e-ISSN: 0975-1556, p-ISSN:2820-2643

Available online on www.ijpcr.com

International Journal of Pharmaceutical and Clinical Research 2023; 15(7); 661-670

Original Research Article

Study of Functional and Radiological Outcome of Proximal Tibial Fractures Managed with Locking Compression Plating Technique

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Received: 20-03-2023 / Revised: 21-04-2023 / Accepted: 16-07-2023
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Conflict of interest: Nil

Abstract

Background: Proximal tibial injuries are considered to be serious as well as challenging to manage as are common intra-articular fractures, representing 1-2% of all fractures. These fractures are common in two age groups: as higher-energy fractures in younger patients and lower-energy fractures in elderly patients secondary to osteopenia. proximal tibia fractures are inherently associated with less soft tissue coverage with increased risk of post-operative complications like infections, wound dehiscence, non-union, malunion or implant failure. Our aim is to obtain anatomical articular congruity with accurate axial alignment using locking compression plate for optimum final outcome of proximal tibial.

Aim: To restore of anatomical articular congruity, stability, and management of soft tissue injuries to promote early mobilization of knee joint.

Objective: The present study was done to evaluate the effectiveness of Locking Compression Plate in the management of proximal tibia fractures using plating technique.

Methods: 40 cases of proximal tibial fractures were treated by using locking compression plate and studied from July 2021 to June 2022 in Department of Orthopaedics, at Gajraraja medical college and JAH, Gwalior, Madhya Pradesh.

Results: The clinical assessment was made according to Rasmussen's functional grading system. Final results showed excellent outcome in 25 cases and good outcome in 12 cases and fair outcome in two cases.All the selected 40 cases were followed up for 6 months. The average time for union of fracture was 16 weeks ranging from 12-22 weeks. An average flexion was achieved was $0\text{-}120^{0.}$ We observed 12 cases of postoperative complications that included 3 infections, 5 knee stiffness, 3 varus deformity and 1 venous thromboembolism.

Conclusions: Surgical management of proximal tibia fractures with plating gave excellent reduction, rigid fixation to restore articular congruity and provides early motion to achieve optimal knee function and reducing post-traumatic osteoarthritis.

Keywords: Fracture, Proximal tibia, Locking compression plate.

Introduction

Knee joint being the major weight bearing articulation of the body with a complex structure, any traumatic injury involving proximal tibia amounts to grave complications and whose management has been controversial. Proximal tibial injuries are considered to be serious as well as challenging to manage. Proximal tibial fractures are both intra articular and extra articular. Due to the rise in the number of road traffic accidents (RTA) approximately 1-2 % of total adult proximal tibial fractures are intra articular[1]. With the increase axial compression combined with valgus &varus force over proximal tibia, tibial plateau fractures occur commonly. tibial plateau is the most critical load bearing area in the human body. The mechanism of injury depends both on the age of the patient and the energy of trauma. Higher-energy fractures in younger patients and lower-energy fractures in elderly patients secondary to osteopenia especially in post-menopausal women. Due to increased usage of motor vehicles, high energy injuries are frequently common contributing to these fractures. High energy injuries are associated with significant lack of soft tissue coverage and

neurovascular damage with compound /open wounds. In such cases, the treatment of damaged soft tissues is of primary concern[2]. Apart from tibial plateau, meniscal tear and ligament injuries should also be assessed[3]. At any age, conservative treatment can be complicated by knee stiffness, malunion and non-union relying on factors like initial fracture displacement, shortening, comminution that have been predictive of mal-union and poor patient outcome. Studies have shown that operative treatment for proximal tibial fracturs results in lower rate of fracture non-union, symptomatic malunion than conservative management. Proper anatomical reduction and soft tissue management is necessary for obtaining stable, congruent mobile joint. With the advent of anatomical Locking Compression Plates (LCP)[4] fixed biologically has revolutionized the management of proximal tibia fractures which helps in obtaining and maintaining a stable articular reduction and adequate limb alignment with early range of motion (ROM)[6]. Also minimising soft tissue injuries and damage to vascular integrity of fracture fragments.

Aims and Objectives

- To restore the anatomy of articular surface of upper end of the tibia and knee joint by operative treatment with internal fixation.
- Early mobilization of knee joint.
- To assess the union of fractures after internal fixation.
- To assess the range of motion of knee joint after surgical treatment.

