Original Article

Outcome of complex tibial plateau fractures treated with external fixator

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Abstract

Background: Tibial plateau fractures are usually associated with communition and soft tissue injury. Percutaneous treatment of these complex fractures is intended to reduce soft issue complications and postoperative stiffness of the knee joint. We assessed the complications, clinical outcome scores, and postoperative knee range of movements, after fluoroscopic assisted closed reduction and external fixator application.

Materials and Methods: Seventy eight complex tibial plateau fractures in 78 patients were included in the study. All fractures were managed with closed reduction and external fixator application. In 28 cases with intraarticular split, we used percutaneous cancellous screw fixation for reduction and fixation of condylar parts. In nine open fractures, immediate debridement was done. In 16 cases, elevation of depressed segment and bone grafting was required, which was done from a very small incision. All patients were clinically and radiographically evaluated at a mean followup of 26.16 months (range 6–60 months).

Results: Clinical results were evaluated according to the Rasmussen's criteria. Average healing time was 13.69 weeks (range 12– 28 weeks). Mean knee range of motion was 122.60° (range 110°–130°). Forty seven results were scored as excellent, 25 good, 2 fair, and 1 as poor.

Conclusion: We believe that minimally invasive treatment by percutaneous techniques and external fixation is a fairly reasonable treatment alternative, if near anatomical reduction of joint surface can be confirmed on fluoroscopy.

Key words: Complex tibial plateau fractures, closed reduction, external fixation

Introduction

The tibial plateau fractures, especially in high-energy trauma due to extensive soft tissue damage, pose a therapeutic dilemma. There are various management options, open reduction and internal fixation by using various types of plates and screws is one of the most commonly used treatment, but there also complications like wound problems, infection, deformities, and stiffness are not known to be less.[1,2] The other option is minimally invasive technique using closed reduction and percutaneous internal fixation and/or supportive external fixation.[3-6] The aim of our study was to find out the functional outcome after the latter modality of treatment, especially when conventional open technique is difficult or contraindicated.

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Materials and Methods

From April 1999 to March 2010, in a prospective study, 78 cases of complex tibial plateau fractures were treated by use of conventional external fixator and minimal percutaneous internal fixation with cannulated cancellous screws (CCS) when required. A total of 75 cases were available for the study, with a mean followup of 26.16 months (range 6-60 months), 3 cases were lost to followup. Sixty six cases were closed fractures with most of them having either blisters or significant bruising. Rest nine were open Gustilo[7] grade II. All patients presented within 48 h of injury The mean age was 41.96 years (range 18–64 years). There were 59 males and 16 females. Only complex tibial plateau fractures were included in the study, which belonged to Schatzker's type V and VI[8,9] or type C of A. O. classification, as these are the fractures with soft tissue injury. There were 36 C1 type, 21 C2 type, and 18 C3 type fractures according to A. O. classification.[10] Fifteen cases had grade 1/2 medial collateral ligament injury, diagnosed clinically on examination of knee, and all of them were treated conservatively. Also, none of the patients had lateral collateral ligament, anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL) injuries. Treatment was decided on radiological findings only and not based on computed tomography (CT) scan.

Almost all, i.e. 69 out of 78 of these patients, had sustained injuries in road traffic accidents (RTA) due to high velocity trauma; the remaining had history of fall at home. All patients were operated immediately after they became fit for anesthesia.

All C1 (n = 36) type fractures were primarily managed with closed reduction under fluoroscopy, followed by knee joint sparing external fixator application around the fractured area. But C2 (n = 21) and C3 (n = 18) types of fractures were treated with half pin external fixator and with additional CCS by closed method [Figures 1A and 1B], percutaneous joystick method, or through open wound after its debridement and sometimes extending the incision for getting reduction. Once reduction was achieved, the fracture was fixed with K wires over which CCS was introduced to stabilize the proximal fragments. Then, external fixator was applied for metaphysiodiaphyseal stability. The fixator was unilateral AO type in 71 cases [Figures 2A and 2B] and hybrid in 4 cases. The proximal pins were kept away 14 mm from the joint line to avoid infection in the knee joint. Elevation of depressed fracture fragments was done by making a small window in the medial upper tibia metaphysis, with bone grafting[11,12] in 16 cases. Mean hospital stay was 5.89 days (range 5–10 days).

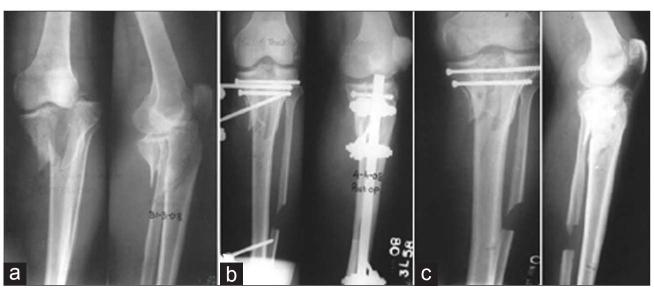

Figure 1A: X-ray anteroposterior and lateral views (a) preoperative X-rays showing tibial plateau fracture (b) immediate postoperative X-rays showing reduction and fixator *in situ* (c) final followup X-rays of same patient showing maintained joint congruity

Active range of motion (ROM) exercise was started after 3–5 days postoperatively in 72 patients, except in three patients where the fixation was not rigid enough to mobilize them early. All the patients were taught pin tract care.

