Fixation of Posterior Tibial Plateau Fracture with Additional Posterior Plating Improves Early Rehabilitation and Patient Satisfaction

Abstract

Introduction: Posterior tibial plateau fractures (PTPF) are difficult to manage because of options of multiple approaches, paucity of implants, and lack of ideal construct for fixation. We investigated the benefits of using posterior approach and buttress plate for fixation of the posterior tibial condylar fractures in terms of the fracture healing rate, clinico-radiological, perioperative morbidity, and patient-related outcomes and compared them in those who achieved acceptable reduction without posterior stabilization. **Patients and Methods:** Seventy two patients with posterior tibial plateau fractures were prospectively followed after random allocation into two Groups A and B. Thirty eight patients of Group A (dual plating) were managed with stabilization of posterior fragment with Lobenhoffer approach in addition to anterolateral plating. Thirty four patients of Group B (single plate) were managed with isolated anterolateral plating after reducing the PTPF. Twelve patients lost to follow-up and sixty patients were available (thirty in either group) for final assessment. Followup was done by clinical examination, radiographs and computed tomography scan, fracture union, articular continuity, and deformities around the knee. Subjective outcome assessment was done with the International Knee Documentation Committee (IKDC) 2000 and Knee Society Score (KSS). **Results:** At 1-year followup, the two groups did not differ in time of fracture union. IKDC and KSS were significantly better in dual-plating group ($P < 0.001$). Mean operative time and blood loss were more in dual-plating group (A). The mean hospital stay and complications did not show significant differences. **Conclusion:** Addition of posterior approach for stabilization of the posterior fragment in posterior tibial plateau fractures achieves early and improved knee functions, good range of movements, minimal deformities, and pain scores by the time fracture unites. However, peri-operative morbidity, Extra implant costs and increased operative time are its disadvantages.

Keywords: *Operative treatment, patient outcomes, posterior approach to knee, posterior tibial plateau fracture*

Shivam Sinha[1,2,3],
Mahipat Singh[1],
Shyam K Saraf[1],
Amit Rastogi[1],
Alok K Rai[1],
Tej Bali Singh[4]

Departments of [1]Orthopaedics and [4]Biostatistics, Institute of Medical Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh, [3]Fellow Arthroscopy and Arthroplasty, SIOR, Pune, Maharashtra, India, [2]Fellow Paediatric Orthopaedics and Limb Lengthening, KUMC, Seoul, South Korea

Introduction

Posterior tibial plateau fractures (PTPF), either medial or lateral, are common and they occur with a frequency of 28.8% as a part of bicondylar tibial plateau fractures.[1] Occurrence of a posteromedial fragment is observed in nearly one-third of the bicondylar plateau fractures on evaluation by computed tomography (CT). According to Barei *et al.*, morphology of this fragment has clinical implications when using currently available laterally applied fixed-angle screw/plate implants for stabilization.[2]

Ideal treatment for such fracture morphology is debatable over surgical approaches and fixation construct because they are difficult to reduce and stabilize

through different strategies.[3-5] Recent surge in exploring these fractures through posterior approaches, such as direct posterior, Burke's, and Lobenhoffer, has enabled surgeons to tackle PTPF more accurately.[6-9] However, these approaches are more technically demanding and have been followed with a few studies for better clinical or radiological outcomes. Limited data are available regarding the use of dual incisions, Like combined anterolateral (anterolateral or anteromedial) and posterior (posteromedial or posterolateral) approach or direct posterior approach for fixation of such pattern of injuries.[8,10]

As these fractures are difficult to reduce, articular incongruity was not found to be detrimental factor in final functional outcomes. Several reports have supported the fact that residual articular incongruence

Address for correspondence:
Dr. Shivam Sinha,
Department of Orthopaedics,
Institute of Medical Sciences,
Banaras Hindu University,
Varanasi - 221 005,
Uttar Pradesh, India.
E-mail: shivamortho81@gmail.com

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is well tolerated by proximal tibial plateau fracture in the form of minimal functional limitation or onset of arthrosis at a midterm followup. Lucht and Pilgaard and Jensen *et al.*, in two separate studies, reported that most patients with residual articular depression up to ≤10 mm have no effect on outcome at 7 years post-injury.[11-14] In contrast, Singleton *et al.*, recently, pointed a proportionate decrease in knee range of movements and more loss of functions as articular depression increases from <2.5 mm to >5 mm.[15] While studying the articular malreductions, on CT scan, 77%–80% of malreductions were found in the posterolateral condylar region recently.[16]

In view of the above facts, we investigated the efficacy of posterior approach for fixation of the posterior fragments in addition to standard anterolateral fixation for PTPF in terms of the fracture healing rate, clinico-radiological outcome, perioperative morbidities, complications and patient-related outcomes.

