ability of their results. In comparison, a prospective registry of 301 patients undergoing reverse total shoulder arthroplasty reported only one patient developing hematoma (0.33%) [23]. A systematic review of the literature, comprising 19,262 shoulder arthroplasty cases, found hematoma developed in only 0.51% of revision shoulder arthroplasty cases and 0.09% of total shoulder arthroplasty cases [24].

The presence of infection can be difficult to exclude based on gross findings at the time of hematoma evacuation. Based on the experience reported with arthroplasty of the hip and knee and the small amount of available literature specific to shoulder arthroplasty, we recommend that deep tissue samples be sent for culture routinely when performing an I&D for hematoma after shoulder arthroplasty. The data obtained from these culture samples are useful and can aid the treating orthopaedic surgeons in consultation with infectious disease specialists to determine the optimal management of these patients.

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QUESTION 3: Should tissue cultures be obtained in primary shoulder arthroplasty (SA) cases with history of prior surgery (arthroscopic, open, open reduction and internal fixation (ORIF), or another non-arthroplasty surgery)?

RECOMMENDATION: Obtaining tissue samples for culture in patients with history of prior non-arthroplasty surgery may be indicated in select cases.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

Primary SA in patients with history of prior surgery in the affected shoulder is common. The reported prevalence is between 18%-23% [1,2], being higher in primary reverse shoulder arthroplasty (32% to 48%) [1,2] than in primary anatomic arthroplasty (11% to 14%) [1,2].

There is evidence demonstrating that prior surgery on a shoulder undergoing primary SA significantly increases the risk that a periprosthetic joint infection (PJI) will develop. Florschütz et al. [1] found that shoulders with prior surgery undergoing primary

SA demonstrated a significantly higher (p = 0.016) infection rate (4.3%) compared with shoulders with no prior surgery (1.3%), exhibiting a 3.35-times higher risk (95% confidence interval (CI), 1.28-8.81) for infection development. Werthel et al. [2] confirmed this finding in a cohort of 4,577 patients treated with primary SA. Of the 813, patients who had undergone prior surgery, 20 (2.46%) developed PJI. In contrast, of the 3,764 patients who did not have prior shoulder surgery only 48 patients (1.28%) developed PJI. This difference was significant in both the univariate (hazard ratio (HR), 2.08; 95% CI, 1.27-3.45; p = .0094 p = .0094) and multivariate analyses (HR, 1.81; 95% CI, 1.03-3.05 p = .0390). Additionally, a higher number of previous surgeries (HR, 1.68 per surgery) and SA for traumatic etiology (HR 4.49) were also significantly associated with an increased risk of PJI.

The mechanism by which prior surgery increases the risk of PJI is unknown. Possibilities include deep tissues open to the environment with increased operative time both during the index surgery and the arthroplasty [3]; altering the ability to combat infection by affecting lymphatic drainage and blood supply of periarticular tissues [3]; or perhaps, organisms, such as *Cutibacterium Acnes,* may colonize the shoulder and the hardware at the time of the index surgery and remain quiescent or as a low-grade infection until an arthroplasty is performed, which provides a larger surface area of prosthetic material for establishment of a biofilm [2]. There is evidence of subclinical low-grade infections without overt signs of infection by *C. acnes* after arthroscopic and open non-arthroplasty surgery [4–7]. Therefore, while we can make no definitive recommendation given the lack of data in patients undergoing SA subsequent to prior non-arthroplasty surgery, it is reasonable to consider sending intraoperative tissue samples for culture to screen for possible low-grade subclinical infections or wound contaminations.

A comprehensive review of the literature on cultures from tissue samples in primary arthroplasty with history of prior surgery was performed and did not find any prospective or randomized studies. While there is lack of evidence for positive cultures in patients with history of prior surgery, there are a number of studies that investigate patients undergoing primary arthroplasty without prior surgery. Levy et al. [8] isolated *C. acnes* from the synovial fluid and tissue prior to prophylactic antibiotics in 41.5% of shoulders undergoing shoulder replacement for osteoarthritis. In this study, *C. acnes* infection was defined as a positive culture in 50% or more of specimens collected (swab or tissue). Maccioni et al. [9] reported positive tissue cultures for *C. acnes* in 3.1% of cases . Matsen et al. [10] collected 50 tissue samples from 10 patients undergoing primary SA without a history of prior surgery after aggressive prophylactic antibiotic and skin preparation and reported that 14% were positive for *C. acnes*. Falconer et al. [11] evaluated the contamination of the surgical field by *C. acnes* in patients undergoing primary SA without history of prior surgery. The rate of one or more positive swab cultures was 33%. The most common site of growth of *C. acnes* was the subdermal layer. Koh et al. [12] assessed the rate of *C. acnes* colonization in patients undergoing primary shoulder arthroplasty. Patients with prior surgery were excluded. Thirteen patients (43%) had positive deep swab cultures on entering the glenohumeral joint. While in these studies there is variability of the reported rates that might reflect the heterogeneity in the culture techniques and the different definitions used to define a positive culture, there is a consistent finding of positive cultures in primary arthroplasties without a history of prior surgery. The clinical relevance of positive cultures from shoulder undergoing primary surgery is unclear.

In light of reports of positive tissue cultures from shoulders without prior surgery, the utility of intraoperative tissue cultures in patients undergoing primary SA with a history of prior surgery is unclear. Further research into the results of cultures in primary arthroplasty with history of prior surgery using standardized culture techniques and better methods to interpret the results is warranted.

Given the lack of evidence, the use of intraoperative tissue samples for cultures in patients undergoing primary SA with history of prior surgery as a screening infection test should be used at the discretion of the treating surgeon. No universal recommendation can be made at this time. However, considering that low-grade infections actually occur after arthroscopic and open shoulder surgeries and that prior surgery is a demonstrated risk factor for PJI, a screening strategy involving a selected group of patients based on the presence of risk factors (multiple prior surgeries; prior failed ORIF; male gender; younger patients may be prudent [1,2,13,14].

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