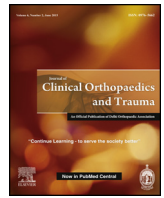




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Original article

A simple method for fashioning an antibiotic impregnated cemented rod for intramedullary placement in infected non-union of long bones

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ABSTRACT

The intramedullary insertion of antibiotic impregnated PMMA rods, beads or nails are widely used and accepted modality of treatment for chronic osteomyelitis of long bones. But at times it becomes difficult to insert and remove these antibiotic delivery systems owing to narrowed medullary canals. Here we present a technique for preparing PMMA rods with diameter ranging from 6 mm to 3 mm. These rods could easily be placed in narrow intramedullary canal of long bones with chronic osteomyelitis or infected non-union.

We have used high viscosity bone cement (Simplex P) along with two antibiotics (cefuroxime and vancomycin) for preparing cement rods. Food grade straw and low profile teflon tube guide wire exchanger used in IM nailing were used as mold. Ilizarov wire, 1 mm K wire and 24 gauge stainless steel wire were used as internal support core material for imparting strength. We used this technique in seven cases and were successful in treating infection of long bones of upper and lower limbs (femur). With average follow up of 7.28 months rate of union in our series was 71% (five cases). Four cases (57%) had no evidence of infection and two cases (29%) had control of infection and in one case (14%) infection was still there but union was achieved.

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1. Introduction

Infected nonunion¹ secondary to post traumatic fractures have always been a challenge to treat owing to numerous associated complexities. Adequate management of such cases necessitates a staged and well planned surgical procedure for achieving bony union and resolution of infection.

Standard treatment of non-union with infection^{1–4} with implant in situ usually involves removal of implant, debridement, use of local antibiotic delivery system⁵ and I.V. antibiotics, along with a provision to provide stability at the fracture site in the form of external fixator or simply by using cast/splint and later on definitive treatment in the form of internal/external fixation with or without bone grafting.

Several methods^{6–9} of local antibiotic delivery system using PMMA are being commonly used which includes hand fashioned or commercially available PMMA beads,¹⁰ PMMA rods^{11–13} and PMMA coated nails.^{1–4} None of these methods provide adequate stability and necessitates secondary procedure for stability at the fracture site in form of intramedullary interlocking nailing, cephalomedullary nailing or LCP with or without autogenous bone grafting. In cases of infected non-union associated with obliteration of intramedullary cavity it is very difficult to use intramedullary antibiotic delivery system. At times it is very difficult to reconstruct medullary canal of size enough to receive a nail up to 9 mm thickness. Moreover it becomes difficult to remove these nails so we present a technique of making PMMA rods up to 6 mm diameter or even lesser which are placed in the pilot hole made for insertion of intramedullary implant later in cases of diaphyseal/diaphyseal-metaphyseal fractures with an obliterated medullary cavity and infected non-union. This study aims at providing a novel technique for designing and inserting antibiotic impregnated intramedullary cement rods in inaccessible narrow

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intramedullary canals of infected bones and assessing its effect on eradication of infection.

2. Material and method

This prospective study was conducted between Jan 2013 and Nov 2015 at our Institution. Subjects between age of 18 and 55 years without any comorbid condition preventing surgical intervention, who presented to us with infected non-union of long bones with or without implant in situ, with narrow medullary cavity (diameter <9 mm), not requiring extensive soft tissue reconstruction, were included in the study.

All the cases were managed as per two stage surgical protocol. In the first stage, surgical debridement and removal of implant if any, was done followed by intramedullary placement of hand fashioned antibiotic impregnated cement rods and if required, placement of cement rod or hand fashioned antibiotic impregnated cement beads in extra-periosteal/sub muscular plane for a period of six weeks. Second stage surgery was performed after six weeks in which we removed the bone cement along with further debridement if required and autogenous bone grafting with definitive internal fixation.

Technique for preparing PMMA rods: A pre chilled (at 4–8 °C) Simplex P, bone cement is hand mixed in a bowl. The cement is kept at a low temperature prior to mixing as at low temperature it retains its liquid form¹⁴ for a longer duration of time and thus allows for procedural time to prepare antibiotic delivery system. Two grams, each of cefuroxime and vancomycin is then added to the mixture^{9,15} and stirred at the rate of one cycle/s for 30 s. Thereafter it is poured in a 50 ml or a 20 ml disposal syringe and then the plunger is inserted (Fig. 1, step 1).

