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Dr. Punit J Tank
Assistant Professor,
Department of Orthopaedics,
Government Medical College,
Bhavnagar, Gujarat, India.

Dr. Vishal A Pushkarna
Senior Resident, Department of
Orthopaedics, M.P Shah Medical
College & G.G Hospital,
Jamnagar, Gujarat, India.

Dr. Sheetal Gamit
Senior Resident, Department of
Orthopaedics, M.P Shah Medical
College & G.G Hospital,
Jamnagar, Gujarat, India.

Correspondence
Dr. Vishal A Pushkarna
Senior Resident, Department of
Orthopaedics, M.P Shah Medical
College & G.G Hospital,
Jamnagar, Gujarat, India.

Role of antibiotic loaded acrylic bone cement in orthopedic infection

Dr. Punit J Tank, Dr. Vishal A Pushkarna, Dr. Sheetal Gamit

Abstract
Introduction: Local antibiotic delivery with antibiotic loaded acrylic bone cement has been used extensively in the management of chronic osteomyelitis and implant related infections. It is considered the gold standard for treatment of musculoskeletal infections (Nelson, 2004). Over the past few decades, attempts have been made to prevent and cure orthopedic implant infections by incorporating antibiotics in polymethylmethacrylate bone cements, in primary and revision surgery. Antibiotic loaded bone cement (ALBC) is popular as it is a proven way to deliver high concentrations of the drug locally, even to avascular areas that are inaccessible by systemic antibiotics. This article review the role of antibiotic loaded acrylic bone cement beads in orthopaedic trauma.
Materials & Methods: This is a Prospective, Non Randomized study carried out in 40 patients posted for orthopaedic procedures. For evaluating the functional outcome of treatment we used the Asepsis Wound Score. Total duration of study is 6 to 9 months.
Results: The mean age of the patient was 40 years (range 20-50 yrs). Incidence of fracture was observed maximum between 40- 50 years of age. Among the 40 cases, males were predominant. We observed predominance Staphylococcus Organism in Pus Culture. Out of 40 cases 53% cases was open fractures and 70% cases were RTA.
Conclusion: The theoretical advantages of antibiotic-impregnated cement and cement beads in the treatment and prophylaxis of orthopedic infections are supported by the results of some studies but Evidence of their efficacy, particularly in comparison with those of systemic antibiotics or with those of antibiotic-impregnated cement or beads in combination with systemic antibiotics, have not been firmly established. In our study there was marked decrease in infection rate by using antibiotic cemented beads but certain infection like Chronic osteomyelitis is often a lifelong disease. Despite all of the advances in antibiotic and operative treatment, osteomyelitis remains difficult to treat.

Keywords: Bone cement, acrylic cement, orthopedic infection, antibiotic loaded cement

Introduction

There is a long history of local antibiotic use for the treatment of orthopedic infections [1, 2, 3, 4]. During World War I, Alexander Fleming observed that locally applied antiseptics failed to sterilize chronically infected wounds, but they did reduce the burden of bacteria. The local use of antibiotics to prevent and treat skeletal infections was revived in Germany with the widespread use of prosthetic joint replacement, a situation in which infections were not an anticipated consequence of trauma or sepsis but a devastating complication of elective surgery.In1970,Buchholz and Engelbrecht [5] reported that penicillin, erythromycin, and gentamicin incorporated into the cement used to attach total hip joint prostheses diffused out into the surrounding tissues over a period of months, thereby providing prolonged concentrations of local antibiotic. On the basis of the success noted in reducing early postoperative arthroplasty infections [5], interest developed in applying antibiotic-impregnated cement as a therapy for osteomyelitis. In 1979, as an alternative to introducing large deposits of antibiotic-impregnated cement at sites of chronic osteomyelitis, Klemm [6] formed gentamicin-impregnated cement into beads and used them to temporarily fill in the dead space created after the debridement of infected bone. Among 128 patients so treated for chronic osteomyelitis, he reported a 91.4% cure rate. As additional systemic antimicrobial agents became available, interest in the topical treatment of wounds waned, but the management of established osteomyelitis remained problematic. Local antibiotic delivery with antibiotic loaded acrylic bone cement has been used extensively in the management of chronic osteomyelitis and implant related infections. Hanssen, 2005; Samuel *et al*., 2010).

