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Single-Stage Tibiotalocalcaneal Arthrodesis With Use of an Antibiotic-Coated Intramedullary Nail for Limb Salvage Following an Open Pilon Fracture Complicated by Osteomyelitis: A Case Report

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ABSTRACT

Severe limb deformity can create a major disability, which can ultimately lead to a nonambulatory lifestyle. Limb deformities created by open fractures not only put a patient at risk for a nonfunctional lifestyle but also may lead to gross contamination and osteomyelitis of the osseous structures. At times, these deformities require amputation for better functionality. It is our belief, however, that an attempt at limb salvage should always be considered. When encountering limb deformities with osteomyelitis, most literature refers to a staged technique in which 2 procedures need to be performed: this includes external fixation and/or a temporary antibiotic spacer followed by a permanent intramedullary nail after complete resolution of the infection. Staged procedures prolong the non-weightbearing status of the patient, often decreasing quality of life. The use of a single-stage antibiotic-coated nail has rarely been discussed in the literature. Here we discuss a single-stage technique that may be an option for major deformity limb salvage in the setting of chronic osteomyelitis. This is a case report presenting a 60-year-old female who suffered an open pilon fracture resulting in osteomyelitis and was successfully treated with use of an antibiotic-coated intramedullary nail in a single stage.

The pilon fracture, also termed *tibial plafond fracture*, was first described by Destot in 1911 as a tibial fracture extending through the distal metaphysis (1). Pilon fractures can lead to severe limb deformities, especially when paired with compromise to the soft tissue envelope. Open pilon fractures are quite susceptible to osteomyelitis because of the relatively thin and fragile soft tissue envelope covering the distal tibia. Complex open pilon fractures in the setting of osteomyelitis often lead to major limb deformities because of the inability to tolerate internal fixation. Often, such traumatic injuries compromised by osteomyelitis ultimately lead to permanent disability. In certain instances, these deformities may require amputation for better functionality. To preserve a patient's ability to ambulate, the authors believe that an attempt at limb salvage should always be considered.

The use of antibiotic-impregnated cement was originally described for infected hip arthroplasty (2–5). Antibiotic-coated devices and implants have been described in the literature for management of infection; however, the literature is sparse for use of antibiotic-coated intramedullary nailing, specifically in foot and ankle surgery (2,6).

Here, we present a single-stage technique that may be used for fixation as an attempt at major deformity limb salvage in the setting of chronic osteomyelitis. Most literature refers to staged procedures (7–11), including a temporary intramedullary antibiotic spacer followed by permanent intramedullary nail fixation after complete resolution of the infection. Staged procedures prolong the non-weightbearing status of the patient, decreasing their quality of life. The use of single-stage antibiotic-coated nailing has rarely been discussed in the literature (12,13).

Case Report

A 60-year-old female presented with a painful severe valgus deformity after sustaining an open pilon fracture to her right ankle in a motor vehicle accident 3.5 years prior. She had had several procedures performed by an outside surgeon, including multiple attempts of external fixation and open reduction internal fixation. The patient developed subsequent osteomyelitis and was treated with intravenous antibiotics. She was completely wheelchair bound for 3 years owing to her painful

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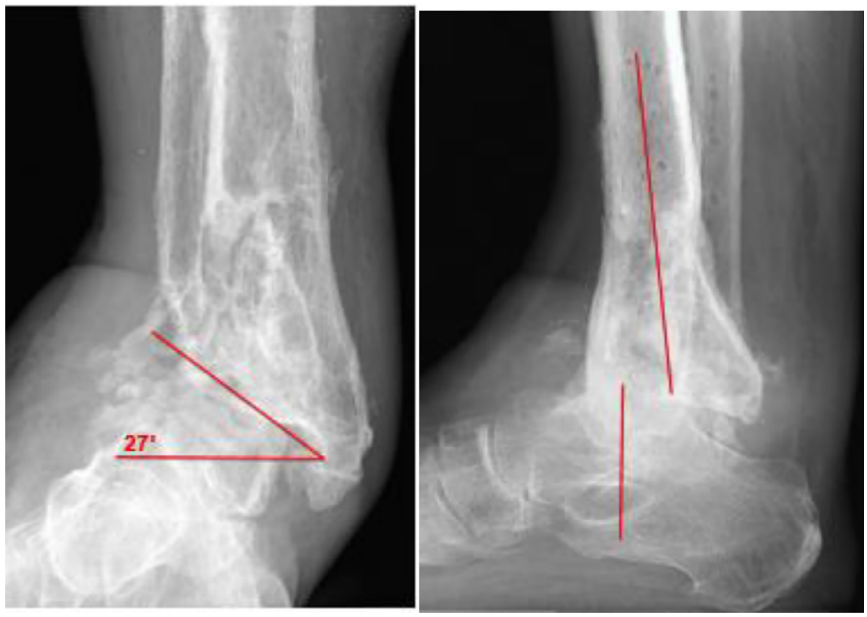

