e-ISSN: 0975-9506, p-ISSN: 2961-6093

Available online on www.ijpqa.com

International Journal of Pharmaceutical Quality Assurance 2025; 16(10); 307-311

Original Research Article

Functional and radiological outcome of arthroscopically assisted reduction and external fixation of high energy tibial plateau fractures with associated soft tissue injury

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Received: 03-08-2025 / Revised: 10-09-2025 / Accepted: 22-10-2025
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Conflict of interest: Nil

Abstract:

Tibial plateau fractures, often from high-energy trauma, pose complex challenges due to associated cartilage, ligament, and soft tissue damage requiring precise management to restore joint function and prevent osteoarthritis. Arthroscopically assisted reduction and internal fixation (ARIF) offer minimally invasive, direct visualization of the joint, enabling accurate fracture reduction and simultaneous treatment of intra-articular soft tissue injuries. Recent studies report excellent to good functional outcomes in 85-97% of patients, with Rasmussen clinical scores consistently high and radiological alignment well maintained over mid- to long-term follow-up (2-15 years). ARIF reduces soft tissue dissection and hospital stay compared to open methods, with complication rates (infection, stiffness, DVT) comparable or lower than traditional open reduction and internal fixation (ORIF). Challenges include a learning curve and operative time, but benefits include early mobilization, lower morbidity, and improved patient satisfaction, making ARIF a reliable option for managing complex tibial plateau fractures with associated soft tissue injury.

Keywords: Soft Tissue Injury, Ilizarov Ring Fixator, Arthroscopically Assisted Reduction and Internal Fixation.

Introduction

Fractures of the tibial plateau are common intra-articular injuries that are associated with high energy road traffic accidents. Among all of the fractures in adults, tibial plateau injuries account for 1%.[1]

Tibial plateau fractures of Schatzker type IV, V and VI are high energy injuries with variable degrees of soft tissue damage. These injuries require extensive exposure for reduction of the fractured bone with a risk of infection and soft tissue complications. The surgical procedure should inflict minimal surgical trauma, to achieve desired outcomes. Therefore, the indirect reduction has now become the standard of care in these fractures. Although indirect reduction has the advantage of avoiding extensive exposures, adequacy of articular reduction can often be difficult to evaluate under routine intra-operative fluoroscopy.[2]

The potential benefits of arthroscopic assisted reduction and internal fixation are well documented.[2] Arthroscopic visualization of tibial plateau provides a better view of the joint surface for lavage and removal of hematoma. Management of small loose fractured pieces of bone and soft tissue injuries to ligaments/meniscus can be addressed using arthroscope. Arthroscopic-assisted reduction limits soft tissue dissection and prevents detachment of the meniscus to gain visualization. Minimal soft tissue incisions help in improved recovery by decreasing pain, shortening hospital stay, and early return of knee flexion.

Percutaneous fixation techniques preserve the periosteal network of blood vessels and avoid extensive open fixation. These techniques limit the risk of infection, necrosis and wound dehiscence.

The Hybrid External Fixator combines the advantages of the mono-lateral pin fixator and the Ilizarov ring fixator. The reported advantages are early joint mobilization, weight bearing, and easy wound surveillance. The hybrid fixator is adjustable, and fracture reduction can be attained after frame assembly. There have been concerns for increased incidence of pin track infections with hybrid fixators but studies have shown no effects on outcome.[3]

Arthroscopic assisted reduction and minimal fixation have been reported in selected Schatzker I, II and III tibial plateau fractures, but a study assessing outcomes of minimal invasive fixation (hybrid external fixation) in high energy injuries type IV, V and VI is lacking.

Aim and Objectives: To assess the functional and radiological outcomes of arthroscopic assisted indirect reduction and hybrid external fixation in high energy tibial plateau fracture (Schatzker type IV, V and VI).

Materials and methods

This study was conducted from July 2015 to July 2017 at the department of orthopedics JIPMER Puducherry. Considering the number of patients with fractures of the tibial plateau that presented to the department of orthopedics in preceding years a sample size of 20 was estimated to complete the study. The study was approved by the institute's ethical committee and post-graduate research monitoring committee. All patients presenting with the fracture of the tibial plateau were screened for inclusion into the study.