Patients and Methods

From June 2015 to July 2017, a comparative prospective cohort study on 60 adult patients was carried out in a tertiary level trauma center, after getting ethical committee clearance by the Institutional Review Board. All study participants gave written informed consent for participation. All skeletally mature patients with closed tibial plateau fractures involving the posterior condyles confirmed on CT scan were included in the study [Figures 1 and 2]. Open fractures, polytrauma, old or maluniting fractures, pathological fractures, and floating knee injuries or those associated with patella fractures were excluded from the study.

Seventy two patients were recruited and allocated in two intervention groups: Group A – double-plate fixation (both posterior and anterolateral) (38 cases) and Group B – single anterolateral plate fixation (34 cases) in PTPFs and followed up to 1 year. Twelve patients lost to followup or could not be traced. At final followup, 30 patients in Group A and 30 patients in Group B were available for patient-related questionnaire assessment.

Patient selection for both groups was random, as they were enrolled alternatively in either group for operative intervention, with no bias for age, gender, or ethnicity. After undergoing the CT and radiographic imaging for confirmation of PTPF, patients were kept on skeletal traction and planned for internal fixation, once the swelling subsided.

Surgical procedure

All cases were done in spinal anesthesia with epidural analgesia and tourniquet application. For primary posterior fixation through posteromedial approach of Lobenhoffer, the patient was laid prone on a radiolucent table [Figure 3]. If necessary, a posterolateral approach was used where

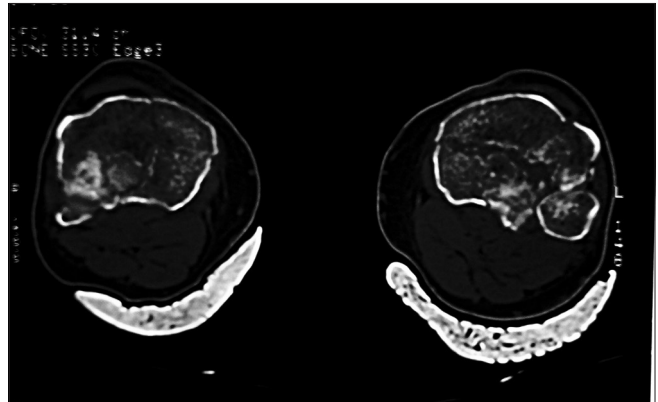**Figure 1: X-rays of enrolled patients with posterior tibial plateau fractures**

Figure 2: Computed tomography scan showing the posterior tibial plateau fractures in enrolled patients

Figure 3: Inspection and handling of neurovascular bundle perioperative through Lobenhoffer approach, patient lying in prone position

posterior condylar fracture was from lateral aspect. After posterior fixation and closure were done, the patient was repositioned to supine position for anterolateral fixation. All primary reduction and final stabilization were done under image intensifier control. Anterolateral plate was used in both the groups through standard anterolateral approach or Minimal invasive percutaneous plate osteosynthesis.

Acceptability of reduction

For Group A, the reduction was done usually under direct vision and assisted with fluoroscopy in two planes. The reduction was also assessed with submeniscal approach [Figure 4].

Purchase in posterior fragment by screws through the anterolateral plate in Group B was attempted in all the cases and was confirmed in followup CT. Reduction was deemed acceptable within 2 mm of stepoff in coronal and sagittal planes [Figures 5 and 6].

