International Journal of Orthopaedics Sciences

ISSN: 2395-1958
IJOS 2019; 5(2): 837-840

www.orthopaper.com
Received: 24-02-2019
Accepted: 28-03-2019

Dr. Abhishek Yadav
Department of Orthopaedics, Sri Devraj Urs Academy of Higher Education and Research, Tamaka, Kolar, Karnataka, India

Dr. Hariprasad Seenappa
Department of Orthopaedics, Sri Devraj Urs Academy of Higher Education and Research, Tamaka, Kolar, Karnataka, India

Dr. Cecil Fernando
Department of Orthopaedics, Sri Devraj Urs Academy of Higher Education and Research, Tamaka, Kolar, Karnataka, India

Dr. Kishore Vellingiri
Department of Orthopaedics, Sri Devraj Urs Academy of Higher Education and Research, Tamaka, Kolar, Karnataka, India

Correspondence
Dr. Hariprasad Seenappa
Department of Orthopaedics, Sri Devraj Urs Academy of Higher Education and Research, Tamaka, Kolar, Karnataka, India

Functional outcome of posterior cruciate ligament avulsion treated with open reduction and internal fixation with cannulated cancellous screws using Burks and Schaffer approach

Dr. Abhishek Yadav, Dr. Hariprasad Seenappa, Dr. Cecil Fernando and Dr. Kishore Vellingiri

DOI: https://doi.org/10.22271/ortho.2019.v5.i2l.100

Abstract
Introduction: Posterior cruciate ligament (PCL) is stronger and less vulnerable to injuries than its anterior counterpart. Injuries to the PCL, either due to bony avulsion or intra-substance tears, if left untreated, can result in chronic pain, patellar degenerative changes and instability. The basic approach to manage PCL bony avulsion varies from open reduction and internal fixation to arthroscopic fixation with screws or sutures. Although both the approaches have their pros and cons, in this study, we present the results of open reduction and internal fixation with cannulated cancellous screws.
Material and Methods: The study group comprised of 18 patients (14 males and 4 females) with PCL avulsion injury between January 2013 to January 2018 who were operated at R L Jalappa hospital and followed up regularly with clinical and radiological assessment. The patient's details and radiographs were collected from patient records in hospital medical record department. Patients were called for examination, and the functional and radiological status was noted. Functional assessment was done using Lysholm knee scoring system.
Results: Mean age of the patients was 39.2 ranging from 21 – 55 years. 3 patients had associated femur shaft fractures, while 2 patients had tibia fracture. The mean Lysholm score was 92.6 (87-96). Clinically, no symptoms of instability were evident, and no signs of PCL deficiency were present. Full range of movements was achieved in all the patients at last follow-up.
Conclusion: Posterior Cruciate Ligament avulsion treated with open reduction and internal fixation with cannulated cancellous screws using Burks and Schaffer approach gives excellent results with minimal morbidity.

Keywords: Posterior cruciate ligament, avulsion fractures, Burks and Schaffer approach

Introduction
Posterior cruciate ligament (PCL) is stronger and less vulnerable to injuries than its anterior counterpart. It stabilises the knee joint by restricting posterior translation of tibia over femur [1]. Avulsion of PCL is a relatively uncommon injury. Injuries to the PCL, either due to bony avulsion from tibial attachment or intra-substance tears, if left untreated, can result in chronic pain and patellar degeneration secondary to posterior subluxation of tibia [2, 3]. Avulsion Injuries of PCL constitute a small subgroup where early diagnosis is usually possible by visualising a bony fragment on standard radiographs. The basic approach to manage tibial bony avulsion varies from open reduction and internal fixation to arthroscopic fixation with screws or sutures [4, 5]. Although both the approaches have their pros and cons, in this study, we present the results of open reduction and internal fixation with cannulated cancellous screws.
As there are very few studies regarding management of posterior cruciate ligament avulsion with open reduction and internal fixation through the Burk and Schaffer approach, particularly in a rural setup, therefore this study was undertaken.

