Clinical Outcome of Tibial Plateau Fractures Related to Slope of the Tibial Plateau

INTRODUCTION:

Treatment of complex tibial plateau fractures remains a problem in orthopaedic surgery. Historically, nonoperative management of these fractures has yielded unsatisfactory results with an unacceptable degree of malalignment and up to 70% of degenerative joint disease leading to limited range of motion and pain. Poor results with closed treatment methods led to the practice of open reduction and internal fixation with plates to achieve anatomic realignment and stability allowing early motion.

The geometry of the articular surfaces of the tibiofemoral joint in combination with the menisci and primary ligaments plays an important role in controlling the biomechanical behavior of the knee joint. Many studies have centered on the varus/valgus alignment of the knee joint. An additional important characteristic of the tibia plateau is its posterior slope. Sagittal malreduction is more common than expected. The posterior inclination of the tibia plateau is a bony factor contributing to deformity, antero-posterior stability, varus and valgus laxity, and tensioning of the anterior cruciate ligament. Therefore the posterior slope of the tibia plateau is considered an important feature in total knee arthroplasty and has been widely studied. Furthermore, recent surgical studies also center on accurate posterior slope reduction. Different approaches to the posteromedial and posterolateral column have been described. In unilateral plate fixation, malreduction of the sagittal plane occurs up to 9.1% of the time. On the one hand, it has been stated that the relationship between objective and subjective knee function and final plateau depression strongly suggests that anatomic reductions are desired. On the other hand, Whiteside and Amador demonstrated that a larger posterior slope results in increased range of motion.

The purpose of this study was to determine if sagittal alignment and posterior slope of the tibia plateau influences range of motion, development of osteoarthritis, and subjective clinical outcome.

METHODS:

Between 2002 and 2005, 196 consecutive patients with 197 operatively treated tibial plateau fractures were prospectively evaluated in a single large private orthopaedic practice affiliated with a Level I teaching trauma center. Excluded patients were related to age younger than 18 years, and incomplete data or follow up. The IRB approved study consisted of 94 patients.

Injuries were classified according to the AO/OTA and Schatzker classification. All surgeries were performed by fellowship trained orthopaedic trauma surgeons. Surgeon discretion determined surgical indications, timing, and options. All surgeries utilized fluoroscopic assistance on a radiolucent table.

Postoperative protocol consisted of initiation of range of motion (ROM) while in the hospital. Formal physical therapy was initiated at two weeks postoperatively. At six weeks postoperatively, strengthening was begun. Weight bearing was begun at the 12 week interval. Further therapy was continued at the surgeon’s and patient’s discretion.

Patients were evaluated clinically and radiographically at 2, 6, 12, 26, 52, and 104 weeks. Osteoarthritis was classified according to Kellgren and Lawrence. SF36 and SMFA were performed at 6, 12, and 24 months. Plain knee lateral radiographs were analyzed. The inclination of the tibia plateau was addressed according to Dejour. All measurements have been performed on plain radiographs using an adjusted ruler or digitally by using the picture archiving and communication system (PACS). Posterior slope in previous studies was measured as 8.5° ± 3.0°. Therefore, we chose a range from 5.5° to 11.5° as “normal” and classified posterior tibia plateau slope < 5.5° as “horizontal” and > 11.5° as “steep”. Gender, age, and BMI were recorded. Descriptive statistics and t-tests were used.

RESULTS:

Gender was 46 (49%) males and 48 (51%) females with a mean age of 49.5 years (19-88). The average BMI was 30.2 kg/m² (17.4-49.9). Mean follow-up was 42 months (20-103). Injuries were related to motor vehicle/cycle accidents (40%) and low energy falls (21%). 36 patients (38.3%) were classified as polytrauma. 13 fractures (13.8%) were open. 8 patients (8.5%) had an associated compartmental syndrome.

AO/OTA classifications included: 3 (2%) 4A, 57 (61%) 4B, 32 (34%) 4C and 2 (2%) unrecorded. Schatzker classification was as follows:

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<thead>
<tr>
<th>Schatzker Type</th>
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<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
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<tr>
<td>Number</td>
<td>2</td>
<td>33</td>
<td>2</td>
<td>16</td>
<td>30</td>
<td>10</td>
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<tr>
<td>Percentage (%)</td>
<td>2.13</td>
<td>35.11</td>
<td>2.13</td>
<td>17.02</td>
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The lateral tibial plateau was involved in 80.5% and the medial plateau in 37.9%. 54.3% underwent additional allograft supplementation. Articular reconstruction with 0-2 mm step-off or gap was achieved in 55% of the fractures. Mean posterior slope was 10.0° (range -8° to 22.5°). Posterior tibial slope did not vary with gender (male 9.96°, SD 4.94, female 10.10°, SD 4.90; p=0.89). No correlation was found for BMI or age to posterior slope, extension, or flexion (p>0.05). Patients with horizontal plateaus had reduced flexion (120°) compared to normal slope (129°) (p=0.15). Increased posterior slope did not result in greater flexion (121°). Increased flexion was related to better outcomes in SFMA and SF-36 at 24 months (p<0.05). Loss of extension was related to worse mobility at 24 months (p=0.01). Loss of extension increased from 0.62° in the horizontal group to 1.38° in the normal and 2.35° in the steep group, but was not significant. Even though extension was not related, limited flexion was related to worsening Schatzker classification (r=0.21; p=0.04).

DISCUSSION:

Fractures including the knee joint are complex injuries and can result in considerable morbidity. Optimal joint function depends on congruency, stability and correct load distribution (alignment). Any residual incongruency or axis deviation increases the risk of posttraumatic osteoarthrosis. Multiple studies have centered on the varus/valgus alignment of the knee joint. Additionally, complete knee extension is important for physiologic walking and standing. Total knee arthroplasty experience and research demonstrated the relationship between tibial plateau angulation and subsequent range of motion.

Total and subgroup ROM were >120° and therefore better than in other studies. Loss of extension is not well tolerated and results in worse mobility measurements in correlation with previous total knee arthroplasty studies. Worse knee extension was related to increasing posterior slope, but did not increase knee flexion. Impaired flexion resulted in worse SF-36 and SMFA measurements. The reduced flexion in the horizontal group was expected. The impaired flexion in the steeper group cannot be mechanically explained, but might be related to osteoarthritis.

Posterior tibial slope has varied ranges. Changes in the posterior slope of the tibial plateau are better tolerated than changes in valgus/varus angulation. Anatomic reduction should be achieved for articular congruity and varus/valgus alignment but also for sagittal alignment. Increasing posterior slope leads to extension deficits but does not improve flexion. Loss of range of motion (extension as well as flexion) reduces patient satisfaction.

A limitation of this study lies in its retrospective design, the variability in measuring ROM by different orthopaedic surgeons, and the fact that different slopes of the lateral and medial tibia plateau exist. We only measured the posterior slope on plain lateral radiographs which correlates more with the medial plateau.

SIGNIFICANCE:

Despite the anatomic complexity, orthopaedic trauma surgeons must assure fracture reduction with normal posterior slope of the tibial plateau to achieve improved functional outcomes.