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To assess the functional outcome of tibial condyle fractures following open reduction and internal fixation with plate and screws -A prospective study

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Abstract

Purpose: To evaluate the functional outcome of tibial plateau fractures treated by open reduction and internal fixation with buttress plating and cancellous screws.

Methods: A prospective study of 25 patients with tibial condyle fractures treated by open reduction and internal fixation at the Government Medical College Trichur during year 2008-2010 was considered for the study.

Results: Functional grading was done based on Modified knee scoring system of Hohl & Luck (1956) – (modified by Dennis Bo Jensen, Claus Raud *et al*)

No patient had lack of extension i.e., all of them were able to extend. But range of movement was limited in few patients. 68% had more than 120°. 16% had < 120° and > 90° movement and 12% having range of motion between 75 and 90 degrees. Similarly instability was not observed widely. Only 4% had > 5° of instability. 4% was unable to walk more than 100 m and all others were able to walk without much pain. Considering all parameters, the total pain score was assessed and 88% had no pain and 8% had mild pain and 4% had moderate pain. All the patients were assessed functionally and assigned grade for their performance. 68% performed excellently and 16% showed good performance and performance is fair only in 12% and 4% performed poor. All the patients were assessed radiologically and assigned grade for their performance. 92% performed excellently and 4% showed good performance and only 4% performed fair.

Conclusion: The overall analysis of this study showed that the functional results were much better with types I, II, III and IV fractures than the complex fractures. Complication rates were also more with type V and VI fractures. Bicondylar fractures can be effectively treated by reduction and fixation with lateral locking plate. Bone grafting after elevation of the depressed fracture is always advisable as it gives a good anatomical as well as functional outcome. Post-operative wound breakdown & infection is a major complication. The chance of infection, delayed wound healing and wound breakdown in complex tibial fractures (types IV, V and VI) are high.

Keywords: Functional outcome, tibial condyle, fractures, internal fixation

Introduction

The tibial plateau is one of the most critical load-bearing areas in the human body. With the ever increasing number of vehicles and thereby, the number of road traffic accidents, fractures of the tibial plateau have become very common injuries. To preserve normal knee function, the surgeon must strive to restore joint congruity, maintain the normal mechanical axis, ensure joint stability, and restore a full range of motion. With more complex fractures, it is essential to consider not only the bone injury but also the associated soft tissue damage. Most opinions in literature favour operative reduction for the correction of displacement, while the converse opinion is that equally good results are obtained with conservative methods as well. Use of limited open approaches in conjunction with ligamentotaxis, indirect reduction aids, wire-guided cannulated screws, and minimally invasive plating techniques allows the surgeon to treat higher energy injuries effectively with internal fixation. If extensive comminution and soft tissue conditions are not favorable for ORIF, hybrid and circular small-wire external fixators offer a safer means for early fracture reduction and stabilization. Treatment based on the general principles and techniques above described usually results in a functionally satisfactory outcome.

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Aim of the Study

The aim of the present study is:

1. To evaluate the functional outcome in tibial plateau fractures treated by open reduction and internal fixation with buttress plating and cancellous screws.
2. To determine the associated complications and demographic profile of tibial plateau fractures.
3. To evaluate the complications associated with ORIF of tibial plateau fractures.

Materials and Methods

A prospective study of patients with tibial condyle fractures treated by open reduction and internal fixation at Government Medical College Thrissur, was considered for the study.

Inclusion Criteria

All cases of tibial plateau fracture treated by open reduction & internal fixation.

Exclusion Criteria

- Tibial plateau fracture treated by conservative means, external fixators & illizarov fixators.
- Open fractures
- Those associated with fracture of lower limb, pelvis & spine.
- Cases lost follow-up
- Cases without sufficient post-operative information.

