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Cement Spacer as Definitive Management for Postoperative Ankle Infection

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ABSTRACT

Background: **Postoperative infection can be a devastating complication of ankle replacement and arthrodesis surgery. Management consists of eradication of the infection and either, revision of the initial surgery or some form of salvage procedure. There are instances however when the patient is asymptomatic, medically unfit, or the local tissue is too tenuous to warrant performing additional surgery. We conducted a retrospective review of the outcome of the use of an antibiotic impregnated cement spacer as the definitive procedure in this kind of patient.** ***Methods:*** **There were nine patients with post operative deep ankle infection following surgery who did not undergo subsequent revision surgery. The initial surgeries were either total ankle replacement (TAR) ($n = 6$) or ankle arthrodesis ($n = 3$). The indications for the retention of the cement spacer were patients who were asymptomatic following insertion of the cement spacer, did not desire further surgery, or were medically unfit for further surgery. The patients all underwent removal of hardware or implants, debridement, and insertion of an antibiotic impregnated cement spacer. Six weeks of intravenous antibiotics were administered according to culture sensitivity results. Patients were followed up closely for complications (wound dehiscence, spacer migration, bone loss), resolution of infection, functionality, and satisfaction.** ***Results:*** **The average time of cement spacer retention was 20.1 months, ranging from 6 to 62 months. The most common infecting organisms were Staph. Aureus ($n = 3$) and Staph. Epidermidis ($n = 3$). One patient had wound complications, possibly due to the proximity of the cement spacer to the anterior skin surface. One patient had a repeat infection at 52 months. The most common co-morbidities were rheumatoid arthritis ($n = 3$) and diabetes ($n = 2$). At final followup, seven patients still had a retained cement spacer and two had subsequent below knee amputations (BKA) performed as a result of delayed complications. Review of the X-rays revealed two patients with loosening and migration of the cement spacer. No patients had signs of excessive bone loss. All patients with a retained antibiotic cement spacer were mobile and able to perform basic activities of daily living with minimal discomfort.** ***Conclusion:*** **The long-term use of antibiotic impregnated cement spacers following postoperative ankle infection is a reasonable option in the low demand patient with surgical or medical co-morbidities.**

Level of Evidence: IV, Retrospective Case Series

Key Words: Infection; Total Ankle Replacement; Ankle Arthrodesis; Salvage

INTRODUCTION

Postoperative deep ankle infection is a relatively uncommon and difficult problem to manage. Unlike the hip joint, the ankle has a frail soft tissue envelope, making infection following surgery a difficult problem to manage. The goals in treating the infection is first to eradicate the infection, and then to restore a painless functional limb. Surgical options for the treatment of postoperative infection include debridement of the joint with retention of hardware (as in fractures and early TAR infection), aggressive debridement of the joint with removal of all hardware, one- or two-stage exchange procedure, one- or two-stage arthrodesis, or amputation.[15]

The two stage procedure involves the use of an antibiotic-impregnated cement spacer or beads at the first surgery. The cement spacer has a two-fold function of preventing soft tissue contracture and delivery of antibiotics locally to the bone and soft tissue by elution. The prevention of soft tissue contracture is important for future revision surgery. The importance of local antibiotics is that infected bone often has poor blood supply, potentially making systemic antibiotics less effective. Calhoun et al. showed that antibiotic impregnated cement beads are beneficial in managing foot infections in the presence of vascular compromise, such as in

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patients with diabetes and/or renal failure. Patients with renal failure are especially difficult to treat as parenteral antibiotics like gentamycin are toxic due to the patients reduced clearance capacity.[4] This elution of antibiotics from the acrylic cement, however, has the disadvantage of uncontrollable pharmacokinetics.[15]

Although there have been reports on the long term use of cement spacers in infected total hip replacements[7,18] and total shoulder replacements,[17,24] there is no similar study on the use of antibiotic impregnated cement spacers as a permanent solution for postoperative ankle infection. We retrospectively reviewed nine patients at two foot and ankle centers. All the patients underwent debridement and antibiotic impregnated cement spacer insertion as the definitive management for postoperative ankle infection.

