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ORIGINAL ARTICLE

Future surgery after revision shoulder arthroplasty: the impact of unexpected positive cultures

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Background: The clinical implications and treatment of unexpected positive cultures (UPCs) in revision shoulder arthroplasty are not well defined. The purpose of this study was to describe results of patients with and without UPCs after revision shoulder arthroplasty.

Methods: A single institutional database was used to retrospectively identify all revision shoulder arthroplasties performed between January 1, 2011, and December 31, 2013. Patients with preoperative suspicion of infection were excluded. Multivariable regression analysis was used to identify risk factors for future surgery after revision shoulder arthroplasty.

Results: There were 117 revision shoulder arthroplasties without preoperative suspicion of infection. There were 28 of 117 (23.9%) with UPCs, of which 15 (57.1%) were *Propionibacterium acnes*; 18 of 28 (64.3%) patients received antibiotics for 6 weeks postoperatively without complications compared with 10 of 28 (35.7%) who received a routine 2-week empirical antibiotic regimen; 2 of 28 (7.1%) patients with UPCs required future surgery, and only 1 (3.6%) had a recurrent infection. Comparatively, 18 of 89 (20.2%) patients without UPCs ($P = .109$) required 25 additional surgeries. Average time to UPC was 4.3 years after index revision. Multivariable regression analysis of patient demographics, comorbidities, surgical procedure, and presence of UPCs found no independent predictors of reoperation.

Discussion: Nearly one-quarter of our institution's revision shoulder arthroplasties had UPCs. The patients without UPCs had a nonsignificantly higher risk of reoperation compared with those with UPCs. We did not identify clinical or demographic variables that independently correlated with reoperation. Further study will be necessary to determine the true clinical benefit of routine culture acquisition in cases with low suspicion for prosthetic joint infection.

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

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Keywords: Shoulder arthroplasty; periprosthetic joint infection; revision arthroplasty; unplanned positive cultures; reoperation; intraoperative cultures

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Indications for revision shoulder arthroplasty include base-plate failure, infection, component dissociation, loosening, dislocation, and periprosthetic fracture.¹⁶ Regardless of the indication for revision surgery, intraoperative culture specimens are routinely taken at many institutions. The clinical implications of unexpected positive cultures (UPCs) in patients without signs and symptoms of infection are not well defined.

Propionibacterium acnes is an anaerobic, gram-positive bacillus that colonizes the shoulder at increased rates compared with the knee and hip.¹⁴ *P. acnes* was previously thought to be nonpathogenic, but it is now recognized as one of the most common causes of periprosthetic joint infection.⁴⁻⁸ *P. acnes* is able to thrive on foreign bodies and can form biofilms, predisposing prosthetic joints to infection.¹ Because of the slow growth of *P. acnes*, nearly 2 weeks of incubation time is required to isolate the organism; however, incubation times beyond 2 weeks increase the likelihood of contamination and false-positive results.² Because of this, it is often difficult to determine whether positive *P. acnes* culture results indicate true infection, inoculation of the deep tissues with bacteria commensal to the skin layer, or laboratory contamination.¹⁹

Mook et al¹² investigated the prevalence of UPCs in open shoulder surgery. The authors found that 20.5% of surgeries produced at least 1 positive culture, and 13.0% of the sterile sponge control group also yielded positive culture results, suggesting a significant rate of contamination. Similarly, Levy et al reported that 42% of patients undergoing primary shoulder arthroplasty had positive deep cultures for *P. acnes*.¹¹ Given the high likelihood of positive cultures in the setting of primary open surgery, optimal strategies for addressing UPCs in revision arthroplasty remain undefined.

The purpose of this study was to identify all patients undergoing revision shoulder arthroplasty at our institution and to compare patients with and without UPCs. We aimed to report our rates of UPC in our revision cases and to analyze how the presence of UPC in the revision setting affects reoperation rates.

