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ORIGINAL ARTICLE

Is previous nonarthroplasty surgery a risk factor for periprosthetic infection in primary shoulder arthroplasty?

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Background: The purpose of this study was to determine the risk of periprosthetic infection after primary shoulder arthroplasty (SA) in patients undergoing previous nonarthroplasty shoulder surgery compared with those without previous surgery.

Materials and methods: All patients undergoing primary SA at our institution between 1970 and 2012 were included in this study. The cohort consisted of 4577 patients treated with 2890 total SAs, 1233 hemiarthroplasties, and 454 reverse SAs; 813 (18%) patients had undergone prior nonarthroplasty shoulder surgery on the operative side. Patients with and without previous surgery were compared for postoperative periprosthetic infection. Univariate and multivariable analyses were used.

Results: Deep postoperative infection of the shoulder was diagnosed in 68 patients (1.49%). Of the 813 patients who had undergone previous surgery, 20 (2.46%) developed a deep postoperative infection. However, of the 3764 patients who did not have previous shoulder surgery, 48 patients (1.28%) sustained deep shoulder infection. This difference was significant in both the univariate ($P = .0094$) and multivariate analyses ($P = .0390$). In addition, older age and female gender were significantly associated with a lower risk of deep postoperative infection ($P = .0150$ and $P = .0074$, respectively). A higher number of previous surgeries was also significantly associated with an increased risk of deep postoperative infection ($P = .0272$).

Conclusions: The risk of infection after primary SA is significantly higher in patients with a history of prior non–arthroplasty-related surgery. This finding should be discussed with the patients before their surgery, and potential preoperative and intraoperative workup should be undertaken to identify at-risk patients.

Level of evidence: Level II; Retrospective Design; Prognosis Study

Keywords: Shoulder arthroplasty; periprosthetic infection; risk factors; rotator cuff repair; reoperation; primary procedure

Investigation performed at the Department of Orthopaedic Surgery, Mayo Clinic, Rochester, MN, USA.

Each author certifies that his or her institution approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research.

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The risk of infection after primary shoulder arthroplasty (SA) has been reported in the range of 0.7% to 4%.[2-4,8,10,11,13,14] This may be under-reported, given the difficulty in reliably diagnosing those infections caused by more indolent organisms, such as *Propionibacterium acnes*.[9] As surgical volumes increase, the rates of periprosthetic infections are projected to

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increase dramatically.[6] Despite its infrequent presentation, periprosthetic infection is a major complication because of its devastating effects on shoulder function and pain and because no treatment has been found to yield satisfactory and reproducible results.[3,11,12] Identification of modifiable risk factors that may increase the risk of infection remains important.

Multiple studies have identified risk factors for infection after SA; these include male gender, younger age, and operative intervention for acute trauma.[4,5,9] Revision SA has also been reported to have a higher risk of infection compared with primary shoulder arthroplasties.[3] However, prior nonarthroplasty surgery (ie, rotator cuff repair, open reduction and internal fixation, acromioplasty) has not been established as a risk factor for infection after SA.

The purpose of this study was to determine the risk of periprosthetic infection after primary SA in patients undergoing previous nonarthroplasty shoulder surgery compared with those without previous surgery. We hypothesized that previous nonarthroplasty shoulder surgery is a risk factor for periprosthetic infection after primary SA.

Materials and methods

Between 1970 and 2012, all primary SAs performed at a single institution were reviewed, using our institutional total joint registry, which has followed all arthroplasties since 1969.[1] All patients are asked to return for an examination and radiographic evaluation at 1 year, 2 years, and 5 years of follow-up and then every 5 years thereafter. Patients who are unable to return for evaluation are sent a standardized, validated questionnaire[12] to assess their function and satisfaction. In addition, patients are requested to send in locally obtained radiographs for review. Complications including infection and interval surgery are recorded in the registry.

The shoulders of patients were included if they were 18 years or older, had SA (total, hemi, or reverse), and completed a minimum 2-year follow-up. There were 152 patients who had arthroplasty performed for oncologic tumor resection excluded, and 59 patients who had undergone débridement for septic reasons before the primary SA were excluded.

