Original Article

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Outcome of patients with proximal tibial plateau fractures treated with small fragment plates

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Abstract

Introduction: Proximal tibial plateau fractures presents with diverse fracture patterns. With an increase in its incidence , these fractures continue to challenge the orthopaedic surgeon to restore the knee to its pre-injury state . We aim to report the clinico-radiological and functional outcomes of patients with proximal tibial plateau fractures who were operated with 3.5 mm small fragment plates.

Methodology: Thirty patients of proximal tibia plateau fractures who were operated from January 2015 till March 2017 were included in our study. They were classified according to the Schatzker classification and Chang et al modification of 3 column classification of Luo . 3.5mm pre-contoured plates, inter-condylar screws and/or Reconstruction plates were used. Patients were evaluated immediately and 12 months post-operatively.

Results: Most common type of fractures were Schatzker type 4-posteromedial fragment (6 cases) and Schatzker type 5 anterolateral and posteromedial fragment (6 cases). Average medial proximal tibial angles immediately and 12 months post-operatively were 88.10 + 2.09 degrees and 87.13 + 2.04 degrees respectively. Similarly, proximal tibial slope angles immediately and 12 months post-operatively were 8.57 + 2.73 degrees and 9.73 + 2.80 degrees respectively. Articular surface reduction was excellent (< 2mm) in 18 patients and satisfactory (2.1 to 5 mm) in 10 patients out of 30 patients. Average KSS knee score was 84.13 + 10.44 and function score was 82 + 17.59 . Average Lysholm score was 84.9 + 8.29 . Average knee flexion was 115 degrees + 23.11.

Conclusions: Our study shows that 3.5 mm small fragment plate is an excellent option for the management of proximal tibial fractures. Keywords: proximal tibial plateau, articular fracture, small fragment plates, trauma , osteosynthesis , 3.5 mm system

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Introduction

Proximal tibial plateau fractures are common and have a bimodal distribution. It occurs more commonly in young adults as a result of high energy injuries and in elderly due to low-energy trauma. There are various types and presentations of such fractures and the principle of treatment is to restore the alignment, congruency and stable mechanical axis. A study in synthetic tibia models demonstrated that posterior buttress plating was the most stable fixation for postero-medial split tibial plateau fractures . Comparative cadaveric studies have demonstrated that medial buttress plating added greater stability to medial tibial plateau fractures without comminution . It has also been demonstrated on synthetic tibia bone models that standard double plate fixation shows better mechanical resistance as compared to a unilateral locking plate . Similar cadaveric studies have shown that subsidence was less for dual plate fixation as compared to isolated lateral fixation . In a metanalysis single locking plate had better union time , patient satisfaction and lesser hospital stay but was associated with higher rate of loss of alignment as compared dual plate fixation . In comparison study of the mechanical properties of 3.5 mm and 4.5 mm locking plates in synthetic composite bone models with bicondylar tibial plateau fracture was done and results showed higher axial resistance with 4.5-mm plates for Schatzker type 5 fractures only. For other fractures there was no biomechanical difference between the two profile plates. The 4.5 mm plates are voluminous and 3.5-mm plates due to their low clinical profile and comparable mechanical resistance seems more advantageous . However the literature is limited regarding the treatment of proximal tibial plateau fracture with respect to low profile plates using the small fragment (3.5 mm) system. In this study, we aim to report the clinico-radiological and functional outcomes of patients with proximal tibial fractures who were operated with 3.5 mm small fragment plates.

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Methodology

Study design and sample population

We prospectively enrolled all adult patients of closed proximal tibia fractures during January 2015 to March 2017. All cases with open fractures or additional fractures in same limb were excluded. Patients satisfying the inclusion criteria were included after obtaining their informed written consent. Forty one cases (age between 18 to 60 years) with proximal tibial plateau fractures Schatzker type 4,5,6 and OTA 41 B2.3, 41 B3.2 , 41 B3.3 and 41 C presented to us during the study period. All cases underwent internal fixation with using 3.5 mm non-locking or locking plates 3.5 mm small fragment non-locking or locking plates in combination with interfragmentary screws for Schatzker type 4, 5 and 6 fractures. The study was approved by the Institutional Ethics Committee. Three patients had concomitant ipsilateral fractures and knee injuries which would alter the functional

