

## Prospective study of infected non-union of long bones treated by Antibiotic impregnated intramedullary nailing

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### Abstract

**Background:** In an era of high velocity injuries, compound fractures are very common in orthopaedic practice and despite of preventive measures taken pre-operatively and post-operatively, infected non-unions still common and they pose a real challenge to the treating surgeon and makes the patient debilitating. In infected non-union case, the preference has to be given to eradication of the infection before aiming to achieve fracture union. Many methods of treatment have been described in the past including Ilizarov fixator and Antibiotic cement impregnated intramedullary nailing (ACIIMN). Sustained and gradual release of heat stable antibiotics which are mixed with the bone cement at a high concentration and coating it on Intramedullary nail (ACIIMN) has gained popularity among the techniques used to treat infected non-unions. Our study is aimed at summarizing our experience with the use of antibiotic cement-impregnated intramedullary nail (ACIIMN) for control of infection in cases of infected non-union. This is a report of series of 27 infected non-union cases, both femur and tibia which were treated by Antibiotic cement impregnated intramedullary nailing (ACIIMN) in our institute.

**Aims and objectives:** To evaluate the outcome of treatment of infected non-unions of long bones treated by Antibiotic cement impregnated intramedullary nailing (ACIIMN).

**Materials and Methods:** Our study is prospective study involving 27 cases of infected non-unions of long bones treated by Antibiotic cement impregnated intramedullary nailing (ACIIMN) at our institute from 2012- 2015. The outcome of procedure was evaluated with regards to infection control, deformity, bony union and limb length discrepancy etc.

**Results:** Infection was eradicated in 23 cases with ACIIMN and the fractures united. In 4 cases, though the infection was controlled with ACIIMN, they required subsequent procedures like exchange nailing with bone grafting to achieve bony union.

**Conclusion:** Antibiotic cement impregnated nailing is a very simple yet economical and very effective procedure than the other methods in treatment of infected non-unions of long bones.

**Keywords:** long bones, Infected non-union, antibiotic cement impregnated intramedullary nail.

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### Introduction

Non-union of long bones secondary to infection is a nightmare to the treating orthopedic surgeon. Despite of thorough careful pre-operative, intra-operative and post-operative precautions taken to prevent infections, still infected non-unions are more common in our country. Causes of infected non-union may be due to the compound wound, loss of soft tissue or bone, severe comminution, and gross displacement. Improper and insufficient immobilization of fracture, a large bone defect etc.

In the past, they use to do debridement with antibiotic cement bead insertion to have highest antibiotic concentration locally followed by systemic antibiotics. In the second stage achieving stability at fracture and bone grafting was the main goal.

One-staged procedures such as debridement and antibiotic cement-impregnated intramedullary nails (ACIIMN) and application of Ilizarov fixator have been described recently. Ilizarov ring fixator can be used for bone transport by doing corticotomy and distraction after acute docking but this is technically demanding surgery and one may face complications like pin tract infections, angulations etc. Thus it is best suited for non-unions with large i.e. >4cm bone defects. In the past many authors have encouraged ACIIMN (antibiotic cement-impregnated intramedullary nail) as a very effective, less expensive yet simple one-stage technique for treating infected non-union. It acts by filling the dead space, releases high concentration of antibiotics locally, and gives excellent mechanical stability for the fracture site. Vancomycin has been the most widely used agent followed by Gentamicin. Many surgeons prefer using both when used with bone cement, widens the spectrum of activity antibiotics. The present study was undertaken to analyze the outcome of the ACIIMN used in cases of infected non-union without much bone loss.

**Aims and objectives:** To study the outcome of treatment of infected non-union of femur and tibia

treated with antibiotic cement impregnated nailing (ACIIMN)

### Materials and methods

Twenty-seven patients presenting to Vijayanagar Institute of Medical Sciences, Bellary, with infected non-union of long bones were included for the prospective study during 2012–2015. Among 27, there were 24 males and 3 females, with the mean age being 31 years (range, 21–53 years).

