**Outcome of Posterior Cruciate Ligament Avulsion Fractures from Tibial Attachment Treated by Open Reduction and Internal Fixation**

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**Abstract**

**Objectives:** To analyze clinical and functional outcome of posterior cruciate ligament avulsion fractures from tibial attachment treated by open reduction and internal fixation.

**Methods**: This was an observational study conducted in the department of orthopedics of a tertiary care medical college. 40 adult patients having PCL avulsion fractures were included in this study on the basis of a predefined inclusion and exclusion criteria. All patients were treated by open reduction and internal fixation. Patients were followed up for 1 year. Functional outcome was assessed by Lysholm scale and knee society score. P value less than 0.05 was taken as statistically significant.

**Results:** There were 34 (75 %) were males and 6 (15%) were females with an M: F ratio of 1:0.17. The mean age of affected patients was found to be 37.3 +/- 7.34 years. Out of 40 patients 29 (72.50%) patients sustained fracture secondary to road traffic accidents while 7 (17.50%) patients had sports related injuries. There was a significant improvement in Lysholm score and knee society score from the time of presentation and at the time of final follow up and the difference was statistically highly significant. Only 1 (2.5%) patient developed residual joint instability as evidenced by drawer test.

**Conclusion:** Patients with posterior cruciate ligament avulsion fracture treated by Open reduction and internal fixation were found to have excellent results in terms of functional outcome.

**Keywords:** Fracture, Internal Fixation, Open Reduction, Outcome, Posterior Cruciate Ligament

**Introduction**

The Posterior Cruciate Ligament (PCL) is stronger than Anterior Cruciate Ligament (ACL) and plays a crucial role in stabilizing the knee.1 It acts as a primary restraint against posterior tibial displacement and works in conjunction with the Anterior Cruciate Ligament (ACL) to regulate external rotation of the knee during extension. PCL injuries are estimated to account for approximately 20% of knee ligament injuries, with higher incidence rates observed in cases resulting from high-energy trauma, such as motorcycle and car accidents, as well as in contact sports among athletes.2 The other common mechanism of injury to posterior cruciate ligament is when force is applied to proximal tibia anteriorly when the knee is flexed. The functional impairment PCL injuries can cause, may range from mild discomfort to severe functional impairment.3 In cases having PCL avulsion fracture a history of posteriorly directed force on flexed knee or history of fall on flexed knee may be present. The physical examination may show presence of joint swelling, hemarthrosis or contusion over anterior tibia. Diagnosis may be confirmed on the basis of anteroposterior and lateral X-Ray of the affected knee which may show presence of bone discontinuity at the posterior tibial articular surface.4 Computerized tomography and MRI may help in further evaluation of fracture as well as identifying accompanying injuries such as meniscal tears or soft tissue involvement. PCL avulsion fractures usually involve tibial attachment and when this occurs it is essential to promptly diagnose and initiate appropriate management to optimize the clinical and functional outcome for patients.5 Once diagnosed the treatment is usually surgical. Unlike in patients with isolated PCL injuries where the repair is usually deferred the cases with avulsion fracture needs prompt surgical intervention to prevent complications such as malunion and non-union. The repair can be done arthroscopically or by open reduction.6 In developing countries arthroscopic surgeries are not commonly performed as arthroscopic surgeries are expensive and facilities as well as expertise to perform arthroscopic repair are not available except in urban areas. Therefor open reduction and internal fixation using screws remain one of the most commonly performed surgeries in rural and semi urban areas for PCL avulsion fractures. Various materials which can be used for internal fixation include lag screws, suture anchors, steel wires and straddle nails in addition to surgical management well designed rehabilitation program is also an essential part of management of these patients.7 The clinical and functional outcomes of patients with PCL fractures treated by ORIF have been a subject of interest for researchers and clinicians alike. Numerous studies have investigated the efficacy of this surgical technique and its impact on patients' quality of life and functional recovery.8 The assessment of outcomes includes parameters such as pain levels, knee stability, range of motion, return to pre-injury activities, and patient satisfaction. Understanding the long-term outcomes of open reduction and internal fixation for PCL avulsion fractures is crucial for guiding treatment decisions, optimizing surgical techniques, and improving patient care.9 This was an observational study to analyze clinical and functional outcome of posterior cruciate ligament avulsion fractures from tibial attachment treated by open reduction and internal fixation.

