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A prospective study of surgical management of bicondylar schatzker type V & VI tibial plateau fracture by dual plating and dual incision

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Abstract
Aim: To assess the clinical and functional outcome of surgically treated Bicondylar Tibial schatzker type V and VI plateau fractures with dual plating at SSIMS-RC, Davanagere during August 2015 TO August 2018.
Objectives
1. To assess the anatomical reduction of articular surface of upper end of tibia perfectly by operative treatment with internal fixation.
2. To assess the radiological union of fractures after internal fixation with dual plating
3. To assess the clinical outcome associated with this treatment modality
a. Knee Range of movements
b. Pain relief
c. Return to normal activities and work
Materials and Methods: Total number of cases studied were 30.
Inclusion criteria: All skeletal mature patients with proximal tibia fracture Schatzker type V and VI (>18years), AO Muller type 41-C_1, 41-C_2, 41-C_3, Gustilo-Anderson type I and II compound proximal tibial fractures.
Exclusion Criteria: Patients with Gustilo- Anderson Type 3 compound tibial plateau fractures, Children with proximal tibial fractures in whom the growth plate is intact, patients with pathological proximal tibial fractures apart from osteoporosis**.**
Observation and Results: Our study used Honkonen Jarvinen Criteria for radiological, functional, clinical outcome which showed excellent to good result.
Our study reported Honkonen Jarvinen Clinical outcome to be 86% excellent, 11.7% good and 1.7% fair. The functional outcome was 81% excellent, 13% good, 5% fair and 1% poor. The Radiological outcome showed 79.2% excellent, 12% good, 0.70% fair results.
Conclusion: From this study we conclude that, surgical management of bicondylar tibial plateau fractures with dual plating gives excellent anatomic reduction, accurate axial and articular alignment with rigid internal fixation by dual locking plate, achieving a stable and functional knee joint.

Keywords: Schatzker type V and VI, Dual Plating, honkonen jarvinen criteria

Introduction
Tibial condyles with their articular surface forms major part of the knee joint, plays an important role in weight transmission and mobility [1]. The proximal tibia fractures account for 1% of all the fractures [1], with increase in high velocity traffic accidents the incidence of proximal tibia fractures are also increasing [1].
The goal of treating these bicondylar tibial plateau fractures is to bring back the functional mobility to pre injury status. Hence near anatomical reduction of articular surface, maintenance of mechanical axis and anatomical alignment has to be achieved with stable fixation and early mobilization [2, 3].
If these high velocity intra/peri articular fractures are not treated properly there will be high degree incidences of malunion, non-union, peri-op infections, varus collapse of the medial condyle, ligamentous instability, malalignment of the axis, articular incongruity leading to post traumatic arthritis.

The advantages in treatment of bicondylar fractures of proximal tibia fractures with dual plating over other types of fixation involve,

- Coronal split of the medial condyle can be separately fixed with posteriomedial plate
- Better reconstruction of articular surfaces
- Better distribution of forces along the axis of the bone
- Better load sharing capability with dual plates compared to single lateral plate alone
- They help at resisting displacement
- Fixation help to prevent the medial condyle collapse
- Early mobilization of the knee joint.

The main objective of the study was to assess the anatomical reduction of articular surface of upper end of tibia and knee joint perfectly by operative treatment with internal fixation. To assess the radiological union of fractures after internal fixation with dual plating to assess the clinical outcome associated with this treatment modality A. Knee Range of movements B. Pain relief C. Return to normal activities and work.

Materials and Methods

This study was prospective cohort study conducted at SSIMS and RC, Davangere from 2015 to 2018 with follow up of one year, total no cases are 30. All the cases were diagnosed with Schatzker type V and VI by standard AP and lateral view x rays were taken in to study, CT was taken to know the exact status of the fragments, MRI was done in few cases to know the status of the ligaments.

