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Original Research Article

A Prospective Study on Functional Outcome of Treatment of Proximal Tibia Fracture (Schatzker Type V and Type VI) by Dual Plating

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Conflict of interest: Nil

Abstract:

Background: Proximal tibial plateau involvement is one of the most common intra-articular fractures. They account for only for 1% of all fractures and 8% of fractures in the elderly (1), these are usually caused by high energy trauma especially the comminuted types (TYPE V, TYPE VI). Our objective is to analyse the functional outcome of treatment of proximal tibial fractures (Type V & Type VI schatzker) by dual plating.

Methods: The observational study included 30 cases at Department of Orthopedics, adichunanagiri Institute of Medical Sciences Mandya, Karnataka; the study was conducted on March 2023 to August 2023. Patients with age between 23 to 82 years and Schatzker's Classification of tibial plateau fractures Type V and VI were included for the study. And analysed using SPSS software for evaluating the statistical significance.

Results: Out of 30 patients 90% are male 10% are female. Adults are affected, more in 36-50 years (40%) followed by 20-35 years (36.6%). Most common type of fracture was type 6 (70%), followed by type 5(30%). In this study, when patients were followed 6 months after surgery, there was considerable improvements in the functional outcome, which was assessed by Rasmussen's functional score. Excellent outcome was obtained in 4 (13.3%), Good outcome in 22(73.3%), Fair outcome in 3(10%), and poor outcome in 1(3.3%).

Conclusion: Dual plate fixation of proximal tibial fractures is an effective surgical technique in maintaining stability of fracture and there is significant improvement in functional outcome.

Keywords: Proximal Tibial Fractures, Bicondylar, Schatzker type V and VI, Dual plates, Rasmussen's functional score.

Introduction

Knee is a major weight bearing part in body. Knee joint assist in movements of human body in its bipedal stature. Bony components knee joint are distal femur, patella and proximal tibia.

Injuries involving these components would definitely involving the flexibility of knee joint. Proximal tibia plateau involvement is one of the most common intra-articular fractures. They occur as a result of either indirect trauma causing coronal fracture pattern or axial compressive patterns.

The proximal tibial fractures account for only 1% of all fractures. These are usually caused by high energy trauma especially the comminuted types (type V and VI). 1-3 % of proximal tibial fractures are open fractures. Isolated lateral condyle occurs in 70%, medial condyle in 15% and rest 15% are bicondylar.

There were multiple modalities of treatment for these fractures, ranging from conservative treatment to contoured LCP plates. By treatment of this fracture, we aim to attain a stable knee joint with normal mechanical axis and congruous articular surface, which gives painless, near normal ROM. The increasing load of high energy tibial plateau fracture is an indicator of future increased osteoarthritis and morbidity later in life unless these fractures are managed properly. In this study management of high energy tibial fractures by dual plating are of great significance.

Aims and objective

- To study the Functional outcome of proximal tibia fracture (schatzker type V and type VI) using dual plating.
- To evaluate the results of this study with fracture union and restoration of knee range of motion.
- To evaluate the complications associated.

Materials and methods

This prospective longitudinal observational study was conducted among 30 patients of proximal tibia fractures (Type V and type VI) treated with dual plates, who meets the inclusion criteria, done in Adichunchanagiri institute of medical sciences and hospital, Mandya. Duration of study was 6 months.

Inclusion Criteria: Patient with Type 5 and Type 6 treated with dual plating

Exclusion criteria

- Open fractures
- Patients with other fractures of the same lower limb
- Fractures with compartment syndrome
- Fractures with neurovascular injuries
- Pathological fractures
- Osteoarthritis of knee of same limb

Methodology

- Patients are followed up for 6 months.
- Age group of 23 to 70 years was included.
- All patients had routine anteroposterior and lateral view x-ray and CT knee to assess intra-articular involvement.
- After surgery patients were followed up at 4 weeks, 12 weeks and 24weeks.

Mechanism of injury: Force that result in injuries to tibial plateau.

- Force directed medially (valgus deformity) or directed laterally(varus deformity)
- Axial compressive force
- Both axial and bending force from the side.

Direction, magnitude, location and position of knee at the time of impact determine the fracture pattern, location and degree of displacement.

