Injury, Int. J. Care Injured xxx (2018) xxx–xxx

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Technical Note

Antibiotic coated hinged threaded rods in the treatment of infected nonunions and intramedullary long bone infections

Jae-Woo Cho[a], Jinil Kim[a], Won-Tae Cho[a], William T. Kent[b], Hyung-Jin Kim[c,**], Jong-Keon Oh[a,*]

[a] Department of Orthopaedic Surgery, Guro Hospital, Korea University Medical Center, Seoul, South Korea
[b] Department of Orthopaedic Surgery, UC Sandiego Medical Center, Sandiego, CA, USA
[c] Department of Orthopedic Surgery Dongtan Sacred Heart Hospital, Hallym University College of Medicine, 40, Seokwoo-dong, Hwaseong, Gyeonggi-do, South Korea

ARTICLE INFO

Keywords:
Intramedullary infection
Infected nonunion
Osteomyelitis
Antibiotic rod
Threaded rod

ABSTRACT

Introduction: Local delivery of high dose antibiotics in the form of antibiotic impregnated polymethyl methacrylate (PMMA) cement beads or coated rods is commonly used in the management of long bone infections. The downsides of antibiotic cement beads for intramedullary long bone infections are associated with difficulty in removal from the medullary canal, bead breakage, and lack of stability. Antibiotic cement-coated smooth flexible guide wires, rods and nails can have complications such as delamination or debonding of the cement. In addition, the current techniques for cement rod insertion have a risk of iatrogenic joint contamination.

To improve upon this technique and decrease potential complications, we propose the use of an antibiotic cement-coated hinged threaded rod as a temporary intramedullary spacer. This technique utilizes both an antegrade and retrograde insertion of the threaded rod into the medullary canal through the bony defect site with connection at the hinge to treat intramedullary long bone infections and infected nonunions.

Material and Methods: A total of 40 patients were included in the study. The details in making the cement rod were well documented. The shape of cement rod and the integrity of the cement at the time of rod insertion and rod removal were compared to identify any cement debonding or delamination. Potential postoperative complications including iatrogenic joint infection, displacement or breakage of the threaded cement rods, and fracture displacement were all carefully documented. The preliminary biological effect of the initial debridement and antibiotic cement rod placement was determined using the negative conversion rate of intraoperative cultures.

Results: A single antibiotic coated threaded rod was inserted in 18 cases. Two separate antibiotic coated threaded rods were inserted and connected via hinge in 22 cases. There were zero cases of rod breakage and no secondary loss of reduction from antibiotic rod placement to the definitive staged operation. There were zero iatrogenic joint infections. There were zero cases of cement debonding or delamination from the rod. The conversion rate to a negative culture after initial debridement and antibiotic rod placement was 85% (34/40 cases).

Conclusions: The use of an antibiotic coated cement threaded rod with a hinge as an intramedullary spacer provides the benefits of local antibiotic delivery, offers improved construct stability, makes implant removal easier without delamination of the cement mantle, and utilizes the versatility of a hinge to prevent violation of native joints when treating infected nonunions and intramedullary long bone infections.

Introduction

Chronic osteomyelitis and infected nonunions are a challenge for both patients and surgeons. Complex cases require staged procedures, oftentimes with repeated irrigation and debridements. In cases of chronic osteomyelitis or infected nonunion of the femur or

* Corresponding author at: Department of Orthopaedic Surgery, Guro Hospital, Korea University Medical Center, 148, Gurodong-ro, Guro-gu, Seoul, South Korea.
** Corresponding author.
E-mail addresses: oskimhyungjin@gmail.com (H.-J. Kim), jkoh@korea.ac.kr (J.-K. Oh).

https://doi.org/10.1016/j.injury.2018.07.016
0020-1383/

tibia with a prolonged history of recurrence, staged reconstruction can be a safer approach for the eradication of infection [1,2]. Current treatment modalities have two main objectives: infection control, which is achieved by radical debridement, implant removal, irrigation, local delivery of antibiotics by polymethyl methacrylate (PMMA)-coated antibiotic bead chains or PMMA-coated rods or nails; and stabilization, which can be achieved by external fixation or definitive fixation with an antibiotic-coated nail [3–5].

PMMA antibiotic beads are potential difficultly with removal due to the ingrowth of granulation tissue, their lack of mechanical stability, and they may prevent the application of an external fixator [5–7]. In addition, beads cannot be inserted into the intramedullary space very easily and are difficult to apply to in the setting of intramedullary osteomyelitis. Smooth wires or nails coated with PMMA are a good alternative to cement beads, fill the intramedullary canal, and provide mechanical stability [3,8,9,10]. However, these smooth wires or nails have complications and delamination or debonding of the cement during insertion or removal (Fig. 1). There are reports of debonding of the cement during insertion and removal with early definitive fixation with antibiotic coated nails [11,12]. Another concern with the current technique of antibiotic coated wires or nails is with the insertion site. There is a risk of iatrogenic joint contamination when placing the coated implant in patients with an intramedullary infection without a previous intramedullary implant [12].

