The Extensile Approach for the Operative Treatment of High-Energy Pilon Fractures: Surgical Technique and Soft-Tissue Healing

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Summary: Perhaps the most important advancement in the surgical treatment of high-energy pilon fractures has been the recognition of the need to delay primary surgery. However, at open reduction internal fixation an adequate incision must be made to clearly visualize the articular surface in an attempt to restore intraarticular anatomy. This article illustrates our extensile approach and its effect on soft-tissue healing. The approach allows complete access to the ankle joint to achieve reduction and fixation of the articular surface, as far medially or laterally as is necessary. In addition, it allows for easy placement of plates medially, laterally, or anteriorly. For fractures extending more proximally, plates can be placed subcutaneously from distal to proximal through the open incision.

Key Words: pilon fracture, surgical technique, extensile approach, soft-tissue technique, open reduction internal fixation, lateral pilon fracture

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INTRODUCTION

Various operative exposures for complex pilon fractures have been reported,[1–8] but no clear description and illustration have thus far been provided. This article describes and illustrates in detail the extensile approach, which permits complete visualization of the articular surface and offers the ability for plate placement medially, laterally, or anteriorly, as necessary. In addition, we report on the effect of this approach on soft-tissue healing in a cohort of 21 patients all treated in a similar fashion.

Surgical Technique

A tourniquet is applied. If an external fixator has been previously placed, it is usually left in place and the lower limb is draped in the sterile field from the level of the tourniquet to the toes. Exsanguination of the limb is accomplished only by elevating the lower extremity and not with use of any compressive bandages. Figure 1A and B shows the line of the skin incision as it is marked on the right limb. The incision is begun 10 mm below the tip of the medial malleolus and proceeds transversely across the ankle to a point just lateral to the midline and then turns at a 105- to 110-degree angle, proceeding proximally 10 mm lateral to the tibial crest. Thus, the incision lies laterally to the tibialis anterior tendon. It is important to make the turn in the incision at the 105- to 110-degree angle and not more acutely approaching 90 degrees. Generally, the vertical limb of the incision measures 15 cm but can be extended more proximally as desired. In situations with more extensive injury to the lateral column of the distal tibia, the point of the turn can be moved a bit more laterally. The transverse and vertical limbs of the incision are made using a No. 24 scalpel blade, but the 105- to 110-degree turn is made with a No. 15 blade, which permits the incision to be perfectly perpendicular to the plane of the skin, and skiving of the tissues is avoided.

The incision is carried down through the subcutaneous tissue (Fig. 2A) and a full-thickness flap is elevated (Fig. 2B). The incision continues onto the extensor retinaculum (Fig. 2C), exposing the underlying tibialis anterior tendon. The retinaculum is incised, with an attempt to leave the tibialis anterior tendon undisturbed in its sheath. This is not always possible, because it is intimately connected to the retinaculum, and thus frequently the sheath is opened (Fig. 3A). The inferior extensor retinaculum is opened, following the line of the incision. The full-thickness flap is retracted medially while the tendon of the tibialis anterior is retracted laterally (Fig. 3B, C). The flap is handled atraumatically without strong retraction or use of forceps, frequently using nylon sutures in the skin to apply traction. At the level of the ankle joint, the articular capsule is opened longitudinally, exposing the talus (Fig. 4; arrow points to talus). Subperiosteal dissection exposes the ankle joint and fracture site (Fig. 5A), and retraction of the tissues laterally exposes the entire lateral articular fragment of Chaput (Fig. 5B, C).

The articular surface is reduced progressively, frequently beginning with any displaced lateral column fragments (Chaput). The reduction proceeds from posterior to anterior and lateral to medial, and the articular fragments are provisionally stabilized with Kirschner wires, first the Chaput fragment (Fig. 6A) and then the anteromedial articular

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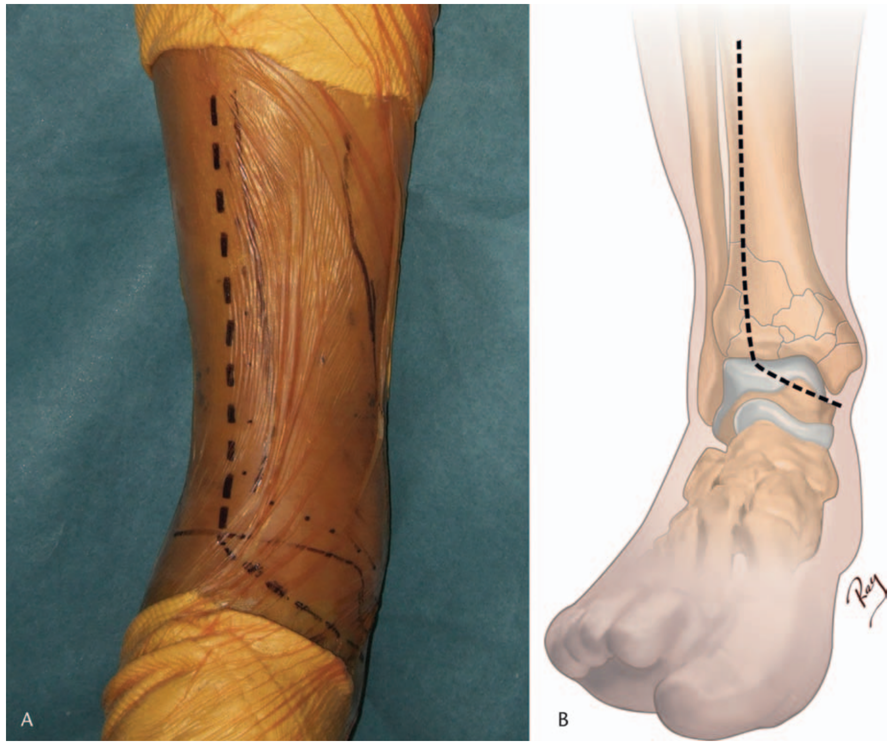