Materials and Methods

Source of Data

The present study was carried out on the patients admitted in orthopaedic ward of Gajra raja medical college and Jah, Gwalior (M.P.) during the period from July 2021 to June 2022. The fractures were assessed for soft tissue injuries and followed by radiological assessment of fracture with Schatzker's classification. All patients included in the study group were given an "inverted hockey stick incision". All patients were followed up regularly at 2, 4, 6 - 8 weeks till total follow-up period of 6 months. A clinical and radiological evaluation was carried out using the modified Rasmussen clinical and radiological criteria.

Study Design

A Prospective study

Study Location

This is a tertiary care teaching hospital based on study done in Department of Orthopaedics, at Gajra raja medical college and JAH, Gwalior (M.P.), India.

Study Period

July 2021 to June 2022

Sample Size

40 patients

Inclusion Criteria

1. Adult (aged over 18 yrs) both male and female
2. Closed / Open Gustilo-Anderson [7] Type I, II
3. Intraarticular and Extraarticular proximal tibial fractures of Schatzker8 Type I, II, III, IV,V.VI.

Exclusion criteria

1. Aged below 18 years.
2. Patients with pathological fractures.
3. Patients medically unfit for surgery.
4. Gustilo-Anderson type[7] III injuries.
5. Patients with distal neurovascular deficit.

Procedure Methodology

A total of 40 patients with proximal tibia fractures were enrolled in the study. The Functional and radiological outcome was assessed using Rasmussen's scoring system[9] and plain radiographs. Union was evaluated clinically and radiographically. Complications were recorded.

Table 1: Schatzker's classification[8]

Type I	Pure cleavage Lateral condyle
Type II	Cleavage combined with depression Lateral condyle
Type III	Pure central depression Lateral condyle
Type IV	Fractures of medial condyle
Type V	Bicondylar fractures
Type VI	Plateau fracture with dissociation of metaphysis and diaphysis

Table 2: Modified Rasmussen criteria for clinical assessment[9]

Clinical characteristics	Score
Pain	
None	6
Occasional	5
Stabbing pain in certain position	3
Constant pain after activity	1
Significant rest pain	-3
Walking capacity	
Normal walking capacity for age	6
Walking outdoor more than one hour	5
Waling outdoor 15 min - 1 hr	3
Walking outdoor <15 min	1
Walking indoor only	0
Wheel chair or bed ridden	-3
Knee extension	
Normal	4
Lack of extension <10º	2
Lack of extension >10º	0
Lack of extension >20º	-2
Total range of motion	
Full	6
At least 120º	5
At least 90 º	3
At least 60º	1
<60º	-3
Power of quadriceps	
Grade 5	2
Grade 3-4	1
Grade <3	-2
Maximum scores	30
Excellent	28-30
Good	24-27
Fair	20-23
Poor	<19

The following protocol was followed after patients were admitted and planned for surgery: At first, Demographic data with mechanism of injury was recorded through thorough history taking. Clinical examination was done upon which the following points were noted, attitude of the patient, presence of abnormal swellings, tenderness, crepitus, blisters present in the proximal third of tibia. The extent of soft tissue injury was assessed for any abrasion, laceration and contusion. Distal neurovascular status of the affected lower limb was examined and also the associated injuries along with fractured tibia were noted. As per our hospital guidelines, Routine investigations before operation done are:

Table 3: Routine Investigations

Haematological	Radiological
Complete blood count	Chest XRAY
ESR, CRP	XRAY of Affected Limb
LFT	3D CT Scan
RFT	MRI Knee
Serology-HIV, HBsAG, HCV	Other
BT, CT, PT, APTT, INR	ECG
ALP	

In addition to pre-operative radiographs, CT-Scan with 3D reconstruction of injured knee was carried out to assess the size, location and extension of articular fragment [10].

Temporary stabilisation of fracture with above knee splint was carried out and limb elevation was given[10].

Final diagnosis formed after clinical and radiological evaluation. Written informed consent obtained before surgical procedure. All patients were operated as early as possible once the patient was declared fit for the surgery by the physician and anaesthetist. Surgeries were delayed in cases where patients developed severe swelling and skin blisters.

