Proximal tibia fracture and its functional outcome: A prospective study

Running Title: Functional outcome in proximal tibia fracture

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Abstract

Background:The management of proximal tibia fracture (PTF) is a key constrain for the adults as the post-treatment recovery time is long. Hence the possible effect of treatment in patients along with the functional outcome is important.Therefore, the current study assessedthe functional outcome and efficacy of various modalities of treatment in patients with PTF, and the complications of these fractures.

Materials and Method: Thisprospective study included 88 patientshaving PTFbased on Schatzker classification. The operative protocol varied for different types of fractures. All the patients underwent surgery within a week of admission and were advised to follow post-operative instructions and exercises. The functional outcome was assessed using Rasmussen scoring systemand patients were evaluated for walking capacity, range of movements and post-operative complications.Pearson Chi-square test was employed to test the association between fracture and outcome. *P*<0.05 was observed to be statistically significant.

Results: Most common mode of injury was road traffic accident (85.23%). Majorityof the cases(42.05%)were operated with open reduction and internal fixation buttress plate. Post-operative walking capacity was normal (63.64%) with higher range of movements (>140) in 34.09% of patients. Few patients had post-operative complications related to pain and range of movement<90º. Majority of them (50%) in type I split fracture had excellent ratingwith a significant association (p=0.0005).

Conclusion: Excellent recovery was seen in 50% of the patient's post-surgery which demonstrated that the procedure applied is dependent on fracture type. Hence, the functional outcome of the research indicated a significant role of the surgery type with improvement in walking capacity and range of movements being high with key advises.

Keywords: Bone plates, Exercise therapy, Fracture fixation, Internal, Open fracture reduction, Tibia, Tibial fractures

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Introduction

Proximal tibia fractures are generally accompanied by wide range of serious injuries which include stable undisplaced fractures with slightest injury in soft tissues to more unstable fractures, and acute involvement of soft tissue. They are generally classified into two broad categories – low energy fractures and high energy fractures.[1,2] Tibial plateau fractures are common intra-articular fractures representing 1.2% of all fractures. [3]

Majority of tibial plateau fractures are due to high velocity road traffic accidents (RTA) and fall from height. [4]These fractures results from direct axial compression, more commonly with a valgus or varus moment and indirect shear forces. [5]The Schatzker classification system for tibial plateau fractures has been broadly used by orthopedic surgeons to evaluate the type of injury, management, and prognosis. [6]

With the gradual changes in treatment modalities of proximal tibia fractures from conservative measures like cast bracing, immobilization to surgical interventions, and traction, a requirement for better fracture fixation technique in view of complications arising due to conventional plating like osteoarthritis, knee stiffness and soft tissue injury is needed. In addition, bone necrosis and osteoporosis at bone plate and screw interface results in infections, loss of fixation, malunion or non-union, and collapse. [5]

Surgical management helps in complete treatment of tibial fractures which include precise reconstruction of articular surface, stable fragment fixation allowing early mobilization and restoration of ligament and other soft tissue lesions. [7]With surgery, a single-incision approach with laterallocked plates is feasible even in bicondylar fractures, with decreased blood loss and minimum wounds. [8,9]Complication rates can be kept lowalso in dual-incision plating. [10]

The use of internal fixation and open reduction has been advocated in recent years using various implants including buttress plates, cancellous screws, external fixators etc. [11] There seems to bediverse change in the field of medicine, especially in orthopaedic trauma. Furthermore, the treatment modalities in tertiary care centers are comparatively less and an awareness of the biomechanics and internal fixation principles, quality of implants is necessary. Studies conducted with different procedures for the treatment of various fracture types are limited. Therefore, the current study aimed to evaluatethe functional outcome and efficacy of various modalities of treatment in patients with proximal tibial fractures, and also to evaluate the complications of these fractures.