FIGURE 1. Patient 7 (Table 1) operated on 15 days postinjury. The skin incision as marked (A) and the corresponding illustration (B) showing the 105- to 110-degree angle between the transverse and vertical limbs of the incision.

fragment (Fig. 6B). Once the articular block has been reconstituted, it is joined to the proximal fragment. It is not necessary to anatomically reduce metaphyseal or diaphyseal fragments, but length and alignment are restored. Specific plate placement is determined by the nature of the fracture, but frequently 2 plates are used, one anterolateral and the other medial. For proximal extension of the fracture, the plates are introduced through the open incision and slid proximally

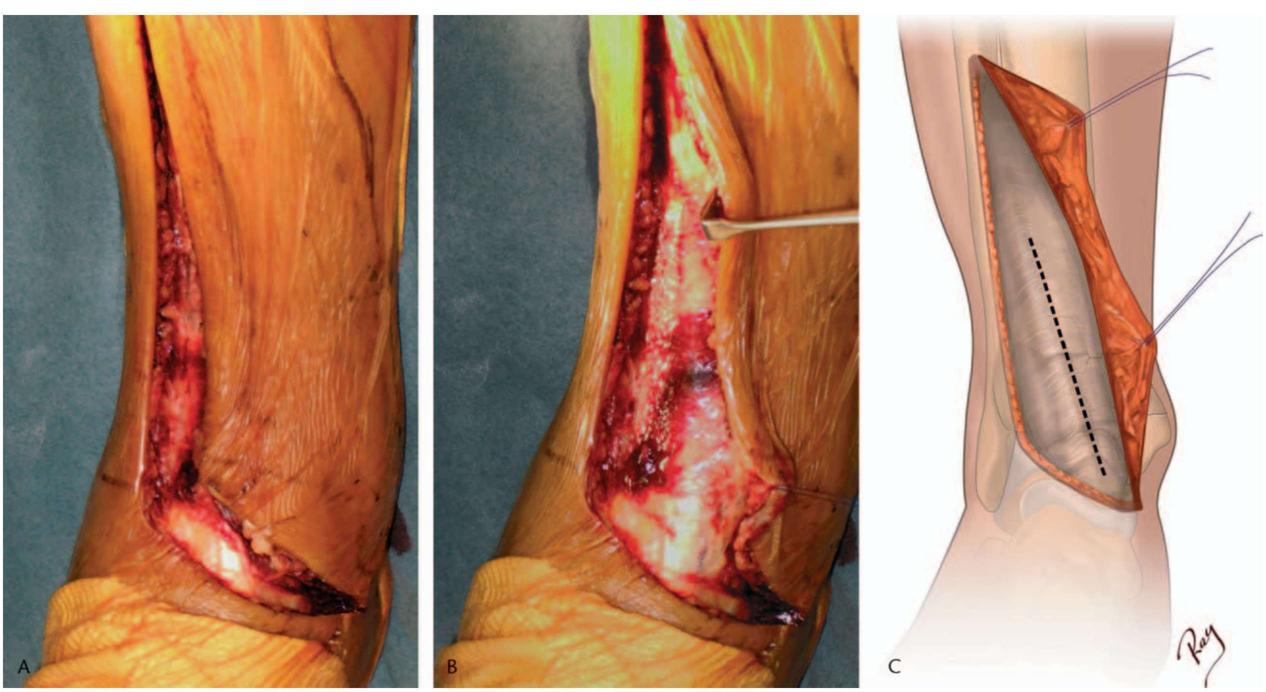

FIGURE 2. The incision is carried down through the subcutaneous tissue (A), and a full-thickness flap is elevated (B, C).

