Primary and Secondary Total Knee Arthroplasty for Tibial Plateau Fractures

Iain Stevenson, MBChB, FRCS
Tristan E. McMillan, MBChB, MRCS
Santosh Baliga, MBChB, FRCS
Emil H. Schemitsch, MD, FRCSC

Abstract

The surgical management of tibial plateau fractures can be technically demanding. In younger patients, the mainstay is fixation with cartilage preservation. In older patients with osteoporotic bone, this method has higher rates of fixation failure; in addition, it requires prolonged bed rest or protected weight bearing, which are major challenges in this group. In contrast, total knee arthroplasty performed acutely for primary treatment of tibial plateau fractures has potential advantages for elderly patients, such as immediate stability, early mobilization, and positive functional outcomes with decreased rates of reoperation. Additionally, arthroplasty can be technically challenging in younger patients with previous tibial plateau fractures in whom debilitating posttraumatic arthritis develops. In these patients, old wounds, retained metalwork, bony deficiency, and instability can lead to poorer outcomes and higher complication rates than in routine knee arthroplasty. In both cases, we recommend surgery be performed by experienced arthroplasty surgeons with ample access to a range of implants with varying constraints and the option of stems and augments.

Fractures of the tibial plateau represent 1% to 2% of all fractures and 8% of fractures in the elderly.1 These injuries, which occur when a valgus or varus force is combined with axial loading at the knee,1 encompass a wide spectrum of fracture patterns and differing degrees of disruption to the articular surface. This spectrum is a result of several factors, including the direction and magnitude of the force applied and the preexisting quality of the patient’s bone.

The primary aim in surgical management is restoration of alignment, secured with stable fixation. Obtaining a stable joint permits early range of motion (ROM), which is favorable for cartilage nourishment and preservation.2 Over the years, a variety of surgical modalities that facilitate cartilage preservation have been used, including open reduction and internal fixation (ORIF), external fixation, and percutaneous screw fixation. However, with the aging of the population and increased incidence of tibial plateau fractures in the elderly and persons with osteoporosis, these modalities are often less suitable. In these patients, fracture fixation is difficult because of poor bone quality and an increased risk of loss of reduction. Interest therefore has developed in treating select patients with arthroplasty, which allows early full weight bearing, thereby reducing the risks associated with prolonged immobility and negating the potential loss of fracture reduction.

Another complication associated with tibial plateau fractures is the development of posttraumatic arthritis. Management of the pain,
decreased function, and morbidity caused by this condition continues to challenge surgeons. Although arthroplasty provides a suitable solution, it is made more difficult by previous scars, bone loss, disrupted alignment, and other factors.

A review of the literature on total knee arthroplasty (TKA) revealed mixed results. TKA holds promise as a primary treatment of tibial plateau fractures in older persons with osteoporotic bone, with reports of immediate stability, early mobilization, and decreased reoperation rates. In addition, TKA has improved pain and, to a lesser extent, ROM in patients with posttraumatic osteoarthritis secondary to previous tibial plateau fractures; however, effects on outcomes and complication rates in this cohort are less encouraging. Surgical management includes evaluation for infection; decisions regarding implants, constraints, stems, and augment; and complications such as stiffness and malunion.

**Background**

In younger patients, the mechanism of injury in tibial plateau fractures tends to be high-energy trauma, whereas in older patients, these injuries are more frequently due to low-energy falls. In 1991, Hohl reported that 55% to 70% of tibial plateau fractures involved the lateral plateau, approximately 10% to 23% involved the medial plateau, and approximately 10% to 30% involved both bicondylar.

