SURGICAL MANAGEMENT OF TIBIAL PLATEAU FRACTURES WITH INTERNAL FIXATION: A CLINICAL STUDY ON FUNCTIONAL OUTCOME: ORIGINAL RESEARCH

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ABSTRACT

BACKGROUND

Intra articular tibial plateau fractures are a type of complex fracture that accounts for 1.2 percent of all fractures. They have an impact on knee function and stability, resulting in significant morbidity. The functional, radiological, postoperative complications, and reoperation rates of tibial plateau fractures treated with open reduction with internal fixation (ORIF) were studied in peer-reviewed published research. The purpose of this study was to look at the functional results of high-energy tibial plateau fractures that were treated with plating.

MATERIAL AND METHODS

In this study, 30 patients with tibial plateau fractures (22 men, 8 women) were treated with open reduction and internal fixation with plates and screws. For a total of six months, their functional and radiological outcomes were evaluated. The major portion of cases (17 cases) were caused by traffic accidents, followed by falls from heights (8 cases), and the remaining 5 cases were caused by other factors. Fractures were classified using the Three-Column concept classification and the Schatzker classification. To treat both posteromedial and posterolateral pieces, column-specific fixation was used. Outcome was assessed using Knee society score and Rasmussen score.

RESULTS

In 23 and 6 cases, excellent and good functional results were observed, respectively, while one patient had a fair outcome. Twenty instances had outstanding radiological results, seven had good results, and three had medium results. Three cases of implant prominence, two cases of infection, one case of knee stiffness, one case of malunion, and one case of wound dehiscence were among the complications that were experienced.
CONCLUSION

The three-column classification of tibial plateau fractures aids in the proper description of the fracture anatomy and subsequent column specific fixation for the best potential results. Surgical treatment of tibial plateau fractures is difficult, but it results in excellent anatomical reduction and rigid fracture fixation, allowing for the restoration of articular congruity and facilitation of early knee mobility, resulting in ideal knee function.

KEYWORDS

Tibial plateau fractures, Schatzker classification, Three-column concept, knee society score, Rasmussen score, internal fixation

INTRODUCTION

One of the three major weight-bearing joints in the lower extremities is the knee joint\(^1\). Tibial plateau or condylar fractures are proximal tibia fractures that extend into the knee joint and are caused by high-speed motor vehicle accidents, violent trauma, and falls from height\(^2\) where fractures are caused by direct axial compression, usually with a valgus (more common) or varus moment, and indirect shear forces. These fractures are frequently linked to significant soft tissue damage. As a result, when treating these fractures, the surgeon considers a variety of criteria such as the type of fracture, soft tissue injury, and ligamentous injury. Tibial plateau fractures account for about 8% of all fractures and 1% of all fractures in the elderly\(^5,6\). These are severe injuries that frequently result in functional disability. For a long time, the best way to treat tibial plateau fractures has been a matter of debate. They were treated both non-operatively and surgically. The use of open reduction and stable internal fixation aids in the preservation of the articular surface and the restoration of mechanical alignment, allowing for early knee motion\(^7,8,9\). The soft tissues are jeopardised by open reduction and internal fixation procedures, and the rate of wound infection is relatively high. Open reduction internal fixation with cannulated screw fixation, Condylar plate with or without bone graft, AO/ASIF Buttress plate (T/L) with or without bone graft, and Proximal tibial locking plate have all been used. In axial compression, four 3.5mm screws outperformed two 6.5mm screws, according to biomechanical data\(^10\). In this study, we used the Rasmussen score and the Knee Society score to assess the functional outcome of tibial plateau fractures treated with internal fixation after a minimum of 6 months. Complex tibial plateau fractures are technically challenging and controversial to treat\(^4\). In tibial plateau fractures, serious intra-articular damage and soft tissue injury, as well as improper treatment, can result in postoperative consequences such as infection, skin necrosis, nonunion, deformity, and arthrosis. The goal of tibial plateau fracture therapy is to achieve anatomic reduction of intra-articular fracture fragments while maintaining stability\(^4\). These fractures are treated with a variety of internal and external fixation procedures\(^11,12\). The Association for Osteosynthesis/Association for the Study of Internal Fixation has recommended bilateral open reduction and internal fixation\(^13\). Bilateral plating, on the other hand, may necessitate extensive dissection of the wounded soft tissue, resulting in wound complications or poor osteosynthesis\(^4,13\). To minimise extra soft tissue trauma, a less invasive surgical approach is preferred\(^4,13\). Bi condylar tibial plateau fractures, according to some authors, can be stabilised with a single lateral locked plating approach while avoiding medial soft tissue incision\(^4,13,18\). This lowers the problems associated with bilateral plate fixation, however it's unclear whether it'll keep the acquired articular reduction. The goal of this study was to use this method to evaluate the
functional outcome of Schatzker types V and VI tibial plateau fractures treated with open reduction and internal fixation.