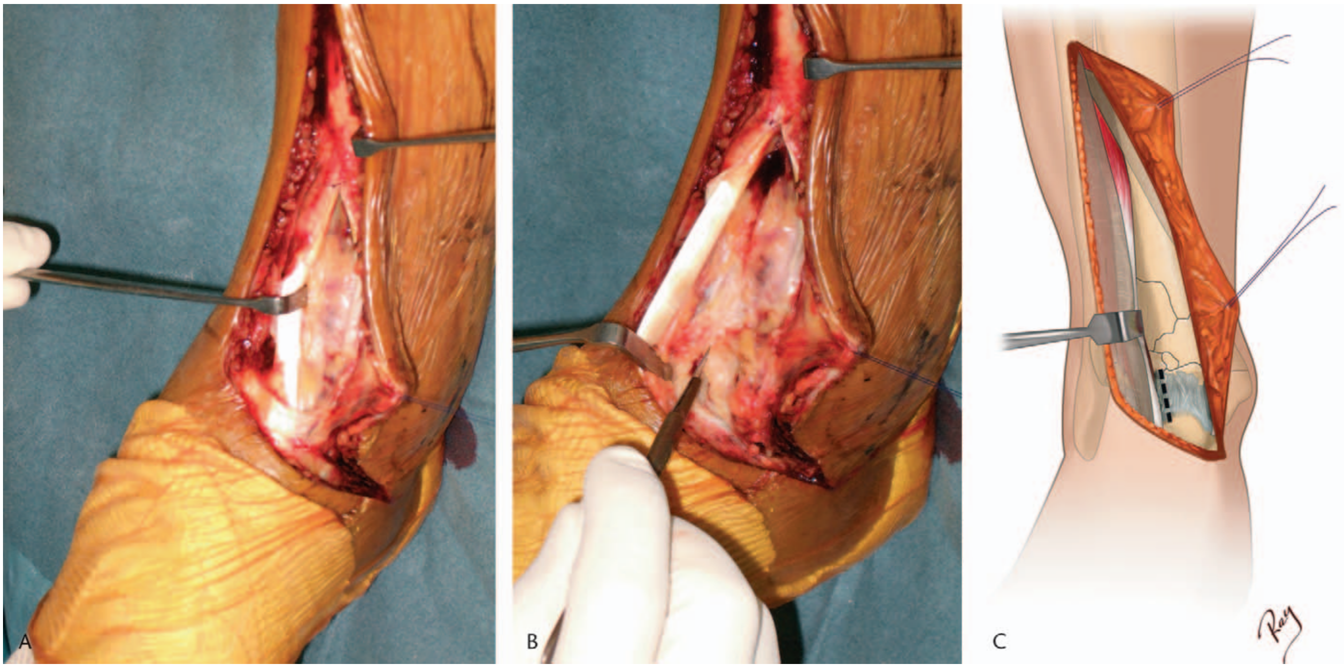

FIGURE 3. The retinaculum is incised, in this case exposing the tibialis anterior tendon (A), and the full-thickness flap is retracted medially while the tendon of the tibialis anterior is retracted laterally (B). The line of the articular capsule incision is noted (C, dotted line).

subcutaneously. The holes in the plate can be easily palpated and screws inserted through small incisions. Depending on the size of the metaphyseal defect, autogenous bone graft or bone graft substitute is added.

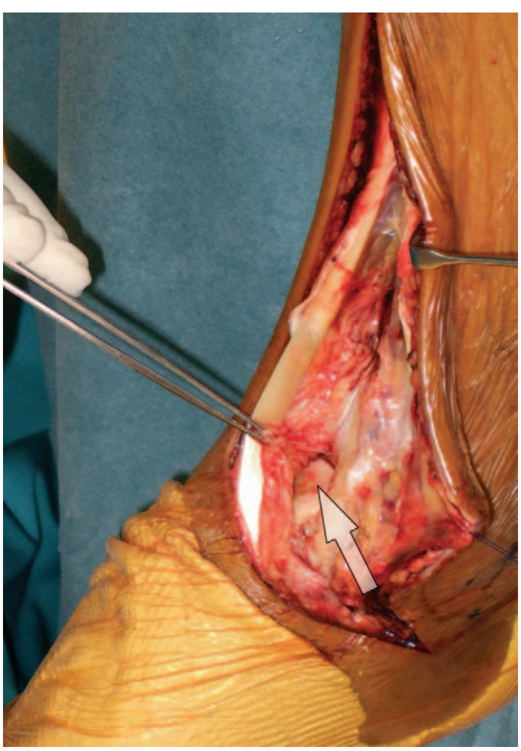

FIGURE 4. The articular capsule is opened longitudinally, exposing the talus (arrow points to talus).

Previously, we always fixed the fibula when we placed the bridging external fixator, which followed the guidelines of *the AO and others who described an anterolateral fragment of tibia that remained connected to the fibula, and if one reduced the fibula, this fragment would be in near-anatomic position. Thus, it could be used as a template for the reduction of the pilon. However, we found that there were cases of malreduction of the fibula, which made reduction of the pilon more difficult. Therefore, we changed our approach and decided not to fix the fibula initially. At definitive surgery, the pilon is approached first. After fixation of the pilon fracture, we use a posterolateral skin incision to place the plate (one-third tubular, or 3.5 mm) on the lateral aspect of the fibula. The fibula is fixed to increase the stability of the pilon fixation.

