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Role of antibiotic-impregnated bone cement rod in control of bone infection and assessing its role in union in cases of infective nonunion of long bones

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Abstract:

INTRODUCTION: Managing and treating infected nonunion is one of the most challenging clinical scenarios despite numerous advances in the fixation methods, soft-tissue management, and antibiotic therapy. The infection of the fracture site causes internal fixation to become unstable and it slows down fracture healing.

AIMS AND OBJECTIVES: To assess role of antibiotic-impregnated bone cement rod in control of bone infection and assessing its role in union in cases of infective nonunion of long bones.

MATERIALS AND METHODS: This was a prospective study comprising of 30 cases of established infected nonunion of long bones carried out in a tertiary care center in Western Maharashtra. Patients of nonunion of long bone diaphysis with established clinical and laboratory evidence of infection were included in the study.

RESULTS: Twenty-one cases showed complete union at 6 months or earlier. Two more cases showed significant callus formation. In three cases, there was no callus formation at fracture site till 6 months.

DISCUSSION: Various authors in their studies confirmed that gentamicin and vancomycin are antibiotics which maintain activity even after being exposed to the high temperatures resulting from poly (methyl methacrylate) hardening.

CONCLUSION: From our study, we confirm that the use of antibiotic-impregnated bone cement rod has a significant role in control of bone infection and also assists in union in cases of infective nonunion of long bones.

Keywords:

Antibiotics, bone rod, cement, infection, long bones, nonunion

Introduction

Infected nonunion of long bones is chronic, tedious, and huge challenge that presents a huge problem to the surgeon today in terms of cost of treatment and time elapsed during the treatment.[1] Some of the factors that lead to infected nonunion are open fracture, loss of soft-tissue or bone infection after internal fixation, chronic osteomyelitis, pathological fracture, and surgical debridement of infected bone.[2] Almost all of the infections that are encountered in orthopedic trauma are caused by biofilm-forming bacteria.[3] Biofilm consists of hydrated matrix of polysaccharide and protein. Once a biofilm is formed, it protects the microorganism from antimicrobial, opsonization, and phagocytosis, and thus, it contributes to re-occurrence of infections.[4] To manage and treat biofilm-related infection, the four principles laid down by Cierny and Mader must be observed and followed: (1) complete surgical debridement with dead space management, (2) fracture/nonunion stabilization, (3) soft-tissue coverage, and

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(4) adequate antibiotic level.[5] The treatment of nonunion follows a two-stage procedure. Stage 1 is of debridement with or without antibiotic cement bead insertion along with systemic antibiotic therapy to change an infected nonunion to aseptic nonunion. Stage 2 is carried out to achieve stability which can be achieved either by external fixation or by internal fixation with or without bone grafting.[2,6-10] The use of antibiotic-impregnated cement-coated intramedullary (IM) nailing for infected nonunion of tibia and femur fractures has been well documented.[11-18] The cement nail which is inserted helps in providing stability across the fracture site which is essential in the management of infected nonunion and which cannot be achieved by cement beads.[17,18] Antibiotic cement release antibiotic at local site up to 36 weeks and it helps in providing a therapeutic effect on refractory infection and has few side effects.[16,17] Gentamicin has been most frequently used agent which is followed by vancomycin as they have broad spectrum of activity, heat stability, and low allergenicity.[19,20]

Based on the above studies, we were encouraged to carry out a study assessing the role of antibiotic-coated cement rod in control of infection and also analyze its role in union infected nonunion of long bones.

Aims and objectives

To assess the role of antibiotic-impregnated bone cement rod in control of bone infection and assess its role in union in cases of infective nonunion of long bones.

Materials and Methods

- This was a prospective study comprising of 30 cases of established infected nonunion of long bones carried out in a tertiary care center in Western Maharashtra for 2 years from June 2014 to July 2016
- Inclusion criteria: Patients of nonunion of long bones diaphysis with established clinical and laboratory evidence of infection were included in the study
- Exclusion criteria: Patient with immature bony skeleton, bone gaps, or infection involving the joint were excluded from this study
- Wound and sinus swabs were sent for gram stain and culture sensitivity
- Antibiotics used in cement were vancomycin and gentamicin due to their heat-stable properties.

