International Journal of Research in Orthopaedics
Chaudhari K et al. Int J Res Orthop. 2022 May;8(3):398-403
http://www.ijoro.org

DOI: https://dx.doi.org/10.18203/issn.2455-4510.IntJResOrthop20221133

Case Report

Outcome of early control of infection using antibiotics impregnated cement beads in early surgical site infection in operated case of intra articular comminuted fracture (AO C3) of distal femur with ORIF: case report and review of literature

Kunal Chaudhari*, Neetin P. Mahajan, Sunny Sangma, Ashish Kumar Jarika, Pritam Talukderg

Department of Orthopaedics and Traumatology, Grant Government Medical College and JJ Group of hospitals, Byculla, Mumbai, India

Received: 23 February 2021
Accepted: 29 March 2022

***Correspondence:**
Dr. Kunal Chaudhari,
E-mail: albus.wand@gmail.com

ABSTRACT

Surgical site infection is the most deleterious complication for any surgery and it's quite a daunting task for the surgeon to manage such post op events which also takes a great toll on patients' health physically as well as financially. Here we are presenting one such case report of early SSI effectively managed with antibiotic cement beads incorporation locally. We report a 65 year old male patient case of left sided comminuted distal femur fracture who was managed operatively with open reduction and internal fixation with 8 holes distal femur plate. Patient developed early SSI and was managed with debridement and antibiotic cement beads which was removed 6 weeks later. Here, we bring to the fore relevant findings to conclude the advantages of antibiotic cement beads for infected surgical wounds. In our case, early intervention resulted in full recovery of the patient from surgical site infection, early rehabilitation of joint mobility, decreased hospital stay and expenses. Looking at the advantages it is concluded from our study that locally impregnated antibiotic beads confers higher effectivity, compliance and cost benefits to the patient.

Keywords: Surgical site infection, Antibiotic beads, Systemic toxicity, Debridement

INTRODUCTION

Surgical site infection (SSI) has been the most discussed complication in the field of surgery mostly so in orthopedics and vascular surgeries especially the ones which involved the use of prosthetic materials and implants. This causes a serious impairment in the recovery of patients' health and may even progress to chronic osteomyelitis of the bone or joint involved as well as non-union of the fracture sites. Not only the patient's health is compromised, SSI also has a heavy toll on patients overall well-being through reduced quality of life, increased length of hospital stay and costs.[1,2] In orthopedic surgery, the cumulative median incidence of surgical site infections (SSI) is 2.7%.[3] Risk factors for developing SSI include old age, poor general health condition, concomitant comorbidities, poor hygiene, smoking and chronic alcoholism. With the increase in the number of orthopedic implant surgeries in the past years, there is also an increase in relative infection rates.[4]

The numbers are increasing with an increasing aging population and higher demand due to higher activity levels of these patients. Treatment of orthopedic surgical infections is difficult, invasive, expensive, prolonged and causes a significant increase of morbidity and mortality.[5] Treatment is individualized and multimodal that usually involves identification of the causative organism through

culture and sensitivity to antibiotics, prolonged systemic and local antibiotics, surgical debridement, irrigation depending upon the causative pathogen, duration of infection, status of surrounding soft tissues and general health condition of the patient. Complications involve recurrence or lack of infection control, systemic toxicity to antibiotics, persistent discharge and wound gaping, multiple surgical interventions, lengthy and frequent hospitalization with prolonged limb dysfunction.[6] Infection might be controlled eventually at the cost of permanent scar, stiffness and weakness as well as nonunion or malunion of fracture.

