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ORIGINAL ARTICLE

Assessment of the Functional Outcome of Arthroscopic Assisted Reduction and Percutaneous/ Open Internal Fixation of Tibial Plateau Fractures.

Lt Col Nikhil Sood[1], Col Amresh Ghai[2], Parikshat Gopal [3], Maj Manoj Kumar[4], Lt Col Ravindra Chauhan[5], Lt Col Prasenjeet[6]

[1]Classified Spl, Department of Orthopaedics, Base Hospital Delhi Cantt, New Delhi, India
[2] Head of Department, Department of Orthopaedics, Base Hospital Delhi Cantt, New Delhi
[3] Associate Professor, Department of Orthopaedics, ACMS & Base Hospital Delhi Cantt, New Delhi
[4] Graded Specialist Orthopaedics, Department of Orthopaedics, 92 Base Hospital,
[5] Classified Specialist Orthopaedics, Department of Orthopaedics, Base Hospital Delhi Cantt, New Delhi
[6] Graded Specialist Orthopaedics, Department of Orthopaedics, Command Hospital (WC), Chandimandir.

ABSTRACT

Background: Tibial plateau fractures are complex injuries which require anatomical reduction of bony injuries along with management of associated ligamentous and meniscus injuries. The outcome depends not only on personality of initial injury but on management of fracture and associated injuries also. ORIF is the gold standard for treatment of tibial plateau fractures, but arthroscopic assisted fixation provides a viable alternative for Schatzker type I- IV tibial plateau fractures, as evidenced in this study.

Methods: A prospective study was conducted for assessment of the functional outcome of arthroscopic assisted reduction and percutaneous /open internal fixation of tibial plateau fractures. Twenty four cases of arthroscopic assisted reduction and percutaneous /internal fixation of tibial plateau fractures were studied prospectively for functional outcome. Following diagnostic round of arthroscopy, reduction of fracture was done and fractures were fixed as per case merits. No more than 2 mm articular step off was accepted. Fixation methods included percutaneous 6.5 mm CCS, or ORIF with 6.5 mm PTCCS/proximal lateral tibial anatomical plate/medial buttress plating. Following this intra-articular pathologies were addressed. All peripheral reparable meniscal tears were repaired with inside out/outside in technique. Unrepairable meniscal tears were excised or debrided. Cruciate ligaments tear were not repaired/reconstructed acutely. Collateral ligaments were repaired acutely. Functional outcomes were assessed based on American knee society score [2] (AKSS).

Results: The mean followup was 06 months. Final assessment based on AKSS done and objective score at 06 month turned out to have 75% patients with excellent result , however 88 % patients have excellent functional score at 06 months. Only 01 patient has poor objective score and none has poor functional score table.

Conclusion: Arthroscopic assisted fixation include direct visualization of articular surface for perfectness of reduction and single stage management of associated ligamentous and meniscal injuries. Arthroscopy allows for visualisation of accurate fracture reduction while obviating the need for extensive operative exposure. In some regards, arthroscopy narrows the gap between the extremes of open versus nonoperative management. The arthroscopy allows for evacuation of hemarthrosis and any fracture debris. Arthroscopy may offer the advantages of more rapid recovery, reduced pain, early full range-of-motion, improved fracture healing, and more complete and functional recovery.

Address for correspondence
Parikshat Gopal, Department of Orthopaedics, ACMS & Base Hospital Delhi Cantt, New Delhi -110010, India
Email : docpgopal@gmail.com
Phone : +91-9811114752