MATERIALS AND METHODS

This is a retrospective, Institutional Review Board approved study examining patients who underwent treatment for post operative ankle infection using an antibiotic impregnated cement spacer as the definitive procedure. We identified nine patients at two institutions from 2004 until 2009. The group consisted of six men and three women. The average age was 63.3 (range, 51 to 75) years. The primary surgical procedure was either a total ankle replacement (TAR) in six patients or an ankle arthrodesis in three patients. All ankle arthrodeses were done through an anterior approach, preserving the medial and lateral malleolus. The ankle arthrodeses were fixed using three cannulated 6.5-mm screws. Time from index procedure to diagnosis of infection ranged from 33 days to 6 years.

Preoperative diagnosis of infection was made with a detailed clinical history, physical examination, radiographic evaluation, and laboratory workup. Laboratory workup consisted of a white blood cell count (WBC), erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP). A history of sudden onset of pain, swelling, or wound drainage with or without fever and clinical findings of tenderness, increased local temperature and effusion, were indicative of infection.[26] An ESR of 30 mm/h or greater together with a CRP of 10 mg/L or greater highly suggestive of infection.[21] In cases where an effusion was palpable, the joint was aspirated under sterile conditions. The fluid was then sent for gram staining and microscopy (cell count), culture, and sensitivity (MC&S). This helped with making a definitive diagnosis as well as deciding on the appropriate antibiotic to mix with the cement at the time of surgery.

No antibiotics were given prior to surgery so as not to affect intraoperative culture specimens. Previous incisions were used for exposure. Most approaches were through an anterior incision. Three intraoperative culture specimens were obtained. These being synovial fluid, inflamed synovial tissue, and tissue from the prosthesis-bone or arthrodesis interface. All specimens were sent for MC&S. In cases where the diagnosis of infection was equivocal, because of either not obtaining fluid on initial aspiration or fluid aspiration preoperative culture and sensitivity results were inconclusive, tissue was sent during surgery for immediate pathologic examination. If the white cell count was greater than five per high power field or gram stain positive, a presumptive diagnosis of infection was made.[16] If present, synovial fluid was also sent for STAT cell count and gram stain. A cell count was positive for infection if there were more than 50,000 leukocytes per ml and more than 80% neutrophils present under high power field.[21] All hardware was then removed. All devitalized tissue was meticulously debrided down to healthy, well perfused tissue. The bony surfaces were debrided of all dead bone to bleeding bone. This is important for systemic antibiotics to be effective. Cement was then mixed with the appropriate culture sensitive antibiotic powder. If no culture was available, two grams of Vancomycin and 1.9 g of Gentamycin were mixed into the cement. This gave good gram negative and positive antibacterial coverage. Time was taken when molding the cement block, making sure not to overstuff the joint or cause protrusion of the cement into the soft tissue envelope (Figure 1). All wounds were then closed primarily.

Following surgery all patients were placed on intravenous antibiotics according to the organism and sensitivity obtained from the cultures, in consultation with an infectious disease specialist. Antibiotics were given through a peripherally inserted central catheter (PICC) for 6 weeks as an outpatient. ESR and CRP were measured on a weekly basis to assess response to therapy. Normalization of blood markers and clinical assessment were used to assess eradication of infection. Patients were allowed to bear full weight, as tolerated, on the affected side once the wound had healed. Patients were kept in a boot for 6 weeks.

Despite resolution of the infection, the patients in this study were either medically unfit ($n = 7$) or they themselves

Fig. 1: Appropriately sized antibiotic cement spacer in the ankle.

Fig. 2: Immediate postoperative X-ray with good cement spacer position. Followup X-ray revealed anterior migration of the cement spacer.

Table 1: Fitzgerald et al.[6] Periprosthetic Infection Classification

Stage	Description	No. of cases
I	Acute fulminating postoperative infection within 3 months	0
II	Indolent infection which becomes apparent at 6–24 months	6
III	Possible hematogenous infection after 2 years of asymptomatic joint replacement	3

refused revision surgery ($n = 2$). Thus the cement spacer was used as a definitive procedure.