Fig. 1. Preoperative anteroposterior and lateral ankle radiographs displaying severe valgus deformity and anterior ankle subluxation.

ankle deformity. The patient obtained several opinions, all offering her a below-the-knee amputation, before visiting the practice of the senior author (L.M.F.).

Once she was in our care, plain film radiographs (Fig. 1) and computerized tomography (Fig. 2) were performed for evaluation and surgical planning. Both imaging modalities revealed severe posttraumatic arthritis with large cystic areas in the tibia. There was collapse of the distal tibia and fibula, resulting in 27° of valgus along with 1.5-cm anterior subluxation of the tibiotalar joint. Clinically, the patient demonstrated only 3° of total ankle joint range of motion with painful crepitation. She had no subtalar joint range of motion and, upon weightbearing, suffered from a severe rearfoot valgus (Fig. 3). Preoperative laboratory markers were measured. The patient's white blood cell count was 6.8, erythrocyte sedimentation rate 18 mm/h, C-reactive protein 2.3 mg/L, vitamin D 20 ng/L, albumin 4.1 g/dL, and prealbumin 26 mg/dL. Our team was unable to obtain any previous bone culture reports or laboratory studies from her original procedures. We developed a surgical plan for the patient in which we would reconstruct the ankle joint and attempt to salvage her leg. We did discuss with the patient the possibility of failure with attempt to salvage, which would result in a below-the-knee amputation; the patient was amenable to this plan.

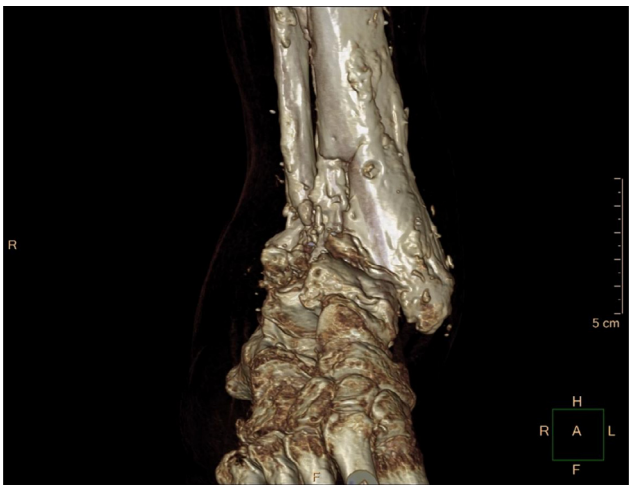

Fig. 2. 3-Dimensional computed tomography reconstruction demonstrating severe deformity.

The patient was taken to the operating room for bone biopsy and culture of the tibia and fibula owing to her history of osteomyelitis. The culture results were negative for microorganisms; however, histology was consistent with chronic osteomyelitis. The patient was referred to an infectious disease specialist and was treated with intravenous ceftaroline for 4 weeks preoperatively. Once the patient completed her antibiotic therapy and was cleared by the infectious disease specialist, she was taken back to the operating room for a single-stage tibiotalocalcaneal arthrodesis with use of an antibiotic-coated nail. Although we believed that the osteomyelitis had arrested, the antibiotic-coated nail was used as a precaution.

