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Original Article

Antibiotic Cement Impregnated Nailing in Management of Infected Non-union of Femur and Tibia

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Abstract

Introduction: Infected non-union of long bones presents a complex problem to the treating surgeon. The treatment of non-union traditionally followed a two-staged procedure. Single-stage procedure such as debridement and use of antibiotic cement impregnated intramedullary nails has been described in the literature currently.

Aim: To evaluate the clinical outcome of compound fractures of femur and tibia managed by antibiotic cement impregnated Küntscher nail.

Materials and Methods: This prospective study was done on 25 cases of infected non-union of femur and tibia. Functional results were evaluated with regard to control of infection, bony union, and complications.

Results: After an average follow-up of 8 months, infection was controlled in 24 of 25 (96%) patients; bone union was achieved in 23 of 25 patients (92%), rate of bony union average of 26 weeks for tibia, and 24 weeks for femur.

Conclusion: Antibiotic cement impregnated nailing is a simple, economical, and very effective procedure than traditional methods in management of infected non-unions of long bones.

Key words: Antibiotic cement impregnated nail, Infected non-union, Long bones

INTRODUCTION

Despite advances in antibiotics and operative treatment, infected non-union remains difficult to treat, with considerable morbidity, and health-care costs. Infected non-union has been defined as a state of failure of union for 6-8 months with persistent infection at the fracture site. The incidence seems to be increasing, especially in view of increasing high-velocity trauma, which is more frequently treated with internal fixation.[1-3] The presence of poorly vascularized tissues, adherence of bacteria to bone, and implants along with slow bacterial replication rate contribute to persisting infection.[4,5]

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Infected non-union presents with dual problems of controlling infection and providing stability. We present our single-stage procedure of treatment, Kuntscher nail coated with antibiotic cement, which combines local antibiotic delivery with good alignment and intramedullary fixation. The use of an antibiotic impregnated cement coated IM nailing for infected nonunion of tibia and femur fractures has been well-documented in the literature.[6-13]Antibiotic nail provides osseous stability which is important in the management of an infected nonunion. Second, antibiotic cement allows higher concentration of antibiotic at the local site than is achievable with systemic antibiotics and is associated with fewer side effects. Antibiotic cement has been shown to elute antibiotic at the local sites for up to 36 weeks thus having a therapeutic effect on refractory infection. Unlike traditional methods of management of infected non-union antibiotic cement-coated nailing acts as a single-stage procedure by providing stability and treating infection at the same time along with other advantages such as early mobilization, avoidance of pin site infections, ease of performance, and being cost-effective.

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Aim

The aim of the study is to evaluate the clinical outcome of compound fractures of femur and tibia managed by antibiotic cement impregnated Küntscher nail.

MATERIALS AND METHODS

This is a prospective study of 25 cases of infected nonunion. One female and 24 male patients (age range, 21-65 years) were included in the study. 12 of the patients were Gustillo's classification Grade III B compound, two were Grade II Compound, two were Gr I compound and nine were closed fractures at the time of injury. All 25 patients had infected non-union at presentation, and 14 patients had bone defect ranging from 1 to 2.5 cms after initial debridement. Average follow-up was 8 months (range, 8-36 months). All patients were evaluated pre-operative with X-rays, hemoglobin, total count, differential count, sedimentation rate, C-reactive protein, pus C/S, comorbid medical issues, and allergy to vancomycin.

Preliminary thorough wound debridement was done. Vancomycin 4 g was mixed with 40 g standard viscosity gentamycin bone cement and was coated over Küntscher nail of appropriate length prepared. In case of the tibia, after selecting the Küntscher nail of appropriate length the Herzog's bend of 8°is created with bench-press 5 cm from the proximal end of Figure 1. Nail diameter is determined by the per-operative reaming diameter. The medullary canal is reamed up to the maximum diameter possible. Küntscher nail of 8 mm or 9 mm diameter is chosen and cement coated up to 1 mm less than diameter of the last reamer.

When the cement reaches doughy consistency Küntscher nail is coated and manually rolled up to uniform diameter. Proximal eye of nail left open while distal nail tip cement is molded to smooth bullet-nose shape. Nail inspected for spotty coverage and smoothened. The diameter required is checked with Küntscher diameter measuring gauge and excess cement is shaved off and nail rerolled before the cement sets and diameter is rechecked. Bone cement is allowed to set for 15 min before insertion for the monomer to evaporate and to prevent cement nail debonding. After setting of cement, nail placed intramedullary. Primary wound closure is attempted alternatively staged plastic surgery procedures planned.

