ORIGINAL ARTICLE

Custom-Made Antibiotic Cement-Coated Nails for The Treatment of Infected Nonunion in Femur

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ABSTRACT

Objective: Evaluation of antibiotic cement impregnated nailing in the management of infected non-union of femur.

Methods: The prospective study was made on 19 cases of infected non-union of femur from 2014 to 2015 Evaluation of functional outcomes was made in reference with controlling of infection and bony union.

Results: Eradication of infection was achieved in 14 cases with antibiotic cement impregnated intramedullary nail (ACIIN) and the fractures united. Despite of the fact that control over infection with ACIIN was noted but successive measures were adopted for achievement of bony union in three cases. One had union in presence of infection while one persisted with infected non-union.

Conclusion: Antibiotic cement impregnated nailing is an effective, very economic and easy technique than that of conventional techniques for managing infected non-unions of long bones.

Keywords: Long bones, antibiotic cement impregnated nail, Infected non-union

INTRODUCTION

Musculoskeletal infections remain a challenge for orthopedic surgeons [1,2]. Infected nonunion of the long bones is the major concern with respect to the cost and time-effectiveness of the treatment [3]. Traditionally the treatment of infected nonunion is a two staged procedure. First being the control of infection and stabilization, second is achieving the bony union [3]. In the first stage control of infection is achieved by debridement with or without local antibiotic delivery system. The fracture is stabilized by internal or external fixation. Followed by post-operative antibiotic therapy according to the culture and sensitivity converting infected nonunion to aseptic nonunion. Bony union is then achieved by removing the previous implant and antibiotic beads. Fracture is then fixed internally or externally and bone grafting is done. Postoperative antibiotic therapy is continued in the second stage [1].

Single staged treatment with debridement, antibiotic cement beads with illizrov external fixation or the use of antibiotic cement impregnated intramedullary nails (ACIIN) have been elaborated in the literature. Paley and Herzenberg in the start of this century (2002) with promising results first advocated the use of ACIIN [2]. Since then many studies have been conducted for the efficacy of the procedure. ACIIN provides stability to the fracture is technically easy and has all the properties of antibiotic cement beads delivering high concentrations of antibiotics locally [3]. Patients can be advised for immediate weight bearing and it also avoids the complication of external fixing lie as pin tract infection and joint inflexibility. In treating infected nonunion the instant approach was designed to reduce the number of potential surgeries for the control of infection and then achieving union at fracture site [1].

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METHODS

This prospective study was done on 19 cases at public sector hospitals during the period of 2014-2015. Inclusion criteria included all the cases of diaphyseal infected nonunion of femur. The omitting criterion was not to add patients having age less than 15 year or older than 70 years, allergic to vancomycin and/or gentimicin, with bone loss more than 4 cm.

Preoperative Planning

Preoperative planning is very important. It is necessary for determining if the patients have any history of allergy to antibiotics in order to avoid usage of such drugs. Preoperative and intraoperative cultures and

sensitivity results evaluation done which provides guides for postoperative use of antibiotics.

Both the lateral and anteroposteior preoperative radiographs were acquired for whole length of the bone so that nail dimensions can be measured and appropriate size nail can be made and it also provides information regarding if there is a need for any additional surgical procedure e.g. deformity correction. Length of nail was measured as for standard interlocking nail. Length was measured from piriform fossa to the distal femur physeal scar.

Surgical Steps

Procedure was performed in two phases. In first phase patient was prepared for surgery while the surgeon makes necessary arrangements for antibiotic cement coated nail. Then surgeon performs a thorough debridement of all the infected bone and soft tissues, which are tailored by copious lavage. Upon completion of debridement the table is cleaned from all the used instruments. Surgeon and the whole team then changed the gowns and gloves, new drapes were put in. Normally, the surgeon making antibiotic cement coated nail of appropriate size and then inserting it starts the second phase.

All ACIIN were made using same antibiotic combination of gentimicin antibiotic cement with 4 grams of vancomycin per 40-gram pack of cement. K-nail was used to mount this cement.

Fig. 1: Fabrication of nail

Preparation of ACIIN involves the use of disposable rubber tube. Antibiotic cement was prepared and with help of gun was inserted into that tube filling its entire length then k-nail was inserted and gently rolled on the preparation table so as to make sure the homogeneous cement mantle. Tube is cut longitudinally after setting the cement with the help of a sharp knife for removing ACIIN. Surfeit cement lying away from the tip of the nail is removed with osteotome and tip of the nail was made smooth for insertion.

