Tibial Plateau Fractures with and without Meniscus Tear
Results of a Standardized Treatment Protocol

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Abstract
Objectives: The purpose of this study was to determine what patient and injury factors are associated with the presence of a meniscus tear in tibial plateau fractures. We also sought to compare functional outcome, pain scores, and range of motion between patient groups with and without meniscal injury.

Materials and Methods: A total of 99 patients with 101 acute tibial plateau fractures were included in the study cohort. Patients were divided into two groups: those with and without meniscal tears at the time of initial injury. Statistical analysis with Student’s t-test for continuous variables and chi square test for categorical variables was performed to compare those with and without a meniscal tear. Logistic regression was performed to identify the variables that predicted the presence of a meniscus tear and repeated ANOVA measures were used to assess functional outcome scores.

Results: Fifty-four patients with 56 tibial plateau fractures (55%) were found to have an associated meniscal tear. The average amount of joint depression in this group was 12.3 mm (range: 2.0 to 29.5 mm). The remaining 45 patients with 45 fractures (45%) had an average depression of 5.4 mm (range: 0.0 to 12.8 mm). Degree of tibial plateau depression was the only significant predictor of meniscal injury.

Conclusions: Our findings suggest that amount of depression in tibial plateau fractures is a significant predictor of the occurrence of a meniscus tear with an odds ratio of 1.36. We also found no significant difference in the functional outcome, pain scores, and knee range of motion between the group with and without meniscus tears at the longest follow-up interval. These findings suggest that acute repair of meniscal injury following traumatic fracture of the tibial plateau could produce functional results similar to those patients that did not sustain a meniscus tear.

The knee is an anatomically complex joint, which is functionally dependent on both soft tissue and bony structures. As one of the largest joints in the body, the tibio-femoral joint is stabilized and controlled by four main ligamentous structures: the medial collateral ligament (MCL), lateral collateral ligament (LCL), anterior cruciate ligament (ACL), and posterior cruciate ligament (PCL), as well as the menisci, which cushion the space between the tibia and femur. The menisci of the knee have many important functions including load transmission, shock-absorption, passive stabilization of the knee joint and cartilage nutrition, and lubrication via synovial fluid. The load bearing and shock absorbing functions of these structures makes them increasingly susceptible to injury during a traumatic event. Direct trauma about the knee produces indirect shearing and compressive forces from axial loading to the tibial plateau. The magnitude of the force and position of the extremity at the time of trauma determine the amount of comminution, articular depression, and extent of soft tissue injury imparted to the joint.

Tibial plateau fractures are complex injuries to treat due to their articular involvement and associated disruption of ligamentous structures in the knee. The primary aim of fracture treatment is to restore the congruence of the articular surface and ensure mechanical axis alignment. Any deviations from anatomical condylar position or ligamentous instabilities may lead to an increased likelihood of
degenerative osteoarthritis and subsequent reduced functional abilities. More recent studies have been conducted examining the incidence of soft tissue injuries associated with displaced and non-displaced tibial plateau fractures. Because of the nature of this injury and the energy required to sustain a fracture of the tibial plateau, it is now widely accepted that the incidence of soft tissue injuries, such as meniscal tears and ligamentous lesions (ACL, PCL, LCL, and MCL), are common, ranging from 47% to 99%. The frequency of soft tissue injury has been found to be in direct correlation with the energy of the initial injury, which often translates to fracture classification. There has yet to be a gold standard for accurately predicting the presence of soft tissue injuries in tibial plateau fractures. However, there have been recent studies that have employed preoperative magnetic resonance imaging (MRI) or operative arthroscopy to evaluate the extent of tissue damage. Although these techniques have proven useful in operative intervention and preoperative planning based on the specific ligamentous or meniscal injuries sustained, they incur extra costs and may require increased operative time and potential complications in cases that are evaluated arthroscopically. To the investigator’s knowledge, there have been no studies to date that have assessed functional outcome and long-term pain scores between patients with and without acute meniscal tears following traumatic fracture of the tibial plateau.

The purpose of this study was twofold. First, we sought to evaluate specific injury and patient factors such as fracture classification, mechanism of injury, amount of condylar depression, age and gender in patients who had sustained tibial plateau fractures with the presence of a meniscus tear identified at the time of surgery. Second, we sought to assess functional outcome at the longest follow-up between those patients who had sustained a meniscus tear in association with a tibial plateau fracture and those who did not.