The critical factors in the treatment of any orthopaedic infection are adequate surgical debridement, integrity of the host immune system, and adequate antibiotic levels (Brien *et al*., 1993). Currently, antibiotic-impregnated cement is used to prevent infections primarily in arthroplasties, in which materials with adhesive properties are required; systemic perioperative prophylactic antibiotics are often given as well. Beads are used temporarily usually weeks to months to provide high local antibiotic concentrations in the dead space after debridement in patients with chronic osteomyelitis or open compound fractures with bone loss. After granulation tissue forms, the beads are removed and a bone graft is place [7]. The aim of this article is to assess the ability of antibiotic coated cement beads in controlling postoperative infection in orthopedics surgery and the potential of improving outcome of infection with antibiotic coated cement beads.

Physical characteristics

Bone cement is generally a polymerized polymethylmethacrylate (PMMA), a powdered bone cement polymer which, when mixed with a liquid methyl metha crylate, polymerizes in 5 to 10 min to form an adhesive material. To incorporate antibiotics, antibiotic powder is mixed with the powdered cement polymer before the addition of the methylmethacrylate. To make beads, the mixture is molded or rolled by hand into 3- to 10 mm spheres which can be used singly or strung onto surgical suture wire [8, 9]. The antibiotic used must be active against the targeted bacterial pathogens and must be available as a powder (pharmaceutical grade appropriate for human use rather than reagent grade) because antibiotic solutions do not mix or harden properly with the powdered bone cement polymer [10, 11]. It must also be stable to the heat generated during the polymerization reaction and, subsequently, in the body's tissue. There are various commercial preparations of antibiotic impregnated PMMA cement. The most common types are Palacos which is used primarily on the European continent, and Simplex P which is used extensively in the United States and the United Kingdom. Antibiotic release is biphasic, with the bulk occurring in the first hours to days post implantation and the remaining elution persisting up to years [12, 13]. In one study [14], gentamicin release from molded rods of PMMA occurred from the surface of the cement and through a network of voids and cracks in its matrix. In another study [15], it appeared to diffuse through the matrices of the cement. A significant proportion of antibiotic may be retained within the cement [14, 15, 8, 16].

Materials and methodology

This is a Prospective, Non Randomized study. Study duration was 6 to 9 months. After obtaining Institution Review Board (IRB) approval and informed written consent from patients, this prospective, randomized, double blind study will be carried out in 40 patients posted for orthopaedic procedures under LA, GA & spinal anesthesia. After thorough pre anaesthetic evaluation and necessary investigations, patient will be included or excluded from the study based on following criteria's.

Inclusion criteria

1. Informed written consent for participation in study
2. Age: 18 - 40 years
3. Patients of either gender
4. ASA physical status I and II (ASA-American society of Anaesthesiologist).
5. Orthopaedic Procedures
6. Adequate fasting period - Nil by mouth 6 hours for solid and 4 hours for fluid.

Exclusion Criteria

1. Patient refusing consent.
2. Anticipated difficult airway.
3. BMI >25.
4. Alcohol or drug addiction.
5. Neuropsychiatric disease.
6. History of drug allergy including allergy to local anaesthetics.
7. Patient taking sedatives, analgesics or any other agent having a cardiac,
8. respiratory and gastrointestinal effects.
9. Antenatal and lactating females.
10. Active upper respiratory tract infection /lower respiratory tract infection
11. primary study patients had a poor physical condition, such as diabetes, malignant tumor.

Evaluation of Outcome

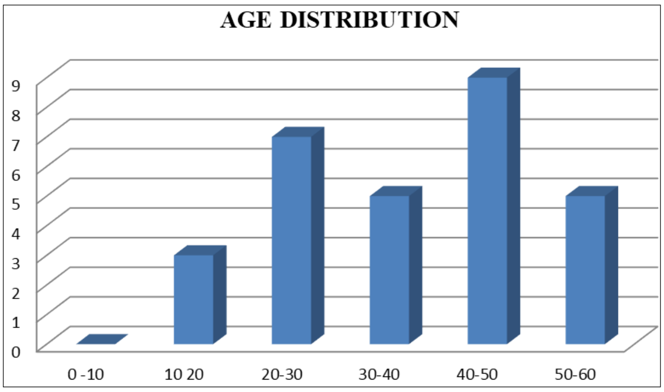
For evaluating the functional outcome of treatment we used the Asepsis Wound Score. This system takes into account the following parameters:

ASEPSIS WOUND SCORE	
	Proportion of wound affected
Wound characteristic	0 <20 20-39 40-59 60-79
Serous exudate	>80
Erythema	0 1 2 3 4 5
Purulent exudate	0 1 2 3 4 5
Separation of deep tissues	0 2 4 6 8 10
	0 2 4 6 8 10
Points are scored for daily wound inspection.	
Criterion	**Points**
Additional treatment:	
• Antibiotics	10
• Drainage of pus under local anaesthesia	5
• Debridement of wound (general	10
anaesthesia)	daily 0 - 5
• Serous discharge*	daily 0 - 5
• Erythema*	daily 0 - 10
• Purulent exudate*	daily 0 - 10
• Separation of deep tissues*	10
• Isolation of bacteria	5
• Stay as inpatient prolonged over 14 days	
* Given score only on five of seven days. Highest weekly score used	
Category of infection: total score 0 - 10 = satisfactory healing; 11 - 20 = disturbance of healing; 20 - 30 = minor wound infection; 31 - 40 = moderate wound infection; (Adapted from Wilson AP et al, *Lancet* 1986[11]).	

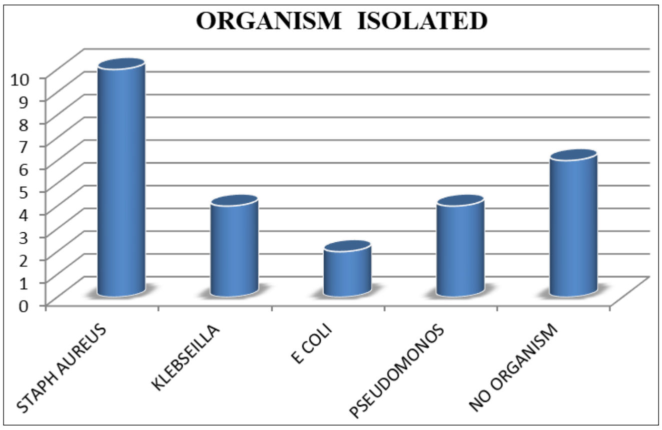
Surgical Method

1. After Careful Anaesthetic Assessment of Patient, They are taken for operative management.
2. All aseptic and antiseptic precautions are taken
3. Painting and draping done
4. Infected suture line is reopened and pus drained. scooping and removal of all devitalized tissue is done
5. After appearance of healthy tissue, antibiotic coated cement are made on table by mixing 40 gm of monomer and getamicin monomer along with vancomycin powder. This mixture is stirred for 6 mins. Doses - 0.1 to 0.3Gm of antibiotic per 1Gm of cement
6. Mixture is stirred upto doughy stage and then moulded into multiple cement beads and fixed to 16 gauze ss pull wire which pretension.
7. Mixture when made to thaw is converted into hard solid beads, which are placed into the infected wound
8. This procedure is followed by wash and closure of wound.