Procedure

Of the total 40 patients studied, all underwent fracture fixation under spinal anaesthesia on standard radiolucent or fracture table. Torniquet applied but not inflated in every case. After proper painting and draping. Initial reduction was attempted by traction and manipulation using principle of ligamentotaxis and large towel clips/ clamps used to hold the fracture fragments in place. reduction confirmed under image intensifier. Kirschner-wires (K-wire) were used to temporarily fix the fracture fragments with the aim to restore the articular congruity. If fracture reduction was not achieved by closed method, then fracture reduction was tried with joystick method using K-wire or Steinmann pin[10]. Once the articular reduction was achieved, meta-diaphyseal component was aligned with the articular part and fracture fragments were held in position using K-wire, Steinmann pins or clamps (Fig. 1). Depending upon fracture pattern either lateral, medial, posterior plate alone or in combination were used.

For lateral plating anterolateral approach was used, approximately 3 to 5cm skin incision[11] proximal to the joint line in lazy 'S' shaped incision was made lateral to the lateral border of the patella tendon. The incision was curved anteriorly over Gerdy's tubercle and then extended distally, staying about 1cm lateral to the anterior border of the tibia. For posteromedial or medial plating, posteromedial approach was used, in which a 6 cm longitudinal skin incision[12]. submuscular space created for plate insertion using appropriate instrumentation. Plate length and placement is determined under image intensifier, proximally just below the joint line and distally distant enough to allow minimum 6 cortices fixation beyond fracture line. Proper plate placement is held with k wires and drill bit. At first compression screw was applied then fixed angle drill sleeve applied to the locking slot of plate to drill for applying locking screw.

Normal saline wash given, Wound was closed layer by layer[13].Aseptic dressing and compressive bandage applied.

Post-operative protocol

limb elevation was given to the operated limb. Intravenous antibiotics were given for three to five days, and oral antibiotic given till suture removal[10]. 4 hourly BP and TPR charting with vitals monitoring and post-operative analgesic given. Dressing checked for soakage. Postoperative X-ray preferably done on the next day. Suture was removed on the 12-13 days of post-operative day.

Static quadriceps exercise advised soon after surgery followed by passive range of motion with protected knee brace up to 6 weeks. After 6 weeks knee mobilization and partial weight bearing was started[10].

Follow-Up

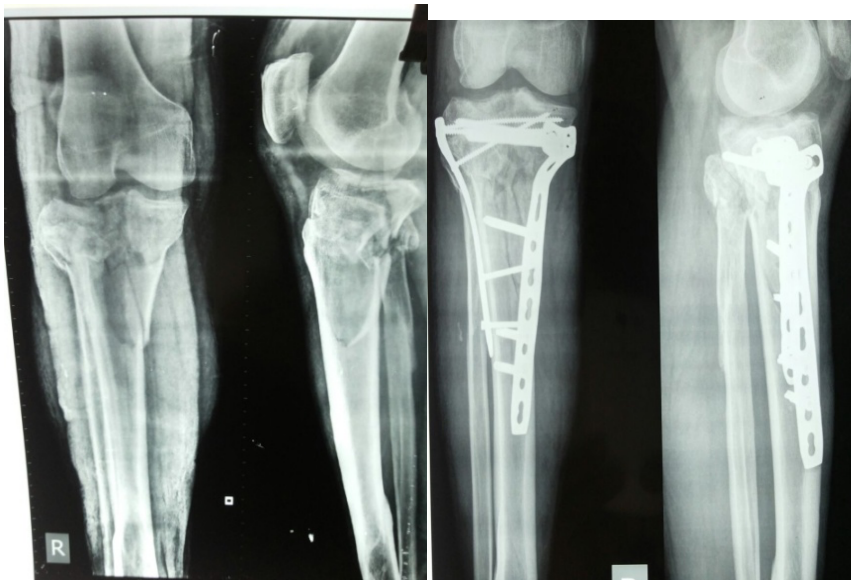
Patient were followed up as per protocol at 2, 4, 6-8 weeks and 6 months. Fracture union was assessed radiologically and clinically. All the complications were recorded like Malunions, delayed union, non-union, Knee stiffness, Nerve injury.

