SH26. Is arthroscopic biopsy/culture efficacious for the diagnosis of PJI? Akshay Krishnan, MD; Scott Paxton, MD

A comprehensive updated literature review was performed to identify all studies on the use of arthroscopic biopsy and culture and its efficacy in diagnosing prosthetic joint infections in shoulder arthroplasty. Searches for the terms "arthroscopic biopsy," "prosthetic shoulder infection," and "arthroscopic biopsy culture" were performed using PubMed. Filters were applied to only include studies within the last 6 years (to update results after the first ICM meeting). Due to the paucity of studies studying this topic, inclusion criteria was broad. All studies were included that reported on the use of arthroscopic biopsy/culture, mini-open biopsy, shoulder aspiration, and percutaneous synovial biopsy . Exclusion criteria were non-English articles and review articles. 9 studies were found within the last 6 years, and 5 were included for review.

Answer: Arthroscopic biopsy and culture are efficacious in establishing the diagnosis of prosthetic shoulder infections when other pre-revision workup studies are inconclusive. The included retrospective studies and systematic reviews demonstrate that arthroscopic biopsy/culture has notably better sensitivity, specificity, negative predictive value, and positive predictive value when compared to synovial fluid aspiration or percutaneous synovial biopsy.

Strength of recommendation: **Strong.**
Recommendation from the 2018 meeting led to a "moderate" strength recommendation. Additional studies performed since that time continue to support the diagnostic utility of arthroscopic biopsy and strengthen the recommendation. Given these updates, the strength of recommendation has been increased to "strong."

Rationale: Traditional workup of prosthetic joint infection has predominantly been guided by standards set in hip and knee arthroplasty. While the utilization of clinical exam, serum labs (ESR, CRP), radiologic findings, and joint aspiration often guide treatment of suspected prosthetic joint infections, their utility in shoulder arthroplasty is limited. This is, in part, because most prosthetic infections of the shoulder involve lower virulence organisms, like *C. acnes*. These lower virulence organisms are less likely to result in clinical or radiographic changes and may not cause obvious elevations in serum labs. Although synovial fluid aspiration is the standard of care when diagnosing prosthetic joint infections in the hip or knee, their utility in confirming the presence of a prosthetic shoulder infection is limited.

At the ICM Meeting in 2018, studies looking at the utility of pre-revision arthroscopic biopsy were analyzed and led to a strength of recommendation of "moderate." In summation, 3 studies were found to lead to this recommendation. Of these studies, 2 were larger retrospective series performed by Dilisio et al. and Tashjian et al. In the study performed by Dilisio et al., 350 patients with painful shoulder arthroplasties were evaluated and 19 underwent arthroscopic biopsies before revision surgery. At time of revision, 41% had positive cultures, all for *C. acnes*. Arthroscopic biopsy culture results are detailed in Table 5 below. These results were superior to glenohumeral joint aspiration with 100% sensitivity and specificity. These statistical values are detailed in Table 2.

In the study performed by Tashjian et al., 77 patients who underwent revision total shoulder arthroplasty were evaluated. Pre-revision biopsy was performed in 17 cases that were considered

"at-risk" for infection. Open biopsy was performed in rotator cuff-deficient patients, while arthroscopic biopsy was performed in patients with an intact rotator cuff. Pre-revision biopsy statistical values are detailed in Table 5. Unfortunately, this study did not differentiate the efficacy of pre-revision biopsy between the open and arthroscopic cohorts. Patients with a clear infection (purulence) or positive aspirate were excluded from their analysis. So these patients all had a negative aspirate. The patient selection may play a role in the results.[8]

Since the ICM meeting in 2018, more studies have been performed that further bolster the "moderate/strong" recommendation. These studies all compared pre-operative sampling techniques and study characteristics are outlined in Table 1. Tables 2, 3, and 4 below all detail sensitivities, specificities, and positive/negative predictive value with aspiration, serum ESR/CRP, and biopsy. Tat et al have recently examined this topic in their systematic review.[9]

The study performed by Akgun et al in 2019 sought to assess the utility of arthroscopic biopsies in detection prosthetic joint infections for painful shoulder arthroplasties without any obvious signs of infection. Of 128 revision surgeries only 23 pre-revision arthroscopic biopsies were performed. Sixteen of the arthroscopic biopsies had positive cultures and 5 of the cases were deemed "true infection" at time of revision surgery based on culture results. Of these 5, culture results matched what was found on pre-revision arthroscopic biopsy.[1]

Doherty et al identified 14 patients who met their inclusion criteria. Of these 14, 3 tissue biopsies were positive for infection. Interestingly, 5 patients underwent glenohumeral aspiration prior to arthroscopic biopsy, but only 2 aspirations had results that correlated with biopsy result. This study did not comment on correlation of arthroscopic biopsy result with biopsy taken at time of revision.[3]

In Guild et al's study, 2 of 13 cases had positive arthroscopic biopsies and matched what was found at time of revision. This led to their conclusion that there is 100% correlation with biopsies taken at time of revision for infection with arthroscopic biopsy. However, in this study they performed arthroscopic biopsy on 13 patients and negative biopsies in 6 combined with treatment of other pathology arthroscopically prevented the need for further open surgery, resulting in an impossibility of calculation a false negative rate for these 6 cases.[4]