Bone cement was first introduced by Gluck in 1870 for fixation of total knee prosthesis and after the introduction of PMMA by Sir John Charnley in 1960 Buchholz and Engelbrecht came with the concept of combining PMMA and antibiotics in order to achieve a high local antibiotic concentration in treatment of infection as PMMA is capable of delivering different antibiotics and copper ions from its surface.[7-10] Antibiotics are admixed with the bone cement in the form of powder or liquid and are incorporated into the chains during the polymerization process.[11] Release of antibiotics from beads occurs in two phases - initial release or burst release where after implantation there is an early increase in local antibiotic concentration that occurs in minutes to hours. Second phase also called sustained release that follows several days to weeks and results in comparatively lower but sustained antibiotic concentration. Since antibiotics are released by dissolution with water present in body fluids an increased surface area with increase in surface roughness and increase in porosity of beads that can be achieved by hand mixing cement instead of vacuum mixing and higher level of antibiotics release rate can be achieved. Highly water soluble antibiotics are preferably used for this process.[12]

It is crucial to increase the local antibiotic concentration above the minimal inhibitory concentration (MIC) of the causative organism. Depending on antibiotics, duration of exposure above MIC (macrolides, β-lactam antibiotics) or highest local concentration above MIC (aminoglycosides, quinolones, and vancomycin) is very important for better effectivity.

CASE REPORT

A 65 years old male with general condition moderate reported in casualty with chief complaints of pain, swelling and deformity over left knee and not able to bear weight with 2×1×1 cm CLW over lateral aspect of knee since 3 days. X Rays showed left sided distal femur comminuted intra articular fracture (AO C3) (Figure 1).

Patient was primarily treated with wound wash, above knee slab, limb elevation, empirical IV antibiotics and a high protein diet till the wound heal. Patients reported no comorbidities like diabetes mellitus, hypertension, bronchial asthma, epilepsy or tuberculosis. Cardiology fitness was taken on 2D Echo and overall fitness for surgery was obtained from pulmonary medicine.

Patient was operated with open reduction internal fixation of distal femur fracture using distal femur plate of 8 holes. Intra-op and post-op was uneventful and no distal neurovascular deficit was noted. Drain was placed in situ which was removed on day 3 at the time of operative site dressing.

Figure 1: Pre-operative X-ray showing distal femur fracture.

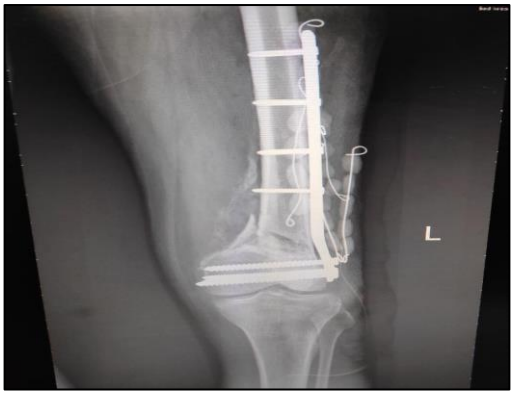

Figure 2: SSI in operated case of distal femur fracture with plating managed with multiple antibiotic beads in situ.

Figure 3: Intra-operative showing antibiotic beads kept *in situ* at the previous operative site.

Check dress was repeated on day 7 and the surgical site showed no soakage, no discharge, no maceration of skin edges and no gaping. On day 13, dressing was soaked and there were pus discharges from the surgical site and local temperature was raised with skin maceration and gaping present. Culture sensitivity of the pus discharge showed Acinetobacter baumannii sensitive to ciprofloxacin and partially sensitive to piperacillin-tazobactam. Patient at first was conservatively managed with appropriate IV Antibiotics, compression bandage, daily dressings, limb elevation, high protein diet and Hb% level maintained above 12 g%.

Figure 4: Antibiotic bead removal.

Figure 5: Healthy surgical site post antibiotic beads removal.

Figure 6: Wound closure post antibiotic bead removal.

After the persistent Pus discharge and continuous rise in ESR and CRP values to higher levels compelled to take definitive and early procedure for the patients well-being. The patient was planned for debridement and wound irrigation. Simplex antibiotic (erythromycin and colistin) impregnated cement beads with Gentamicin admixed was made in the traditional fashion by surgeon's hand in the operating room intraoperatively and 5 such bead chains were incorporated in the deep muscular layer as well as in the subcutaneous layers (Figure 3) and wound closed with prolene 3-0 and ethilon 2-0.

Intra-op samples were sent for Culture sensitivity and genexpert both of which came negative for organisms. Patient was continued on appropriate previous sensitive antibiotics as per previous c/s reports with close LFT/RFT monitoring.

Figure 7: Post op X-ray after antibiotic bead removal and showing union at the fracture site.