Materials and Methods

This current prospective study was carried out in a tertiary care center. Eighty eight subjects having proximal tibia fracture after obtaining a written informed consent were selected.The study was conducted after approval from Institutional Ethics Committee. Subjects of both genders aged >18 years with radiologically demonstrable tibia condyle fracture with fracture line extending into the articular surface of the knee joint and fractures classified based on Schatzker classification were a part of the study.[6]Patients with extraarticular fracture, pathological fractures, refractures, cardiopulmonary status compromised for surgery, compound wound Gustilo Anderson Type 3, patients below 18 years, and those not willing to participate in the study were excluded.On the basis ofprevalence of 27%, a minimum sample size required was 76 with a confidence interval of 95% and maximum error of 10%. Hence a total of 88 subjects were included for this study.

Patientswereclinically assessed for demographical details, vital parameters and based on the source of injuries, head, neck, chest, and abdominal,injuries were checked. In addition, patients underwent local examination and based on that, skin condition was noted.Also, fracture blisters, hemarthrosis(open or closed), distal neurovascular compromise, and any signs ofcompartment syndrome were also noted. The limb was immobilised in Thomas splint incasualty,immobilised with A/K slab, and any other associated limb injury or bony injury was noted.On the basis of general condition

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and vital parameters, intravenous fluids were given accordingly. Other bony injuries were immobilized and appropriately treated.

In surgically treated group of patients, depression >2-4 mm split in either sagittal or coronal plane was taken for surgery. All the cases were treated operatively, as articular surface reconstruction was the main consideration. Computerized tomographic assessment was conductedin cases which had morecomminution, with inconclusive data from X-ray and magnetic resonance imaging (MRI) was carried out in suspected ligamentous and soft tissue injuries. Patient was suitably anaesthetized-(regional or general), and surgery was performed in supine position with or without tourniquetcontrol with image intensifier and X-rays taken after 1,3,6 and12months were checked.

All patients post-operatively were advised to do exercises (staticquadriceps) throughout the day. They were advised to delay partial weight bearing for 6 weeks, and full weight bearing was allowed after 12 weeks, depending on thesign of union noticedon radiograph.

Implants used for internal fixation of tibial condylar fracture

Implants in the study included buttress plate, locking compression plate, screws (cortical, cancellous and locking screws). Buttress plates have widening ends of long bone consisting of huge amount of cancellous bone. Different types of buttress plates included T plate, L plate and hockey stick plate. Locking compression plates are specified for certain high energy bicondylar fractures, those with severe comminution and in osteoporoticfractures.Laterally based locking plate offers a replacement to an additionalmedial plate or external fixator for support of the medial column in bicondylarfractures.

Cortical screws of 4.5 mm diameter of various lengths for which 3.2mm drillbit and 4.5mm tap was used. Full threaded screwsacted as fastening device for the plate. Partially threaded screws were used aslag screws to attain compression of fractured articular surface.Cortical screws, self-tapping in nature, have a thick core with narrow thread and were used forpurchase in cortical bone.

The operative protocol varied for different types of fractures. For central depression fracture, a window was made in the metaphyseal area below the depressedfragment.The depressed fragment was elevated, and autogenous corticocancellousbone graft was packed beneath. Autogenous bone graft was harvested from thefront aspect of the iliac crest. Fragment and graft were balanced withcancellous screws or plate fixation. For split and depressed fracture, surgical intervention was necessary in fractures more than 2-4 mm split and depressed. The depressed fragment was elevated and autogenous bonegrafts from iliac crest were put and split was reduced, and reduction was held withKirschner wires. The fragments were then fixed with suitable plates andcancellous and cortical screws. For total condylar depression, fracture of medial or lateral condyle needed appropriate reduction asmalunion might develop with varus or valgus mal-alignment. The depressedplateau was elevated, articular surface reconstructed and fixed with buttressplate. For bicondylar fracture, a mid-line or two incision technique was used for reduction of both thecondyles. Depending upon comminution, fixation wascarried out by L, T or hockeystick plate or locked plates and cancellous screws. Dual plating could be conducted ifother side were unstable where collapse might occur.