Inclusion criteria

1. All skeletal mature patients with proximal tibia fracture schatzker type V and VI (>18years)
2. AO Muller type 41-C_1, 41-C_2, 41-C_3
3. Gustilo-Anderson type I and II compound proximal tibial fractures

Patients willing to participate in study

Exclusion criteria

a) Tibialunicondylar plateau fractures {type I, II, III, IV type of Schatzker classification
b) Patients with Gustilo - Anderson Type 3 compound proximal tibial fractures.
c) Skeletally immature patients.
d) Patients with pathological proximal tibial fractures apart from osteoporosis
e) Delayed presentation of fractures more than 2 weeks

On admission, demographic data was recorded and a thorough history was taken to assess mode of injury and associated co-morbidities. General systematic and local examination were done

Preop planning consists of:

- Patients were received in the casualty and initially stabilised. Then intramuscular analgesics were given. The injured lower limb was immobilised in an Above Knee Splint and Anteroposterior, Lateral, Oblique X-rays (if required) were taken.
- Then with minimal traction an Above Knee Slab was applied. Distally the slab was slit open for checking distal pulses. Three Dimension Computed Tomography was done to assess the fracture pattern
- If Required Calcaneal pin traction was applied for soft tissue injury to heal. Adequate time was given for soft tissue to heal around (5–14days). Clinical signs of soft tissue recovery included decreased swelling, absence of fracture blisters, wrinkling of skin around proximal tibia.
- Complete blood count, ECG, blood urea and serum creatinine, FBS, HBA1C, HIV and HBSAG profiles, blood grouping was done ECG, 2D-ECHO Where necessary, were taken
- Selection of appropriate sizes of LCP plates, posterior medial and medial plates and screws, with their corresponding instruments
- Appropriate antibiotics and pre-anaesthetic medications were given.

Surgical procedure

Preoperatively IV antibiotics Inj cefeperazone 1g + sulbactum 500 mg were given after test dose as prophylaxis.

The patient in supine position with folded pillow under knee and a sand bag under ipsilateral gluteal region for anterolateral approach and a sand bag under contralateral hip with figure of four position of ipsilateral leg for posteromedial approach. First indirect fracture reduction was achieved with longitudinal traction, under C-arm guidance. Percutaneous K wires were used to hold the fragments in reduction. We typically fix medial tibial condyle first. If medial condyle is comminuted we fix lateral condyle to achieve length.

Through posteromedial approach to proximal tibia with approximately 6cm incision over posteromedial border of proximal tibia. After opening subcutaneous fat, the long saphenous vein and saphenous nerve identified and preserved. Pes anserinus expansions identified. Tibia approached after incising pes anserinus longitudinally in the line of skin incision. The gastronemics muscle was gently freed from posteromedial surface by blunt dissection.

The fracture fragments visualized, reduced under c arm guidance. If there was articular depression a bone punch was used to elevate the depressed portion and the void was filled with bone graft. The reduced fragments were fixed with 3.5 mm proximal tibia posterior medial locking plate.

The lateral condyle fracture was approached antero laterally. “S” shaped incision was made starting 5 cm proximal to joint line curving the incision anteriorly over gerdy’s tubercle and extend it distally 1cm lateral to anterior border of tibia. Joint capsule was incised. Tibialis anterior was elevated by blunt dissection.

Under C arm guidance, fracture reduced and fixed with Proximal Tibia Lateral Locking Compression Plate. If depression was present in articular surface, elevation followed by bone grafting was done if necessary. A drain was kept for both wounds with help of Y connector.

Fig 1: Posterio-medial incision

Fig 2: fixation of the posterior medial plate under C-ARM Guidance

Fig 3: Fixation of the posterior medial plate

Fig 4: Fixation of the lateral plate

Fig 5: Bicondylar plate fixation under C-ARM guidance

Post-Operative Protocol

Well-padded sterile dressing was done. Knee was not immobilized. Drain was removed on 48 hrs. Post-operative period. Active knee mobilization was encouraged as_much as the patient could tolerate. Suture removal was done on 12th Post-operative day with advice to follow up for next 6months. Patient was discharged with Non weight bearing crutch walking.

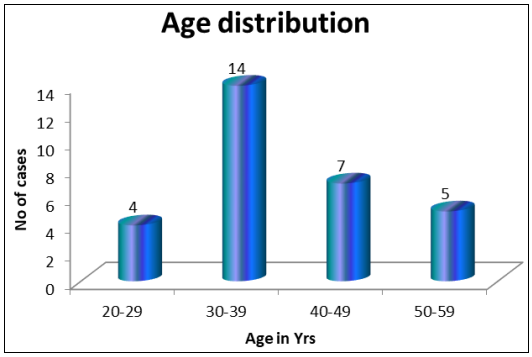
Follow Up

Patient was reviewed in Out Patient Department every 4 weeks and X rays were taken every month for first 6 months to assess union Partial weight bearing was started after 8 weeks. Full weight bearing was allowed after radiological evidence of bony union was achieved. At every follow up, operative site was examined for wound dehiscence and radiological evaluation was done to assess fracture union and any loss of reduction and implant related failure After 6 months patients were reviewed every 2 months.