Partial weight bearing crutch walking was started from 10 weeks in C1 type of fractures, whereas it was delayed to 12 weeks in C2/C3 type of fractures. In one case which was badly comminuted, partial weight bearing was delayed up to 20 weeks. Full weight bearing was started after clinical and radiological signs of union appeared.

All patients were followed up and evaluated clinically as per Rasmussen's criteria [Table 1] and radiographically for presence of callus. Radiological (X-rays) evaluation was six-weekly for the first 3 months, followed by three-monthly for the next 1 year. In this series, the final outcome was evaluated using Rasmussen's criteria.[13,14] Followup ranged from 6 to 60 months (mean 26.16 months). Healing of the fractures was assessed clinically by stability without pain and radiographically by the evidence of formation of callus. The average healing time was 13.69 weeks postoperatively (range 12–28 weeks). The external fixator was removed in outpatient department, after healing of fracture. The fracture healed in all cases except in one open type C3 fracture where there was nonunion which was treated by

Table 1: Rasmussen's functional score system

	Clinical features				
Rating	**Pain**	**Walking capacity**	**ROM**	**Clinical signs**	**Stability**
Excellent	No	Normal	Normal	No	Normal
Good	Minimal	Walking outdoor for at least 1 h	75% of normal	+	Minimal
Fair	Occasional ache	Walking outdoor for 15 min	>50% of normal	Swelling, ++	Instability in flexion
Poor	Pain at rest	Walking indoor only	50% of normal or less	+++	Instability in flexion as well as in extension

ROM: Range of motion

Figure 1B: Clinical photographs of same patient showing (a) extension at knee (b) flexion at knee

Figure 2A: X-ray anteroposterior and lateral views showing (a) preoperative X-rays showing tibial plateau fracture (b) postoperative X-ray showing fixator *in situ* (c) final followup X-rays of the same patient

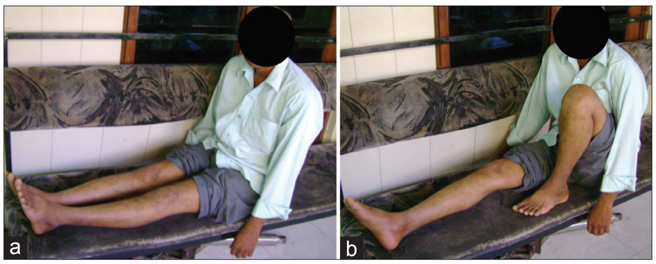

Figure 2B: Clinical photograph showing (a) extension at knee (b) flexion at knee

cancellous bone grafting to augment the process of union. Mean hospital stay of all patients was 5.89 days (range 5–10 days). Nine patients having compound fractures had mean hospital stay of 8.1 days (range 7-10 days), they had to be in hospital for more time for their wound healing. Wounds healed completely in all the patients. However, compound fractures fared equally well as compared to simple fractures in terms of ROM knee and radiological/clinical signs of union. Mean knee ROM was 122.60° (range 110°-130°). No patient had clinically obvious flexion deformity. The final outcome was excellent in 47 (62.8%) cases, good in 25 (33.30%) cases, fair in 2 (2.66%) cases, and poor in 1 (1.33%) case.

In 12 (16%) cases, varus malunion Mean 15° (range 10°–20°) occurred due to loss of reduction/alignment in fixator. However, functionally, the knee ROM was unaffected. Fracture anatomy leading to collapse at fracture site and poor hold of pins in metaphyseal bone was the only main reason for loss of alignment and varus malunion. We noted no valgus nonunion in our study. There was superficial pin tract infection in 9 (12%) cases which resolved with pin tract care and oral antibiotics.

Discussion

Tibial plateau fractures are complex problems. Management of these fractures is difficult and varies from surgeon to surgeon. Such injuries are usually associated with extensive soft tissue injury even if they are not open fractures and often there is marked comminution of articular surfaces. The common notion for treating these fractures is open anatomical reduction at least of the articular surfaces, use of cancellous bone graft as required, and fixation using condylar buttress plates.[15] For open fractures, treatment using Illizarov's ring fixator, whenever feasible, or knee-spanning external fixator application is preferred. Early joint motion is probably the most important factor in promoting cartilage nutrition and healing.[16] Knee-spanning fixator cannot allow early mobilization, so joint stiffness is inevitable in those cases.