The procedure began with a 12-cm linear incision over the right fibula. On exposure of the fibula, there were multiple loose bony fragments noted at the distal fibula that corresponded with nonunion. An osteotome was used to gain access to the ankle joint. No acute signs of infection were appreciated on dissection of the ankle joint. The bone quality was hard and viable with no signs of osteomyelitis. There were no sinus tracts, purulence, or malodor signifying infection. With use of a sagittal saw, planar remodeling of the tibial plafond and talar dome was performed. The foot was still noted to be in a valgus position with the talus sitting lateral to the foot. The medial malleolus was noted to be blocking the reduction of the valgus deformity; resection of the medial malleolus was performed. Once the medial malleolus was removed, the entire foot was translocated underneath the tibia. Next, the ankle joint was wedged in a more rectus position. The use of a 14-mm section of freeze-dried femoral head shaved wedge allograft was tamped into place from lateral to medial with the base sitting lateral, resulting in resolution of the deformity. Once proper positioning was appreciated, the ankle joint was copiously irrigated with 3 L of antibiotic solution. An axis guide and reaming system by Wright Medical (Memphis, TN) was used to create a canal for the intramedullary nail, reaming 2 mm over to allow for the cement-coated nail insertion. The Valor intramedullary nail (Wright Medical) was coated in 40 g of polymethylmethacrylate cement, 2 g of vancomycin powder, and 3.6 g of tobramycin

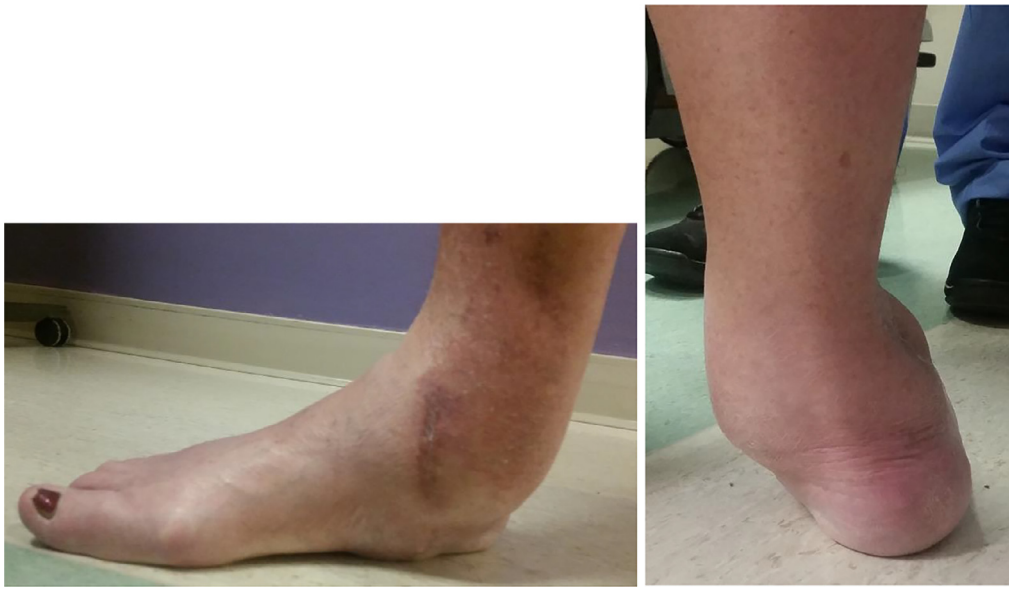

Fig. 3. Clinical photographs of the patient weightbearing preoperatively.

powder as a permanent coating (Fig. 4). After the nail was coated in antibiotic cement, it was inserted according to the manufacturer's standard protocol. The medial malleolus was used as an autograft; it was milled and packed on the medial and lateral aspects of the ankle joint, as well as the cystic areas, fortifying our construct.

The patient was placed in a non-weightbearing well-padded posterior splint for 3 weeks with use of an external bone stimulator. She was then transitioned to a non-weightbearing cast for an additional 9 weeks. Serial radiographs were taken until successful union of bone was noted. At postoperative week 12, the patient was transitioned into a controlled ankle movement walker, and physical therapy was initiated.