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Figure 1: case 1 – pre-operative AP and Lateral view Radiographs of knee joint

Figure 2: Joint spanning external fixator applied immediately , which was followed by CT scan

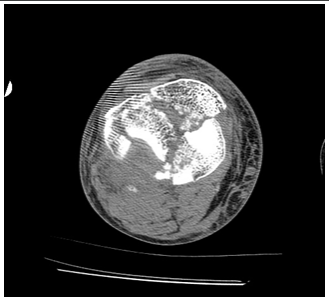

Figure 3A: Axial cuts CT scan images post external fixator application.

outcome were excluded from the study. Two of these patients had an ipsilateral distal femur fracture (OTA – 33 B & C) and the other had anterior cruciate ligament injury and a lateral collateral ligament injury. Furthermore, two cases had sustained fracture in a post polio residual paralytic limb and one case was skeletally immature and hence were excluded from the study. Hence total 33 patients were enrolled.

Patient management and surgical technique

After primary trauma survey and clinical examination, plain radiograph of the knee was performed. After initial evaluation of plain radiographs which revealing periarticular fractures a CT scan of the knee was done to understand fracture characteristics in detail. The amount of displacement and depression of articular surface was evaluated. Sagittal and coronal cuts and with three dimensional reconstruction of CT scan images helped in further understanding (Fig. 3(a) & 3(b)). Classification of fractures was done by Schatzker classification and Chang et al modification of 3 column classification of Luo in which the tibial plateau was further divided into 2 condyles and 4 articular plateau quadrants—the medial and lateral condyles and the anteromedial, anterolateral, posteromedial, and posterolateral quadrants. Pre-operatively swelling and soft tissue condition was taken into consideration before planning the surgery. In cases with swelling, limb elevation and ice fomentation was done. Patients having tense and shiny skin were treated with external fixator. In our patient population, 14 patients required external fixator to reduce the swelling and maintain length and alignment as has been suggested by Yoon et al. (Fig. 2). In cases requiring external fixator application, the CT scan was done after applying joint spanning fixator. All the cases were internally fixed by closed or open reduction. Fixation was achieved using 3.5mm locking or non-locking plates were used in all the patients as deemed appropriate by the operating orthopaedic surgeon. All surgeries were performed by two senior orthopaedic surgeons assisted by an orthopaedic resident. In Bicondylar fractures anterolateral, posteromedial or even an posterolateral approach was used depending upon fracture patterns. Minimally invasive approaches were used to reduce soft tissue trauma. Articular surface reduction was achieved using bone tamp and fracture was fixed provisionally using K wires (Fig. 5). Articular surface congruency was checked under fluoroscopy before final fixation. In patients with intra-articular comminution, fixation was done using raft screws.

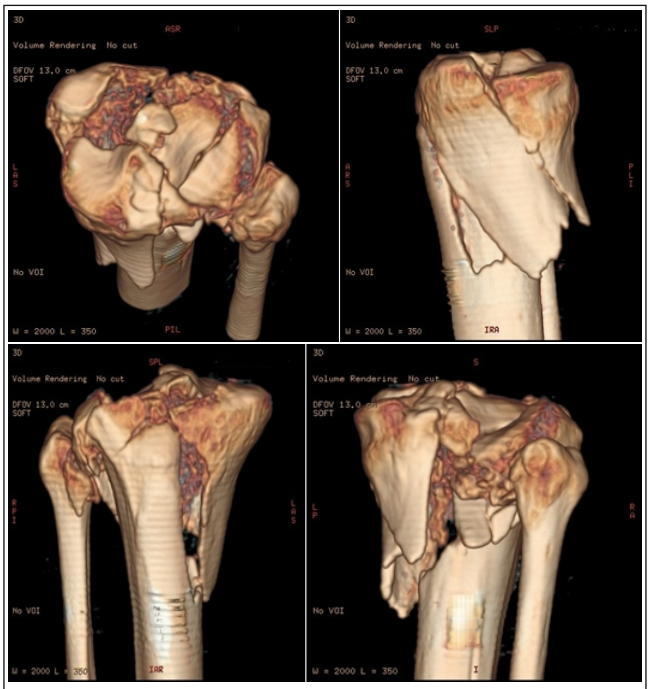

Figure 3B: 3D reconstruction CT scan images demonstrating a type 6 proximal tibia fracture with involvement of Antero-medial , Postero-medial and Postero-lateral columns.

