Early aseptic reoperation after shoulder arthroplasty increases risk of subsequent prosthetic joint infection

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Background: Despite the success of anatomic total shoulder arthroplasty (TSA) and reverse shoulder arthroplasty (RSA), the clinical course of some patients necessitates operative intervention in the acute postoperative period. In this study, we evaluate the risk of subsequent prosthetic joint infection (PJI) in patients who undergo an aseptic reoperation within 90 days of primary shoulder arthroplasty.

Method: A retrospective review of patients with primary TSA and RSA was performed using a commercially available national database (PearlDiver Inc., Fort Wayne, IN, USA). Queries were performed with use of International Classification of Diseases, Ninth Revision and Tenth Revision and Current Procedural Technology codes. Patients were divided into cohorts based on undergoing aseptic reoperation, reoperation for PJI, or no reoperations within 90 days of index procedure. Primary outcome was subsequent PJI within 1 year of index procedure. Observed PJI rates were compared using chi-square analysis. Risk factors for PJI were compared using logistic regression.

Results: From 2010 to 2018, a total of 96,648 patients underwent primary shoulder arthroplasty: 46,810 underwent TSA and 49,838 underwent RSA. The rate of aseptic reoperation within 90 days was 0.72% and 1.5% in the TSA and RSA cohorts, respectively. At 1 year postoperatively, patients who underwent an aseptic reoperation within 90 days had an elevated risk of subsequent PJI compared with the overall rate of PJI in the TSA (3.54% vs. 0.75%; P < .001) and RSA (3.08% vs. 0.73%; P < .001) cohorts. On multivariate logistic regression analysis, aseptic reoperation within 90 days was identified as a significant risk factor for subsequent PJI in the TSA cohort (odds ratio, 14.19; P < .001) and RSA cohort (odds ratio, 8.38; P < .001). The most common indication for aseptic reoperation was postoperative prosthetic joint instability in both the TSA (31%) and RSA (49%) cohorts.

Conclusion: Aseptic reoperation within 90 days of primary TSA or primary RSA was associated with a notably increased risk of subsequent PJI.

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Anatomic total shoulder arthroplasty (TSA) and reverse shoulder arthroplasty (RSA) continue to grow in popularity with expanding indications. Despite continuous advancements in techniques and technology for each of these procedures, periprosthetic joint infections (PJIs) continue to plague patients at a reported rate ranging from 0.5% to 5.0%.‡1,13-16,20,24 The consequences of PJI are devastating for patients and represent a significant economic burden for our healthcare system.15,20,23 Several studies have identified risk factors associated with PJI in TSA and RSA.13,14,16,24 Understanding these factors enables surgeons to identify patients with increased risk, optimize modifiable factors, and counsel patients appropriately.

Early reoperation for aseptic indications has been identified in the total hip arthroplasty and total knee arthroplasty literature as a significant risk factor for subsequent development of PJI.5,7,8 To our knowledge, no study has been published which examines early aseptic reoperation after primary shoulder arthroplasty as a risk factor for subsequent development of PJI. The objective of this study was to determine if there is an elevated risk of PJI for those patients who require aseptic reoperation within 90 days after primary shoulder arthroplasty.

Materials and methods

Patient records were queried from PearlDiver (PearlDiver Inc., Fort Wayne, IN, USA), a commercially available national database of

This study was conducted solely with use of a commercially available national database and is exempt from institutional review board approval.

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The primary procedure was then queried and compared. PJI was defined using ICD-9 code 81.88 and ICD-10 codes 0RRJ00Z and 0RRK00Z. Patients that received RSA were identified by procedural codes indicating a deep joint infection requiring a surgical intervention to exclude any superinfection. Patients that received anatomic TSA were identified in inpatient records using ICD-9 code 81.80 and ICD-10 codes ORRJ0Z and ORRK0JZ. Patients that received RSA were identified using ICD-9 code 81.88 and ICD-10 codes ORRJ0Z and ORRK0Z. Patients were queried from the database using ICD-P-9/10 and Current Procedural Technology (American Medical Association, Chicago, IL, USA) codes can be searched in isolation or in combination with one another to yield the number of patients with matching claims.

Patients who underwent aseptic reoperation within 90 days of the index shoulder arthroplasty had an elevated risk of PJI at 1 year (odds ratio [OR], 14.19; 95% CI 9.99-19.69; P < .0001). Additional significant factors included age (OR, 1.26; 95% CI 1.05-1.52; P = .014), male gender (OR, 1.24; 95% CI 1.03-1.50; P = .023), and obesity (OR, 1.26; 95% CI 1.05-1.52; P = .014). Diabetes and CCI did not reach significance (Table III). After multivariate analysis, only reoperation within 90 days (OR, 14.19; 95% CI 9.99-19.69; P < .0001) and aseptic reoperation within 90 days (OR, 11.0; 0.23; P = .023) remained significant (Table III).

