A Simple Method for Fashioning an Antibiotic Cement–Coated Interlocking Intramedullary Nail

Ryan U. Riel, MD, and Paul B. Gladden, MD

Abstract

Acute or chronic infection in the presence of nonunited fracture or chronic nonunion often necessitates staged surgical treatment. Treatment typically involves removal of hardware, débridement of infected tissue, use of local antibiotic delivery, and a long-term course of intravenous antibiotics. Several methods of local antibiotic delivery using antibiotic-impregnated polymethylmethacrylate (PMMA) have been commonly used, including commercial or hand-fashioned PMMA beads, antibiotic spacers, and antibiotic PMMA–coated guide rods. While these methods address the problem of infection, they do little to address fracture stability.

In this report we describe a simple method for fashioning an antibiotic cement–coated interlocking intramedullary nail to treat an infected tibia fracture. This technique capitalizes on local delivery of antibiotics through use of antibiotic cement with the added benefit of improving fracture stability and fixation with an interlocking nail to achieve bony union.

Acute or chronic infection in the presence of nonunited fracture or chronic nonunion often necessitates staged surgical treatment. Standard treatment of the infection involves removal of hardware, débridement of infected tissue, use of local antibiotic delivery, and a long course of intravenous (IV) antibiotics. Fracture stability can be addressed with a variety of options, including immobilization, external fixation, and internal fixation. Ultimately, more than one surgical procedure is typically required to achieve resolution of the infection as well as definitive fixation and bony union of the fracture.

Several methods of local antibiotic delivery using antibiotic-impregnated polymethylmethacrylate (PMMA) have been commonly used, including use of commercial or hand-fashioned PMMA beads, antibiotic spacers, and antibiotic PMMA–coated guide rods. All of these methods are temporary and provide no significant stability to the fracture, except for the antibiotic PMMA–coated guide rods, which provide limited stability to axial and bending forces but no rotational stability. Essentially, none of these methods results in stability that is comparable to a locked intramedullary nail, and none is likely to consistently achieve bony union without a subsequent procedure.

> "Using the 12-mm reamer allows sufficient room for nail insertion without dislodging of the cement."

It would be advantageous to be able to treat infected, nonunited fractures using a single-stage procedure in all patients, particularly in patients whose medical comorbidities make general anesthesia an abnormally high risk. In this case report, we present a technique in which an antibiotic PMMA–filled/coated interlocking nail was used to treat an infected tibia fracture.

Materials and Methods

A man in his mid-60s presented to our trauma center with injuries resulting from pedestrian versus automobile collision. In addition to other less severe injuries, the patient sustained Gustilo grade IIIA open right diaphyseal tibia and fibula fractures. After initial resuscitation and stabilization, the patient was taken to the operating room for urgent débridement and irrigation of the open fracture. A uniplanar external fixator was

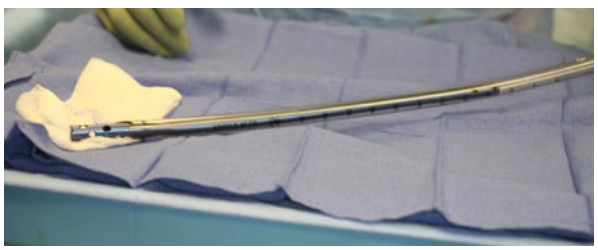

Figure 1. Nail to be coated inside of chest tube.

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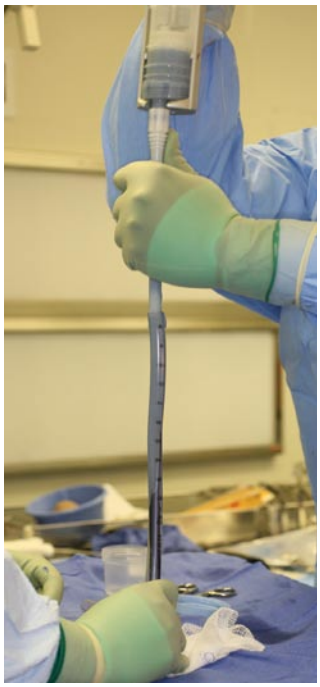

Figure 2. Cement being infused in and around nail.

placed for temporary stabilization of the fracture and soft-tissue management. The patient was treated with IV antibiotics and underwent repeat débridement and irrigation of the open fracture approximately 48 hours later. Delayed fracture fixation was performed with an intramedullary nail when the soft tissues appeared amenable on post-injury day 5.