Knee function was assessed and scored according to honkonen jarvinen criteria: (1992) clinical outcome criteria.

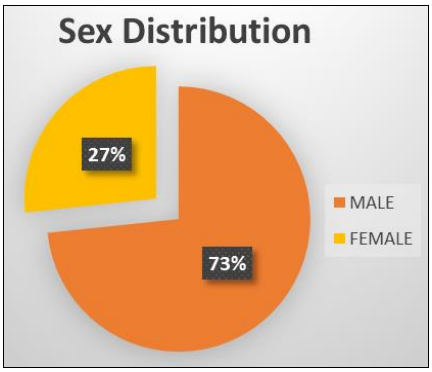
Results

This study included 30 patients with tibial plateau fractures diagnosed with Schatzker Type V and VI. Most of the patients in our study are males in the age group of 30-40 years.



Graph 1: Age distribution graph

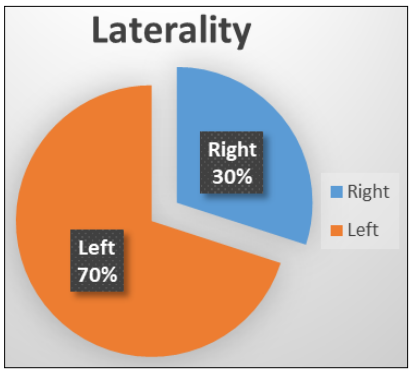
Sex distribution



Graph 2: Sex distribution graph

Mode of injury

RTA V/S Fall laterality

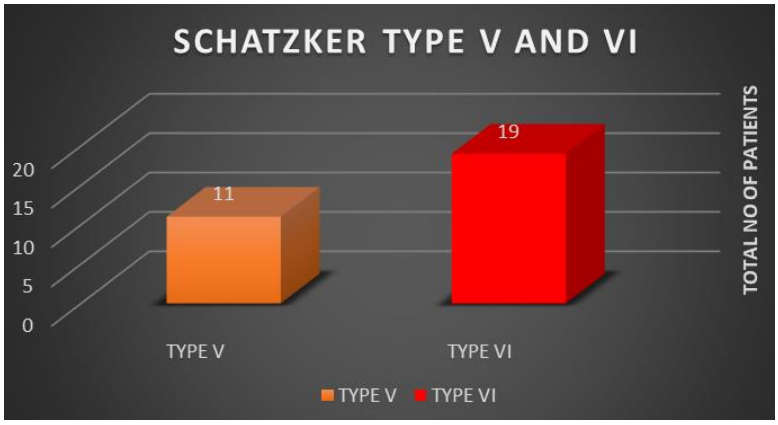


Graph 3: Laterality graph

Table 1: Distribution according to age

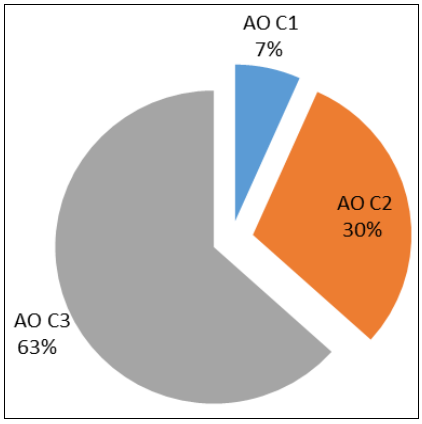
Mode of injury	RTA	Fall from height
20-29	6	0
30-39	14	0
40-49	7	0
50-59	2	1
Total	29	1