Management

- Principles of management.
- Factors affecting management.
- Degree of comminution
- Amount of fracture displacement
- Extent of soft tissue injury
- Associated neurovascular injury Magnitude of joint involvement
- Degree of osteoporosis
- Complex ipsilateral fractures(patella and femur)

Aim of treatment

- To attain anatomical reduction of joint surface
- Restoration of joint congruity
- To maintain normal mechanical axis of knee joint
- To attain full normal painless ROM of knee joint by early mobilization

Operative management

A fracture is considered stable if it does not exhibit, varus or valgus stressing, more than 10 degrees of instability at any point in arc of motion, from full extension of 90 degrees to 90 degrees of flexion. And also in medio-lateral plane.

- Sequences in surgical management
- Restoration of articular surface
- Metaphyseal alignment
- Impaction of fracture in osteoporotic patients
- Early mobilization of knee

Type 5:- Bicondylar fracture stabilized with medial and lateral plates.

With the advent of locking plates, laterally placed plates with screws that lock to the plate creating a fixed angle construct provide enough stability to counteract forces seen by the medial tibial plateau , this allows for less surgical dissection and decrease in the incidence of soft tissue complications.

Type 6:- implies metaphyseal-diaphyseal dissociation. Following articular reconstruction, the articular segment is stabilized to the tibial shaft using a single plate, dual plate and a contralateral two pin external fixator.

Locking Compression Plates: these implants combine the principles of angular stable construct and compression plating.

Its design and characteristics allow it to be used by a minimally invasive approach by using the principles of biological osteosynthesis.

Complications

- Infection:- rates vary from 1%-38%
- Thromboembolic manifestations :- 5 to 10 %
- Malunion
- Post traumatic arthritis
- Painful hardware
- Loss of fixation
- Non union
- Vascular injuries

Study tools: Rasmussen's functional grading

Result:

Table 1: Distribution of study population according to type of fractures

Type	Frequency	Percentage
Type 5	9	30%
Type 6	21	70%
Total	30	100%

Table 2: Distribution of study population according to functional outcome

Outcome	Frequency	percentage
Excellent	4	13.3%
Good	22	73.3%
Fair	3	10%
Poor	1	3.3%
Total	30	100%

Table 3: Distribution of study population based on type of fracture and Rasmussen's functional score outcome

Type of fracture		Excellent	Good	Fair	Poor	Total
Type-5	No	2	5	1	1	9
	%	6.7	16.7	3.3	3.3	30
Type-6	No	2	17	2	0	21
	%	6.7	56.7	6.7	0	70

Table 4: Distribution of study population based on age group and post-surgical ROM

Age group		140		At least 120		At least 90		Total
		Type 5	Type 6	Type 5	Type 6	Type 5	Type 6	
20-35 year	No	0	1	2	7	0	1	11
	%	0	3.3	6.7	23.3	0	3.3	36.7
36-50 year	No	1	0	2	6	2	1	12
	%	3.3	0	6.7	20	6.7	3.3	40
>50 year	No	0	0	1	5	1	0	7
	%	0	0	3.3	16.7	3.3	0	23.3

Age	140	%	At least 120	%	At least 90	%	Total	%
20-35	1	9.1	9	81.8	1	9.1	11	100
36-50	1	8.3	8	66.67	3	25	12	100
>50	0	0	6	85.7	1	14.3	7	100
Total	2		23		5		30	