The most common indication for reoperation within 90 days after primary TSA was prosthetic dislocation (31%) followed by rotator cuff tear (26.3%) and implant loosening or mechanical issue (15.6%). All indications for reoperation and their rates are displayed in Table II. Demographic data for these cohorts can be viewed in Table I.

**Results**

Between January 1, 2010 and June 30, 2018 102,752 patients were identified in the Pearldiver database as receiving primary shoulder arthroplasty, 96,648 of which did not meet any of the exclusion criteria. Of these patients, 270 (0.28%) had a PJI and 1086 (1.1%) had an aseptic reoperation within 90 days of primary surgery. The overall rate of PJI was 0.74% at 1 year after shoulder arthroplasty.

The patients were divided into cohorts based on surgery type with 46,810 patients in the TSA cohort and 49,838 in the RSA cohort. In the TSA cohort, 339 (0.72%) patients underwent aseptic reoperation and 110 (0.23%) had a PJI in the first 90 days after primary surgery. In the RSA cohort, 747 (1.50%) underwent aseptic reoperation and 160 (0.32%) has a PJI within 90 days of primary surgery. Demographic data for these cohorts can be viewed in Table I.

**TSA cohort**

The overall observed rate of PJI at 1 year after primary TSA was 0.75%. Patient who underwent an aseptic reoperation within the first 90 days after primary TSA had a subsequent PJI rate of 3.54% (P < .001) at 1 year postoperatively. Patient who had no aseptic reoperation or PJI within the first 90 days had a PJI rate of 0.49% (P < .001) at 1 year (Table II). Univariate analysis of risk factors found that patients who underwent aseptic reoperation within 90 days had an elevated risk of PJI at 1 year (odds ratio [OR], 15.23; 95% confidence interval [CI] 10.77-21.01; P < .0001). Additional significant factors included age (OR, 0.95; 95% CI 0.94-0.96; P < .001), male gender (OR, 1.24; 95% CI 1.03-1.50; P = .023), and obesity (OR, 1.26; 95% CI 1.05-1.52; P = .014). Diabetes and CCI did not reach significance (Table III). After multivariate analysis, only reoperation within 90 days (OR, 14.19; 95% CI 9.99-19.69; P < .001) and age (OR, 0.95; 95% CI 0.94-0.96; P < .001) remained significant (Table III).

**RSA cohort**

The overall PJI rate at 1 year after primary RSA was 0.73%. Patients who underwent aseptic reoperation within 90 days of the primary
surgery had a subsequent PJI rate of 3.08% (P < .001) at 1 year, while those who had no reoperation (aseptic or PJI related) within 90 days of surgery had a 1-year PJI rate of 0.37% (P < .001) (Table V). Univariate analysis of risk factors found that patients who underwent aseptic reoperation within 90 days had an elevated risk of PJI at 1 year (OR, 10.28; 95% CI 7.95-13.13; P < .001). Additional factors that reached significance in univariate model included age (OR, 0.94; 95% CI 0.93-0.95; P < .001), male gender (OR, 1.83; 95% CI 1.53-2.18; P < .001), and obesity (OR, 1.35; 95% CI 1.13-1.61; P < .001). Diabetes and CCI did not reach significance (Table VI). Aseptic reoperation within 90 days remained significant on multivariate analysis (OR, 8.38; 95% CI 6.45-10.77; P < .001), as did age (OR, 0.94; 95% CI 0.93-0.95; P < .001), male gender (OR, 1.54; 95% CI 1.29-1.84; P < .001), and CCI (OR, 1.04; 95% CI 1.00-1.08; P = .038) (Table VI).

The most common indication for reoperation after primary RSA was prosthetic dislocation (49%) followed by implant loosening or mechanical complication (18%) and fracture (13%). All indications for reoperation can be viewed in Table IV.

### Discussion

This study demonstrated a 4.2- and 4.7-fold increase in risk of subsequent deep PJI after aseptic reoperation within 90 days after primary RSA and TSA, respectively. The risk associated with early reoperation remained significant on multivariate regression analysis in both cohorts. This finding highlights the importance of preventing avoidable complications and emphasizing patient compliance, in the acute postoperative period after shoulder arthroplasty to minimize risk of future PJI.

The rate of PJI requiring a reoperation in the first 90 days was low at 0.23% for TSA and 0.32% for RSA. Notably, patients who at 90 days after index procedure had not undergone a reoperation for any indication had 1-year PJI rates of 0.49% and 0.38% in the TSA and RSA cohorts, respectively. Comparing patients who had an early aseptic reoperation to those who had no reoperation in the first 90 days, the aseptic reoperation cohort had a 7.2- to 8.3-fold increase in risk of subsequent PJI. This further highlights the importance of the acute postoperative period and is reassuring for patients who do not suffer an early complication after shoulder arthroplasty.