Incidence according to Schatzker type



Graph 4: Distribution of fracture according to schatzker classification

Incidence according to AO classification

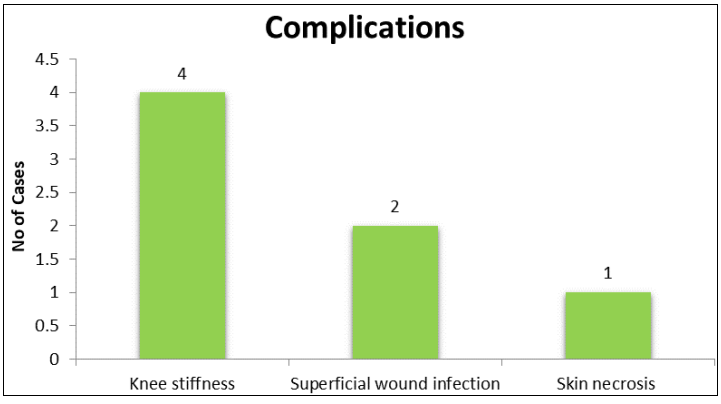


Graph 5: Classification of fracture according to AO classification

Time of surgery

The average period from day of injury to surgery was 5.3 days with a range between 3 to 9 days.

- Most common complication is knee stiffness among 4 patients which was overcome with strict physiotherapy regimen,
- Two patients had superficial wound infection which was given treated with wound debridement and antibiotic prophylaxis according to culture sensitivity
- One patient had skin necrosis, split skin grafting was done. Which improved with regular saline dressing.

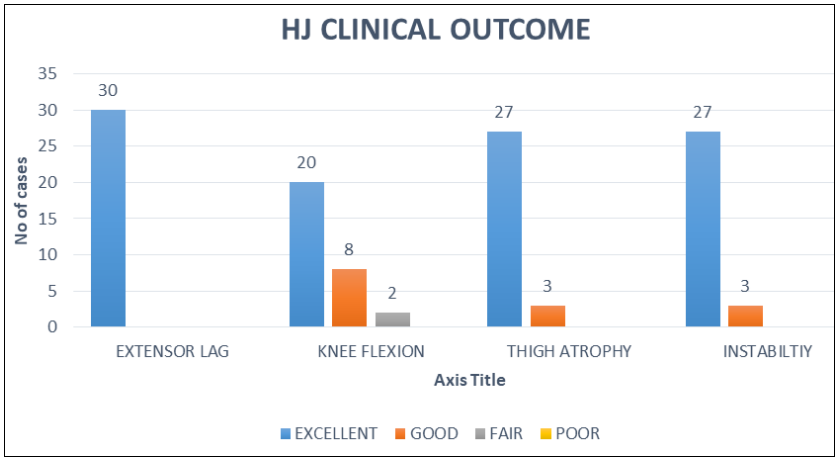


Graph 6: Complications

HJ clinical outcome

- None of the patients had extension lag.
- The average knee flexion was 125.9° with range from 95° to 135°. The reason for fair range of motion in two patients was poor adherence to physiotherapy.
- The average thigh atrophy was 0.09 cm with range from 0 – 1 cm.

There was grade1 antero posterior instability in 4patients

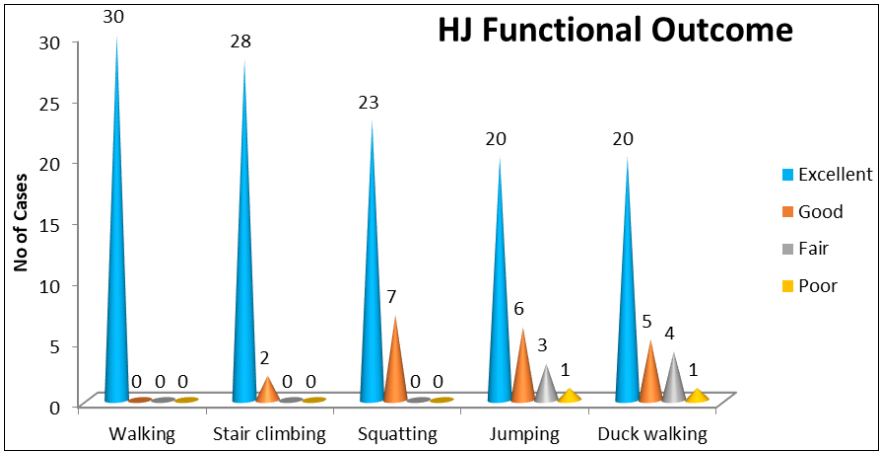


Graph 7: Clinical outcome according to HJ criteria

HJ Functional outcome

All 30 patients were able to walk excellent.