Tibial plateau fractures are commonly classified by the AO/OTA system or the Schatzker method. In the AO/OTA classification, the proximal tibia is denoted as 41, with intra-articular fractures further categorized into B1-3 and C1-3 subgroups on the basis of partial and complete articular involvement, respectively. The Schatzker system divides tibial plateau fractures into six types: split fracture of the lateral plateau (type I), split depression of the lateral plateau (type II), central depression of the lateral plateau (type III), split of the medial tibial plateau (type IV), bicondylar tibial plateau fracture (type V), and tibial plateau fractures with dissociation between the metaphysis and diaphysis (type VI). The AO/OTA classification is considered more reproducible and reliable.

Nonsurgical management is appropriate for some fractures, including those that are low energy with minimal or no displacement, and in patients with medical contraindications to surgery. Relative indications for surgery are an articular step-off of >3 mm, condylar widening of >5 mm, and >5° of coronal alignment disruption. Surgical management of fractures of the tibial plateau is challenging, and the decision to proceed is multifactorial, involving the patient, the fracture, and the surgeon.

**Acute Primary Total Knee Arthroplasty**

Primary treatment of an acute fracture of the knee with TKA was first reported by in 1982. In recent years, interest in acute TKA for periarticular knee fractures has grown, particularly with respect to the elderly population, for whom conventional internal fixation methods are associated with considerable problems. Interest has focused primarily on fractures of the distal femur, with recent work showing that TKA eliminated fracture healing issues and allowed early mobilization and immediate weight bearing.

As literature in support of TKA for proximal tibial fractures is emerging, we wonder whether the same benefits can be obtained (Table 1).

In a retrospective review of 42 consecutive patients with surgically treated tibial plateau fractures, reported a 79% fixation failure rate in patients aged >60 years and a 100% fixation failure rate in patients with marked osteoporosis. In addition, they showed that complex fragmentation (P < 0.001), severe preoperative displacement (P < 0.001), and nonadherence with weight-bearing instructions (P < 0.05) were significantly correlated with loss of reduction. documented difficulty in achieving stable fixation and the risk of loss of reduction in this group. Others have similarly shown a higher frequency of failures of plate and screw fixation in osteoporotic bone.

Delaying full weight bearing beyond 10 weeks can lower this risk; however, this can be difficult in older persons. showed that patients older than 60 years had more difficulty adhering with partial weight bearing than younger participants. Moreover, a prolonged period of decreased mobility can
increase the risk of medical complications. Abelseth et al\textsuperscript{22} showed that the incidence of deep vein thrombosis (DVT) in lower extremity fractures was 28%, with 43% of these DVTs occurring in patients with tibial plateau fractures. Older age and prolonged immobility can further increase this risk. Frattini et al\textsuperscript{23} reported wound infections in 5 of 35 elderly patients (14%) with tibial plateau fractures treated with ORIF.

In contrast, in 2003, Bengston\textsuperscript{11} presented the case of a 78-year-old woman who had an acute tibial plateau fracture treated with primary TKA without complication and returned to independent, pain-free mobility within 6 weeks of surgery. However, the author presented minimal details on the surgical technique, including the timing and approach.

Nau et al\textsuperscript{16} presented a series of six female patients (mean age, 79 years) with preexisting severe osteoarthritis and acute periarticular fractures of the knee treated with primary TKA. Three of these patients had fractures of the tibial plateau classified as 41 C2, 41 C3, and 41 B3. They were all treated with a cemented, stemmed prosthesis within 14 days of injury, and the results appeared positive with no reported wound complications. All patients returned to mobilization with varying degrees of mobility aids. In a similarly small series but with longer follow-up, Nourissat et al\textsuperscript{17} reported on four patients age 75 years with Schatzker IV and V fractures treated with a long-stemmed, cemented tibial component. The authors reported zero reoperation rates and good retained joint alignment. They advocated use of a constrained or hinged prosthesis for