**Methods**

The study was conducted in the Department of Orthopedics, Prakash Institute of Medical Sciences and Research Centre, Islampur, Sangli. India. The duration of study was 2 years from April 2021 to March 2023. Since this was an observational study ethical committee approval was not required. In this study 40 adult patients of either gender with PCL avulsion fractures were included on the basis of a predefined inclusion and exclusion criteria. The inclusion criteria was Adult patients with isolated PCL avulsion fracture diagnosed on the basis of imaging (X-Ray, Computerized Tomography and Magnetic resonance imaging) in whom PCL fragment was displaced more than 5 mm and those who presented within 4 weeks of injury. Patients who refused consent or those who presented after 4 weeks of injury and patients in whom PCL fragment was displaced less than 5 mm were excluded from the study. Patients with musculoskeletal conditions likely to affect the outcome assessment such as those having osteoarthritis, rheumatoid or psoriatic arthritis and those with multiple fractures were also excluded. A detailed history was taken from all the patients with respect to type of trauma and duration since injury. A through clinical examination was done by senior orthopedician in all the cases. Drawer test was performed to make a preliminary diagnosis of PCL injury. Imaging was done in the form of anteroposterior as well as lateral view radiographs of the affected knee. In selected cases 3D computerized tomography was done. The extent of injury to PCL and associated injuries to other ligament was assessed by magnetic resonance imaging. Preanaesthetic evaluation was done in all the cases. Routine investigations such as complete hemogram, renal function tests, bleeding and clotting time and Hepatitis B and HIV ELISA was done in all the cases. In cases above 45 years of age physician’s opinion regarding fitness for the surgery was also taken. All patients were treated by open reduction and internal fixation of avulsion fracture.

Postoperative above knee slab given with padded support to superior part of calf to keep knee in anterior drawer position. Quadriceps exercises and non-weight bearing mobilization started from next day. Suture removal was done after 15 days. Passive knee bending started after 1 month with toe touch weight bearing. Full weight bearing started after full range of movements achieved after 6-8 weeks. Although full routine activities were allowed after 3 months, participation in contact sports was avoided till 9 – 12 months according to rehabilitation and muscle strength recovery.

The patients were followed up every monthly till 3 months and after that every 3 months till 12 months. At every follow up visit patient clinical and functional assessment was done using Lysholm knee score (LKS) and Knee Society Score10. Qualitative data were represented in percentages and quantitative data was represented as mean with standard deviation. The statistical analysis was done using SSPS 22.0 software and p value less than 0.05 was taken as statistically significant.

**Results**

40 cases of posterior cruciate ligament avulsion fractures from tibial attachment treated by open reduction and internal fixation were included in this study of which there were 34 (75 %) were males and 6 (15%) were females with a M: F ratio of 1:0.17. 26 (65 %) of the participants had right side affected whereas remaining 14 (35 %) of the cases had left sided PCL avulsion fracture .The analysis of the age group of the patients showed that the most common affected age group was between 31-40 years (57.5%) followed by 41-50 years (27.50%). The mean age of affected patients was found to be 37.3 +/- 7.34 years (**Table 1**).

**Table 1 Age Distribution of the studied cases.**

|  |  |  |
| --- | --- | --- |
| **Age** | **No of cases** | **Percentage** |
| **18-30 years** | 3 | 7.50% |
| **31-40 years** | 23 | 57.50% |
| **41-50 years** | 11 | 27.50% |
| **Above 50 years** | 3 | 7.50% |
| **Total** | 40 | 100 % |
| **Mean Age** | 37.3 +/- 7.34 years | |

Out of 40 patients 29 (72.50%) patients sustained fracture secondary to road traffic accidents while 7 (17.50%) patients had sports related injuries. In 4 (10%) patients fracture was secondary to falls. Majority of the patients (52.50%) presented within 7 days of sustaining injury. 19 (47.50%) patients presented between 8 days to 4 weeks after injury (**Table 2**).