Closure of the wound begins with the extensor retinaculum, with interrupted 2-0 Vicryl (polyglactin 910; Johnson & Johnson International, Brussels, Belgium) sutures (Fig. 7). The subcutaneous tissue is then closed with the same size Vicryl suture, and the skin, with interrupted 3-0 nylon suture using the Allgöwer modification of Donati (Fig. 8A, B).[9]

Postoperatively, patients are maintained at bed rest for 48 to 72 hours, with the limb elevated. If the wound appears satisfactory after that time, the patient begins ambulation, allowing only 10 kg of weight-bearing for 10 to 12 weeks. Range-of-motion and muscle-strengthening exercises are prescribed. The patient is discharged with a removable splint to prevent equinus deformity.

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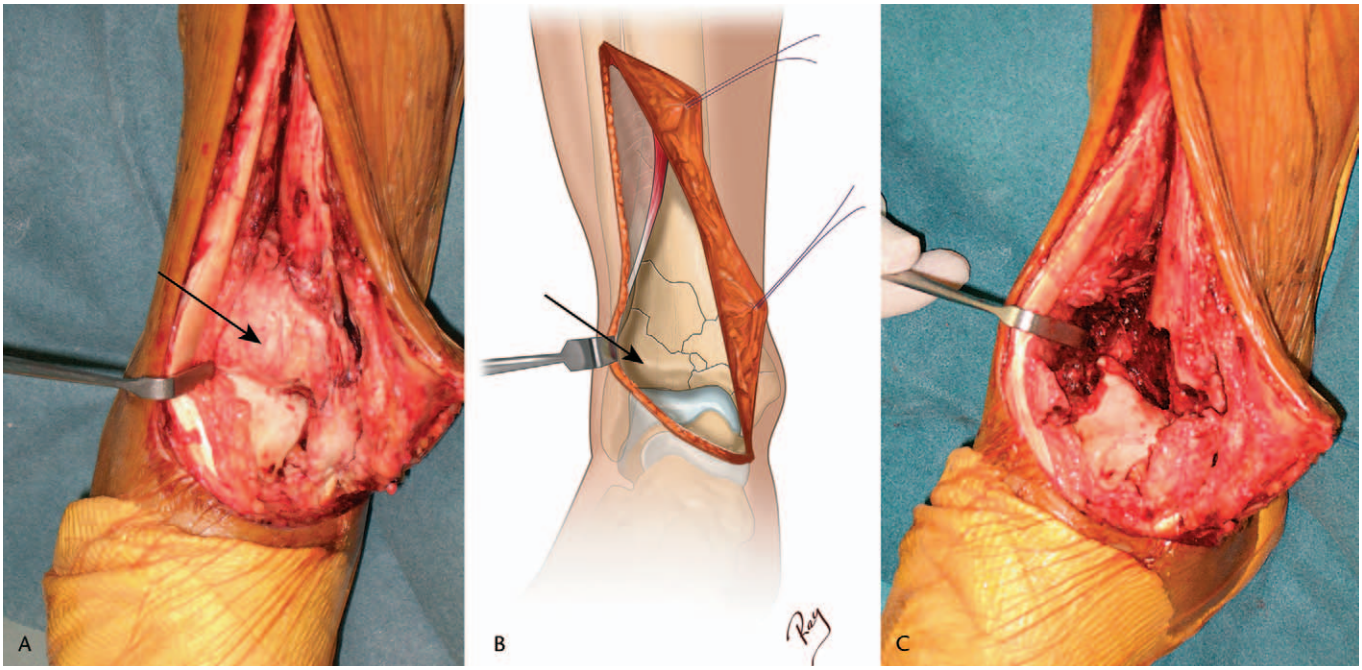

FIGURE 5. Subperiosteal dissection exposes the ankle joint and fracture site, and retraction of the tissues laterally exposes the entire lateral articular fragment of Chaput (A and B, arrows). The Chaput fragment is then retracted laterally (C, behind retractor).

PATIENTS AND RESULTS

Between January 2003 and December 2004, we used this approach in the operative treatment of 21 patients with 21 closed fractures (Table 1). There were 16 male and 5 female patients, with a mean age of 32.5 years (range, 16–48 years). All fractures were complete articular injuries, classified as AO/OTA 43-C, with extension to the metaphyseal-diaphyseal junction and frequently more proximal. In all patients, a spanning external fixator was applied urgently. In only 2 of 17 patients with a fibular fracture was the fibula fixed at the same time the external fixator was applied; in the remaining 15 patients, it was fixed at the definitive pilon surgery. The