The patient was discharged to a skilled nursing facility several days after injury. The patient returned approximately 3 weeks after fixation with obvious purulent infection at the site of the open fracture. The nail was removed and débridement and irrigation were performed at the wound site and the intramedullary canal using a 12-mm reamer that is coupled with an irrigator and aspirator (Reamer/Irrigator/Aspirator [RIA], Synthes, West Chester, Pa). The patient was placed on appropriate IV antibiotics. A repeat débridement and irrigation was performed 3 days after surgery and an antibiotic cement–coated locked intramedullary nail was placed. A 6-week course of IV antibiotics was planned with a possibility of exchange nailing after resolution of infection if necessary.

Surgical Technique

After removal of infected hardware and adequate débridement and irrigation of the wound and intramedullary canal, the antibiotic cement–coated nail was prepared in the operating room. A 40 French chest tube was lubricated with sterile mineral oil, and 1 g of gentamycin in 80 g of PMMA cement (Palacos R + G bone cement, Zimmer, Warsaw, Ind) was prepared. An 8-mm × 360-mm hollow tibial nail was inserted into the chest tube (Figure 1), leaving the proximal portion of the nail out of the chest tube. The cement was pressurized into the chest tube using a cement gun to completely coat and partially fill

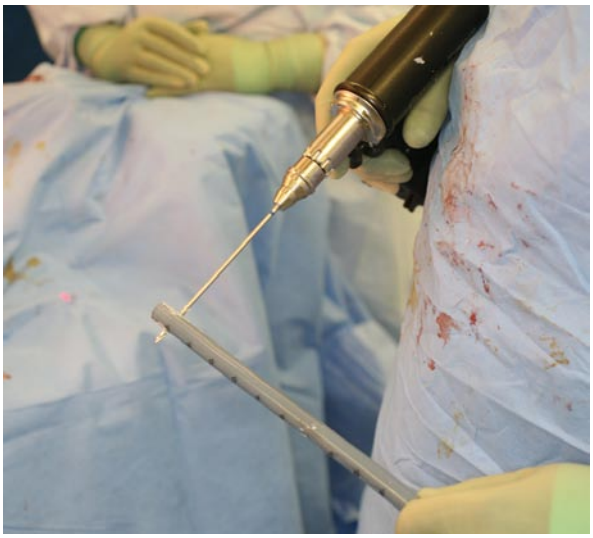

Figure 3. Interlocking holes being cleared of cement.

the nail with the cement (Figure 2). The proximal portion of the nail is not completely filled by distal pressurization, which allows the proximal threads to remain clear for placement of the insertion jig. Alternatively, the jig can be inserted into the nail prior to application of the cement. The cement was allowed to harden. The interlock holes were cleared of cement using a drill to allow easier placement of the new interlocking screws (Figure 3). The chest tube was then sliced lengthwise with a scalpel and peeled off of the cement-coated nail. Examination of the nail demonstrated partial filling of the nail lumen with cement and a 1- to 2-mm layer of cement coating the nail. A rongeur is used to trim any excess cement. The nail (Figure 4) was then inserted into the tibia using standard technique with both proximal and distal interlocking screws placed. Using the 12-mm reamer allows sufficient room for nail insertion without dislodging of the cement. Anteroposterior and lateral radiographs are shown in Figure 5.

Discussion

The standard approach to treatment of acute infection in the setting of open fracture or chronic osteomyelitis is eradication of the infection, management of soft tissues, and bony union. Mainstays of infection control are adequate surgical débridement of infected and necrotic tissue as well as a combination of systemic and locally delivered antibiotic agents.

Figure 4. Antibiotic cement–coated nail removed from chest tube.

