Functional outcome of tibial condyle fractures treated with open reduction and internal fixation with plate and screws

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ABSTRACT

Aims and objectives
To evaluate the functional outcome of tibial plateau fractures treated by open reduction and internal fixation with buttress plating.

Materials and methods
25 patients with tibial condyle fractures treated by open reduction and internal fixation at the Government Medical College, Thrissur during year 2008-2010 were included in the study.

Results
Functional grading was done based on modified knee scoring system of Hohl & Luck (1956), modified by Dennis Bo Jensen and Claus Raud et al. In the final assessment, 68% of the patients had more than 120° extension, 16% had range of movement between 90 and 120 degrees and 12% had range of motion between 75 and 90 degrees. Instability was not observed widely. Only 4% had > 5° of instability. 4% were unable to walk more than 100 meters and all others were able to walk without much pain. Considering all parameters, the total pain score was assessed. 88% patients had no pain, 8% had mild pain and 4% had moderate pain.

Functional results were excellent in 68%, good in 16%, fair in 12% and poor in 4%. Radiologically, 92% had excellent performance, 4% each had good and poor performances respectively.

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

Bi condylar 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 and functional outcome. Post operative wound breakdown and infection is a major complication, especially in complex tibial fractures (Schatzker types IV, V and VI).

Keywords: Tibial condyle fractures, internal fixation, buttress plating

INTRODUCTION
The tibial plateau is one of the most critical load bearing areas in the human body. With the ever increasing number of road traffic accidents (RTA), fractures of the tibial plateau have become very common.

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 bony 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 favourable for open reduction and internal fixation (ORIF), hybrid and circular small wire external fixators offer a safe means for early fracture reduction and stabilisation. Treatment based on the general
principles and techniques described above usually results in a functionally satisfactory outcome.

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

MATERIALS AND METHODS
This was a prospective study of patients with tibial condyle fractures treated by open reduction and internal fixation at Government Medical College Thrissur, Kerala during the period 2008-2010.

Inclusion criteria
All cases of tibial plateau fracture in adults, treated by open reduction and internal fixation.

Exclusion criteria
1. Tibial plateau fracture treated by conservative means, external fixators and Ilizarov fixators.
2. Open fractures
3. Those associated with other fractures of lower limb, pelvis or spine.
4. Cases without sufficient post operative information and those lost to follow up.

Data was collected using a pre-tested questionnaire on personal data (sex, age, 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 and VI fractures, fractures with neurovascular damage and tibial condyle fractures in a polytrauma patient were considered as complex fractures and treated as early as possible.

All patients were admitted to the hospital, resuscitated and evaluated systematically. Stabilisation of the associated injuries and treatment of surgical and medical problems were then undertaken.

Mechanism of injury, amount of articular depression and comminution, associated fractures 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 traumatised patient and whether patient had evidence of osteoarthritis of the knee before injury were noted. The time to surgery and the operating time was recorded.

After discharge, all patients were followed up regularly with 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 osteoarthritis. Radiological features of osteoarthritis (OA) included joint space narrowing, articular margin osteophytes, subchondral cysts and sclerosis. Mean duration of follow up was 20 months.

Primary management
In the casualty, necessary resuscitative measures were taken up. Airway was maintained, IV access obtained and parenteral fluids given to maintain adequate circulation.

If after a preliminary evaluation, the surgery was decided to be done on the same day, the leg was immobilised in a splint.

If there was a delay in surgery, the limb was either immobilised in a long leg slab or in case of high energy injuries, a lower tibial skeletal traction was applied.

Surgical technique
A lateral incision was used in 20 cases whereas 5 cases were operated by a medial incision. Screws alone were used to fix the fractures in 8 cases. Of these, 2 had bone grafting as well. Buttress plates were used to fix 17 cases of tibial plateau fractures with 12 of them requiring bone grafting.

Thus bone grafting was used in a total of 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 iliac crest.

Grading system used for assessment of results was the Modified knee scoring system of Hohl & Luck (1956) modified by Dennis Bo Jensen, Claus Raud et al. This included functional grading and radiological grading.

Functional grading
This was based on different parameters like lack of extension, range of movement, instability, walking distance and pain score. In the present study, no patient had lack of extension, i.e., all of them were able to extend. But range of movement (ROM) was limited in a few patients. 68% had more than 120° ROM, 16% had ROM between 90 and 120° and 12% had ROM between 75 and 90°. Instability was not observed widely. Only
4% of patients had >5° of instability. 4% of patients were unable to walk more than 100 meters due to pain. All others were able to walk without much pain. Considering all parameters, the total pain score was assessed. 88% had no pain, 8% had mild pain and 4% had moderate pain.

