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Success rates, characteristics, and costs of articulating antibiotic spacers for total knee periprosthetic joint infection

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ABSTRACT

Background: The optimal type, characteristics, and success rates of articulating antibiotic spacers used during total knee arthroplasty (TKA) periprosthetic joint infection (PJI) have not been well defined in a single series. We sought to (1) determine the success rate for three unique spacer constructs and (2) evaluate any microbiological, surgical, or patient characteristics that would influence the success rate.

Methods: We retrospectively reviewed patients who underwent a two-stage exchange for a TKA PJI with a prefabricated spacer (PREFAB), home-made mold (MOLD), or autoclaved femoral component (AUTOCL). Patient demographics, microbiology data, amount of antibiotic in each spacer construct, postoperative course, and infection cure outcomes were evaluated.

Results: The success rate for being infection free at final follow-up without the need for further reoperation for infection was 82.7% in the PREFAB group, 88.4% in the MOLD group, and 79.4% in the AUTOCL group ($p = 0.54$). There was no clear statistical link between raw quantities of vancomycin and aminoglycoside in the spacer and a successful outcome. The surgeon's own intraoperatively created mold group had the lowest construct cost at a mean \$1341.00 ± 889.10 ($p < 0.0001$) per construct, while the commercial cement molds had the highest mean cost at \$5439.00 ± 657.80 ($p < 0.0001$).

Conclusions: There was no statistically significant difference in the success rates between the antibiotic spacer types. The surgeon's own intraoperative mold had the least overall associated cost.

1. Introduction

Infection rates of primary hip and knee joint arthroplasty have been reduced to 0.3 to two percent with modern aseptic techniques, but this rate may reach 20% in some revision procedures [1,2]. Periprosthetic joint infection (PJI) after total knee arthroplasty (TKA) is a difficult complication associated with increased patient morbidity and substantial cost to the healthcare

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system. Options for PJI treatment vary depending on the timing of the infection, duration of symptoms, and health of the patient. Commonly used treatment strategies include irrigation and debridement (I&D), one-stage exchange arthroplasty, two-stage revision arthroplasty with antibiotic spacer placement, arthrodesis, resection arthroplasty, and amputation in extreme cases [3–12]. Component retention with antibiotic suppression in patients with multiple failed attempts at infection eradication has also been used as a viable option for patients unhealthy enough or unwilling to undergo further surgical procedures. Currently, the gold standard for delayed or chronic PJI remains the two-staged revision arthroplasty with antibiotic spacer placement due to the consistently high rates of infection control, and lower rates of re-infection [13–16].

Two-stage revision knee arthroplasty with antibiotic cement spacers has historically provided infection control rates above 80% [8,13–15]. Although effective, this method is a significant source of patient morbidity, financial burden, limited mobility, and increased soft tissue and skeletal damage resulting in additional augmentative procedures at the time of reimplantation [13,17]. Local antibiotic delivery via cement mixtures has been shown to achieve high local concentrations of antibiotic able to effectively treat the local bacterial burden [18]. The safety of antibiotic cement and cement spacers in regard to systemic toxicity has well been established, and only a few case reports exist describing toxic adverse events [19–21].

There are currently few Food and Drug Administration (FDA) approved premixed cements available in the United States, and the doses (0.5–1.0 g of aminoglycoside antibiotic per 40 g of cement) of antibiotic in these cements are limited [22]. This has led surgeons to create their own antibiotic cement mixtures intraoperatively, producing a variable final product [1,23]. Commercially available prefabricated spacers, intraoperative spacer molds, and a variety of different intraoperatively created static and articulating antibiotic spacer constructs have been described in the literature. Each construct or product has been evaluated with small case series that suggest acceptable cure rates, but there are few reports comparing these commonly used constructs in a single study [24–32].

The ideal antibiotic spacer construct with a standardized antibiotic concentration has yet to be determined. The current literature supports the use of a variety of articulating spacer constructs, but there are limited studies comparing the effectiveness of these constructs in a single series. The purpose of this study was to (1) determine the success rate for three unique spacer constructs, and (2) evaluate any microbiological, surgical, or patient characteristics that would influence the success rate. We hypothesize the overall success rates will be similar between the antibiotic spacer types.

2. Methods

Prior to the start of the study, approval for database review was obtained from our Institutional Review Board. An institutional PJI database consisting of 30 arthroplasty surgeons was retrospectively reviewed for all two-stage exchange procedures for TKA PJI between April 2009 and April 2014. Patients undergoing surgery for PJI were identified using billing and Current Procedural Terminology (CPT) codes. Additionally, patients with a prefabricated spacer before 2009 were identified using manufacturer billing data which identified patients between 2005 and 2009. Two hundred and seventy-five TKA PJI patients were available for review, of whom 153 underwent a two-stage exchange. Six of these patients were excluded because they had a static antibiotic spacer, and seven were excluded because they had either an irrigation and debridement procedure or previous two-stage exchange prior to presenting to our institution. This left 140 TKAs that underwent a two-stage exchange for PJI.

Charts were reviewed for patient demographics, preoperative laboratory values, type of antibiotic spacer used, surgical explant and replant details, microbiology data, length of postoperative antibiotic treatment, and reoperation. The number of methicillin resistant strains for *Staphylococcus aureus* (MRSA) and *Staphylococcus epidermidis* (MRSE) was evaluated in each group. Details of the antibiotic spacer construct were recorded from the intraoperative surgical record including the amount of antibiotics that came in the cement from the company, type and amount of additional antibiotic added by the surgeon, and the number of antibiotic cement bags used to create the spacer construct. In addition, if a prefabricated spacer was used, the amount of antibiotic in the spacer was added to the antibiotic spacer total. Patients were included if they met the definition of PJI based on the Musculoskeletal Infection Society classification system [32], and if they had an articulating antibiotic spacer. Patients were excluded if they had a static antibiotic spacer, had a previous surgery for infection, or if they had incomplete operative and postoperative data for review.

Each patient underwent a preoperative work-up at our institution including inflammatory laboratory values, radiographs, and advanced imaging as needed. Preoperative aspiration for organism identification and cell count analysis was routinely performed. The first operative stage consisted of explantation of both the femoral and tibial components with a thorough I&D. Antibiotics were routinely held prior to intraoperative culture collection. Synovial fluid cultures were taken using a sterile syringe, and multiple tissue cultures were taken using a rongeur or sharp blade. Samples were taken directly from the wound and placed into a sterile container without further manipulation by the surgical team. The type of antibiotic spacer placed was based on surgeon preference and practice routine. Infectious disease consultation at our institution was obtained in all cases, and patients were started on high-potency antibiotics directed against the cultured pathogen. All patients were treated and followed by the same team of infectious disease physicians at our institution. The type and duration of antibiotic treatment were recorded for each patient, as was the time between the first and second stage procedures. Patients were made partial weight bearing while the antibiotic spacer was implanted. Reimplantation of new TKA components was timed based on the decrease of inflammatory laboratory values, negative synovial fluid aspiration results taken at least two-weeks after the cessation of antibiotics, and satisfactory healing of the surgical site. At time of reimplantation, multiple surgical cultures were obtained to confirm the absence of infection.

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