For antero-medial fragment an antero-medial approach was used with 3.5 mm antero-medial pre-contoured plates fixed with 2 to 3 screws proximally and one buttress screw in distal fragment.

For postero-medial fragment postero-medial approach was used and manually contoured T plates was used. In cases of anterolateral fragment an anterolateral locking L Raft plate was used. The voids left after elevating the fragments were not filled using bone graft. Post-operatively knee was immobilized for 24 hours and later continuous Passive Motion (CPM) was applied. After 24 hours patients were allowed to walk non-weight bearing for the next 6 weeks. Weight bearing was allowed after 6 weeks considering union progression. Fracture union was defined as bridging of three cortices in two orthogonal planes and non-union was defined as non-union up to 6 months (24 weeks). Immediate post-operative radiographs were taken and followed at 6 weeks, then monthly for one year. Suture removal was done on the 15th day post operatively.

Figure 4: Articular surface reduction was achieved using bone tamp and fracture was fixed provisionally using K wires

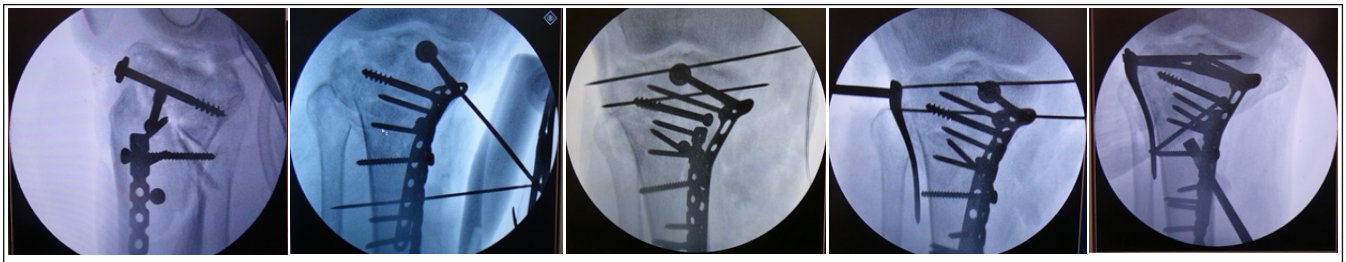

Figure 5: Intra-operative Fluoroscopic images

Data collection and analysis

Various radiological parameters like medial proximal tibial angle, proximal tibial slope angle, articular step off were noted for all the patients immediately post-operatively and at least 12 months post-operatively using antero-posterior and lateral radiographs. Medial proximal tibial angle (MPTA) is the medial angle between the tangential line and anatomical axis of the tibia in anterio-posterior radiographs(Fig. 9) and posterior proximal tibial angle (PPTA) or also known as the proximal tibial slope angle (PTS) is the angle between the tangential line of medial plateau and the perpendicular line of the anterior tibial cortex on lateral radiographs (Fig. 8) -. Alignment of the proximal tibia was assessed by measuring the MPTA and PPTA/PTS and both the angles were measured according to the criteria suggested by Freedman and Johnson. Mal-alignment was considered when MPTA was greater than 92°or less than 82°, or PPTA was greater than 14° or less than 4°.

Articular surface depression was evaluated on plain radiographs with measurement markers on digital imaging viewing software. Distance for magnification was taken into consideration which was found to be 20 percent. Articular surface depression was evaluated by measuring the distance from the normal articular surface to the most depressed articular surface on plain radiograph of Anteroposterior view of knee joint (Fig.10 & 11). Articular surface depression was evaluated as excellent for 2 mm or less articular depression, satisfactory for 2.1 to 5 mm depression and poor for more than 5 mm depression.7, , Fracture union time and time to full weight bearing was noted for all patients. Functional evaluation of all the patients was done after 12 months post-operatively using the Knee Society Score (KSS) consisting of knee and function score, knee flexion angle and Lysholm score .