RESULTS

After an average follow-up of 8 months, infection was controlled in 24 of 25 (96%) patients (Table 1). Bone union was achieved in 23 of 25 patients (92%) (Table 2). Rate of bony union average of 26 weeks for Figure 2-4 and 24 weeks for Figure 5-7 (Table 3). Complications encountered were non-union persisting in 2 cases, broken and bending nail in 2 cases, and nail cement debonding in 2 cases. Recurrence of infection was observed in 1 patient (Table 4). According to Paley's bony criteria, there were 20 excellent results, 2 good results, 1 fair, and 2 poor result, respectively. According to Paley's functional criteria 18 excellent results, 5 good results and 2 poor results were recorded (Graphs 1 and 2).

DISCUSSION

The treatment of infected nonunion requires procedures to control the infection and to provide stability to achieve union.[9] There is no single universally accepted modality of treatment presently available for the management of infected nonunion. Conventionally, infected non-union has been managed using two-step procedure to control the infection first and subsequently to treat the nonunion.

Delivery of antibiotics to the infection site systemically or locally is essential to control infection. Long-term

Table 1: Control of infection

Bone treated	Number of cases	Infection controlled	Percentage
Tibia	19	18	95
Femur	6	6	100

Table 2: Bony union

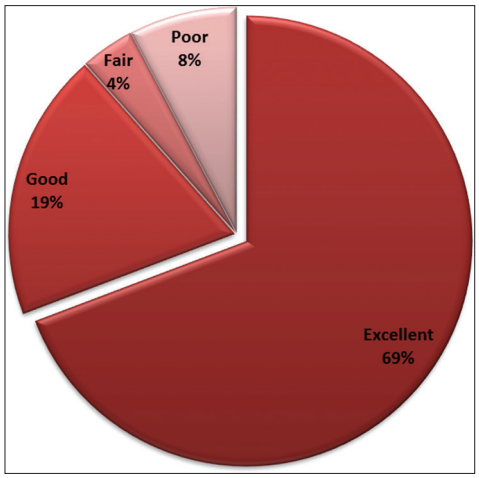
Bone treated	Number of cases	Union	Percentage
Tibia	19	18	95
Femur	6	5	95

Table 3: Rate of union

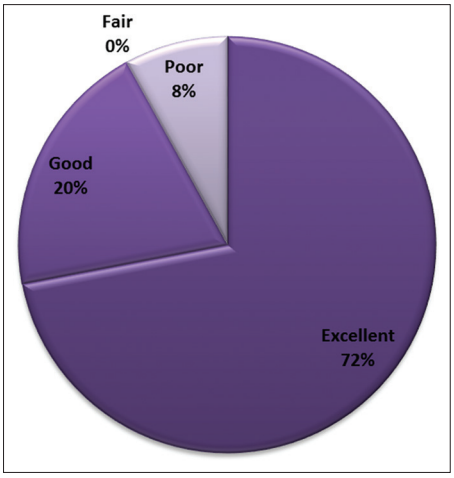
Bone treated	Minimum duration (weeks)	Maximum duration (weeks)	Mean (weeks)
Tibia	16	30	20
Femur	14	26	16

Table 4: Complications

Complications	Number of cases
Non-union persisting	2
Infection not controlled	1
Nail bending	1
Nail breakage	1
Proximal nail impingement	2
Distal nail migration	1
Nail cement debonding	2



Graph 1: Paley's bony criteria



Graph 2: Paley's functional criteria

Figure 1: Antibiotic Implant

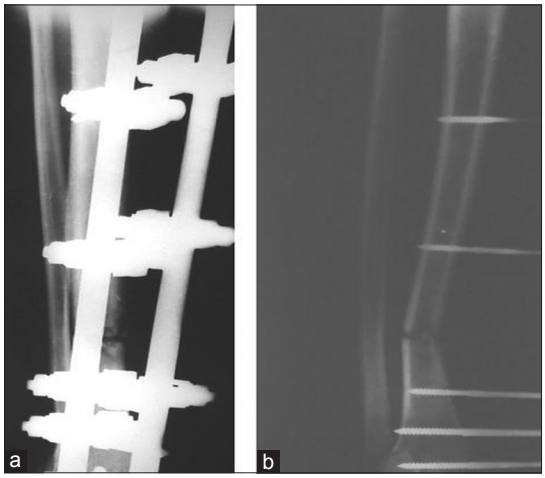


Figure 2: (a and b) Tibia pre-operative X-ray, compound Grade III *B* with flap cover

