RESEARCH ARTICLE

Functional Outcome and Incidence of Osteoarthritis in Operated Tibial Plateau Fractures

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Abstract

Background: In the challenging tibial condyle fractures despite anatomical joint reconstruction, development of osteoarthritis may still occur secondary to the initial articular cartilage and meniscal injury. The aim of the study was to know incidence of osteoarthritis in our operated cases of tibial plateau fracture and to evaluate functional outcome.

Methods: Our operated 60 patients of tibial plateau fractures between 2006 to 2013 were evaluated retrospectively. Pre-operative radiographs were classified using Schatzker classification. Patients were followed up clinically and radiologically and were assessed for functional outcome and development of osteoarthritis.

Results: The average duration of follow up was 76.32 months ranging from 42 to 130 months. The average age was 41.28 (20-73) years. According to Schatzker classification type VI accounted for 32.5% and type V for 20 %. Average VAS Score was 1.35 ranging from 0 to 4. According to American knee society scoring system, 47patients had excellent and 8 patients had good knee scores, while 52 patients had excellent, 4 patients had good and 1 patient had poor functional scores. According to Ahlback classification 25 patients had grade I, while 9 patients had grade II, 7 patients had grade III and 3 patients had grade IV osteoarthritis of knee.

Conclusion: Incidence of osteoarthritis goes higher with Schatzker's grading. Despite presence of radiological arthritis patients can have good clinical function if the articular reduction and limb alignment are maintained. Treatment goals should include a congruent articular reduction, adequate knee stability, anatomical limb alignment and avoidance of complications.

Level of evidence: IV

Keywords: Functional outcome, Knee society score, Long term followup, Osteoarthritis, Tibial plateau fractures

Introduction

Fractures of proximal Tibia comprises of 1.2% of all fractures (1). These fractures can be quite challenging to manage. The injury pattern, the mechanics of fracture and the associated injuries have a big impact on the overall prognosis of the patient and understanding of these factors have evolved over the years (2, 3). These fractures are difficult to reduce, align and stabilize, and prone to develop wound complication and infections. They have various configurations depending on the force of injury .The comminuted type fracture is characterized by the loss of the articular congruity ,dissociation of the diaphysis from the metaphysis, and is often associated with severe soft tissue injuries around the knee that require special clinical attention (4). There is a considerable debate regarding the best method for

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treating proximal tibia fractures. during the treatment of proximal tibia fracture with intraarticular extension , the primary goal is to obtain a congruent and stable joint with alignment of the limb to the match to pre injury status and permitting early range of motion for cartilage nourishment and preservation (5). The defined criteria in functional assessment of patients with proximal plateau fractures of tibia include the ability of the patient to walk, ability to climb stairs, time taken for radiological and clinical bony union, severity of pain while walking, climbing stairs or at rest, severity of knee instability if present, loss of active extension and the deformities of knee (6, 7). These fractures usually affect the younger age group in their productive years of life and thus have an significant socioeconomic impact due to time taken for recovery and can lead subsequent surgeries and finally to total knee replacement at early age due to the early onset of osteoarthritis. In order to assess the effect of these fractures on functional outcome of knee and development of osteoarthritis, we have done a retrospective study of series of patients with tibial plateau fractures treated in our institution for incidence of osteoarthritis and functional outcome.