Figure 8: Healthy surgical site after suture removal on day 14 of antiobiotic bead removal.

Compression bandage, early mobilization, high protein diet, vitamin C supplementation, regular monitoring of ESR CRP, parenteral nutritional therapy and daily physiotherapy was done. Check dress was done on day 3 and the wound was healthy with no discharge or gaping. During the period patient came positive for COVID-19 and was shifted to covid care centre for a period of 7 days after which patient came negative and transferred back to

orthopaedic ward. Antibiotic beads were kept in situ for a month with delayed suture removal done at 21 days. Surgical site was healthy and dry with no discharge, gaping or erythema. Patient was re-posted for antibiotic beads removal surgery after 6 weeks and wound sutured in layers (Figure 6) after properly managing the dead space left after beads removal. (Figure 4 and 5) post-op remained uneventful and post op X-rays showed signs of fracture union. (Figure 7) The patient was continued on the same IV antibiotics post op till suture removal. (Figure 8) On subsequent check dresses done on day 3 and day 13 were healthy and no further discharges, gaping, erythema, swelling or local rise in temperature were noted. The patient was allowed on partial weight bearing during this phase while maintaining the Hb% >12 g%.

DISCUSSION

In the current orthopedics practices, application of Antibiotic loaded cement beads for infection control is based on proper dead space management, soft tissue management and local antimicrobial therapy. In our case the patient was selected for the antibiotic loaded cement beads application due to the debilitating general health condition of the patient who was already a high risk, old and surgical site in close proximity to a healed wound over the knee which was already susceptible to infection. Continuous rise in ESR and CRP values to higher levels compelled to take definitive and early procedure for the patients well-being. Patient had huge pus pockets in the wound that were meticulously drained and the wound irrigated with 10 l of normal saline and betadine wash followed by Chains of antibiotic beads kept in situ filling the whole infected cavity intramuscularly and below it reaching the bone. 6 weeks later posted for antibiotics beads removal and intraoperatively no sign of pus or pus pocket was seen.

Due to early intervention, infection had been controlled. Further delay with conservative approach could have had a ravaging effect not only on soft tissues but also in deeper and bony tissues ultimately leading to malunion or non-union of fracture site. Use of higher concentration of local antibiotic concentration level and with lower systemic levels virtually eliminated the systemic complications. Overall general health condition of the patient improved with better antibiotic tolerance, increasing appetite and improving limb functionality. Restricted knee range of motion due to prolonged limb disuse was treated with knee ROM exercises and CPM while the high protein diet in the form of protein powder supplement continued.

The importance of local antibiotic beads therapy does not end with SSI management but also extends to the management of Prosthesis joint infection, Total joint arthroplasty and chronic osteomyelitis. For chronic osteomyelitis 2 stage surgeries are required in which first surgery involves implant removal, debridement, filling of bone defect with allograft, autograft Or bone void filling biomaterial and during the second stage, the cement beads are removed once the wound heals and infection is controlled and also the patients health status improves to a level where patient is physically and mentally fit to undergo the procedure.[13] Gentamicin, erythromycin, Vancomycin, Tobramycin, clindamycin and ciprofloxacin are good and most commonly used antibiotics for their increased heat stability and solubility nature. Multiple antibiotics can be used for broadening the spectrum or for synergistic effects.[14] Beads fill the entire infected cavity thus reducing and effectively managing the dead space which decreases the amount of hematoma to dissolve the antibiotic concentration.[15] In order to achieve even higher antibiotic concentration mini beads can be used whose concentration can go upto 7 fold increase as compared to normal beads.[16] Beads are required to be removed after a few weeks when their sustained antibiotic release concentration drops below the MIC otherwise it might form an Anchorage for local bacterial inoculation.[17,18]

One of the challenges faced while using the ALBC is the biofilm formation in which bacteria encapsulates itself for protection from the immune system and detaches into surrounding tissues and blood.[19] The biofilm prevents culturing of microorganisms and may lead to false negative cultures and missed diagnosis of infections. Due to these protection mechanisms antibiotic concentration must exceed the MIC level by far to act on biofilms but the literature at present today regarding the effect of high local concentration of higher antibiotics on biofilms is not convincing nor conclusive.[20]