Data were collected using a pre-tested questionnaire containing personal data (sex, age of the patient, occupation, socioeconomic status) and data pertaining to the injury (time, cause, type of injury, side of injury, associated soft tissue injuries). Fractures were classified according to the Schatzker classification. The determination of the fracture type is an important element in planning operative treatment. Types V & VI fractures, compound fractures, fractures with neurovascular damage and tibial condyle fractures in a polytraumatized patient were considered as complex fractures and treated as early as possible. Mechanism of injury, amount of articular depression and comminution, association with fracture of the upper fibula, amount of soft tissue damage, pre-operative ligament instability, general condition of the patient, associated medical illness, occupation of the patient, other associated injuries in a poly traumatized patient and whether patient had evidence of osteoarthritis of the knee before injury were noted. The time of surgery, whether operated on the same day or another day was recorded. All patients were admitted to

the hospital, resuscitated, and evaluated for multiple injuries. Stabilization of the associated injuries and treatment of surgical and medical problem were then undertaken. After discharge, all patients were followed-up regularly for clinical and radiological assessment. At final follow-up, all radiographs were reviewed for any degree of joint depression, loss of alignment and the presence of OA. Radiological features of OA included the presence of joint space narrowing, articular margin osteophytes, as well as subchondral cysts and sclerosis. Mean follow-up was 20 months

Types of cases managed by ORIF

1. All types of fracture with displacement of fragment, articular depression of more than 2 mm and knee instability.
2. All type V and VI fractures after initial evaluation

Preliminary treatment of tibial condyle fracture

When the patient was brought to the casualty, in the case of a polytraumatized patient, necessary resuscitative measures were taken up. Airway was maintained, IV access obtained and parenteral fluids given to maintain adequate circulation. No open fracture were taken into account in our study Then the leg is immobilized in a splint after preliminary evaluation, if the surgery is decided to be done on the same day. If there is a delay in surgery, the limb is either immobilized in a long leg slab or a lower tibial skeletal traction is applied (in case of high energy injuries).

Surgical Aspects

Incision: Lateral incision was put in 20 cases whereas 5 cases were operated by a medial incision.

Fixation device used: Screws alone were used to fix the fractures in 8 cases of these cases, 2 had bone grafting as well. Buttress plates were used to fix 17cases of tibial plateau fractures with 12 of them requiring bone grafting. Bone grafting was used in 14 cases. These cases were usually the joint depression types of the lateral tibial condyle (Types II & III and Type VI fractures). The graft was harvested from the ipsilateral or contra lateral iliac crests. There were 3cases of hypertension, and 2 case of diabetes mellitus.

Grading system used for assessment of results

Modified knee scoring system of Hohl & Luck (1956) – (modified by Dennis Bo Jensen, Claus Raud *et al*)

(1) Functional grading

Table 1

Grade	Lack of extension (degree)	ROM (degree)	Varus/valgus instability (degrees)	Walking (metres)	Pain
Excellent (all of the following)	0	≥120	<5	≥3000	None
Good (not more than one of the following)	>0	<90	>5	<1000	Mild on activity
Fair (not more than 2 of the following)	≥10	<75	>5	<100	Moderate on activity or intermittent at rest
Poor	All results worse than fair				

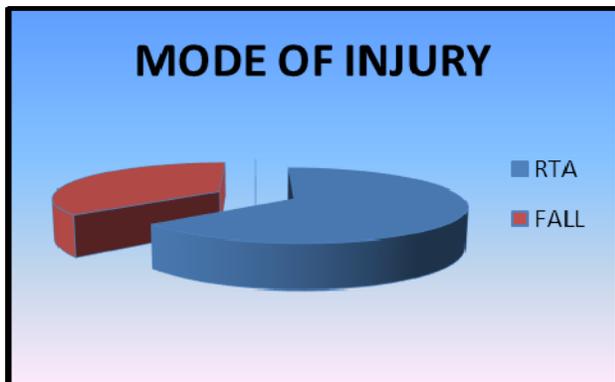
(2) Radiological grading

Table 2: Functional grading: analysis of cases

Grade	Varus/valgus deformity (degrees)	Depression of articular cartilage (mm)	OA
Excellent (all of the following)	≥5	<5	None
Good (not more than one of the following)	>5	>5	Minimal
Fair (not more than 2 of the following)	>10	>5	Moderate