MATERIALS AND METHODS

Between 2010 and 2015, we analyzed 20 patients who underwent surgical treatment for a bicondylar tibial plateau fracture. Ten patients (seven males and three females; five right knees and five left knees; mean age, 51.3 years; range, 34 to 73 years) were assigned to group 1, which received a dual locking plate, and ten patients (eight males and two females; five right knees and five left knees; mean age, 51.2 years; range, 25 to 83 years) to group 2, which received a lateral locking plate. Study site: Department of Orthopaedics, Dr. Balabhai Nanavati Hospital, Mumbai. Study population: Data was collected from patients who underwent open reduction and internal fixation for tibial plateau fractures from May 2018 to May 2019. Study Design: Prospective observational study. Sample Size: Sample size was decided as 30 cases. The prevalence of tibial plateau fracture is very low approximately 1.2%.  

\[ n = \frac{(Z\alpha)^2 \cdot P(1-P)}{E^2} = \frac{(1.96)^2 \cdot (98.8 \cdot 1.2)}{(5 \cdot 5)} = 18.21 = 19 \text{ cases} \]

\[ Z = 1.96 \text{ for 95% confidence interval}, \]

Absolute Precision = E = 5%  
P= Prevalence of tibial plateau fracture is 1.2%. Anticipating lost follow up / missing cases, sample size was decided as 30. Time frame to address the study: 1 year

INCLUSION CRITERIA: All patients who have been diagnosed as displaced tibial plateau fracture, Patient age more than 18 years, Closed fractures

