Using Cement Plugs in Soft Tissue Infection and Osteomyelitis

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Abstract: Operative foot and ankle osteomyelitis is challenging for orthopedic surgeons because of the area’s unique anatomy, high trauma incidence, local and systemic disease effects, and often limited space. Standard treatment includes aggressive operative debridement with local and systemic antibiotic administration to control infection. Dead space management is critical yet technically demanding. The authors report a modified antibiotic cement bead therapy technique in which antibiotic sticks, minnows, and mushroom-shaped plugs are used to strike a balance between the stability of the load-bearing unit and radical removal of infection to preserve a functional foot. Three cases are presented. [Orthopedics. 2014; 37(1):32-36.]

Operative foot and ankle osteomyelitis is likely in part a product of this area’s unique anatomy, high trauma incidence, and local and systemic disease effects. The lower extremity’s thin soft tissue envelope is occasionally further compromised by poor vascularity from high-energy trauma, diabetes mellitus, smoking, and peripheral vascular disease. Standard treatment includes aggressive operative debridement with local and systemic antibiotic administration to control infection. Such debridement can be technically demanding, but the removal of all nonviable tissue is essential to creating a healthy tissue bed and decreasing the infectious load. However, this process creates a dead space that needs to be managed.

One way to manage such space is with cement spacers that can be molded into various shapes and loaded with antibiotics. This local delivery of high concentrations directly to the tissues offers a distinct advantage over the vascular-supply-dependent delivery of high and potentially toxic levels via systemic delivery. Antibiotic cement can be molded into large blocks and spheres to fit a patient’s anatomy, providing structural integrity and preventing soft tissue contracture, or into beads strung on suture for smaller areas (eg, those in the lower extremity). This bead technique has been modified for use within the crowded anatomy of foot and ankle operative osteomyelitis. The authors have successfully used this technique for many patients, resulting in infection resolution and more preservation of normal tissue and structural stability.

Technique

Contouring the shape of the antibiotic forms creates maximum surface contact and facilitates insertion into tight spaces (Figures 1-2). Long “sticks” are used for penetrating sinuses, tunnels, and abandoned hardware paths; they have a large surface area for eluting the antibiotic and can be easily shortened to a custom length even after the cement hardens. After hardware removal, plugs or “mushrooms” are used in the screw holes to provide structural integrity and direct delivery of antibiotics to the bone. “Minnows” are used to help contour voids created by surgical debridement.

Institutional review board approval was waived for this study.
study. Informed consent was obtained from the patients.

**CASE REPORTS**

**Patient 1: Antibiotic Mushrooms**

A 20-year-old man had swelling and serous wound drainage 4 months after a left ankle fibula fracture was treated with a plate and syndesmotic tightrope device. He underwent debridement.

After dissection, the screws securing the plate were removed. A tunnel from the superficial tissue extending deep was found with 3 to 4 mL of purulent material. The hardware was removed. The bone plate interface and screw holes were debrided with a curette. All wounds were copiously irrigated and closed primarily. A packet of cement was mixed with tobramycin (2.4 g) and vancomycin (2.0 g) until tacky and fashioned into small mushrooms (Figure 2), which were inserted into the screw holes. Because the cement was still slightly pliable, it formed to the bone hole, leaving a flat disk shape on the outside of the bone. Biplanar fluoroscopy confirmed removal of all hardware (Figure 3) and indicated syndesmosis widening, but no additional fixation was undertaken, given the infected tissue bed. The patient was allowed to bear weight as tolerated postoperatively. The patient had excellent infection resolution and no recurrence 3 years postoperatively.

**Patient 2: Antibiotic Sticks**

A 54-year-old man had a history of morbid obesity, ankylosing spondylitis, and peripheral neuropathy. He had had severe right forefoot deformity, hallux valgus, and laterally deviated and clawed second through fifth toes and had undergone reconstructive surgery elsewhere, with subsequent recurrent deformity and ulcerations on the plantar aspect of the second metatarsal. One month after revision surgery, he jammed his right second toe, pushing the pin in farther. He presented 1 day later with edema, blistering, erythema of the foot, and purulent pin site drainage.

He underwent a second-toe amputation at the metatarsophalangeal joint, where purulence and necrotic tissue were debrided. After copious irrigation, cement sticks and plugs fashioned with vancomycin and tobramycin were placed in and around the second metatarsal (Figures 4-6). Two stitches were lightly applied to secure the sticks and plugs in place, allowing fluid egress.

One week later, the patient had clean soft tissue and markedly decreased swelling. He returned to the operating room.
A pack of antibiotic cement containing 2.4 g of tobramycin was mixed with 2 g of vancomycin. Several minnow-shaped cement spacers were fashioned for insertion into the wound.