Post-operative instructions

Post-surgery, wounds were closed over suction drains, and drains were removed after 48 hours.Above knee slab or removable knee brace with leg elevation was given to reduce the pain and edema. In addition, injectable antibiotics were given for 3 to 5 days. Static quadriceps exercises and ankle pump exercise were advised to start on secondday. The patients with stable fixation were allowed with intermittent kneemobilization once the wound pain subsided, early in type I, II and III in 5 to10 days and late in type V and VI in 14 days or later depending uponcomminution of fracture.Stitches were removed after twelve

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days and progressive muscle strengthening exercises along with passive exercises were instituted.Knee immobilisation with brace or above knee cast was used in caseswith ligamentous injuries for 4 to 6 weeks.Weight bearing waspostponed until proof of union was noticed on x-rays (usualby 14 -16 weeks).
The patients were followed up every 4 weeks for a period of one year.Partial weight bearing was started from 10- 14 weeks depending upon thefracture configuration and correlation with the x-ray. Full range of motion isexpected at 8-10 weeks after discharge.

The functional outcome of the tibial proximal plateau fracture in terms of pain was evaluated using functional grading of Rasmussenet al with the scoring system as excellent (28-30), good (24-27), fair (20-23), and poor (<20), with a maximum possible score of 30.[12]Patients were evaluated for walking capacity and range of movements. In addition, post-operative complications were also assessed.

Data was analyzed using SYSTAT software version 12. Categorical variables were represented in frequency and percentage. Pearson Chi-square test was employed to check the association between fracture and outcome. *P*<0.05 was considered statistically significant.

Results

The mean age of the subjects enrolled were 43.14±16.15 years. A significant number of patients were in the age group of 30-40 years and majority of the patients were males (79.54%). The most common mode of injury was observed to be road traffic accident (85.23%) followed by height fall (10.23%) and other domestic injuries (4.54%). The distribution of subjects based on socio-demographic variables are presented in Table 1.
With respect to the procedure in patients with proximal tibia fracture, the most frequently used procedure was open reduction and internal fixation (ORIF) with buttress plate (42.05%). Type 1-split and type -2 split depression fracture types (25%) were the common type of fractures observed in the study (Table 2). In terms of walking capacity, majority of the patients (63.64%) had normal walking capacity. Majority of the patients (34.09%) had range of movements >140º (Table 3).
The possible Schatzkers classification of upper tibial fractures seen in the study revealed a statistically significant association (p=0.0005) between Type 1 split and rating. With respect to clinical outcome, majority of the patients in Type 1-split fractures had excellent rating which demonstrated that rating changes with the type of fracture (Table 4).
With respect to complications, post operative infections were noted in 13 patients , pain in 18 patients and range of motion <90º in 8 patients respectively.

Discussion

Fracturesof knee joint are very common. [13-15]
The main cause for fractures are reflected because of the proximal tibia, which is emphasized in the recent years. This further results with traumatic conditions in patients with intense fracture. Hence the treatment for upper tibial fractures with intra articular extension has become a challenge for the orthopaedic surgeon.Outcome of tibial plateau fracture fixation depends mainly on knee range of movements and strength of the quadriceps.
In the current study, most of the fractures were reported in the age group of 30-40 years which was almost similar to the studies conducted by Jagdev et al and Rajappan et al which reported maximum prevalence of fractures in the age group of 30-50 years. [15,16]
In terms of gender, majority of males had fractures compared to females in the current study. This was in concordance to the study conducted by Abhishek et al. [17] The reason for male dominance with fractures might be because of the fact that males are more involved in outdoor activities and majority of the motor vehicles are driven by them.
With regard to the type of fractures, type-1 split, and type-2 split were the most prevalent type of fractures seen in the current study. These results were in concurrent to the studies conducted by Polat et al with majority of patients having type I and type II fractures.

[14] This might be due to the valgus force on the knee which is usually seen in individuals of the 4th decade or older with osteoporotic changes in bone. [6] In contrast, study conducted by Aseri et al had type 5 and type 6 fractures as the most common type. [18]

With respect to walking capacity, most of the patients experience normal walking and most of them had range of movements >140º in the current study. In a study carried out by Abhishek et al, more than 50% of the patients had walking capacity and most of them had range of movements >120º. [17] In terms of pain and range of motions, few patients experienced pain and less than 10% had range of motions <90º. These improvements in walking capacity and few complications in terms of pain and range of movements in our current study might be because of the benefits of stable fixation followed by early mobilization which improves function depending on the type of fracture.