Postoperative protocol

Postoperative protocol for both groups was similar. Third day after surgery, dressing was changed and isometric exercises were initiated for quadriceps. Fifth day to 2 weeks after surgery when pain subsided, knee range of motion exercises was initiated. Six weeks postoperative, patients walked with walker but with partial weight-bearing on the affected extremity. 16–20 weeks later, when radiograph revealed early bone union, full weight-bearing was allowed.

Assessment of outcome

Patients were evaluated by plain radiographs every 6 weekly till fracture union is evident. Fracture union was assessed by cortical continuity and progressive loss of fracture line on X-rays [Figure 7]. End of followup was fracture union, and functional status at 1-year postoperative CT scanogram was done at final followup to record articular subsidence, nonunion, coronal, or sagittal deformities. For coronal alignment, medial proximal tibial angle of $87 \pm 5°$ and sagittal alignment with $9 \pm 5°$ of posterior proximal tibial angle were taken as acceptable [Figure 8].

Knee function scoring was assessed by the International Knee Documentation Committee 2000 subjective knee evaluation form and objective functional Knee Society

Figure 4: Perioperative assessment of reduction of posterior tibial plateau fractures in dual-plating group by posterior exposure and submeniscal approach

Figure 5: Fluoroscopic assessment of reduction and posteromedial plate application
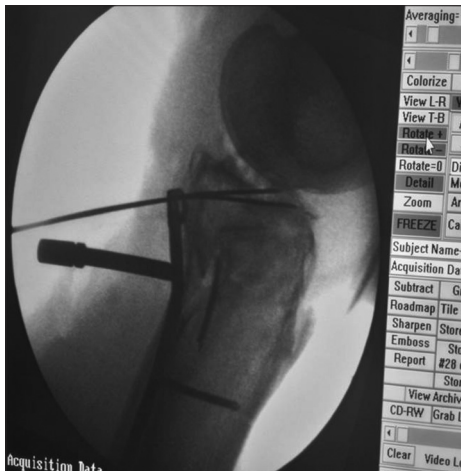

Figure 6: Fluoroscopic assessment of joint congruity in lateral view in Group A

Figure 7: Fracture union in Group A (dual plate)

Score (KSS).[17,18] Primary outcome measures were clinical evaluation of range of movement, flexion deficit, patient-related outcome, knee instabilities, and deformities.

Statistical analysis

Data interpretation was done by SPSS® version 21.0, IBM, Armonk, NY, USA. Time of union and other numerical parameters were analyzed by Student's *t*-test. Categorical/nominal variables were analyzed by Chi-square test with continuity correction.

Results

Demographic data of sixty patients in both the groups available for final followup are demonstrated in Table 1. About 62.5% of patients were in the age group of 30–50 years. About 95% of the traumas were due to road traffic accidents. Patients in both the groups were classified under AO Type 41–C2 (50%) followed by 41–C3 (42.5%). Perioperative parameters and postoperative parameters were analyzed statistically [Table 2]. In Group A, acceptable articular reduction was achieved in all the cases during surgery. In Group B, all but two achieved acceptable articular reduction due to the absence of purchase of screws in posterior fragment through the anterolateral plate.

Complications

Two patients of Group A developed deep wound infection. One patient recovered with antibiotics, but the other required regular debridement and finally removal of implant. Another patient of the same group developed wound dehiscence initially that healed after responding to oral antibiotics. A prominent lateral plate was seen in

Figure 8: Computed tomography scanogram at 1-year followup, to assess for deformities and articular subsidence

Table 1: Demographic data

Parameters	Group A	Group B
Cases	30	30
Male/female ratio	28/2	26/4
Mean age (years)	41.5±10.5 (20-60)	42.8±13 (25-74)
Injured limb (right/left)	20/10	19/11
Trauma mechanism	28 (RTA)/2 (sports injury)	28 (RTA)/2 (slip and fall)
Fracture pattern AO		
41-C1	2	4
41-C2	16	18
41-C3	12	8