**Table 2 Mechanism of injury and duration since injury.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Mechanism and duration of injury** | | **Number of cases** | **Percentage** |
| **Mechanism of Injury** | Road Traffic Accidents | 29 | 72.50% |
| Sports Injuries | 7 | 17.50% |
| Falls | 4 | 10.00% |
| **Duration Since Injury** | Within 24 hours | 9 | 22.50% |
| 2-7 days | 12 | 30.00% |
| 8 days-2 weeks | 10 | 25.00% |
| 15 days -4 weeks | 9 | 22.50% |

Functional assessment of the patients at the time of each follow up was done by Lysholm score as well as knee society score. At the time of presentation, the mean Lysholm score of the patients was found to be 4.5 +/- 2.8. There was gradual improvement in patients’ Lysholm score with each follow up and at the time of 3 months the mean Lysholm score was found to be 72.8 +/- 9.2 whereas at the time of final follow up the mean Lysholm score was found to be 98.2 +/- 10.1. There was a significant improvement in Lysholm score from the time of presentation and at the time of final follow up and the difference was statistically highly significant (**Fig 1**).

**Fig. 1 Mean Lysholm Score at presentation and during follow up.**

The functional assessment of the knee was also done by knee society score. At the time of presentation, the mean knee society score was 34.16 +/- 12.34 which gradually improved to 82.76 +/- 10.36 at 6 months and at the time of final follow up the mean knee society score was 92.34 +/- 8.12. There was significant improvement in cases as assessed by knee society score (P < 0.0001). At the time of presentation all patients were having moderate to severe pain. The mean VAS score at the time of presentation was 6.3 +/- 2.62 . In postoperative period the pain reduced signifciantly over a period of weeks to months. At the time of final follow up at 12 months there was significant reduction in VAS scores. At the time of final follow up the mean VAS score was found to be 1.24 +/- 0.72 (P<0.0001) (**Table 3**).

**Table 3 Mean Knee Society Score at presentation and during follow up.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Comparison of Knee society and VAS scores** | | **Mean +/- Std Deviation** | **P Value** |
| **Knee Society Score** | At Presentation | 26.34 +/- 9.98 | P < 0.0001  (Paired t test)  Highly significant |
| At 1 Month | 42.16 +/- 12.34 |
| At 2 Months | 46.78 +/- 14.62 |
| At 3 Months | 64.38 +/- 14.02 |
| At 6 months | 78.64 +/- 12.16 |
| At 9 months | 82.76 +/- 10.36 |
| **VAS Score** | Final Follow Up (1 year) | 88.20 +/- 8.12 |
| At Presentation | 6.36 +/- 2.64 | P < 0.0001  (Paired t test)  Highly significant |
| At 1 Month | 3.94+/- 1.84 |
| At 2 Months | 3.12 +/- 1.74 |
| At 3 Months | 2.68 +/- 1.36 |
| At 6 months | 2.12 +/- 1.22 |
| At 9 months | 1.80 +/- 0.92 |
| Final Follow Up (1 year) | 1.24 +/ 0.72 |

The final functional outcome as assessed by Knee society score showed that out of 40 cases 29 (72.50%) cases had an excellent outcome whereas 6 (15%) and 4 (10%) patients had fair outcome. Only 1 patient (2.50%) had KSS below 60 suggestive of poor outcome (**Table 4**).

**Table 4 Outcome of patients on the basis of knee society score.**

|  |  |  |
| --- | --- | --- |
| **Outcome (KSS score)** | **Number of patients** | **Percentage** |
| Excellent (80-100) | 29 | 72.50% |
| Good (70-79) | 6 | 15.00% |
| Fair (60-69) | 4 | 10.00% |
| Poor (< 60) | 1 | 2.50% |

The analysis of the patients on the basis of complications showed that out of 40 patients 32 (80%) patients didn’t have any complications. 5 (12.5%) patients had residual intermittent pain, 2 (5%) patients had wound infections which was successfully treated by oral antibiotics and local wound care. Only 1 (2.5%) patient developed residual joint instability as evidenced by drawer test (**Fig 2**).

