthroscopic fixation of posterior cruciate ligament avulsion fractures: a new minimally invasive technique. Knee Surg Sports Traumatol Arthrosc 2010;18:781–3.
[6] Burks RT, Schaffer JJ. A simplified approach to the tibial attachment of the posterior cruciate ligament. Clin Orthop Relat Res 1990;254:216–9.
[7] Jazayeri SM, Esmaili Jah AA, Karami M. A safe postero-medial approach to posterior cruciate ligament avulsion fracture. Knee Surg Sports Traumatol Arthrosc 2009;17:244–7.
[8] Dhillon MS, Singh HP, Nagi ON. Posterior cruciate ligament avulsion from the tibia: fixation by a posteromedial approach. Acta Orthop Belg 2003;69:162–7.
[9] Minkoff J, Jaffe L, Menendez L. Limited posterolateral surgical approach to the knee for excision of osteoid osteoma. Clin Orthop Relat Res 1987;223:237–46.
[10] Nicandri GT, Klineberg EO, Wahl CJ, *et al*. Treatment of posterior cruciate ligament tibial avulsion fractures through a modified open posterior approach: operative technique and 12- to 48-month outcomes. J Orthop Trauma 2008;22:317–24.
[11] Agha RA, Sohrabi C, Mathew G, *et al*. The PROCESS 2020 guideline: updating consensus Preferred Reporting Of CasE Series in Surgery (PROCESS) guidelines. Int J Surg 2020;84:231–5.
[12] Veltri DM, Warren RF. Isolated and combined posterior cruciate ligament injuries. J Am Acad Orthop Surg 1993;1:67–75.
[13] Song J-G, Nha K-W, Lee S-W. Open posterior approach versus arthroscopic suture fixation for displaced posterior cruciate ligament avulsion fractures: systematic review. Knee Surg Relat Res 2018;30:275–83.
[14] Katsman A, Strauss EJ, Campbell KA, *et al*. Posterior cruciate ligament avulsion fractures. Curr Rev Musculoskelet Med 2018;11:503–9.
[15] Prakash J, Jaiman A, Chopra RK. Posteromedial versus direct posterior approach for posterior cruciate ligament avulsion – a comparative study. J Orthop Trauma Rehab 2020;27:166–72.
[16] Khatri K, Sharma V, Lakhotia D, *et al*. Posterior cruciate ligament tibial avulsion treated with open reduction and internal fixation through the Burks and Schaffer approach. Malays Orthop J 2015;9:2–8.
[17] Ogata K, Mccarthy JA. Measurements of length and tension patterns during reconstruction of the posterior cruciate ligament. Am J Sports Med 1992;20:351–5.
[18] Joshi S, Bhatia C, Gondane A, *et al*. Open reduction and internal fixation of isolated posterior cruciate ligament avulsion fractures: clinical and functional outcome. Knee Surg Relat Res 2017;29:210.