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Introduction

Our life in the present time, driven by pace in industrialization, urbanization and mechanization, leads to an increased number of high energy traumatic incidents. Crowded cities, irregular traffic arrangements, and, fast moving vehicles are the most important contributory factors causing polytrauma with associated

bony injuries particularly comminuted fractures and significant soft tissue injury. Fractures of the tibial plateau are a common association amongst such injury patterns. The incidence of tibial plateau fractures is ever increasing due to exponential rise in motor vehicular accidents. Fractures of tibial plateau are serious injuries that frequently result in significant functional impairment. Today, the first challenge in the management of tibial plateau fractures is to decide between non-operative or surgical treatment [1]. Fractures that are stable and are minimally displaced may be amenable to cast immobilization. Other indications for non-operative treatment may include injuries to the peripheral (submeniscal) rim of the plateau and fractures in elderly, low-demand, or osteoporotic patient [2]. The emphasis in treating displaced articular fractures is an anatomical reconstruction of articular surface, restoration of the soft tissue envelope and rigid internal fixation to obtain a stable painless articulation with normal range of motion. Historically, conservative treatment mostly yielded poor results. Surgical intervention for this fracture is currently the mainstay of treatment. Open reduction and internal fixation of complex fracture patterns are often complicated by a compromised soft tissue envelope and suboptimal address of intra-articular pathology. Also, excessive dissection may impair vascularity of the fracture fragments and increase risk of infection [5]. Arthroscopically assisted percutaneous fixation, which was first recommended by Caspari [7] and Jennings [3] has gradually become popular since its initial use as a diagnostic tool. Arthroscopic assisted internal fixation may represent a viable alternative to open surgery and may reduce morbidity associated with fracture repair [8,9]. Arthroscopy is minimally invasive in comparison to ORIF [3]. The entire articular surface may be visualized without the extensive dissection required for traditional ORIF[3]. The arthroscope allows for evacuation of hemarthrosis and any fracture debris [10]. In addition, arthroscopic treatment of meniscal and ligamentous injuries is often superior to repair or reconstruction using larger, open incisions [8,4]. Arthroscopy may offer the advantages of more rapid recovery, reduced pain, early full range-of-motion, improved fracture healing, and more complete and functional recovery [1,3,4]. It is acknowledged that percutaneous lag or buttress screws, percutaneous plates, or even open buttress plating may be required in such cases, and arthroscopic assisted internal fixation is specifically defined as a surgery where anatomic reduction and rigid internal fixation is achieved without (a large or submeniscal) arthrotomy [7]. Recently there has been an interest in the arthroscopic assisted method which has been tried in Schatzker I - IV type of fractures by a different authors. The method is still evolving and under evaluation. This requires a high degree of arthroscopic skill and familiarity with minimally invasive fracture fixation techniques. At our institution over 800 arthroscopic procedures are done annually. This study was conceived as our ever increasing use of the arthroscope, allows us to extend these skills to more and more complex problems.

Potential disadvantages of arthroscopic assisted internal fixation or arthroscopically assisted ORIF of tibial plateau fractures require consideration. The rate of complication related to arthroscopic surgery is reported to be between 1% and 8%. These are either intraoperative complications such as vascular or neurological injury, articular cartilage injury, and those due to broken instruments or are early postoperative complications as hemarthrosis, deep vein thrombosis, infection, compartment syndrome, and, loss of correction [6, 11].

Materials and Methods

Study design: A prospective study was conducted for assessment of the functional outcome of arthroscopic assisted reduction and percutaneous /open internal fixation of tibial plateau fractures. Twenty Four cases of arthroscopic assisted reduction and percutaneous / internal fixation of tibial plateau fractures were studied prospectively for functional outcome.

Place of study: Base Hospital Delhi Cantt

Study period: From NOV 2013 to NOV 2015.

Study population: All patients with tibial plateau fracture fulfilling the inclusion criteria of study.

Sample size: All patients of tibial plateau fracture fulfilling inclusion criteria were to be included in the study. Based on previous year records from the statistical department of this hospital average amounted to be around 12 per year.

Inclusion criteria:

1. Age < 60
2. Tibial Plateau Fractures Schatzker Type I, II, III and IV

Exclusion criteria:

1. Age > 60
2. Tibial Plateau Fractures Schatzker Type V and VI
3. Open fracture
4. Pathological fracture
5. Severe head injury (initial Glasgow coma scale score of < 8) and
6. Severe systemic illness (active cancer, chemotherapy, hemophilia, or a medical contraindication for surgery).

