SH48: Is there a role for ultrasound guided aspiration / synovial biopsies pre-operatively in suspected PJI?

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Response: Given high specificity but low sensitivity and strong association between synovial neutrophil count and PJI, attempted US guided aspiration/synovial biopsy may have value in cases of suspected PJI.

Strength of Recommendation: Limited

Delegate Vote: 53 (98%) agree; 1 (2%) disagree; 0 abstain

Rationale: A comprehensive literature review was performed to identify all studies evaluated the use of ultrasound guidance for preoperative aspiration/ synovial biopsy in the setting of suspected periprosthetic joint infection (PJI) following shoulder arthroplasty. A search for shoulder arthroplasty AND periprosthetic joint infection AND ultrasound AND preoperative aspiration OR preoperative biopsy was performed in the search engines PubMed and Scopus through October 2024. Inclusion criteria for our review were all English studies (Level I-IV evidence) that reported on utility of ultrasound guidance for obtaining preoperative aspirations/synovial biopsy in the setting of PJI. Exclusion criteria included non-English language articles, nonhuman studies, retracted papers, case reports, review papers, studies with less than <10 patients in the sample size, technique papers without patient data or did not specifically mention postoperative stiffness in setting of PJI. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) criteria were followed.

Preoperative joint aspiration and biopsy are commonly used in the evaluation of periprosthetic joint infection (PJI), though their diagnostic significance remains variable. Mederake et al. conducted a retrospective study of 56 patients undergoing revision shoulder arthroplasty, identifying PJI in 27% (n=15) of cases[3]. As part of the standard preoperative diagnostic assessment, all patients underwent fluoroscopy-guided joint aspiration, with 48% resulting in “dry taps”. In these cases, a synovial biopsy was performed. The standard diagnostic workup without biopsy demonstrated a sensitivity of 67% and a negative predictive value (NPV) of 89%. However, when synovial biopsy was added, sensitivity increased to 100% with a specificity of 83%.

Similarly, Zanna et al. conducted a retrospective study examining the concordance between preoperative synovial aspirate cultures and intraoperative cultures in 50 patients who met the 2014 Musculoskeletal Infection Society criteria for shoulder PJI. They found a high rate of discordance between the two, though preoperative cultures positive for *C. acnes* were more likely to be concordant with intraoperative results (p=0.022)[7]. In a separate multicenter prospective study of 69 patients undergoing revision shoulder arthroplasty, researchers compared preoperative fluoroscopy-guided synovial biopsy and joint aspiration performed by musculoskeletal radiologists with intraoperative open biopsy results[2]. They found that preoperative aspiration failed to detect any of the infections confirmed via open biopsy, while percutaneous synovial biopsy

identified only 19% of infections. Compared to open biopsy, percutaneous biopsy had significantly lower sensitivity, specificity, positive predictive value (PPV), and NPV, highlighting its limitations in diagnosing PJI.

Joint aspiration or biopsy is often considered low yield for diagnosis due to the high incidence of dry taps, which may be mitigated with ultrasound guidance to improve needle placement accuracy. However, limited prospective data exist on the effectiveness of ultrasound guidance in preoperative joint aspiration and biopsy.

There is one study that investigated the diagnostic value and reliability of ultrasound guided biopsies prior to revision shoulder arthroplasty for PJI[4]. Pruijn et al preformed a prospective investigation of 55 patients undergoing revision shoulder arthroplasty surgery. Prior to surgery, six ultra-sound guided synovial tissue biopsies were collected for culture and two for multiplex polymerase chain reaction (mPCR). All ultrasound- guided biopsies were performed by an experienced radiologist. Additionally, prior to surgical incision shoulder aspiration was obtained for synovial fluid and sent for mPCR, interleukin-6, calprotectin, white blood cell (WBC) and erythrocyte sedimentation rate (ESR). Blood samples were also obtained for ESR, C-reactive protein (CRP), and WBC. Intra-operatively, six tissue biopsies were obtained. Twenty-four of 55 patients (44%) had intra-operative tissue biopsies which were positive for infection. Cultures obtained via ultrasound guided biopsy were positive for infection in 7 of the 24 patients yielding a sensitivity 29.2%, specificity 93.5%, positive predictive value (PPV) 77.8%, and negative predictive value (NPV) of 63.0% and accuracy of 65.5%. Interestingly, in patients that were indicated for revision surgery under suspicion of infection (n=13), six of these patients were identified via ultrasound guided biopsies with sensitivity increasing to 46.2%, specificity of 75%, PPV of 85.7% and NPV of 30%. The best diagnostic value was found when ultrasound guided biopsies were combined with synovial WBC and calprotectin (sensitivity of 69.2% and NPV of 80%). Ultimately this study was terminated early due to lack of reliability to diagnosis PJI.

