Arthroscopic-Assisted Fixation of Tibial Plateau Fractures: Patient-Reported Postoperative Activity Levels

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abstract

Tibial plateau fractures may result in significant limitations postoperatively. Studies have described outcomes of arthroscopic-assisted percutaneous fixation (AAPF) of these injuries but have rarely reported postoperative activity levels. Between 2009 and 2013, patients who sustained a lateral split, split depression, or pure depression type tibial plateau fracture (Schatzker types I-III fractures) and underwent outpatient AAPF were eligible for the study. Outcomes were assessed using Knee Injury and Osteoarthritis Outcome Score (KOOS), International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form, Lysholm score, and Marx activity score. Twenty-five consecutive patients were eligible for the study, and 22 (88%) were included in the final analysis, with average follow-up of 2.5 years (range, 1-5.2 years). Thirteen women and 9 men with an average age of 48.3 years (range, 23-65 years) comprised the study population. Average number of screws used for fixation was 2 (range, 1-4). The average depression was 8 mm preoperatively and 0.9 mm (range, 0-3 mm) postoperatively. Four patients (18%) had complications: 2 with hardware removal and 2 with postoperative deep venous thrombosis. Average postoperative Marx activity score was 5.7. Average postoperative KOOS Symptoms, Sports, and Quality of Life scores were 88 (range, 68-100), 85 (range, 45-100), and 77 (range, 50-100), respectively. Average IKDC and Lysholm scores were 81 (range, 55-97) and 87 (range, 54-100), respectively. The AAPF surgical technique, which was performed in an outpatient setting, facilitated excellent postoperative range of motion, outcomes, and activity scores with minimal complications. [Orthopedics. 2016; 39(3):e486-e491.]

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Table: Published Studies Reporting Outcomes After AAPF of Tibial Plateau Fractures

<table>
<thead>
<tr>
<th>Study</th>
<th>Level of Evidence</th>
<th>Total No. of Patients/Fracture Types</th>
<th>Mean Age, y</th>
<th>Average Follow-up, mo</th>
<th>Radiologic Outcome</th>
<th>Functional Outcome</th>
<th>Complications/Reoperation Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rossi et al, 2008</td>
<td>IV</td>
<td>46/Schatzker II-III</td>
<td>48 (SD, 13)</td>
<td>60</td>
<td>Average Rasmussen score: excellent in 5 (11%), good in 39 (85%), and fair in 2 (4%) patients; valgus deviation present in 4 patients (8.7%) on weight-bearing radiographs</td>
<td>Average Knee score: 93.2 (SD, 7.7); average HSS score: 93.4; average Rasmussen clinical score: 28.2 (SD, 1.4)</td>
<td>4 patients with radiographic osteoarthritic changes</td>
</tr>
<tr>
<td>Siegler et al, 2010</td>
<td>IV</td>
<td>27/Schatzker I-III</td>
<td>45 (range, 18-79)</td>
<td>59.5</td>
<td>Mean Rasmussen score: 8; early osteoarthritis present on radiographs in 47.6% of patients</td>
<td>Mean IKSS scores: 85.2 (knee score) and 91 (function); mean Lysholm score: 86; mean Tegner score: 4</td>
<td>4 cases of CRPS, 4 cases of secondary compression, 2 surgical revisions, and 11 hardware removal</td>
</tr>
<tr>
<td>Levy et al, 2007</td>
<td>IV</td>
<td>16/Schatzker II</td>
<td>44.8 (range, 32-78)</td>
<td>41</td>
<td>Mean Rasmussen score: 16.8; mean fracture depression at final follow-up: 0.6 mm (range, 0-4)</td>
<td>No functional outcomes assessed</td>
<td>4 patients had radiographic fracture collapse and 3 patients had &lt;2 mm depression</td>
</tr>
<tr>
<td>Kayali et al, 2008</td>
<td>IV</td>
<td>21/Schatzker I-III</td>
<td>41</td>
<td>38 (range, 12-96)</td>
<td>Based on Rasmussen criterion: 11 excellent (52%), 7 good (33%), and 3 fair (14%) results</td>
<td>Clinical results: 13 excellent (62%), 6 good (28%), and 2 fair (10%)</td>
<td>4 patients required hardware removal; mild changes in 3 patients (14%) and moderate changes in 2 patients (10%)</td>
</tr>
<tr>
<td>Current study</td>
<td>IV</td>
<td>22/Schatzker I-III</td>
<td>30</td>
<td>Average postoperative Marx activity score: 5.7; average postoperative KOOS Symptoms, Sports, and Quality of Life scores: 88 (range, 68-100), 85 (range, 45-100), and 77 (range, 50-100), respectively; average IKDC score: 81 (range, 55-97); average Lysholm score: 87 (range, 54-100)</td>
<td>Average postoperative depression on radiographs: 0.9 mm</td>
<td>4 patients (18%) had complications: 2 required hardware removal and 2 had postoperative DVT</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviations: AAPF, arthroscopic-assisted percutaneous fixation; CRPS, chronic regional pain syndrome; DVT, deep venous thrombosis; HSS, Hospital for Special Surgery; IKDC, International Knee Documentation Committee; IKS, International Knee Society; KOOS, Knee Injury and Osteoarthritis Outcome Score; ROM, range of motion.
reported postoperative activity scores in patients.4

