Operative Results of Closed Tibial Plateau Fractures

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Abstract

Management of tibial plateau fractures remains challenging because of their number, variety and associated soft tissue injuries that further augment their complexity. Comparison of operative results in recent reports has been difficult due to a lack of standard fracture classification scheme and uniform standardized objective criteria for evaluating results.

Material and Methods: Between August 2003 to December 2004, 27 closed tibial plateau fractures were treated operatively using methods and principles advocated by AO/ASIF and followed up for an average of 35.74 months (range 24-68 months). Fractures were classified according to Schatzker’s staging system and results evaluated using Rasmussen’s 30-point clinical grading system and Rasmussen’s radiological evaluation of the knee at a minimum follow-up of 2 years.

Results: Type II was the most common fracture type (12 cases) followed by type I (8 cases). There were 37% excellent and 51.85% good functional results with only 3 patients having unacceptable results. The mean Rasmussen’s functional score was 25.062 (range 15-30). Minimal fixation in comminuted or depressed fractures as compared to rigid fixation was the cause of unacceptable results. Loss of knee range of motion in a few cases was attributed to delayed knee mobilization in these cases. Using Rasmussen’s radiological grading, 2 patients had excellent results and 81.48% patients had good results. Only 3 patients had poor radiological results. The mean Rasmussen’s radiological score was 15.33 (range 10-18). Moreover, clinical evaluation did not correlate with the follow-up radiograph.

Conclusion: Anatomic reduction and rigid internal fixation followed by early knee motion and partial weight bearing during bone healing are the cornerstones in the treatment of tibial plateau fractures. Standard fracture classification, uniform reporting and evaluating criteria, along with detailed analysis of uniform treatment methods, has helped us to enhance our understanding of these fractures.

Key Words: Tibia – Fracture – Intra-articular – Surgical result.

Introduction

FRACTURES of the tibial plateau are serious injuries that frequently result in functional impairment. The emphasis in treating displaced fractures is on anatomical restoration of articular surface, repair of soft tissue injuries and rigid internal fixation to obtain a stable painless knee joint with normal range of motion controlled by well functioning muscles however, comparison of operative results in recent reports has been difficult due to a lack of standard fracture.

Classification scheme and uniform standardized objective criteria for evaluating results. This article reviews the results of operative treatment of tibial plateau fractures using Schatzker’s staging system [1].

Material and Methods

Between August 1998 to December 2002, 31 closed tibial plateau fractures were treated operatively using methods and principles advocated by AO/ASIF [1,2]. Four patients were lost to follow-up and were excluded from the study. All cases were studied prospectively.

There were 23 males and 4 females with an average age of 42 years (range, 18-65 yrs).

The right knee was involved in 15 cases and left in 12 cases. The mode of injury was road traffic accidents or fall from height. Patients with multiple injuries, open fractures and those below 18 yrs were excluded from the study.

Pre-operative planning consisted of AP and lateral views in all cases and amount of displacement, depression and angulations were recorded. CT scan was kept as an option incases where fracture pattern or amount of depression was unclear. Condylar depression was measured from a
reference line level with the uninjured plateau. Condylar widening was obtained by measuring total width of tibial plateau just below the joint line and measuring the width of femoral condyles just above the joint line. These two measurements are normally equal [3].

Based on the radiograph, fractures were classified according to Schatzker’s staging system [1]. Operative treatment was performed when any intraarticular displacement or depression was present, or when the knee was clinically unstable when examined in extension.

Operative technique: The patients were operated using general or regional anesthesia. The type of surgical procedure undertaken was determined in part by the condition of soft tissues and other factors that determine the "personality of the fracture".

In minimally displaced fractures without depression, 6.5 mm cancellous screws were used to fix the fracture fragments through stab incisions over the fractured condyle. Since the majority of fractures involved the lateral condyle, a lateral incision was used most often. Medial approach was used for medial condylar fractures. Fractures involving both plateaus were exposed by two incisions lateral and medial to avoid dead bone sandwich.

All fractures were treated according to the principles advocated by AO/ASIF [1,2]. These principles include anatomic restoration of joint surface, rigid internal fixation combined with repair of ligaments and torn menisci.