RTA=Road traffic accident, AO=Arbeitsgemeinschaft für Osteosynthesefragen

Table 2: Preoperative and postoperative parameters and their analysis

Parameters	Group A	Group B	*P*
Injury to surgery time (days)	6.9±3.6 (2-16)	4.6±3.3 (1-15)	0.045
Operative time (min)	120.5±21.3 (90-180)	87.5±31.6 (65-120)	0.001
Blood loss (ml)	147.00±37.6 (90-250)	87.2±16.2 (50-180)	<0.001
Postoperative hospitalization period (days)	9.0±2.7 (5-14)	8.3±3.6 (5-18)	0.517
Union time (weeks), mean	15.9±3.0	16.6±3.	0.401
Functional outcome			
KSS clinical outcome objective	85.4±6.9 (68-100) (excellent)	70.9±12.4 (50-90) (good)	<0.001
KSS functional outcome	81.0±4.2 (75-90) (excellent)	71.8±11.4 (50-90) (good)	<0.001
IKDC score, mean (%)	68.3±8.0 (60-86.2)	58.7±10.9 (39-80.4)	0.003
Followup (months), mean±2SD	10.9±4.4	13.2±7.3	0.81
Deep/superficial wound infection	3	1	0.72
Flexion deformity (>5°, ROM restriction)	5	8	0.25
Articular malreduction/valgus varus deformity	2	5	0.4

KSS=Knee Society Score, IKDC=International Knee Documentation Committee, ROM=Range of motion, SD=Standard deviation

two patients, which was not causing any clinical problem. Articular malreduction was observed in one patient, but his functional scoring was acceptable with good range of movements [Figures 9 and 10].

In Group B (single plate), one case developed superficial infection that subsided on antibiotics. Five (25%) patients developed stiffness. Two patients complained of hardware impingement. A patient developed varus collapse at final followup and another had valgus deformity [Figures 11 and 12]. None of patients in either groups showed vascular injury, peroneal nerve palsy, deep vein thrombosis, hematoma formation, or required fasciotomies (postoperative compartment syndrome).

Discussion

The goals of operative treatment for PTPF were anatomic reduction, especially by restoring articular congruity, stable fixation for early rehabilitation and avoiding complications, particularly infection, and nonunion. In the present study, we assessed the posterior tibial plateau fracture fixation

with the use of additional posterior stabilization and compared for fracture union, loss of reduction, residual deformities, and patient-related outcomes in those in which posterior plate was not used.

Attempts by researchers in past to correlate the functional outcomes with the various fixation construct such as bipillar plating, only posterior buttress, and additional medial antiglide plating have not been found satisfactory.[19,20] For example, Lee *et al*. compared the outcome of tibial plateau fractures among three groups, wherein Group I (*n* = 15) isolated lateral tibial plating, Group II (*n* = 19) classic dual plating, and Group III (*n* = 11) with hybrid dual plates (one lateral approach locking compression plate + medial antigliding plate) were assessed using the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scoring for at least 18 months. They demonstrated no significant differences in those scores. Contrary to this, our study revealed a significant difference in objective and functional KSS at 1-year followup which implies a better outcome in the dual plating. Difference could be explained

Figure 9: Late articular subsidence and malreduction in a patient of Group A, anteroposterior view
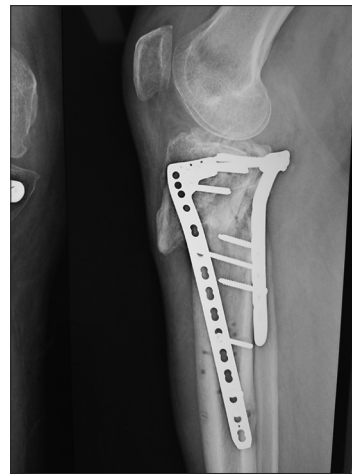

Figure 10: Articular malreduction in Group A, lateral view

Figure 11: Late varus collapse in a patient of single-plate group

Figure 12: Late valgus deformation in single-plate group but no articular subsidence

by the fact that the former study did not specifically define the posterior condylar fixation. Furthermore, we achieved the superior results when the fracture united at minimum of 5–6 months; moreover, the WOMAC scoring was inappropriate in our context as posttraumatic osteoarthritis does not set in as early.