Materials and Methods

A retrospective study was done in tertiary care center. This study was examined and approved by the Human research ethics committee, H M Patel center of medical care & education, Karamsad, Gujarat, India with approval number *HREC/UGPG/23/Session3/1*. The inpatient records of all patients treated for proximal tibia fracture from Jan 2006 to June 2013 were traced from the medical records department. In this time period interval 71 patients were identified out of which 11 patients were lost in follow up, therefore excluded from final analysis. Thus 60 patient's indoor records were examined and preoperative data including demographic data, mode of injury, and fracture classification were collected. In those included patients 51 were male and 9 female with mean age of 41.28 years ranging from 20 to 73 years [Table 1]. The mean duration of follow up was 76.32 months (range 42 to 130 months). Radiographic findings including the fracture pattern, displacement of fragments, and depression of fragments were also noted. Computed tomography scan findings, intraoperative findings, interval between injury and definitive treatment, and data regarding the course in the hospital were collected from the inpatient records. The fractures were graded preoperatively as per Schatzker's classification of tibial plateau fractures by routine anterior posterior and lateral radiographs of knee [Figure 1] (8). Open injuries were classified by the Gustilo–Anderson classification of open fractures and closed fractures by Oestern and Tscherne classification (9-11). If there was extensive soft tissue injury, as

Table 1. Demographic data

Variable	N (n=60)
Gender	
Male	51
Female	9
Mean Age ,years(range)	41.28 (20-73 years)
Injury mechanism	
Road traffic accident	48
Fall	11
Assault	1
Side involvement	Right (n=38)
	Left (n= 22)

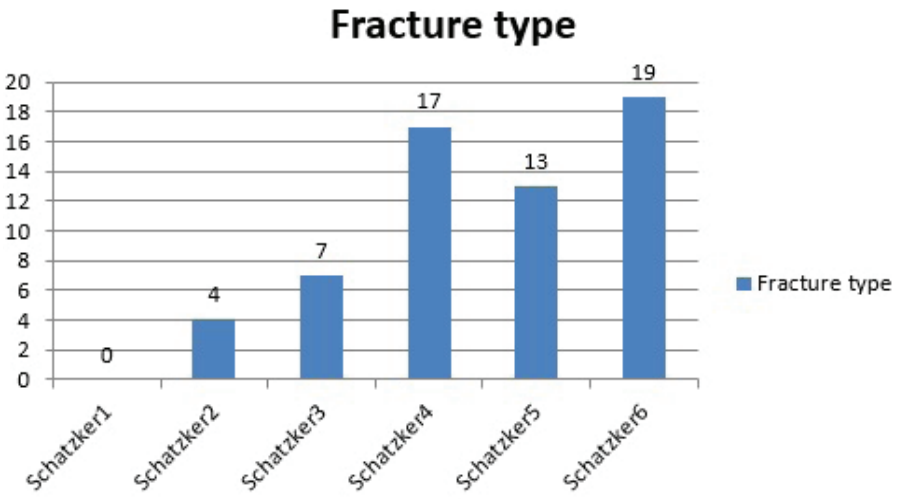

Figure 1. Fracture distribution according to Schatzker's Classification.

Table 2. Operative procedure

Procedure	No	Percentage
Lateral Plate (Locking)	28	46.66%
Medial buttress plate	5	11.66%
Medial buttress plate(Locking)	2	11.66%
Dual plating Lateral plate (locking) n=17 Lateral plate n=2 Medial buttress plate (locking) n=13 Medial buttress plate n=6	19	31.66%
Lateral plating with medial Cannulated Cancellous screw fixation	4	6.67%
Cannulated Cancellous screw fixation	2	3.35%
Total	60	100%

indicated by fracture blisters, surgery was delayed until resolution of edema and appearance of skin wrinkles. Preoperatively 39 patients were given above knee slab and elevated on Bohler's splint, 17 were given skeletal tractions through calcaneal Steinman pin with elevation on Bohler's splint and 4 patients underwent temporary knee spanning AO external fixator till the definitive internal fixation. Bony fixation was achieved using implants suitable to fracture pattern and surgeon's preference [Table 2]. The physiotherapy was started on the second postoperative day with static quadriceps exercises and ankle pump exercises. Patients were called for follow up and were clinically and radiologically approximately four to six weeks after surgery, partial weight bearing was encouraged. Full weight bearing was delayed upto radiological fracture union. During the follow-up routine anteroposterior, lateral radiographs were obtained at four, eight and then every four weeks until clinical and radiological fracture union. The articular step-off parameter was assessed 6 months after surgery. Radiological union was defined as the presence of trabeculation crossing the fracture at three cortices on x-rays. Clinical union was defined as the presence of painless full weight bearing. Functional assessment was performed using the American Knee Society criteria at the final follow up and reported as knee scores and functional scores and radiographs were assessed for osteoarthritis by two senior orthopedic surgeon for joint depression, alignment loss, joint space narrowing and presence of osteoarthritis, which was was classified using the Ahlbäck classification. Pain was assessed using the visual analogue scale (VAS) at every follow-up.

