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Management of deep postoperative shoulder infections: is there a role for open biopsy during staged treatment?

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Background: Despite the gold standard treatment of 2-stage exchange arthroplasty, reinfection after periprosthetic shoulder infections and periarticular osteomyelitis can be as high as 37%. This study describes a protocol to detect persistent deep shoulder infection before revision arthroplasty.

Methods: Patients who presented with periprosthetic shoulder infections and osteomyelitis after previous surgery were treated with a standardized protocol of irrigation and debridement (I&D), removal of implants, antibiotic cement spacer placement, and pathogen-directed antibiotic therapy for 6 weeks. After completion of antibiotics and resolution of clinical symptoms, specimens were obtained from an open biopsy performed in the operating room, followed by revision arthroplasty at a later date if final cultures were without evidence of infection. If evidence of infection persisted, then another course of I&D and antibiotic treatment was performed. American Shoulder and Elbow Surgeon scores were used to evaluate clinical outcomes.

Results: Eighteen patients were included between 2005 and 2012. The most common pathogens isolated were *Propionibacterium acnes* (44%), *Staphylococcus epidermidis* (39%), and *S aureus* (22%). Four patients (22%) had evidence of persistent infection on specimens from open biopsy and required subsequent rounds of I&D before replantation. The infecting pathogen in 75% of patients with persistent infection was *P acnes*, and 38% of patients with *P acnes* infection had recurrence. Mean follow-up of 24 months showed no signs of recurrent infection in any patient and an average American Shoulder and Elbow Surgeon score of 71.

Conclusion: Despite prior staged treatment for deep postoperative shoulder infections, specimens obtained from open biopsy before replantation detected a persistent infection rate of 22% in all patients and 38% in patients with *P acnes* infection, which may indicate a role for this procedure in the prevention of recurrent infections.

Level of evidence: Level IV, Case Series, Treatment Study.

Keywords: Deep shoulder infection; open biopsy; recurrent infection; shoulder arthroplasty

Periprosthetic shoulder infections, although less common than periprosthetic infections after total knee or hip arthroplasty can have devastating effects.[5,10] The reported incidence of infection after primary anatomic total shoulder arthroplasty (TSA) ranges between 0.4% and 3% and can be as high as 5% for reverse TSA (RTSA).[1-3,8,9,13,17] When

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shoulder arthroplasty infection does occur, the current accepted treatment algorithm includes explant of the infected prostheses, followed by antibiotic cement spacer placement and at least a 6-week course of antibiotic therapy before reimplantation of a new prosthesis.[4,16,18,19] Reinfection rates of between 0% and 37% have been reported after a 2-stage revision.[16,18] In addition, *Propionibacterium acnes*, a pathogen that can be difficult to diagnose and eradicate, is the primary pathogen in up to 20% of shoulder arthroplasty infections.[7,20]

Because TSA is becoming more common in the United States,[14] further investigation is necessary to properly treat deep postoperative joint infections that may arise as a complication. In this study, we evaluated our single-institution protocol for treatment of periprosthetic joint infections and periarticular osteomyelitis. This protocol consists of explantation of the infected prosthesis, antibiotic spacer placement, and antibiotic treatment for 6 weeks, followed by culture of specimens from open biopsy to ensure eradication of infection before a new shoulder prosthesis is reimplanted. We hypothesized that this would be an effective method for the detection of persistent deep shoulder infections despite standard treatment with 2-stage exchange arthroplasty and would subsequently decrease recurrent infection rates.

Methods

This study consisted first of removal of all previous hardware through a standard deltopectoral approach once the deep infection was diagnosed by a combination of clinical signs and various diagnostic methods, including deep draining sinus, purulent drainage from the wound, erythema, abnormal white blood cell (WBC), C-reactive protein (CRP), erythrocyte sedimentation rate (ESR), computed tomography, magnetic resonance imaging, and joint aspiration. This was followed by a thorough debridement of necrotic and infected tissue, and copious irrigation with antibiotic saline solution. A resection arthroplasty of the humeral head was performed in the setting of osteomyelitis of the humeral head, diagnosed through magnetic resonance or computed tomography imaging and in some cases with a bone biopsy specimen, if there had not already been a humeral prosthesis. Any previous cement was removed with osteotomes or an ultrasonic bone cement removal device. Antibiotic-impregnated cement consisting of 1 gram vancomycin and 1.2 grams tobramycin for every bag of polymethyl methacrylate was used to space the joint before the wound was closed (Fig. 1).

After surgical therapy, patients were administered pathogen-directed antibiotic therapy, as determined by infectious diseases specialists, for at least 6 weeks. Patients were re-examined a minimum of 4 weeks after completion of this course of antibiotic therapy. After resolution of clinical signs of infection and normalization of CRP and ESR, the patients underwent an open biopsy and limited debridement in the operating room.

This procedure consisted of using the previous deltopectoral incision and deep dissection until the antibiotic spacer and bone junction was visualized. At this point, a specimen of the surrounding soft tissue and bone was obtained and sent for cultures, and a limited debridement of scar tissue was performed. At least 3 cultures were taken at each procedure and held between 7 and 14 days, according to hospital protocol, to evaluate for bacterial growth and to decrease the risk of skin contamination. If the results of the cultures of the open biopsy specimens were negative, then the patient was scheduled for reimplantation of a shoulder prosthesis with removal of the antibiotic spacer. However, if the culture results were positive for an organism, then the patient underwent another formal irrigation and debridement (I&D) with exchange of the antibiotic spacer and another 6-week course of directed antibiotic therapy. This process was repeated until cultures from the open biopsy specimen were negative.

Figure 1 Postoperative radiograph after explantation of previous shoulder prosthesis, followed by irrigation and debridement and placement of an antibiotic cement spacer.

This treatment algorithm was performed on 18 patients affected with deep shoulder infections at our institution from 2005 through 2012. The patients were monitored in the clinic after completion of the treatment protocol and replantation of new shoulder components for up to 3 years. American Shoulder and Elbow Surgery (ASES) scores, range of motion, and pain levels were recorded during follow-up, and analysis of variance testing was used to determine statistical significance, with significance set at $P < .05$.

Results

During the study period, 18 patients (15 men and 3 women) presented with evidence of periprosthetic joint infection or osteomyelitis after shoulder surgery. Five of the 18 infections occurred at our institution between 2005 and 2012, and the index procedures in other 13 patients occurred at other hospitals. Mean patient age was 69 years (range, 52-88 years). The mean follow-up was 24 months (range, 12-