

Authors: Jay Keener, Ofer Levy, Adrien Jacquot

### QUESTION 3: What intraoperative findings are concerning for shoulder periprosthetic joint infection (PJI)?

**RECOMMENDATION:** The presence of humeral stem loosening and cloudy synovial fluid should raise suspicion for shoulder PJI. Gross intra-articular pus (without a mechanical or rheumatologic explanation) or the presence of a sinus tract, communicating with the implant, are pathognomonic for periprosthetic shoulder infection.

**LEVEL OF EVIDENCE:** Consensus

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

#### RATIONALE

Each specific clinical question was queried via input of keywords into the PubMed search engine. Appropriate references were reviewed to summarize findings and determine the level of evidence. The bibliographies of selected articles were scanned for additional references that may be applicable to the question. The findings of applicable studies were synthesized to formulate recommendations.

#### Synovial Fluid Analysis

The presence of “cloudy” fluid noted intraoperatively is associated with *C. acnes* culture positive prosthetic shoulder revisions. When combined with other patient demographics (male), radiographic features (humeral osteolysis and glenoid loosening) and the presence of a humeral membrane, cloudy fluid was associated with a 3-6 fold increase in the risk of shoulder PJI [1,2]. The presence of cloudy fluid suggests an elevated white blood cell (WBC) count. However, what constitutes “cloudy fluid” is subjective. Additionally, the threshold value for an elevated WBC for shoulder PJI is unknown and may be lower than accepted levels for other prosthetic joint infections given the lower virulence of *C. acnes*. *C. acnes* infections have been associated with relative increases in lymphocytes and plasma cells rather than polymorphonuclear leukocyte (PMN) [3]. The currently accepted white blood cell count thresholds of > 1100-3000 cells/cc with a > 80% PMN differential for chronic hip and knee arthroplasty infections [4,5] are likely not relevant for the diagnosis of shoulder PJI due to the less vigorous inflammatory response elicited by common shoulder bacterial pathogens. However, given the potential for infection by bacterial species other than *C. acnes*, a synovial fluid WBC with differential is a potentially valuable initial screening test for shoulder PJI.

#### Gross Biofilm

There is weak evidence linking the presence of increased biofilm, specifically humeral membrane, to the presence of bacterial infection, notably *C. acnes* [1,2]. The presence of biofilm forma-

tion is common with bacterial infections and not specific to *C. acnes*. Humeral membrane can also be present in cases of aseptic humeral loosening. The amount of biofilm formation that would be considered pathologic or indicative of infection is subjective and not known.

Furthermore, biofilm formation present in infected cases may not be macroscopically detectable. The absence of increased biofilm visually does not rule out a bacterial infection. The presence of biofilm (membrane) alone does not accurately diagnose an infection but may be used as an adjunct finding.

#### Sinus Tract

See Shoulder: Section 2.3. Diagnosis: Diagnostic Criteria, Question 1 for discussion of sinus tract as diagnostic marker for PJI.

#### Humeral Stem Loosening

See Shoulder: Section 2.3. Diagnosis: Diagnostic Criteria, Question 5 for discussion of the association between humeral component loosening and PJI.

#### REFERENCES

- [1] Hou C, Gupta A, Chen M, Matsen FA. How do revised shoulders that are culture positive for *Propionibacterium* differ from those that are not? *J Shoulder Elbow Surg.* 2015;24:1427-1432. doi:10.1016/j.jse.2015.01.003.
- [2] Pottinger P, Butler-Wu S, Neradilek MB, Merritt A, Bertelsen A, Jette JL, et al. Prognostic factors for bacterial cultures positive for *Propionibacterium acnes* and other organisms in a large series of revision shoulder arthroplasties performed for stiffness, pain, or loosening. *J Bone Joint Surg Am.* 2012;94:2075-2083. doi:10.2106/JBJS.K.00861.
- [3] Levy O, Iyer S, Atoun E, Peter N, Hous N, Cash D, et al. *Propionibacterium acnes*: an underestimated etiology in the pathogenesis of osteoarthritis? *J Shoulder Elbow Surg.* 2013;22:505-511. doi:10.1016/j.jse.2012.07.007.
- [4] Zmistowski B, Della Valle C, Bauer TW, Malizos KN, Alavi A, Bedair H, et al. Diagnosis of periprosthetic joint infection. *J Arthroplasty.* 2014;29:77-83. doi:10.1016/j.arth.2013.09.040.
- [5] Parvizi J, Ghanem E, Sharkey P, Aggarwal A, Burnett RSJ, Barrack RL. Diagnosis of infected total knee: findings of a multicenter database. *Clin Orthop Relat Res.* 2008;466:2628-2633. doi:10.1007/s11999-008-0471-5.