A ruptured meniscus was either repaired if possible or excised, whereas a meniscus torn from its marginal attachment or detached to permit better visualization of the fracture was fixed with sutures. Torn anterior cruciate ligament (ACL) was left as such. The articular surface was reconstructed and depressed fracture fragments reconstituted with autogenous bone grafts from the iliac crest or artificial bone graft or both. Once anatomical reduction was obtained, fractures were fixed with 6.5 mm cancellous screws, cannulated screws or a precontoured T or L buttress plate. On completion of fixation, the stability of the fractures and knee were checked and any ruptured collateral ligaments repaired. The C-arm was used to check the adequacy of reduction before closure. A tension free, layered closure was carried out over a suction drain.

Post-operative care: The knee was immobilized in 10-60 degree of flexion in a long knee brace and isometric quadriceps exercises and hip raising exercises were started from 1st post-operative day. Knee mobilization was started from 3rd week onwards depending on the type of fracture, adequacy of fixation and the treating surgeon’s judgment. Protected weight bearing was begun in 15 patients within first 2 months post-surgery and in 12 patients over the next one month. The average interval between surgery and weight bearing was 10.52 weeks.

The patients were followed up in the outpatient department at 3 weeks, 6 weeks, 3 months, 6 months, and thereafter at appropriate intervals. During each visit the patients were evaluated both subjectively and objectively, using the Rasmussen’s 30-point clinical grading system and Rasmussen radiological evaluation of knee [4]. This system evaluated the patients both subjectively and objectively and thus gave a comprehensive picture of the patient’s condition. The results were analyzed in relation to fracture type, adequacy of reduction, associated injuries and time of knee mobilization. Relevant complications of the operative procedure and any subsequent secondary surgeries performed were also recorded. The final results were given at a minimum follow-up of 2 years.

Results

The average follow-up was 35.74 months (range 24-68 months). Type II fracture was most common, occurring in 12/27 patients followed by type I fracture in 8 patients. Type III occurred in 2 patients and type V and VI occurred in 5 patients each. There were no cases with type IV fracture.

Most patients (23) were operated within 10 days of injury. One patient was initially treated in a cylinder cast for 3 months, developed delayed union and then underwent buttress plating 5 months post-injury. The average interval between injury and operation was 6 days excluding the above-mentioned patient. Two patients developed septic arthritis and 3 patients had superficial infection, which resolved within 3 weeks. There were no cases of non-union/pseudoarthrosis, myositis ossificans, pulmonary embolism, deep vein thrombosis or failure of fixation. Radiographic Examination: Preoperative fracture depression averaged 4.42 mm (range 0-15 mm). Post-operative fracture depression averaged 2 mm (range 0-7 mm). Two patients had depression greater than 4 mm at final follow-up, one knee had 5 mm depression and one had 7 mm depression. No knee lost the initial post-operative reduction by more than 1 mm (Table 1).
Preoperative and postoperative x-ray of 3 cases.
Preoperative fracture displacement averaged 9 mm (range 0-27 mm). Post-operative fracture displacement averaged 2 mm (range 0-10 mm). Seven patients had >4 mm fracture displacement at final follow-up (Table 1).

Table (1): Fracture depression and separation.

<table>
<thead>
<tr>
<th>Fracture Depression (Mm)</th>
<th>Preoperative</th>
<th>Post operative</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-4</td>
<td>16 (59.25%)</td>
<td>25 (92.6%)</td>
</tr>
<tr>
<td>5-10</td>
<td>8 (29.63%)</td>
<td>2 (7.4%)</td>
</tr>
<tr>
<td>&gt;10</td>
<td>3 (11.11%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Table (2): Results criteria.

<table>
<thead>
<tr>
<th>Grading (Rasmussen’s)</th>
<th>Excellent</th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pain evaluation</td>
<td>13</td>
<td>7</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>Walking capacity</td>
<td>22</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Extension lag</td>
<td>22</td>
<td>2</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Range of motion</td>
<td>19</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Stability</td>
<td>27</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Functional results</td>
<td>10</td>
<td>14</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Radiological results</td>
<td>2</td>
<td>22</td>
<td>3</td>
<td>0</td>
</tr>
</tbody>
</table>

Associated Injuries: Associated intra-articular soft-tissue injuries occurred in 10 patients with ligamentous tears in 5 patients and meniscal injuries in 9 patients. Lateral meniscus was torn most commonly in 8 patients followed by anterior cruciate ligament (ACL) tears in 5 patients. Two patients had impending compartment syndrome. There were no cases with neurovascular deficits. Reported excellent functional results and 14/27 (51.85%) patients had good results. Only 3/27 (11.11%) patients reported a fair outcome with no poor outcomes (Table 2).