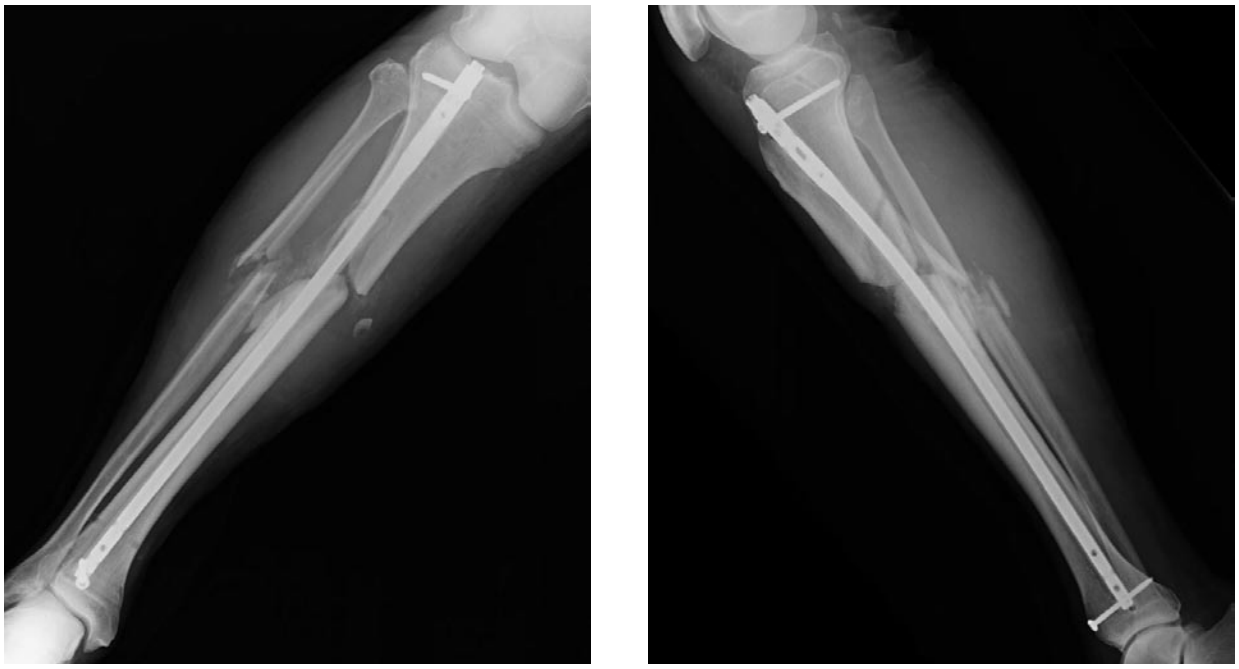

Figure 5. (A) Anteroposterior and (B) lateral radiographs show placement of nail with new interlocks.

Previous investigators (Buchholz and Engelbrecht,[1] Wahlig and Buchholz,[2] and Elson and colleagues[3]) have shown the ability of antibiotic-impregnated PMMA cement to achieve high local concentrations of antibiotics via elution without causing excessive systemic levels. This was initially shown to have clinical efficacy in treating infection in the setting of arthroplasty. Subsequent studies have evaluated local antibiotic therapy in the form of antibiotic bead pouches used for treatment of open fractures. Ostermann and colleagues[4] reported a reduction of infection rate from 12% to 3.7% when antibiotic bead pouches were used in combination with systemic antibiotics for treatment of open fractures. Antibiotic bead pouches have also been studied for treatment of infected nonunion. Calhoun and colleagues[5] compared the use of long-term systemic antibiotics with the use of antibiotic beads without long-term systemic antibiotics in patients with infected nonunions. The rate of success for these 2 methods was 83% and 89%, respectively.

Paley and Herzenberg[6] previously reported on a cohort of 9 patients in which antibiotic cement nails were fashioned using guide wires as a scaffold and used to treat chronically infected tibial nonunion. After staged operations, union was achieved in 7 of 9 patients. The antibiotic nails were retained between 29 and 753 days. Quiang and colleagues[7] reported a series of 19 patients who had developed deep infection after tibial nailing. After hardware removal and débridement, they also used antibiotic cement nails fashioned using a guide wire in addition to systemic antibiotics and found no recurrent infection in 18 cases, with 11 achieving bony union and 6 achieving partial union. They recommended use of external fixation or other modes of fixation in cases of significantly unstable fractures.

More recently, Thonse and Conway[8] reported on a case series of 20 patients with a variety of infected nonunions and osteomyelitis. They used antibiotic cement–coated interlocking nails created using custom molds. By using interlocking nails, this technique has the added advantage of providing increased stability as well as delivering antibiotics locally to the intramedullary space. Thus, the issues of infection and stability are addressed simultaneously. Nineteen of the 20 patients in this series achieved infection control, and 17 of 17 patients for whom the goal was to achieve bony union did so. Nine of the 17 patients in whom union was achieved underwent only the single procedure without having to undergo additional surgeries. The remaining 8 patients had an additional bone graft procedure performed to achieve union.

Conclusions

In this report, we describe a simple technique using a chest tube to create an antibiotic cement–coated interlocking nail without need for custom molds. This technique capitalizes on the current principles of treating deep infection via local delivery of antibiotics through use of antibiotic cement. In addition, the added benefit of addressing fracture stability and fixation to achieve bony union makes this an attractive option. Lastly, the use of commonly available chest tubes to fashion the cement mantle obviates the need for inconvenient and expensive custom molds.

Authors' Disclosure Statement

Dr. Gladden wishes to note that he is a consultant to Synthes to evaluate and develop products. Dr. Riel reports no actual or potential conflict of interest in relation to this article.

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This paper will be judged for the Resident Writer's Award.