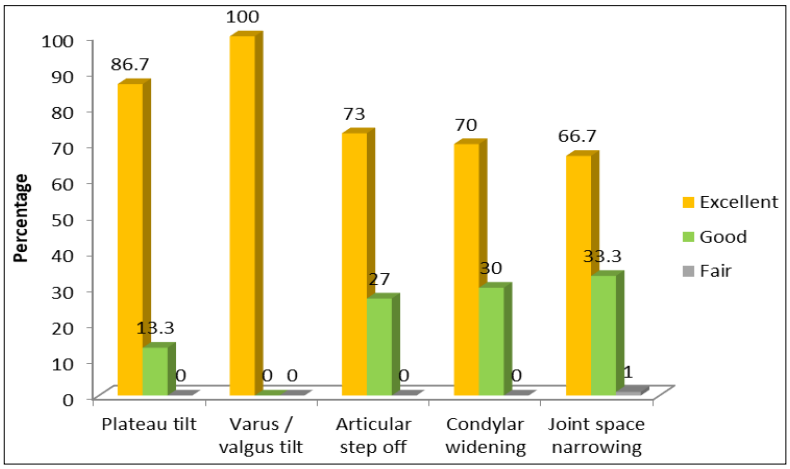
- 28 patients had excellent stair climbing function but it was impaired in 2 patients due to pain.
- 23 patient were able to squat well while it was impaired in 7 patients due to pain.
- 20 patients were able to jump normally and it was impaired due to pain in 6 patients. 3 patients were able to jump only with the aid of UN injured leg. 1 patient was not able to jump.
- 20 patients were able to duck walk normally and 5 patients were able to keep only a few steps. 4 patients were able to keep only one step 1patient was unable to do.



Graph 8: Functional outcome according to HJ criteria

HJ Radiological outcome

- 26 patients scored excellent and 4 patients had scored well with < 5° plateau tilt compared to opposite side.
- All 30 patients had excellent results with no varus/valgus tilt.
- 22 patients did not have any articular step off. 8 patients had 1-3 mm articular step.
- 21 patients had no condylar widening. 9 patients had condylar widening of 1-5mm.
- 20 patients did not have any joint space narrowing, 10 patients had <50% joint space narrowing, 1 patient had >50% joint space narrowing.



Graph 9: Radiological outcome according to HJ criteria

Clinical and radiological photographs

Pre Op X Rays

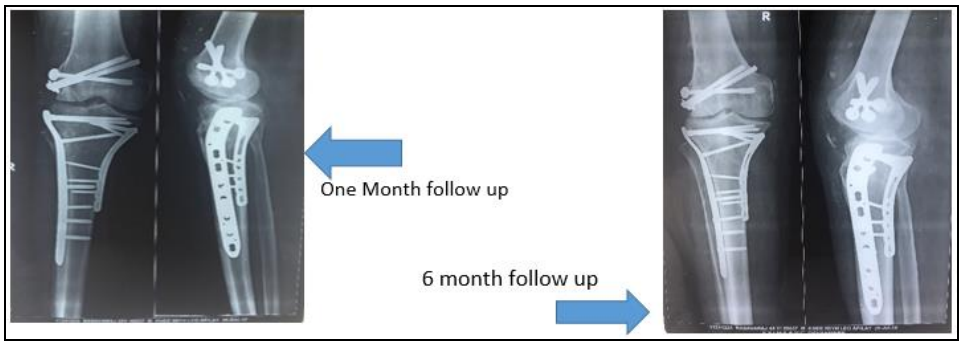
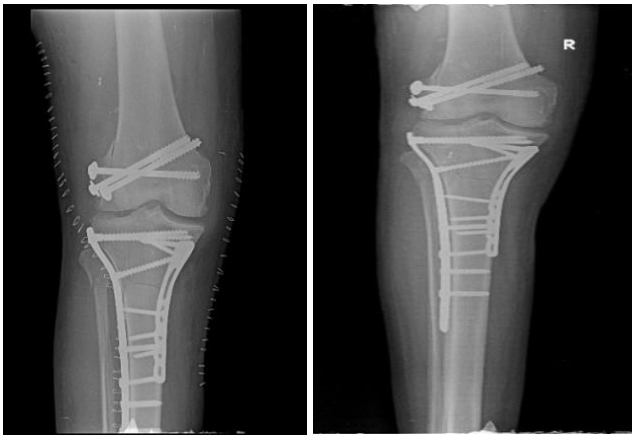