The purpose of this study was to report a series of unicodylar tibial plateau fractures treated with AAPF, with an emphasis on functional outcome using traditional knee outcome scores, as well as an activity-based functional outcome, the Marx activity score.

**Materials and Methods**

After obtaining institutional review board approval, a retrospective chart review was conducted to identify all patients who underwent AAPF of lateral split, split depression, or pure depression type (Schatzker type I-III) tibial plateau fractures at a single ambulatory orthopedic specialty center.5 All patients had standard anteroposterior and lateral radiographs, and all but 1 patient subsequently underwent computed tomography or magnetic resonance imaging. All patients were evaluated in the clinic preoperatively by the surgeon and scheduled for outpatient surgery. Preoperative radiographs were compared with postoperative radiographs at a minimum of 3 months (range, 3-24 months) for maintenance of reduction.

Indications for this technique included split, split depressed, or pure depression lateral tibial plateau fractures with 3 mm or more of joint depression. Poor bone quality or severe comminution was not considered a contraindication as these characteristics were believed to be best suited for this indirect technique.

Intraoperatively, diagnostic arthroscopy was performed. Depressed fractures were elevated using the technique described by Levy et al.6 This technique uses a cortical window to elevate the depressed area with a bone tamp under fluoroscopic guidance after the depressed area is localized in 2 planes with a guide pin and overdrilled. Anterior cruciate ligament (ACL) guides were not routinely used in this series; however, ACL guides may be used for ease based on the surgeon’s comfort with C-arm localization.

Anatomic reduction was confirmed using both fluoroscopy and direct visualization with arthroscopy. Cannulated screws were placed percutaneously, and bone defects were filled with allograft or bone substitute. Hinged knee braces were used postoperatively, and progressive range of motion was allowed. Weight bearing was commenced at the surgeon’s discretion.

Postoperatively, patients underwent clinical examination, and anteroposterior and lateral radiographs of the affected knee were obtained. Patients completed the KOOS functional score,7 Lysholm knee scale,8 International Knee Documentation Committee (IKDC) Subjective Knee Evaluation Form,9 and Marx activity rating scale.10

**Results**

Twenty-five consecutive patients were eligible for the study, and 22 patients (88%) were included in the final analysis, with average follow-up of 2.5 years (range, 1-5.2 years). One patient moved out of state and transferred care after the 2-week postoperative visit, and 2 patients did not have 1 year of complete clinical follow-up; these patients were excluded from the study. Thirteen patients were women, and 9 patients were men. Average patient age was 48.3 years (range, 23-65 years). Average time from injury to surgery was 12 days (range, 5-21 days).

