Composite Fixation of Proximal Tibial Nonunions: A Technical Trick

Publish date: September 27, 2018
Authors: Jonne Prins, MD Johanna C.E. Donders, MD and Peter Kloen, MD, PhD
Author Affiliation | Disclosures

Authors’ Disclosure Statement: The authors report no actual or potential conflict of interest in relation to this article.

Dr. Prins is PhD candidate, Department of Surgery, Erasmus Medical Center, Rotterdam, The Netherlands. Dr. Kloen is an Orthopedic Surgeon, and Dr. Donders is PhD candidate, Department of Orthopedic Surgery, Academic Medical Center, Amsterdam, The Netherlands.

Address correspondence to: Peter Kloen, MD, PhD, Department of Orthopedic Surgery, Academic Medical Center, Meibergdreef 9, 1100 DD, Amsterdam, The Netherlands. (tel, 31-205669111; fax, 31-205669117; email, p.kloen@amc.uva.nl).

Am J Orthop. 2018;47(9). Copyright Frontline Medical Communications Inc. 2018. All rights reserved.

Take-Home Points

- Treatment goals for a nonunion are bone union, re-establishment of (joint) stability, extremity alignment, and recovery of function.
- A nonunion of a tibia plateau fracture is often associated with poor soft tissues from previous surgeries and/or infections.
- Ideally a combination of minimal soft tissue damage and maximal stable fixation is used for salvage.
- There is a high risk of complications when using dual plating in these cases.
- A combination of an external fixator with limited internal fixation can be a good alternative.

Operative management of a proximal tibial nonunion is challenging, compromised by limited bone stock, pre-existing hardware, stiffness, poor soft tissue conditions, and infection. The goals of treatment include bone union, re-establishment of both joint stability and lower extremity alignment, restoration of an anatomic articular surface, and recovery of function. Currently, various treatment options such as plate fixation, bone grafting, intramedullary nailing, external fixation, functional bracing, or a combination of these are available. Rigid internal fixation is the gold standard for most nonunions. However, sometimes local soft tissues or bone quality preclude standard internal fixation. Bolhofner described the combination of a single plate and an external fixator on the contralateral side for the management of extra-articular proximal tibial fractures with compromised soft tissues, and the technique known as composite fixation was coined. The external fixator on 1 side and the plate on the other, generate a balanced, stable environment while limiting the use of foreign hardware, thereby avoiding both additional soft-tissue damage and periosteal stripping. In this technical article, we describe the indication,
Materials and Methods

Patients

Between January 2014 and July 2016, 3 patients each with a proximal tibial nonunion that developed after a bicondylar tibial plateau fracture (Schatzker type VI) were treated with composite fixation (Table). The 3 patients were female with an average age of 61 years (range, 60-62 years), and a body mass index of 23.7 kg/m² (range, 19.0-31.9 kg/m²). All 3 patients had sustained a tibial plateau fracture that was primarily treated with open reduction and internal fixation. Two of them had a diagnosis of rheumatoid arthritis and were being treated with methotrexate and Humira (adalimumab) (case 1), and with methotrexate, prednisolone, and etanercept (case 3). The etanercept was discontinued after discussion with the treating rheumatologist when a deep infection developed. Two patients (cases 1 and 2) were referred to us because of their nonunions. All 3 patients developed extra-articular nonunions with compromised bone stock. Two patients had developed deep infections during treatment of their plateau fractures; 1 of these patients underwent a medial gastrocnemius flap for wound coverage (case 1). The second patient (case 3) with a deep infection underwent partial hardware removal, a Masquelet salvage procedure, and revision plate fixation. However, the infection recurred. The hardware was removed, and 2 débridements with conversion to a hybrid external fixator with thin wire fixation were done. Due to her longstanding rheumatoid arthritis, the patient had bilateral valgus knee malalignment causing the ring fixator to strike her contralateral knee when she walked. The period from the initial tibial plateau fracture to our composite fixation averaged 11.3 months (range, 11-12 months). Indications for the use of the composite fixation comprised previously infected soft tissue on the lateral side and inability to walk with a hybrid thin wire fixator because of valgus knees (case 3), a medial gastrocnemius flap (case 2), and poor bone quality (case 1). Follow-up consisted of clinical examination, Timed Up and Go (TUG) test that is a standardized test for mobility, and radiographic evaluation at routine appointments up to 1 year or until healed. At the last follow-up visit, patients filled out the International Knee Documentation Committee (IKDC) subjective knee form.