EXCLUSION CRITERIA: Skeletally immature patients, Age more than 70 years, Associated neurovascular injuries, Concomitant fractures, Open fractures, Associated pre-existing knee joint disease (osteoarthritis). Clinical history sheets and operation notes were included in the hospital records. They were examined to ascertain the kind of injury, demographic information, surgical delay, therapy administered, accompanying ligament injuries discovered during fracture fixation, fracture or treatment-related sequelae, and revision surgery, if necessary. Data on comorbid illnesses, related limb injuries, and injury side were also gathered. Soft tissue injury was suggested by soft tissue oedema or blister formation, thus surgery was postponed. When the soft tissue oedema and blisters disappeared and skin wrinkles appeared, the patient was scheduled for surgery. In all patients, a single dose of preoperative antibiotic (1.5 gm cefuroxime intravenous) was given one hour before to skin incision. The procedures were carried out in a normal operating room with tourniquet control and regional or general anaesthetic. Depending on the fracture configuration, the fracture was approached from the anterolateral, posteromedial, or both sides. Anterolateral exposure was achieved by making a skin incision over Gerdy's tubercle. With a skin incision posterior to the posteromedial edge of the tibia and extension along the path of the pes anserinus tendons, a posteromedial exposure was achieved. To address the posteromedial part of the tibia, the pes tendons were retracted anteriorly and the medial gastrocnemius and popliteus were retracted posteriorly. With low subperiosteal elevation, the anteromedial surface was dissected to a minimum. To visualize the articular surface, a sub meniscal arthrotomy was performed, and meniscal repair was performed when needed. Intraoperative fluoroscopy and direct visualization were used to achieve articular reduction. The
fixed angle locking plates were used on the medial and lateral sides depending on the fracture configuration. Medial proximal tibia plates are used to buttress the posteromedial fragment mainly which is often single and noncomminuted. The lateral proximal tibial plates are used in bridging mode; hence they are longer than the medial proximal tibial locking plates. Cannulated cancellous screw fixation was used wherever required. Subarticular defects were filled with autograft or bone graft substitutes in cases whenever required. The radiographs including the immediate post injury, postoperative, and follow-up radiographs were studied to confirm the correct classification of the fracture, treatment employed, articular reduction achieved, and any loss of articular reduction or malalignment on follow-up radiographs. Radiographs were assessed by all the authors to assess the articular reduction. The joint reduction was considered to be satisfactory if articular depression was less than or equal to five millimeters and plateau widening was less than or equal to five millimeters compared to the width of the distal femoral condyle. Computerized tomography was used to plan the treatment. Pre injury and Post injury employment status were also recorded. The patients were advised non-weight-bearing mobilization and quadriceps exercises on the first postoperative day. The patients were encouraged to do active assisted knee bending from the third postoperative day. They were reviewed at 3 weeks, 6 weeks, 12 weeks, and at 24 weeks and 3 monthly intervals thereafter till radiological union and maximal functional recovery at 1 year. Union was defined as bone healing by direct means as seen in at least two radiographic planes. Full painless weight bearing over the operated limb was considered as an indirect sign of healing. Subsequently they were followed at six-month intervals. The patients were asked twelve questions about the degree of pain in knee, any difficulty in toilet activities, ability to perform household activities, climbing up or downstairs, ability to knee, night pains, any limp in the operated limb, ability to kneel and stand again, and any discomfort in washing and drying oneself due to knee and various other questions mentioned in Oxford knee score. The maximum attainable score is 60. The patients were graded as poor (0 to 19), moderate (20 to 29), good (30 to 39), and excellent (40 to 48). The patients who has scored more than 40 were considered as cases with satisfactory functional outcome and minimal disability. Pre-operative, post-operative and most recent radiographs (antero-posterior and lateral) for each patient were analyzed to assess the anatomical outcome using Rasmussen’s system of grading 7. This rating system evaluates joint depression, condylar widening and varus or valgus angulation. Postoperative reductions with less than 3mm of residual joint depression on antero-posterior or lateral views were considered acceptable. Postoperative reductions with more than 5mm of residual joint depression on antero-posterior or lateral views were rated as poor. Follow-up radiographs were used to detect post-traumatic osteoarthritis. Osteoarthritis was recorded if there was progressive obliteration of joint space, osteophyte formation and subchondral sclerosis. The requirement for total knee joint replacement was recorded. All radiographs were checked for magnification, penetration and exposure before measurements and observations were taken to eliminate magnification errors. In both groups, functional and clinical outcomes after treatment were rated according to the Knee Society Knee Scoring System (KSS), Rasmussen functional score (RFS), Rasmussen radiological score (RRS). Radiographic healing was defined as callus bridging of three of four cortices on antero-posterior and lateral radiographs as well as painless weight bearing on the affected extremity. Radiological assessments were performed in a comparative manner with the contralateral side. Radiographic examination included coronal alignment of the proximal tibia, medial proximal tibial angle (MPTA), tibiofemoral anatomic angle (TFAA), sagittal alignment, and proximal posterior tibial angle (PPTA). Radiological measurements were carried out from immediately
postoperatively to the last visit at the outpatient clinic with 3-month intervals. The last clinical and radiological evaluations were performed at final follow-up. Approaches used: anterolateral approach, posteromedial approach, posterolateral approach, Posterior approach. Post-Operative Protocol: Outcome Measurement: Functional Outcome assessed by Knee Society Score, Radiological outcome by Rasmussen criteria. The knee objective score and functional scores are considered separately. They are graded as follows: 80-100: Excellent / 70-79: Good / 60-69: Fair below / 60: Poor. The Rasmussens radiological scores are graded as follows: 18: Excellent, 12-17: Good, 6-11: Fair, <6: Poor

STATISTICAL ANALYSIS:
This is a hospital based prospective observational study. Data collected was analyzed by using the appropriate statistical tests wherever necessary. Data was analyzed by using Student’s $t$-test and correlations were analysed using the Pearson correlation coefficient. The statistical significance was determined at $\alpha$ value less than 0.05

RESULTS:
Distribution according to age groups illustrated in fig no 1.