Of the 22 patients, 12 (55%) were injured after a fall from a standing height (9 patients) or a more substantial height (3 patients), 9 (41%) were injured during sports participation, and 2 (9%) sustained contact injuries from falls from bikes. Four patients had concomitant injuries that included an ipsilateral radial head fracture, an ipsilateral Weber A distal fibula fracture, a contralateral calcaneus fracture, and an ipsilateral ankle sprain; all of these injuries were treated nonoperatively. Twenty patients had lateral split depressed Schatzker type II fractures, 1 patient had a lateral split Schatzker type I fracture, and 1 patient had a Schatzker type III fracture. Figure 1 shows radiographs of a lateral depression plateau fracture.
There were no intraoperative complications. Arthroscopic examination revealed a total of 10 patients with 12 meniscal tears. Six tears were treated with partial meniscectomy and 4 tears were repaired; the remaining 2 tears were stable and required no intervention. Figure 2 shows an arthroscopic view of depressed cartilage and a depressed posterior horn. One medial collateral ligament injury was found, and a primary repair using suture anchors in the proximal tibia was performed. A single screw was used in 3 cases, 2 screws were used in 10 cases, 3 screws were used in 8 cases, and 4 screws were required in 1 case. Bony defects were filled in all but 1 patient. In 16 of the 22 cases, calcium phosphate cement was used to fill the defect, and in 8 cases, cancellous allograft was used. None of the patients had postoperative hematomas, and there were no wound complications. Figure 3 shows a typical postoperative anteroposterior radiograph.

All fractures united, and no revision surgeries were required. Preoperatively, the average depression was 8 mm, and postoperatively, the average depression was 0.9 mm (range, 0-3 mm). One patient was admitted postoperatively for hypoxemia; this patient was discharged the following day without any residual effects. All of the other patients were treated as outpatients. Four patients underwent screw removal for prominent hardware. Two patients developed a postoperative deep venous thrombosis and were treated with warfarin. At final follow-up, mean flexion was 132° (range, 110°-165°) and mean extension was zero (range, -2° to 10°). Full weight bearing was allowed at an average of 44 days (6.2 weeks) postoperatively.

Twenty of the 22 patients (89%) completed the outcome measures at final follow-up. The average postoperative Marx activity score was 5.7 (range, 3-12), and 50% of patients returned to recreational sports. All patients were able to return to their desired activity level. Average KOOS Symptons, Sports, and Quality of Life scores were 88 (range, 68-100), 85 (range, 45-100), and 77 (range, 50-100), respectively. The average KOOS Pain and Function scores were 92 (range, 64-100) and 97 (range, 85-100), respectively. Mean postoperative IKDC score was 81 (range, 55-97), and mean postoperative Lysholm score was 87 (range, 54-100).

DISCUSSION

The management of tibial plateau fractures has been debated in the literature for many years. Ideal management results in anatomic reduction with stable fixation to allow for early range of motion. Methods that can minimize surgical dissection and disruption of the fracture site while also avoiding an arthrotomy may include arthroscopic-assisted fracture reduction and fixation. The use of this method avoids the disruption of any meniscal or ligamentous attachments. In addition, because the reduction of the fracture is performed in an indirect manner, the need for extensive dissection of bone fragments also is avoided.

Arthroscopic-assisted percutaneous fixation has gained popularity since first being described by Caspari et al and Jennings. Recent reports of arthroscopic techniques advocate its use not only to better visualize the articular surface of the tibia, but also to evaluate the rest of the joint. Other advantages include the ability to identify and treat intra-articular soft tissue injuries.

Most series describing AAPF have focused primarily on Schatzker types I-III fractures. The current study is similar and includes only patients with those fracture types. In this population, AAPF is particularly useful as it can be performed efficiently and with minimal increase in operative time.

Arthroscopic-assisted percutaneous fixation has been suggested as a potential risk factor for compartment syndrome during arthroscopic examination. However, only 2 cases of compartment syndrome have been reported after AAPF, and Chen et al concluded in their recent systematic review that the risk of true compartment syndrome is low. There were no cases of compartment syndrome in the current series.