Discussion

Tibial plateau fractures occur in an important load-bearing joint. The aim of treatment is anatomical restoration of articular surface, similarly, repair of soft tissue injuries and rigid internal fixation to minimize pain, stiffness, deformity and instability. We have reviewed the results of 27 tibial plateau fractures, which were treated operatively according
to the principles advocated by AO/ASIF. We adhered to uniform reporting and evaluation criteria using Rasmussen’s functional and radiological grading system [4].

The patients reported in our series had some similarities with other published series. In 27 case studies done at our hospital, the mean age was 42 years. The majority of patients were in the age group 40-50. We found that the age variable did not show any significant association with results according to Krashkal Wallis Test (p=0.705) and hence was eliminated as being a confounder in our study. Similarly, it has been shown that age had no significant effect on the final results [5-7].

Nine out of 15 patients with condylar deformity were stable in 20° flexion suggesting that depression of the tibial condyle did not increase the rate of instability. This was attributed to an intact medial collateral ligament. Similar results were also given by Martin (1960) [8]. This however was not found to be statistically significant using Students t test (p=0.450) and Mann Whitney U test (p=0.705).

Type II was the most common fracture type occurring in 12 cases followed by type I in 8 cases. Bicondylar fractures occurred in 7 cases. There were no cases of type IV fracture. Biyani et al. [9] had also found type II to be the most common fracture type. Lateral condylar and bicondylar fractures were found to be more common than medial condylar fractures.

Marwah [10] and Ruslan et al. [11] stated the same in their studies. According to Chi Square Test, there was found to be no statistical association between fracture type and functional or radiological results (p=0.828 and 0.818 respectively). Similarly Lachiewicz and Funcik [12] had stated that fracture type was not a cause of less than excellent results in their study. During surgery, effort was made to achieve anatomical reduction of the fracture irrespective of the degree of comminution. The post-operative fracture depression was within 0-4 mm in 25 patients and the average was found to be 1.96 mm. The post-operative condylar separation was within 0-4 mm in 20 cases with an average of 2 mm. Blokker [13] stated that the single most factor in predicting outcome was the adequacy of reduction. A residual step of >5 mm at weight bearing was associated with unsatisfactory results in his series.

In our series we found that 17 patients with <4 mm residual widening had acceptable functional results. Using Spearman’s Rank test, there was no statistical correlation between residual condylar separation and functional results (Coefficient of correlation=0.143, p=0.486).

Implants used for fracture fixation were buttress plates, cancellous screws, and cannulated screws. We found that minimal fixation in comminuted or depressed fractures were associated with poorer results as compared to rigid fixation. Moreover, according to Chi-square test (p=0.044) and Spearman’s Rank test (Coefficient of correlation= 0.482, p=0.011) rigidity of fixation was directly related to better functional results. These maintain anatomic alignment of fractures, while buttressing the fragments and prevent loss of reduction under torsion or bending.

We also found that good range of movements at the knee was achieved in cases where knee mobilization was started early [Spearman’s Rank correlation coefficient= -0.540, p=0.004 (Highly significant)]. Early movements were possible in cases, where congruous articular surface and rigid fixation was achieved. Delay in mobilization resulted in periarticular scarring and loss of movements. Thus, in our study a direct relationship between congruous articular surface, early physiotherapy and resultant range of motion at the knee was found. Lachiewicz and Thomas [12] had stated that patients immobilized for >3 weeks, had mean range of movements 14° less than those immobilized for shorter periods. Rasmussen [4] and Drennan et al. [14] considered 6 weeks to be the upper limit of knee mobilization for restoring normal range of movements.

In our series we did not find any statistical correlation between period of immobilization and functional results due to comparatively larger number of patients mobilized within 4 weeks as compared to later on (Spearman’s Rank correlation coefficient= -0.214, p=0.285).

Finally, we believe that open reduction and rigid internal fixation, achieving a congruous joint surface, facilitates early knee mobilization and consequent good functional results in a majority of these controversial fractures.

References
3- STOKEL E.A.: Tibial Plateau Fractures—Standardized