Clinical features [10]

- Surgical scar
- Range of movement
- Presence of pain
- Stability

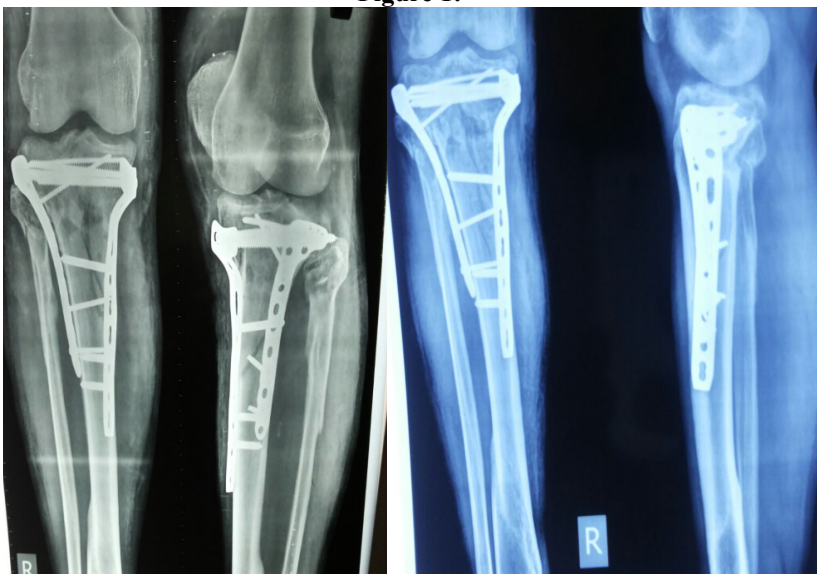
Radiological features [10]

- Callus formation
- Maintenance of reduction
- Widening and depression of articular surface.
- Varus and valgus collapse
- Sign of secondary osteoarthritis
- Assessment of functional outcome was done using the modified Rasmussen clinical and radiological grading system.



Pre-op x ray immediate post op x ray

Figure 1:



6 weeks followupx ray 12 weeks followup x ray

Figure 2:

Follow up pic showing full flexion follow up pic showing full extension

Figure 3:

Results

Upon analysis of data, following observations were made.

In our study, 31 (77.5%) were male patients and 9 (22.5%) were female patients with mean age 39.03 years (Table 4).

Table 4: Sex Distribution

Gender	No. of Patients	Percentage (%)
Male	31	77.5
Female	9	22.5
Total	40	100

Most of the patients belonged to the age group of 18 - 50 years (72.5%), which was the highly active and mobile age, thereby being prone to road traffic accidents.

Table 5: Age Distribution

Age Distribution		
Age Groups (Years)	**No. of Patients**	**Percentage (%)**
18-20	2	5
20-30	8	20
31-40	14	35
41-50	5	12.5
51-60	6	15
>60	5	12.5

In our study, 32 patients (80%) were injured due to road traffic accident (RTA), 4 patients (17.5%) due to falling from height and 1 patient (2.5%) due to direct high velocity injury on the leg. Thus, the major mode of injury in this study is road traffic accident.

Table 5: Mode of Injury

Mode of Injury		
	No. Of Patients	**Percentage (%)**
RTA	32	80
Fall From Height	07	17.5
Assault	01	2.5

Study shows that, unilateral fractures were more common than bilateral. 23 (57.5%) patients sustained injury on right side and 17 (42.5%) on left side, so there was slight predominance of right side as compared to the left side.

Table 6: Side of Fracture

Fracture Side			
Side	**Right**	**Left**	**Bilateral**
No. of Cases	*23*	*17*	*0*

Most of the patients were found to be type II – 13 patients (32.5%) and type V – 12 patients (30%) Schatzker's classification (62.5%). Thus type-II and type V-were more common.