infection and repeated debridement create excessive fibrosis around the non-union site and hinder antibiotic permeability.[14] Hence, delivery of antibiotics to the local site is far more beneficial than systemic administration of antibiotics. The use of antibiotic-impregnated poly methyl methacrylate cement beads for local delivery of antibiotics without any systemic toxicity has been well documented for the management of osteomyelitis and open fractures.[15,16] However, these antibiotic cement beads do not provide any stability across fracture site and cannot be placed in the intramedullary canal as it entails difficult removal due to fibrous ingrowths. Gentamycin and vancomycin are common choices for local delivery of antibiotics because of their broad spectrum of activity, heat stability, and low allergenicity. Vancomycin up to 4 g and gentamycin up to 2% per 40 g do not alter the mechanical property of bone cement. Elution of antibiotics follows a biphasic pattern, with an initial rapid phase and a secondary slow phase.[9,17] Elution is at its maximum during the 1st day, greatly declines on the 2nd day, and then, gradually decreases over time and stabilize between days 5 and 10. Animal and clinical studies consistently have shown high local concentrations and undetectable or very low serum levels of the locally delivered antibiotics with no systemic toxicity. The systemic absorption of the locally delivered antimicrobial agent is limited and results in extremely low serum levels, which have ranged from 0.3 to 0.5 μg/mL in the case of gentamycin. Clinical and experimental studies show them to have good elution properties from bone cement, and no deleterious effects on bone healing. The process of surface adhesion and biofilm development is a survival

Figure 3: 24 weeks post-operative X-ray tibia

Figure 4: (a-d) Range of movement in 2 years follow-up with antibiotic nail in tibia

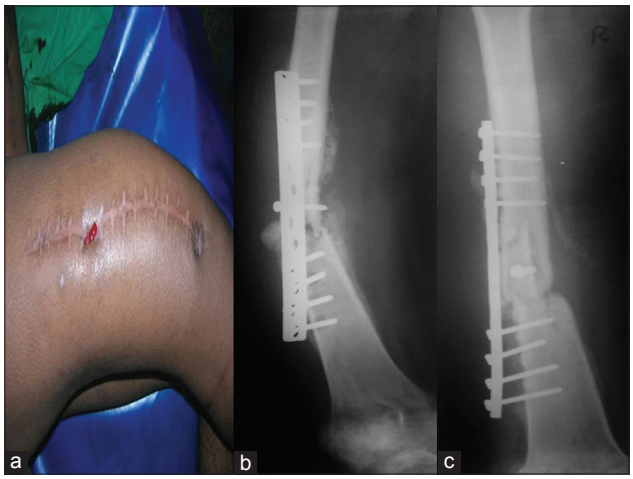


Figure 5: (a-c) Pre-operatively below knee amputee right lower limb with infected non-union shaft of femur with implant failure

strategy employed by bacteria. This process is designed to anchor microorganisms in a nutritionally advantageous environment with adhesion to implant surface avoided in this technique.[11] Control of infection in 24 out of 25 cases in our study is comparable to results of infection control in all cases by Ashok *et al.* Indian journal of orthopedics

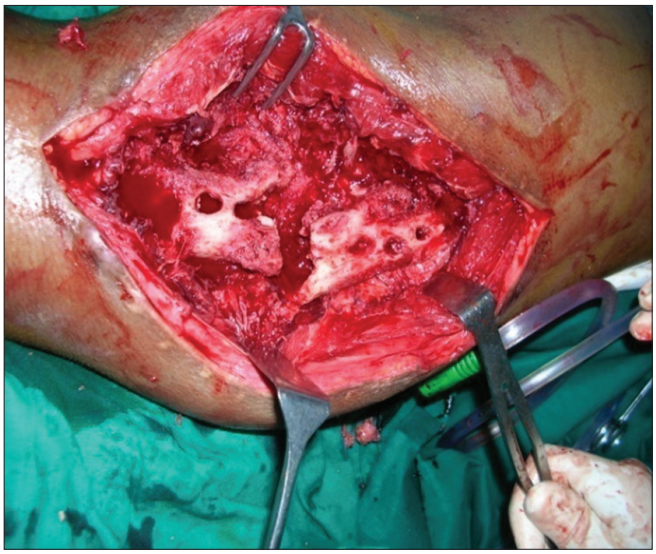


Figure 6: Per-operative picture of enlarged screw holes in femoral cortex

Figure 7: At 2 years follow-up with good fracture union and patient was able to weight bear and walk with below knee stump prosthesis

2009. All cases were further managed with exchange nailing by Shyam *et al.*[18], but exchange nailing was done for only 3 cases in our study to achieve bony union in 23 out 25 cases in our study. Qiang *et al.* have shown bony union in only 11 out of 19 cases.[7] Thonse *et al.* have shown bony union in 17 out of 20 cases.[9] Rate of bony union average of 26 weeks for tibia and 24 weeks for femur is comparable with results shown by Han *et al.* of 26.4 weeks for tibia and 31.5 weeks for femur.[19]

CONCLUSION

Antibiotic cement impregnated nailing provides effective infection control and good stability to promote union. It is advantageous over external fixators and has good patient compliance. Thus, antibiotic cement impregnated nailing is a simple, economical, and very effective procedure when compared to the traditional methods in management of infected non-unions of long bones.

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