Results

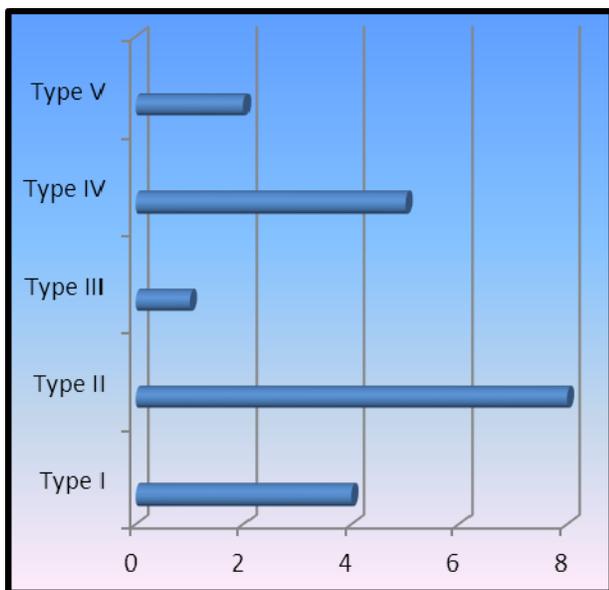
The study population included all age groups, of which maximum subjects were in 30-39 age group, followed by 40-49 and 20-29 age group. The mean age was found to be 37.2 years. Male dominated (76%) in the study population and the sex ratio was found to be 3.16. Females were represented by only 24%.



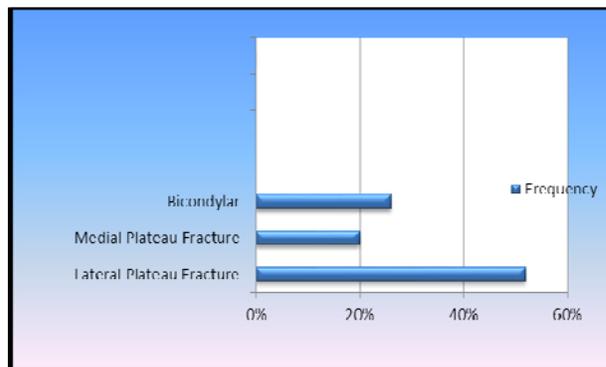
Road traffic accident (64%) was found to be single major reason for different injuries. All other causes were minor causes. Other causes included fall accounts to 34% of fractures.

Most of the patients with tibial condyle fractures were of the low socioeconomic status (84%) and middle class accounts to about 16%

Frequency of fractures based on Schatzker types



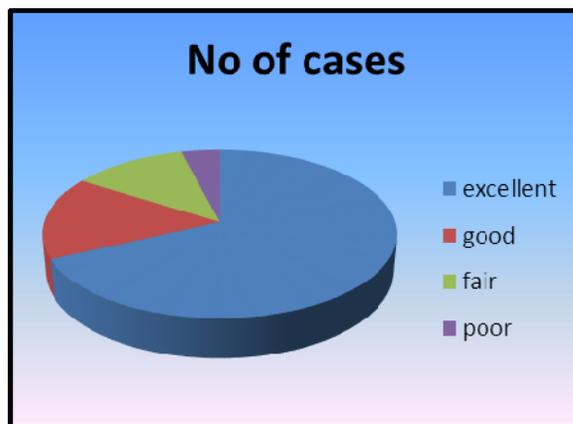
Type II fracture was dominated (32%) in the study population which was followed by type IV and type VI fractures each represents 25% in the study population. Type III fractures were the Least