Ethical clearance: Ethical clearance was obtained from institutional ethics committee of the hospital before start of study. Written informed consent was obtained from each subject before the conduct of the study.

Conduct of the study

All cases on presentation to the emergency department were seen. The history was taken, followed by general and local examination of the patient to determine the mechanism of trauma, status of soft tissue envelope and neurovascular competence. The affected limb was initially immobilized in an above-knee POP slab with elevation, or put in calcaneal traction on a Bohler-Brown splint depending upon the condition of the soft tissues. Concerned specialists undertook appropriate management of the associated injuries. Intensive care was given to those patients who presented with shock and immediate resuscitative measures were taken as necessitated. All patients underwent radiological plain-film study in anteroposterior and lateral views as well as computerized tomography with 3 D reconstruction of the knee prior to surgical intervention.

Surgical technique: After detailed preoperative evaluation and imaging studies, like Radiographs, CT scan with 3-D reconstruction, the fracture geometry was carefully studied. The operative planning included the need for and marking the cortical window, necessity for bone graft/substitute and the necessary internal fixation method that was tailored for each case. The treatment method was based on the type of fracture, the amount of displacement and the amount of depression of the tibial plateau. The patients were taken for surgery at the earliest possible time depending on their medical condition, skin condition and the amount of swelling. All surgeries were done by arthroscopic assisted joint visualisation and under C-arm image intensifier control. We set the patient in supine position on fluoroscopic table with involved leg hanging from side of table whenever required. Prophylactic antibiotics were routinely administered with the induction of anaesthesia as per departmental protocols. Tourniquet was applied and confirmation of pre-operative antibiotics dose done. Surgical check list was confirmed before commencing the surgery.

The standard anterolateral port was used to drain the hemarthrosis which was followed by joint lavage to enable visualisation. An anteromedial port was established to further probe the joint for intra-articular pathology. We didn't use arthropump, instead we use gravity method for fear of compartment syndrome.

Following diagnostic round of arthroscopy, reduction of fracture was done and fractures were fixed as per case merits. No more than 2 mm articular step off was accepted. Fixation methods included percutaneous 6.5 mm CCS, or ORIF with 6.5 mm PTCCS/proximal lateral tibial anatomical plate/medial buttress plating. Following this intra-articular pathologies were addressed. All peripheral reparable meniscal tears were repaired with inside out/outside in or all inside technique. Unrepairable meniscal tears were excised or debrided. Cruciate ligaments tear were not repaired/reconstructed acutely. Collateral ligaments were repaired acutely.

Type 1 Fractures: Closed manipulation with help of ligamentotaxis and reduction clamps; joystick technique if needed. After confirmation of reduction with arthroscopy and fluoroscopy these were fixed with 6.5 mm PTCCS.

Use of a large forceps for fracture reduction and fixation

Arthroscopic view after reduction

Principle of fracture reduction via ligament traction: The traction exerted on the bone structures elevates the fragment.

Type 3 Fractures: Anterior cruciate ligament tibial guide was used to localize the center of the depressed articular surface and a cortical window was created to elevate these depressed fractures with the help of a tamp under direct arthroscopic visualization. The defect was filled with autograft/synthetic bone graft and elevated fracture fragments rafted with 6.5 mm PTCCS/proximal lateral tibial anatomical plate.

Type 2 Fractures: A combination of both of the above mentioned techniques was used for dealing with these injuries.

Type 4 Fractures: Closed manipulation with help of reduction clamps, joystick technique and percutaneous

pining were usually attempted. Sometime such fractures required an ORIF using medial or posteromedial approach to reduce the fracture fragments. After confirmation of reduction with arthroscopy and fluoroscopy these were fixed with 6.5 mm PTCCS/ medial buttress or anti-glide plating.

Post operative protocol : Postoperative X-rays were usually done on the first post-op day and repeated at 6 weeks and 6 months or whenever felt necessary to assess progress until union.