Patients and Methods

All patients with acute tibial plateau fractures were evaluated by one of two orthopaedic traumatologists at our academic medical center. One hundred and ten consecutive patients with 112 tibial plateau fractures were identified between April 2006 and August 2011 and enrolled in this registry. Eleven patients (10.0%) were found to have fracture stability with minimal displacement and therefore did not receive operative treatment. These patients were subsequently excluded from our study. All subjects received preoperative CT scans or plain radiographic films or both. Fractures were classified according to the Schatzker system by the attending orthopaedic surgeon. Socio-demographic data was recorded, including: patient age, gender, and mechanism of injury. The amount of plateau depression was measured in millimeters from the coronal plane of computed tomography (CT) scans using the PACS Imaging System (GE Medical Systems, Chalfont, St. Giles, United Kingdom) or from the anteroposterior (AP) view of plain radiographic films if CT scans were not available, as was the case in seven fractures (6.9%). Measurements were taken by drawing three lines: the first line was drawn tangential to the neutral plane of the articular surface of the unaffected condyle, the second line was drawn tangential to the lowest point of depression, and the third line was a perpendicular measurement between the two horizontal lines, indicating the total amount of depression. In cases of bicondylar involvement, depression was assessed in the same manner as previously described; however, the highest point on the less severely affected condyle was used as the point from which to measure the first horizontal line. If CT scans were not available, the same method was used on the AP view of plain radiographic films. All measurements were conducted in this fashion by trained research assistants (Fig. 1).

All fractures with clinical varus or valgus instability or articular incongruity of 4 mm or greater were indicated for operative repair. Surgery was delayed if there was significant swelling about the knee. Operative fixation was based on fracture displacement, angulation, and plateau depression. The presence of a meniscus tear was noted intraoperatively in all cases and patients were grouped according to the presence or absence of a meniscus injury. All operatively treated compartments were inspected for the presence of a meniscal tear. No attempt was made to visualize soft tissues within an unaffected compartment of the knee. Subjects requiring a submeniscal arthrotomy who were not found to have any

Figure 1 Preoperative coronal reformatted CT image of a Schatzker II tibial plateau fracture. Forty-eight-year-old male sustained the injury status post fall from a motorcycle. A lateral meniscus tear was noted intraoperatively and repaired. Measurements: A, Tangential line to neutral plane of articular surface; B, Parallel to line A, tangential to lowest point of depression; C, Perpendicular measurement indicating total amount of depression.
soft tissue damage at the time of injury were placed into the group without a meniscal tear.

The study cohort included 52 men (52.5%) and 47 women (47.5%) with an average age at the time of surgery of 47 years (range: 19 to 86). The mean follow-up period was 14.2 months (range: 6 to 36 months). Mechanism of injury included a low velocity fall in 28 patients (28.3%), high velocity fall in 12 (12.1%), motor vehicle accident in 13 (13.1%), pedestrian struck in 26 (26.3%), sports injuries in 5 (5.1%), motorcycle accident in 8 (8.1%), altercation or assault in 2 (2.0%), bike vs. car in 3 (3.0%), crush injury in 1 (1.0%), and gunshot wound in 1 (1.0%). Fractures were assessed using the Schatzker classification systems. Schatzker classification distribution was as follows: 3 Schatzker I (3.0%), 51 Schatzker II (50.5%), 1 Schatzker III (1.0%), 9 Schatzker IV (8.9%), 12 Schatzker V (11.9%), and 25 Schatzker VI (24.7%).

Patients were asked to complete a Short Musculoskeletal Function Assessment (SMFA) questionnaire, visual analogue scale (VAS) pain scores, and knee range of motion measurements obtained by the treating physician during regularly scheduled clinical follow-up at 3, 6, and 12 months. Patients with a period of 6 months or greater follow-up were included in our analysis of functional outcome as determined by SMFA, pain scores, and range of knee motion. Patients with less than 6 months follow-up were analyzed for demographic variables and amount of depression only in relation to the presence or absence of a meniscus tear.

Statistical Methods
The two groups (meniscus tear vs. no meniscus tear) were compared for significant differences in specific demographic and clinical variables such as age, gender, amount of depression, Schatzker classification, and mechanism of injury. In the univariate analysis, Student’s t-test was performed for continuous variables and chi square test was performed for categorical variables. Repeated measures analysis of variance (ANOVA) was used to compare the groups with regard to change in SMFA scores, pain scores, and range of motion between the baseline and longest follow-up interval. Logistic regression was performed to identify the variables that predicted the presence of a meniscus tear. All statistical tests were conducted with a two-tailed hypothesis and type I error rate of 0.05 using SPSS version 17 (IBM Corporation, Chicago, Illinois, United States).

