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Surgical management of periprosthetic shoulder infections

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Background: The treatment of periprosthetic joint infection is a difficult challenge in shoulder arthroplasty. This study investigated 1-stage modular component exchange vs. 1-stage complete removal and reimplantation (CRR) vs. 2-stage revision arthroplasty for periprosthetic joint infection.

Methods: Between January 1, 2004, and December 31, 2012, 79 patients received a component exchange (n = 15), CRR (n = 45), or a 2-stage (n = 19) revision for infection. A binary logistic regression analysis was performed to determine factors presenting the greatest risk of reinfection. Complications and functional outcomes were also evaluated.

Results: Overall, 4 of 15 (27%) component exchanges, 2 of 45 (4%) CRRs, and 4 of 19 (21%) 2-stage procedures required a reoperation for infection with a minimum of 1 year of follow-up. The difference between the CRR group and exchange group was significant ($P = .030$); however, the difference between the CRR group and 2-stage group did not reach statistical significance ($P = .059$). No preoperative and intraoperative selection bias between the groups was found. Binary logistic regression predicted that reinfection was highest in patients whose cultures grew *Staphylococcus aureus* ($P = .004$) or coagulase-negative *Staphylococcus* species ($P = .041$) or those treated with a component exchange ($P = .015$). The difference between groups for noninfection-related complications was not significant ($P = .703$). All procedures provided improved functional outcomes and pain relief.

Conclusion: Patients with infection caused by *Staphylococcus aureus* or coagulase-negative *Staphylococcus* species may require additional operations to treat the infection. Although effective in some cases, component exchange presents an increased risk for reinfection. A 1-stage CRR procedure had similar reinfection rates as a 2-stage procedure in our patient population.

Level of evidence: Level III; Retrospective Cohort Design; Treatment Study

Keywords: 1-stage shoulder arthroplasty; periprosthetic shoulder infection; 2-stage shoulder arthroplasty; reverse shoulder arthroplasty; shoulder infections; component exchange

Western Institutional Review Board's Affairs Department determined this project met the conditions for exemption.

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Literature concerning surgical management of periprosthetic joint infection in the shoulder is limited. Surgeons disagree about how many débridements are required for successful management of infection, as judged by clinical recurrence with a minimum of 1-year follow-up after treatment.[8,9,11,13,17,24,26] Some authors have reported lower recurrence rates after a 2-stage surgical débridement, whereas others have had satisfactory results after a 1-stage débridement.[15]

Despite this, the results of 1-stage exchange arthroplasty for infection are promising. The advantages of 1-stage surgery include less destruction and dissection, immediate reconstruction, decreased patient anxiety, avoidance of secondary adhesions, and lower hospital costs.[8] Studies evaluating 1-stage reimplantation have reported recurrent rates of infection from 0% to 46%.[2-4,20] Two-stage revision arthroplasty is a well-established method for treating late infections in the hip and knee literature; however, few reports have been published about 2-stage revision in the shoulder, although many consider it to be the "gold standard."[16] Two-stage reimplantation protocols involve component explantation and placement of a polymethylmethacrylate antibiotic-impregnated spacer or a hemiarthroplasty with antibiotic cement, followed by an extended course of intravenous antibiotics and reimplantation.[4,22] The risk of infection recurrence has been reported as 6% to 37% with this method.[19,22]

The primary purpose of this study was to evaluate the reoperation rates for infection with 1-stage component exchange, 1-stage complete removal and reimplantation (CRR), and 2-stage reimplantation arthroplasty with a minimum of 1 year of follow-up. We hypothesized that a 1-stage component exchange would have the highest reinfection rate, followed by a 1-stage CRR. The secondary purpose was to report noninfection-related complications and functional outcomes for each treatment.

Materials and methods

Revision shoulder arthroplasty patients who were treated for periprosthetic shoulder infection by a single surgeon (M.A.F) at a single institution between January 1, 2004, and December 31, 2012, were identified (Table I; detailed search information is available in the Appendix.) A total of 545 revision shoulder operations were performed in 475 shoulders (469 patients). Those revision shoulder operations were reviewed to determine which operations had positive intraoperative cultures, the bacteriology of those cultures, positive pathology, and whether the patients were treated as having infection, as determined by the treating surgeon and infectious disease specialist. Overall, 109 of 475 revision shoulders (23%) were determined to have been treated as having an infection at the time of revision and were treated with a 1-stage component exchange (exchange), 1-stage CRR, or a 2-stage reimplantation.

Table I Preoperative revision shoulder diagnosis

Diagnosis	No. (%) (N = 475)
Failed hemiarthroplasty	228 (48)
Failed total shoulder arthroplasty	109 (23)
Failed reverse shoulder arthroplasty	94 (20)
Failed rotator cuff repair*	23 (5)
Failed open reduction internal fixation	11 (2)
Failed bipolar hemiarthroplasty	9 (2)

* Only failed rotator cuff repairs with indolent infection suspected were included.

The electronic medical records of the 109 patients were reviewed in detail for preoperative history, physical examination, laboratory studies, intraoperative cultures and pathology, procedure performed, and complications, including reoperation for infection. Excluded were 3 patients who died before 1 year. Of the remaining 106 patients, 89 had a minimum of 1 year of follow-up and were included in the study.[8,9,11,13,17,24,26]

Diagnosis and preoperative evaluation

All patients had substantial pain preoperatively, with clinical evidence of a failed prior shoulder surgery. The average preoperative American Shoulder and Elbow Surgeons (ASES) total score was 33.5 (range, 0-81.7), the Simple Shoulder Test (SST) score was 2.0 (range, 0-11), active forward elevation was 57° (range, 0°-155°), abduction was 48° (range, 0°-170°), external rotation was 21° (–50° to 90°), and internal rotation was to S1 (greater trochanter-T6).

The clinical diagnosis of infection was based on a combination of history of previous infection, findings on physical examination (ie, skin erythema, swelling, draining sinus), laboratory tests (white blood cell count, erythrocyte sedimentation rate, and C-reactive protein) when obtained, and positive intraoperative findings, including purulence, intraoperative frozen section showing more than 5 polymorphonuclear leukocytes per high-powered field for 5 fields, and cultures (a detailed intraoperative specimen collection protocol is available in the Appendix).

Treatment

The study population consisted of 15 exchanges, 45 planned 1-stage CRRs (42 reverse shoulder arthroplasties [RSAs], 4 total shoulder arthroplasties), and 29 planned 2-stage procedures. The 60 1-stage patients underwent 1-stage débridement and a modular component exchange or a complete removal of the components with reinsertion of a prosthesis with antibiotic cement. The initial procedure in the 2-stage group was a thorough débridement with component and cement removal and insertion of a metal hemiarthroplasty with antibiotic cement. Of the 29 planned 2-stage repairs, 10 elected not to undergo the second stage. These 10 did not have a recurrence as of the end of the study; however, they were excluded from the analysis. The treatment decision was based on the surgeon's subjective assessment of the adequacy of the soft tissue débridement, age and comorbidities of the patient, and accompanying pathology, including bone loss, which might require an allograft.

The number of each procedure was graphed (Fig. 1). All patients were treated with a postoperative course of 6 weeks of intravenous antibiotics as directed by an infectious disease physician who used the intraoperative cultures (these will be reported in the Results as type of bacteria, whether bacteriology influenced reoperation rates, and reoperation bacteriology) and histologic analysis to guide the selection of antibiotics. The number of patients that were treated with chronic antibiotic suppressive therapy is not known.