Functional Assessment

Functional grading was done based on different parameters like lack of extension, range of movement, instability, walking distance and pain score. No patient had lack of extension i.e., all of them were able to extend. But range of movement was limited in few patients. 68% had more than 120°. 16% had < 120° and > 90° movement and 12% having range of motion between 75 and 90 degrees. Similarly instability was not observed widely. Only 4% had > 5° of instability. 4% was unable to walk more than 100 m and all others were able to walk without much pain. Considering all parameters, the total pain score was assessed and 88% had no pain and 8% had mild pain and 4% had moderate pain.

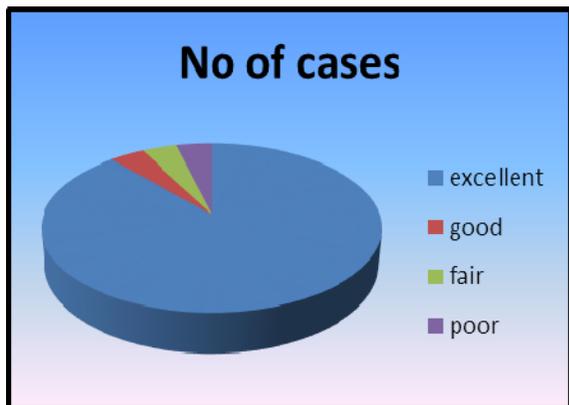
All the patients were assessed functionally and assigned grade for their performance. 68% performed excellently and 16% showed good performance and performance is fair only in 12% and 4% performed poor.



Functional Assessment

X ray readings were analyzed for radiological grading on the basis of three parameters like valgus/varus deformity, depression of articular surface and osteoarthritis. X ray readings also confirms with functional grading. Only one patients (4%) showed >5° valgus/varus deformity. Depression of articular surface was also with in normal range for all except for two patients (8%). No patient reported osteoarthritis.

All the patients were assessed radiologically and assigned grade for their performance. 92% performed excellently and 4% showed good performance and only 4% performed fair.

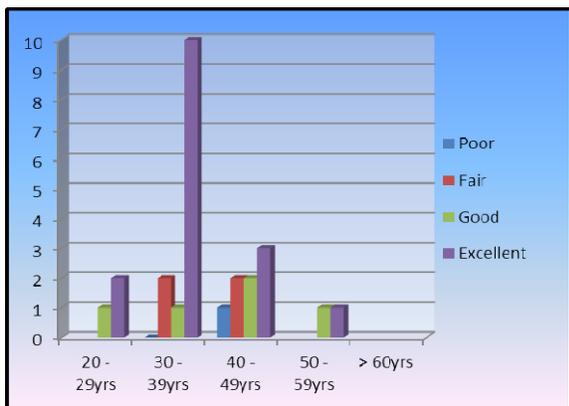


Radiological Assessment

92% were normal according to radiological assessment. 8% had persistent osseous depression and no patient had arthritis.

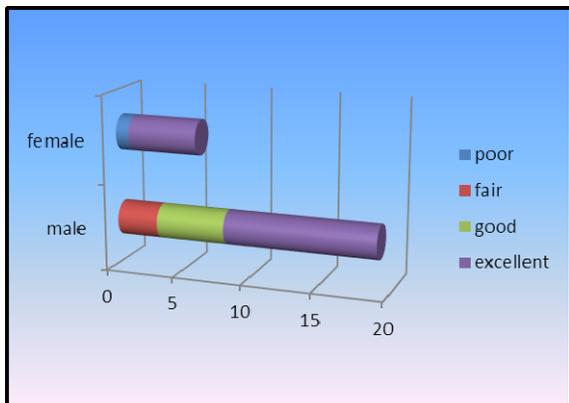
Table 3: Radiological assessment

X Ray Assessment	Frequency	Percentage
Normal	23	92
Persistent Osseous Depression	2	8
Arthritis	0	0