Results
Fifty-four patients with 56 tibial plateau fractures (55.4%) and an average age of 47 years (range: 19 to 75 years) were identified as having a meniscus tear. The average amount of condylar depression for this group was 12.3 mm (range: 2.0 to 29.5 mm). Four of the 57 injuries (7.1%) were found to have tears of the medial meniscus; the remainder of the group sustained injury to the lateral meniscus only. In all but one case, the tear occurred at the meniscosynovial junction. One patient (1.8%) required a partial knee lateral partial meniscectomy because the complex meniscus tear was irreparable. All other meniscal injuries were repaired intraoperatively. In all cases, a submeniscal arthrotomy was performed to gain direct access to the site of depression and allow for restoration of articular congruity (Fig. 2). Any further disruption of intracapsular soft tissue was repaired prior to closing. Forty-five of the 101 fractures (44.6%) did not have an associated a meniscus tear. This group had an average patient age of 48 years (range: 19 to 86 years) and an average amount of depression of 5.4 mm. No significant differences existed in age, gender, mechanism of injury, or Schatzker classification between the two groups (p = 0.891, p = 0.842, p = 0.678, and p = 0.554, respectively). The most significant variable indicating the presence of a meniscus tear was the amount of condylar depression (p < 0.001) (Table 1).

Logistic regression analysis demonstrated that every 1 mm increase in the amount of depression is associated with a 36.2% increase in the odds of having a meniscus tear (95% CI [18, 57]); no other demographic data or Schatzker classification type fracture were found to be significant predictors of the presence of a meniscus tear in the same logistic regression model (Table 2 and Fig. 3).

Seventy-one patients (71.7%) were evaluated at clinical follow-up at an average of 14.2 months postoperatively. Fifty-one of the 71 patients (71.8%) included in our functional analysis had a 12 month or greater follow-up interval. Twelve subjects (12.1%) were lost to follow-up; one patient (1.0%) died from unrelated causes. Fifteen patients (15.2%) had not reached the 6 month follow-up interval and were subsequently excluded from our analysis. Demographic and injury data were not found to be significantly different between the patients who were lost to follow-up and those excluded and those included in our long-term functional outcome. No significant differences were observed in any...
category of the SMFA at the most recent follow-up between the two groups (14.5 and 13.9 months for the tear and no tear groups, respectively). Pain scores and range of motion, as determined by comparing flexion and extension to baseline for each patient also did not demonstrate any significant differences (p = 0.306, 0.742, and 0.271 for pain, flexion, and extension, respectively).

Radiographically, 81 out of 101 (80.2%) fractures healed with near anatomic alignment. In the meniscus tear group, 3 patients (5.5%) developed early post-traumatic arthritis at a mean 6.7 months and 2 patients (3.7%) that were found to have lateral plateau collapse or settling. In the group without meniscus tears, two had developed post-traumatic arthritis (4.4%) at a mean of 6.0 months with one patient (2.2%) undergoing a total knee arthroplasty (TKA) at 10 months as a result of exacerbation of pre-existing osteoarthritis.

Four patients (7.4%) within the meniscus tear group experienced postoperative complications. One patient (1.9%) had restricted range of motion due to arthrofibrosis and was indicated for surgical manipulation of the knee under anesthesia; one patient (1.9%), in each respective category, was treated for postoperative cellulitis, pulmonary embo-

### Table 2 Predictors of Meniscus Tear

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Standard Error</th>
<th>Significance (p-value)</th>
<th>Odds Ratio</th>
<th>95% CI for Odds Ratio Lower</th>
<th>95% CI for Odds Ratio Upper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 1*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.018</td>
<td>0.483</td>
<td>0.988</td>
<td>0.954</td>
<td>1.022</td>
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<tr>
<td>Gender</td>
<td>0.495</td>
<td>0.995</td>
<td>0.997</td>
<td>0.378</td>
<td>2.627</td>
</tr>
<tr>
<td>Schatzker</td>
<td>0.452</td>
<td>0.939</td>
<td>1.035</td>
<td>0.427</td>
<td>2.510</td>
</tr>
<tr>
<td>dSchatzker</td>
<td>1.626</td>
<td>0.834</td>
<td>0.711</td>
<td>0.029</td>
<td>17.220</td>
</tr>
<tr>
<td>Mech of Injury</td>
<td>0.088</td>
<td>0.776</td>
<td>1.025</td>
<td>0.863</td>
<td>1.218</td>
</tr>
<tr>
<td>Depression</td>
<td>0.074</td>
<td>0.000</td>
<td>1.362</td>
<td>1.178</td>
<td>1.574</td>
</tr>
</tbody>
</table>
ism and deep infection requiring subsequent irrigation and debridement. Five patients (11.1%) in the no meniscus tear group had a postoperative complication. Complications included arthrofibrosis in one patient (2.2%) and four different patients who developed four separate complications including: one anterior compartment syndrome, one chronic osteomyelitis, one septic arthritis, and one infected nonunion (2.2%, respectively), (Table 3).