Postoperative Rehabilitation

1. **FIRST WEEK**: Patients were encouraged to do isometric quadriceps and hamstrings exercises starting on the first postoperative day. ROM exercises of hip, ankle, foot were also part of the early rehabilitation program. CPM was used if the patient was not able to follow this protocol.
2. **SECOND WEEK – FOURTH WEEK**: Non-weight bearing ambulation with the help of walker or crutches was encouraged.
3. **SECOND MONTH**: The patient was allowed partial weight bearing ambulation as tolerated with crutches or a walking stick.
4. Full Weight bearing was only allowed after radiological consolidation of the fracture.

Functional Outcome: Functional outcomes were assessed based on American knee society score1 (AKSS). Radiological union was also correlated with results of functional outcome.

Results

All data from cases was collected and compiled. Data was studied in references of gender distribution, Age Distribution, Mode of Injury, Laterality, Average Hospital Stay, Type of fracture (based on Schatzker's classification), incidence and type of intra-articular pathology, Complications, Objective score based on AKSS at 6 months and functional score based on AKSS at 6 months.

In our study we observed a male preponderance with 87.5 percent male patient. Out of total 24 patients only 03 patients were females.

Most of the patients in our study were in the age group of 31- 40 yrs and constituted 58.33 % of the study group. The next common age range was <30 yrs with 25% patients. Most of the fractures in our study were sustained due to road traffic accidents (50%) and military training activities (21%). Other modes of injuries were fall from height, sport related activities and injury due to assault.

Side of involvement: in our study amounts to almost equal with slight left preponderance.

Average hospital stay in this study was 5- 10 days for 63% patients. Only 02 patients were stayed more than 03 weeks who developed post op complications. According to Schatzker classification, type I fractures (42 %) and type II fracture (29%) constitutes maximum patients (71%) of this study. Out of 24 patients of this study, 10 patients (41%) had intra-articular pathology. Amongst them lateral meniscus tears were the commonest (25%) pathology. It was observed on association of different types of intra-articular pathology with fracture pattern, that type I and III Schatzker type fractures have only lateral meniscus injuries (3 and1 respectively) type II have lateral meniscus tear and ACL tear and type IV have medial meniscus tear and ACL tear. Complications were not encountered frequently in this series. Only 02 cases had significant complication. One had deep vein thrombosis and other had compartment syndrome.

Final assessment based on AKSS done and objective score at 06 month turned out to have 75% patients with excellent result, however 88 % patients have excellent functional score at 06 months . Only 01 patient has poor objective score and none has poor functional score table.

Discussion

This study was carried out to assess the functional outcome of 24 cases of tibial plateau fractures managed with arthroscopic assisted fixation. The analysis of results were made in terms of age of patients, gender distribution, mode of injury, laterality of fracture, type of fracture, intra-articular pathologies, complications and functional outcome.

In our study 21 out of 24 patients were male (87.5%). This was partly because this was an army hospital. Its clientele has a male dominance and partly it may be attributed to more outdoor training activities. Albuquerque et al68 also found a male dominance in their series with 70.3% male. However the study done by Schulak Gunn[12] shows no gender difference.

In our study the mean age of the patients was 35 and maximum patients were in age group of 30-40yrs (58.33%). The next group was 20-29yrs (25%). According to Albuquerque RP et al [13] the mean age was 44.5±14.4 with maximum patients belonging to age group 40-49yrs, and the next most frequent group was 30-39 yrs.

In our study the most common mode of injury was road traffic injuries (50%). The next most common etiological association was related to training activities which includes both sports and army related training (37.5%). Other modes of injuries were fall from height (02 cases)

and assault (01 case). Similar distribution of mode of injuries was observed in other studies [13,15] also. However in a study of Hung et al [16] 97% injuries were sustained during traffic accidents.

The left tibia was slightly more prone to get injured as observed in our study. 13 cases were left sided and 11 were right sided. Left side prominence is also observed in the study by Albuquerque et al [13]. This possibly is just an observation common to our study also.