In this study, we treated 23 tibias and 4 femurs, with 26 patients having sustained high-velocity trauma and one patient having sustained domestic injury. There were 4 closed fractures and 23 open fractures. 15 patients had intramedullary nail in situ, 11 patients had external fixator, and one patient had Ilizarov ring fixator in situ when they presented to us and they were treated in different centers earlier. All patients when presented to us, had full blown infected non-unions, with 25 patients undergoing multiple procedures like, repeated debridement, external fixator application, Ilizarov fixator, implant removal that failed to achieve union etc., the mean duration of infection was 8.1 months.

### Exclusion criteria

Patients with non-union with bone defects more than 4 cm, patients aged below 15 years, patients allergic to vancomycin and patients with non-union secondary to other causes other than infection.

**Procedure:** All patients were subjected for complete pre-operative evaluation including the following investigations: complete blood count, ESR, C Reactive Protein, culture and sensitivity, sinogram. X-rays of the part in two views were also obtained.

**Surgical steps:** At the beginning implant in situ is removed and a thorough debridement of the infected fracture site and soft tissues is done. All the nonviable slough and infected tissues, including the skin, soft tissue and bone are excised until fresh bleeding in viable tissue is seen at the resected margins, followed by pulsed lavage. The excised bone, soft tissues and any purulent samples were sent for culture and sensitivity.

The next step is preparing the intramedullary canal. Reaming is done to accommodate a largest possible diameter nail which gives more stability at nonunion site. Medullary canal and the wound are given a thorough lavage with betadine solution and saline.

The entire surgical team then changes their gowns and gloves. Re preparation and re-draping of limb is

done. The next step is the preparation of antibiotic cement impregnated nail. The nail is prepared on a separate sterile table. Nail length is measured pre-operatively. Nail diameter is determined by the largest reaming diameter. Kuntscher nail or V nail or regular IMIL nail or Ender nail of 6 mm or 7 mm diameter is selected. Standard viscosity bone cement was used (40 gm). The cement was thoroughly mixed with 2 gm. Vancomycin, following which the polymer was added. When the cement reaches doughy consistency, the selected nail is coated with bone cement using an endotracheal tube to make the diameter uniform along the length of the nail. In case intramedullary interlocking nails, screw holes are left uncemented to accommodate locking bolts. Nail is inspected for spotty coverage and smoothed. The diameter is checked with Kuntscher diameter measuring gauge, excess cement is shaved off and the nail rolled before the cement sets. The diameter is re checked. Bone cement is allowed to set for 15 minutes before insertion to allow the monomer to evaporate and to prevent cement nail de-bonding. Bone loss of up to 4 cm due to primary bone defect following fracture, sequestrectomy or freshening of bone ends were docked primarily. Bone ends aligned and nail is placed.

Wound is inspected at intervals of 48-72 hour. The systemic antibiotics are given based on culture and sensitivity reports.

Further treatment was with oral antibiotics for 6 weeks. Complete blood count (CBC), Erythrocyte Sedimentation Rate (ESR) and C-reactive protein (CRP) levels were performed at regular intervals. Clinical and radiological features were used to assess the progress of bony union at 4 weeks interval till union was detected.

After the wound healing, a patellar tendon-bearing cast was applied in case of tibia and gradual full weight bearing was permitted. The cast was changed every 6 weeks and continued till union was confirmed with clinico-radiological assessment. Active physiotherapy for regaining ankle and knee mobility were advised till the range of movement was satisfactory.

### Results

Functional results were evaluated with regards to control of infection, bony union, deformity, limb length discrepancy. Out of 27 cases of infected non union of long bones treated by ACIIMN, Infection was eradicated in 23 cases and the fractures united. In 4 cases, though the infection was controlled with ACIIMN, they required subsequent procedures like exchange nailing with bone grafting to achieve bony union.



**Fig. 1: Antibiotic cement impregnated IM nail preparation**



**Fig. 2: (A): infected non-union in a compound fracture treated with ex fix (B): Immediate post op X ray of ACIIMN done with IMIL nail, 3 months later dynamised (C): 1 year post-operative follow up X Ray with good union**



**Fig. 3: (A)(B): Immediate post op X ray of infected nonunion of tibia treated by ACIIMN(V Nail) (C)(D): 1yr post operatively, removed the nail which was backed out.**



**Fig. 4: 2 yrs. Post-Operative**

### Discussion

Thorough debridement, rigid fixation, and antibiotics are the mainstay in the treatment of infected non-union of the long bone. Many staged procedures have been described for the management of infected non-union. Intramedullary devices have been used with good results. We studied the results of the use of ACIIMN in cases of infected non-union of long bones.