Discussion

While fracture classifications provide the treating physician with information about the fracture pattern and joint stability, serving as guides to understanding the energy of trauma to the affected limb,15 they do not always address associated soft tissue injuries. Because of the complex structure of the knee joint itself, careful preoperative planning must be employed to obtain an acceptable reduction while attending to these critical associated soft-tissue injuries. The ability to develop an algorithm based on various patient factors without the use of costly diagnostic modalities would serve as an invaluable guideline to preoperative planning of these injuries. This study demonstrated a direct relationship between the amount of condylar depression and the increasing incidence of meniscal injury, as determined by measurements from plain radiographic films and coronal plane CT scans. Although this relationship may seem intuitive, specific quantifiable analysis provides an accurate reference for the prediction of soft-tissue injury. Along with developing an algorithm to predict the presence of a meniscus tear following tibial plateau fractures, we also found no significant difference between functional outcome and pain scores or range of knee motion at the longest follow-up interval. This finding suggests that successful acute repair of meniscal lesions following this type of injury provides patients with equal rehabilitation potential and may not negatively affect long term functional ability.

Various studies have employed the use of magnetic resonance imaging (MRI) as a tool for preoperatively diagnosing the presence of soft-tissue injury as well as the severity of tibial plateau fractures.5,11,14,16,17 Many investigators reported that MRI affords an accurate evaluation of bony defects in addition to depicting the extent of soft tissue damage, as opposed to computed tomography.13,14 Barrow and coworkers13 suggested that MRI was comparably effective as CT in depicting the amount of articular depression, however, was a significantly more effective modality for appreciating the extent of comminution as well as ligamentous and meniscal injuries. Patients were found to have an increased prevalence of associated soft tissue injury as the amount of condylar depression increased and as a result of high energy trauma, with Schatzker classified fracture types II, IV, and VI. Although the results of this study demonstrated that MRI served as a more accurate evaluation of the extent of comminution, measurements of articular depression, which were more closely associated with meniscal or ligamentous injury as assessed with tomography and MRI, were essentially the same.

In another MR imaging study, Brophy and colleagues14 concluded that the use of MRI as a preoperative diagnosis

Table 3  Postoperative Complications—Meniscus Tear versus No Meniscus Tear

<table>
<thead>
<tr>
<th>Postoperative Complications (%)</th>
<th>Meniscus Tear (N = 54)</th>
<th>No Meniscus Tear (N = 45)</th>
</tr>
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<tbody>
<tr>
<td>Arthrofibrosis</td>
<td>4 (7.4)</td>
<td>5 (11.1)</td>
</tr>
<tr>
<td>Cellulitis</td>
<td>1 (1.9)</td>
<td>1 (2.2)</td>
</tr>
<tr>
<td>Pulmonary embolism</td>
<td>1 (1.9)</td>
<td>0</td>
</tr>
<tr>
<td>Infection</td>
<td>1 (1.8)</td>
<td>0</td>
</tr>
<tr>
<td>Compartment syndrome</td>
<td>0</td>
<td>1 (2.2)</td>
</tr>
<tr>
<td>Osteomyelitis</td>
<td>0</td>
<td>1 (2.2)</td>
</tr>
<tr>
<td>Septic arthritis</td>
<td>0</td>
<td>1 (2.2)</td>
</tr>
<tr>
<td>Infected nonunion</td>
<td>0</td>
<td>1 (2.2)</td>
</tr>
</tbody>
</table>
and preoperative planning tool was superior to other modalities such as radiographs and CT scans. This conclusion was supported by evidence that MRI is valuable in bony evaluation as well as direct visualization of soft-tissues, therefore, providing a more accurate predictor as to whether or not surgical management is required, particularly for minimally or non-displaced fractures. Shepherd and associates\textsuperscript{11} found that physical examination alone may not adequately assess soft-tissue pathology for nonoperative, minimally displaced tibial plateau fractures. This study reported an overall 90\% (18 of 20) incidence of the non-displaced tibial plateau fractures having associated soft-tissue lesions, comprised of 80\% (16 of 20) meniscal tears, as evaluated by MRI. This finding provides strong support that soft tissue injury is still likely to be prevalent even in non-displaced fractures. Orthopaedic surgeons should be mindful of this information when treating these fractures nonoperatively to avoid potential for further damage or arthritis of the joint. However, the natural ability for ligamentous or meniscal injuries to repair during the fracture healing process is unknown, and therefore, no standard indication exists as to whether or not surgical intervention is necessary.