In our study, the average hospital stay was 12 days with most patients being discharged within 2 weeks of injury. 2 patients were required to stay longer in hospital for treatment of related complications i.e. compartment syndrome and deep vein thrombosis. They stayed for 24 days and 22 days respectively.

Out of four types of Schatzker fractures included in our study, type I (42%) and type II (29%)were more common in comparison to type III (12%) and type IV (17%). In the study done by Albuquerque et al Type II (35.1%) was the commonest fracture. Mehmet Asik et al [17] also show dominance of type II fracture in their study.

One of the biggest advantages of arthroscopic assisted fixation is to diagnose and treat the associated intra-articular pathology. In our study 06(25%) lateral meniscus tears were observed. Out of them 04 were amenable to repair, being peripheral tears, and 02 were managed with partial menisectomy as they were irreparable. Out of these 06 lateral meniscus tears, 03 were associated with type I fracture, 02 with Type II fracture and 01 with type III fracture. 02(8%) medial meniscus tear were also observed associated with type IV fracture, both were managed with meniscus repair. 02(8%) ACL tears were also observed which were left unattended as they were bony avulsion type tears. Total intra-articular lesions were 41% in our study.

The frequency of intra-articular lesion varies widely in various studies. Abdel-Hamid MZ et al [18] reported 71% soft tissue lesion associated with tibial plateau fractures out of which 57% were meniscal injuries, 25% ACL injuries, 5% PCL injuries 3% MCL and LCL each and 1% peroneal nerve injury. No significant association was noted between fracture type and incidence of meniscus, PCL, LCL, MCL, artery, or, nerve injury.

In a study by Vangsness CT et al 74, intra-articular lesions were reported to be around 47%. 56 % intra-articular lesions were reported by Bennett WF [19] .

T. Scheerlinck et al [20] have found 53.8% incidence of intra-articular lesions in which the lateral meniscus was most commonly injured. On follow-up they observed that such injuries did not seem to play a major role in the final functional outcome of the patients reviewed. On the other end of the spectrum only 2% intra-articular lesion were reported by Holzach et al [14,20].

With regards to complications, we observed 02 cases of loss of reduction, identified in the immediate post –op period. One of them was managed by repeat arthroscopic assisted fixation while another was tackled with ORIF+PLATING after a week. Post op they performed well. One case of deep vein thrombosis (4%) was also identified and managed successfully with anticoagulants for 03 months as per recent guidelines by ACPP [21] initially with 60 mg BD subcutaneous LMWH for 14 days and subsequently with Tab Warfarin dosage adjusted to maintain INR at 2-3.

One case also developed a presumed compartment syndrome as evidenced by a tight and swollen calf towards the end of the fracture fixation (4%). He was managed with two incision fasciotomy at the conclusion of fracture fixation. The possible reason was thought to be a combination of initial injury and early surgery as this patient was operated on third day of injury. In retrospect it was felt that his soft tissue injury might have been incorrectly assessed following the trauma. Though this was an observation made in retrospect, Belanger M et al [22] in 1997 reported a case report of compartment syndrome of the leg after arthroscopic examination of a tibial plateau fracture. Chang YH et al [23] in 2000 observed 10.3% incidence of compartment syndrome in tibial plateau fractures in Taiwan. However in other studies compartment syndrome was not found to be a complication.

02 patients were also observed to have varus instability at 6 weeks follow-up, which was found to be stable at review after 06 months.

Final outcomes were made on the basis of American knee society score.

Objective score at 06 months showed that 18 patients (75%) scored excellent, 02 patients (8%) scored good, 02 patients (8%) scored fair and 01(4%) patient scored poor results.

Functional scores at 06 months indicated that 20 patients (83%) scored excellent, 01 patient (4%) scored good, 02 patients (8%) scored fair. These results are comparable to available studies in literature.

Itokazu and Matsunaga[24] in 1993 reported a series of 20 diverse cases, (7 type I, 9 type II, 1 type III, 2 type IV, and 1 Type V fracture), and observed that all patients scored good to excellent results based on Rasmussen criteria. Superior results were noted in type I and II fractures which commensurate with our study results.