The rate of reoperation within 90 days of index procedure was higher in the RSA cohort at 1.50% compared with the TSA cohort at 0.72%. Previous studies have shown this relationship of increased reoperation rates in the 90-day period after RSA compared with TSA.9-12 The etiology of the increased complication rate is likely multifactorial and related to host factors, surgical technique, implant design, and other factors associated with RSA procedures.

In an institutional database study, Streubel et al12 reported shoulder instability as the most common indication for reoperation within 90 days of index shoulder arthroplasty. Our study supports this finding as shoulder instability accounted for 31% and 49% of the aseptic reoperations in the first 90 days after TSA and RSA, respectively. Proper component positioning and restoration of soft-tissue tensions intraoperatively are critical for prevention of postoperative instability.2,18,19 Patients who may be at increased risk for postoperative instability should be identified preoperatively to optimize outcomes. Postoperative hematoma has been reported as a common complication after index shoulder arthroplasty procedures, particularly in the RSA literature.9-11 Hematoma was a relatively rare indication for reoperation in this study, accounting for 7% in the TSA group and 6% in the RSA group. This discrepancy is likely owing to the present study only accounting for hematomas which require an operation, excluding those treated conservatively or joint aspiration performed in clinic.

Numerous prior studies have indicated male gender and younger age as risk factors for subsequent PJI after TSA and RSA.4,11,13-16,20 In the present study, male gender, younger age, and CCI were significant risk factors in multivariate analysis of the RSA cohort. Analysis of the TSA cohort showed male gender and younger age to be significant factors on univariate analysis; however, only younger age remained significant on multivariate analysis. This discrepancy may be explained by the fact our study is the first to include early aseptic reoperations in the multivariate analysis and only reports serious infections requiring reoperation within the first year.

While this is the first study to address infection-risk associated with early aseptic reoperation after shoulder arthroplasty,
The retrospective design of this study is a limitation as we cannot directly review, thus the scope of the investigation is inherently limited to information captured in billing codes. Given this, we are unable to comment on relevant information such as species of pathogens, rates of perioperative culture collection during reoperation, or possible interventions to mitigate the increased risk of infection after reoperation. In addition, accurate billing codes, miscoding, and noncoding by physicians are all potential sources of error. The study included patients before and after the introduction of ICD-10 codes, thus ICD-9 and ICD-10 codes were used to query patients. A code translator was used to identify corresponding codes, thus ICD-9 and ICD-10 codes were used to query patients that subsequently had a contralateral shoulder arthroplasty. This restriction limits our ability to comment on the relationship between early reoperation and subsequent infection. In addition, there may be host factors that increase a patient’s risk of experiencing early reoperation that may independently increase a patient’s risk of developing PJIs.

The literature from other fields has reported similar findings. Goldman et al. published on a series of patients with total hip arthroplasty requiring aseptic reoperation within the first year of primary arthroplasty reporting an 8- to 13-fold increased risk of PJIs. The group reported similar findings on a series of patients with total knee arthroplasty with an associated 4- to 9-fold increased risk of subsequent PJIs. At a cellular level, wound healing is a carefully orchestrated process which requires tight control of oxygen tension and pH levels for appropriate healing response and infection prevention. The disruption of a healing wounds oxygen tension level and pH level with the early insult of a reoperation may in part explain the relationship between early reoperation and subsequent infection. In addition, there may be host factors that increase a patient’s risk of experiencing early reoperation that may independently increase a patient’s risk of developing PJIs.

The congruence of our findings with those available in the literature speaks to the validity of this national database study. The 1-year PJIs rates for TSA (0.75%) and RSA (0.73%) reported in this study are within the range of expected PJIs based on current literature. The combined 90-day aseptic reoperation rate after shoulder arthroplasty observed in this study was 1.12% which significantly differs from the 0.91% reported in the institutional database study by Streubel et al. Use of the PearlDiver database allowed us to query 96,648 shoulder arthroplasty patients across multiple payer-types and geographic locations. Early aseptic reoperations and PJIs are each relatively uncommon events after shoulder arthroplasty, thus access to a large, heterogeneous population was a major strength of this study and makes these results generalizable.

Conclusion

Patients who underwent an aseptic reoperation within 90 days of index shoulder arthroplasty surgery experienced a 4.2- to 4.7-fold increase in risk of prosthetic joint infection at 1-year. The rates of 90-day reoperation were 0.72% in the TSA cohort and 1.50% in the RSA cohort.

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Supplementary data

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