Materials and Methods
18 patients with PCL avulsion tears, satisfying the inclusion and exclusion criteria were included in this study between January 2013 and January 2018.

The patients treated with other methods or lost to follow up were excluded from the study. The hospital records were noted to establish the mode of injury, demographic data, injury severity score, delay in surgery, treatment given, complications of either the fracture or treatment and revision surgery if any required. The data pertaining to any comorbid conditions, associated limb injuries and side of injury were also noted. Diagnosis was done by thorough clinical examination and radiologically (both antero-posterior and lateral views). The patients were examined by the Lachman test, and the anterior and posterior drawer test for integrity of cruciate ligaments. Varus and valgus stress in extension and in 30 degrees flexion were done to assess the collateral ligaments. The Dial test and external recurvatum test were also done to assess the associated postero-lateral ligament complex insufficiency. In doubtful cases, magnetic resonance imaging evaluation was done to confirm the diagnosis, and any associated lesions in the affected knee were also ruled out by careful examination.

The patients with age >18 years with PCL bony avulsion injury presenting within 3 weeks of injury along with associated tibial or femoral fractures were included in the study. Those cases presenting beyond 3 weeks, or those with multi-ligamentous injuries or degenerative tears or infection were excluded from the study. All the patients underwent open reduction and screw fixation using 4 mm cannulated cancellous screws and washer through the Burk and Schaffer approach. Approval of institutional ethics committee was taken prior to the start of the study (IEC/247/2018-19).

Surgical technique: The procedure was performed under spinal anaesthesia, in prone position under tourniquet control. An inverted L-shaped incision was taken with the horizontal limb just proximal to the flexion crease of the knee and the vertical limb overlying the medial aspect of the gastrocnemius muscle. Dissection was done till deep facial layer. Next, space was created between medial head of gastrocnemius and semimembranosus to reach posterior joint capsule by blunt finger dissection. Motor branch of the tibial nerve and the middle geniculate artery were carefully identified. A longitudinal cut in the capsule allows good exposure of the avulsed fragment to facilitate visualisation, slight flexion of the knee is done by keeping a leg roll beneath the ankle. The avulsed fragment is identified and the bony bed of the fragment is debrided and freshened. Subsequently, the bony fragment is reduced on its bed and provisionally fixed with a 2 mm Kirschner wire (K-wire). The position of this K-wire is confirmed under fluoroscopy, and if satisfactory, a 4 mm cannulated cancellous screw/s with washer was used for fixation of the avulsed fragment. Next, the screw position and the reduction was confirmed with fluoroscopy. The wound was then closed in layers after giving adequate wash. Figures 1 to 3, illustrate one case example demonstrating the intra-operative dissection and reduction and fluoroscopic images.

Fig 1: Intraoperative exposure using Burks and Schaffer approach.

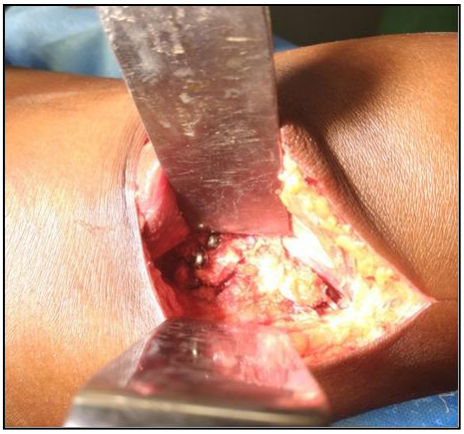

Fig 2: Fixation with two cannulated cancellous screws with washer.