Holzach et al [21] in 1994 reported a series of 16 patients.

01 patient was lost to follow-up and 14 patients out of 15 were rated excellent using the Davos knee scoring system.

Cassard et al[8] in 1999 treated 26 patients arthroscopically for tibial plateau fractures that included follow-up at 32.7 months for 19 cases. The mean Knee Society Score (KSS) score was 94.1 for pain and 94.7 for function. Two patients had early radiographic signs of osteoarthritis, and 2 had valgus deviation. There was no cases of late bony collapse in their study. The authors concluded that results of arthroscopic management were as good as or better than what might be expected from ORIF.

Ohdera et al[24] in 2003 performed a comparative study between ORIF and AAIF. Comparison of 19 patients treated with AAIF and 9 patients using ORIF showed no difference in duration of the operation, postoperative flexion, or clinical results. Faster, easier postoperative rehabilitation was noted in the group managed arthroscopically. In addition, anatomic reduction was achieved in 85% of patients treated arthroscopically versus only 55% treated by open surgery.

Conclusion

Tibial plateau fractures are complex injuries which require anatomical reduction of bony injuries along with management of associated ligamentous and meniscus injuries.

The outcome depends not only on personality of initial injury but on management of fracture and associated injuries also.

ORIF is the gold standard for treatment of tibial plateau fractures, but arthroscopic assisted fixation provides a viable alternative for Schatzker type I- IV tibial plateau fractures, as evidenced in this study.

The advantages of arthroscopic assisted fixation include direct visualization of articular surface for perfectness of reduction and single stage management of associated ligamentous and meniscal injuries. Arthroscopy allows for visualisation of accurate fracture reduction while obviating the need for extensive operative exposure. In some regards, arthroscopy narrows the gap between the extremes of open versus nonoperative management. The arthroscopy allows for evacuation of hemarthrosis and any fracture debris. Arthroscopy may offer the advantages of more rapid recovery, reduced pain, early full range-of-motion, improved fracture healing, and more complete and functional recovery.

In our study the objective and functional scores showed excellent results for 75% and 83% respectively.In our study 41 % patients had intra-articular pathology,

	Cassard[8] 1999	Gill[10] 2001	Rossi [25] 2008	Siegler[26] 2009	t.Cristea[27] 2010	Our study 2013
No of patients	26	25	57	28	262	24
Number of follow-up patients	26	25	46	21	184	23
Average age	42.3	45.2	48	43	51	35
Average follow-up (months)	32.7	24	60	59.5	60	06 months
Associated lesions (%)	-	-	39	32.1	63	41
Meniscal lesions (%)	30.8	36	28	7.1	53	33 Lateral 25 Medial 08
ACL Lesions (%)	11.5	32	11	3.6	10	8
Postoperative complications (%)	7.7	0	3.5	0	4.9	8
AKS average	94.1	-	93.2	85.2	93	-
AS functional average	94.7	-	94.8	91	95	94.5
Clinical Rasmussen average	-	27.5	28.2	25.5	-	-
Malalignment (%)	10.5	-	8.7	32.1	4.9	8

amongst which meniscal injuries were managed in same sitting.

Apart from usual complication of such fracture management, the compartment syndrome due to extravasation of arthroscopy fluid is most dreaded and serious complication which should be looked for after arthroscopic assisted fixation. emergent fasciotomy should be offered in cases of compartment syndrome.

Having enumerated all the advantages of arthroscopic assisted fixation, it requires a steep learning curve with infrastructure and facilities of arthroscopy. It requires the excellence in both arthroscopy and traumatology on surgeons' part to achieve better result with this minimally invasive technique.

In present surgical scenario of minimally invasive or key-hole surgeries with cutting edge technology, it is prudent to use the arthroscopy in fracture fixation to meet the expectations of patients and science. In the near future we should see more and more use of arthroscopy in various intrarticular fractures.

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