### Table 1

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients (Mean Age, yr)</th>
<th>Grade</th>
<th>Time to Surgery</th>
<th>Prosthesis</th>
<th>Follow-up</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengston\textsuperscript{11}</td>
<td>1 (78)</td>
<td>Schatzker V</td>
<td>NA</td>
<td>No stem</td>
<td>12 mo</td>
<td>Full ROM, stable, no loosening</td>
</tr>
<tr>
<td>Boureau et al\textsuperscript{12}</td>
<td>11 (77.9)</td>
<td>Schatzker II (n = 5)</td>
<td>Within 11 d</td>
<td>Cemented stemmed implants</td>
<td>31 mo\textsuperscript{a}</td>
<td>Knee score of 84 points and mean function score of 43 points</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Schatzker IV (n = 2)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Schatzker V (n = 3)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Schatzker VI (n = 1)</td>
<td></td>
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<tr>
<td>Hsu et al\textsuperscript{13}</td>
<td>1 (82)</td>
<td>Schatzker V</td>
<td>NA</td>
<td>A stemmed nonconstrained posterior-stabilized knee</td>
<td>6 wk</td>
<td>ROM of 0° to 90°</td>
</tr>
<tr>
<td>Kini and Sathappan\textsuperscript{14}</td>
<td>9\textsuperscript{b} (73)</td>
<td>Schatzker II (n = 6)</td>
<td>Within 12 d</td>
<td>All stemmed tibial implants, posterior-stabilized implants (n = 5) or constrained implant (n = 1)</td>
<td>26 mo</td>
<td>Mean Knee Society score of 84, no radiographic loosening, all knees corrected to within a mean of 1.7° of the calculated mechanical axis, mean ROM of 114°</td>
</tr>
<tr>
<td>Malviya et al\textsuperscript{15}</td>
<td>15 (80\textsuperscript{a})</td>
<td>41 A (n = 1)</td>
<td>Within 16 d</td>
<td>Rotating hinge (n = 7); super stabilized with high post (n = 6); PCL retaining (n = 2)</td>
<td>38.8\textsuperscript{a} mo</td>
<td>Mean Knee Society score of 90.2, mean function score of 35.5, and mean of ROM 87.3°</td>
</tr>
<tr>
<td>Nau et al\textsuperscript{16}</td>
<td>3 (74.7)</td>
<td>41 C2, 41 C3, and 41 B3</td>
<td>Within 14 d</td>
<td>Stemmed</td>
<td>24.4\textsuperscript{a} mo</td>
<td>Good outcomes, although not differentiated from included patients undergoing TKA for distal femoral fracture</td>
</tr>
<tr>
<td>Nourissat et al\textsuperscript{17}</td>
<td>4 (&gt;75)</td>
<td>Schatzker V (n = 3)</td>
<td>NA</td>
<td>Long-stemmed tibial component</td>
<td>2-7 y</td>
<td>Knee scores excellent (90, 95, 95) in 3 patients and fair (45) in 1 patient; no radiographic loosening</td>
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<tr>
<td>Schatzker IV (n = 1)</td>
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<tr>
<td>Parratte et al\textsuperscript{18}</td>
<td>16 (80.5\textsuperscript{c})</td>
<td>41 B (n = 8)</td>
<td>Within 22 d</td>
<td>NA</td>
<td>16.2 mo</td>
<td>Mean Knee score of 82 points\textsuperscript{c} and mean function score of 54 points</td>
</tr>
<tr>
<td>41 C (n = 8)</td>
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<tr>
<td>Vermeire and Scheerlinck\textsuperscript{19}</td>
<td>12 (73)</td>
<td>41 A (n = 1)</td>
<td>Within 21 d</td>
<td>Cemented posterior-stabilized (n = 11) or constrained condylar (n = 1) TKA with a stemmed tibial component</td>
<td>31\textsuperscript{c} mo</td>
<td>Median final knee score of 78 points (50-100 points) and median function score of 58 (0-100)</td>
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<tr>
<td></td>
<td></td>
<td>41 B (n = 8)</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>41 C (n = 3)</td>
<td></td>
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</table>

NA = not available, PCL = posterior cruciate ligament, ROM = range of motion, TKA = total knee arthroplasty
\textsuperscript{a} Data not differentiated from patient cohort undergoing TKA for distal femoral fracture.
\textsuperscript{b} Three patients had diaphyseal tibial fractures.
\textsuperscript{c} One patient died following unrelated surgery.
these cases to minimize difficulty with soft-tissue balancing in an osteoporotic knee with a compromised joint surface.

