

# Primary Ankle Arthrodesis for Severely Comminuted Tibial Pilon Fractures

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**Abstract:** Management of severely comminuted, complete articular tibial pilon fractures (Rüedi and Allgöwer type III) remains a challenge, with few treatment options providing good clinical outcomes. Twenty patients with severely comminuted tibial pilon fractures underwent primary ankle arthrodesis with a retrograde calcaneal nail and autogenous fibular bone graft. The fusion rate was 100% and the varus malunion rate was 10%. Fracture union occurred at a mean of 16 weeks (range, 13-18 weeks) postoperatively. Primary ankle arthrodesis is a successful method for treating highly comminuted tibial pilon fractures, having a low complication rate and a high satisfaction score. [*Orthopedics*. 2017; 40(2):e378-e381.]

**P**ilon fracture is a severe and challenging to treat distal tibial injury. Because there is a limited muscle cover between skin and bone at this level of the lower limb, energy derived from injury is transferred directly to these soft tissue structures.<sup>1</sup> These fractures account for approximately 1% of lower limb fractures and less than 10% of

all tibial fractures.<sup>2</sup> In contrast to the rotational mechanisms that result in malleolar fractures and fracture-dislocations of the ankle, high-energy axial loading mechanisms, caused by falls from heights or motor vehicle accidents, typically result in distal tibial pilon fractures.<sup>3</sup> Typically, remarkable comminution and impaction of the

joint surface is associated with these high-energy traumas.<sup>4-6</sup>

A case series of primary ankle arthrodesis using a retrograde calcaneal nail to treat closed comminuted tibial pilon fractures is presented. Clinical and radiologic outcomes as well as complications were analyzed.

## MATERIALS AND METHODS

This was a prospective follow-up study. All operations were performed between December 2010 and December 2014 in the Department of Orthopedic Surgery and Traumatology, Benha University Hospital. This study was approved by the ethical committee of the Benha Faculty of Medicine, and patients gave informed consent.

Twenty consecutive patients with closed highly comminuted nonreconstructable (>50% affection of the articular surface) pilon fractures underwent primary ankle arthrodesis using a retrograde calcaneal nail. Patient age at the time of injury ranged from 20 to 47 years

(average, 33 years). There were 3 female (15%) and 17 male (85%) patients. Fractures affected the right tibial pilon in 13 patients (65%) and the left tibial pilon in 7 patients (35%). The chief mechanisms of injury were motor vehicle accidents (n=17; 85%) and falls from heights (n=3; 15%). Fractures were graded according to Rüedi and Allgöwer<sup>7</sup> as type III. The Rüedi and Allgöwer classification system is simple and easy to apply. The AO classification, although comprehensive, is complicated and difficult to apply. Rüedi and Allgöwer described 3 groups, specific to tibial pilon fractures, based on the size and displacement of articular fragments. Type I represents nondisplaced intra-articular fractures without loss of articular congruency. Type II represents displaced fractures with loss of articular congruency. Type III represents severely comminuted fractures with impaction of the distal tibia. Average follow-up was 34 months (range, 12-60 months).

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Exclusion criteria included open fractures; grade I and II pilon fractures (according to the Rüedi and Allgöwer classification); less than 50% affection of the distal tibial articular surface (ie, to be treated by open reduction and internal fixation only); medical comorbidity (eg, diabetes); dysvascular limb disease; and insufficient plantar heel fat pad.

### Operative Technique

Early operative management through a tenuous soft tissue envelope risks wound healing difficulty, invites infection, and can potentially lead to limb amputation. On the day of admission, all patients were placed on a below-the-knee posterior slab with elevation of the lower limb. Ice packing was used over the affected limb. Blisters were left intact and covered with dry sterile gauze to be changed daily (Figure 1). If a blister ruptured spontaneously, it was unroofed and covered with a nonadherent dressing.

Anteroposterior and lateral radiographs of the affected ankle joint were carefully analyzed. Computed tomography evaluation was mandatory. Surgery was delayed to allow tissue swelling to subside. The leg was operated on once Langer's lines were visible on the overlying skin, blisters were dry, and no cellulitis or erythematous margins existed about the wound.<sup>8</sup> Average time from trauma to fusion surgery was 16 days (range, 7-20 days).