Per-operative samples of infected tissues were also taken for culture and sensitivity, which included bony fragments, infected soft tissues and sinus tracts.

Insertion of nail

ACIIN insertion technique was similar to the technique used for simple K-nail insertion. Medullary canal was reamed atleast 2mm more than the size of the nail on which antibiotic cement was applied. Fracture was reduced and guide wire inserted and nail was slided onto the wire into the medullary canal until it reached the distal femur physeal scar. Wounds were washed and closed over the suction drain. Antiseptic dressing of the wound was done using adhesive dressing.

Fig. 2: Insertion of nail

Fig. 3: Insertion of nail

Post-operative follow-up

Drain was removed on very next day of surgery followed by discharging of the patient on intravenous and oral antibiotics according to culture and sensitivity reports obtained before the surgery. Each patient was called for follow-up on 10th post-operative day, wounds inspected and stitches were removed. Wound condition and status of discharge were noted. Antibiotic therapy continued and called for further follow-up at 3,6,12,24 weeks and 1 year.

RESULTS

The study group included a total of 19 patients. Study population comprised of all male patients with a mean age of 34 $\pm$ 5.4. All these patients had prior surgery on the affected femur, which had been complicated by infection and non-union.

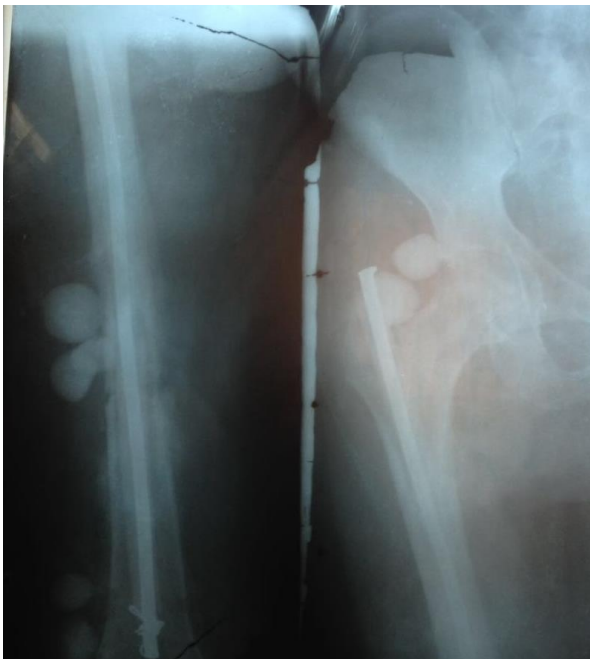

Fig 4: Preoperative Radiograph

Out of these 19 patients, 14(73.68%) patients were cured of infection and had union at fracture site at 24 weeks follow up and then at 1 year. 3(15.78%) patients developed sterile non-union for which second surgery was done to achieve union. 1(5.26%) patient had persisted with infection but achieved union. 1(5.26%) patient was not benefitted from this and persisted with infected non-union and underwent second surgery with debridement and external fixation with ilizrov's fixator.(Table No. 1)

Table 1: Study Results.

	Union Achieved	Union Not Achieved
Infection Eradicated	14(73.68%)	1(5.26%)
Infection Persisted	3(15.78%)	1(5.26%)

