

QUESTION 9: Is there a role for preoperative joint aspiration in the evaluation of a shoulder arthroplasty for periprosthetic joint infection (PJI)?

RECOMMENDATION: Glenohumeral joint aspiration has a role as part of the investigation for shoulder PJI.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

Synovial fluid obtained from joint aspiration in the evaluation for PJI can be analyzed to determine nucleated cell count, culture and sensitivity, and various inflammatory markers (interleukin (IL)-6, tumor necrosis factor- α , and alpha defensin). Aspiration for culture is commonly performed. Controversy remains regarding the role of preoperative aspiration in the diagnosis of shoulder PJI. While multiple Level III and IV studies report using preoperative aspiration to evaluate a suspected shoulder PJI, many studies discuss the challenges of obtaining an adequate sample [1–3] as well as a variable incidence of false negative cultures [4,5]. In addition, the unique bacteriology of shoulder PJI, with a preponderance of the non-planktonic organism *C. acnes*, impacts the utility of shoulder aspiration in some clinical settings. No large study has adequately explored the predictive value of preoperative joint aspiration for synovial fluid culture in the diagnosis of shoulder PJI. Thus, there is limited evidence to support routine preoperative aspiration during the workup of a suspected shoulder PJI.

Millett et al. [6] reported on a series of 10 patients presenting with chronic shoulder pain arising after shoulder surgery. In all cases, a preoperative aspiration was carried out, but, in many cases, the tap was dry even after saline lavage. Infection was subsequently determined by positive bacterial culture from a sub-deltoid specimen [6].

In a retrospective multicenter review of infected reverse shoulder arthroplasties, Jacquot et al. [7] reported that preoperative joint aspiration was carried out in 14/32 (44%) cases and was positive in 12/14 (85%). They advocated joint aspiration before any single stage revision shoulder arthroplasty to determine the infective organism and antibiotic sensitivity that would allow selection of an appropriate antibiotic to include in the polymethylmethacrylate cement. Klatte et al. [8] reported on a series of 35 patients undergoing single stage exchange arthroplasty for shoulder PJI. All of the patients had preoperative joint aspiration. Antibiotics were withheld for two weeks prior to joint aspiration. Culture samples were incubated for 14 days, and the results were used to guide the choice of antibiotic added to cement at time of single stage revision. They felt their high cure rate after single stage treatment of shoulder PJI was due, in part, to the isolation of the infective organisms from the preoperative joint aspiration and the ability to add the appropriate antibiotics to polymethyl methacrylate cement as well as initiate the antibiotic treatment.

Ince et al. [4] reported on a series of patients undergoing single stage revision shoulder arthroplasty for shoulder PJI. Preoperative aspiration was performed in all patients and antibiotics were withheld for one week prior to aspiration. The authors were able to identify the infecting organism in 13/16 (83%) of the cases. Intraoperative biopsy and culture was needed to identify the infecting organism in the other three cases. Cultures were routinely held for 14 days to improve sensitivity.

Dilisio et al. [9] in a retrospective study compared the culture results of preoperative joint aspiration prior to arthroscopy to the

results of intraoperative arthroscopic tissue biopsy. Fourteen of nineteen cases undergoing joint aspiration underwent fluoroscopic guidance with contrast to confirm intra-articular placement of aspiration needle. Only 1 of 14 patients (7%) had positive cultures. In contrast, 9 of 19 arthroscopic tissue biopsy cultures were positive. The authors reported that the sensitivity, specificity, positive predictive value and negative predictive value for arthroscopic biopsy was uniformly 100%. In contrast, preoperative aspiration had a sensitivity of 17%, a specificity of 100%, a positive predictive value of 100% and a negative predictive value of 58%. The authors concluded that arthroscopic biopsy is better than preoperative aspiration for identifying shoulder PJI.

Ghijssels et al. [10] reported on 17 patients with shoulder PJI. The authors noted that 15 patients had preoperative cultures, but only 6 patients had undergone joint aspiration. Given the lack of a consistent protocol regarding preoperative joint aspiration, the authors did not comment on any recommended indication for joint aspiration. Sabesan et al. [11] reported on a retrospective review of 27 patients treated with two-stage revision for shoulder PJI. The authors recommended preoperative aspiration, if there was a high suspicion for infection. Twelve of 17 patients underwent aspiration. Fluid was available in 10/12 (83%) patients, and 6 of these had positive cultures.

