Temporary Transarticular K-wire Fixation of Critical Ankle Injuries at Risk: A Neglected “Damage Control” Strategy?

Jamie Friedman, MD; Anhchi Ly, MA; Cyril Mauffrey, MD; Philip F. Stahel, MD

Abstract: High-energy ankle fracture-dislocations are at significant risk for postoperative complications. Closed reduction and temporary percutaneous transarticular K-wire fixation was first described more than 50 years ago. This simple and effective “damage control” strategy is widely practiced in Europe, yet appears largely forgotten and abandoned in the United States. Anecdotal opposing arguments include the notion that drilling K-wires through articular cartilage may damage the joint and contribute to postinjury arthritis. This article describes the experience in a US academic level I trauma center with transarticular pinning of selected critical ankle fracture-dislocations followed by delayed definitive fracture fixation once the soft tissues are healed. Median patient follow-up of 2 years showed that the transarticular pinning technique was performed safely, not associated with increased postoperative complication rates, and characterized by good subjective outcomes using the American Academy of Orthopaedic Surgeons Foot and Ankle Outcome Score questionnaire. [Orthopedics. 2015; 38(2):122-127.]

Most ankle fractures are managed as an outpatient procedure by early definitive internal fixation, with a low risk of wound complications and surgical site infections.1-5 A recent large case-control study in the United Kingdom revealed an incidence of 4% for superficial and 1.1% for deep surgical site infections after ankle fracture fixation,2 rates in line with those previously published.6 A subset of patients with acute ankle injuries is considered at particular risk for postoperative wound complications and infections. These patients include smokers and those with diabetes mellitus, osteoporosis, bimalleolar ankle fractures, open ankle fractures, malreduced ankle fractures requiring revision surgery, and intraoperative placement of a surgical drain.5-11 High-energy ankle fracture-dislocations represent a particularly challenging entity susceptible to postoperative wound complications and unplanned surgical revisions, including the potential downstream need for transtibial amputations in cases of unsalvageable infections.12-16

The ideal management strategy for unstable ankle-fracture dislocations with critical soft tissues remains a topic of debate.17,18 The widely used concept of closed reduction and temporary splint immobilization until definitive fracture fixation bears the risk of prolonged soft tissue swelling and ongoing skin tension due to the unstable ankle joint.19,20 This modality also precludes adequate monitoring of the soft tissue envelope related to recurrent ankle joint dislocation or subluxation whenever the splint is removed. Alternative options include immediate definitive surgical management with open reduction and internal fixation (ORIF)21-25 and the more conservative “damage control” approach of temporizing external fixation.26-28

The concept of percutaneous vertical transarticular
pin fixation as a “salvage” option for unstable fracture-dislocations of the ankle dates back to descriptions in the Italian literature in 1958 and in the British literature in 1963. The first landmark article in the US literature appeared in 1965. The technique described by Childress involves placement of one 7/64-inch (2.8 mm) diameter or 2 parallel 3/32-inch (2.4 mm) diameter Steinmann pins. Multiple current publications from Europe emphasize the validity and safety of this staged concept with initial closed reduction and transarticular pin fixation followed by delayed definitive ankle fracture fixation once the soft tissue swelling has subsided. However, this “historic” technique has been largely abandoned in the US orthopedic community.

The current study was designed to analyze the experience in a US academic level I trauma center with the damage control approach of temporary transarticular pin fixation followed by delayed definitive ORIF for selected ankle fracture dislocations at risk for significant soft tissue complications.