Another major concern with high concentration of antibiotics is the cytotoxicity and systemic toxicity. Though multiple studies on pharmacokinetics suggest lower serum and urine concentrations below toxic thresholds and also some studies described nephrotoxicity and acute renal failure.[21,22] Another major concern of using ALBC is after the release of the majority of antibiotics the remaining antibiotics lead to suboptimal concentration level below MIC causing mutational antibiotic resistance and the implanted beads become a local foreign body as anchor for bacterial growth.[23,24]

McGuinness et al reviewed 275 papers out of 6951 total publication results from 1978 to present of which most (94.2%) had positive conclusions. Most common indications for antibiotic beads included osteomyelitis, orthopedic prosthetic infections and trauma. Also in vascular surgeries beads were used for treatment of graft infections with no recurrence rate in 41% to 87.5% reportedly.

Wahl et al analysed from his study of 94 beads implantations in 87 patients for various infective indications concluded that overall systemic exposure remained within a safe range while local concentration of antibiotic was 10 times more but still below cell toxicity level. Concentration decreased over several weeks but remained more than minimal inhibitory concentration for upto 3 months post operatively.

Trujillo et al in his analysis of patient records from 2004 to 2015 of each patient who received antibiotic beads whose outcomes were defined solely by readmission within 30 days for repeat intervention only 15 out of 142 patients were readmitted. The study shows promising use of antibiotic beads in treatment and prevention of soft tissue surgical site infection.

In our case, patient had full recovery from SSI with early joint mobility and preservation of limb functionality. The procedure was more compliant as well as cost effective for the patient as it required fewer medications and decreased hospital stays.

CONCLUSION

SSI is the most common yet most debilitating complication of orthopaedic surgeries which is quite a cumbersome and time consuming affair which takes a heavy toll on patients' health and pocket. Longer duration of hospitalization, multiple surgeries, prolonged higher antibiotics not only exhaust the patient physically but also dwindles the mental health. Early and most productive approach to counter the infection is using high local concentration of higher antibiotics such as antibiotics impregnated cement beads in situ and tapering down the high systemic toxicity of antibiotics which yields good outcome in managing SSI in high risk patients. The local antibiotic release confers decreased arthrofibrosis and allows patients to continue partial joint mobility exercises as well which prevent any residual stiffness over the joint and affected limb deformity. As compared to systemic IV antibiotics, antibiotic beads are far superior in delivering the right amount of antibiotics to the specified part locally which is economically feasible, more acceptable, more antibiotic tolerance and less resistance. Here we conclude after analysing from our study case that the use of antibiotic cement beads as overall significantly lowers the morbidity and duration of treatment and renders a good satisfaction to patient.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: Not required