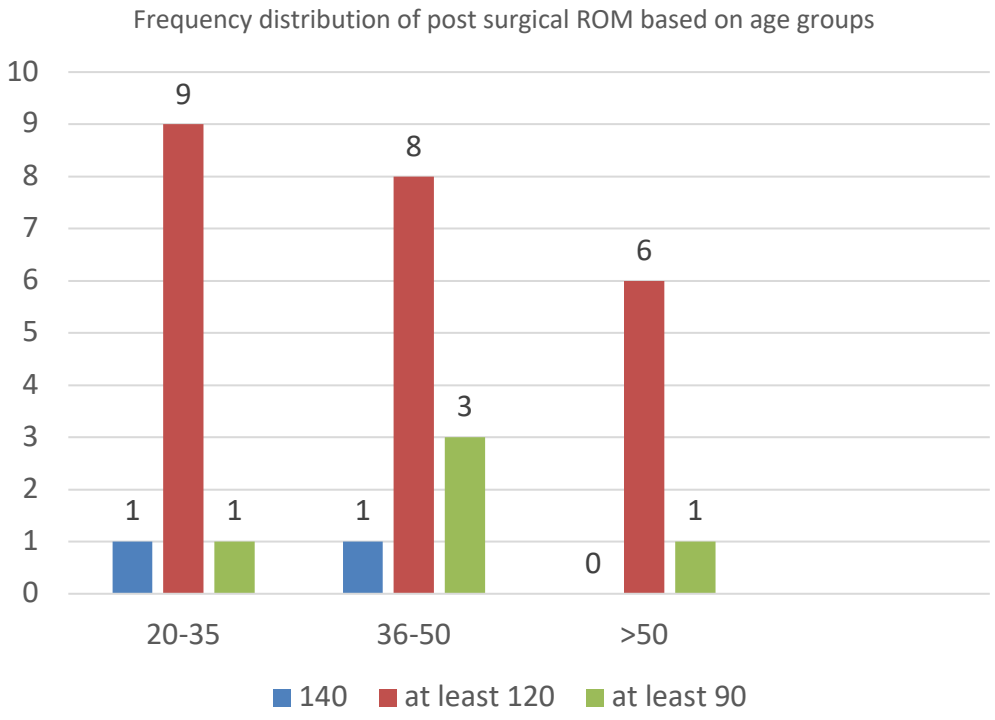

Figure 1: Frequency distribution of post surgical ROM based on age groups

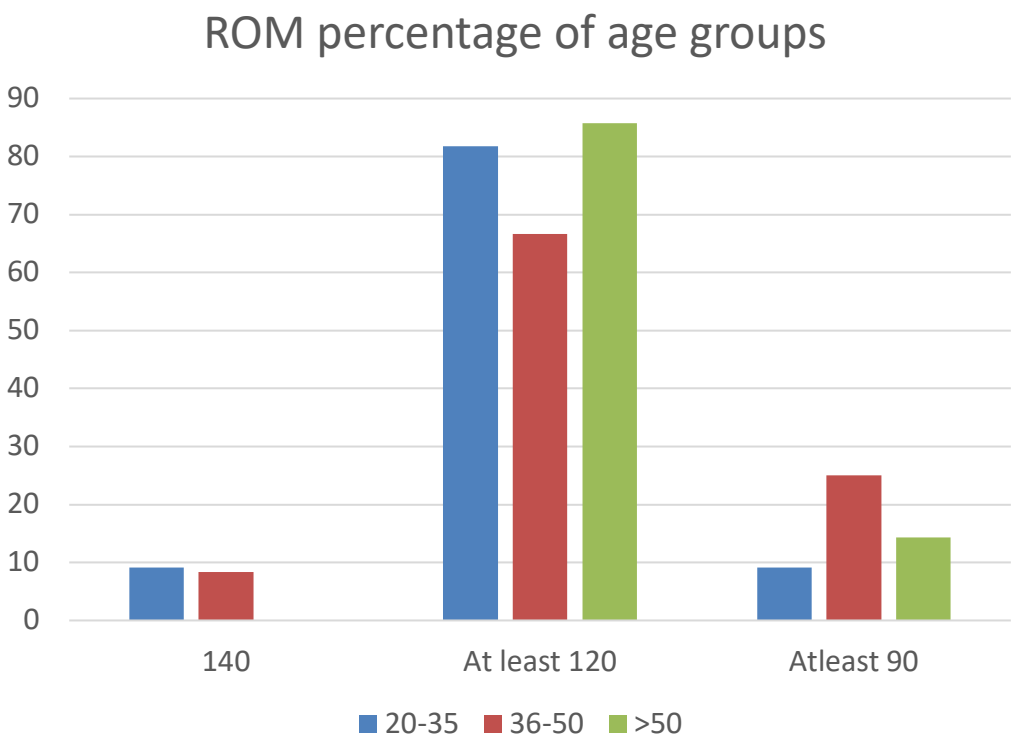

Figure 2: ROM percentage of age groups

Pre-operative and post-operative Radiographs

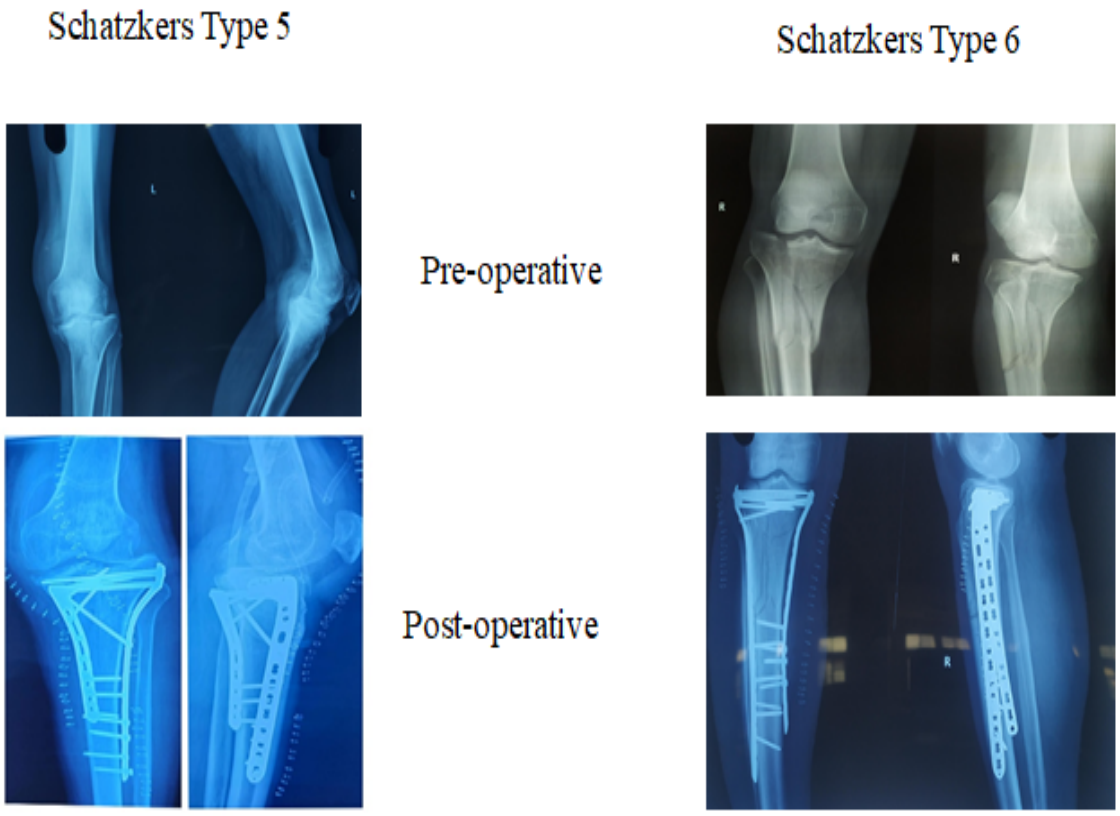

Figure 3:

Discussion

Fractures of the tibial plateau historically had been known to be one of the notorious fractures that compromise the functional capacity of individual by producing problems in the lower limb, by the following mechanism.

1. Altering the function of knee joint w.r.t to ROM & stability
2. Changing the mechanical axis of lower limb
3. chronic pain
4. Making the knee joint susceptible to early osteoarthritic changes
5. Producing length disturbances that will eventually predispose to early development of osteoarthritic changes in adjacent joints

These injuries which usually happen mostly happen as a result of high velocity injuries like road traffic accidents and fall from height occur mostly in the young and productive age group with increased predisposition to males, there by crippling the individual and the families who are dependent on the victims of the injuries.

Fractures of the tibial plateau have the potential to be devastating injuries especially when they have significant bony and soft tissue involvement along with knee instability and incongruity as in type V and VI injuries. Fractures of the proximal tibia are the result of high energy injuries and because of lack of soft tissue coverage in this region, it is vulnerable and open fractures commonly encountered. In such cases, the treatment of damaged soft tissue is of primary concern [2] As open factures can interfere with ORIF my study exclude open fractures and hence is not a true reflection of outcome of Type 5 and type 6 fractures, but rather a reflection of complicated schatzker fractures.