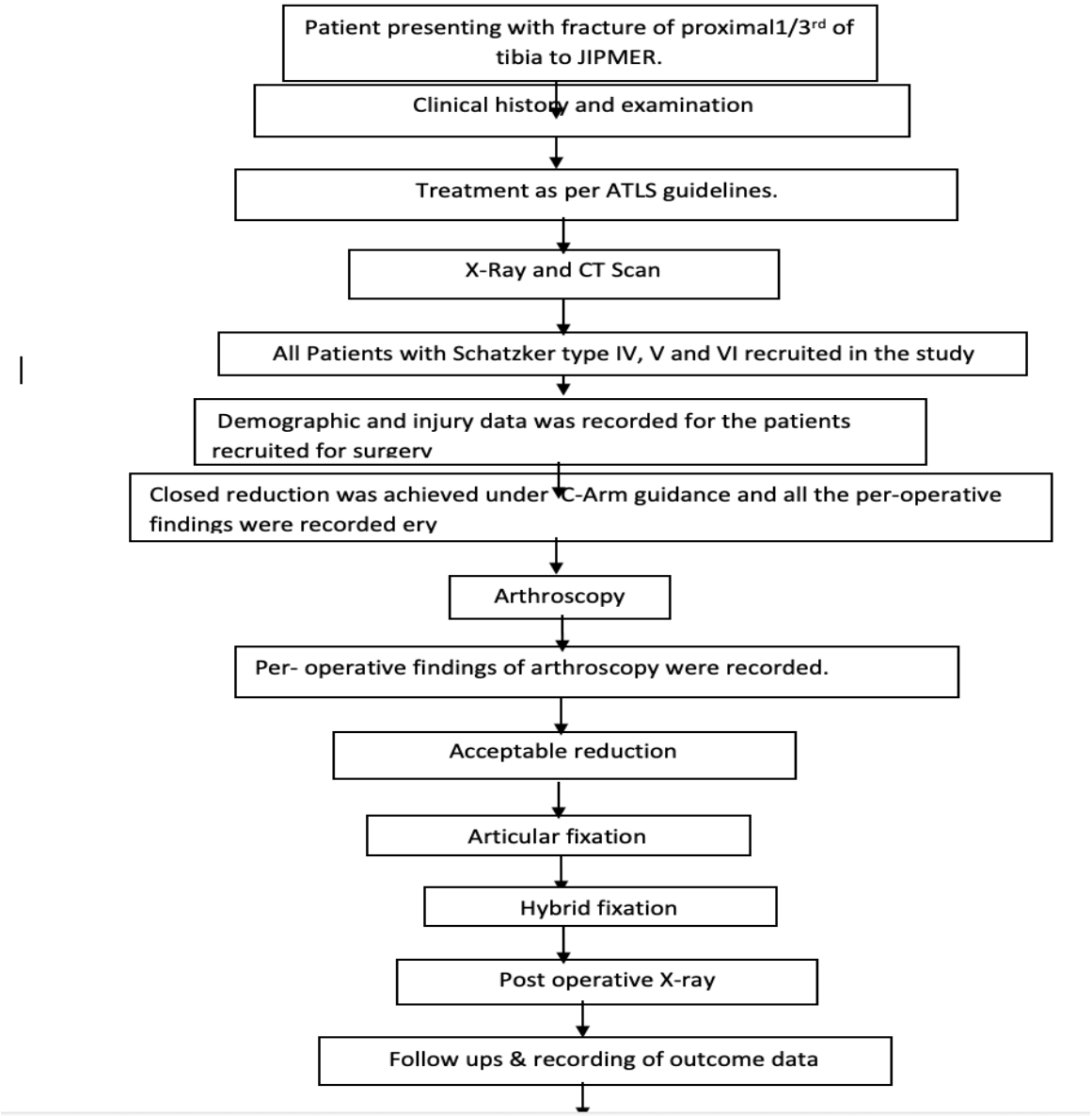
The Inclusion Criteria:

1. Age greater than 18 years (skeletally mature).
2. Isolated tibial plateau fractures with Schatzker types IV, V and VI open or closed.

The Exclusion Criteria:

1. Neurovascular injury at presentation
2. Ipsilateral long bone injuries, floating knees or other long bone injuries that have potential to influence functional outcomes.
3. Compartment syndrome.
4. Bilateral injuries

Study procedure



At presentation, patients with fracture of the tibial plateau were screened for inclusion into the study. All patients that met the inclusion criteria were included into the study. The patients were managed as per the ATLS principles and were stabilized. Subsequently, anteroposterior and lateral X-rays of the knee were obtained to confirm the fracture. A CT scan with three-dimensional reconstruction was done to view the geometry of fracture. The fractures were classified per the scheme given by Schatzker et al. into types IV, V or VI. All patients consenting to take part in the study were planned for surgical fixation. Limb elevation was given to reduce the effects of soft-tissue injury and then definitive fixation was done with the hybrid external fixator depending on the nature of soft tissues.