Mederake et al identified 56 patients with a painful arthroplasty who subsequently underwent a revision procedure. Of these 56, all had undergone standard pre-operative glenohumeral aspiration as part of their workup. In patients with a dry tap or negative aspiration with persistent symptoms, an arthroscopic biopsy was performed (22). Of these 56 patients who underwent revision arthroplasty, 15 were for confirmed prosthetic joint infection. The statistical values are detailed in Tables 2 and 5 below, but it is striking to note that standard diagnostic workup comprised of labs and aspiration could not make a diagnostic of prosthetic joint infection based on MSIS criteria. Meanwhile, 10 of the pre-revision arthroscopic biopsies were positive.[6]

Prijin et al specifically sought to compare the utility of sterile glenohumeral aspiration vs. arthroscopic or mini-open pre-revision biopsies. Their patient cohorts were taken from different time periods. Between August 2012 and February 2018, joint aspiration was the primary diagnostic tool. 56 patients (57 aspirations) were identified to be used in this study. Between May 2014 and May 2021, 37 biopsy procedures were identified to be included in this study. Of the studies

discussed thus far, this marks the first that identified separate patient cohorts and compared results for these two diagnostic tools.[7] The statistical values are detailed in Tables 2 and 5 below.

Authors	**Study Type**	**Total Patients**	**Number Aspirations**	**Number Pre-Revision Biopsies**
Dilisio et al, 2014	Retrospective	19	14	19 (arthroscopic)
Tashjian et al, 2017	Retrospective	77	77	17 (mixed)
Akgun et al, 2019	Retrospective	23	0	23 (arthroscopic)
Guild et al, 2020	Retrospective	13	0	13 (arthroscopic)
Doherty et al, 2019	Retrospective	14	5	14
Prujin et al, 2022	Retrospective	56 aspirations 37 biopsies	57 aspirations	12 arthroscopic 25 mini-open
Mederake et al, 2021	Retrospective	56	56	22 (arthroscopic)

Table 1: Study Characteristics

Authors	Sensitivity %	Specificity %	PPV %	NPV %
Dilisio et al, 2014	16.7	100	100	58.3
Tashjian et al, 2017	50	33	50	33
Akgun et al, 2019	-	-	-	-
Guild et al, 2020	-	-	-	-
Doherty et al, 2019	33	73	25	80
Prujin et al, 2022	20	91	63	59
Mederake et al, 2021	0	100	-	73

Table 2: Utility of synovial fluid aspiration[9]

Authors	Sensitivity %	Specificity %	PPV %	NPV %
Dilisio et al, 2014	100	67	50	100
Tashjian et al, 2017	88	100	100	67
Akgun et al, 2019	11	91	50	58
Guild et al, 2020	0	100	-	57
Doherty et al, 2019	0	82	0	75
Prujin et al, 2022	-	-	-	-
Mederake et al, 2021	60	56	33	79

Table 3: Utility of elevated serum ESR or CRP[9]

Lapner et al also completed a multi-center prospective cohort study comparing the diagnostic accuracy of aspiration and percutaneous synovial biopsies. Of note, in this study the percutaneous synovial biopsies were obtained from 6 specific sites that were the same as the sites for open biopsy at time of revision.[5] The statistical values are listed below:

Diagnostic Test	Sensitivity %	Specificity %	PPV %	NPV %
Percutaneous Synovial Biopsy	37	81	37	81
Synovial Fluid Aspiration	0	81	0	78

Table 4: Diagnostic accuracy of elevated percutaneous synovial biopsy and synovial aspiration from Lapner et al

Given the relatively poor sensitivity and positive predictive value of the standard infection screening tests (ESR, CRP, aspiration), arthroscopic tissue biopsyhas gained popularity in suspected shoulder PJI given the higher accuracy, especially with the high positive predictive value at just under 90%. Arthroscopic biopsies also avoid the diagnostic dilemma of a dry tap. When compared with mini-open biopsies obtained prior to revision, the diagnostic accuracy appears comparable. Pooled statistical results detailing the diagnostic value of arthroscopic biopsy are shown in the table below:

Authors	Number of scopes	Positive scope culture/total cases	Sensitivity %	Specificity %	PPV %	NPV %
Dilisio et al, 2014	19	9/19	100	100	100	100
Tashjian et al, 2017	17	11/17	75	60	82	50
Akgun et al, 2019	23	16/23	100	39	31	100
Guild et al, 2020	13	2/13	67	100	100	80
Doherty et al, 2019	14	3/14	100	100	100	100
Prujin et al, 2022	12	4/12	60	86	75	75
Mederake et al, 2021	22	11/22	100	83	67	100
Total	120	56/120	76	91	88	81

Table 5: Utility of arthroscopic biopsy[9]

In summation, the studies above demonstrate that arthroscopic tissue biopsies can serve as an appropriate and efficacious diagnostic tool in the setting of suspected prosthetic shoulder joint arthroplasty. The low sensitivity of both synovial fluid aspirations and serum ESR/CRP make them much less reliable in evaluation of a possible joint infection in the setting of a painful shoulder arthroplasty. In the setting of painful shoulder arthroplasty with an inconclusive workup, the addition of arthroscopic biopsy can provide surgeons with a more reliable tool to confirm or rule out prosthetic infection prior to undergoing a revision surgery.

References:

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