Statistical analysis

STATA 14.0 was used for data variation analysis. Data are presented as means, medians, and proportions according to the underlying distribution. Where suitable, 95% confidence intervals (CI) were calculated as a measure of precision. Statistical association between grade of osteoarthritis and schatzker type was calculated using chi square test. Analysis of variance between American knee society score(Knee score), American knee society score (functional score) and Type of fracture (Schatzker classification) was done using one way ANOVA, The *Pvalue* for statistical significance was set at $P<0.05$.

Results

The mean duration of follow up was 76.32 months (range 42 to 130 months).The mechanism of injury was 4 wheeler versus two wheeler in 37 patients, two-wheeler versus pedestrian in 22 cases, falling from height in one. The age of the patients varied from 20-73 years (mean age 41.28 years). There was involvement of left side in 22 cases and 38 on the right side and none of the cases had bilateral tibial plateau fracture [Table 1]. The majority of the fractures were operated within 2weeks.There were 13 open and 47 closed fractures. Out of 13 open fractures, 7 were open grade 1, four were open grade 2 and two were open grade 3A. Out of 47 closed fractures maximum of the patients were type 2 injuries and only two patients were of type 3 injury. Three patients with open fracture required flaps and skin grafting for wound closure. In this study, four patients (6.67%) developed post-operative infection in which 2 had superficial infection which were treated with debridement and IV antibiotics. Third patient had deep infection not responding to debridement, hence the implants were removed after bony union which led to eradication of infection. The fourth patient with deep infection was treated with implant removal and Ilizarov external fixation. Of the four patients who had developed infection, three had type 2 diabetes mellitus and one had open fracture. There was residual varus deformity in 8 patients (13.33%) out of which 1, 3, and 4 patients were having Schatzker's type IV, V, and VI fractures respectively. At 6 months follow-up, a total of 13 cases had step-off of more than 2 mm (one case of schatzker type 3, five of schatzker type 4, two of schatzker type 5 and five of schatzker type 6) and 47 had intraarticular step less than 2 mm. All the varus deformity was less than 10 degrees, with no functional

Table 3. Functional Results	
Mean duration of follow-up (months)	76.32 (range: 42-132)
Mean ROM	102.8° (88°-126°)
Mean time of bone union (weeks)	18.4 (range 14-28)
Mean time of full weight-bearing (weeks)	18.8 (range 14-37)

impairment and hence none of these patients required corrective procedures. The mean time for radiological bony union was 18.4 weeks [Tables 3]. Mean time of full weight bearing was 18.8 weeks [Table 3]. At the final follow up the American Knee society functional score was excellent in 52 patients (86.67%) and fair in 3 (5%) [Table 4] [Figures 2; 3]. The American Knee society knee

Table 4. American knee society score (Functional score) and Schatzker type

American knee score: Functional Score	Schatzker Type						Patients	percentage
	I	II	III	IV	V	VI		
Excellent (80-100)	-	4	7	15	10	16	52	86.67%
Good (70-79)	-	0	-	1	2	1	4	6.66%
Fair (60-69)	-	-	-	1	1	1	3	5%
Poor (<60)	-	-	-	-	-	1	1	1.67%
Total patients	-	4	7	17	13	19	60	100%
Mean Functional Score	-	96±8.86	94±6.21	87±3.68	84±6.80	73±15.41	86.78	

P value: 0.01 * significant.