Radiological grading was done on the basis of valgus-varus deformity, depression of articular surface and osteoarthritic changes. Radiologically, 92% had excellent performance, 4% good and 4% had fair performance. No patient had signs of osteoarthritis.

**RESULTS**

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

RTA was found to be single major causative factor (64%). Other causes including falls, accounted to 34% of fractures. (Figure 1)

Most of the patients with tibial condyle fractures were of the low socioeconomic status (84%) and the middle class accounted for the rest of the cases.

The incidence of Schatzker type II fractures was 32%, which were followed by type IV and type VI fractures, each of

<table>
<thead>
<tr>
<th>Grade</th>
<th>Lack of extension (deg)</th>
<th>ROM (deg)</th>
<th>Varus / valgus instability (deg)</th>
<th>Walking (meters)</th>
<th>Pain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>0</td>
<td>&gt; 120</td>
<td>&lt;5</td>
<td>&gt; 3000</td>
<td>None</td>
</tr>
<tr>
<td>Good</td>
<td>&gt; 0</td>
<td>&lt; 90</td>
<td>&gt; 5</td>
<td>&lt; 1000</td>
<td>Mild on activity</td>
</tr>
<tr>
<td>Fair</td>
<td>&gt; 10</td>
<td>&lt; 75</td>
<td>&gt; 5</td>
<td>&lt; 100</td>
<td>Moderate on activity or intermittent at rest</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
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</tbody>
</table>

Table 1. Criteria for functional grading

<table>
<thead>
<tr>
<th>Grade</th>
<th>Varus / valgus instability (deg)</th>
<th>Depression of articular cartilage (mm)</th>
<th>OA changes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>&lt;5</td>
<td>&lt;5</td>
<td>None</td>
</tr>
<tr>
<td>Good</td>
<td>&gt;5</td>
<td>&gt;5</td>
<td>Minimal</td>
</tr>
<tr>
<td>Fair</td>
<td>&gt; 10</td>
<td>&lt;5</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Table 2. Criteria for radiological grading

![Mode of Injury](image)

Figure 1. Causes for tibial condyle fractures in the study population

![Incidence of various types of tibial condyle fractures](image)

Figure 2. Incidence of the various types of tibial condyle fractures (Schatzker classification)
which represented 25%. Type III fractures were the least common type. (Figure 2) 52% patients had isolated lateral plateau fractures, 20% had isolated medial plateau fractures and the rest had bicondylar fractures. (Figure 3)

All the patients were assessed functionally and assigned grade for their performance. Functional results were excellent in 68%, good in 16%, fair in 12% and poor in 4%. (Figure 4)

In the radiological assessment, 92% were normal, 8% had persistent osseous depression but no patient had arthritic changes. (Table 3, Figure 5)

Comparison between age and rating of results
Majority of the patients had an excellent rating after treatment. Irrespective of their age, they responded well to the treatment. Even though Chi square analysis showed no significant (P>0.05) influence of age in the final rating of outcome, younger the the age, better was the response to treatment.

Comparison between gender and rating
Most female patients showed better response to treatment and had an excellent rating. Male patients has variable results. (Figure 7) Chi square analysis showed no significant association between sex and rating. Gender of the patient had no influence on final outcome or the total rating of patients.

Comparison mode of injury and rating
Mode of injury also did not show any significant association with the final outcome or rating. Maximum injury followed RTA. Majority (80%) of the RTA cases had excellent ratings, one patient showed poor response and the rest had a fair rating. In the patients with the history of fall, one had good rating all others had excellent ratings. (Figure 8)
Effect of time delay on the final rating

Time delay was found to be a significant (P < 0.001) factor that affects outcome 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 poorly to treatment. The time delay was inversely associated with the outcome rating (Figure 9).

Comparison between Schatzker type and rating

Majority (63.75%) of the 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 whereas higher types like type V and VI recorded poor outcome. Even though the Schatzker classification did not show any statistical significance with rating, higher types resulted in poor rating. Regression analysis also showed an inverse relationship between classification type and rating (Figure 10).

Association between bone grafting and rating was not statistically significant. All cases with bone grafts had excellent rating whereas, those without bone grafting had good rating in three and fair rating in two patients.

Analysis of the radiological appearances and rating

The radiological assessment in cases with persistent osseous depression showed poor outcome whereas other cases responded well to treatment (P < 0.001). (Figure 11) One patient who had a compartment syndrome of the leg was treated with fasciotomy during the initial surgical procedure.
These were no cases of implant loosening. Two patients, who had additional K wires used in fixation, which were removed secondarily.

**Post-operative complications**

1. Infection and delay in wound healing

Delay in wound healing and wound breakdown seen in two patients. Both of them had Type VI injuries. These were treated by regular dressings. No frank infection or osteomyelitis were observed, 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 persisted for about 6-8 weeks, after surgery. An oedema 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. This persisted even up to 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 was noted, which was treated with fasciotomy.