**Materials and Methods**

The authors performed a retrospective analysis of a prospective database of all ankle injuries managed at Denver Health Medical Center during a 5½-year period from January 1, 2009, to July 1, 2014. The following Current Procedural Terminology (CPT) codes were applied to the general search of the overall study population: 27814, 27822, 27826, 27827, 27828, 27792, 27766, 27769, 28445, 20690, 20692, 20696, 27810, 27818, 27788, 27825, 27788, 27762, 27768, and 28436. Inclusion criteria for the study cohort of interest were patients 18 years and older with the presence of a closed ankle fracture-dislocation and associated critical soft tissue injury (Oestern-Tscherne grade I-III) or an open fracture (Gustilo-Anderson type I-III) managed by temporary transarticular pin fixation and delayed definitive ORIF. Exclusion criteria included injuries other than ankle fractures (eg, pilon fractures, subtalar dislocations), stable ankle fractures, closed ankle injuries without soft tissue compromise (Oestern-Tscherne grade 0), ankle fractures managed by treatment modalities other than defined by the inclusion criteria (eg, 1-stage ORIF, external fixation, retrograde tibiotarcal nails), skeletaly immature patients younger than 18 years, and patients with diabetes mellitus. Outcome parameters were the incidence of postoperative complications, unplanned revision surgery, and the subjective patient results on the 25-item Foot and Ankle Outcome Score (FAOS) questionnaire used in the British literature in 1963. Of these, 25 patients (1.8%) were managed with temporary transarticular ankle pin fixation. Five patients underwent transarticular ankle pinning as definitive fixation as part of the definitive ORIF procedure; they were therefore excluded from the study. Six patients with the diagnosis of diabetes mellitus were excluded due to the distinct susceptibility to complications and Charcot arthropathy. One patient in the transarticular pinning group cohort was lost to follow-up.

**Results**

A total of 1372 patients were retrieved during the initial database search during the 5½-year period of January 1, 2009, to July 1, 2014. Of these, 25 patients (1.8%) were managed with temporary transarticular ankle pin fixation. However, this “historic” technique has been largely abandoned in the US orthopedic community.

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The remaining 13 patients represented the main study cohort of interest (Figure 3). Of these, 8 patients (61.5%) were available for subjective follow-up scoring using the 25-item FAOS questionnaire. Foot and Ankle Outcome Score questionnaire scores were obtained at a median of 23.5 months (range, 6-42 months). Patient demographics, fracture, and soft tissue classifications, and outcome parameters are listed in the Table. Surgical conversion to definitive ORIF occurred at a median of 14 days after ankle K-wire transfixation (SD, ±5.2 days; range, 5-25 days). There were no ankle-related complications in the 13 patients managed with staged ankle pinning and delayed ORIF procedures, as determined by the authors’ standardized prospective departmental QA database. In particular, no wound healing problems, wound breakdown, or postoperative surgical site infections were observed in this selected study cohort.

**DISCUSSION**
The data from this study support the long-standing notion that the concept of temporary transarticular ankle pin fixation and delayed conversion to ORIF after subsidence of soft tissue swelling is safe and feasible in a selected subset of non-diabetic patients with high-energy injuries.
This simple damage control concept for critical injuries at risk for significant soft tissue complications, including the potential need for transtibial amputations in cases of unsalvageable infections,2,3,5,14,16 appears to be an intuitive and appealing alternative to external fixation or immediate definitive ORIF. The subjective outcome scoring at a median follow-up of 2 years (range, 6 months to 3.5 years) using the FAOS questionnaire revealed that most patients recovered well, with scores of 65 to 93 points on a scale ranging from 0 to 100 points. These findings support the notion that the 2×2.0-mm drill holes placed through the subtalar and tibiotalar joints (Figure 1) do not induce clinically relevant articular damage that would manifest in the development of secondary post-injury arthritis. Only 1 patient had an FAOS questionnaire score below 50 points (Patient 2; Table). This 65-year-old man sustained a high-energy type IIIB open ankle fracture-dislocation after a motorcycle accident, requiring multiple surgical revisions and soft tissue flap coverage. The patient was unable to regain full unrestricted function at his preinjury activity level as a martial arts (Kung Fu) instructor, which influenced his lower FAOS questionnaire score.