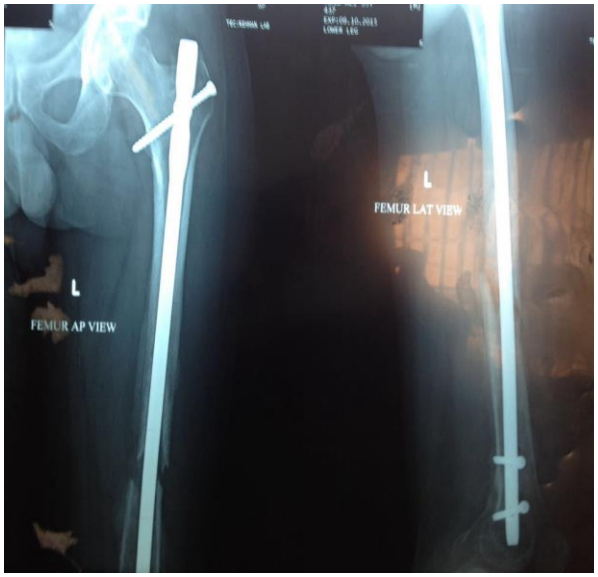

Fig. 5: Post operative Radiographs

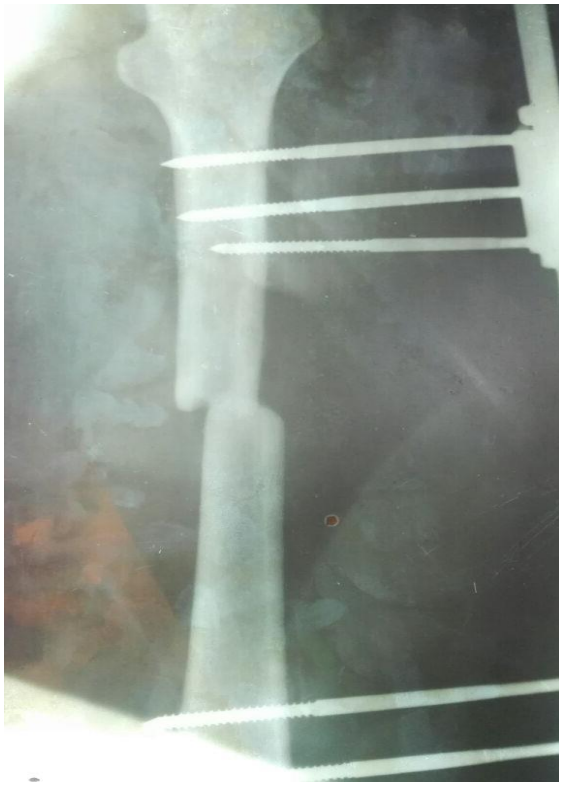

Fig. 6: Preop Radiograph

(a) **(b)**

Fig. 7a & b: Postoperative Radiographs at 6 & 12 weeks

DISCUSSION

For controlling infection, infected nonunion require multiple procedures, owing to provision of stability to the fracture and achievement of union. In order to control infection, either systemically or locally delivering antibiotics and surgical debridement are traditionally used. Reduced systemic levels and highly concentration of local antibiotics are common results of local antibiotic rehabilitation [4].

For treating open fractures and osteomyelitis, the beads of antibiotic saturated PMMA are in practice [5,6].

Yet, for removal of beads, there is obligation for another procedure. Conventional techniques for delivering local antibiotics comprises of delivery of bio absorbable means of transportation like as synthetic polymers, calcium sulfate [4,7].

Latest vehicles for delivering synthetic bio absorbable are under development for avoiding the necessitation of second procedure of surgery and in a few cases for the promotion of osseous union [8,14].

In literature many benefits and drawbacks of antibiotic coated intramedullary nails has been described. Benefits include High concentration of local antibiotic elution: up to 200 times greater than with systemic drug administration, independent of vascular supply [15], stability to the fracture/nonunion site, allowing for early weight bearing, local antibiotic delivery independent of patient compliance [16], systemic toxicity of antibiotics very rarely observed [17], versatility of modifying antibiotic as per the culture report [18], control of infection and stability is achieved with a single procedure [19], alternative for patients refusing or not being right candidates for external fixation [20].

Drawbacks are very much less in number and include local antibiotic carriers have never been shown to be superior to intravenous administration of antibiotics in terms of cure rate [15], require repeat surgery with possibility of emergence of resistance [16] and MMA toxicity [21,22].

Our study was small scale but showed significantly important results which suggest that antibiotic coated cemented intramedullary nails can result in eradication of infection and achieving union in infected fractures of femur without undergoing a second procedure.

Mantri D et al, conducted a study in 2015 and found that antiobiotic cement coated intramedullary nail has got a success rate of 96%. These results are comparable to our results in which union was achieved in 89.64% of cases and 5 % cases were made sterile without achieving union [23].

Though our study has demonstrated significant results showing a high rate success with ACIIN but there is a need to conduct large scale trials of this procedure considering other parameters like bone gap at fracture site and culture from infected bone.

CONCLUSION

After the availability of antibiotic loaded acrylic bone cement, it remains a golden standard in local antibiotic delivery. This is also true in case of long bone medullary infections, where antibiotic cement nails remain an important treatment option. The major advantage of ACIINs is locally releasing of highly concentrated antibiotic, heavily exceeding systemic administering with either no or low systemic toxicity.

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