**Figure 7:** A 47-year-old man with a chronic draining sinus after open debridement of plantar fasciitis.

**Figure 8:** Intraoperative image showing a large medial portion of the plantar fascia was excised and sent for culture. The bone was not involved in the infection.

**Figure 9:** A pack of antibiotic cement containing 2.4 g of tobramycin was mixed with 2 g of vancomycin. Several minnow-shaped cement spacers were fashioned for insertion into the wound.

for suture and spacer removal. Minimal devitalized tissue was noted and debrided with curette and scalpel. New antibiotic cement sticks and plugs were placed, and the wound was closed with 3-0 nylon horizontal mattress and simple sutures. The wound was covered and placed into a bulky dressing. The patient was restricted to heel weight bearing only for 2 weeks. The patient had infection resolution at 1 week and no recurrence at 4 years.

**Patient 3: Antibiotic Minnows**

A 47-year-old man had a chronic draining sinus after open debridement elsewhere for plantar fasciitis of the right foot (Figure 7). Aggressive debridement was performed, and a large medial portion of the plantar fascia was excised and sent for culture (Figure 8). The bone was not involved. The wound was copiously irrigated. A packet of cement containing tobramycin (2.4 g) was mixed with vancomycin (2.0 g). Several minnow spacers (Figure 9) were placed, the “heads” deep to fill the void from the debridement and the “tails” wrapped around the medial aspect of the calcaneus. The wound was closed with 2-0 nylon simple, deep stitches. The patient was kept non-weight bearing for 6 weeks. The wound healed uneventfully, and the drainage stopped. Intraoperative cultures showed no growth. The patient was treated with a 7-day course of oral cefalosporin for the first week postoperatively. The spacers were removed 8 weeks postoperatively. The patient healed with some delay. There was no recurrence at 1 year.

**DISCUSSION**

Operative infection control is facilitated by a thorough debridement and microbialspecific antibiotic administration, but the surgical management of osteomyelitis is challenging. A suboptimal technique can result in recalcitrant chronic infection. Antibiotics can be delivered systemically or locally. Effective systemic application requires a high serum level, which can cause systemic side effects. However, an effective local delivery system incorporates surgically can provide the needed concentration of antibiotics while minimizing systemic toxicity. Antibiotic-loaded bone cement represents the gold standard for local antibiotic delivery and provides for dead space management. This concept is based on the pioneering work of Buchholz and Engelbrecht in the 1970s. In 1979, Klemm extended the indications for antibiotic bone cement by developing gentamicin-polymethylmethacrylate bead chains for chronic osteomyelitis surgery. He reported that 91.4% of 128 patients with chronic osteomyelitis treated with this technique had complete infection subsidence. Some studies have shown that the local deposit of antibiotics is a safe and useful method and provides favorable results for osteomyelitis and open fractures. However, Level I evidence is still limited.

The original principles of osteomyelitis surgery included an atraumatic approach and removal of all necrotic or nonviable material with reconstruction in mind. However, management of the ensuing dead space is a key factor for a successful outcome. When serial debridement is indicated or inadequate local tissues require additional surgeries for closure, antibiotic-impregnated beads or spacers are implanted to inhibit and kill remaining pathogens and to preserve useful dead space for maintaining working length, facilitating closure.
and preparing for later clean reconstruction.\textsuperscript{7,22} Because antibiotic spacers are intended for subsequent removal, generally after soft tissues have completely recovered (3 to 4 weeks, or 10 to 14 days if they are within the medullary canal), the second stage of surgery includes bead or spacer removal, repeat irrigation and debridement, and exchange for bone graft or a bone graft substitute.\textsuperscript{7} The longest recommended removal time is 4 to 6 weeks after implantation; removal thereafter can be incomplete or difficult because of fibrous tissue or callus enclosure.\textsuperscript{23}

Although the current literature still has limited clinical data on foot and ankle infection treated with local antibiotic-loaded cement, complications related to the use of antibiotic beads for bone infection are uncommon.\textsuperscript{8,11,21}

**Conclusion**

This technique modifies existing antibiotic bead therapy for the often-limited space in foot and ankle surgery and deep sinuses that are difficult to reach. It is designed to strike a balance between the stability of the load-bearing unit and radical removal of infection to preserve a functional foot. The sticks, minnows, and mushroom-shaped plugs are easy to place and retrieve. The mushroom-shaped plugs are most useful in the screw holes and local defects created by surgery or disease process. The sticks can be placed around the crowded locus in foot and ankle anatomy. The minnows are a hybrid shape that fills a long narrow tunnel and a larger zone of dead space. In the authors’ experience, the technique is a useful adjunct for infections in the foot and ankle.

**References**