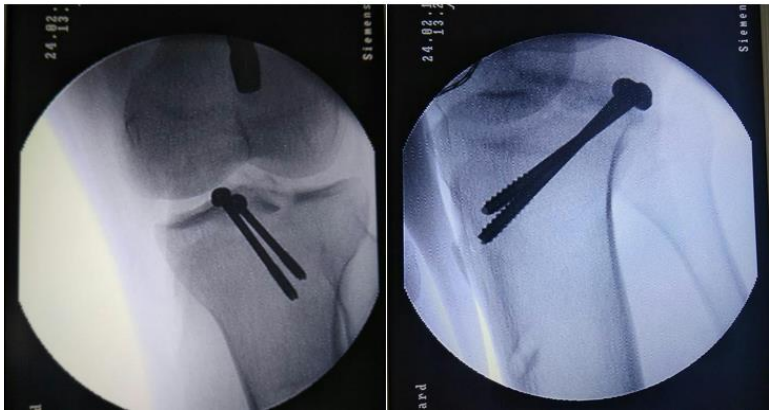

Fig 3: Intraoperative fluoroscopic images showing the reduction and fixation of the fragment

Post-operative management: Postoperatively, the knee was immobilized with a long knee brace. After 2 weeks, the extension knee brace was converted to a hinged knee brace and partial weight bearing was allowed. During the period of immobilization, static quadriceps, hamstring flexion exercises, and straight leg raising exercises were performed. And by the end of 4 weeks, full weight bearing was instituted. Open chain quadriceps exercises were not initiated until 6 weeks postoperatively. The patients were followed up at three weeks, six weeks, three months, six months and one year. Except at the first visit, in which only range of motion and local wound condition was addressed, subsequent visits

included thorough clinical and radiological assessment. Clinical examination included posterior drawer test and radiological assessment was done with antero-posterior and lateral radiographs of knee. The patients were allowed to fully bear weight depending upon the associated injuries and ambulate without brace subsequent to bony union. Bony union was defined as bony consolidation seen on radiographs, absence of pain and stable knee. This was achieved in the majority of cases between ten to twelve weeks. Strengthening exercises were carried out after bony union and majority of the patients had returned to their previous occupation within six months. Return to the previous full range of movements and activities were achieved at the end of 6 months. The functional outcome in our study was assessed by clinical and radiological parameters like range of motion, ligament laxity, crepitus, subjective measurement, radiographic findings, activity levels and functional strength. The results were evaluated using Lysholm scoring.

Fig 4: Pre-operative X-ray of a patient included in the study showing the avulsed posterior cruciate ligament fragment

Fig 5: Post-operative X-ray of the patient demonstrating cancellous screw fixation with washer of the displaced avulsed fragment

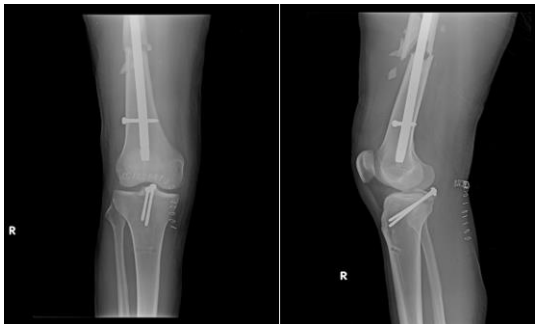

Fig 6: Post-operative X-ray of the patient with associated femur shaft fracture.

Results

From January 2013 to January 2018, 18 cases with bony avulsion of the PCL were operated. There were 14 males (77.7%) and 4 females (22.2%), and their ages ranged from 21 to 55 years, average age being 39.2 years. 12 (66.66%) patients had right side involvement, while the left side was involved in 6 (33.33%) cases. Mechanism of injury being road traffic accidents in 14 (77.77%) cases and sports injury in 4 (22.22%) cases. The average surgery duration was 74.5 minutes and ranged from 60-90 minutes. The average intraoperative blood loss was 50 ml (30-60 ml). Follow-up ranged from 2 months to 3 years. Associated injuries included ipsilateral femur fracture in 3 cases (16.66%) and tibial fracture in 5 cases (27.77%). The duration between injury and surgery ranged from 1 day to 14 days. Routine lateral X rays could identify the avulsed fragment in all cases (fig 4), CT scan was done as an adjunct to the X-rays in 4 cases, while MRI was done in 5 cases.