Rohra *et al.* prospectively followed 34 patients for 3 years to determine functional and radiological outcome and the complications of Schatzker V and VI tibial plateau fractures treated with bicolumnar plating using the KSS and radiological outcomes by modified Rasmussen assessment criteria. They found that only 3% of patients were of poor functional KSS and nearly 6% of patients had fair radiological outcome. However, these results were not compared with a control population because of relative scarcity of such fracture pattern.[21] Barei *et al.*, in a retrospective study, using a rank-order analysis, found that no significant relation existed between severity of injury (injury severity score) and achieving articular reduction in bicondylar tibial fractures. They also found improved functional outcomes by musculoskeletal functional assessment scoring with medial antiglide plate group. Moreover, they did not mention about PTPF; instead, with rank-order analysis, they classified articular communition in any plane, as one variable.[22] This might be the explanation of good results despite poor articular reduction in few patients of Group A.

Perioperative parameters showed significant differences in both the groups; time for undertaking surgery posttrauma was significantly different. The operative time and mean blood loss were significantly higher in the Group A (dual plate). This time included the time involved in repositioning from prone to supine and to redrape the patient. Despite this, the mean length of stay in the hospital was not statistically different. On contrary, Yao *et al.* followed 86 patients treated with either dual buttress plates (DP group) or a lateral locking plate (LP group). Durations of hospital stay and operation were significantly shorter and blood loss was significantly less, in the LP group than in the DP group, in their observations.[23] Another meta-analysis conducted by Chang *et al.* showed lower surgical time, hospital stay, union time, and incision necrosis in single-plate group as compared to the dual-plate group. The 12-month Hospital for Special Surgery scoring was better in single-plate group in this analysis.[20]

Despite technical difficulties in dual plating in Group A, difference in time for fracture union was not significant as compared to single-plate group (B). Previous researches also made similar observations as union was achieved on an average of 15–16 weeks in either Group.[19,20] A more closer followup or large population sample is required to obtain significance in fracture healing rate.

Complications, such as late varus collapse, delayed union, hardware impingement, valgus deformity, and articular malreduction, were observed in both the groups but were not statistically significant. Indeed, meta-analysis by Chang *et al.* cautioned that patients with such fractures demonstrated substantial residual dysfunction after treatment as compared with general population, as late as 4.5 years of followup.[20-22]

Early gain of movements can be explained by biomechanical stability of the orthogonal dual fixation, which has been proved superior in various cadaveric models. Zeng *et al.* found that the posterior T-shaped buttress plate allowed the least subsidence of the posteromedial fragment and produced the highest mean failure load than other constructs, such as anteroposterior screws and anteromedial-based Limited contact dynamic compression plate (LC-DCP).[24] Similarly, Higgins also demonstrated that dual-plate fixation allows less subsidence in the bicondylar tibial plateau fractures. However, vertical subsidence was not significantly different, with usage of unilateral locked plate or dual-plating fixation because it was proved to be dependent on applied load.[25,26]

Complications were not found to be significant in between the two groups. Qiu *et al.*, in their study of 95 cases, reported an overall complication rate of nearly 5% which were mainly vascular complications. Despite increased operative time and blood loss in dual-plate group, infection rates though low were not statistically significant in between the groups.[27] On contrary, certain studies did not report any infections in their cohort.[20,28,29]

Our study has certain limitations; first, owing to this undetected yet common injury, we have a relatively small sample. Second, follow-up duration is short as it was aimed toward fracture union and outcome at the time of full weight-bearing. We ought to follow these cases for long, regarding implant-related problems, late subsidence, posttraumatic osteoarthritis, deformities as they may still happen with posterior approaches, and at that time, implant removal or revision will be technically demanding. Third, individual radiological parameters such as tibial slope and mean axis deviation were not correlated for subsidence, late displacement, good range of movements, and deformities. Fourth, longer operative time, more blood loss, and addition of another implant need to be evaluated for cost-effectiveness of the procedure with respect to resumption of activities of daily living.

Conclusion

Our study highlights the importance of posterior tibial plateau fracture which was deemed unimportant in the past. Our results highlight the importance of fixation of PTPF and achieving an early and satisfactory functional outcome at followup. The fixation does not expedite the fracture healing, but rehabilitation and patient-related scores are significantly better. Posterior approaches demand technical expertise and have certain minor complications, prolong operative time, more blood loss, and hospital stay which are its potential disadvantages.

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