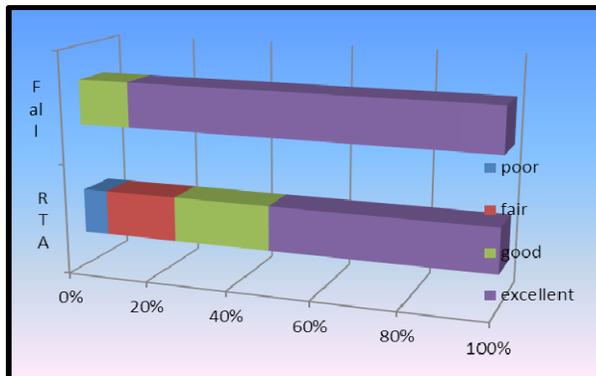
Comparison between age and rating

The patients responded well, which was evident by the outcome rating both from functional as well as radiological scoring. Most of the patients were rated excellent after treatment. Irrespective of their age, they responded to the treatment. Even though Chi square analysis showed no significant ($P>0.05$) influence of age in the final rating of outcome, young age found to be more responsive to the treatment as less than 40 years age group formed maximum of excellent rating category



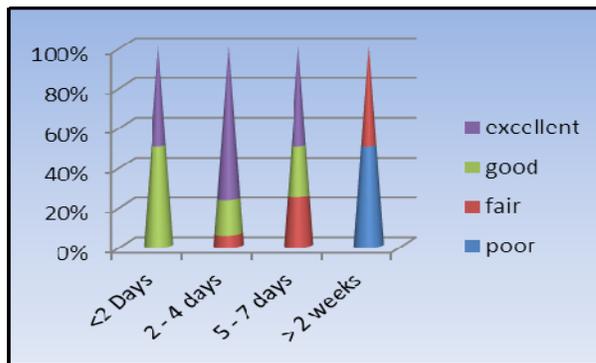
Comparison between gender and rating

Similarly sex also had no influence on final outcome or the total rating of patients. Chi square analysis showed no significant association between sex and rating. Even though female folk was only meager, most of them showed better response to treatment as the most of folk rated excellent, whereas male patient rated differently.



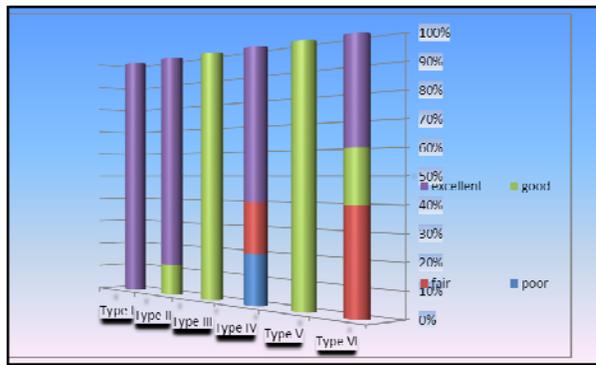
Comparison between mode of injury and rating

Mode of injury also did not show any significant association with the final outcome or rating. Maximum injury was due to RTA. Majority (80%) of the RTA cases rated excellent and few came good and one patient showed poor response. All the fall patients responded well and one rated good and all others rated excellent.



Comparison between time of delay and rating

Time delay was found to be a significant ($P<0.001$) factor that affect out come or rating. As the time delay increased, the outcome rating reduced. All the cases done within 4 days showed better response and rated excellent where as a patient who was not reported to hospital for more than 2 weeks responded poor or fair. The time delay was inversely associated with the outcome rating.