All the patients were operated within ten days of the trauma. Adequate consent was obtained, and demographic data were recorded. The fracture was gently manipulated under image intensifier control to achieve acceptable reduction

The arthroscope was introduced into the knee Joint. Once the articular surface was visualized, the reduction was analyzed for acceptability. If necessary, a suitable instrument was used to elevate the articular fragment under direct arthroscopic visualization. Once reduction was achieved, the articular surface was fixed and stabilized either with 4mm or 6.5mm cancellous screws or with olive wires fixed to a juxta-articular Ilizarov ring.

After confirmation of reduction, arthroscope was withdrawn and the fixation of the metaphyseal part of the fracture completed as per the pre-operative plan using 4.5mm Schanz pins and AO clamps.

Early postoperative mobilization was encouraged, but weight bearing was delayed till radiological confirmation of fracture healing. The patient was called for follow-up at six weeks, three months and six months after the surgery. At each visit, anteroposterior and lateral radiographs of the knee were obtained. The functional outcome was measured using Rasmussen score at all visits.

Radiological outcomes were measured by Rasmussen's radiological outcome scores.

Results

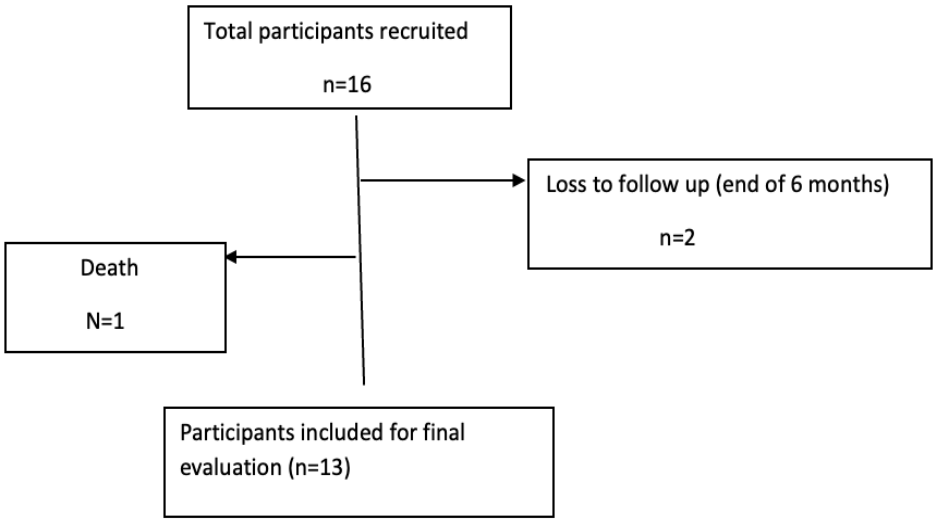


Table 1: Demographic Data

Age range	< 20 Years	1	18 to 63 years, mean + SD = 39.15±12.57
	20-40 years	5	
	40-65 years	7	
Gender	Male = 12 Female = 1		
Side of fracture	Right = 7 Left = 6		
Comorbidities	Diabetes mellitus – 3 Hypertension - 1		
Associated injuries	Head injury – 1 Anterior cruciate ligament injury – 1 Patella fracture – 1 Tibial spine fracture – 1 Opposite side intertrochanteric fracture – 1		

Table 2: Distribution of Schatzker type tibial platue fractures in study participants	
Type IV	**2**
Type V	**4**
Type VI	**7**

Table 3: Clinical results at 12 weeks and 6 months follow up (n=13)			
Results	**6 weeks**	**12 weeks**	**6 months**
Excellent	0	1	1
Good	1	5	4
Fair	11	7	8
Poor	1	0	0
Total	13	13	13

16 patients with Schatzker IV, V and VI injuries were recruited in the study during the study period. Two patients did not follow-up at the end of 6 months (final evaluation) and therefore were excluded from the study. One patient died due to reasons unrelated to the limb injury and was excluded. A total of 13 patients were available for final evaluation (Figure: 1). There were 12 males and one female (Figure: 2). There was one patient of age < 20 years, five patients between 20 to 40 years and seven patients between 40 -65 years. The mean age of the patients was 39.15 ± 12.6 years (Figure: 2). Right leg was fractured in 7 patients, and left in 6.