2.1. For preparing PMMA rods of less than 5 mm diameter (Fig. 1, steps 2 to 5)

We have used food grade straw as a mold to make cement rods and pre sterilized it in glutaraldehyde 2% solution. Alternatively,

commercially available teflon tubes or soft silicone tubes of desired dimension could be used. We have used 24 gauge SS wire or 1 mm K wire as internal support core material for imparting strength to the impregnated cement construct. K-wires are better and easy to use as they are relatively stiffer than SS wire and can be easily negotiated inside the core of cement which is about to set. Before the cement sets in completely, the shape of construct can be manipulated depending upon that we need a straight or a slightly curved cement rod. Once the cement sets in completely then it is a rigid construct. The above mentioned antibiotic impregnated PMMA is injected into the straw/tubes (step 2) and then wire with one end twisted in form of knot is inserted into the bone cement contained in tube till the knot gets flushed with bone cement (step 3). Protruded end of wire at other end is cut at desired length. This construct is left for 12–15 min as cement sets in and becomes hard. Thereafter the tube is slit longitudinally with scalpel to take out the cement rods (step 4, 5). Cement rods of required length can be fashioned in this way to be placed in medullary cavity.

The melting point of the straw molds¹⁶ is more than 157 °C and the heat dissipated as a result of exothermic reaction during polymerization of PMMA¹⁷ is up to 82.5 °C only. So, these molds retain their physical properties and safety profile.

The technique is cost effective as food grade straw which has been used is freely available and is very cheap and does not add to the cost of treatment significantly, whereas antibiotic bead preparation templates commercially available are very costly. It is easy to prepare without much of extra surgical time, as mold to prepare cement rod i.e., straw is easily available and after the cement sets in the mold then cast is obtained simply by removing the mold with an ordinary surgical blade without much of effort and does not require any technical expertise.

2.2. For preparing 5 mm PMMA rods

We have used low profile teflon tube guide wire exchanger (manufactured by Shakti Ortho-Surgicals India Pvt Ltd.) used in IM nailing as mold to make cement rods which was pre sterilized by autoclaving. Even a good quality teflon tube guide wire exchanger becomes soft after multiple autoclaving and could be easily cut. Alternatively, commercially available teflon tubes or soft silicone tubes of desired dimension could be used and preferably should be pre sterilized in glutaraldehyde 2% solution. In these tubes instead of SS wire/K wire we have used 1.8 or 2 mm Ilizarov wire as an internal support core material for imparting strength. Rest of the technique remains same.

In our technique after adding 4 g of antibiotic powder in 40 g pack of bone cement, we prepared a cured antibiotic impregnated cylindrical cement block of 64 g having a volume of 50 ml with density of 1.28 g/cm³ and the actual quantity of antibiotic contained per unit length of rod is described in Table 1.

2.3. Removal

Due to inherent stiffness and smoothness of rods they do not get entangled in fibrous tissues and fascia, thus it is easy to remove

Table 1

Antibiotic contained in the rods prepared by our technique in comparison to antibiotic coated IM Nail.

Type	Length	Antibiotic actually contained
PMMA Rod of 2.5 mm diameter	10 cm	40 mg
PMMA Rod of 5 mm diameter	10 cm	160 mg
Cement coated IM nail of 11 mm diameter (3 mm cuff of cement)	10 cm	368 mg

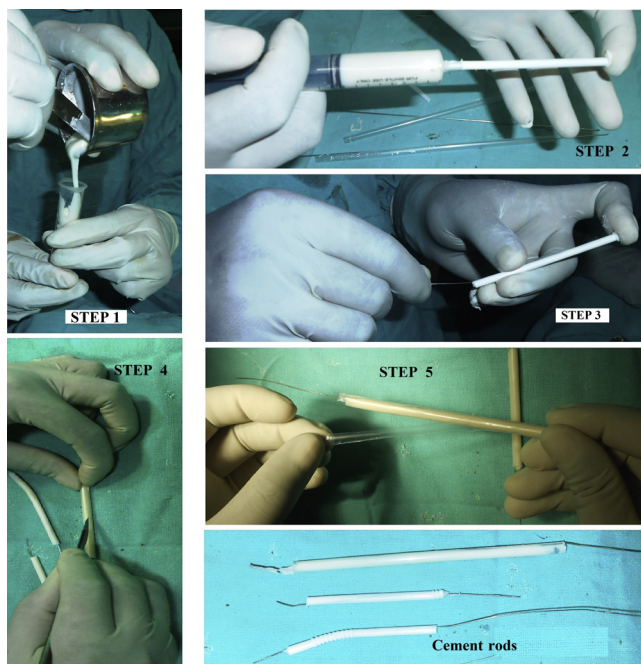


Fig. 1. Technique for fashioning bone cement rods, Step I – Pre chilled cement mixed and attained liquid form. Step II – Straw being filled up with semi fluid cement. Step III – SS wire being introduced in cement within the straw. Step IV – Straw/mold being cut longitudinally. Step V – Cement rod being taken out.

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