**Fig. 2 Complications in the studied cases.**

**Discussion**

Posterior cruciate ligament injuries usually result from road traffic accidents or contact sports injuries. Unlike in cases of isolated PCL tears where the management remains controversial the guidelines for PCL avulsion fractures is unanimous and open reduction and internal fixation remains preferable line of management and conservative management is not desirable given the high chances of non-union or malunion which may further destabilize the affected knee.11

In this study there was a significant male preponderance in cases of PCL avulsion fractures. Male preponderance is almost universal across the studies because of predominant involvement of males in road traffic accidents and contact sports which remains common causes of PCL avulsion fractures. Bali K *et al* conducted a study to analyze the outcome of posterior cruciate ligament (PCL) avulsion fractures of tibia with open reduction and internal fixation.12 Forty-two patients (30 males and 12 females) with a median age of 26 years (range: 14-53 years) who underwent ORIF through a modified posterior approach for PCL fossa avulsion fractures were assessed after a median follow up of 18 months (range 10-42 months). In 30 patients’ surgery was performed within 3 weeks of injury. This study showed a significant male preponderance with an M: F ratio being 1:0.4. Similar male preponderance was also reported by the authors such as Khatri K *et al*13 and Fan N *et al*14. The mean age of studied cases in this study was found to be 37.3 +/- 7.34 years. 29 (72.50%) patients sustained fracture secondary to road traffic accidents while 7 (17.50%) patients had sports related injuries. In 4 (10%) patients’ fracture was secondary to falls. In western world most of the PCL injuries are result of what is popularly known as dashboard injuries where the injury occurs in sitting position and sudden abrupt force is applied on the anterior aspect of tibia. However, in developing world including in India PCL injuries are usually result of road traffic accidents involving bikes. Chen W *et al* conducted a study to investigate the feasibility and clinical efficacy of using a toothed plate and hollow lag screw in the surgical treatment of posterior cruciate ligament (PCL) avulsion fractures of the tibia.15 This was a retrospective study of patients with PCL avulsion fractures of the tibia caused by road traffic accidents (n = 9), sports-related injuries (n = 6), falls (n = 5) and machinery-related injuries (n = 1). 20 patients presented with fresh fractures and one with an old fracture. The patients (13 men, eight women) had a mean age of 41.5 (range 19–72) years. The findings in this study were similar with respect to cause of avulsion fracture however the mean age of patients in this study was slightly higher. Similar findings were also reported by the authors such as Owesen C *et al*16 and Sanders TL *et al*17. In this study all patients were treated by open reduction and internal fixation of avulsed part of tibia. Patients were followed up for 1 year. During follow up visits x-rays were taken to assess the union. Also, functional assessment was done using Lysholm score and knee society score. Both Lysholm and knee society score were found to gradually improve over the period of follow up and both there was a significant functional improvement in mean Lysholm and knee society score when compared from presentation to last follow up visit. In this study outcome assessment by KSS (Knee society score) showed that out of 40 cases 29 (72.50%) cases had an excellent outcome whereas 6 (15%) and 4 (10%) patients had fair outcome. Only 1 patient (2.50%) had KSS below 60 suggestive of poor outcome. In a similar study Joshi S *et al* performed open reduction and internal fixation using cannulated cancellous screws in 14 patients (mean age, 33.9 years) with isolated PCL avulsion injuries.18 At the time of final follow up the authors found The Lysholm functional score was excellent in 11 patients, good in 2 patients and fair in 1 patient with an average score of 97±7.6. Similar findings were also reported by the authors such as Wu S *et al*19 and Khalifa AA *et al*20.

In conclusion patients with posterior cruciate ligament avulsion fracture treated by Open reduction and internal fixation combined with quadriceps exercises in post-operative period were found to have excellent results in terms of functional outcome.

**Limitation of the study:-**

Being a purely observational study, it has its inherent biases. A randomized control trial would be needed to further substantiate the outcome of this observational study.

**Conflict Of Interest: None**

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