Results

In our study, we included 30 patients in total of infective nonunion of long bones. Out of 30 patients, male patients were 22 and we had 8 female patients in our study. Out of 30 patients [Figure 1], 21 patients were of femur nonunion and 9 were of tibia nonunion. The age range of the patients was 18–45 years with a mean age of 34.5 years. Twenty patients had a culture of *Staphylococcus aureus* from a preoperative or an intraoperative specimen. Six patients had a culture that was positive for Enterobacter. Rest of the patient had a sterile culture despite obvious signs of infection. All the patients were treated with the same regimen. First, all the wounds and sinus were properly cleaned and culture swabs were taken and sent for evaluation, and later on, patients were treated with open reduction and internal fixation with antibiotic-coated cement rod. Sterile dressing was done on day 2, day 5, and day 8, and sutures were removed on day 14. Twenty-six cases showed complete union at 6 months or earlier. Two more cases showed significant callus formation. In two cases, there was no callus formation at fracture site till 6 months. Fracture union occurred at 6 months or earlier in eight cases. Four cases showed solid bony union at 8 months. No refractures occurred in these cases. In one case where infection healed but nonunion persisted, she was given an external fixator. Later, the patient obtained a satisfactory union. However, two patients continued to have an infected nonunion. In both of these cases, the Rod with anti-biotic cement was removed and patients given external fixator. Twenty-three patients experienced no recurrence of infection. Four patients continued to have draining wounds, but the discharge was significantly reduced. In two cases, it was a thin watery fluid, and in two other cases, the discharge persisted as a purulent discharge, which was greatly reduced in volume. Patients were discharged after suture removal and were followed up in outpatient department at regular intervals of 2 weeks each to assess the progress.

Figure 1: Treatment pictures of femur

Discussion

IM infection is a well-recognized complication of IM nailing for trauma. Infected nonunions of long bones are particularly very difficult to treat. The combination of mechanical instability and infection of the fractured bone provides an unfavorable condition for fracture healing. Thirty patients who had an infected nonunion of the long bone were treated using antibiotic bone cement rod. Twenty-one femurs and 9 tibias were treated. The age range of the patients was 18–45 years with a mean age of 34.5 years. In our study, we had used 40 g of plain cement mixed with 1 g of injection vancomycin powder or 40 g of gentamicin bone cement alone or in combination with 1 g of injection vancomycin powder. Sterling *et al*.[21] confirmed that gentamicin and vancomycin are antibiotics which maintain activity even after being exposed to the high temperatures resulting from poly(methyl methacrylate) hardening. Klekamp *et al*.[22] recommended combining vancomycin and an aminoglycoside in bone cement for their potential synergistic effect in the treatment of severe infections caused by resistant *S. aureus*. This was confirmed by studies of González Della Valle *et al*.[23] Miller *et al*.[24] confirmed that when infection is associated with fractures, stability is important in the treatment of infection. The antibiotic-impregnated cement rod fills dead space while locally eluting high concentrations of antibiotics. It simultaneously provides mechanical support for the bone.

In our study, we found that twenty-three patients experienced no recurrence of infection. Four patients continued to have draining wounds, but the discharge was significantly reduced. In two cases, it was a thin watery fluid, and in two other cases, the discharge persisted as a purulent discharge, which was greatly reduced in volume. Schlatterer and Anders (2005)[25] in their study encountered one case that required re-debridement and exchange antibiotic re-rodding after 6 weeks. This patient went on to full recovery and one case had persisting discharging sinus. In the study done by Paley and Herzenberg[11] to treat IM infections with antibiotic cement rods, they noted no recurrence of infection in any of the nine cases studied by them. Emami *et al*.[26] treated 37 cases of infected tibia nonunion. Twenty-one patients required repeat debridement. No recurrence of infection was noted in any cases for 2 years of follow-up.

We found that in our study, we had achieved 26 cases of complete union at 6 months or earlier. Two more cases showed significant callus formation. In two cases, there was no callus formation at fracture site till 6 months. In the study done by Paley and Herzenberg[11] to treat IM infected nonunions in three cases with antibiotic cement rods, they achieved fracture healing after re-nailing or plating once infection healed. Ueng *et al*.[27] obtained bony union in diaphyseal infected nonunions in 15 patients with antibiotic beads, external skeletal fixation, and staged bone grafting. Fifteen cases were considered and all united. External fixator was removed at 7–15 months (average 9 months).

Conclusion

On the basis of our study conducted, we recommend the use of antibiotic-impregnated bone cement rod in control of bone infection and that it significantly helps in union of infective nonunion of long bones.

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Conflicts of interest
There are no conflicts of interest.

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