Figure 2. Pre op Anterior Posterior and Lateral of Schatzker type VI with radiological and functional outcome at 7 years.

Figure 3. Pre op Anterior Posterior and Lateral of Schatzker type VI with radiological and functional outcome at 4.3 years.

Table 5. American knee society score (Knee score) and Schatzker type

Knee Score	Schatzker Type						Patients	percentage
	I	II	III	IV	V	VI		
Excellent (80-100)	-	4	6	15	10	12	47	78.34%
Good (70-79)	-	0	1	1	3	4	9	15%
Fair (60-69)	-	-	-	1	-	2	3	5%
Poor (<60)	-	-	-	-	-	1	1	1.67%
Total patients	-	4	7	17	13	19	60	100%
Mean Knee score	-	88±4.76	84±7.69	83±5.04	85±6.34	74±14.76	81.25	

P value: 0.02 * significant.

score was excellent in 47 patients (78.34%), fair in 3(5%) [Table 5]. Significant reduction in the pain was seen at the follow-ups using the Visual analogue scale. The mean VAS Score was 1.35 ranging from 0 to 4 [Table 6]. The radiological union in different types of fracture is given in Table 7. The incidence of osteoarthritis in our study according to Ahlback classification was grade 1 in 41.67% of patients, and none of the patients had grade 5 osteoarthritis Patients with schatzker type IV, type V, type VI had increased incidence of osteoarthritis as compared to schatzker type II and III. The difference between the occurrence of osteoarthritis and fracture group was statistically significant (*P=0.01*) [Table 8]. There was a statistically significant difference in knee

Table 6. VAS score

SCORE	Number	Percentage
0	15	25.00%
1	22	36.66%
2	12	20%
3	9	15%
4	2	3.33%
>4	0	0
Total	60	100

Table 7. Radiological Union vs Schatzker type

Radiological Union (Weeks)	Schatzker Type						Patients
	I	II	III	IV	V	VI	
14-16	-	2	4	1	-	-	7
17-19	-	1	2	8	4	3	18
20-22	-	1	1	6	2	4	14
23-25	-	-	-	2	6	9	17
26-28	-	-	-	-	1	3	4

Table 8. Radiological grade of OA knee (Ahlbäck classification) in different fracture grade

OA grade (Ahlback)	Schatzker Type						Patients	Percentage
	I	II	III	IV	V	VI		
0	-	3	2	7	3	1	16	26.67%
I	-	1	4	8	5	7	25	41.67%
II	-	-	-	2	4	3	9	15%
III	-	-	1	-	-	6	7	11.66%
IV	-	-	-	-	1	2	3	5%
V	-	-	-	-	-	-	-	0%

Pearson chi2(16) = 38.107 *P value*=0.01* significant

society score (knee score and functional score) in correlation to the type of fracture pattern (*P=0.02*) [Figures 4; 5]. According to the chi square test in this series, it was found that incidence of osteoarthritis showed significant statistical association (*P=0.01*) with the Schatzker fracture type. The higher grade of osteoarthritis was noted in Schatzker high energy fractures (type V and VI). There was an increased variation in the knee functional score among the fracture patterns. [Figure 6]. The degree of soft tissue injury decided the timing and type of surgery and the overall rehabilitation protocol. Patients with higher degree of soft tissue injury and open wound underwent delayed knee ROM and thus has fair results. 87% of the patients with intrarticular step of less than 2mm have better functional outcome and knee range of movement as compared to the group of patients with intraarticular step of more than 2 mm.