Usually infected foci in the bone is surrounded by an avascular sclerotic bone, covered by a thickened periosteum, scarred soft tissues. This avascular surroundings prevent systemic antibiotics from reaching to the infected site. Thus positive cultures are seen in majority of patients even though all patients were receiving broad spectrum antibiotics. In our study all the intraoperative specimen cultures were positive, and helped to decide an appropriate antibiotic regimen post operatively.

Intramedullary infection leading to non-union of the fracture is a known complication of intramedullary nailing. Compound fractures have a higher incidence than closed fractures treated with intramedullary nailing. Our series had 4 closed fractures and 23 compound fractures, of which 15 were treated with intramedullary nailing primarily.

Use of antibiotic-impregnated cement was first noted by Buchholz and Engelbrecht. A high local concentration of antibiotics and low systemic side effects were the major advantage. Gentamicin has been the most widely used agent followed by vancomycin. Use of two antibiotics, namely gentamicin and vancomycin, with bone cement widens the spectrum of activity and also enhances the elution properties of the two antibiotics. Now days, Vancomycin is most widely used antibiotic because of its broad spectrum of activity, heat stability and low allergenicity. Klemm was the first to use antibiotic cement beads in cases of osteomyelitis. Cement beads fill the dead space and also allow a high concentration

of local antibiotics. The effectiveness of the antibiotic-impregnated cement beads in the control of bone infection is well established. Cement beads have been used for intramedullary infections. However, they offer no mechanical stability and are difficult to remove after 2 weeks.

ACIIMN can provide stability, is easy to remove, and also provides all the advantages of the cement beads. Use of ACIIMN has been first reported by Paley and Herzenberg. Paley et al have shown that control of infection was about 85 % and bony union achieved in about 80% cases by ACIIMN in infected non-union of long bones. Use of external fixators is associated with poor compliance and pin site complications. They are difficult to apply and maintain in obese patients. Such patients benefit from the antibiotic cement impregnated nailing.

ACIIMN should not be used in cases with bone defects >4 cm, where it fails to achieve an adequate stability and infection control, and for such cases, procedures like Ilizarov fixator with bone transport or lengthening with acute docking should be used.

In our study, out of 27 cases of infected non-union of long bones treated by ACIIMN, Infection was eradicated in 23 cases and the fractures united. In 4 cases, though the infection was controlled with ACIIN, they required subsequent procedures like exchange nailing with bone grafting to achieve bony union. The time for bony union was an average of 20 weeks for tibia and 28 weeks for femur.

Advantages of antibiotic cement impregnated nailing:

1. Release of antibiotic in high concentration locally (200 times greater than systemic injection) irrespective of compromised vascularity and it is evenly distributed along entire length of bone.
2. No systemic toxicity of antibiotics.

3. Antibiotics level above the minimal inhibitory concentration of sensitive organisms.
4. Patient will be very compliant compared to Ex-fix and Ilizarov fixator.
5. Because of early rehabilitation post-operative morbidity is very less
6. Chances of hospital acquired infections is very low as hospital stay is very short
7. A single procedure achieves control of infection as well as gives stability.
8. It is very cost effective.
9. Non cumbersome compared to Ilizarov or Ex-Fix
10. Soft tissue coverage procedures can be easily done after nailing.

### Conclusion

We find that

1. ACIIMN was a good procedure to achieve early infection control in cases of infected non-union with bone defect <4 cm.
2. Highly economical and cost effective method utilizing easily available instruments and materials. And very effective procedure when compared to the other methods.
3. Both, effective infection control and good stability to enhance union is obtained by antibiotic cement impregnated nailing and it has got good patient compliance also
4. It is a safe and simple procedure, patient friendly and it can be easily done at any center.

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