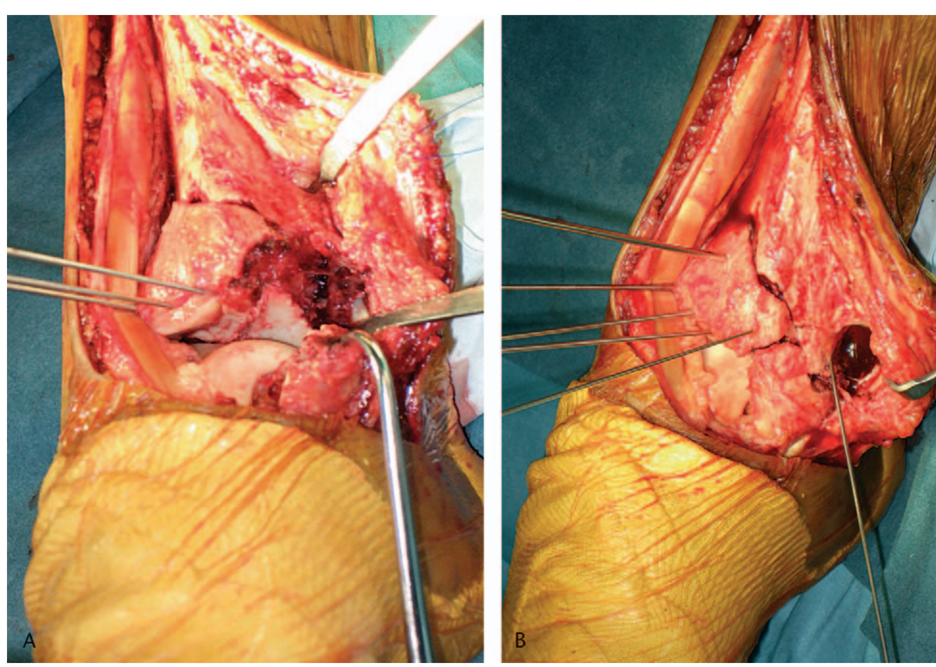

FIGURE 6. After the reduction of the posterior articular surface, 3 Kirschner wires were placed into the lateral articular fragment of Chaput (A), followed by reduction and Kirschner-wire fixation of the anteromedial articular fragment (B).

TABLE 1. Patient and Treatment Characteristics

No.	Age/Sex	Side Injured	Mechanism	AO/OTA	Time in Ex Fix*	Fibula Fixation†	Follow-up‡	Wound Healing
1	48/M	R	MVA	43-C1	12	Delayed	12	Good
2	42/F	L	Fall	43-C2	21	Urgent	12	Good
3	39/M	R	MVA	43-C3	16	Delayed	14	Good
4	38/M	R	Hang gliding	43-C3	16	Delayed	13	Good
5	40/F	R	MVA	43-C3	17	Delayed	14	Good
6	26/M	R	MVA	43-C3	18	Delayed	15	Good
7	37/M	R	Fall	43-C3	15	Delayed	17	Good
8	38/M	L	MVA	43-C3	14	None§	18	Good
9	19/F	R	Hang gliding	43-C3	13	None§	12	Good
10	27/M	L	MVA	43-C3	16	Delayed	15	Disturbed‖
11	17/M	R	MVA	43-C3	18	Delayed	19	Good
12	19/M	R	MVA	43-C2	16	Delayed	16	Good
13	37/M	R	Fall	43-C3	17	None§	12	Good
14	26/F	R	MVA	43-C3	15	Delayed	13	Good
15	23/F	R	MVA	43-C3	15	Delayed	12	Good
16	44/M	L	MVA	43-C3	18	Urgent	12	Good
17	35/M	L	MVA	43-C2	17	Delayed	13	Good
18	30/M	L	Fall	43-C3	20	Delayed	12	Good
19	39/M	L	Fall	43-C3	19	None§	14	Good
20	26/M	R	MVA	43-C3	16	Delayed	12	Good
21	32/M	L	MVA	43-C3	15	Delayed	13	Good

*Length of time (days) between initial application of external fixator and definitive surgery.
†Fibula fixation (if performed) either at urgent bridging external fixation or delayed.
§None implies that there was no fibula fracture.
‡Latest follow-up (months).
‖Superficial infection at proximal portion of wound.

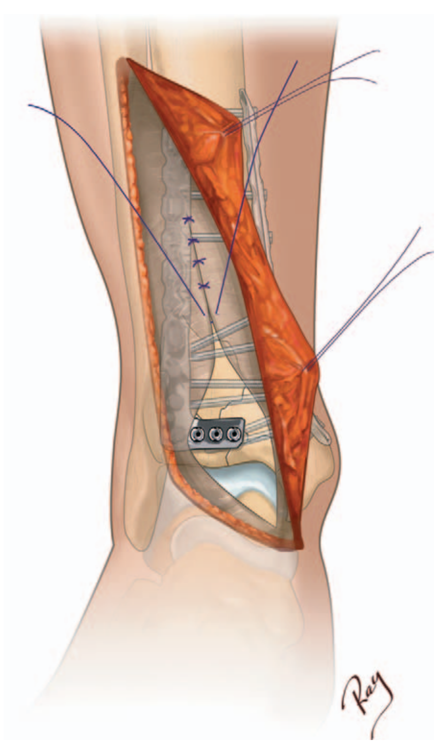

FIGURE 7. Closure of the extensor retinaculum.

average time between application of the bridging external fixator and definitive surgery was 16.4 days (range, 127–21 days). The extensile approach was used in all patients. In some patients, the external fixator was removed before the definitive surgery; however, in most cases the fixator was left in place to help with distraction intraoperatively.