Siegler et al were the first to include KOOS scores in their study, and the cur-
The current series is only the second study to include this outcomes measure. The scores in the current study are similar to those reported by Siegler et al. In addition, Williamson et al recently presented data on normative data in a population with uninjured knees. The postoperative KOOS results in this series were similar to that noted in a population of 40- to 50-year-old men and women with no previous history of knee injury. This suggests that when taking into account age-related changes in the KOOS, patients were able to return to baseline compared with a normal population of uninjured adults.

To date, no other AAPF study has used the Marx activity scale, which measures a patient’s functional activity by avoiding sport-specific questions, unlike many of the knee outcome measures. The scale is not based on participation in specific sports but instead asks questions about components of physical function that are common to different sporting activities. This becomes important as the mean patient age in the current series was 48 years, and this age group tends to be less involved with organized sports activities. Thus, it is important to measure their true daily functional abilities.

The Marx scale consists of 4 questions, each scored 0-4, resulting in a minimum score of zero and a maximum score of 16 and pertains to the patient’s highest peak activity in the past year. This distinction is important since activity level at a given point in time can be affected by the season or by a recent injury. In the original study by Marx et al, the median baseline Marx score was 7 among 40 volunteers tested with a mean age of 33.7 years (range, 18-50 years).

Spindler et al described the average baseline Marx score was 12 prior to ACL injury in a cohort of 375 men and women with an average age of 28 and 25 years, respectively. Two years after ACL reconstruction, the median Marx score was 9, and this dropped to 7 at the 6-year follow-up examination. The mean Marx score of 5.7 in the current study seems appropriate given the average age of the current cohort; however, comparison with other studies is not possible because no other AAPF studies have included the Marx activity score.

Multiple reports describe inpatient stays after open reduction and internal fixation of tibial plateau fractures. The reported length of stay has ranged from 2 to 7 days postoperatively. In the current series, surgery was safely performed in the outpatient setting; only 1 patient required admission postoperatively secondary to hypoxemia, which resolved overnight, and the patient was discharged the following day. No drains were used given the outpatient basis, and no hematomas or wound complications were observed. Patients in the current series achieved excellent range of motion, and none required a manipulation. The authors performed hardware removal in 4 patients (15%). This compares to other studies, which have reported hardware removal rates ranging from 2% to 52%. Hardware removal is not always considered a complication in some studies and may be underreported. Thus, the incidence in the present study is comparable to the literature.

There were several limitations to the current study. These include the retrospective nature of the study, the small number of patients, and the short length of follow-up. However, a recent systematic review by Chen et al on AAPF tibial plateau fractures noted only 2 level III studies and no prospective studies since 2001. In addition, the systematic review noted a total of 609 patients in all of the included studies, with only 1 of the studies reporting activity levels in patients postoperatively. Additional limitations of the current study include the cohort including only Schatzker type I-III fractures, whereas other studies were more inclusive of all fracture types. These particular fracture types are well suited for AAPF. In the current study, all of the patients underwent surgery at an outpatient surgery facility, and no patients presented with Schatzker type IV-VI fractures. However, the principles of AAPF can aid surgeons in the treatment of all tibial plateau fractures, as described by the various fracture types in the systematic review by Chen et al.

The complication rate in the current study was higher than reported in the systematic review by Chen et al. However, not all studies consider hardware removal a postoperative complication. Finally, the retrospective nature of the current study precluded the ability to compare pre- and postoperative Marx activity scores. However, all of the patients in the study were able to return to their desired level of activity. Use of the Tegner or other activity scores would also allow for more analysis regarding the activity level of these patients; however, the current study did not use such scales.

CONCLUSION
This study is one of the first to report on activity levels after AAPF in a population of patients who sustained Schatzker type I-III fractures of the tibial plateau. This surgical technique enabled patients to begin early rehabilitation, facilitating return of function and range of motion, and excellent outcome and activity scores were achieved in the study population. In addition, the surgical technique was performed in an outpatient setting, with minimal complications.

REFERENCES