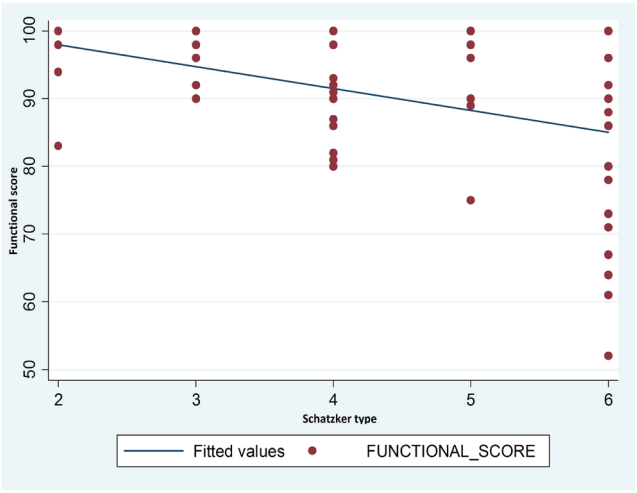

Figure 4. Box plot of fracture type and KSS. Upper and lower hinges represent 25% and 75% quartiles ,middle represent median (50% quartile).

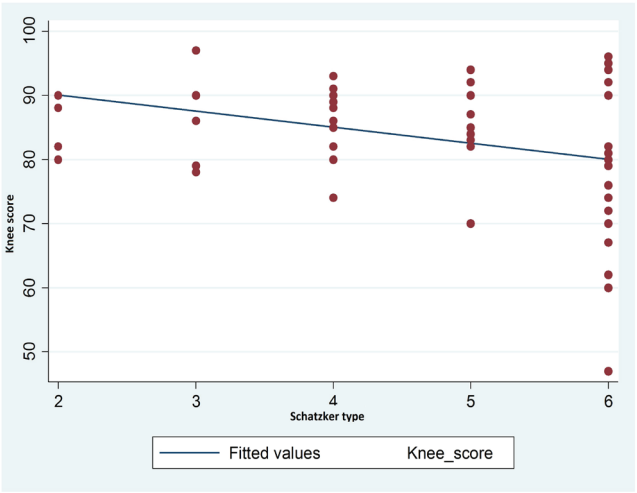

Figure 5. Scatter plot of American knee society score (Functional score) against Schatzker type fracture.

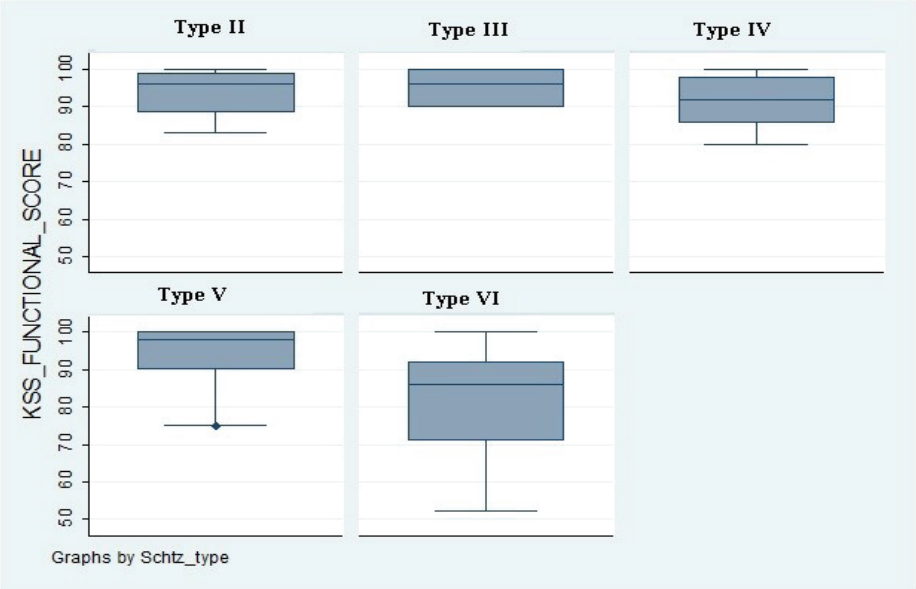

Figure 6. Scatter plot of American knee society score (Knee score) against Schatzker type fracture.