A representative example is that of a 37-year-old man who sustained a closed pilon fracture of the right lower extremity in a motor vehicle crash. The preoperative radiographs at admission to the hospital (Fig. 9), immediately after application of an external fixator (Fig. 10A, B), and after computed tomography (Fig. 11A, B, C) showed a complete articular fracture localized to the epiphysiometaphyseal region without extension into the diaphysis, with a multifragmentary articular surface and a fibular fracture. The AO/OTA classification was 43−C3.2. Anteroposterior and lateral radiographs (Fig. 12A, B) 1 week postoperatively showed satisfactory reduction of the articular surface and stabilization with anterolateral and medial plates. Excellent healing of the soft tissues was observed at 3 months postoperatively (Fig. 13), and radiographs at 6 months postoperatively (Fig. 14) showed a well-healed fracture.

All patients were followed up for a minimum of 12 months postoperatively to allow for accurate assessment of wound and fracture healing. All patients except 1 had uneventful wound healing, with no flap necrosis or infection. One patient developed a local infection at the most proximal

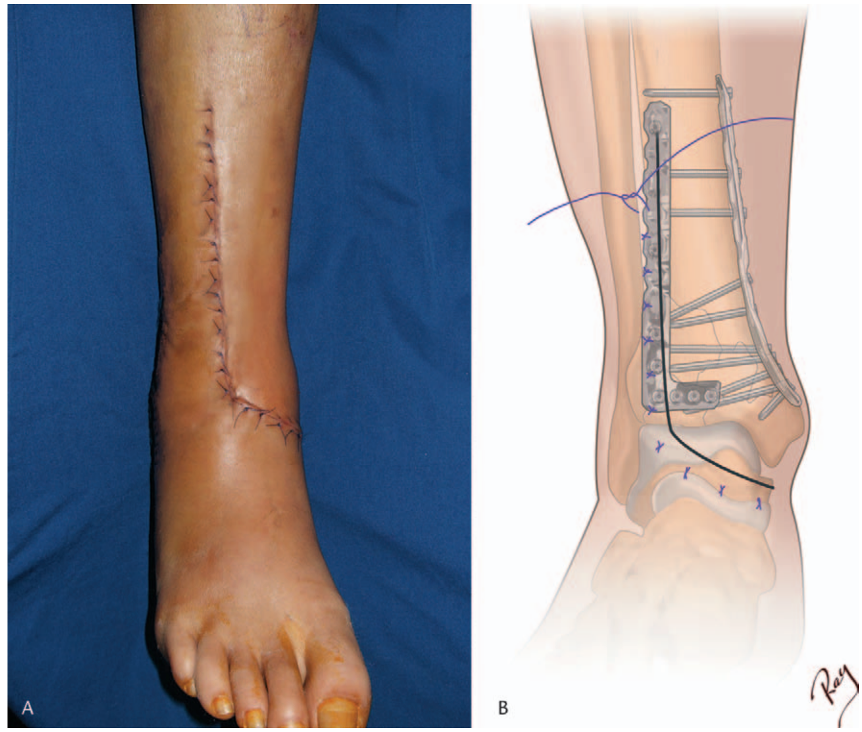

FIGURE 8. Photograph (A) at 48 hours postoperatively and illustration (B) showing the extensile incision closed with the Allgöwer modification of the Donati suture.

portion of the vertical incision and not at the lateral inferior corner of the flap at the articular margin. We believe this occurred because a technical error placed one of the tibial pins for the bridging external fixator very close to the planned surgical incision, and the incision was carried to within 1 cm of the pin site. The infection was treated by local incision and drainage and appropriate antibiotics, with early and complete resolution. The lesson learned from this complication is that, if possible, it is important to try and place the external fixation pins in the very proximal tibia. All fractures united without

FIGURE 9. Anteroposterior (A) and lateral (B) radiographs of a 37-year-old man (patient 7; Table 1) who was involved in a high-energy motor vehicle crash, sustaining this multifragmentary pilon fracture of his right ankle (AO/OTA classification, 43-C3.2). This is the same patient shown in the previous figures.