Amongst the complications observed, 14% developed post-operative infection that was comparable to the study conducted by Egol et al who reported no infection. [8]Inspite of these minor complications, present study showed a statistically significant association with 50% of patients in type-1 split showing excellent rating in clinical outcome. These results were in accordance to the study conducted by Kancheria et al which also reported excellent clinical and radiological outcome in 50% of proximal tibia fracture patients. [5] In contrast, Rohra et al reported 85.3% of patients with excellent outcome. [19] This might be because of the treatment modality selected by classifying the fracture type during admission and early surgery. These results were in line with the results reported by Oh et al, Yu et al, Zhang et al and Prasad et al.[20-23]

Overall study results reported a positive clinical outcome in terms of surgical treatment modality used in the present study. However, the study has few limitations. In the present study, there was limited sample size to provide justification on the clinical outcome of patients. Furthermore, the study duration and follow-up was short to comment on the past traumatic osteoarthritis. Hence, future studies on larger sample size with longer duration are warranted to prove the clinical outcomes in patients with proximal tibia fracture.

Conclusion

Type of procedure influenced the functional outcome of the study with most of the patients showing excellent results post-surgery. Benefits of stable fixation followed by early motion had to be balancedwith risk of fracture reduction, compromisedligamentous and soft tissue healing, and failure of internal fixation. Hence, the fixation technique used in the current study could provide a good outcome in patients with proximal tibia fracture.

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Table 1: Socio-demographic variables of the patients selected

Variables	Number of cases (%)
Age (Years)	
<20	4 (4.54)

20 – 30	19 (21.59)
30 – 40	24 (27.27)
40 – 50	12 (13.64)
50 – 60	14 (15.91)
60 – 70	11 (12.50)
>70	4 (4.55)
Gender	
Male	70 (79.54)
Female	18 (20.46)
Occupation	
Business	10 (11.36)
Employee	10 (11.36)
Farmer	40 (45.46)
Housewives	10 (11.36)
Labourer	10 (11.36)
Student	8 (9.10)
Mode of injury	
Domestic	4 (4.54)
Height fall	9 (10.23)
RTA	75 (85.23)
Side affected	
Left	27 (30.68)
Right	61 (69.32)

RTA: Road traffic accident

Table 2: Procedure and fracture type in patients with proximal tibia fracture

Variables	Frequency,n (%)
Procedure	
CC Screw	13 (14.77)
ORIF with buttress plate	37 (42.05)
ORIF with bicondylar buttress plate	13 (14.77)
ORIF with buttress plate + Graft	5 (5.68)
ORIF with locking plate	10 (11.36)
ORIF with locking plate + Graft	1 (1.14)
ORIF with medial buttress plate	9 (10.23)
Fracture type	
Type 1-Split	22 (25.00)
Type 2-Split depression	22 (25.00)
Type 3-Central depression	13 (14.77)
Type 4-Split fracture, medical plateau	9 (10.23)
Type 5-Bicondylar fracture	13 (14.77)
Type 6-Dissociation of metaphysis and diaphysis	9 (10.23)

CC: Canulated cancellous; ORIF: Open reduction and internal fixation

Table 3: Walking capacity and range of movements in patients with proximal tibia fracture

Variables	Frequency (%)
Walking capacity	
Normal	56 (63.64)
Indoor walking	1 (1.14)

Outdoor walking (> 15 min)	2 (2.27)
Outdoor walking (1 hour)	29 (32.95)
Range of movements (degrees)	
30 – 60	5 (5.68)
60 – 90	3 (3.41)
90 – 120	28 (31.82)
120 – 140	22 (25.00)
>140	30 (34.09)

Table 4: Association between type of fracture and rating

Fracture type	Excellent	Good	Fair	Poor
Type 1-Split	18	4	0	0
Type 2-Split depression	17	5	0	0
Type 3-Central depression	0	13	0	0
Type 4-Split fracture, medical plateau	9	0	0	0
Type 5-Bicondylar fracture	0	8	2	3
Type 6-Dissociation of metaphysis and diaphysis	0	5	3	1
Total	44	35	5	4