Additional MR imaging studies have reported similar findings to those previously mentioned, including the largest MRI series of operative plateau fractures to date, conducted by Gardner and coworkers\textsuperscript{5}; the investigators of this study reported an overall higher incidence of soft-tissue injury than previously reported as determined by preoperative MRI. Of 103 patients, 94 (91\%) patients had significant injury to the lateral meniscus, medial meniscus lesions were reported in 45 (44\%) patients, and a total of 102 (99\%) showed evidence of disruption of soft tissue structures surrounding the knee joint. The most common fracture type seen with lateral meniscus tears was Schatzker II (81\%); a Schatzker IV fracture pattern was associated most frequently (76\%) with a medial meniscus injury. With the reported incidence of soft-tissue damage associated with tibial plateau fractures increasing, many of these studies suggest that the use of MRI is superior to plain radiographs and CT scans because it provides an increasingly accurate method for which to predict lesions to functionally and structurally important soft tissues in the knee joint.\textsuperscript{10,17} One such study by Yacoubian and colleagues\textsuperscript{18} reported a statistically significant 23\% of preoperative management plans changed after evaluating MRI in addition to plain radiographs as compared to a group with plain radiographs alone. Kode and associates\textsuperscript{19} compared the efficacy of MR imaging with CT scans to evaluate the extent of soft tissue injuries in plateau fractures. The study revealed that MRI was superior or equivalent to two-dimensional computed tomography in depicting fracture composition in 86\% (19 of 22) of patients, with a 55\% (12 of 22) incidence of meniscal injury detected, which was not visualized in computed tomography.

Although MRI has proven to be a useful tool in diagnosing soft-tissue injury in these technically difficult to treat fractures, it is associated with high costs and limited availability at some medical centers. The use of MRI in diagnosing meniscal injury may also be inaccurate in fractures of the tibial plateau because of excessive edema in the surrounding tissues, which can alter the diagnosis. A study by Gardner and coworkers\textsuperscript{5} employed the use of preoperative anteroposterior (AP) plain radiographs and MRI to determine whether condylar depression and widening were predictive of soft-tissue injury in Schatzker II tibial plateau fractures. This study attempted to correlate the amount of plateau depression and widening as measured on plain radiographs with occurrence of soft-tissue injury to allow treating surgeons to quantitatively estimate the probability of these injuries without the use of expensive diagnostic tools with limited availability such as MRI. Results demonstrated that when there was condylar depression greater than 6 mm and widening greater than 5 mm, lateral meniscal pathology was noted in 83\% (20 of 24) of patients; these findings confirmed that soft-tissue injury occurs with increasing frequency above specified thresholds of fracture displacement.

Another method for which to diagnose soft-tissue injuries associated with tibial plateau fractures is through arthroscopic evaluation. A study conducted by Abdel-Hamid and colleagues\textsuperscript{9} reported a 71\% (70 of 98) frequency of associated soft-tissue injuries in fractures of the tibial plateau; peripheral meniscal injury was the most common lesion in all six types of Schatzker classified fractures with no significant correlation between fracture type and incidence of soft-tissue injury. In an arthroscopic study by Vangsness and associates,\textsuperscript{9} 47\% (17 of 36) of closed tibial plateau fractures had sustained damage to the meniscus at the time of injury; no correlation between fracture pattern and meniscal injury was noted. However, of the 25 fractures requiring internal fixation, 16 (64\%) had meniscal tears as compared to one meniscus tear of the 11 (0.9\%) fractures treated by closed methods. Both studies concluded that arthroscopy provides a quick, safe, and precise method of diagnosis and treatment, although not necessary for diagnosis of soft-tissue lesions in such injuries. Arthroscopy may serve as an accurate modality for which to evaluate these injuries; however, studies have not demonstrated superior results in assessing incidence of soft tissue injury as compared to CT scans or MRI. This method requires increased operative time, which incurs extra costs and may increase the risk of patient morbidity at the surgical site.