There were three patients with diabetes and one patient with hypertension in the study (Figure: 2). 2 patients had associated head injury, one patient each had associated anterior cruciate ligament injury, fracture of the patella and tibial spine avulsion on the same side. One patient had the intertrochanteric fracture of opposite side. (Figure: 2). There were 2, 4 and seven patients with Schatzker type IV, V and VI respectively at the time of final evaluation.

Main Outcomes: We had 1excellent four good and eight fair results as per the Rasmussen functional outcome score at the end of 6 months. (Table: 4)

There was one excellent, ten good and two poor outcomes as per Rasmussen classification for radiological outcomes (Table: 4).

Discussion

This study evaluated 13 patients at the end of 6 months for radiological and functional outcomes using Rasmussen scores in tibial plateau fractures Schatzker type IV, V and VI. We combined the use of arthroscopic assisted reduction and hybrid external fixation in high energy tibial plateau fractures. We had one excellent, four good and eight fair patients with Rasmussen's functional score and one excellent, ten good, and two poor radiological outcomes at final follow-up.

Various investigators have reported excellent to good functional outcomes in patients with tibial plateau injuries type 1 to 4, but our study specifically investigated Schatzker tibial plateau fractures type 4 to 6 and therefore we had good to fair outcomes. Dall'oca et al. failed to report excellent to good outcomes in tibial plateau fracture type 5 and six which is similar to the results reported in our study.[4]

Outcome assessment for soft tissue injuries was beyond the scope of our study since it was a short-term study.

Studies have found an incidence of 71% of associated soft tissue injuries in tibial plateau fractures. The frequency of 57%, 25%, and 5% have been observed for meniscal, anterior cruciate ligament and posterior cruciate ligament injuries respectively. The lateral collateral ligament (LCL), medial collateral ligament (MCL) and the peroneal nerve have been found to be injured in 3%, 3% and 1% of cases respectively. A higher incidence of soft tissue injuries has been reported with Schatzker tibial plateau fractures of type V and VI.[5]

We had 11 cases of type V and VI Schatzker tibial plateau injuries, and 2 of these patients sustained soft tissue injuries (Figure 6). We had two patients with anterior cruciate ligament and medial collateral ligament injuries. We had no meniscal injuries in our patients.

Studies have reported decreased operating time, hospital stay, and healing times in patients operated through arthroscopic assisted fixation and minimal incisions.[6] We had a mean operating time of 120 minutes and an average hospital stay of 15 days. Patients recruited in our study achieved clinical and radiological union at the end of 8 and ten weeks respectively.

Studies have demonstrated better visualization of chondral surface reduction, lavage of the hematoma, easier removal of smaller loose fragments, decreased soft tissue dissection using arthroscopic assisted reduction. We found an easier reduction in patients up to 5-7 mm of chondral depression, but greater amounts of depression and displacements required an open approach for elevation and reduction. [3]

Studies have compared hybrid external fixation with bi-columnar plating and have reported reduced hospital stay, complication rates, and reoperation rates. The number of unplanned surgical operations were also found high in patients with bi-columnar plating. We had two patients that required screw removal at a later date in follow-up which was due to infection. [7]

Studies have reported increased risk of pin track infections after treatment with hybrid external fixation. The reported risk of pin track infection is up to 26%. We had 16 patients with superficial pin track infections in our study. This accounted for 100 % of patients with pin track infections.

Strength of the study: To the best of our knowledge ours was the first study that combined arthroscopic assisted reduction and minimally invasive fixation (hybrid fixation) to assess outcomes of severe tibial plateau injuries.

Limitations of the Study

1. One of the major limitations of the study was a failure to achieve target sample size of 20
2. Three patients were excluded from the study at final evaluation which amounts to a loss of 19% follow-up. This finding introduced selection bias for selective reporting of good results.
3. Our study reported short term outcomes in severe tibial plateau injuries. Studies have shown unsatisfactory outcomes on long term follow-up (9 years) of severe tibial plateau injuries. Patients develop degenerative arthritis of the knee on long follow-up.

Conclusion

To conclude this study found excellent to good outcomes as per rasmussen's functional and radiological score at short term (6 months) in severe tibial plateau fractures (schatzker's type IV, V and VI). Arthroscopically assisted reduction and external fixation is an effective, safe technique that optimizes functional recovery and radiological outcomes in high-energy tibial plateau fractures, especially when soft tissue injury is present.

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