Fig 6: Follow UP X rays 1month and 6 month follow up



One year follow up

Fig 7: Movements following the follow up

Skin Necrosis

Discussion

High energy intra-articular fractures involving the tibial plateau still remain a challenge to orthopaedic surgeons. Road traffic accident is the most common cause of these fractures. In order to reconstruct the stable and painless mobile knee, still needs an expertise and sufficient technical knowledge. These fractures still are challenge for reduction in order to maintain the articular congruity, prevent varus collapse, and prevent the early onset of the secondary osteoarthritis in these complex tibial plateau fractures. Operative treatment remains the optimum treatment for early mobilization, various methods of fixation have been described like external fixation, hybrid fixator, plating through a single midline incision, plating using Mercedes Benz incision.

Historically using a poor technique to fix these high-velocity fractures using dual plates fixation using the single incision like Mercedes Benz incision is associated with the many complications this has led to Ilizarov, hybrid external fixator system being employed to treat these fractures.

The use of the laterally applied LCP which acts as a fixed angle device were associated with the complication like varus collapse of the medial fragment, as they were stabilised by screws. This raised the question of sustainability of the fixation by isolated lateral plating which further paved way for the dual plating via two incision technique.

A two incision double-plating technique is been recommended by the Association for Osteosynthesis/ Association for the Study of Internal Fixation for the treatment of bicondylar tibial plateau fractures [19].

In our study males predominate the female with the ration of 3.75:1, which shows the more active life style involving the high velocity injury. Which are in accordance with the series of 14 patients reported by Eggli *et al*. in which 10 were male and 4 were female [24].

Among 30 patients most common mode of injury being the road traffic accident, left side being more commonly involved than right side, we had 19 schatzker type VI and 11 schatzker type, When AO classification was considered most common type was AO 41C3 followed by AO41C2, and AO41C1.

Our study used Honkonen Jarvinen Criteria [25] criteria for radiological, functional, clinical outcome which showed excellent to good result.

Our study reported Honkonen Jarvinen Clinical outcome to be 86% excellent, 11.7% good and 1.7% fair. The functional outcome was 81% excellent, 13% good, 5% fair and 1% poor. The Radiological outcome showed 79.28% excellent, 20.72% good, 0.70% fair results.

Most common complication encountered in the study was the knee stiffness (13.3%) in 4 patients associated with poor compliance with protocols and follow up, further superficial wound infection noticed in two patients (10%) who were taken up for wound debridement. Skin necrosis was another complication noticed in 1(3%) our study which was dealt with regular saline dressing, skin grafting was done.

One implant has been removed at the end of study with complete union, we noticed knee stiffness has predominately

affects outcome than the wound infection or the skin necrosis, There was no cases of non-union and all fractures had either united or were uniting by the end of 1 year follow-up. There were also no cases of implant related failures like screw back out or implant breakage.

The management of tibial plateau fractures has improved dramatically for the past 50 years. In the early 1950's these fractures were treated non operatively and many surgeons published favourable results by this management [1].

Apley in his study found that longitudinal traction would control the deformity and knee can be mobilized early [1].

Lasinger *et al*. had an extensive 20 year follow up of patients with non-operative management. He concluded that coronal instability of less than 10 degree had favorable outcome [1].

Duwelius and Conoly showed that early mobilization of patients managed by closed reduction with or without percutaneous pins had 89% good clinical outcome [1].

Hence from these studies it is evident that proximal tibia can tolerate modest deformities. However Sarmiento *et al*. in his study showed that bicondylar tibial plateau fractures with intact fibula when managed conservatively resulted in varus malalignment on weight bearing [1].

This led to origin of Operative management in tibial plateau fractures in early 1980's. Every Surgeon had his own criteria to operatively treat these fractures. Hence the need for classifying these fractures evolved [1].

Thus Schatzker's era (1970's) evolved with his major contribution to classifying tibial plateau fractures which remains central among other classifications.