Ringus and coworkers\textsuperscript{20} sought to determine the degree to which CT images predicted the presence of a lateral meniscus tear. Twenty eight (32.9\%) out of the 85 total patients included in the study cohort were found to have a lateral meniscus tear at the time of surgery. This study revealed that tibial plateau fractures with depression greater than or equal to 10 mm were eight times more likely to have sustained a lateral meniscus tear as compared to those with less than 10 mm of depression. They also determined that patients younger than 48 years of age had a four-fold increase in the
risk of having sustained a lateral meniscus tear than older patients. Although this study demonstrated similar findings to ours, no assessment of long-term functional outcome was provided. In a series examining 30 tibial plateau fractures, Bennet and colleagues reported a 56% frequency (17 of 30) of associated soft tissue injuries, the most common of which being medial collateral ligaments and meniscus, occurring in 6 of 30 (20%), respectively. Meniscus tears were present only on the fractured condyle in Schatzker type I, II, and IV; amounts of plateau depression or comminution were not quantified.

There has yet to be a gold standard for the method in which to treat ligamentous or meniscal injury following tibial plateau fractures. However, acute fixation of osseoligamentous injuries is mandatory in decreasing the risk of chronic knee instability and osteoarthritis. Blokker and associates found that poor functional results may have been associated with failure to recognize concomitant ligamentous or meniscal injuries. All recognized ligamentous injuries were surgically treated at the time of definitive repair with a reported 75% (45 of 60) rate of satisfactory results. Previous fixation techniques in tibial plateau fracture treatment did not account for the role of the meniscus, and meniscectomies were performed in an effort to visualize and gain fixation of the fracture fragments in the intracapsular space. This technique was later discovered to present the most significant risk of secondary osteoarthritis. In a study examining the occurrence of degenerative osteoarthritis following tibial plateau fractures, Honkonen and coworkers found that intraoperative removal of the meniscus resulted in second- ary arthritic degeneration in 74% of cases. Injuries in which the meniscus was intact or surgically repaired produced a comparatively lesser 37% incidence of degenerative cases. Schatzker and colleagues emphasized the importance of salvaging the meniscus at all costs because of the important role it plays in joint stability and prevention of osteoarthrit- is. All cases included in our study that were found to have meniscal injury at the time of definitive fixation were treated with acute surgical repair of the soft-tissue injury. Studies have indicated that optimal postoperative functional outcome depends primarily on restoration of the joint to anatomic reduction, stability, proper load distribution, the quality of soft-tissues within the knee joint, and early mobiliza-

Limitations to this study include the disparities in measurements from CT scans and plain radiographs when preoperative CT scans were not available, as was the case for seven fractures (6.9%). Location of meniscal injury was noted (i.e., medial or lateral); however, no distinction between the location was made during evaluation of functional outcome or amount of depression. Although these factors were not directly controlled for in our statistical analysis, we do not anticipate any significant effect to our final results. When assessing bony displacement in these fractures, we only sought to evaluate the amount of condylar depression and did not account for medial or lateral displacement. Fractures with minimal depression and significant displacement along the horizontal plane may also be at greater risk of sustain- ing injury to the meniscus; however, this relationship was not defined in our analysis. In summary, we found that the presence of meniscal injury is directly related to amount of condylar depression as measured on coronal plane CT scans or plain radiographic films. These findings may serve as a guide for surgeons in developing a preoperative plan without the use of expensive and invasive diagnostic modalities, such as MRI and arthroscopy, when treating fractures of the tibial plateau. This algorithm may also advocate a more thorough physical examination for patients who meet the criteria of increased risk of soft-tissue injury.

Conclusion
Findings of this study revealed that the most significant predictor of the presence of a meniscus tear in conjunction with fractures of the tibial plateau was the amount of articular depression. This relationship can be quantitatively analyzed to provide guidelines to accurately predict the occurrence of meniscal injury; results of statistical analysis indicated that every millimeter increase in the amount of condylar depression is associated with a 36.2% increase in the odds of having a meniscus tear. No significant differences were noted in the functional outcome between the two groups as determined by SMFA scores, pain scores, and range of knee motion measurements. These results suggest that the successful acute repair of meniscus tears in tibial plateau fractures may produce functional results similar to those in patients that did not sustain meniscal injury.

Disclosure Statement
None of the authors have a financial or proprietary interest in the subject matter or materials discussed, including, but not limited to, employment, consultancies, stock ownership, honoraria, and paid expert testimony.

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