The patient originally presented with 27° of ankle valgus and a 1.5-cm anterior dislocation of the tibiotalar joint. Near-rectus alignment of the ankle joint was achieved with 3° of valgus after total reconstruction with use of an antibiotic-coated intramedullary nail (Fig. 5). Osseous union was achieved at 12 weeks, and the patient no longer is dependent on a wheelchair. At an intermediate follow-up term of 29 months postoperatively, the patient was identified as fully ambulatory with use of a cane. After extensive physical therapy, the patient has complete resolution of pain with no evidence of osteomyelitis or obvious limb-length discrepancy.

Discussion

Open fractures must be managed diligently to prevent contamination and infection of the underlying osseous structures. Often, external fixation is applied until negative cultures are obtained, followed by permanent internal fixation. Instances in which medullary bone becomes infected often require more creative means of fracture stabilization.

Most literature refers to a staged procedure using a temporary antibiotic nail, which may be exchanged for a permanent nail after infection resolves. This results in additional procedures and a prolonged nonweightbearing status for the patient. Miller et al (7) described a case in which a 23-year-old who sustained a pilon fracture was later treated with a total ankle replacement which subsequently failed because of infection. The patient was temporized with an Ilizarov antibiotic-coated rod followed by permanent intramedullary nailing. This sequence of surgical management resulted in 2 separate procedures, which delayed the patient's functionality. To eliminate the downfalls of a staged

Fig. 4. Application of antibiotic to the intramedullary nail.

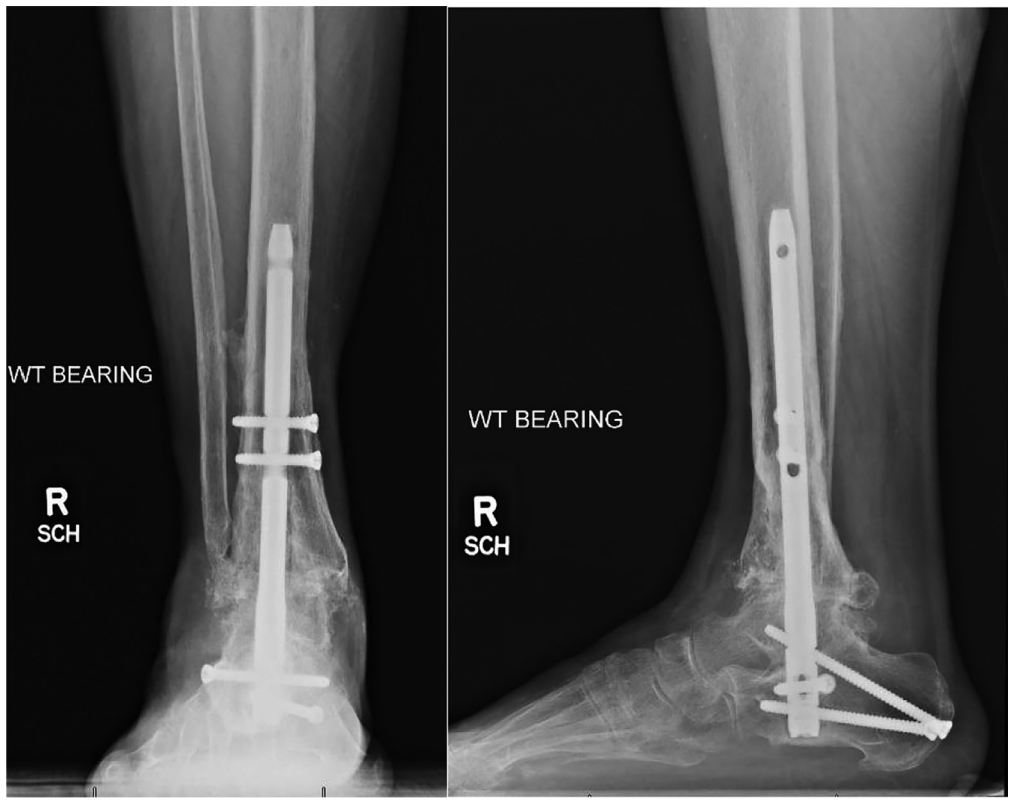

Fig. 5. Postoperative anteroposterior and lateral radiographs showing stable correction of the patient's ankle with maintenance of a plantigrade foot.

procedure, antibiotic-coated permanent fixation is an option provided that provisions are in place to address infection.