Surgical Technique

A fellowship-trained orthopedic trauma surgeon treated all patients. Patients were placed on a radiolucent operating table after general or regional anesthesia. Previous incisions were used. Two patients had a midline incision; the third had both a posteromedial and an anterolateral incision. Five deep tissue cultures were taken after which antibiotics were given intravenously. All unstable or failed hardware was removed. Aggressive débridement of the nonunion was performed. After débridement, multiple holes were drilled with a 2.0 mm drill bit until blood was seen to egress from both sides of the medullary canal. Malalignment of the proximal tibia was corrected and checked fluoroscopically. Fixation was done with an anatomic locking plate (LCP Proximal Tibia Plate 3.5; DePuy Synthes) with a mixture of locking and non-locking screws. In 2 patients, a tricortical graft from the posterior iliac crest was positioned in the defect. Additional autologous bone graft and demineralized bone matrix was added around the nonunion. Although locking screws were used, the fixation did not appear to be strong enough to resist the varus (cases 1 and 2), or the valgus (case 3) deforming forces. Additional fixation was thus needed. However, the contralateral soft tissues were compromised in case 2 (medial gastrocnemius flap), and case 3 (a previously infected area with very tenuous skin laterally), whereas the bone was considered to be of insufficient quality in case 1. The opposite side of the nonunion was stabilized using composite fixation with a 2-pin external fixator to circumvent the need for additional plate fixation. In 2 patients, the plate was placed
laterally, and the external fixator medially. In the third patient, the plate was positioned medially, and the external fixator laterally. The plate was always placed first. The external fixator was placed last. Using fluoroscopy, we ensured that the fixator pins would not interfere with the screws. The pins were predrilled and positioned perpendicular to the tibia through small stab incisions. We prefer hydroxyapatite-coated pins (6-mm diameter, XCaliber Bone Screws; Pro-Motion Medical) to increase their holding power in the often osteopenic bone. Postoperative management consisted of toe-touch weight-bearing for 6 weeks and progressed to full weight-bearing at 3 months. Radiographs were taken on postoperative day 1, at 6 weeks, and at 12 weeks until healed. No continuous passive motion was used postoperatively. Antibiotics were continued until cultures were negative. No specific pin care was used. We advised patients to shower daily with the external fixator in place, once the wounds have healed.

Results

On average, patients were hospitalized for 5 days (range, 3-7 days). There were no postoperative complications. None of the patients developed a clinically significant pin site infection. There were no re-operations during follow-up. All patients achieved union at a mean of 5.2 months (range, 5-5.5 months) (Figure 1). Deformity correction was achieved in all 3 patients. The average range of motion (ROM) arc was 100° (range, 100°-115°). None of the patients had an extension deficit. TUG test was <8 seconds in all patients. The IKDC knee score averaged 52 (range, 41-66). Of note is that 2 patients already had compromised knee function before the fracture because of rheumatoid arthritis. The Ahlбёck classification of osteoarthritis showed grade 1 in cases 1 and 3, and grade 2 in case 2. Postoperative ROM of the knee returned to pre-injury levels in all patients (Figure 2). The 2-pin external fixator was removed at 9 weeks on average (range, 6-12 weeks) postoperatively in the outpatient clinic. At the last follow-up appointment at an average of 10.3 months (range, 9-12 months), all wounds had healed without infection. All patients had a normal neurovascular examination.

Discussion

Nonunion after a proximal tibial fracture is rare. In cases when nonunions do develop, they most often pertain to the extra-articular component with the plateau component healed. Surgical exposure for débridements, hardware removal, bone grafting, and revision of fixation carries the risk of wound breakdown, necrosis, and infection. The alternative strategy of composite fixation (a plate combined with a contralateral 2-pin external fixator) to limit additional soft tissue compromise was already described in proximal tibial fractures by Bolhofner. He treated 41 extra-articular proximal tibial fractures using this composite fixation technique and attained successful results with an average time to union of 12.1 weeks. There was only 1 malunion, 2 wound infections, and 3 delayed unions.