Comparison between type of Schatzker and rating

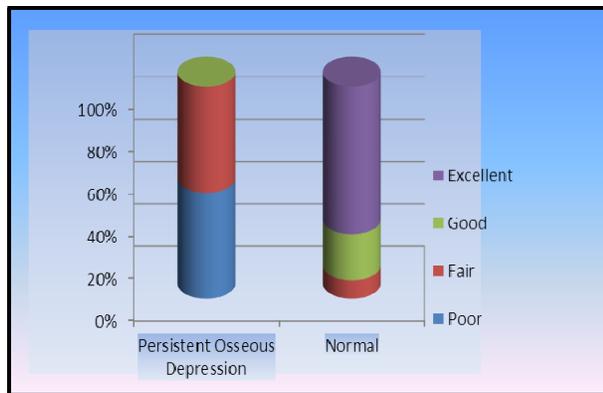
The maximum (63.75%) patients suffered Type II fracture had excellent or good outcome. Most of the patients with lower type viz, Type I to Type III showed better or excellent outcome where as higher Types like Type V and VI recorded poor outcome as evident from present study. Even though the Schatzker classification did not showed any statistical significance with rating, higher types were resulted in poor rating. Regression analysis also showed and inverse relationship between classification type and rating.

Association between bone grafting and rating was not statistically significant but those with bone grafting came with excellent rating where as with out bone grafting did not showed full excellent outcome instead three came with good rating and two patients with fair rating

Comparison between X- ray and rating

The total radiological assessment using persistent osseous depression showed poor outcome whereas normal people was responded excellent to treatment significantly ($P < 0.001$).

One patient who had a compartment syndrome of the leg was treated with fasciotomy during the initial surgical procedure. 4 patients had lateral meniscal injury and 2 had medial meniscal injury. For this meniscectomy was done These were no cases breakage of implants or loosening of screws. For two patients provisional fixation with K-wires were removed secondarily.



Post-operative complications

The following post-operative complications were encountered.

1. Infection and Delay in wound healing

Delay in wound healing and wound breakdown seen in 2 patients. both of them were having Type VI injuries. this was treated by regular dressing. No frank infection or Osteomyelitis were there probably, due to the fact that cancellous bone resists infection.

2. Limb Oedema

There was no demonstrable joint effusion in any of the patients. However, oedema around the knee persited for about 6-8 weeks, after surgery. An edema of the lower part of the leg and around the ankle and foot was noticed in most of the cases belonging to types IV, V and VI fractures, after surgery. It persisted even upto 2 months in some cases. An increased soft tissue dissection may be the causative factor. It however subsided by gradual passive and active exercises. There was no case of synovial fluid leak.

3. Neurovascular Complications

A single case of compartmental syndrome, for which fasciotomy was done.

4. Knee instability

Patients had lateral meniscal injury and 2 had medial meniscal injury. For this meniscectomy was done during surgery There were 2 cases of isolated medial collateral ligament injury in association with tibial plateau fracture, which were repaired primarily There was an overall incidence of 20% meniscal/ligament injuries in association with tibial plateau fractures.

5. Persistence of Osseous depression

Osseous depression persisted after radiological union and consolidation of fracture in 2 cases. In 1 of these cases bone grafting was done and hence graft failure is the likely cause. In the other 1 cases bone grafting was not done. In one of the cases the depression is on the lateral side, and type II injuries and other case the depression was on the medial side and Type IV.



Type I



Type II



Type III



Type IV



Type V



Type VI

Fig 1: Fixation of tibial condyle fractures

Discussion

In our study of 25 patients, a total of 19(76%) were male patients and the rest 6(24%) were females. The youngest patient was 26 years of age and the oldest was 54 years. Of the male patients 11 had excellent, 5 had good, 3 fair and. Of the 6 females 5 had excellent outcome and one had poor outcome. Maximum patients were in the age-group of 30 to 39, 12 patients belong to 30-39 age group (48%) and of this 10 patients had excellent outcome and good and fair outcome for one each. Next comes 40-49 age group patients which accounts to about 8 patients (32%) followed by 20-29yrs and at last 50-59yrs. 84% of patients belong to low socioeconomic group in our study. The commonest cause for tibial plateau fractures was road traffic accidents which accounts to about 16 patients (64%) in our study followed by fall. Of the RTA patients 9 had excellent outcome, 5 had good and 1 had poor outcome. Among patients who sustained fall 7 had excellent outcome and one had good outcome. No open fracture were taken into account in our study 52% of patients had isolated lateral plateau fractures and 20% had isolated lateral plateau fractures and bicondylar in the rest. Fractures were classified according to Schatzker and results were evaluated Type II showed maximum prevalence (32%) followed by Type IV (25%) and Type VI (25%). Type V and Type III were the least accounts to about 8% and 4% respectively