As it is known, open reduction internal fixation necessitates extensive soft tissue stripping for adequate exposure, and hence is associated with a high incidence of complication, e.g. nonunion, wound dehiscence, infection, and stiffness.[17] This joint stiffness occurs even with anatomical reduction of articular surfaces. Also as this site being prone for infections even for closed injuries and due to its proximity to knee joint, the fear of pyogenic arthritis of the joint keeps haunting the surgeon.

Furthermore, sometimes there is a secondary collapse at the fracture site, even with the plate *in situ*, which occurs after weight bearing and becomes evident on followup X-rays, and then we are left with no option but a re-surgery with its own risks. This can be avoided most of the times with just a simple readjustment in an external fixator. We did not note the exact number of patients who required re adjustment of external fixator.

This study shows that optimum reduction of articular surface i.e less than 2 mm of articular step, and use of even knee-sparing external fixator leads to stable biological fixation without any further damage to soft tissue at the fracture site and without periosteal stripping, thus allowing early knee joint mobilization immediately after surgery.[18] We believe cancellous bone graft and minimal percutaneous internal fixation with CCS along with fixator, helped in achieving

Table 2: Comparison of results with other studies

Features	External fixator by Faldini *et al.*[20]	Plating Krupp *et al.*[26]	External fixator Krupp *et al.*[26]	Hybrid fixator by Aggarwal *et al.*[25]	Our study
No. of patients (n)	32	28	30	56	75
Mean age group	37.8 years (21–64)	47 years (22–76)	49 years (25–51)	39.4 years (18–66)	41.96 years (18–64)
Mean followup	48 months (38–57)	10 months (6–24)	16 months (6–53)	42.5 months (12–67)	26.16 months (6–60)
Mean time to union	24 weeks (18–29)	6 months (3–14 months)	7 months (3–15)	20.5 weeks (13–48)	13.69 weeks (12–28)
Nonunions	1	3 (10%)	4 (13%)	2	1
Malunions	2	4 (14%)	13 (43%)	6 (11.5%)	12 (16%)
Knee ROM	105° (75°–125°)	109° (75°–150°)	103°–8° (80°–135°)	0°–130° to 15°–90° (5°–103°)	122.6° (110°–130°)
Pin tract infection				13 (23%)	9 (12%)

good to excellent clinical outcome. None of our patients had osteoarthritis till the last followup, and we propose this is because there was near anatomical reduction, i.e. maximum articular step of 2 mm, and the early mobilization helped in providing nutrition to the articular cartilage. A long term followup is still needed to come out with a definitive conclusion in this regard.

The use of Illizarov's ring fixator would also give comparable results. Also, one study[19] showed that though the fracture healing is good, the range of movement achieved after this technique is less due to the most proximal ring, there is mechanical obstruction to terminal knee movement, and as pins are passing through the soft tissues, there is sometimes pain and difficulty in movements. However, in our series, the knee range of movement was goodfrom very early postoperative period, and thereby we got very good range of movement. The incidence of varus malunion increases with external fixator compared to ring fixator; also, weight bearing needs to be delayed, and thereby union is slightly delayed.

According to a study on the use of external fixators by Faldini *et al.*,[20] the average healing time was 24 weeks, nonunion occurred in 1 (3.33%) patient, varus deformity in 2 (6.25%) patients, and the mean knee ROM was 105° (range 75°–125°).

According to a study by Richard,[21] the primary aim is to protect soft tissue and there were high complication rates due to the amount of soft tissue dissection needed to adequately expose the fracture site for open reduction, as it devitalizes the comminuted bone fragments. Deep infection rate has been reported to be as high as 73–80%,[22,23] as compared to our study where the deep infection rate was nil. This has caused many surgeons to seek alternative treatment methods such as spanning external fixation or hybrid external fixation to minimize the injuries to the soft tissue while still stabilizing the fracture. The incidence of infection with external fixation is obviously less.[24,25] If there is significant bruising, swelling, or blistering of the soft tissue envelope, a spanning external fixator to align and distract the fragments is applied and left in place until the swelling subsides and the blisters heal. Prevention of further damage to the soft tissues is the most important initial consideration in these fractures.

Krupp *et al.*[26] compared between locked plating and external fixator, and found that locked plating was associated with decreased union time (5.9 vs. 7.4 min), decreased malunion (7% vs. 40%), decreased knee stiffness (4% vs. 13%), and decreased overall complications (27% vs. 48%). But Schatzker type VI's subgroup accounted for 93% complication rate in locked plate compared to 83% in external fixator group. Their study reserves use of external fixator in the treatment of tibial plateau fractures to span fracture site until the patient is amenable to definitive fixation with locked plating. The results obtained in this study are comparable to those found in literature, though a few known complications occurred like pin tract infection (12%) and varus malunion (16%) [Table 2].

We suggest the use of this minimally invasive technique as an alternative treatment method for complex tibial plateau fractures especially resulting from high-energy trauma and having bad skin condition in which conventional buttress plating may be contraindicated.

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