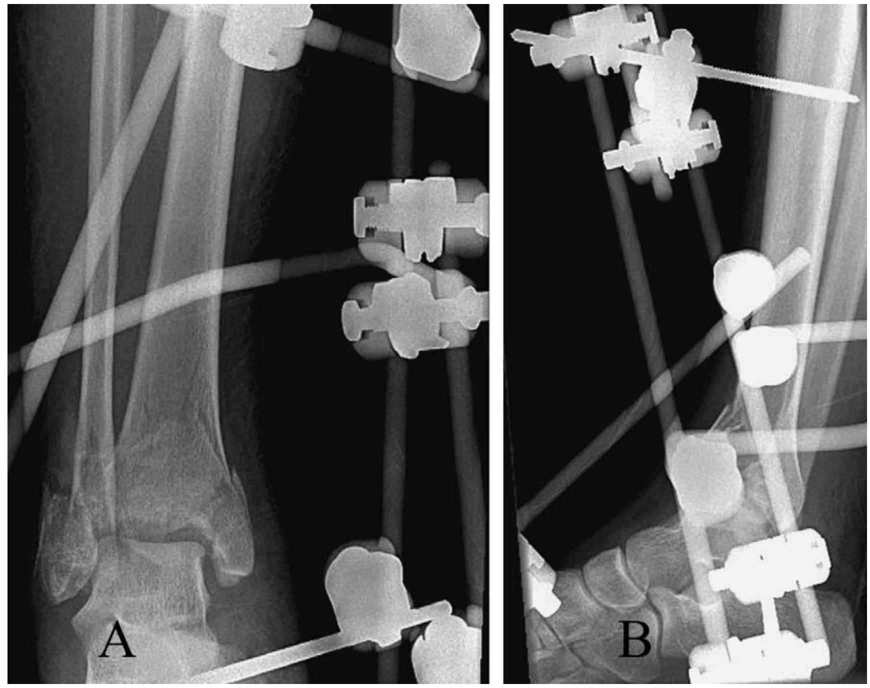

FIGURE 10. Anteroposterior (A) and lateral (B) radiographs after application of an external fixator.

radiographic evidence of avascular necrosis of any of the articular fragments. The most important aspect of this report is to describe our experience with the extensile approach and its effect on the soft tissues. Given that goal, the clinical outcome of these patients for other parameters such as range of motion, gait, radiologic assessment, return to work and sporting activities, and health impairment parameters is peripheral to the main objective of this study.

FIGURE 11. Sagittal (A), coronal (B), and transverse (C) computed tomographic views.

FIGURE 12. Anteroposterior (A) and lateral (B) radiographs 1 week postoperatively, showing the anatomic reduction.

FIGURE 13. Photograph at 3 months postoperatively. Note good healing of the wound.

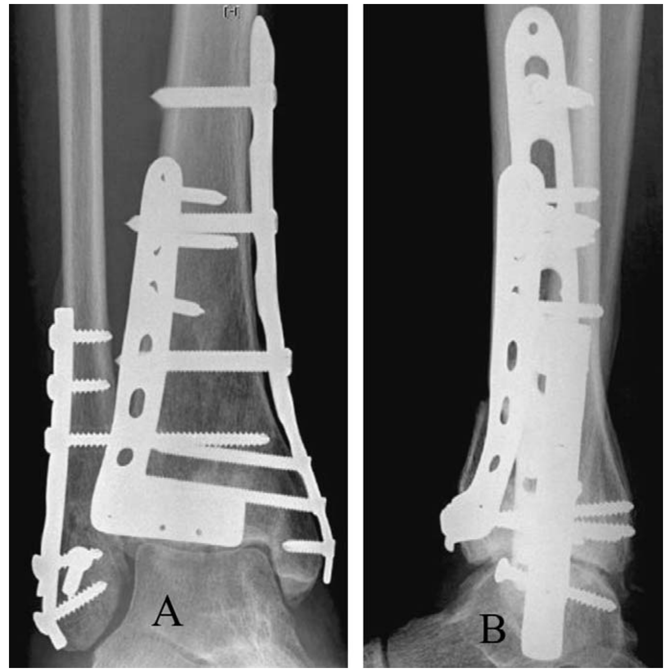

FIGURE 14. Anteroposterior (A) and lateral (B) radiographs 16 months postoperatively.

DISCUSSION

The most important advancement in management of the high-energy pilon fracture has been the recognition of the need to delay primary surgery. The use of a bridging external fixator, with or without fixation of any fracture of the fibula, has become common to stabilize the soft tissues and prevent wound-healing complications.[2,3,5,6,10,11] Second has been the interest in minimally invasive techniques to stabilize the fracture, which has led some to consider the ideal treatment to be a limited exposure of the joint with use of cannulated screws for fixation of articular fragments, followed by either a spanning external fixator or a nonspanning hybrid fixator for definitive treatment of the fracture.[8,12–14] The rationale for such an approach has been related to the concern for wound-healing problems, including deep infection with use of more extensile approaches. However, if the goal is to restore articular congruity, then limited incisions may fail to adequately visualize the joint surface and achieve an anatomic reduction. Minimally invasive techniques for joint reduction are therefore frequently inadequate but may permit less surgical dissection

TABLE 2. Pitfalls and Tips

Pitfall	Effect	Tip
Transverse limb of incision is made too proximal	Difficult to visualize articular surface	Be sure the transverse incision begins 10 mm inferior to medial malleolus
Transition from transverse to vertical limbs is made too medial	Difficult to visualize lateral pilon	Make the transition midway between the malleoli or slightly more lateral
Transition from transverse to vertical limbs is made too medial	Anterior tibial tendon lies directly under scar	Be sure the incision is at least 10 mm lateral to the tibial crest
Junction between transverse and vertical limbs is made ≤90°	Puts the corner of the flap at risk	Make this a transition at 105°–110°
Not keeping knife edge perpendicular to skin at transition from transverse to vertical limbs	Skives the incision; may disturb wound healing at corner of flap	Keep knife edge perfectly perpendicular during the transition
Using too long a scalpel blade	Skives the incision (as above)	Use a No. 24 scalpel blade for the incision, but at the corner change to a No. 15 blade
Separating the layers as flap is developed	Negatively affects vascularity to the flap	Raise up the medial flap as a full-thickness flap
Rough retraction of the flap	Will disturb the blood supply to the flap	Be gentle! Use full-thickness nylon sutures to apply traction to the flap
Letting the flap or tendon desiccate	May lead to skin or tendon necrosis	Frequently moisten the flap and any exposed tendon

proximally when the articular injury extends past the metaphyseal-diaphyseal junction and into the shaft of the tibia. To clearly visualize the entire joint surface, particularly with more valgus-type pilon fractures and extensive injury to the lateral column, we have favored an extensile approach. We strongly follow the principle of a delay in definitive surgery, waiting on average more than 14 days with a bridging external fixator in place.