In our practice, we have extrapolated this idea to an extra-articular nonunion that developed after a tibial plateau fracture. With the use of an external fixator, we provided sufficient mechanical stability of the nonunion without unnecessarily compromising previously infected or tenuous soft tissues, a muscle flap, or further devascularizing poor bone. Limitations of this study include the retrospective data and small sample size prone to bias. However, all patients received the same treatment protocol from 1 orthopedic trauma surgeon, follow-up intervals were similar, and data were acquired consistently.

Meanwhile, we have used this technique in a fourth patient with a septic nonunion of a tibial plateau fracture. All 4 patients in whom we have used this method so far have healed successfully.
Conclusion

This technique respects both the demand for minimal soft tissue damage and a maximal stable environment without notable perioperative and postoperative complications. It also offers an alternative option for the treatment of a proximal tibial nonunion that is not amenable to invasive revision dual plate fixation. As such, it can be a useful addition to the existing armamentarium of the treating surgeon.

Key Info

Figures/Tables

Figures / Tables:

![donders0918_f1.jpg](donders0918_f1.jpg)

**Figure 1.** Cases 1, 2, and 3, respectively, shown on anteroposterior radiograph of the nonunion (left panel); after composite fixation (second panel); clinical picture (third panel); and on anteroposterior radiograph at the latest follow-up after removal of the external fixator (right panel).
Figure 2. Case 3: At final follow-up, the patient was doing well. She ambulated without assistive devices and reported no pain. She had well-aligned legs with a good range of motion of the right knee. There were no signs of infection.

Table. Patient Characteristics and Outcomes

<table>
<thead>
<tr>
<th>Age/ Sex</th>
<th>Initial Treatment</th>
<th>Revision surgeries prior to composite fixation</th>
<th>NU time (months)</th>
<th>NU type</th>
<th>History of infection</th>
<th>Position of external fixator</th>
<th>Preoperative ROM</th>
<th>Postoperative ROM</th>
<th>IKDC score + OA classification</th>
<th>Time to union (months)</th>
<th>FL time (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E0F</td>
<td>Triple plating (non-locking) Medial incision</td>
<td>None</td>
<td>11</td>
<td>AT</td>
<td>-</td>
<td>Medial, poor bone quality due to osteoporosis and RA</td>
<td>95-8-0</td>
<td>115-6-9</td>
<td>41 (1)</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>E1F</td>
<td>Double locked plating Medial incision</td>
<td>Medial gastrocnemius flap, removal medial plane</td>
<td>12</td>
<td>AT</td>
<td>Y</td>
<td>Medial, gastrocnemius flap</td>
<td>N/A</td>
<td>100-8-9</td>
<td>49 (2)</td>
<td>5.5</td>
<td>9</td>
</tr>
<tr>
<td>E2F</td>
<td>Double locked plating+ autograft Dual incision</td>
<td>5 Additional surgeries: Partial HR/Masquelet I&amp;B 1x Lateral plating + 8G, I&amp;B x1 HR + thin wire hybrid fixation</td>
<td>11</td>
<td>AT</td>
<td>Y</td>
<td>Lateral, deep infection</td>
<td>125-5-0</td>
<td>130-15-0</td>
<td>56 (1)</td>
<td>5</td>
<td>12</td>
</tr>
</tbody>
</table>

Abbreviations: AT, atrophic; BG, bone graft; FLU, follow up; HR, hardware removal; I&B, irrigation and debridement; IKDC, International Knee Documentation Committee; N/A, not available; RU, nonunion; OA, osteoarthritis; RA, rheumatoid arthritis; ROM, range of motion.

References


**Multimedia**
Product Guide

- STRATAFIX™ Symmetric PDS™ Plus Knotless Tissue Control Device
- STRATAFIX™ Spiral Knotless Tissue Control Device
- BioComposite SwiveLock Anchor
- BioComposite SwiveLock C, with White/Black TigerTape™ Loop

Citation

Jonne Prins, MD Johanna C.E. Donders, MD and Peter Kloen, MD, PhD. Composite Fixation of Proximal Tibial Nonunions: A Technical Trick. Am J Orthop.
Publish date: September 27, 2018