Other reports have commented on the low yield of preoperative joint aspiration because of the high incidence of dry taps and/or false negative results. Sperling et al. [12] reported that preoperative joint aspiration was possible for only 56% of patients and that *P. acnes* was identified in less than 30%. Codd et al. [13] reported that aspiration was positive in only 39% of shoulders and that cultures were positive in about 29%. Romanó et al. [14] and Coste et al. [15] also reported that the preoperative joint aspiration was diagnostic in only 34–50% of the cases. Strickland et al. [5] reported that joint aspiration for shoulder PJI yielded a 34% false negative rate.

Finally, two review articles merit mention. Hsu et al. [16] evaluated 14 studies that attempted to define shoulder PJI. Of these, 4 used preoperative aspiration to identify the infective organisms. Mook and Garrigues [17] published a review article opining that preoperative serologies, synovial fluid cultures and synovial leukocyte count lacked the necessary specificity and sensitivity for diagnosis of shoulder PJI, especially those caused by *C. acnes* and other slow growing organisms. The authors conceded that, “There are no rigorous large-scale investigations available that address the following questions: (1) When is it appropriate to diagnostically aspirate a prosthetic shoulder joint? (2) If the decision is made to aspirate the shoulder prior to, or during, revision arthroplasty, what values of the synovial fluid leukocyte count are predictive of infection?” The authors add that guidelines for interpreting the results of joint aspirate are borrowed from hip and knee and are largely left up to surgeon judgment.

Based on our evaluation of the shoulder arthroplasty literature and consideration of data on hip and knee arthroplasty, we believe that aspiration of the shoulder joint being investigated for PJI may provide important information and should be attempted, when possible. We realize that a substantial number of these joint aspirations are likely to be dry or yield inadequate synovial fluid to allow all analyses. We also realize that shoulder joint aspiration can be performed with minimal risk and could provide critical information regarding the infective organism(s) and allow determination of the antibiotic sensitivity prior to surgical intervention.

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2.5. DIAGNOSIS: SAMPLING

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QUESTION 1: Should tissue samples be obtained for culture in all revision shoulder arthroplasties?

RECOMMENDATION: Tissue samples should be obtained for culture in all revision shoulder arthroplasties when there is suspicion for infection.

LEVEL OF EVIDENCE: Consensus

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

RATIONALE

Prosthetic joint infection (PJI) is a devastating complication following shoulder arthroplasty and varies between 0-5% with increasing risk in revision arthroplasty [1,2]. As such, organism identification and appropriate antibiotic administration is essential.

The failure to address infection without the relevant antimicrobial therapy results in poor outcomes with Coste et al. [3], reporting 30% residual infection when infected shoulder arthroplasty was treated with resection arthroplasty alone and 60% residual infection when purely antibiotic treatment was advocated. The appropriate surgical procedure, combined with the relevant antibiotic therapy, is therefore integral to the effective management of revision shoulder arthroplasty.

Aseptic loosening can be indistinguishable from acute infection and unexpected positive cultures are not uncommon and can be as high as 29% [4,5]. This is particularly relevant when considering the indolent nature of *Cutibacterium acnes*, a common shoulder path-

ogen, which can be isolated in as high as 60% of revision shoulder arthroplasties in which there were no positive preoperative or intra-operative investigations suggesting infection [5]. Tissue samples for culture should therefore be undertaken at the time of the procedure to both diagnose and confirm infection. Indeed, even in the presence of known infection, alternative organisms can be reported at the time of revision, which can also influence postoperative antibiotic therapy.

Interpreting positive cultures in a previously regarded aseptic revision can, however, be difficult due to false positives from contaminants. False negative results can also prove a challenge, particularly with regard to *Cutibacterium*, which can take 8-10 days to grow [6]. Extended culture incubation for a minimum of 10-14 days is, therefore, recommended [6,7]. Notwithstanding this, the multifocal and low-grade nature of chronic infection can lead to false negative cultures, and sampling bias must, therefore, be considered as a cause for negative cultures.