Vermeire and Scheerlinck\textsuperscript{19} reported comparable outcomes in a retrospective review of 12 patients (mean age, 73 years) with complex tibial plateau fractures treated with a cemented prosthesis with a stemmed tibial component. Seven patients required supplemental stabilization with a plate and/or screws before cementing of the tibial component. Although results were comparable to those from other centers, the authors made the valid point that functional outcomes in this specific population were also a reflection of the patients’ general condition.

Vermeire and Scheerlinck\textsuperscript{19} highlighted that experienced knee arthroplasty and knee revision surgeons performed all procedures reported in their paper. This is an important point because these are not straightforward procedures; many parameters must be considered because of the disruption of normal anatomic references, coexisting ligamentous injury, and in some cases loss of circumferential cortical stability on which to base the prosthesis.

Kini and Sathappan\textsuperscript{14} suggested that some of these technical complexities can be addressed by using a navigated TKA system. They presented a case series of nine patients, including six patients with tibial plateau fractures, treated acutely with TKA using computer-assisted navigation. They advised that the navigation assisted with accurate bone cuts in the presence of fracture deformity, prosthesis alignment, and soft-tissue balancing. At 1 year after surgery, all knees were corrected to within a mean of 1.7° of the calculated mechanical axis. All nine of these patients returned to their pre-morbid functional level, with a mean movement of 114° (range, 95° to 125°) and a mean Knee Society score of 84.

A 2011 retrospective study by Malviya et al\textsuperscript{15} included 15 patients with a periarticular proximal tibial fracture due to largely low-energy injuries, with 12 of the fractures classified as 41 B, 2 fractures classified as 41 C, and 1 fracture classified as 41 A. They reported 90% patient satisfaction and an 81% return to preinjury functional levels. On average, patients underwent TKA 4 days after injury and returned to independent mobilization at 24 days. As mentioned previously, this level of early mobilization and, in most cases, immediate weight bearing is one of the key advantages of TKA in the acute management of tibial plateau fractures.

Malviya et al\textsuperscript{15} recommended stemmed cemented components because they are thought to confer primary stability, allowing early, unrestricted mobilization. Many other authors share this opinion, although Bohm et al\textsuperscript{24} suggested that the surgeon might forgo the use of a stemmed tibial implant in the presence of good circumferential cortical support. Although most of the literature supports the use of cement, its effect on associated fracture union remains largely unknown (Figure 1).

Timing of surgery is documented in only some of the literature reviewed. Most patients had surgery within 2 weeks of injury, with no studies recommending deliberate delay. Reported wound issues varied in the literature. Vermeire and Scheerlinck\textsuperscript{19} reported that 3 of 12 patients (25%) developed postoperative wound hematomas that resolved without intervention. One patient had a DVT and a superficial wound infection that the authors attributed to obesity. Similarly, Kini and Sathappan\textsuperscript{14} and Malviya et al\textsuperscript{15} each reported one superficial wound infection. Parratte et al\textsuperscript{18} described two patients with wound issues, one of which led to deep infection and subsequent prosthesis removal; however, it is unclear whether this patient’s primary fracture was of the femur or the tibial plateau.

In patients for whom bone loss was a concern, various augmentation methods were documented: cement, metal wedges, and cone-shaped augments. However, there is no clear consensus in the literature as to which is most favorable, and so surgeons must choose based on the degree of bone loss and local availability of augments. Unlike with the distal femur, resection and replacement of the proximal tibia en masse are associated with major potential complications, specifically disruption of the tibial tubercle and the extensor mechanism, as well as potential soft-tissue coverage issues.