In study by Jain RK et. Al [3] majority of the patients were males-46 out of 58 0114%). This can be attributed to the Indian setup where males are more involved in outdoor activities and thus more liable for such injuries. Unnikrishnan et [4] study population has a 76-24 ratio for male to female. Our study had 27 out of 30 were male and rest 4 (13.3%) patients were females with a male to female ratio of 9.1. were Khin et al. [5] total 30 patients were studied, out of them 26 (86.7%) patients were al and rest 4 (13.3%) patients were females. There were 33 (82.5%) male patients md 3 were females In study by Shyam S 74 and 7 (17.5%) female patients in study by Thiruvengita Prasad et al there were 16 men and women in study by Ebrahim Ghayem Hassan Khan of thin a series of 22 patients of proximal tibial fractures.

High energy tibial fractures usually affect the younger age group in productive life years and have significant socioeconomic impact due to late recovery time and subsequent requirement of early total knee replacement in some complicated cases. 76.67% subjects of our study was between 20 and 50 years, who belongs to the earning and productive age group which result in extensive financial loss both for the family and for nation. 36.67% were between 20-35 years, the time during which one will be starting to bloom, preventing their ability to attain the best position vocationally, socially, and financially later. 40% of the people were between 36-50 years, the time in which one would be settling well financially and planning for the wellbeing of next generation, making them dependent on the young generation early and creating so much emotional problems. Mean age of patients who sustained tibial plateau fractures Schatzker type V and VI was 38.17 years in study by Shyam S Khatri et.al (4) with a standard deviation of 8.23 years. These are comparable with mean age of 37.7 years in study by Yong Zhang et al. [6] mean age of 35 years in study by Ebrahim Ghayem Hassankhani et al. [7] and mean age of 40 years in study by G. Thiruvengita Prasad et al. [8]

The AO/OTA classification is well-accepted and defines the fracture morphology precisely [9], similarly the Luo 3 Column classification describe the fracture with specificity to the region that require fixation. However we choose the classification that withstood the time, as we wanted to evaluate the outcome of those high-energy tibial plateau fracture morphology which remains a challenge to orthopaedic surgeons, with the bicondylar type (Schatzker type V) and the comminuted type (Schatzker type VI) fractures being the most difficult to treat, because of the high complication rates

In our study 21 out of 30 (70%) were Type 6 and rest 9(30%) were Type 5 fractures. Type 5 fractures were more in 36 - 50 years (55.5%) compared to 20-35 year age group (22.2%) Type 6 fractures were more in 20 - 35 years (438) sustained the highest toll of type 5 & type 6 combined (40%) next to the 20-35 year group (36.6%). The sex distribution of type 5 and type 6 schatzker fracture also followed the 9:1 ratio in our study.

The main aim was the surgical reconstruction of the articular surface with elevation of depressed bone fragment and stable fragment fixation allowing early range of movement. Bone grafting or G bone(hydroxyapatite crystals) grafting was done in cases where proper articular congruity was not able to be obtained by elevation alone similar to study by Kerkhoffs GM et.al, where primary bone grafting was performed to fill bone defects only in case of depressed fractures

73.3% of the population in our study had good functional outcome and 13.3% had excellent outcome, together accounting for the 86.7% of

satisfactory outcome (good +excellent) similar to our reference study by Shyam S Khatri, which has 93.3% of satisfactory outcome. In our study out of the 9 type 5 fracture 2(22%) had excellent outcome were as 2 out of 21 type 6 fracture (9.5%) had excellent outcome. 5 out of 9 type 5 fracture (56%) had good result compared to 17 out of 21 type 6 fracture (80.9%) had good result. 1 patient with type 5 fracture had fair and 1 type 5 fracture had poor functional result at end of 6 months of surgery and 2 type 6 fracture had fair results (9.5%).

Most of the patients in our study were initially treated by AK slab compared to skeletal traction [9], and the functional outcome were more or less comparable in both groups.

