RATIONALE

PJI after both primary and revision shoulder arthroplasty remains a challenging and costly problem. It is important to recognize medical comorbidities as well as demographic factors that may be risk factors for shoulder PJI. Medical comorbidities can negatively impact surgical outcomes and lead to an increased risk of complications; however, there is limited evidence specifically linking medical comorbidities and shoulder PJI. There are some helpful general measures of health, including American Society of Anesthesiologist (ASA) grading, Charlson Comorbidity Index (CCI) and Functional Comorbidity Index (FCI), among others. These indices can often be linked to surgical outcomes and PJI, including shoulder PJI [1].

A literature review was performed to identify all studies regarding medical comorbidities and demographic factors that may be risk factors for shoulder PJI. Search terms "shoulder replacement," "shoulder arthroplasty," "infection," "comorbidities" and "risk factors" were utilized for PubMed and Google Scholar searches through February 18, 2018. All abstracts were reviewed and full text article review was completed for screening of relevant articles. Ultimately, 13 studies were included for final analysis.

Medical comorbidities that have been shown to be potential risk factors for shoulder PJI include American Society of Anesthesiologists (ASA) grade III or higher [1], rheumatoid arthritis [2], long term corticosteroid use [2], current and former smokers [3], Hepatitis C virus [4], HIV-positive [5], weight loss/nutritional deficiency [6], drug abuse [6] and iron deficiency [7].

Increased body mass index greater than or equal to 35 kg/m^2 has been associated with increased superficial wound infection but was not shown to be associated with shoulder PJI [8]. Patient demographic factors that have been shown to be risk factors for shoulder PJI include younger age [6,7,9–11] and male gender [6,8–11].

There is a limited but growing body of literature to support medical comorbidities and demographic factors that are potential risk factors for shoulder PJI. It is important to recognize and treat potentially modifiable medical comorbidities as well as counsel patients regarding additional non-modifiable comorbidities and demographic factors.

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Authors: Mark Frankle, Jason Hsu

QUESTION 2: Does previous shoulder surgery (arthroscopic or open non-arthroplasty) increase the risk of periprosthetic joint infection (PJI)?

RECOMMENDATION: Previous ipsilateral non-arthroplasty shoulder surgery likely increases the risk of shoulder PJI.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

Due to the inability of skin preparation solutions [1–3] and antibiotics [3–5] to eradicate bacteria (e.g., *Cutiibacterium acnes*) living underneath the skin surface, transection of the dermal structures leads to inoculation of bacteria into the deep tissues [6]. Therefore, previous non-arthroplasty surgery theoretically may increase the risk of PJI.

To answer this question, we performed a systematic review using the following search phrase: ("previous" OR "history of") AND "shoulder arthroplasty" AND ("infection" OR "culture"). Thirty-nine results were filtered by title and abstract, and reference lists were reviewed for relevant studies. Studies were included for analysis if they compared infection rates for shoulder arthroplasty in a group of patients with and without history of previous non-arthroplasty surgery. Studies that included previous arthroplasty (rather than non-arthroplasty) surgery as a risk factor were excluded.

Two studies have addressed the question of whether previous non-arthroplasty surgery increased the risk for shoulder PJI. Werthel et al. [7] looked at non-arthroplasty surgery as a risk factor for PJI and found that previous non-arthroplasty surgery was a risk factor for deep infection after both a univariate ($p = 0.0094$) and a multivariate analysis ($p = 0.0390$). An increased number of previous surgeries was associated with a greater risk of deep infection ($p = 0.272$).

Florschütz et al. [8] also reported that patients undergoing primary total shoulder with history of previous non-arthroplasty surgery had a significantly higher (p = 0.016) rates of infection compared to patients with no previous surgery on the operative shoulder.

A few other studies not aimed directly at answering this question directly support this conclusion. Foruria et al. [9] studied 107 patients with unexpected positive cultures at revision shoulder arthroplasty and found that the number of previous surgeries was higher in patients deemed to have "true infections" compared to "contaminants" (p = 0.025) (it is unclear if these were arthroplasty or non-arthroplasty surgeries). Horneff et al. [10] found that patients undergoing revision arthroscopic surgery had a significantly higher rate of positive culture growth than those undergoing primary arthroscopic surgery (29.4% vs. 3.2%). Zavala et al. [11] reported on their experience with deep infection after reverse shoulder arthroplasty and found an overall infection rate of 6% and an infection rate of 12.9% for those who had previous failed cuff surgery.

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Authors: Mark Frankle, Jason Hsu

QUESTION 3: Does prior corticosteroid injection increase the risk of periprosthetic joint infection (PJI) after primary or revision shoulder arthroplasty?

RECOMMENDATION: An increased number of corticosteroid injections and a shorter interval between corticosteroid injection and shoulder arthroplasty may increase the risk for surgical site infection or shoulder PJI.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

It is well-documented that usual skin preparation solutions do not adequately penetrate below the skin surface to eliminate bacteria, such as *Cutibacterium* [1,2]. Therefore, any instrument transecting the skin surface and sebaceous glands can theoretically inoculate the deep tissues [3].

To answer the question of whether corticosteroid injections increase the risk for surgical site infection/PJI, we performed a systematic review using the following search phrase: ("corticosteroid" OR "steroid" OR "cortisone") AND "shoulder" AND ("arthroplasty" OR "replacement"). Fifty-two results were filtered by title and abstract, and reference lists were reviewed for relevant studies. Studies were included for analysis if they were a study on primary or revision shoulder arthroplasty and studied preoperative injections as a risk factor.

A total of four studies have directly investigated the effect of previous steroid injection on the shoulder – one database study, one clinical study and two studies investigating deep cultures.

Werner et al. [4] performed a Medicare database study that compared three groups: arthroplasty within three months after injection, arthroplasty within three and 12 months after injection and a control group. Infection was defined by ICD-9 and CPT codes for both superficial and deep infection. The odds ratio for infection after arthroplasty was 2.0 at both three months (p = 0.007) and six months (p = 0.001) in patients who underwent injection within three months of arthroplasty and controls. No statistical difference was seen comparing those patients who underwent injection 3-12 months prior to arthroplasty and the control group. This study suggests that patients undergoing arthroplasty within three months after injection have a higher risk of infection.

Rashid et al. [5] performed a retrospective matched cohort study of 23 patients undergoing shoulder arthroplasty with history of preoperative intra-articular corticosteroid injection and 60 patients without a history of injection. None of the patients in either group had a superficial surgical site infection, and only one of the patients had a deep surgical site infection (defined as obvious purulence).

Two other studies have investigated the rate of positive deep cultures at the time of primary open shoulder surgery in patients that have and patients that have not had previous corticosteroid injections. Mook et al. [6] prospectively collected data on 104 patients undergoing open shoulder surgery at which time control