In 2011, Hsu et al\textsuperscript{13} proposed a systematic approach for primary TKA in tibial plateau fractures. To produce a stable platform for the eventual prosthesis, they recommended initial stabilization and fixation of any diaphyseal fractures before reconstruction of column support. Following sound revision principles, the knee arthroplasty is then completed using long press-fit stems, bypassing the fracture and engaging the tibial diaphysis to unload stress at the fracture sites. In addition, initial conservative management or temporary fixation of fractures can help restore tibial bone stock and extensor mechanism integrity for planned early-stage TKA in substantially comminuted plateau fractures in elderly patients.

Finally, although the literature has shown promise for primary TKA for tibial plateau fractures in elderly persons, offering immediate weight bearing and early mobilization, it has not shown full restoration of patients’ preinjury autonomy.\textsuperscript{12} That said, retention of autonomy and Parker scores at follow-up tend to be better in this cohort than in patients...
undergoing TKA in the acute treatment of distal femoral fractures.\textsuperscript{12}

**Secondary TKA**

In advanced disabling osteoarthritis of the knee, TKA continues to be the most common surgical intervention. Davidson et al\textsuperscript{25} found the overall incidence of TKA after tibial plateau fracture was 3\% and up to 4\% in females. A larger cohort study by Wasserstein et al\textsuperscript{26} showed that 7.3\% of patients treated with ORIF for a tibial plateau fracture underwent TKA at 10 years. This was compared with 1.8\% in the matched control group. After adjustment for comorbidity in the statistical modeling, the risk of TKA was more than five times as likely in the tibial plateau ORIF group as in the control group. Risk factors included increasing age, split depression or condylar fractures, and female sex. Table 2 summarizes the literature reporting outcomes for secondary TKA in patients with a previous tibial plateau fracture.

It is well established that TKA for posttraumatic osteoarthritis secondary to malunion is associated with a higher rate of complications and poorer functional results than TKA for primary osteoarthritis of the knee.\textsuperscript{35} In posttraumatic arthritis, common issues are intra-articular and extra-articular malalignment, osseous defects, joint instability, retained internal fixation devices, periarticular adhesions, and a compromised soft-tissue envelope. These factors may require alterations in surgical exposure and technique and ultimately may compromise outcomes.

Roffi and Merritt\textsuperscript{36} reported the first series of TKAs after a variety of fractures around the knee. Poor results were noted in $>28\%$ of patients as a result of pain, limited ROM, and residual instability. In addition, they reported a revision due to infection and three cases of further surgery because of soft-tissue complications.

Lonner et al\textsuperscript{28} reported on a series of 31 patients, 20 of whom had sustained a tibial plateau fracture. After TKA, 58\% of patients reported excellent or good functional outcomes, and 71\% of postoperative Knee Society scores were excellent or good, with a mean score of 78. In 2001, Saleh et al\textsuperscript{31} analyzed 15 consecutive patients who had undergone TKA performed at an average of 39 months after ORIF for tibial plateau fractures. Four of the 15 patients had an excellent result; 8, a good result; 1, a fair result; and 2, a poor result. The average Hospital for Special Surgery knee score was 51 points before the arthroplasty and 80 points at follow-up. Most recently, Scott et al\textsuperscript{32} presented 31 consecutive patients who underwent TKA for posttraumatic arthritis at an average of 24 months after tibial plateau fractures. They showed no significant differences in Oxford knee scores and patient satisfaction when compared with an age- and sex-matched primary osteoarthritis cohort.

In a cohort of 47 TKAs for posttraumatic arthritis, of which 27 were associated with fractures of the proximal tibia, Shearer et al\textsuperscript{33} found...
a trend toward worse preoperative knee scores among younger patients (ie, <50 years). In addition, they identified worse outcomes (ie, pain and functional scores) in combined femoral and tibial deformities, increasingly complex deformities, and soft-tissue compromise necessitating flap coverage.