Discussion

Fractures of the proximal tibia occur due to high energy trauma and because of subcutaneous anatomical position of the tibia, it is vulnerable to open fractures. The management of these fractures is a challenging task for a surgeon, as they are often associated with number of complications (12, 13). Classification of proximal tibia has been an issue of debate and has previously been addressed in the literature; however, evaluation criteria and optimal management remain controversial (14). Over the past years, a number of treatment modalities have been developed, such as simple skin traction, cast immobilization, external skeletal fixation, and open reduction and internal fixation with different implants. Open reduction and internal fixation with plating, 6.5 mm Cannulated cancellous screws is considered one of the acceptable methods of treatment in tibial plateau fractures (15). The current literature does not provide a clear picture regarding the outcome of surgically

treated tibial fractures mainly due to heterogeneous inclusion criteria, different classification systems and fixation techniques or even missing functional outcome data (16). In our study, Schatzker type V and VI consist of over 50% of total cases. This may be due to location of our hospital near the national highway which is responsible for increased incidence of high velocity vehicular accidents. These type of injuries are usually associated with compromised soft tissue and other associated injuries. There was residual varus deformity in 8 patients (13.33%) out of which 1, 3, and 4 patients were having Schatzker's type IV, V, and VI fractures respectively. Gaudinez et al. reported 19% of varus deformity in his series of 18 complex (types V and VI) fractures (17). The most dreadful complication associated with the management of tibial plateau fractures is infection. The incidence rate depends on surgical timing, type of fracture, grade of compounding, soft tissue handling during surgery, and associated co morbidities of the patient. In our series four patients developed infection (6.67%). Infection rates range between 0 and 87.5% in the literature (18-21). The incidence of OA following tibial plateau fractures varies in the literature. The occurrence of post traumatic osteoarthritis is mainly due to articular incongruity, and change in mechanical axis (22, 23). Rasmussen reported 17% overall incidence of posttraumatic osteoarthritis in his series of 260 fractures; however, its incidence in the bicondylar group was 42% (24). Decoster et al. reported radiological changes in 32% of patients with an average follow-up of ten years (25). Rademakers et al. reported a 31% incidence of arthritis with symptomatic degeneration, which was more severe in cases with malalignment of more than 5 degrees (26). Gaudinez et al. reported 83% of radiological changes in one year follow-up of patients with comminuted tibial plateau fractures (27). N.Manidakis et al reported osteoarthritis in 26.40% patients in his series of 125 patients (28). In our series, radiological evidence of OA was present in 44 out of 60 cases (73.34%), out of which 56.67% had grade 1 and grade 2 osteoarthritis while incidence of grade 3 and 4 arthritis were 11.66% and 5% respectively. Despite radiological arthritis 76% patients were asymptomatic at final follow-up. Our results are comparable with other published studies. In evaluating the functional outcome excellent results have been reported in 81% patients in one of the series by Lachiewicz and Funcik (29). Oh et al. have also reported excellent results in 91% of the cases treated with open reduction and internal fixation of proximal tibial plateau fractures (30). In our series 86.67% had excellent and 6.67% had good functional outcome. Most of the degenerative changes occur in the first decade of the initial injury. The probability of degenerative changes increased significantly with higher age at the time of injury. The main factors in preventing early degenerative changes after intraarticular fractures appear to be the early restoration of joint congruity, realignment to the normal anatomical and mechanical axis, and early movement of the joint. We conclude that tibial plateau fractures continue to remain an important cause of morbidity. Treatment should be based on the fracture pattern, soft tissue condition and general condition of the patient in cases of high velocity injuries. Functional outcome and limitation of post-traumatic osteoarthritis is directly related to the achieved articular congruency and anatomical limb alignment and avoidance of complications. Regaining full range of movements depends on early and aggressive knee mobilization which finally gives optimal functional recovery and patient satisfaction.

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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