Figure 6: 3Immediate post-operative Radiograph

Results

Out of 33 patients enrolled, three were lost to follow up. Finally, 30 patients were available for final evaluation for the study of which 27 were males and average age was 38.03 ± 10.97 years. Most common type of fractures were Schatzker type 4-posteromedial fragment(6 cases) and Schatzker type 5 (6 cases) anterolateral and posteromedial fragment (Table 1). Nineteen patients needed an external fixator. All patients were followed for at least 12 months postoperatively.

Average union time in our sample population was 13.13 + 1.33 weeks (range 8 to 16 weeks) and they took 13.30 + 2.62 weeks to achieve full weight bearing (range 8 to 17 weeks).

Table 1: Baseline characteristics of the patients included in the study

Total number of patients	30
Average age in years (range)	38.03 ± 10.97 (18 to 57)
Gender distribution	
Males	27
Females	3
Fracture classification according to Schatzker and Chang et al	
Type 4 – Anteromedial fragment	4
Type 4 – Posteromedial fragment	6
Type 5 – Anterolateral fragment and Posteromedial fragment	6
Type 5 – Anteromedial fragment and Anterolateral fragment	3
Type 5 – Posteromedial fragment and Posterolateral fragment	3
Type 5 – Anteromedial fragment , Posteromedial fragment & Anterolateral fragment	1
Type 6 – Anterolateral fragment and Posteromedial fragment	1
Type 6 – Anteromedial fragment and Anterolateral fragment	1
Type 6 – Posteromedial fragment and Posterolateral fragment	1
Type 6 – Anterolateral fragment , Anteromedial fragment & Posteromedial fragment	2
Type 6 – Anterolateral fragment , Posterolateral fragment & Anteromedial fragment	1
Type 6 – Posterolateral fragment , Anteromedial fragment & Posteromedial fragment	1

No non-union or malunion was observed. Average medial proximal tibial angles immediately and 12 months post-operatively were 88.10 + 2.09 degrees and 87.13 + 2.04 degrees respectively (Table 2). Similarly, proximal tibial slope angles immediately and 12 months post-operatively were 8.57 + 2.73 degrees and 9.73 + 2.80 degrees respectively. Immediate post-operative articular surface reduction was excellent in 20 patients , satisfactory in 9 patients and poor in 1 patient . At the end of 12 month follow up post-operative articular surface depression was excellent in 18 patients , satisfactory in 10 patients and poor in 2 out of the 30 patients.

Average KSS knee score and function score was 84.13+ 10.44 and 82+17.59 respectively (Table 3). Average Lysholm score was 84.9+ 8.29 which is graded as good . 20 patients had excellent clinical KSS and only 1 patient had poor score. Whereas 21 patients had excellent functional KSS knee score and 1 patient had poor KSS . Lysolhm score was excellent for 9 patients , good for 9 patients , fair for 11 patients and poor for 1 patient . Average knee flexion was 115 degrees + 23.11 .Knee stiffness was reported by two patients, because of non-compliance of physiotherapy. Surgical site wound condition was evaluated on follow up. Only one case was found to have superficial infection at surgical site which resolved uneventfully on oral and intravenous antibiotics. Other complications included a case of instability and a case of screw loosening. Reason for instability was the initial trauma responded well to aggressive physiotherapy. Screw loosening was due to osteoporosis and was managed with a screw exchange on first follow up and lead to good union eventually.

Discussion

Knee joint is a major weight bearing joint of the body. Therefore, to preserve the full range of motion of the knee joint, patient management must aim to restore the stability of the joint and achieve proper alignment, rotation and congruent articular surfaces. Due to the anatomical challenges associated with proximal tibia and its surrounding soft tissues treatment plans have to often customise to the patients. Though conservative management can be done in some cases, operative management with internal or external fixation, and arthroscopic techniques are associated with better joint reduction and early mobilization of the patient. Locking plates improve rigidity and minimize soft tissue injury. However, for comminuted and complicated fracture patterns (Schatzker type V and VI) a lateral locking plate is not sufficient to prevent fracture collapse and an additional medial plate might be necessary.4 However, solitary lateral locked plating is being used extensively for bicondylar tibial plateau fractures because the screw vector is determined according to the design of the plate in currently available proximal tibial locking plates.