RESULTS

The average time of cement spacer retention was 20.1 months, ranging from 6 to 62 months. The infections in TAR patients were classified according to Fitzgerald et al. periprosthetic infection classification (Table 1).[8] Four patients were stage II and two were stage III. The ankle fusions were all Cierny 3B ankle infections.[5] The infecting organisms were identified in seven patients. Three of the patients had Staph. Aureus, three had Staph. Epidermidis, and one had Strep. Viridans. In two patients no organisms were cultured. This did not rule out infection as MC&S has a sensitivity ranging from 55% to 70%. These two patients had clinical signs and blood markers indicative of infection. False negative MC&S is a big problem, especially when patients have received antibiotics from their primary care physician prior to seeing their surgeon. Another problem is that once the bacteria have formed a biofilm obtaining an accurate culture becomes very difficult. At followup visits, all patients had radiographs of their ankles, including flexion/extension views. Radiographs were assessed for cement spacer position, bone stock, loosening, osteomyelitis, and range of motion. On reviewing the radiographs, one patient had anterior subluxation and another had loosening of the cement spacer (Figure 2). Both of these patients later required BKA's for wound complications and pain as a result of the cement spacer loosening. There was some mobility in the ankle with the cement spacer (Figure 3). No patient had evidence of excessive bone loss radiographically. One patient had superficial wound breakdown early after surgery, which healed with local wound care. The other eight patients had no wound problems immediately after the surgery. Of the nine patients, six had only one surgical procedure for management of the infection and three patients required multiple procedures. One required a subsequent debridement and cement spacer exchange 52 months after cement spacer insertion while the other two had multiple procedures ending with BKA's at 16 and 22 months after the index procedure, respectfully. Six patients had co-morbidities which made them high-risk patients. The most common co-morbidities were rheumatoid arthritis ($n = 3$) and diabetes mellitus ($n = 2$). At final followup, seven of the patients still had the cement spacer in place. All these patients had no or occasional mild pain, did not use pain medication on a daily basis, and did not have their sleep pattern disturbed. They were all able to mobilize full weightbearing, some with an assistive device ($n = 2$ one crutch and one lace-up high top boot), and perform their basic daily activities. The other two patients had a subsequent BKA. These patients had their BKA at 16 and 22 months

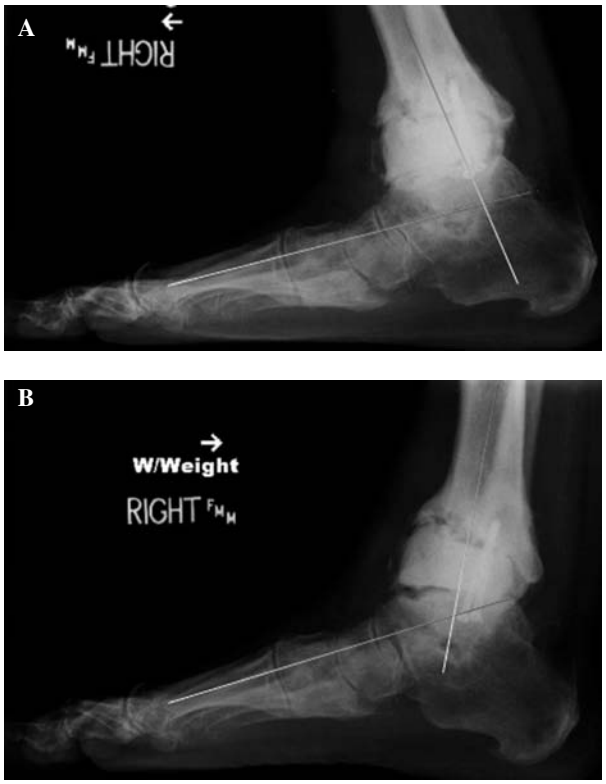

Fig. 3: A, Ankle dorsiflexion X-ray with cement spacer in situ. B, Ankle plantarflexion X-ray with cement spacer in situ.

after the cement spacer insertion, respectively. Infection in the seven patients with retained cement spacers had resolved.