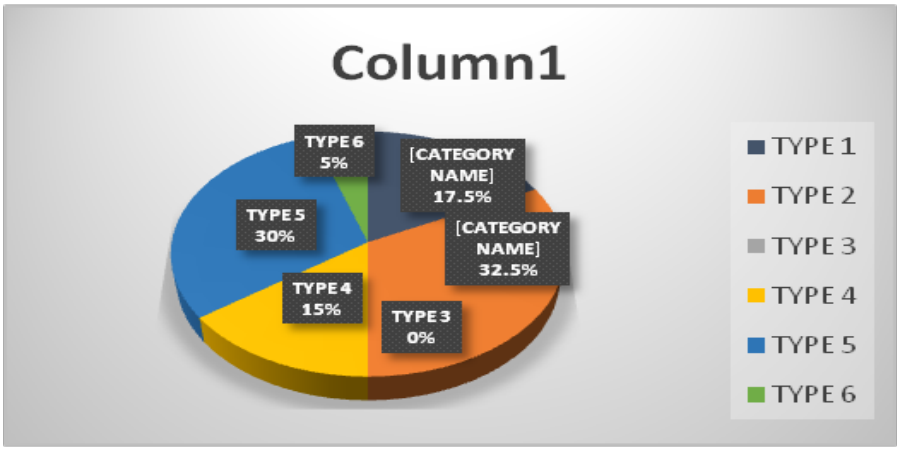


Figure 4: Schatzker Type Distribution

Table 7: Type of fracture and percentage of cases: schatzker's[8] classification

Schatzker Fracture Type	Number	Percentage
I	7	17.5%
II	13	32.5%
III	0	0.0%
IV	6	15%
V	12	30.00%
VI	2	5%
Grand Total	40	100.00%

In our study, the mean duration for complete radiological union was seen at 16.075 weeks. The earliest union was seen at 12 weeks and few patients shown radiological union between 21 to 24 weeks. In this study all the fractures united and no non-union was noted.

Table 8: Time of Radiological Fracture Union

Weeks of Follow Up	No. of Patients
12 WKS or less	2
13-16 WKS	21
17-20 WKS	16
21-24 WKS	1

Most patients had good range of motion of 120* following surgery treated by physiotherapy and range of motion exercises. Out of 40 patients, the complications observed in 12 patients, two patients (5%) had superficial infection, were treated by dressing and antibiotics.

One patient (2.5%) had deep wound infection, managed by further debridement and antibiotics as per pus culture and sensitivity report followed by regular dressings. five patients (12.5%) developed joint stiffness, persistent pain and reduced range of motion owing to excessive articular surface comminution.

None of the patients demonstrated any implant failure or non-union. three cases (7.5%) united in malposition that is mostly in varus deformity due early excessive load bearing but that deformity did not alter the patient's activity of daily living. A single case of venous-thromboembolism (2.5%) was noted, managed by putting patient on thrombolytics and anti -platelet agents after getting general surgeon opinion for the same.

Table 9: Postoperative Complications

Post Operative Complication	No. of Patients	Percentage (%)
Infection	3	7.5
Joint Stiffness	5	12.5
Implant Failure	0	0
Non-Union	0	0
Varus Deformity	3	7.5
Venous –Thromboembolism	1	2.5

Of all 40 fractures treated, 25 fractures gave excellent result, 12 fractures healed with good results. Only 2 of the patients showed fair results and 1 had poor result. Clinical and radiological outcomes based on modified Rasmussen criteria.

Table 10:

Clinical Results	Number of Fractures	Percentage
Excellent	25	62.5 %
Good	12	30 %
Fair	2	5 %
Poor	1	2.5 %
Total	40	100

Finally (62.50%) of patients got excellent result at end of study which is 6 months.

Discussion

In this prospective clinical study, we presented the result analysis of surgical treatment of 40 closed proximal tibial fractures with locking compression plate4. Results obtained were evaluated in terms of gender, age, occupation, mode of injury, laterality, duration of hospitalization, types of fracture (Schatzker's classification), period of immobilization, complications and clinical results. These patients were followed up on 2 weeks, 4 weeks, 6-8 weeks and 6 months of postoperative period. The average time of union and functional outcome were assessed with Rassmussen's[9] scoring system.

Age Distribution: The average mean age in the present study was 41.40 years with maximum incidence ranging between 19 to 50 years (72.5%). This was in accordance with a study by P. A. Cole[14] et al in 2004 with an average age of 45 years, Prateek Girotra et.al[15] in their study found the average mean age to be 40.40 years ranging from 23 to 68 years.

Sex Distribution: in this study, the male predominance in tibial plateau fractures was seen as 77.5% patients were male and 22.5% were females. In a study by Tang Xin et al (2012)16, of the 42 cases in the study most patients were males (30 cases) and females (12 cases) of the total number, this gender distribution is similar to our study. males sustained this high energy fractures more owing to their more active and outgoing Indian life style. low energy fractures were commonly seen among osteoporotic female patients.