<table>
<thead>
<tr>
<th>Study</th>
<th>No. of Patients (Mean Age, yr)</th>
<th>Surgical Procedure</th>
<th>Mean Interval to TKA (yr)</th>
<th>Outcomes</th>
<th>Major Complication Rate (Deep Infection, Extensor Pull-off, DVT, Nerve Injury) (%)</th>
<th>Infection Rate (%)</th>
<th>Mean Gain ROM (*)</th>
<th>Noninfective Revision Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Civinini et al(^27)</td>
<td>25 (57) with 29 TKAs</td>
<td>Case series of patients who had previous ORIF for tibial plateau fracture</td>
<td>3.5</td>
<td>Mean improvement of 61 points on the KSS and mean functional improvement of 40 points</td>
<td>32</td>
<td>4 (deep) 4 (superficial)</td>
<td>26</td>
<td>8% at 3 yr</td>
</tr>
<tr>
<td>Lonner et al(^28)</td>
<td>30 (60) with 31 TKAs</td>
<td>Series evaluating outcomes of TKAs in posttraumatic OA</td>
<td>13</td>
<td>Mean improvement of 42 points on the KSS and mean improvement in function score of 28 points</td>
<td>57</td>
<td>10</td>
<td>6</td>
<td>26% at a mean follow-up of 4 yr</td>
</tr>
<tr>
<td>Marczak et al(^29)</td>
<td>27 TKAs for previous tibial plateau fractures</td>
<td>Case series of various types of knee arthroplasty for knee OA with concomitant axial limb deformity related to previous isolated fractures of the tibia (n = 25 knees), or femur (n = 9), or both (n = 2)</td>
<td>15.2</td>
<td>Mean improvement of 39 points on the KSS and mean functional improvement of 33 points</td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>No failures at a mean follow-up of 4.8 yr</td>
</tr>
<tr>
<td>Parratte et al(^30)</td>
<td>40 (63)</td>
<td>Multicenter retrospective case series of TKAs after distal femoral, patella and proximal tibial fractures.(^a)</td>
<td>21.8</td>
<td>Mean improvement of 32 points on the KSS</td>
<td>26</td>
<td>7 (deep)</td>
<td>5</td>
<td>NA</td>
</tr>
<tr>
<td>Saleh et al(^31)</td>
<td>15 (56)</td>
<td>Retrospective case review of the outcomes of TKAs performed after ORIF for tibial plateau fractures</td>
<td>3.2</td>
<td>Mean improvement of 29 points on the Hospital for Special Surgery knee score</td>
<td>33</td>
<td>20</td>
<td>18</td>
<td>6.2 yr</td>
</tr>
<tr>
<td>Scott et al(^32)</td>
<td>31 (65)</td>
<td>Retrospective matched cohort study evaluating the outcomes and complications of TKA after tibial plateau fractures; 24 had undergone ORIF and 7 received nonsurgical management</td>
<td>2</td>
<td>Mean improvement of 2.5 points on Oxford Knee score at 5 yr; mean improvement of 10.1 and 8.3 points, respectively, on Physical and Mental components of the SF-12</td>
<td>18</td>
<td>3 (deep) 13 (wound)</td>
<td>NA</td>
<td>3.2% at 5 yr</td>
</tr>
<tr>
<td>Shearer et al(^33)</td>
<td>27 (56.5)</td>
<td>Case series reviewing the outcomes of TKA for posttraumatic OA due to fractures of the distal femur (n = 12), proximal tibia (n = 27), or both (n = 8)</td>
<td>NA</td>
<td>Mean improvement of 27 points on the KSS; mean function improvement of 7 points</td>
<td>21</td>
<td>4.3 (deep)</td>
<td>NA</td>
<td>2.1% at 4.3 yr</td>
</tr>
<tr>
<td>Abdel et al(^34)</td>
<td>62 (63)</td>
<td>Retrospective case series evaluating the outcomes of TKA after tibial plateau fractures; prior management included ORIF (n = 38), external fixation (n = 1), and nonsurgical treatment (n = 23)</td>
<td>13.6</td>
<td>Mean improvement of 36 points on KSS pain score; mean function improvement of 18 points</td>
<td>34</td>
<td>3.2 (deep) 3.2 (superficial)</td>
<td>6</td>
<td>18% (11 of 45) revision at 15 yr(^b)</td>
</tr>
</tbody>
</table>