DISCUSSION

Postoperative joint infection is an unfortunate and difficult problem to manage. The aims of management are to eradicate the infection, give the patient pain relief and when possible restore joint function. Due to many factors, including soft tissue, load distribution, and bone stock, restoring ankle function is extremely difficult. Traditional management options for post operative ankle infection are debridement of the joint with retention of hardware, long-term antibiotic suppression, one- or two-stage exchange procedure, one- or two-stage arthrodesis, or transtibial amputation.[5,6,15,27]

Cierny et al. developed a classification system for ankle infection in 1985. He extended this classification in 1989 when reporting on 36 ankle infections treated with arthrodesis. His classification consisted of two important concepts. The first was a biological classification of the patients' physiological capacity to recover from the infection. This is used to prognosticate treatment.[5,6] Blaha et al. stated in his study that the Cierny-Mader physiological classification correlated well with predicting success in resolving infection.[2] The second was an anatomical three column classification of the ankle which is used to decide what fixation (internal or external) and whether grafting is necessary for fusion. This article reported that single stage arthrodesis of an infected ankle, using an external fixator, was a good salvage operation. Cierny et al. also showed that when there is a large central column defect, a two-stage arthrodesis is recommended.[5,6] Saltzman did a similar study in 2005 reporting on the use of circular frames for single stage arthrodesis in diffuse ankle infection. Seven of the eight ankles fused with no subsequent surgery required after 3.4 years of followup.[19] Hawkins et al. reviewed 20 cases of complex ankle fusions using the Ilizarov technique. Sixteen of the ankles were infected, of which 15 resolved and united. He stated that this form of treatment was technically demanding and should be done by experienced surgeons. Patients need to be educated regarding the procedure and emphasis should be placed on the duration of the treatment process which can be emotionally, mentally and physically demanding.[11] A major advantage of using the external ring fixation technique is that in the presence of major bone loss, the resulting length discrepancy can be corrected by simultaneous proximal lengthening (Bifocal Osteosynthesis). With large defects (more than 2 cm) peripheral perfusion should be checked when closing down the defect. If the defect is too large the frame can be used to coapt the fusion surfaces over time, so as not to compromise the blood supply.[22,25]

In 1970 Bucholz et al. reported on the ability of acrylic cement to elute high concentrations of antibiotics into local tissue.[3] Stevens et al. demonstrated that antibiotic impregnated cement spacers allowed for high local concentrations of the antibiotic without the systemic toxic risks. In his study, Palacos cement with 10% or more antibiotic by weight, yielded bioactivity levels above Minimum Inhibition Concentration (MIC) for more than 80 days.[23] Blaha et al. showed a higher incidence of toxic adverse reactions with parenteral antibiotics, as compared to antibiotic impregnated cement spacers.[2] As a result of these properties two-stage revision arthroplasty became the most successful form of management for septic total hip replacements (THR) and total knee replacements (TKR). There is a 92% success rate reported with two stage revisions in septic THR.[9] In the two-stage revision procedure, an antibiotic impregnated cement spacer is used in the interim between exchange arthroplasty. There is not much written in the literature discussing specific management of an infected TAR. Most of the literature discusses failed TAR which has numerous causes. Thus management of infected TAR comes from extrapolation of infected THR and TKR management data. The majority of surgeons would agree on doing a two-stage revision with an antibiotic impregnated cement spacer, should the bone stock be adequate. Kotnis et al. in 2006 suggested that ankle fusion is preferable to revision TAR.[14] The antibiotic impregnated cement can either be in the form of beads or a block spacer. The block spacer has the advantage of maintaining soft tissue

tension and stability, which is important when planning to do a revision. Hsieh et al. compared the use of cement beads with a cement spacer prosthesis in two stage THR revision surgery. The patients with the cement prosthesis had a higher hip score, shorter hospital stay and better walking capacity.[12]

As Cierny mentioned, some hosts have local, systemic or a combination of factors which make them poor candidates for revision surgery. Management options for these patients are long-term antibiotic suppression, limb ablation or a permanent antibiotic impregnated cement spacer. In our series not all patients were poor hosts. Some patients ($n = 2$) were planned for a staged revision, but these patients were pain free and functional at followup. They thus opted not to have the revision surgery. Sometimes patients need a physical and mental break from surgery, as was the case with these patients.