To address these issues, we propose a technique for the use of an antibiotic cement-coated threaded rod with a hinge connection that can be inserted through the bony defect and debridement site. Theoretically, cement binding to a threaded rod would provide increased resistance to debonding, thus lessening the risk of delamination. In addition, the threaded cement rods can also be connected via the hinge to make intramedullary splinter without an additional incision for insertion or create a 130-degree angle for providing antibiotic effect and stability to the head and neck of proximal femur. The purpose of this study was to introduce and evaluate the effectiveness of antibiotic cement coated threaded rods with a hinge and dual hinged cement coated threaded rod constructs.

Patients and methods

This retrospective case series was approved by our institutional review board. Between January 1, 2013 and January 1, 2015, 183 patients were treated with a diagnosis of post-traumatic osteomyelitis and infected nonunion at our level 1 trauma center. Diagnoses of post-traumatic osteomyelitis and infected nonunion were determined by clinical examination, laboratory evaluation (white blood cell count, C Reactive Protein, and Erythrocyte Sedimentation Rate), imaging (radiographs, CT scan, MRI) and intraoperative tissue cultures. Classification of infected nonunion and post-traumatic osteomyelitis based on the status of bony continuity. Acute infected nonunion case which could be treated with implant removal and debridement were excluded. Among 183 patients, 73 patients who were proven to intramedullary osteomyelitis by intraoperative site specific culture (refered to as Intramedullary-, Center) and were required radical resection of dead bone which resulted in critical sized bone defect were included in this cohort. Among 73 patients, 33 patients who treated by other modality (with cement spacer or bead alone) or had insufficient follow up data at least one year were excluded. Finally, 40 patients who treated with an antibiotic cement coated hinged threaded rod were enrolled in final cohort.

Staged reconstruction protocol

All patients were treated with a 3-staged surgical protocol. The first stage is a radical debridement with application of an antibiotic coated cement hinged threaded rod, cement spacer insertion and temporary stabilization. The second stage was removal of the antibiotic coated hinged threaded rod, conversion to the definitive fixation construct with placement of an antibiotic-loaded PMMA cement spacer. The final stage is removal of the cement spacer and autogenous bone grafting.

During the staged surgical protocol, site-specific tissue cultures were performed intraoperatively for identifying the microorganism and confirming the presence of intramedullary osteomyelitis. Site-specific intraoperative cultures were performed in a systematic fashion. At least five tissue cultures were obtained, beginning at the center of the osteomyelitis lesion and expanding to the periphery during the debridement portion of the procedure (referred to as: center, intramedullary proximal-(IMP), intramedullary distal-(IMD), extramedullary proximal-(EMP), and extramedullary distal-(EMD)). Copious irrigation with normal saline followed the debridement. After these portions of the procedure, all drapes were replaced and contaminated

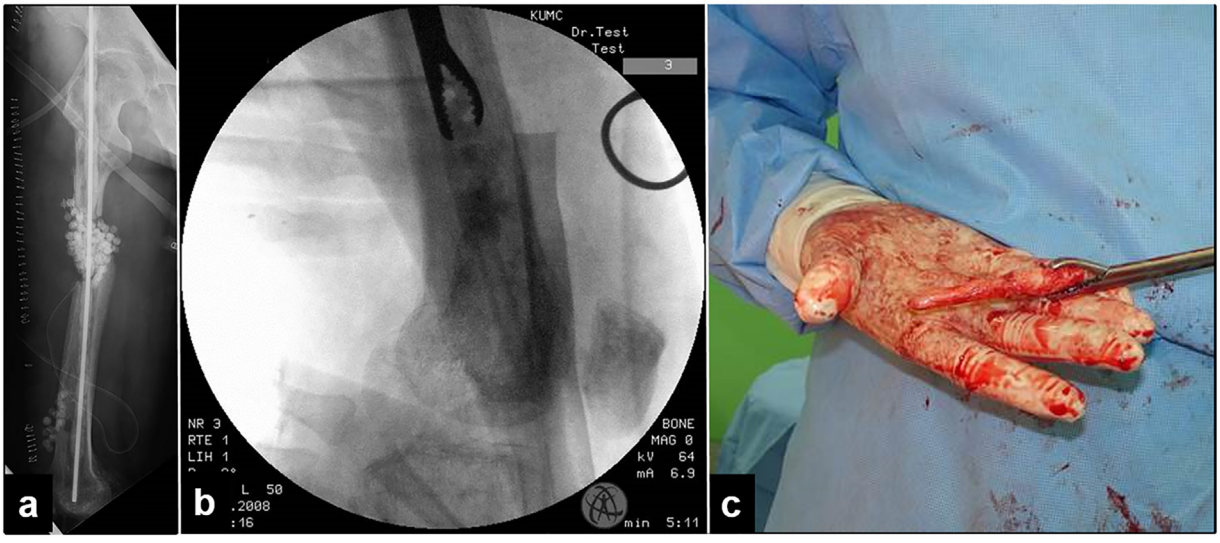

Fig. 1. Cement breakage of the smooth, flexible nail. a) Radical debridement of femur diaphysis osteomyelitis and implantation with smooth flexible nail and antibiotic cement bead chain. b and c) Coated cement breakage of the nail during removal.

Please cite this article in press as: J.-W. Cho, et al., Antibiotic coated hinged threaded rods in the treatment of infected nonunions and intramedullary long bone infections, Injury (2018), https://doi.org/10.1016/j.injury.2018.07.016