Using antibiotic cement nail with multiple screws fixation as a single-stage salvage procedure for patient with infected tibiotalocalcaneal arthrodesis: A case report

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Abstract
Tibiotalocalcaneal (TTC) arthrodesis with retrograde nail is a widely used treatment option for severe ankle arthropathy. With inherent biomechanical benefits in axial loading and strong bending stiffness, high union rate and good clinical outcomes have been reported in the literature. However, some undesired complications, such as osteomyelitis or implant failure, can develop after this procedure. Herein, we report the case of an 86-year-old man with right ankle osteomyelitis after TTC arthrodesis with retrograde nail. After removing the previous implants and extensive debridement, we used an antibiotic cement nail with multiple screws fixation as a salvage procedure in the same operation. The patient fully recovered without further surgical treatment.

Keywords
antibiotic cement nail, intramedullary infection, osteomyelitis, tibiotalocalcaneal arthrodesis

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Introduction
Tibiotalocalcaneal (TTC) arthrodesis with retrograde nail is a widely used procedure that is performed in cases of severe ankle and hindfoot arthropathy. In comparison to plate-and-screw constructs, the retrograde nail is a load-sharing device with improved bending stiffness and rotational stability that allows for early ambulation. The inherent biomechanical advantages make it a good choice for TTC arthrodesis, and the reported outcomes were satisfactory. According to the previous literature, the union rate ranges from 76% to 96%, and the satisfaction rate could be up to 92%. However, it is not a complication-free procedure. Various complications such as delayed wound healing, infection, pseudoarthrosis, malunion, nonunion, fracture, implant prominence, and implant failure have been reported. Moreover, the management of infection after intramedullary nailing remains a challenge for orthopedic physicians. In the presence of infection, implant removal with extensive debridement is usually needed to reduce the biofilm load and increase the cure rate. However, it could result in loss of ankle and subtalar joint stability, which is essential for bony growth and union. Restabilizing the infection site after removing the nail is still controversial. Furthermore, the intramedullary dead space and relatively low local antibiotics concentration make the treatment more difficult. Renailing with a

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new retrograde TTC nail is an option, however, it could result in a high reinfection rate. Some authors preferred using an external fixator, but the related complications, such as pin tract infection, make it an unfavorable option for these difficult cases. Herein, we describe a case of delayed osteomyelitis after TTC fusion with retrograde nail in which the patient was successfully treated with removal of implants and extensive debridement followed by antibiotic-cemented nail insertion with multiple screws fixation.

Case report

An 86-year-old male patient presented to our institute in August 2018 because of left ankle painful swelling with sinus tract discharge (Figure 1). He had a medical history of chronic atrial fibrillation, hypertension, and a myocardial infarction. The patient suffered from a left ankle fracture 6 years ago but only received conservative treatment. After that, a progression of left ankle deformity with pain was noted. He was diagnosed with advanced ankle arthritis with severe equinovarus deformity at other hospital, and TTC fusion with retrograde nail was performed in April 2018. However, 3 months after the surgery, progressive painful left ankle swelling and wound breakdown with purulent discharge from a sinus tract were noted. An imaging study revealed implant loosening and nonunion at the fusion site (Figure 2). An elevated erythrocyte sedimentation rate and C-reactive protein level and leukocytosis were detected in the laboratory examinations. Surgical debridement was recommended because intramedullary osteomyelitis was diagnosed, but the patient refused. Hence, empirical intravenous antibiotics with oxacillin were given for infection control at that time. The antibiotics were changed to teicoplanin 4 days later because the wound culture examination revealed oxacillin-resistant Staphylococcus aureus (ORSA). However, the infection showed no improvement after 2 weeks of teicoplanin treatment. Therefore, the patient was referred to our hospital for further surgical management according to his request.

An operation was scheduled immediately because of the failure of conservative treatment. After discussion with the patient and his family, he decided to undergo a single-stage surgery rather than two-stage surgery in consideration of the risk of repeated anesthesia. During the operation, the previous implants were removed, and the soft tissue and intramedullary canal were extensively and carefully debrided. Nonunion over the fusion site was also noted during surgery. We also repeatedly reamed and irrigated the intramedullary canal with normal saline. Then, an antibiotic-loaded polymethylmethacrylate (PMMA) nail was made with a 36-French chest tube and two 2.4-mm Kirschner wires and inserted into the previous intramedullary canal. The PMMA cement was mixed with vancomycin and piperacillin, which are both sensitive to the offending pathogen, ORSA. Finally, we augmented the fixation of the TTC joint with three screws to provide immediate stability (Figure 3). After the operation, intravenous antibiotic treatment with teicoplanin was prescribed for infection control.

The symptoms gradually improved with medication. The surgical wound was healed at 3 weeks postoperatively, and the stitches were removed. The erythrocyte sedimentation rate and C-reactive protein level were checked regularly to monitor the infection status. The patient was discharged after 4 weeks of intravenous antibiotic...
treatment. During discharge, the patient was also prescribed oral antibiotic treatment with fusidate and rifampin for continuing infection control. The inflammatory markers returned to their normal values 10 weeks postoperatively, and the antibiotics were discontinued at that time. Solid fusion was noted in a radiographic examination and pain-free walking without assistance for short distances was achieved 5 months after surgery.