Previous studies have used large titanium plates with 5.0 mm locking screws. Recently developed proximal tibial locking plates are stainless steel implants with different fragment specific options which aim at improving and maintaining articular reduction. Previously published studies have suggested a wide range of residual displacement from 2 to 10 mm to be clinically acceptable. , Moreover, Rademakers et al demonstrated that radiographic and clinical outcome of an articular step-off of up to 4 mm was not statistically different from that of less than 2 mm.12 On the other hand, the importance of restoring the articular congruity was highlighted in a study by Blokker et al in which a residual step-off of more than 5 mm was associated with unsatisfactory results.13 In our study 28 out of 30 patients had excellent to satisfactory articular reduction (less than 5 mm articular surface depression).

While comparing the 3.5 mm and 4.5 mm locking pre-shaped anatomical plates Ehlinger et al found that range of motion restoration and functional healing were similar in the two groups and it depends more on the severity of the lesions rather than the type of implant used. In their study the radiologic outcomes were equally comparable in terms of rate and time of unit and the quality of articular reduction. When compared by Hasan et al, the biomechanical properties of 3.5 and 4.5 mm locking plates were found to be similar.6 Moreover, a 3.5 mm locking plate with a smaller fragment size offers a better alternative to its 4.5 mm counterpart by avoiding irritation and causing less impairment of the periosteal capillary network, resulting in fewer wound healing complications, as have been reported earlier with 4.5 mm plates. ,6 In a study by Krettek et al they found complications of periosteal stripping and devitalisation of bones while using 4.5 mm plates. In our study too there was just one superficial wound complication which responded well to antibiotics and healed without any other intervention.

Clinical and functional outcome is the next criteria on which any fixation method for proximal tibia fracture is judged.

Table 2: Radiological evaluation immediate post-operative and at final follow up

Radiological variable	Immediately post-operatively (mean ± SD)	12 months post-operatively (mean ± SD)
Medial proximal tibial angle	88.10 ± 2.09	87.13 ± 2.04
Proximal tibial slope angle	8.57 ± 2.73	9.73 ± 2.80
	Immediately post-operatively	12 months post-operatively
Articular step	n	n
0 to 2 mm	20	18
2.1 to 5mm	9	10
>5.1 mm	1	2

Table 3: Evaluation of the patients at the final follow up (12 months post-operatively)

Variable	Mean ± SD (range)
Fracture union time in weeks	13.13 ± 1.33 (8 to 16)
Full weight bearing in weeks	13.30 ± 2.62 (8 to 17)
KSS knee score	84.13 ± 10.44 (50 to 97)
KSS function score	82.0 ± 17.59 (10 to 100)
Knee Flexion	115 ± 23.11 (40 to 140 deg)
Lysholm score	84.9 ± 8.29 (61 to 99)

Bagherifard et al have found 3.5 mm simple plates also give a good clinical, functional outcome for proximal tibia plateau fractures.7 The average Lysolhm score in the study by Bagherifard et al of analysis of 32 patients was 76.8+1.6 compared to our study in which the average Lysolhm scores for 30 patients is 84.9+ 8.29. The mean union time in the study by Bagherifard et al was 13+1.2 weeks compared to our study in which it was 13.13+ 1.33 weeks. Thus a 3.5 mm plate is not only soft tissue friendly but is also clinically as sound as a 4.5 mm plate.

Our study is limited by a small sample size and no comparative group. However we believe that low complication rate with good union rate and clinical and functional outcome, help in supporting our hypothesis

Conclusion

Results of our study show that 3.5 mm small fragment plate is a good alternative for the management of proximal tibial plateau fractures. With a lower clinical profile these plates are associated with good clinical, radiological and functional outcomes. Future studies are required from similar settings with Randomised controlled trials to evaluate long term efficacy of small fragment plates.

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