In a retrospective study performed by Paley and Herzenberg (8), 9 patients underwent placement of antibiotic chest tube cement rods. At an average of 164 days, the cement rods were removed, and 6 of the 9 patients required an additional procedure resulting in placement of a permanent intramedullary nail. In another retrospective study performed by Sancineto and Barla (9), 19 patients were treated with antibiotic cement rods for infection to the lower extremity. The cement rods were removed 6 to 76 weeks later; 12 of their patients subsequently required permanent nail insertion. Qiang et al (10) described 19 patients with lower extremity infections, 13 tibias and 6 femurs, who underwent antibiotic chest tube rods. Thirteen necessitated an exchange for a permanent nail at an average of 57 days. Eleven achieved complete union, and the remaining achieved partial union with no complications.

As stated previously, single-stage techniques are scarce in the literature; however, Thonse and Conway (12) reported a study in which a 1-stage technique was performed. The study consisted of 20 cases using an antibiotic-coated nail secondary to infection in the lower extremity. Infection was controlled in 19 of 20 patients; 1 patient underwent above-the-knee amputation for intermittent wound discharge. The authors did report that half of their patients required additional procedures to achieve the goals of eradication of infection and successful bony union (12). Although 10 patients required additional procedures, the remaining 10 did well with a single-stage technique of intramedullary nailing coated with antibiotic cement.

Woods et al (13) described a method for a single-stage technique in which the intramedullary nail is coated in cement by hand. The authors then recommended reaming the tibial canal 1.5 mm larger than the diameter of the intramedullary nail to accommodate the cement. The authors stated that this technique can be useful in the setting of chronic or suspected infection or those with previous or recurrent infection (13). Bhatia et al (14) performed a prospective study of 20 patients with infected tibial nonunions treated with use of a single-stage antibiotic cement–coated nail. After a 13-month follow-up period, 19 of the 20 subjects had complete resolution of infection; 8 of the 20 subjects required further surgical management. Vancomycin paired with gentamicin has been traditionally cited in the literature for treatment of osteomyelitis. The authors made use of vancomycin with teicoplanin when creating their antibiotic-coated nail because of gentamicin-resistant *Staphylococcus aureus*. The authors concluded that antibiotic-coated intramedullary nailing is a very viable option in the setting of infected tibial nonunions (14). Reilly et al (15) conducted a retrospective review of 41 patients who underwent antibiotic-coated intramedullary nailing for previous infected intramedullary tibial nails. The authors reported resolution of infection in 76% of the subject pool after a 6-month period, concluding that antibiotic nailing is a viable option (15).

Vancomycin paired with gentamicin has been well documented for treatment in the setting of osteomyelitis. We used both of these antibiotics in combination owing to their broad-spectrum coverage, heat stability, and ability to easily elute from polymethylmethacrylate cement (8,12,14,16,17).

Other fixation methods for deformity correction were discussed for our patient, such as open reduction internal fixation and external fixation. However, these fixation methods were already attempted by an outside surgeon with less than satisfactory results. The patient was at her last attempt to salvage her leg before considering a below-the-knee amputation. With the amount of deformity noted both clinically and with imaging, intramedullary nailing was the best option for obtaining the most correction while creating a stable, plantigrade foot. Although this patient's osteomyelitis was eradicated in our care, it was beneficial to prophylactically treat the patient with use of an antibiotic-coated intramedullary nail because of the chronic history of osteomyelitis.

We had great success with limb salvage and reconstructing this severe deformity; however, this case report does not come without its shortcomings. Because this is a single case report, a larger study must be performed to truly understand the effectiveness of this method. In addition, at 26 months postoperatively, we are at an intermediate follow-up duration; we will need to follow this patient for a longer length of time.

In conclusion, we have described a case in which a patient was completely wheelchair bound for 3.5 years, living a nonfunctional lifestyle owing to severe deformity and chronic osteomyelitis of her lower extremity. We were successful in reconstructing her ankle with the use of a single, permanent procedure. We believe that this procedure can be replicated in similar cases in which the patient is suffering from chronic infection.

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