The Antibiotic Nail in the Treatment of Long Bone Infection: Technique and Results

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KEYWORDS

• Antibiotic nail • Local antibiotic delivery • Infection • Long bone infection

KEY POINTS

- Antibiotic nails are made primarily of polymethyl methacrylate and local antibiotics.
- Antibiotic nails can provide fracture stability, manage intramedullary dead space, and allow delivery of local antibiotics.
- Antibiotic nails have proven very successful in the treatment of intramedullary bone infection.

INTRODUCTION

Antibiotic cement nails are implants created to provide an intramedullary antibiotic delivery device that also provides fracture stability. Although techniques vary by individual surgeons, these antibiotic nails are typically fashioned from metal coated with antibiotic-impregnated polymethyl methacrylate in the shape of an intramedullary nail or antibiotic cement coating an existing intramedullary nail.[1–14] Paley and Herzenberg[6] were the first to describe the utility of this device for the treatment of intramedullary osteomyelitis.

Since then, the technique has become widely described in the literature with reported indications ranging from the treatment of diagnosed intramedullary osteomyelitis to prophylactic use in damage control situations whereby there is a high risk of intramedullary osteomyelitis.[1] There are several relatively small case series documenting the utility of this device as a component of intramedullary osteomyelitis treatment in addition to adequate boney debridement and systemic antibiotics.[2,5–8,10,15] Additionally, there are several articles describing modifications to the fabrication technique of these devices.[3,4,13] The purpose of this article is to review the rationale, indications, techniques, and outcomes of antibiotic nail use in the treatment of long bone infections.

RATIONALE

The rationale for intramedullary antibiotic cement rods is an extension of the known utility of antibiotic-impregnated bone cement in the treatment of osteomyelitis. There are several studies describing the effective use of bone cement as a delivery device of antibiotics directly to an area of musculoskeletal infection.[16–23] The importance of local antibiotics in the treatment of bone infection has been well accepted and become a standard component of current osteomyelitis management.[16,23–26]

Cierny and colleagues[25,27–29] described 4 key principles in the treatment of osteomyelitis:

1. Debridement and dead space management
2. Stabilization
3. Soft tissue coverage
4. Adequate antibiotic administration

Disclosure: The techniques in this article of using intramedullary antibiotic rods and antibiotic beads to treat osteomyelitis are off-label usage of a Food and Drug Administration–approved product or device.

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The implementation of an antibiotic nail as part of long bone osteomyelitis management directly addresses 3 of these 4 principles. Clearly an antibiotic nail satisfies the need for local antibiotic administration to the intramedullary canal; however, the cement nail infused with antibiotics uniquely provides a method of filling the canal dead space as well as providing stability to the bone.[6]

The antibiotic nail's stability will vary depending on the amount of antibiotics placed in the cement, as this alters the integrity of the cement after curing, as well as the metal device on which the surgeon molds the cement.[9,11,30] Although the strength of these different nail techniques has not been compared scientifically, it makes sense to hypothesize that a larger metal device at the center of the nail would provide greater stability. Coating an intramedullary nail in cement would likely create an antibiotic nail most resistant to deformity, which Thonse and Conway[9] described; but an antibiotic implant with such stability is unnecessary in most chronic osteomyelitis cases.

In addition to the stability that antibiotic nails offer, there are several advantages provided by the nail. Antibiotic beads are a proven method of treating osteomyelitis.[16,17,21] Problems cited with bead use within the intramedullary canal include lack of dead space filling as well as potential extraction difficulty if left in place for a long duration.[6] In contrast, the antibiotic nail can be sized in a custom fashion to fill the patients' canal, filling the dead space as well as maximizing the amount of antibiotic cement introduced into the canal. The duration of which the antibiotic nail can be left in place as well as the relative ease of extraction are further unique advantages of the nail over beads. Paley and Herzenberg[6] described removal of a nail after 753 days with relative ease.

INDICATIONS AND CONTRAINDICATIONS

Given the numerous advantages of the antibiotic cement nail and relative ease of implementation as well as extraction, there is expanding use of this technique. The original description of its use entailed treatment of intramedullary osteomyelitis. Most of these patients required a long duration of external fixation for deformity correction with subsequent infection of the intramedullary canal.[6] Since that time, additional case series have documented utilization of the antibiotic nail in other circumstances, which include treatment of chronic osteomyelitis and infected nonunions of the diaphysis.[4–10,14,15] Moreover, other surgeons advocate the use of an antibiotic nail as a prophylactic modality in the setting of prolonged external fixation either in the face of severe trauma requiring staged fixation or in lengthy deformity correction.[1]

There are no absolute contraindications to the use of an antibiotic nail in the treatment of long bone infection. Open physes in children may limit the use of antibiotic nails because of the potential harm caused to the growth plate by insertion of the nail. Nonetheless, Bar-On and colleagues[12] were able to use antibiotic rods in the intramedullary canal without disrupting the physes in children as young as 4.5 years of age. Shyam and colleagues[8] reported concern with bone defects greater than 6 cm because of a lack of stability provided by antibiotic nails in their study. It is unclear that this is valid for all antibiotic nail constructs, and it does not seem to be reason for not using the antibiotic nail as much as it is reason to augment the nail with another form of stabilization.

TREATMENT METHODOLOGY

Effective utilization of antibiotic nails for the treatment of long bone infection consists of several important treatment steps. These steps are consistently described throughout the literature reporting antibiotic-infused cement nail use. The sequence of appropriate infection treatment with antibiotic nails includes infection diagnosis, debridement, antibiotic nail placement, and antibiotic nail removal with or without definitive hardware placement.

Diagnosis

To begin, patients must have an accurate diagnosis, which includes culture identification of the infectious agent as well as sensitivities and susceptibilities. Thorough patient history is important to identify any factors that will affect treatment, such as immune-compromise, or aid in treatment, such as surgical and infection history. In particular, the history of an intramedullary device is an important factor in diagnosing long bone infection. Laboratory evaluation should include white blood cell count, erythrocyte sedimentation rate, C- reactive protein, and blood cultures. These studies will potentially aid in diagnosing infection and will certainly help with monitoring the effectiveness of treatment.

Imaging is an important part of diagnosing intramedullary osteomyelitis. Radiographic signs are not present in an acute infection but in chronic osteomyelitis include diffuse demineralization, soft tissue swelling, periosteal reaction, involucrum formation, and trabecular destruction