![Chart showing age distribution]

Figure I: Majority of patients belong to age group 31-40 (12), followed by 18-30 (8), 41-50 (5), 51-60 (3) and 61-70

<table>
<thead>
<tr>
<th>Gender</th>
<th>No. Of patients (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>22</td>
<td>73.33</td>
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<tr>
<td>Female</td>
<td>8</td>
<td>26.67</td>
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<tr>
<td>Total</td>
<td>30</td>
<td>100</td>
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</table>

Table I : Gender distribution.
In our study we found that there is wide gender disparity amongst patients. Males showed predominance over females. No of males presented with fracture was 22 and that of females was 8.

Distribution of laterality/side.

It was found that right side was fractured more than left. 18 fractures were on the right and 12 left respectively.

Distribution of fractures according to Schatzker’s and Three-coloumn classification.

![Figure II: depicting cases distribution according to type of fracture.](image)

In our study, we observed that the most commonly involved part of the tibial plateau is the lateral condyle. It’s pure split accounts for 7 (23.34%) and its split associated with depression accounts for 8 (26.67%) of cases. Lateral condyle fractures along with PM(AM+AL+PM) accounted for 3 cases (10%) and involvement of postero-lateral fragment was seen in least cases with 1 (3.3%)

Isolated fractures of medial condyle are associated with 2 cases- (6.67%)

Distribution according to complications

In this study, it was observed that majority of patients (22), didn’t come across any complication which means they had better functional outcome. 3 patients showed implant prominence, 1 suffered from stiffness, 1 from malunion, 1 from wound dehiscence and 2 patients had developed infection during healing

Distribution according to Knee Society Knee Score
<table>
<thead>
<tr>
<th>Grade</th>
<th>No of patients (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>23</td>
<td>76.67</td>
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<tr>
<td>Good</td>
<td>6</td>
<td>20</td>
</tr>
<tr>
<td>Fair</td>
<td>1</td>
<td>3.33</td>
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<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100</td>
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</table>

Table II: Postoperative grading according to knee society score.

Post operatively 23 patients showed excellent Knee Society Score while 6 patients showed good and 1 patient showed fair Score.

Distribution according to Rasmussen’s Score.

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. Of patients (n)</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>20</td>
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<tr>
<td>Good</td>
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<td>Fair</td>
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<td>10</td>
</tr>
<tr>
<td>Poor</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>100</td>
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</tbody>
</table>

Table III: Table depicting postoperative grading according to Rasmussen’s scoring system.

Post operatively 20 patients were graded as excellent, 7 were graded as good and 3 were graded as fair Score.
Fig III: Preop x ray and ct of one of the patient and immediate post op and follow up x ray, functional outcome.
DISCUSSION:

Intraarticular tibial plateau fractures are complex fractures accounting for about 1.2% of all fractures. They affect knee function and stability which results in considerable morbidity. The aim of our study was to evaluate the functional outcome of tibial condyle fractures treated by surgically by internal fixation. There is no universal scoring system for assessing the functional outcome for these fractures. Literature shows multiple scoring system like Rasmussen, knee society score and oxford knee score. Functional outcome of the treatment also depends upon activity levels of the patients. In our study, we have evaluated the patients using Rasmussen score which is a subjective score and knee society score which is an objective score. Majority patients were from age group 31-40 years. Our study correlates well with other studies in the literature which also show increased incidence in 30-40 year group. Honoken et al in 1995
reported a mean age 39.8 years whereas Stevens et al in 2001 and Myatt et al in 2014 report mean age of 40 years and 43.6 years respectively. There was male preponderance in occurrence of tibial plateau fractures having male to female ratio as 2.75:1. This can be attributed to the Indian setup where males are more involved in outdoor activities and thus more liable for such injuries. The major reason of fracture in elderly patients is due to osteoporosis. Right knee is 1.5 times more commonly fractured than left side. Majority of cases were having type I fractures. Involvement of postero-lateral fragment was found in least number of cases accounting for 1 and Type IV fracture found in 2 cases. Varying degree of incidences of various fracture types have been reported in the literature. However, it was found that incidences of low energy types (Schatzker I, II, III) are much higher than the rest. In our study low energy fractures made up 60% of the cases. Schatzker et al in their study found 67% of the case of tibial plateau as low energy fracture types and rest as high energy ones. Honoken et al reports low energy fractures to occurring in only 52% cases. In our study Type II fractures underwent submeniscal arthrotomy, joint elevation and bone grafting Postero-medial condyle was fixed in prone position. In case of both antero-medial and antero-lateral column involvement, medial side was fixed first and it was used as a template to fix lateral condyle. In fractures involving postero-medial and postero-lateral columns, first posteromedial fragment was fixed in prone position and then posterolateral fragment in supine position. 22 cases showed uneventful healing of fracture wound and 8 cases showed complications such as implant prominence in 3 cases, malunion in one patient, stiffness in one case, and infection in two patients. Wound infections remain a serious problem in the treatment of tibia plateau fractures, with infection rates ranging from 3% to 32%. In our study two patients reported post-operative infection. Both the patients were managed successfully conservatively by administration of intravenous antibiotics. In an earlier study by Schatzker22 the most common complication was a peroneal nerve injury. In this study, there were no cases of perineal nerve injury. In our study, none of the cases were reported to have complications such as non-unions, neurovascular complications. On post operative follow up at regular intervals 3 weeks, 6 weeks, 12 weeks, 24 weeks and 1 year. we evaluated cases with knee society score, 23 cases showed excellent results, 6 showed good and one patient had fair result at 1 year follow up. On grading patients with Rasmussen’s scale Post operatively 20 patients were graded as excellent, 7 were graded as good and 3 were graded as fair Score at 1 year follow up. Our results were comparable with the study conducted by Ravi Kant Jain et al (33) who found that implant prominence and wound dehiscence were the most common complications (3% respectively). While, other being: stiffness (2%), malunion (1%), infection (1%) and stiffness with infection (1%). 22 out of 28 patients (78%) in the high activity group achieved excellent results. The high activity group included farmers, laborers, and manual workers. While in the sedentary group only 8 out of 15 patients (53%) had excellent outcomes. The sedentary group included housewives, patients with office jobs, and retired, unemployed patients. Our results are also similar with the study conducted by Janakpally et al24.

CONCLUSION:

Surgical treatment is warranted in most of the cases accounting to the major weight bearing surfaces and higher functional demand. The aim of surgical treatment is rigid fixation of the bone with reconstruction of the articular surface and restoration of the depressed fragment, so that early range of motion and return to function can be provided. The Three-column classification of tibial plateau fractures helps to define the fracture anatomy accurately and subsequent column specific fixation to get the best possible outcomes. There is no universal modality of surgical
treatment. The choice of surgery depends upon the fracture morphology, functional demands of the patients and surgeon preference. Although the surgical treatment of tibial plateau fractures is challenging, yet it yields in excellent anatomical reduction and rigid fracture fixation and enables the restoration of articular congruity and facilitation of early knee motion thus achieving optimal knee function.

LIMITATIONS: Limited study group & Needs randomized control trials

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10. Patil S, Mahon A, Green S, McMurtry I, Port A. A biomechanical study comparing a raft of 3.5 mm cortical screws with 6.5 mm cancellous screws in depressed tibial plateau fractures. The Knee. 2006;13(3):231-5.