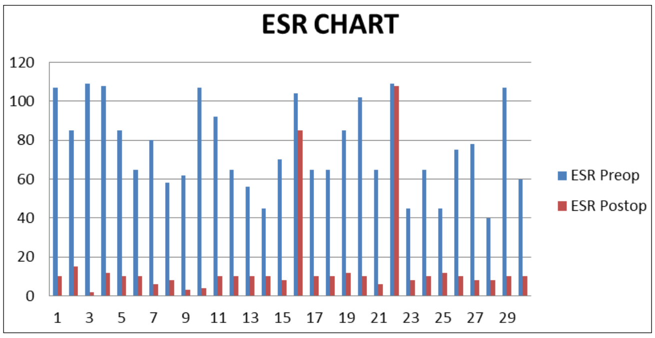
Observation and results



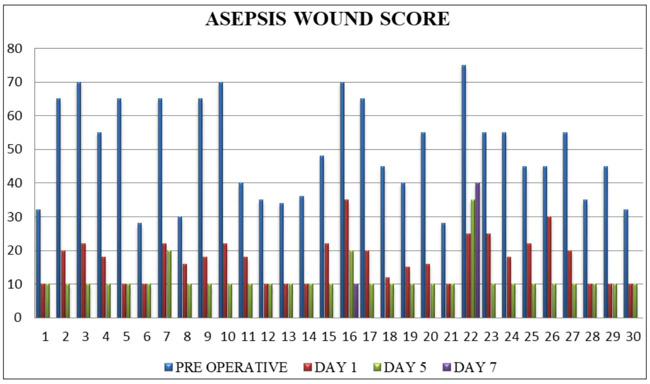
Graph 1: Age Distribution



Graph 2: Organism Isolated



Graph 3: ESR Preoperative/Postoperative



Graph 4: Asepsis Wound Score

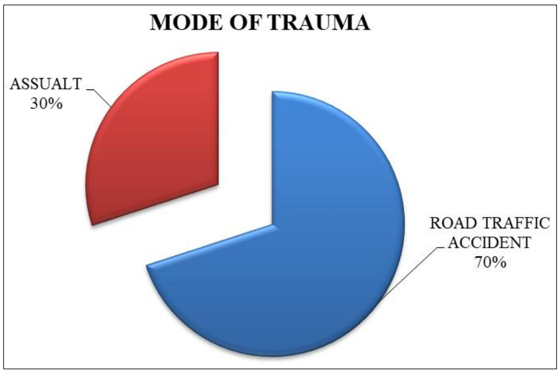


Table 5: Mode of Trauma

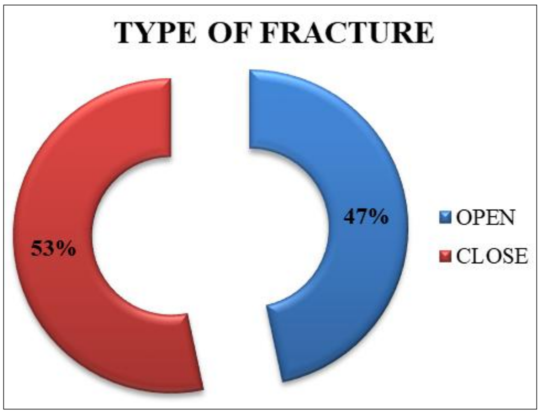


Table 6: Type of Fracture

Discussion

Infections by bacteria are a serious complication in orthopaedic trauma. Over the past few decades, attempts have been made to prevent and cure orthopedic infections by incorporating antibiotics in polymethylmethacrylate bone cements. The ideal local antibiotic delivery system has not been created and the search is still on for both the ideal delivery vehicle and the ideal antibiotic. Self- made antibiotic loaded bone cement beads are cheaper, antibiotic specific and have no availability issues

In our study we have found that local antibiotics loaded cement beads decreased the rate of infection which was evaluated with asepsis wound score. Esr rate was deceased when compared to pre operative time to post operative period. Serious adverse reactions, including allergic reactions, due to antibiotic-impregnated cement or beads have not been reported, and adverse reaction rates were lower than those among patients receiving systemic antimicrobial agents [17]. Although the effect of antibiotics on the mechanical properties of bone cement varies depending on the quantity and type of antibiotic, it is minor by most criteria [18], but long-term follow-up may be necessary to uncover an effect on rates of mechanical failure. Theoretical problems with prolonged implantation of antibiotic-impregnated beads include secondary infection in the presence of a foreign body and the emergence of bacterial resistance. These issues have not been well studied but do not seem to be major clinical problems.

In our study among 40 patients with chronic infection treated with gentamicin-impregnated beads, 15 of 40 who had elective bead removal had recurrent infection, whereas among 25 patient whose beads were left in place for approximately 6-7 months 5 patient shows positive culture after removal and remaining cases were shown no sign of recurrent infection. The investigators concluded that the high initial antibiotic concentrations at the wound site were sufficient to overcome resistance (as defined by MIC breakpoints based on lower achievable concentrations in serum) and that bacteria were suppressed until the regenerating bony environment eradicated residual organisms [19].