REFERENCES

1. Kurtz SM, Lau E, Watson H, Schmier JK, Parvizi J. Economic burden of periprosthetic joint infection in the United States. The Journal of arthroplasty. 2012;27(8):61-5.
2. Whitehouse JD, Friedman ND, Kirkland KB, Richardson WJ, Sexton DJ. The impact of surgical-site infections following orthopedic surgery at a community hospital and a university hospital: adverse quality of life, excess length of stay, and extra cost. Infect Control HospEpidemiol. 2002;23(4):183-9.
3. Korol E, Johnston K, Waser N, Sifakis F, Jafri HS, Lo M, Kyaw MH. A systematic review of risk factors associated with surgical site infections among surgical patients. PLoS One. 2013;8(12):e83743.
4. Dale H, Hallan G, Hallan G, EspehaugB, Havelin LI, Engesaeter LB. Increasing risk of revision due to deep infection after hip arthroplasty. ActaOrthop. 2009;80(6):639-45.
5. Zmistowski B, Karam JA, Durinka JB, Casper DS, Parvizi J. Periprosthetic joint infection increases the risk of one-year mortality. J Bone Joint Surg Am. 2013;95(24):2177-84.
6. DeCoster, Thomas A. MD; Bozorgnia, Shahram MD Antibiotic Beads, Journal of the American Academy of Orthopaedic Surgeons. 2008;16(11):674-8.
7. Brand RA, Mont MA, Manring MM. Biographical sketch: Themistocles Gluck. Clin. Orthop. Relat. Res. 1942.469:1525-7.
8. Charnley J. Anchorage of the femoral head prosthesis to the shaft of the femur. J. Bone Joint Surg. Br. 1960;42-B:28-30.
9. Charnley J. The classic: the bonding of prostheses to bone by cement. Clin. Orthop. Relat. Res. 2010;468:3149-59.
10. Buchholz HW, Gartmann HD. Infection prevention and surgical management of deep insidious infection in total endoprosthesis. Der Chirurg; Zeitschrift fur alleGebiete der operativenMedizen. 1972;43:446-53.
11. Walenkamp GH, Vree TB, van Rens TJ. Gentamicin-PMMA beads. Pharmacokinetic and nephrotoxicological study. Clin Orthop Relat Res. 1986;205:171-83.
12. Belt H, Neut D, Schenk W, van Horn JR, van der Mei HC, Busscher HJ. Gentamicin release from polymethylmethacrylate bone cements and Staphylococcus aureus biofilm formation. ActaOrthop Scand. 2000;71:625-29.
13. Lazzarini L, Mader JT, Calhoun JH. Osteomyelitis in long bones. J. Bone Joint Surg. Am. 2004;86-A:2305-18.
14. Sanz-Ruiz P, Carbo-Laso E, Del Real-Romero JC, Aran-Ais F, Ballesteros-Iglesias Y, Paz-Jimenez E. Microencapsulation of rifampicin: A technique to preserve the mechanical properties of bone cement. J Orthop Res. 2018;36:459-66.
15. Klemm K. Gentamicin-PMMA-beads in treating bone and soft tissue infections (author's transl). ZentralblChir. 1979;104:934-42.
16. Walenkamp G. Small PMMA beads improve gentamicin release. ActaOrthop Scand. 1989;60:668-9.
17. Nelson CL, Griffin FM, Harrison BH, Cooper RE. In vitro elution characteristics of commercially and noncommercially prepared antibiotic PMMA beads. Clin. Orthop. Relat. Res. 1992;284:303-9.
18. BertazzoniMinelli E, Benini A, Magnan B, Bartolozzi P. Release of gentamicin and vancomycin from temporary human hip spacers in two-stage revision of infected arthroplasty. Journal of Antimicrobial Chemotherapy. 2004;53(2):329-34.
19. Arciola CR, Campoccia D, Speziale P, Montanaro L, Costerton JW. Biofilm formation in Staphylococcus

implant infections. a review of molecular mechanisms and implications for biofilm-resistant materials. Biomaterials. 2012;33:5967-82.
20. Griffin JW, Guillot SJ, Redick JA, Browne JA. Removed antibiotic-impregnated cement spacers in two-stage revision joint arthroplasty do not show biofilm formation in vivo. J. Arthroplasty. 2012;27:1796-9.
21. Salvati EA, Callaghan JJ, Brause BD, Klein RF, Small RD. Reimplantation in infection. elution of gentamicin from cement and beads. Clin Orthop Relat Res. 1986;83-93.
22. Luu A, Syed F, Raman G, Bhalla A, Muldoon E, Hadley S. Two-stage arthroplasty for prosthetic joint infection: a systematic review of acute kidney injury, systemic toxicity and infection control. J Arthroplasty. 2013;149:e1.
23. Thomes B, Murray P, Bouchier-Hayes D. Development of resistant strains of Staphylococcus epidermidis on gentamicin-loaded bone cement in vivo. J Bone Joint Surg Br. 2002;84:758-60.
24. Kendall RW, Duncan CP, Smith JA, Ngui-Yen J.H Persistence of bacteria on antibiotic loaded acrylic depots. A reason for caution. Clin Orthop Relat Res. 1996;329:273-80.

Cite this article as: Chaudhari K, Mahajan NP, Sangma S, Jarika AK, Talukderg P. Outcome of early control of infection using antibiotics impregnated cement beads in early surgical site infection in operated case of intra articular comminuted fracture (AO C3) of distal femur with ORIF: case report and review of literature. Int J Res Orthop 2022;8:398-403.