DVT = deep vein thrombosis, KSS = Knee Society score, NA = not available, OA = osteoarthritis, ORIF = open reduction and internal fixation, ROM = range of motion, SF-12 = Medical Outcomes Study 12-Item Short Form, TKA = total knee arthroplasty

\(^a\) Only the data for those with isolated tibial malunions have been included in this table.

\(^b\) Seventeen patients had incomplete follow-up (<15 years); 16 died and 1 was lost to follow-up.
Surgical Versus Nonsurgical Fracture Management

Abdel et al reported on the largest series of patients undergoing TKA (ie, 62 patients), all of whom had prior tibial plateau fractures with 15 years of follow-up after arthroplasty. A subgroup analysis comparing patients treated previously by internal fixation (n = 38) with those receiving nonsurgical management (n = 23) found no significant differences in either intraoperative or postoperative complications or postoperative pain or Knee Society score. Although one patient underwent external fixation, to date no studies with matched cohorts have compared TKAs after various fixation methods (eg, TKA after ORIF versus TKA after external fixation).

Exposure and Incision

Lonner et al advocated several important guidelines for surgical management of tibial plateau fractures when multiple previous skin incisions are present. The most recent scar should be used, provided it allows adequate exposure. In addition, selecting the most lateral of surgical scars preserves oxygen tension to the medial flap. Short peripatellar incisions may generally be disregarded. Prior transverse incisions may be crossed with a longitudinal incision at a right angle (Figure 2).

Alignment and Stemmed Implants

Weiss et al reported implant malposition and residual deformity in 14 of 62 patients (23%). The authors of the study noted that these patients had poorer outcomes than did patients who had lower limb axial alignment restored. Standard landmarks for determining axial and rotational alignment of implants may be distorted after a tibial plateau fracture, increasing the likelihood of implant malposition. Techniques to overcome this include computer navigation systems and custom-made cutting blocks. Scans of both lower limbs can also be beneficial. Mullaji and Shetty reported accurate restoration of limb alignment with computer navigation in patients with extra-articular deformities. Whether this translates to better outcomes in patients who have had tibial plateau fractures with subsequent intra-articular deformity has yet to be determined.

Lonner et al observed aseptic loosening in eight patients (26%) with posttraumatic arthrosis that was treated with TKA. Loosening was related primarily to malalignment and subsidence; in seven patients, stemmed tibial components were not used. They therefore recommended the use of stemmed tibial implants in patients with compromised metaphyseal bone stock. Civinini et al used stemmed implants in 72% of 29 TKAs. When followed up at a mean of 92 months, only 13% of patients had evidence of radiographic loosening; none was more than 2 mm or progressive.
A 70-mm central stem was reported to carry 23% to 38% of the axial load in TKAs. This load-sharing capability potentially protects the remaining host bone from excessive stress and possible implant migration. The predominant use of stemmed components by Civinini et al.27 may have contributed to the lower percentage of aseptic loosening compared with results in other series.27,28,31

Bone loss and defects are an issue in up to 48% of TKAs.27 Preventive options include cement augmentation, metaphyseal cones and sleeves, wedges, or a bone graft. Although these techniques have their unique advantages and drawbacks, there is little in the literature to support one technique over another (Figure 3).