After 3 months, radiographs of the knee were taken to note fracture healing in all the patients. There were no major complications such as infection, deep vein thrombosis, or neurovascular deficit at 12 months follow-up. Few patients had Grade-I laxity on examination, however no patient had any complaints of instability. Mean Lysolm score was 92.6 (87-96) at last follow up.

Table 1: Demographic and surgical details

Age (mean)	**39.2years**
Gender M: F	14:4
Side Right: Left	12:6
Mechanism of injury	
Road traffic accidents: sports injury	14:4
Associated injuries	
Femur fracture: Tibial fracture	3:5
Duration of surgery(mean)	74.5mins
Intraoperative blood loss(mean)	50ml
Lysolm score (mean) at one year	92.6

Discussion

PCL avulsion injuries are now being a target of concern because of its increasing incidence, expanding population, high prevalence in young generation, challenges in management, dependency, morbidity, mortality, economic burden and social impact. A displaced PCL avulsion fracture results in functional compromise and instability [6]. Open technique allows clear visualization of the fracture fragment with complete reduction and secure fixation [7]. Conservative management is not advised as it can lead to early degenerative changes, meniscus tears, and chondral damage [2, 8]. In 1975, Meyer had reported poor functional outcomes of conservatively managed PCL avulsion injuries [2]. Surgical PCL repair can prevent these complications.

In the present era of minimally invasive surgery, arthroscopic techniques for fixation of such avulsed fractures have gained importance, however, the arthroscopic technique requires advanced instrumentation, longer period of surgery, and lastly a long learning curve [9].

Literature review of open surgical approach shows many different fixation methods have been described for PCL avulsion tears. In 1997, Seitz *et al*. described fixation with K-wires and cannulated screws, with comparable results[5]. In 2003, Dhillon *et al*, reported good functional outcomes using cannulated screws in their 9 cases with complete fracture healing and no pain at the end of 6 months[10]. Piedade S R and Mischan MM, reported good outcome in 43% and excellent in 57% in subjective evaluation (Lysholm scoring) and residual posteriorisation of + (.5 cm) in 57% and + + (1 cm) in 38% of

the cases in posterior drawer test. And therefore, surgical management of PCL bony avulsion has satisfactory subjective results inspite of objective laxity [11].

In 2011, Fu *et al*. reported a surgical technique utilising anchors with cannulated screws [12]. In 2016, Chen *et al*. used toothed plate and hollow lag screw with good functional results and intraoperative blood loss of 54.3 ml, average surgery time of 65.5 min and average post-operative lysolm score of 93.6 [13].

With regards to the posteromedial open approach, satisfactory reduction was achieved with average surgical time of 74.5 min and average intraoperative blood loss of 50 ml, results being comparable to the arthroscopic technique. Also, all patients included in our study were able to resume the previous athletic and strenuous activities after 9 months. Moreover, only few cases of complications have been reported with this technique. In 2015, Khatri *et al*, reported arthrofibrosis in two of their 27 patients post fixation [14]. In 2016, Li *et al*. reported a case of a broken screw post operation of the PCL avulsion tear, leading to further meniscus as well as chondral damage [15]. In our study, none of the patients had any post-operative complications.

Limitations of the study; Being a retrospective study, selection bias could not be ruled out. The sample size was small and it's a short-term outcome study and associated bony injuries were also included. Further long-term studies are required to assess the functional outcome of fixation of PCL avulsion.

Conclusion

Posterior Cruciate Ligament Avulsion treated with open reduction and internal fixation with cannulated cancellous screws using Burks and Schaffer approach gives excellent results with minimal morbidity. Burks and Schaffer's is a safe approach with minimal risk of damage to the neurovascular structures.

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