There were 3 patients with polytrauma, one had soft tissue injury which was sutured. One had Ipsilateral fracture both bone fore arm treated by primary fixation with plate and screws and another one with head injury which was treated symptomatically. 4 patients had lateral meniscal injury and 2 had medial meniscal injury. For this meniscectomy was done during surgery. There were 2 cases of isolated medial collateral ligament injury in association with tibial plateau fracture, which were repaired primarily. About 30% was associated with meniscal or ligament injuries. If the ligament injuries were not treated properly or were over-looked, residual instability of the knee resulted which often lead to posttraumatic arthritis of the knee. As supported by many investigators; residual instability of the knee is a frequent cause of post-traumatic arthritis. Only one case of compartment syndrome was encountered during our study which was treated by limited fasciotomy and definitive fixation later. A recent series of 41 bicondylar fractures reported 9.76% incidence of compartment syndrome. Ebraheim *et al.* reported a 23% incidence in their series of 117 fractures treated with ORIF.



Fig 2: Compartment syndrome

In this study 18 patients (%) had undergone surgery within 2 to 4 days of injury of whom 13 patients (81%) had excellent and 3 had good outcome and one had fair outcome. 4 patients were operated within 2 to 3 days of which all had excellent outcome. There was a delay of 5 to 7 days in 4 patients due to co-morbid conditions of which 2 had excellent, 1 good and 1 fair result. There was only 2 patients with a delay of more than 2 weeks for whom the results were 1 poor and 1 good.

When treating intra-articular fractures, the goal is to obtain a stable joint permitting early range of motion for cartilage nourishment and preservation. Despite anatomical joint reconstruction, development of osteoarthritis may still occur secondary to the initial articular cartilage and meniscal injury. In young patients this could be detrimental as it can lead to total knee replacement (TKR) at an early age.

Post-operative infection is a major complication of any invasive surgery for tibial plateau fractures, and in this study the incidence of wound breakdown was seen in 8% of patients and all of them were having Type VI injury. Infection rates range between 0 and 87.5% in the literature. No frank infection or osteomyelitis was seen. The chance of infection, delayed wound healing and wound breakdown in complex tibial fractures (types IV, V and VI) are high.

In this study 64% of the cases had excellent functional results, 20% good results, 12% fair results and 4% poor results. Of the 25 patients 17 had range of movements $>120^\circ$ (68%), 4 had $>90^\circ$ (16%) and 3 $>75^\circ$ (12%). There was 1 patient with varus/valgus instability. 24 patients had walking distance more than 3000 m (96%), 1 less than 100m (4%).

92% of patients had excellent anatomical results, 4% -good, 4%-fair and 0%-poor. There were 1 patient with varus/valgus deformity. 1 with >5 and none with >10 . There were 2 patients with the articular surface depression >5 (8%) of which 1 had fair and other had good outcome.

There were 14 patients who had bone grafting done. 72% of them had excellent results.

Another cause of poor anatomic and functional results is the persistence of osseous depression following operative or non-operative treatment. The causative factors may be due to inadequate reduction or the hesitation in using bone graft. A delay in surgery in depression types of fractures can lead to consolidation of the depressed segment, and thereby difficulty in elevating the same. In this study, there were 2 cases of persistent osseous depression. No patient reported osteoarthritis in our study.