Conclusion

The theoretical advantages of antibiotic-impregnated cement and beads in the treatmen tand prophylaxis of orthopedic infections are supported by the results of some studies but Evidence of their efficacy, particularly in comparison with those of systemic antibiotics or with those of antibiotic-impregnated cement or beads in combination with systemic antibiotics, have not been firmly established. Fortunately, adverse reaction rates seem to be low. In our study there was marked decrease in infection rate by using antibiotic cemented beads but certain infection like Chronic osteomyelitis is often a lifelong disease. Despite all of the advances in antibiotic and operative treatment, osteomyelitis remains difficult to treat.

Clinical Photos

References

1. Dombrowski ET, Dunn AW. Treatment of osteomyelitis by debridement and closed wound irrigation-suction. Clin. Orthop. 1966; 43:215-231.
2. Fleming A. The action of chemical and physiological antiseptics in a septic wound. Br. J Surg. 1919-1920; 7:99-129.
3. Jensen NK, Johnsrud LW, Nelson MC. The local implantation of sulfanilamide in compound fractures. Surgery. 1939; 6:1-12.
4. Organ CH. The utilization of massive doses of antimicrobial agents with isolation perfusion in the treatment of chronic osteomyelitis. Clin. Orthop. 1971; 76:185-193.
5. Buchholz HW, Engelbrecht H. Uber die Depotwirkung einiger Antibiotica bei Vermischung mit dem Kunstharz Palacos. Chirurg. 1970; 41:511-515.
6. Klemm K. Gentamycin-PMMA-Kugeln in der Behandlung abszedierender Knochen- und Weichteilinfektionen. Zentralbl. Chir. 1979; 104:934-942.
7. Fish DN, Hoffman HM, Danziger LH. Antibiotic-impregnated cement use in U.S. hospitals. Am. J Hosp. Pharm. 1992; 49:2469-2474.
8. Goodell JA, Flick AB, Hebert JC, Howe JG. Preparation and release characteristics of tobramycin-impregnated polymethylmethacrylate beads. Am. J Hosp. Pharm. 1986; 43:1454-1461.
9. Gruninger RP, Tsukayama DT, Wicklund B. Antibioticimpregnated PMMA beads in bone and prosthetic joint infections, In R. B. Gustilo, R. P. Gruninger, and D. T. Tsukayama (eds.), Orthopaedic infection diagnosis and treatment. The W. B. Saunders Company, Philadelphia, 1989, 66-74.
10. Marks KE, Nelson CL, Lautenschlager EP. Antibioticimpregnated acrylic bone cement. J Bone Jt. Surg. Am. 1976; 58:358-364.
11. Popham GJ, Mangino P, Seligson D, Henry SL. Antibioticimpregnated beads. Part II. Factors in antibiotic selection. Orthop. Rev. 1991; 20:331-337.
12. Salvati EA, Callaghan JJ, Brause BD, Klein RF, Small RD. Reimplantation in infection: elution of gentamicin from cement and beads. Clin. Orthop. 1986; 207:83-93.
13. Torholm C, Lidgren L, Lindberg L, Kahlmeter G. Total hip joint arthroplasty with gentamicin-impregnated cement a clinical study of gentamicin excretion kinetics. Clin. Orthop. 1983; 181:99-106.
14. Baker AS, Greenham LW. Release of gentamicin from acrylic bone cement. J Bone Jt. Surg. Am. 1988; 70:1551-1557.
15. Bayston R, Milner RDG. The sustained release of antimicrobial drugs from bone cement. J Bone Jt. Surg. Br.

1982; 64:460-464.
16. Shurman DJ, Trindade C, Hirshman HP, Moser K, Kajiyama G, Stevens P. Antibiotic-acrylic bone cement composites. J Bone Jt. Surg. Am. 1978; 60:978-984.
17. Blaha JD, Calhoun JH, Nelson CL, Henry SL, Seligson D, Esterhai JL *et al*. Comparison of the clinical efficacy and tolerance of gentamicin PMMA beads on surgical wire versus combined and systemic therapy for osteomyelitis. Clin. Orthop. 1993; 295:8-12.
18. Marks KE, Nelson CL, Lautenschlager EP. Antibioticimpregnated acrylic bone cement. J Bone Jt. Surg. Am. 1976; 58:358-364.
19. Henry SL, Hood GA, Seligson D. Long-term implantation of gentamicin-polymethylmethacrylate antibiotic beads. Clin. Orthop. 1993; 295:47-53.