The patient was placed in the supine position. An antibiotic was administered intra-

venously before surgery and a pneumatic tourniquet was inflated. The skin was prepared with a povidone-iodine solution according to strict aseptic guidelines. A direct transfibular approach was used along the posterior border of the distal fibula with a curve directed toward the toes (Figure 2) to protect the peroneal tendons. The ankle joint was exposed through a lateral approach; the distal fibula, comminuted fragments, and remaining articular cartilage were excised; and a curved intramedullary tibiofibular nail and an autologous bone graft using the excised distal fibula were inserted. In accordance with the manufacturer of the nail, the distal fibula was removed (ie, 10-cm distal fibulectomy).<sup>9</sup> Removal of the distal fibula leads to easier reduction alignment and a single surgical incision. Fracture alignment was achieved through a gentle manual traction to overcome distal tibial shortening and overriding that results from the fracture and to gain nearly normal tibial length to facilitate guidewire entry and nail reaming. Regarding length, the fractured limb can be compared with the unaffected limb.

The site for arthrodesis was prepared through denuding the articular cartilage from the talus bone and the remaining distal tibial articular fragments, which were replaced by fibular graft pieces. The best position for arthrodesis is in neutral dorsiflexion, 4° hindfoot valgus, and external rotation (the anteromedial tibial border is parallel to the second ray of



Figure 1: Fracture blisters.



Figure 2: Skin incision.

the involved foot).<sup>10</sup> The entry point is crucial. In the sagittal plane, a line was drawn from the second toe to the center of the heel to intersect with a line drawn in the coronal plane bisecting the medial malleolus at the junction of the anterior and middle thirds of the heel pad. The intersection of these lines indicates the correct entry portal for the nail.<sup>11</sup> A guidewire was inserted at the entry point, followed by reaming and nail introduction (Figure 3). Proximal locking screws were used. Compression at the fracture site was followed by distal nail locking, preventing torsional and rotational deformities.

### Postoperative Regimen

Intravenous antibiotics were administered for 48 hours post-

operatively. Oral antibiotic prophylaxis was administered for the next 5 days. Intramuscular injections of nonsteroidal anti-inflammatory drugs were usually necessary the first few days postoperatively. A below-the-knee slab was used for 2 weeks after the sutures were removed. Absolute non-weight bearing was advised until the appearance of radiologic signs of union.

## RESULTS

### Clinical

Clinical assessment was performed using the American Orthopaedic Foot and Ankle Society (AOFAS) ankle score.<sup>12</sup> The mean score was 85.4 (range, 80-86). At final follow-up, patients had no pain, had a stable plantigrade foot, and could ambulate while wearing normal shoes without assistive devices.



Figure 3: Intraoperative nail reaming. Note the entry point.



**Figure 4:** Postoperative lateral radiograph of the ankle showing subtalar joint fusion.

### Radiologic

Average follow-up was 34 months (range, 12-60 months). Union was achieved in all patients, with a fusion rate of 100%. Union was confirmed radiologically at an average of 16 weeks (range, 13 to 18 weeks). No secondary procedures were required to obtain union. As a result of retrograde tibiocalcaneal nailing, the subtalar joint was also fused in all cases (**Figures 4-6**).

Complications included varus deformity ( $8^\circ$  and  $10^\circ$ ) in the first 2 cases and Sudek's atrophy in 7 cases. There were no infections or soft tissue problems.

### DISCUSSION

Tibial pilon fractures constitute a challenge for orthopedic surgeons. The ideal treatment for severely comminuted tibial pilon fractures remains controversial. Most articles about treating these fractures focus on the results of open reduction and internal fixation. The use of primary ankle arthrodesis with fracture reduction has received much less attention.

However, an anatomic reduction does not prevent the development of posttraumatic



**Figure 5:** Preoperative anteroposterior radiograph (A), coronal computed tomography scan (B), and lateral radiograph (C) of the right ankle showing severe comminution and greater than 50% affection of the articular surface.

arthritis. A percentage of anatomic reductions are bound to evolve unfavorably. The severity of the damage on the joint surface plays a significant role in determining the risk for development of posttraumatic arthritis. Aggression to the articular cartilage (chondrolysis) is probably closely related to this.<sup>13</sup>

Severely comminuted tibial pilon fractures are often associated with a high rate of complications. Lesions may be too severe for reconstruction.<sup>14</sup> Primary ankle arthrodesis is a good solution in these cases.