Methods

A retrospective analysis of an institutional shoulder arthroplasty database was conducted to identify all revision arthroplasties performed at a single institution from January 1, 2011, to December 31, 2013. Original construction of this database included all primary and revision shoulder arthroplasty procedures identified by *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) codes. The codes queried were 79.31 (open reduction of fracture of humerus), 80.01 (arthrotomy for removal of a prosthesis without replacement), 81.80 (total shoulder arthroplasty), 81.81 (shoulder hemiarthroplasty), 81.82 (repair of recurrent dislocation of shoulder), 81.83 (other repair of shoulder, arthroplasty), 81.88 (reverse total shoulder arthroplasty), and 81.97 (revision joint replacement of upper extremity). Not all of these codes are specific to shoulder arthroplasty, so individual operative reports identified by this broad query were reviewed to identify the patients who truly underwent shoulder arthroplasty. In this study, we then excluded all patients who underwent primary arthroplasty, leaving just the revision cases.

Patients with preoperative signs and symptoms of infection (drain-ing wound, sinus track, elevated erythrocyte sedimentation rate or C-reactive protein level, and positive synovial aspiration) were excluded from the study. Patients undergoing a dual-stage revision arthroplasty were excluded.

Per protocol at our institution, after a standardized skin preparation and surgical exposure, the glenohumeral joint was aspirated with a needle before opening the joint capsule. Fluid was sent for culture. Once the joint was opened, tissue from the anterior capsule, inferior capsule, glenoid, humeral canal, and underneath the prosthetic humeral head was sent for culture. Each culture specimen was retrieved using “fresh instruments” and placed directly into sterile specimen containers. Specimens were sent for both aerobic and anaerobic cultures and held for 2 weeks. All procedures were performed at 1 institution with 1 microbiology laboratory.

Data regarding demographics, patient comorbidities, surgical procedure performed, culture positivity, antibiotic treatment, and future surgical interventions were collected by direct chart review. Medical comorbidities were analyzed for each patient independently and in aggregate by calculating age-adjusted Charlson Comorbidity Index (AACCI). The AACCI is a previously validated quantification of a patient’s medical conditions using ICD-9-CM codes, originally designed to determine 10-year mortality risk.^{3,17} The type of bacteria grown in culture, the antibiotic treatment, and any future surgical intervention were recorded. We specifically analyzed the patients who grew *P. acnes*, given the high prevalence of this bacterium in shoulder arthroplasty.

Descriptive statistics were used to compare patients with and without UPCs. Continuous variables were compared by Student paired *t*-test; categorical variables were compared by *z* scores of proportions. A χ^2 analysis was performed to examine the relationship between culture positivity and reoperation after index revision surgery. Multivariable regression analysis was performed to analyze whether patient demographics, comorbidities, surgical procedures, and presence of UPC were independent predictors of further surgery after revision arthroplasty. A 2-tailed *P* value of $< .05$ was considered a statistically significant difference. All statistics were calculated with Microsoft Excel (2013; Redmond, WA, USA) and SPSS Statistics (version 20.0; IBM, Armonk, NY, USA).

Results

Review of our institutional database identified 1028 primary arthroplasties, 146 one-stage revision arthroplasties, and 38 antibiotic spacers implanted. There were 117 one-stage revision shoulder arthroplasties performed in 114 patients during the 3-year study period that did not have preoperative concern for infection. The diagnoses at time of revision surgery were rotator cuff dysfunction (32/117; 27.3%), glenoid wear after shoulder hemiarthroplasty/painful shoulder hemiarthroplasty (23/117; 19.7%), glenoid loosening (17/117; 14.5%), dislocation (11/117; 9.4%), malunion/nonunion (11/117; 9.4%), instability (10/117; 8.6%), arthrofibrosis (7/117; 6.0%), and humeral loosening (6/117; 5.1%). Of these cases, 28 (23.9%) had positive cultures, whereas 89 (76.1%) did not. The average time from index surgery to revision arthroplasty with UPC was 4.3 ± 4.5 years (range, 20 days–16.7 years). In comparison, the average time from index surgery to revision arthroplasty in those

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