External fixation represents an established and widely used alternative damage control approach in the acute management of ankle fracture-dislocations with associated critical soft tissues, including open fractures.26-28 However, from the perspective of cost-effectiveness, the costs of implants should be taken into consideration, particularly in the current era of diagnosis-related groups and bundled payments. A recent estimate of direct costs of temporary external fixators used for damage control application in pelvic injuries and lower extremity fractures at the authors’ institution revealed an average cost of $5900 per fixator frame construct and implant costs of $670,805 annually.41 In contrast, a non-threaded stainless steel K-wire costs approximately $8. Thus, a conservative estimate of $20 per dual-wire ankle pinning extrapolates to a 300-fold decrease in implant costs compared with an average spanning external fixator construct.41 From a biomechanical perspective, another evident benefit of ankle pinning is the achievement of rigid stability and retention of tibiotalar joint reduction by trans-articular K-wires, compared with the relative stability by spanning external fixators allowing residual micromotion at the ankle joint. Figure 4 shows an example of damage control pin transfixation for a

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**Table**

<table>
<thead>
<tr>
<th>Patient No./Sex/ Age, y</th>
<th>AO Classification (44-)</th>
<th>Gustilo-Anderson Classification</th>
<th>Oestern-Tscherne Classification</th>
<th>Injury Mechanism</th>
<th>Polytrauma</th>
<th>Ankle-Related Complications</th>
<th>FAOS Questionnaire Score</th>
<th>Follow-up, mo</th>
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<tr>
<td>1/F/58</td>
<td>B2.3</td>
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<td>-</td>
<td>MVA</td>
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<td>None</td>
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<tr>
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<td>IIIB</td>
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<td>MCA</td>
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<tr>
<td>4/F/54</td>
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<tr>
<td>5/F/42</td>
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<td>IIIA</td>
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<td>MVA</td>
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<td>82</td>
<td>21</td>
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<tr>
<td>6/F/25</td>
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<td>None</td>
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<tr>
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<td>None</td>
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<td>III</td>
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<td>10/F/62</td>
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<td>12</td>
</tr>
<tr>
<td>13/M/53</td>
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<td>-</td>
<td>Fall</td>
<td>Yes</td>
<td>None</td>
<td>N/A</td>
<td>12</td>
</tr>
</tbody>
</table>

Abbreviations: FAOS, Foot and Ankle Outcome Score; MCA: motorcycle accident; MVA: motor vehicle accident; N/A, not available.

*Classification of severity of open fractures.27
*Classification of severity of soft tissue injury in closed fractures.26
*Polytrauma per “Berlin definition” consensus group.44
*Complications restricted to ankle injury, as entered in a prospective real-time departmental quality assurance database,29 including wound healing problems, surgical site infections, and unplanned surgical revisions.
type IIIA open fracture-dislocation and the retained anatomic reduction by K-wires at the point of delayed ORIF 14 days later.

Limitations of this study include the design of a retrospective analysis of a prospective database, the shortcomings of a CPT-based data query, and the small study cohort of 13 patients. In addition, only 8 of 13 patients (61.5%) were available for FAOS questionnaire follow-up scoring. This is likely due to the large proportion of indigent and homeless patients served by Denver Health, the regional safety-net hospital in Colorado.

In essence, this study confirms the findings of the landmark article published by Childress 50 years ago. Childress also published a follow-up study on his 16-year experience with 92 consecutive patients treated with closed reduction and vertical Steinmann pin fixation for unstable ankle-fracture dislocations in 1976. He described the technique as moderately simple to apply and without a skin incision, and reported that the procedure had been found to provide efficient and reliable short-term stabilization of the ankle and subtalar joints with minimal complications. This successful strategy is widely established in Germany, Switzerland, Austria, and the United Kingdom. It is time the US orthopedic community receives this message.

**CONCLUSION**

Staged temporary transarticular pin fixation of critical ankle injuries at risk for soft tissue complications followed by delayed definitive ORIF represents a simple, effective, safe, and cost-efficient damage control concept. The authors found good subjective outcomes at up to 3½ years of follow-up.

**REFERENCES**