Previous surgeries are routinely recorded in the joint registry. Medical records and the surgeon's clinical notes and operative reports were reviewed to determine the type of prior surgery. These were categorized as rotator cuff repair (353), open reduction and internal fixation (185), débridement for nonseptic reasons (235), acromioplasty (111), capsular repair (131), hardware removal (35), and other surgeries (152).

Patients were separated in 2 groups, depending on whether they had undergone previous nonarthroplasty shoulder surgery.

Follow-up for the patients who had had previous surgery was 6.8 years (range, 2-35 years) compared with 7.4 years (range, 2-35 years) in patients with no previous surgery ($P = .9962$). There were 1914 patients with a follow-up of 2 to 5 years, 1347 patients with a follow-up of 6 to 10 years, 1048 patients with a follow-up of 11 to 20 years, and 268 patients with a follow-up of >20 years.

The final cohort included 4577 primary shoulder arthroplasties. This group was made up of 63% total shoulder arthroplasty (TSA), 27% hemiarthroplasty (HA), and 10% reverse shoulder arthroplasty (RSA). The mean age at arthroplasty was 66 years (±12.42), with 45% of shoulders being male. Mean body mass index (BMI) was 29.56 (±6.37). Median follow-up was 63 months (24-424 months) in the whole cohort including those undergoing reoperations. The most common operative diagnosis was primary osteoarthritis in 45% of patients. Other diagnoses included cuff tear arthropathy in 20%, rheumatoid arthritis in 12%, chronic post-traumatic arthritis in 13%, acute trauma in 5%, and other in 5%.

Previous nonarthroplasty shoulder surgery was the primary risk factor studied. The cohort was divided into 2 groups according to whether they had undergone prior nonarthroplasty surgery on the affected shoulder. The demographics of these groups are detailed in Table I. The cohort included 813 (18%) patients with prior surgery. Among these, 258 (32%) had undergone more than one prior surgery.

The primary outcome of interest was deep infection. A detailed review of the medical records, surgeon's clinical notes, infectious disease clinical notes, and operative reports was conducted on all patients who experienced any complication. Definitions for periprosthetic infection were constructed in discussions with 2 experienced orthopedic surgeons who have worked closely with infectious disease consultants in managing these infected cases during the last 4 decades (J.W.S., R.C.). An infected arthroplasty was diagnosed by the presence of 1 or both of the following: (1) positive joint fluid culture from needle aspiration, arthroscopic procedure, fluid obtained at surgery, or fluid draining from a wound communicating with the humerus or (2) positive synovial or bone tissue culture. In those patients without a positive joint fluid culture, the presence of a clinical infection was determined when the treating orthopedic surgeon believed an infection was present on the basis of clinical presentation (history and physical examination), documentation in the surgeon's note, and one or both of the following: (1) operative findings including purulent joint fluid, thick serosanguineous joint fluid, or the presence of necrotic synovial tissue or (2) a positive blood culture.

Infections that were limited to the skin and subcutaneous tissue without any extension deep to the fascial planes (suture infections or stitch abscesses) were categorized as superficial infections and were not considered a deep infection for the purposes of this study.

Covariates

Several known risk factors for infection after SA were also included in the covariate analysis. Risk factors assessed included age, gender, BMI, operative time, type of surgery (TSA, HA, RSA), number of previous surgeries, type of implant fixation, and underlying diagnosis (Table I). Age, BMI, and operative time were treated as continuous variables. Underlying diagnoses were categorized as osteoarthritis, rheumatoid arthritis and other inflammatory diseases, cuff tear arthropathy, acute trauma related, chronic trauma related, and other diagnoses. The acute trauma category included acute fractures of the proximal humerus or glenoid and acute dislocations. The chronic trauma category included post-traumatic arthritis, post-traumatic avascular necrosis, and chronic dislocation.

Statistical analyses

Summary statistics for the frequency of deep postoperative infection are reported as the mean and standard deviation. Cox proportional hazards survival regression analyses were used to examine the association of potential risk factors with deep postoperative infection, reporting a hazard ratio (HR) and 95% confidence interval (CI). We