Surgery was done after the patients were stabilized and local soft tissue condition assessed pre-operatively, else the surgery was deferred till the wrinkle sign appeared. This resulted in variability of time period before surgery. The surgeries had an average preoperative waiting period of 1 week. 19 of them were treated within 1 week and 11 of them were treated after 1 week. The results of waiting period on functional outcome were statistically insignificant though. In study by Shyam S Khatri et.al, [4] mean time interval between injury and surgery was 8.8 days with a standard deviation of 4.6 days. In majority of the patients (76.7 %) tissue oedema settles and wrinkle sign appears within 10 days of injury (5 to 7 days in 50% and 8 to 10 days in 26.7%). Injury surgery interval was 7.1 days in study of proximal diametaphyseal tibia fracture by Peter A. cole et al , The average injury surgery Interval was 8.5 days in study by Cong-Fengluo et al, While single lateral locked screw plating of bicondylar tibial plateau fractures mean injury surgery interval was 7.5 days in study by T. Gosling et al

Jain D et al series, 14 patients had concomitant injuries to other systems with head injury observed in maximum number of cases and in eight cases; other long bone fractures were also present. Our series also had similar concomitant injuries, but did not show any statistical correlation with functional outcome at 6 months post operatively. In our study out of the total subjects 24 out of 30 (80 %) had only orthopaedic injury and the rest 20% had combined surgical and orthopaedic injury. This seemed to be contradictory to the finding that type 5 and type 6 schatzker fractures being high velocity injuries, should be associated with more combined injuries rather than pure orthopaedic injuries.

By our analysis it's found out that this was a selection bias, because of the exclusion criteria of excluding polytrauma and open fractures. As high energy injuries associated with combined injuries were producing such injuries more compared to closed schatzker fractures. Unlike the study done by Duwaliuss and Connoly who concluded that observations based on roentgen graphic examinations did not correlate with the functional end results, our study showed a correlation between 6 months post-operative roentgen graphic results assessed by Rasmussen's anatomic scores and functional results. All the excellent functional results were obtained for those who were having good anatomic scores. Those who were having fair anatomic scores had a functional outcome ranging from good to poor. This association was found to be statistically significant by Chi square test and Fischer exact test with a degree of freedom of 1.

Similarly statistically significant correlation was obtained between post-surgical infection and functional outcome by Chi square test and Fisher exact test with #degree of freedom of 1. 24(80%) had no infection, were as 6 of them had infection and were having poorer outcome compared to those who were not having infection.

Age doesn't seem to be decisive factor when it comes to functional outcome as all age group tend to show good outcome. The only noteworthy point is that the excellent results were obtained more in younger groups we measured ROM and range of flexion and extension is taken from 90 degree to full extension, ie 90 degrees from a straight leg. Extension is defined from 40 degree up till 180 degrees of extension. Flexion is defined from 90 degree up fill degree to 140 degree of flexion. Deformity of flexion is defined as inability to extent up to 90+70 degree both actively and passively (<20 short of full extension). Deformity of extension is defined as inability to flex up to 90 +30 degree both actively, and passively (<20 short of fuld flexion). All those have deformities in in sagital plane of motion of knee joint (flexion & extension) is defined to have stiffness, quadriceps power if grade 4 or 5 and all those have at least. 120 degree knee ROM and grade 4 or 5 power is not defined to have stiffness.

Age doesn't seem to influence post-surgical ROM of knee joint also. Only 2 people obtained full range of ROM, however most of the patients 23 out of 30(76.7%) had obtained an ROM of at least 120 degrees. In study by Shyam S Khatri et al, mean range of motion was 122.33 degree. Mean range of motion was 121.2 degree in a study of treatment of complicated tibial plateau fractures with dual plating via a 2 incision technique by Yong Zhang et al mean range of motion was 115 degree in a study on functional outcomes of bicondylar tibial plateau fractures treated with dual buttress plates and risk factors, by Yunfeng Yao, et al [10]

Surgery using single midline incision not only puts the soft tissue on excessive stretch but also the problem of reaching the posteromedial fragment through a single incision causes wide periosteal

stripping and extensive muscle dissection and may hamper reduction as well. Treatment by open reduction and internal fixation either with a single or dual plates through a single mid line incision causes extensive soft tissue injury of the proximal tibia, causing de-vascularization of the fracture fragments, thereby decreasing fracture healing and leading to risks of wound complications, In our study we did dual plate by using double incision technique through an anterolateral and a posteromedial incision.