When a negative prognosis is established at the outset and understood by the patient, early arthrodesis reduces the severity of the resulting sequelae, the number of surgical procedures, and the period of disability.<sup>2,3,15</sup>

A direct posterolateral transfibular approach was used to perform a 10-cm distal fibulectomy. Denuding and removing tibiotalar joint articular cartilage and fragments, replacing them with an autogenous excised fibular graft, and preparing the ankle joint for arthro-

desis led to patients having just one surgery.

The current study is in agreement with that of Niikura et al<sup>16</sup> that when ankle arthrodesis is performed for a tibial pilon fracture, an intramedullary nail is thought to be superior to a plate. The latter is bulky and may impede soft tissue healing, leading to more skin and soft tissue complications. One incision was used for all surgery, thus limiting the incidence of skin problems postoperatively. The surgical technique is easy, avoiding assembly of the highly comminuted articular parts.

Retrograde calcaneal nailing seems to be a more logical choice of procedure than antegrade tibiocalcaneal nailing. Antegrade nailing is more difficult to perform. Multiple incisions are needed to perform articular cartilage denuding to prepare the ankle joint for arthrodesis. Antegrade nailing has a higher incidence of varus malalignment postoperatively.<sup>17</sup>

Kirjavainen and Lindahl<sup>4</sup> studied 22 consecutive severely comminuted pilon fractures treated with open reduction and an anterior locked plate combined with the assistance of a bridging external fixator. Complications included nonunion in 2 cases treated with plate removal and a ring frame fixator; early wound problems in 4 cases treated with local muscle flaps; and loss of reduction in 1 case treated with a frame fixator and a bone graft. This technique had a high rate of complications requiring other surgeries. In the current

study, complications included 2 cases of varus malunion and 7 cases of Sudek's atrophy.

Regarding clinical assessment using the AOFAS score, there was no postoperative pain. Patients had a stable plantigrade foot and could ambulate while wearing normal shoes without assistive devices. The highest score, 86 points (of a possible 100), was due to the loss of 14 points through ankle and subtalar arthrodesis (8 points in dorsiflexion and plantarflexion and 6 points in subtalar inversion and eversion). In this case series, there were no major complications jeopardizing primary ankle fusion as a treatment option for highly comminuted pilon fractures.

### Limitations

Study limitations included a relatively small number of patients. A greater number are needed for more definite conclusions. However, the long follow-up period of this study was a strength. The author believes that this work adds support to the notion that primary ankle arthrodesis is a safe and satisfactory treatment option for severely comminuted pilon fractures.

### CONCLUSION

Primary ankle joint fusion using a retrograde calcaneal nail seems to be a logical so-

lution with a low complication rate for severely comminuted tibial pilon fractures, which have a high affinity for post-traumatic arthritis and subsequent need for further surgery.

### REFERENCES

- Jacob N, Amin A, Giotakis N, Narayan B, Nayagam S, Trompeter AJ. Management of high-energy tibial pilon fractures. *Strategies Trauma Limb Reconstr.* 2015; 10(3):137-147.
- Bozic V, Thordarson DB, Hertz J. Ankle fusion for definitive management of non-reconstructable pilon fractures. *Foot Ankle Int.* 2008; 29(9):914-918.
- Dujardin F, Abdulmutalib H, Tobenas AC. Total fractures of the tibial pilon. *Orthop Traumatol Surg Res.* 2014; 100(1)(suppl):S65-S74.
- Kirjavainen M, Lindahl J. Treatment of pilon fractures using anterior locking plate: review of current literature and preliminary results in 22 patients in Helsinki University Central Hospital. *Suom Ortop Traumatol.* 2006; 29:36-39.
- Milenkovic SI, Mitkovic M, Micic I, et al. Distal tibial pilon fractures (AO/OTA type B, and C) treated with the external skeletal and minimal internal fixation method. *Vojnosanit Pregl.* 2013; 70(9):836-841.
- Fernández-Hernández Ó, Álvarez-Posadas I, Betegón-Nicolás J, González-Fernández JJ, Sánchez-Herráez S. Fractures of the tibial pilon: long-term functional results. *Rev Esp Cir Ortop Traumatol.* 2008; 52(3):152-160.
- Rüedi TP, Allgöwer M. The operative treatment of intra-articular fractures of the lower end of the tibia. *Clin Orthop Relat Res.* 1979; 138:105-110.
- Patterson MJ, Cole JD. Two-