4. Knee instability

Four patients had lateral meniscal injury and 2 had medial meniscal injury. In these cases, meniscectomy was done during the primary 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 or 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 two cases. In one of these cases, bone grafting was done and hence graft failure was the likely cause. In one case, the depression was on the lateral side and in the rest, it was on the medial side. The osseous depression persisted in these cases.

**DISCUSSION**

In our study of 25 patients, a total of 19(76%) were male patients and the rest 6 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 and 3 had fair results. Of the 6 females, 5 had excellent outcome and one had poor outcome.

Majority of the patients were in the age-group of 30 to 39 years, 12 patients (48%) belonged to 30-39 age group and of this 10 patients had excellent outcome. One each had good and fair outcomes. The 40-49 age group accounts to about 8 patients (32%) followed by the 20-29 year age group and finally the 50-59 year age group.
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%). 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.

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 accounted to 8% and 4% of cases respectively.

There were 3 patients with polytrauma, including one with 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 the primary 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 post traumatic arthritis of the knee. This has been supported by many investigators.

Only one case of compartment syndrome was encountered during our study which was treated by limited fasciotomy, followed by a definitive fixation later. A recent series of 41 bi condylar fractures reported 9.76% incidence of compartment syndrome. Ebraheim et al. reported a 23% incidence in their series of 117 fractures treated with ORIF.

In this study 18 patients had undergone surgery within 2 to 4 days of injury. In these, 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 were only 2 patients with a delay of more than 2 weeks for whom one each had poor and good results.

In the treatment of 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 damage 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 surgery for tibial plateau fractures. In this study the incidence of wound breakdown was seen in 8% of patients. All of them had type VI injury. Infection rates range between 0 and 87.5% in the literature.

No frank infection or osteomyelitis was observed. 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% had good results, 12% had fair results and 4% had poor results. Of the 25 patients 17 (68%) had range of movements (ROM) >120°, 4 (16%) had > 90° ROM and 3 (12%) had > 75° ROM. There was one patient with varus-valgus instability. 24 patients had walking distance more than 3000 m (96%) and in 1 it was less than 100m (4%).

92% of patients had excellent anatomical results, 4% each had good and fair results and 0% had poor results. There was one patient with varus-valgus deformity, 1 with > 5 mm instability. There were 2 patients (8%) with the articular surface depression >5 of which one had fair and other had a good outcome. There were 14 patients who had bone grafting. 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 had evidence of osteoarthritis in our study.

Articular depression ranging 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. on a cadaver model of tibial plateau fractures showed significant increase in contact pressures when the articular incongruity exceeds 3 mm. Although much is still to be learnt of the degree of articular incongruity that is tolerable by the joint, most agree that an
articular cartilage step off sufficiently severe to produce clinical instability 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.

In the absence of stress radiography, we could not determine the extent of instability that was caused secondary ligamentous laxity due to the residual osseous depression. All fractures of the tibial plateau usually unite well by 4 to 6 months. Type IV, V and VI fractures needed more time for union. No cases of pseudarthrosis were 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. In literature, better scores were obtained with anatomical reduction of the articular surface and in 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. Schatzker fracture types also influenced the treatment outcome. Complex fractures had delay in fracture union, wound healing, increased incidence of postoperative infection, knee stiffness, limb oedema and early osteoarthritis. These type of fractures also needed extensive soft tissue dissection during surgery. Type II and IV fractures were more often 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 osteoporotic bones.

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

**Conclusion**

1. More than 80% of patients, who sustained this fracture, were moderate to heavy workers.
2. Road traffic accidents form the commonest mode of injury (64%).
3. 52% of the tibial condyle fractures were Schatzker type II.
4. Fractures of the lateral tibial condyle were the commonest type of tibial plateau fractures, with the bi condylar type coming next (26%).
5. Bone grafting after elevation of the depressed fracture is always advisable as it gives a good anatomical as well as functional outcome.
6. Bi condylar fractures can be effectively treated by reduction and fixation with lateral locking plate.
7. Higher the grade of injury, higher is the chance of a poor outcome.
8. The degree of instability of the joint most often decides the occurrence of post traumatic osteoarthritis. Meniscectomy also contributes.
9. Persistence of osseous depression has a significant contribution to the demonstrable instability and thereby the development of osteoarthritis leading to a less favorable anatomical and functional outcome.
10. Initiation of early knee joint motion is the most important factor to prevent knee stiffness and late osteoarthritis.
11. Post operative wound breakdown and infection is a major complication. The chance of infection, delayed wound healing and wound breakdown is higher in complex tibial fractures (types IV, V and VI).
12. Extensive soft issue dissection is to be avoided as this often results in limb oedema, delayed wound healing and hence a delay in mobilisation.

**References**

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