In order to improve outcome of high-energy tibial plateau fractures treatment, fixation using double buttress plates via a medial and a lateral incisions is been widely used. This technique leads to anatomic joint reduction and minimal soft tissue dissection and its associated complications and therefore adequate fixation of the fracture fragments, hence allowing early mobilization of knee joint [11]. Limbs treated with dual-plate fixation had less subsidence than limbs treated with a single lateral dissection and its associated complications and therefore adequate fixation of the fracture fragments, hence allowing early mobilization of knee joint [11] Limbs treated Med. This technique leads to anatomic joint reduction and minimal sali of the with dual-plate fixation had less subsidence than limbs treated with a single lateral locking plate and dual-plate fixation had better mechanical strength compared with other fixations .The LCP plate and screws form one stable system and the stability of the fracture depends on the stiffness of the construct. Locking the screw into the plate to ensure angular as well as axial stability, eliminate the possibility for the screw to toggle slide or be dislodged and thus strongly reduces the risk of postoperative loss of reduction. The fixed angle stability avoids subsidence of fixation in metaphyseal areas. This allows for less precise contouring of the plate, as fixation depends of plate screw construct rather than friction between plate bone interfaces. As a result accurate contouring of the plate is not mandatory where the MIPPO technique is indicated or possible. In our study we used MIPPO technique wherever possible and open reduction was done only when MIPPO was not possible to be employed.

Deep infections were defined as those that extended below the fascia; superficial infections remained above the fascia. Out of 30, 24 had no infection (80%). One had superficial infection, which was treated by IV antibiotics and daily wound care. 3 developed deeper infection, which required minimal debridement and wound care together with IV antibiotics and infection settled in duration around a month. 2 developed osteomyelitis and infection was persistent even after 6 months post-surgery and for one patient we had to remove the implant to get the infection under control. Ebrahim Ghayem Hassan Khani et al [7] in their study of treatment of complex proximal tibial fractures by double plate fixation with single anterior incision recorded skin infection in 2 out of 22 patients. In a study by Yong Zhang et al recorded superficial infection in 4 & 2 in buttress plate group and combination group respectively and deep infection in 2 & 1 patients respectively. Barei et al studied the complications in 83 patients treated with dual plating and found a deep infection tale of 8.4%, Study by Shyam S Khatri et.al in comparison had a significantly lower Nate of deep infection of 3.1% Steven N. Shah, M.D., and Madhav A. Karunakar din 2007 have reported on the wound complications in their series of 29 patients and found an overall infection rate of 17% with deep infection being 13%

Bony union was defined radiographically by the treating surgeon as >3 tortical unions during the follow-up period. Non-union was defined as no evidence of healing after 9 months fracture not united radiologically (tri cortical union) by 12 weeks ,it's defined as delayed union and if it's not united by 24 weeks, then it taken as non-union, as our follow up period was till 24 weeks only. Varus/ Valgus angulation 10 degree is considered as malunion. 5 cases of delayed union and 2 case of malunion surgery. Occurred in study. The malunion were secondary to varus collapse post-surgery.

These fractures may also be associated with cruciate and collateral ligament injuries and meniscal tears. However they cannot be identified clinically during the acute post injury period as examination is limited by pain. In our study the influence of injury to supporting structures of knee joint is also not considered, but could have been an influential factor in post-surgical outcome.4 patients had abnormal stability in 20 degree flexion of knee joint and one had instability in extension of <10 degree. Majority 25 out of 30 (83.3%) had a stable knee joint post surgically

Conclusion:

Proximal tibial locking plates are implants that combine the principles of angular stable construct and compression plating. The use of dual plates in the treatment of complex tibia plateau fractures allows obtaining near normal anatomy of articular surface, acceptable joint congruity and most importantly early mobilization following surgery. LCP prevents posteromedial fragment sagging and improves functional outcome. This is evidenced by the statistically significant correlation obtained between Rasmussen's anatomic and functional scores. So the treatment of proximal tibia fractures (type 5 & 6) by dual plating helps to obtaining better functional outcome.

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