Occupation, Mode of Injury & Side of Extremity: Occupationally, people with high level of activity, travel and outdoor working habits have more proximal tibial fractures. In our study the commonest mode of injury was road traffic accident (80%), followed by fall from height (17.5%) and single case due to assault (2.5%). There was a significant preponderance of right side laterality. The right tibia was affected in 57.5% and left tibia in 42.5% of cases.

Type of Fracture: During the study, we have used Schatzker classification for the proximal tibial plateau fractures type I to VI with the incidence of type-I 7 (17.5%), type-II 13(32.5.53%)-most common, type –III 0 (0.0%)-rare, type –IV 6(15.0%), type – V 12 (30.0%) and type –VI 2(5.0%). In Girish H V and co-workers' study17, Schatzker type I and II dominated the total fractures making 50%, with type V and VI having 18.8% and 12.5% involvement, respectively. Similarly, Rademakerset al[18] reported that 64% of patients sustained a lateral condyle fracture (Schatzker type I and II). In MRI analysis of 103 patients, Gardner et al[19] reported that the most frequent fracture pattern was a lateral plateau split-depression (Schatzker type II) which concordant to our study.

Time of Union & Rom: The radiological and clinical union in this study was noted within a period of 12-22 weeks with a average period of 16.07 weeks. An average of 120º knee joint range of motion was achieved. Soft tissue damage, intraarticular fracture, fracture pattern - displacement and physiotherapy determined knee range of motion. In a study by Prasad et al20 all patients had union in 8-22 weeks (average 14 weeks). most of his patients had 120* and above knee flexion with excellent surgical outcome like our study Mahesh Kumar Dindivanam21 found that the time for union was 17 weeks in their study of 30 patients of Tibial plateau fractures.

Complications: In our study post-operative complications were seen in 12 patients. 2 patient developed post operative superficial surgical site infection, treated by oral antibiotics as per C & S and regular dressings. Postoperatively One patient developed deep wound infection for which debridement followed by I/V antibiotics and dressings done. Later patients improved. 5 patients developed post operative mild to moderate knee stiffness at the end of study period, further knee physiotherapy was advised. 3 patient had varus deformity ranging between 7 to 10 degrees with walking disability. only 1 patient developed venous thromboembolism due to prolonged immobilisation

for subsiding swelling during pre-operative period. In our study no implant failure, non-union, post-operative compartment syndrome or peroneal nerve injury occurred unlike in other studies like Cole et.al,[14]Phisitkul et.al.[22]. Vasanad et al[17] also showed knee stiffness in three patients, mal-union in two patients, infection and wound dehiscence in three patients, extensor lag in one patient and loss of reduction in one patient.

Functional Outcomes: We evaluated the functional outcome of proximal tibia fractures fixed with Locking Compression Plate4 using Rassmussen's scoring system.[9] By the end of 6 months. We achieved 62.5% excellent result, 30 % good and 5% fair results with our standard surgical care using periarticular proximal tibia plating and allowing early mobilisation of the knee. Only in 1 (2.5%) of the patients, the result was poor. Vasanadet al[17] had 44% excellent result and 44% good results (overall 88% acceptable results).

Mayank Patel et.al23 obtained functional results which were excellent in 71.42%, Good in 21.42% and Fair in 7.14% in his study. In a prospective study by Prateek Girotraet.al[15] ,53.3% of the patients had excellent functional results, 36.7% of patients had good results and 10% had fair results with a significant relationship between the type of fracture and the functional results.

Conclusion

Incidents of Proximal tibial fractures are inclining with increase in the number of motor vehicle accidents. These fractures are often associated with poor soft tissue coverage due to high velocity impact and since these fractures involves the productive age groups, they need optimum clinical and radiological assessment and treatment. A Surgical approach is best to manage intra articular and periarticular fractures but it is quite an orthopaedic challenge to restore the anatomical reduction with accurate axial and articular alignment.

Preoperative soft tissue status and their repair at the right time with rigid fixation significantly affects the result outcome. thus, locking compression plate4 offers better biomechanical stability, early rehabilitation and less rate of complications that helps to achieve a stable and functional knee joint. Minimal invasive surgery leads to less soft tissue dissection without draining fracture haematoma thereby reduction in the period of immobilization with less chances of infection and stiffness lead to excellent functional outcome of the knee joint. In our study, we found that proximal tibial locking plate provides complete union and early mobilisation to attain better functional outcome.

Funding: No funding sources

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