The traditional surgical approach, described by the AO Group[7] and others,[1,3] is the classic anteromedial incision, which generally does not allow for complete exposure of the lateral column of the tibia. A straighter medial incision has been recommended by some[2,4–6] to provide access laterally to the tubercle of Chaput. An approach based on the primary fracture line has been suggested,[8,15] with many incisions therefore centered over the lateral pilon. This approach has usually been done in cases of limited internal fixation and hybrid external fixation[8] but may not suffice for more complex injuries that also extend medially. Specialized approaches, posterolateral[16] or "posteromedioanterior,"[17] have also been described for particular fracture patterns but again are limited in their ability to completely expose the entire articular surface.

There are specific pitfalls with our extensile approach, and thus recommendations to avoid these errors are summarized in Table 2. The primary complication related to the surgical treatment of pilon fractures relates to the soft tissues. The problems of wound healing, soft-tissue and bone infection, and even amputation have been well described and are probably related to the failure to appropriately delay performing the definitive procedure, wrong choice of incision, and poor handling of the soft tissues. Because our goal is to restore articular anatomy, clear visualization of the joint is mandatory. Although our extensile approach can theoretically place the flap more at risk, we did not see any adverse effect on wound healing and saw no increased complication of infection in our 21 patients.

REFERENCES

1. Bartlett C, Weiner L. Fractures of the tibial pilon. In: Browner B, Jupiter J, Levine A, et al, eds. *Skeletal Trauma*. 3rd ed. Philadelphia, Pa: Saunders; 2003:2257–2306.
2. Borrelli J Jr, Catalano L. Open reduction and internal fixation of pilon fractures. *J Orthop Trauma*. 1999;13:573–582.
3. Hahn MP, Thies JW. Pilon tibiale fractures. *Chirurg*. 2004;75:211–230.
4. Mast J. Pilon fractures of the distal tibia: a test of surgical judgment. In: Tscherne H, Schatzker J, eds. *Major Fractures of the Pilon, the Talus, and the Calcaneus*. Berlin, Germany: Springer-Verlag; 1993:7–27.
5. Patterson MJ, Cole JD. Two-staged delayed open reduction and internal fixation of severe pilon fractures. *J Orthop Trauma*. 1999;13:85–91.
6. Sirkin M, Sanders R, DiPasquale T, et al. A staged protocol for soft tissue management in the treatment of complex pilon fractures. *J Orthop Trauma*. 1999;13:78–84.
7. Summer C, Rüedi T. Tibia: distal (pilon). In: Rüedi T, Murphy W, eds. *AO Principles of Fracture Management*. Stuttgart, Germany: Thieme; 2000: 539–556.
8. Tornetta P3rd, Weiner L, Bergman M, et al. Pilon fractures: treatment with combined internal and external fixation. *J Orthop Trauma*. 1993;7:489–496.
9. Müller M, Allgöwer M, Willenegger H. *Manual of Internal Fixation*. New York, NY: Springer-Verlag; 1970:94.
10. Egol KA, Wolinsky P, Koval KJ. Open reduction and internal fixation of tibial pilon fractures. *Foot Ankle Clin*. 2000;5:873–885.
11. Hontzsch D, Karnatz N, Jansen T. One- or two-step management (with external fixator) of severe pilon-tibial fractures. *Aktuelle Traumatol*. 1990; 20:199–204.
12. Babis GC, Vayanos ED, Papaioannou N, et al. Results of surgical treatment of tibial plafond fractures. *Clin Orthop Relat Res*. 1997;341:99–105.
13. Barbieri R, Schenk R, Koval K, et al. Hybrid external fixation in the treatment of tibial plafond fractures. *Clin Orthop Relat Res*. 1996;332:16–22.
14. Bonar SK, Marsh JL. Unilateral external fixation for severe pilon fractures. *Foot Ankle*. 1993;14:57–64.
15. Tornetta P 3rd, Gorup J. Axial computed tomography of pilon fractures. *Clin Orthop Relat Res*. 1996;323:273–276.
16. Konrath GA, Hopkins G 2nd. Posterolateral approach for tibial pilon fractures: a report of two cases. *J Orthop Trauma*. 1999;13:586–589.
17. Kao KF, Huang PJ, Chen YW, et al. Postero-medio-anterior approach of the ankle for the pilon fracture. *Injury*. 2000;31:71–74.