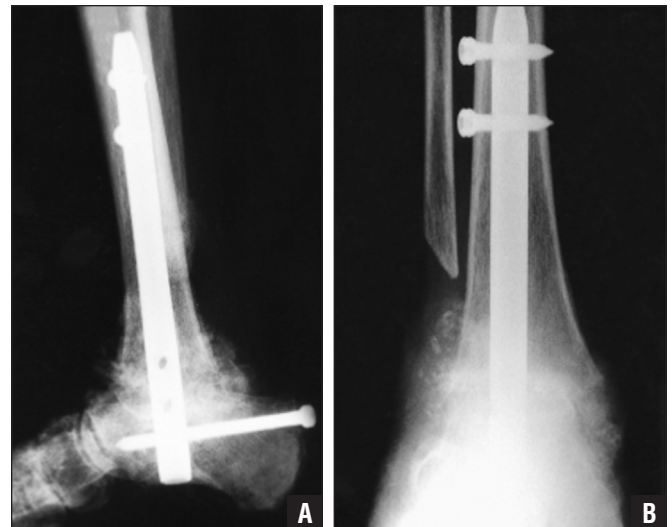


Figure 6: Lateral (A) and anteroposterior (B) radiographs of the right ankle 5 months postoperatively showing complete ankle fusion.

- staged delayed open reduction and internal fixation of severe pilon fractures. *J Orthop Trauma.* 1999; 13(2):85-91.
- Synthes. Titanium cannulated hindfoot arthrodesis: nail expert technique guide. <http://synthes.vo.llnwd.net/o16/LL-NWMB8/US%20Mobile/Synthes%20North%20America/Product%20Support%20Materials/Technique%20Guides/SUTGHhindfootJ7028D.pdf>. Accessed October 8, 2016.
- Pickering RM. Arthrodesis of the ankle, knee, and hip. In: Canale ST, Beaty JH, eds. *Campbell's Operative Orthopaedics*. Vol 1. 11th ed. Philadelphia, PA: Mosby; 2007:181-186.
- Stephenson KA, Kile TA, Graves SC. Estimating the insertion site during retrograde intramedullary tibiototalcalcaneal arthrodesis. *Foot Ankle Int.* 1996; 17(12):781-782.
- Kiatoka HB, Alexander II, Adelaar RS, Nunley JA, Myerson MS, Sanders M. Clinical rating systems for the ankle-hindfoot, midfoot, hallux, and lesser toes. *Foot Ankle Int.* 1994; 15(7):349-353.
- Beardsley C, Marsh JL, Brown T. Quantifying comminution as a measurement of severity of articular injury. *Clin Orthop Relat Res.* 2004; 423:74-78.
- Stapleton JJ, Zgonis T. Surgical treatment of tibial plafond fractures. *Clin Podiatr Med Surg.* 2014; 31(4):547-564.
- Beaman DN, Gellman R. Fracture reduction and primary ankle arthrodesis: a reliable approach for severely comminuted tibial pilon fracture. *Clin Orthop Relat Res.* 2014; 472(12):3823-3834.
- Niikura T, Miwa M, Sakai Y, et al. Ankle arthrodesis using antegrade intramedullary nail for salvage of nonreconstructable tibial pilon fractures. *Orthopedics.* 2009; 32(8):e611-e614.
- Hsu AR, Szatkowski JP. Early tibiototalcalcaneal arthrodesis intramedullary nail for treatment of a complex tibial pilon fracture (AO/OTA 43-C). *Foot Ankle Spec.* 2015; 8(3):220-225.