In the total hip arthroplasty (THA) literature, there are three studies investigating the utility of ultrasound guidance for hip aspiration in the setting of PJI. The first study looked to compare the sensitivity, specificity, and cost of ultrasound versus fluoroscopy guided aspirations in 52 hips (49 patients)[5]. Ultrasound guided aspiration performed by an experienced radiologist yielded a sensitivity and specificity of 89% and 60%, respectively. Fluoroscopy guided aspirations performed by orthopedic surgeons yield a sensitivity and specificity of 94% and 81%, respectively. However, cost analysis revealed ultrasound guided aspirations to be significantly lower. Another study analyzed 290 hip aspirations performed under ultrasound versus fluoroscopy guided aspirations by fellowship trained musculoskeletal radiologist, sports medicine or pain management physicians[6]. Their results demonstrated that ultrasound guided aspirations were less likely to result in a dry tap and more likely to obtain a greater volume. Furthermore, ultrasound guidance was more sensitive at diagnosing infection (85% vs. 73%, p=0.03). Lastly, a review of 349 ultrasound guided hip aspirations performed by orthopedic surgeons demonstrated an accuracy of 87 %, sensitivity of 83 %, specificity of 89 %, positive predictive value of 79 %, and negative predictive value 91 %[1].

Table 1. Summary of pre-operative guided aspiration in setting of PJI

Article	Arthroplasty Type	Type of Aspiration	# of Patients	Sensitivity	Specificity	PPV	NPV
Lapner et al	SA	Fluoro	69	37%	81%	37%	81%
Mederake et al	SA	Fluoro	56	67%	95%	84%	89%
Pruijn et al	SA	US	55	29.2%	93.5%	77.8%	63%
Zanna et al	SA	US	50	-	-	-	-
Duck et al	THA	US	349	83%	89%	79%	91%
Randelli et al	THA	US	52	89%	94%	-	-
Treu et al	THA	US	290	85%	100%	-	-
THA: Total Hip Arthroplasty; SA: Shoulder Arthroplasty; US: ultrasound guided; Fluoro: fluoroscopy guided; PPV: Positive predictive value; NPV: negative predictive value;							

References:

1 Duck H, Tanner S, Zillmer D, Osmon D, Perry K. Value of ultrasound-guided aspiration of hip arthroplasties performed in an orthopedic clinic by orthopedic surgeons. J Bone Jt Infect 2021;6:393-403. 10.5194/jbji-6-393-2021

2 Lapner P, Nam D, Cheema A, Sheikh A, Hodgdon T, Pollock JW et al. Diagnostic accuracy of preoperative percutaneous synovial biopsy and aspirate compared with open biopsy for prosthetic shoulder infections. Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al] 2025;34:441-448. 10.1016/j.jse.2024.08.016

3 Mederake M, Hofmann UK, Fink B. The significance of synovial biopsy in the diagnostic workup of the low-grade periprosthetic joint infection of shoulder arthroplasty. Archives of Orthopaedic and Trauma Surgery 2022;142:3157-3164. 10.1007/s00402-021-03932-x

4 Pruijn N, Heesterbeek PJC, Susan S, Boks SS, van Bokhoven SC, Schreurs BW et al. The predictive value and reliability of ultrasound-guided synovial aspiration and biopsies for diagnosing periprosthetic shoulder infections. Arch Orthop Trauma Surg 2024;144:2983-2992. 10.1007/s00402-024-05398-z

5 Randelli F, Brioschi M, Randelli P, Ambrogi F, Sdao S, Aliprandi A. Fluoroscopy- vs ultrasound-guided aspiration techniques in the management of periprosthetic joint infection: which is the best? Radiol Med 2018;123:28-35. 10.1007/s11547-017-0811-1

6 Treu EA, Cushman DM, Wheelwright JC, Blackburn BE, Teramoto M, Archibeck MJ. Is ultrasound-guided hip aspiration more successful than fluoroscopic-guided aspiration in diagnosing prosthetic joint infection? J Bone Jt Infect 2023;8:151-163. 10.5194/jbji-8-151-2023

7 Zanna L, Sangaletti R, Akkaya M, Shen T, Abuljadail S, Gehrke T et al. What is the concordance rate of preoperative synovial fluid aspiration and intraoperative biopsy in detecting periprosthetic joint infection of the shoulder? Journal of shoulder and elbow surgery / American Shoulder and Elbow Surgeons [et al] 2023;32:492-499. 10.1016/j.jse.2022.10.008