One of the perceived problems with long-term cement spacer use is that it could cause bone loss.[18] In our series, however, there was minimal bone loss when comparing X-rays. Loss of range of motion in the joint after long-term spacer usage was also a problem encountered with two-stage exchange arthroplasty. Thus articulated spacers were developed for use in the management of infected THR's. Articulated cement spacers have evolved from being hand molded, to using casting molds, and finally prefabricated spacers. The problem with prefabricated cement spacers is that they have low dose antibiotics so as to maintain structural integrity of the prosthesis. The benefit of an articulated spacer versus beads or rods, is that articulated spacers promotes improved joint function, early mobilization, and retains adequate soft tissue tension while maintaining soft tissue planes.[1] The initial use of cement beads and rods in TKR resulted in arthrofibrosis and soft tissue contractures, making revision surgery very difficult with poor functional results. This was improved by using block spacers which retained soft tissue tension. However, range of motion was still a problem and a new problem of bone loss arose. Articulated spacers addressed all these problems and thus became popular in the management of infected TKR. Studies showed that patients had similar or better range of motion post revision surgery using an articulated spacer.[10,13] There is no literature describing the use of articulated cement spacers in infected TAR.

There are a couple of articles describing the long term use of antibiotic impregnated cement spacers in septic THR and TSR. Regis et al. reported on a 6-year followup of a patient with a permanent cement spacer following a septic TKR. This patient had good range of motion and walked pain free with assisted weight bearing. Of importance, X-rays at 6 years showed good preservation of bone stock.[18] Durbhakula et al. reported on two patients who were medically unfit for the second stage of their revision surgery. At 5-year followup both patients were mobilizing with an assistive device and experiencing minimal pain.[7] Scharfenburger et al. presented a series of 16 patients who had retained cement spacers. Ten patients were high risk surgical candidates who were all functioning well with the spacer in situ. The other six patients had refused revision surgery due to functioning well with the spacer.[20] In our series two patients refused revision surgery due to being mobile and pain free with the spacer *in situ*. Themistocleous et al. reported on 11 patients with long-term cement spacer use post infected total shoulder replacement (TSR). At 22 months, nine patients were pain free and had adequate shoulder function to perform normal daily activities. They suggested that long-term cement spacers in the shoulder was a useful alternative in patients with a poor general medical condition.[24] Proubasta et al. also felt that a permanent articulated antibiotic impregnated cement spacer in septic TSR is an option in low demand patients who refuse major surgery or when inadequate bone stock is present.[17]

In our series the antibiotic impregnated cement spacer was effective in eradicating infection, as 92% of infections resolved. One patient had a reinfection at 52 months, which resolved after redebridement and spacer exchange. At 1 year, 100% of patients were functioning and pain free with a spacer in situ. At final followup, seven of the patients still had their spacer in situ and were satisfied. Two patients underwent a BKA at 16 and 22 months after the initial surgery. In total, 78% of the patients had a functional result as they were able to perform activities of daily living.

When choosing antibiotics, they need to be thermostable, water soluble and not adversely affect the properties of the cement.[18] It is very important when inserting the cement spacer not to overstuff the joint or leave the cement protruding anterior to the tibia. The authors feel this can result in increased wound healing problems due to the thin soft tissue envelope around the ankle. However, there needs to be enough cement to stabilize the joint and maintain soft tissue tension.

Wound complications are common after cement spacer insertion in the ankle, since there is only a thin soft tissue

Fig. 4: It is important that the cement spacer does not protrude anterior to the tibia.

envelope covering the cement. Thus there is no physiological support for the radially orientated blood supply of the skin. The authors feel that this complication can be minimized by ensuring that the cement spacer doesn't overstuff the joint and more importantly does not protrude anteriorly to the tibia (Figure 4).

CONCLUSION

Most patients with postoperative ankle infection can be managed by resolving the infection and either revising the primary procedure, as in TAR, or doing a salvage arthrodesis. In rare instances patients are not able to have the revision surgery. In these situations the long-term use of an antibiotic impregnated cement spacer for a postoperative ankle infection is a viable option in the low demand patient with surgical or medical co-morbidities.

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