**Infection**

Deep infection has consistently been higher in patients undergoing secondary TKA than in those undergoing standard TKA. Rates vary from 3% to 20%.27,28,30,31,38 The lowest rate of deep infection (3%) was achieved by Weiss et al.,38 who advocated a routine, thorough, preoperative workup using blood markers, bone scanning, and knee aspiration to rule out infection. When the work was republished with a 15-year follow-up, the incidence of postoperative complications within the cohort was 34%, with 90% of these occurring within 2 years of surgery.34 This included three wound breakdowns, two superficial infections, and two deep infections.

After an average follow-up of 4.7 years, Marczak et al.29 reported no significant infections from 36 TKAs performed in patients with previous isolated fractures of the tibia and femur. Although they did not focus specifically on tibial plateau fractures, the authors did support the use of antibiotic-impregnated absorbable bone graft substitutes (ie, bone void filler; Herafill Beads G, Heraeus Medical) while avoiding the use of allografts in multiply operated knees.

Saleh et al.31 reported infections in 3 of 15 TKAs (20%), all of which had negative preoperative knee aspirates before proceeding to arthroplasty. They attributed this to a combination of soft-tissue compromise from the initial injury, implants, and subsequent surgical procedures. They subsequently recommended frozen-section analysis of intraoperative specimens for infection in all patients. Additional recommendations include care and attention intraoperatively to minimize injury to the subfascial dermal plexus by minimizing flap elevation, avoiding excessive retraction, and use of blunt dissection techniques.

**Range of Motion**

Parratte et al.30 noted a mean gain in flexion of 5° (standard deviation, ±20°) after a tibial plateau fracture. Similarly, Lonner et al.28 achieved a mean improvement of 6° in flexion. Weiss et al.18 noted an average improvement of only 4° despite remanipulating more than 8% of knees. Saleh et al.31 reported an average increase in range of motion of...
advantages of immediate stability, early mobilization, and decreased re-operation rates. At the earliest opportunity, experienced arthroplasty surgeons should perform the surgery. In some cases, however, particularly with severe comminution, delayed TKA after initial conservative treatment allows fracture consolidation and healing of the tibial tubercle. A medial parapatellar approach is recommended. Achieving a stable platform on which to mount the prosthesis may require supplementary osteosynthesis and/or augmentation with wedges and/or bone graft.

The choice of implant and level of constraint should be determined per the nature of the injury, the perioperative findings, and the preference of the surgeon managing the fracture; however, the use of cement and a stemmed tibial component is advised for most of these cases.

TKA for patients with post-traumatic osteoarthritis secondary to previous tibial plateau fractures has improved pain and, to a minor degree, range of motion; however, functional outcomes tend to be poorer, and the incidence of complication is higher in patients than in patients undergoing standard TKA. Patients should be routinely evaluated for infection preoperatively with aspirate, cultures, and blood markers. An experienced revision surgeon should undertake the surgery. When possible, the incision should encompass previous surgical wounds, and transverse incisions should be avoided. Tibial defects should be addressed in a similar manner, with the use of cement, bone graft, or augments. We do not routinely recommend stemmed prostheses in patients for whom subsidence is a concern, in older/osteoporotic patients, or in those with major tibial defects. Stiffness continues to be a major concern in these patient groups, and future research should focus on this issue. Patients should be appropriately counseled preoperatively.

Perioperative soft-tissue balancing and contracture release are key, as is intensive postoperative rehabilitation under the care of a physical therapist.

References

Evidence-based Medicine: Levels of evidence are described in the table of contents. In this article, reference 41 is a level II study. References 6, 12, 21, 25, 30, 32-35, and 38-40 are level III studies. References 2, 3, 5, 7, 9, 22, 23, 26-29, 31, 36, 37, and 42 are level IV studies. References 8, 10, 11, 13, and 20 are level V expert opinion.

References printed in bold type are those published within the past 5 years.


10. Rosen AL, Straus E: Primary total knee arthroplasty for complex distal femur...