Articular depression ranges from 4 to 10 mm have been described as acceptable. Long term follow-up studies have found little correlation between residual articular depression of the tibial plateau and the development of arthritis. However, a biomechanical study by Brown *et al.* of a cadaver model of tibial plateau fractures showed significant increases in contact pressures when the articular incongruity exceeds 3 mm.⁵ Although much is still to be learnt of the degree of articular incongruity which is tolerable by the joint, most agree that if the articular cartilage step-off is sufficiently severe to produce clinical instability, this is predictive of a poor result. Restoration of the correct mechanical axis of the lower limb is a critical factor in the long term function and prevention of osteoarthritis of the knee.

On the basis of clinical examination and in the absence of stress radiography, we could not determine the extent of instability that was caused secondary to ligamentous laxity to that caused by residual osseous depression.

All fractures of the tibial plateau usually unite well by 4-6 months. Type IV, V and VI fractures took more time for

union. No cases of pseudarthrosis was seen in this study.

Depressed fractures are always best treated with supplementation of bone graft. Articular step and osseous depression may persist when the depressed fractures are not treated by proper elevation and filling of the space with bone graft. If there was delay in surgery by over a week, there was difficulty in elevating the depressed fragment as well. In literature it is noted better scores with anatomical reduction of the articular surface and fractures with lesser degrees of comminution.

In earlier studies of Schatzker, the most common complication was a peroneal nerve injury which recovered by several weeks. In this study, there were no cases of peroneal nerve injury reported.

Schatzker fracture types also influenced the treatment outcome. Complex fractures had delay in fracture union, wound healing, more incidence of post-operative infection, knee stiffness, early osteoarthritis and limb oedema. These type of fractures also resulted in extensive soft tissue dissection during surgery and late mobilization the patient. Type II and IV fractures were more associated with ligament and meniscal injuries.

The fixation device used also had an impact on the final result. Buttress plating resulted in more soft tissue dissection and chances of infection than fixation with cancellous screws alone, but the fixation was more rigid. It is better to have a stable fixation in an osteoporotic bone.

The overall analysis of this study showed that the functional results were much better with types I, II, III and IV fractures than the complex fractures. Complication rates were also more with type V and VI fractures.



Fig 3: Persistence of osseous depression



Fig 4: Post-operative surgical site infection

Conclusion

1. In this study 64% of the cases had excellent functional results, 20% good results, 12% fair results and 4% poor results.
2. 92% of patients had excellent anatomical results, 4% - good, 4% - fair and 0% - poor
3. Road traffic accidents form the commonest mode of injury (64%).
4. More than 80% of patients, who sustained this fracture, were moderate to heavy workers and hence required a stable joint
5. 52% of the tibial condyle fractures come under Schatzker types I, II and III. And the most common one is Type II
6. Fractures of the lateral tibial condyle (52%) were the commonest type of tibial plateau fracture, with bicondylar type coming next (26%).
7. Bone grafting after elevation of the depressed fracture is always advisable as it gives a good anatomical as well as functional outcome
8. Bicondylar fractures can be effectively treated by reduction and fixation with lateral locking plate
9. Higher the grade of injury more is the chance of getting a poor outcome
10. The degree of instability of the joint most often decides the occurrence of post-traumatic osteoarthritis. Meniscectomy also contributes to this.
11. Persistence of osseous depression has a significant contribution to the demonstrable instability and thereby the development of osteoarthritis and hence, a less favorable anatomical and functional outcome.
12. Initiation of early knee joint motion is the most important factor to prevent knee stiffness and late osteoarthritis.
13. Post-operative wound breakdown & infection is a major complication, The chance of infection, delayed wound healing and wound breakdown in complex tibial fractures (types IV, V and VI) are high.
14. Extensive soft tissue dissection is to be avoided as it often results in limb oedema, delayed wound healing, delay in mobilization.

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