Discussion

Treatment of osteomyelitis after nailing is still a challenge for orthopedic physicians even with developments in the field of medicine in recent decades.8,9 For these cases, the treatment principles include thorough surgical debridement, stabilization of the fracture site, soft tissue coverage, and usage of adequate antibiotics.15 In our case, infection and nonunion were the two main complications that were encountered. Although some authors recommend retaining the nail regardless of the presence of active infection, removal of the implant is still crucial in reducing the biofilm load and increasing the cure rate.10,11 However, the stability of the fracture or fusion site, which is essential for bony union, could be lost after implant removal. Therefore, ways to achieve stability after implant removal and surgical debridement remain unclear to date.11

External fixation after nail removal could stabilize the nonunion site. Ueng et al. reported successful treatment of 15 patients with an infected femoral shaft nonunion using an external skeletal fixation for fracture stabilization.16 Lin et al. proposed a staged protocol comprising Ilizarov’s technique followed by the application of an intramedullary nail to treat chronic tibia osteomyelitis that resulted in satisfactory outcomes.17 However, external fixator-related complications, especially pin tract infection, are major concerns with such a protocol. Schalamon et al. reported that the infection rate could be up to 52% in pediatric fractures.18 Furthermore, the cumbersome frame of an external fixator could result in a low satisfactory rate and make it an unreasonable choice for these patients.

In the treatment of osteomyelitis, extensive debridement followed by dead space management and adequate antibiotics administration is crucial for a cure. However, the local antibiotic concentration might be less than 20% of the serum level even in healthy bone.12 In addition, debridement in cases of intramedullary infection usually requires reaming of the canal to remove the intramedullary debris and infected bone. Further, it may take approximately 4 weeks to achieve sufficient revascularization after reaming that could further decrease the local intramedullary antibiotic level.19 Therefore, bactericidal concentration may not be achieved even with prolonged antibiotic administration.

Antibiotic-loaded cement bead chains were first introduced by Klemm for the treatment of osteomyelitis.20 It can deliver a high concentration of drug locally even in an avascular area. Moreover, the systemic antibiotic level with this approach is very low, which could diminish the toxicity. However, although the use of antibiotic-loaded cement bead chains is a widely accepted technique with satisfactory treatment outcome, there are still some drawbacks of this procedure in terms of intramedullary osteomyelitis. First, the cement beads do not conform to the intramedullary dead space shape. Second, the beads are difficult to remove because of fibrous tissue overgrowth. Finally, they could not provide any stability for the fracture or nonunion site. Hence, additional fixation or a staged operation, removal of the cemented beads followed by reapplication of a new implant after infection control, is usually required.

The antibiotic cement nail technique was first described by Paley and Herzenberg in 2002 to solve the problems of cement bead chains.21 This technique facilitated the delivery of high amounts of antibiotics, provided limited stability, and helped manage the intramedullary dead space. The nail could also be removed without difficulty if needed; however, its stability is not good enough for fracture healing. Therefore, the antibiotic-coated interlocking nail was introduced to provide both infection control and osseous stability, simultaneously.22 These nails have been successfully used in various locations and have resulted in good outcomes. However, we found that it is relatively difficult to use the antibiotic-coated nail in our daily practice. With this technique, we are required to use a smaller nail to provide some space for the cement which can decrease the stability. In addition, the calcaneus bone was eroded after previous implant loosening in our case, which may decrease the stability of the interlocking screw and nail.
There is still debate whether single-stage or multiple-stage operation is preferable for osteomyelitis treatment. Staged surgery with repeated debridement followed by soft tissue and bone reconstruction procedures has been recommended to improve the outcome. However, this requires a prolonged hospital stay and might increase the risk owing to multiple anesthesia procedures. Research has also proven that waiting for an operation is stressful and could cause preoperative anxiety. For single-stage surgery, there is still no consensus to date regarding the treatment strategy owing to variability in the offending pathogens, clinical presentation, and host conditions. Single-stage surgery would avoid the drawbacks related to multiple surgeries although the risk of recurrent infection and treatment failure is a major concern. However, some reports have found single-stage operation to be feasible for these difficult cases.

Our patient was elderly and had cardiovascular disease, which might be a relative contraindication for multiple operations. We used additional screw fixations to achieve adequate stability after antibiotic cement nail insertion. Because the space around the TTC region is much wider than the nail, applying screws is not difficult even with the nail inside. Through our technique, we were able to achieve resolution of the complications in this case in a one-stage operation, which was crucial considering the comorbidity in this case.

Conclusion

Until now, there is no consensus regarding the treatment of intramedullary infection after TTC arthrodesis with retrograde nail. We performed a single-stage operation to treat an elderly patient with cardiovascular disease and had good results. We believe that this procedure could be an alternative choice for patients who are contraindicated for or do not desire multiple surgeries. Although the outcome was satisfactory, further prospective randomized study is indicated to prove the efficacy and feasibility of our technique.

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Author contributions

Y-CC and I-CC contributed equally to this work.

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