Surgical treatment has now revolutionized in management of tibial plateau fractures. The goal of treatment as proposed by Lambotte being;

1. Restoring articular congruity
2. Axial alignment
3. Joint stability
4. Early Knee motion16.

Operative treatment includes

1. Isolated lateral locking plate
2. Dual plating with lateral locking plate and posteromedial buttress plate
3. Hybrid external fixator
4. Ilizarov
5. LISS

Each technique has its own merits and demerits

The use of Isolated Lateral Locking plate and Dual Plates is still a debate. Patients treated with isolated lateral locking plate had high risk of loss of reduction and increased incidence of malunion [17].

Lasanianos *et al*. showed that collapse of medial tibial plateau occurred in isolated lateral locking plate when he compared the biomechanical properties of intramedullary nail, dual plates and isolated lateral locking plates [18].

While Ilizarov fixation and Hybrid external fixation seems reasonable methods of fixation of these fractures, there are a few problems including the insufficient fracture reduction [19], inconvenience of an external fixator that requires careful maintenance, possibility of pin tract infections, joint capsule penetration with resultant septic arthritis [17], subsequent collapse of fracture fragments [8], and prolonged hospitalization [20]. However they are useful in the treatment of open Schatzker type 5 and 6 tibial plateau fractures [18].

Though LISS (Less Invasive Stabilization System) permits in direct fracture reduction, fixed angle construct, percutaneous sub muscular implant, the cost is high and only case series has been published.

Gosling *et al*. reported significant malreduction in 16 of 69 bicondylar fractures treated with LISS [19].

Dual Plating is preferred over other techniques as it has several advantages:

- Better visualisation of fracture fragments, especially posteromedial fragment and articular surface [19].
- Dual incision reduces wound complications [19].
- Both lateral and medial column is fixed to obtain stability [16].
- Achieves interfragmentary compression [17].
- Rigid construct [17].

Tul B Pun *et al*. in his study reported the outcome of 17 tibial plateau fractures. 9 of which were managed by dual plating and 8 managed by hybrid ex fix. Based on Honkonen Jarvinen Criteria all patients could walk, climb stairs, jump, 90% could squat, 50% could duck walk. 85% had plateau tilt <5°, 92% had articular step off < 2 mm. No major infection [18].

Ebrahim Ghayem Hassankhani *et al*. in his study reported 22 patients with tibial plateau fractures treated with dual plating. The outcome was assessed based on knee society score. 86. 4% had excellent, 9. 1% had good, 4. 5% had fair and no one showed poor results [20].

G. Thiruvengita Prasad *et al* in his study reported 40 patients fixed with double plating and based on oxford knee society score 30 patients had excellent and 10 patients had good outcome respectively [3].

Yong Zang *et al*. in his study reported 41 patients fixed with double buttress plate and 38 patients fixed with lateral locking plate and buttress plate. The mean Hospital for Special Surgery Score was 77. 9 ± 9. 4 and 79 ± 7.9 Respectively [19].

Chang Wug Oh *et al*. in his study reported 23 unstable proximal tibia fractures treated with double plating [21]. patients had excellent and radiographic results, 1 patient had shortening (1 cm), 2 cases had mild varus malalignment (<10°), 1 case had superficial infection which improved with implant removal, no deep infection occurred [21].

David P. Barei *et al*. in the year 2006 in there study of 83 patients showed, the patients with very high velocity injury to proximal tibia can still have satisfactory articular reduction with dual plating [2].

Neogi *et al*. in there study have shown that the dual plating for bicondylartibial fracture has better outcome than a single lateral locking plate as dual plating gives better anatomical reduction of the proximal tibia [22].

Niel Rohra *et al*. in 2013 showed excellent to good functional outcome with minimal soft tissue complications with dual plating of tibial bicondylar fractures. They also show that fixation done by dual plating helps in early mobilisation of the knee joint in there fractures [23].

Table 2: Comparative study according to different studies

David p, Barei *et al*.	75% satisfactory
G T Prasad *et al*.	80% satisfactory
Nil Arora *et al*.	85% satisfactory
Our study	82.32% excellent to good results

Conclusion

From our study we conclude that,

- High velocity tibial plateau fracture have excellent to good clinical, functional and radiological outcome.
- Early mobilisation of the joint provides good range of motion.
- Posteromedial plating provides a buttress to posteromedial fragment and thereby prevents varus collapse.
- The patients with good soft tissue cover should undergo anatomical reduction and rigid fixation immediately without deferring time.
- This is a short term study and need long term follow up to predict the further outcome.

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