



Routine cultures for seemingly aseptic revision shoulder arthroplasty: are they necessary?

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Propionibacterium acnes has recently gained attention as the leading cause of periprosthetic joint infections (PJIs) after shoulder arthroplasty. Unlike PJIs in the lower extremity, PJIs after shoulder arthroplasty usually have an indolent course and are notoriously difficult to diagnose. Most of the time, the diagnosis is made after positive intraoperative cultures are taken at the time of revision surgery. Adding even more complexity to the diagnosis is the high rate of *P acnes*-positive cultures taken at the time of primary shoulder surgery. In many cases the preoperative workup yields no suspicion for infection; however, intraoperative cultures are taken to completely eliminate the potential of an ongoing indolent infection. Concerns over how to interpret positive *P acnes* culture results and the high rate of culture positivity in primary shoulder arthroplasty, as well as the potentially high rate of contamination, have led surgeons to wonder about the utility of obtaining intraoperative cultures at the time of revision shoulder arthroplasty. We present evidence for and against the practice of obtaining routine intraoperative cultures at the time of seemingly aseptic revision shoulder arthroplasty.

Level of evidence: Narrative Review

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Propionibacterium acnes has recently come to the forefront of shoulder arthroplasty as a leading cause of periprosthetic joint infections (PJIs).^{21,26,27,31} The diagnosis of a PJI after shoulder arthroplasty can be difficult because of its indolent nature. A high index of suspicion is needed to diagnose periprosthetic shoulder infections as these rarely present with any overt clinical, laboratory, or radiographic features.^{3,18,31,32} Many times, the only presenting complaint is prolonged shoulder pain or stiffness. Making the diagno-

sis even more challenging, there are no diagnostic criteria or consensus statements for shoulder PJIs as there are in hip and knee arthroplasty.²⁴

P acnes is a lipophilic, aerotolerant-anaerobic, gram-positive bacillus that lives within the pilosebaceous glands and poses a unique diagnostic challenge for shoulder surgeons. These glands have a higher density in the chest, shoulder, and back, leading to greatest concern for *P acnes* infections in orthopedic shoulder and spine surgery.¹⁰ *P acnes* is a slow-growing organism that possesses low virulence, making it difficult to diagnose and difficult to culture. Reports have shown the poor sensitivity of standard laboratory markers such as white blood cell count, C-reactive protein, erythrocyte sedimentation rate, and leukocyte esterase.²⁹ Current

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frozen pathology grading systems result in low sensitivity for *P acnes* infections, and although changing thresholds for polymorphonuclear leukocyte per power fields can improve sensitivity and specificity, pathology is not an ideal point-of-care diagnostic test.⁷ Immunoassays of cytokine profiles (IL-6, tumor necrosis factor α , and IL-2) show promise for diagnosis of shoulder PJIs⁵; currently, the diagnosis of a *P acnes* PJI is made within 2 weeks postoperatively based on intraoperative culture results taken at the time of the revision shoulder arthroplasty.

It has been suggested that standard culture techniques may not be adequate for slow-growing organisms such as *P acnes*. Because of this long incubation time, the possibility of contamination and false-positive results is increased and may lead to over-treatment of aseptic revisions. Although cultures are an important part of the diagnostic process, the accuracy of *P acnes* cultures has not been determined and there is debate regarding the number of positive cultures needed to diagnose a *P acnes* PJI. There is no doubt that true infections exist, but with the rates of culture-positive revisions as high as 56% and the rates of positive cultures during primary shoulder arthroplasty as high as 56%, what do these culture results mean in the face of a seemingly aseptic revision?^{26,28} We believe that rational arguments can be made for and against the practice of obtaining routine cultures at the time of revision shoulder arthroplasty in the setting of seemingly aseptic failures. In this review, we present both sides of this argument.

Argument in favor of routine cultures for seemingly aseptic revisions

Recent literature on failed shoulder arthroplasties has introduced the idea of “stealth” infections—clinically important infections that do not present with “obvious” infectious signs and symptoms but rather with more vague, insidious symptoms of pain, stiffness, and component loosening.^{3,10,19,26} *Propionibacteria*, the most common bacteria associated with failed shoulder arthroplasties, are generally considered less virulent and do not incite a robust host immune response.^{21,26,27,31} Therefore, the results of a standard preoperative workup of serum laboratory values (white blood cell count, erythrocyte sedimentation rate, and C-reactive protein) and preoperative aspiration of synovial fluid often do not have any striking abnormalities.^{3,18,31} Given the smoldering nature of these infections, the timing of failure can often be months to years after the index surgical procedure.¹⁷ Not uncommonly, patients who underwent arthroplasty a few years earlier with a seemingly successful initial outcome may present with an insidious onset of pain and stiffness in the absence of obvious mechanical failure—a so-called honeymoon period. Because of this, multiple studies that have reported low rates of reoperation for single-stage revision in the setting of positive intraoperative cultures may be limited by short-term follow-up.^{8,13,22,31}

Intraoperative signs of infection may similarly be lacking.²⁶ Cloudy fluid and collar membrane formation may suggest a low-grade infection, but even patients without any of the indicators of infection may have multiple positive cultures. Intraoperative frozen sections may provide some information, but similar to preoperative serum tests and preoperative aspiration, the sensitivity of these tests is not high enough to appropriately rule out infection in most cases.^{7,31}

In the absence of highly sensitive preoperative or intraoperative tests for infection, there is no substitute for intraoperative cultures in determining the presence of bacteria. Bacteria may not be evenly distributed in the case of a stealth periprosthetic shoulder infection as in more suppurative infections; thus, collecting multiple samples of tissues throughout the shoulder and sending explants for analysis at the time of surgery will most reliably recover the potential offending bacteria.^{1,2,15} Obtaining a negative culture from fluid samples, either preoperatively or intraoperatively, is not sufficient to rule out infection—sending tissue and the explanted prosthesis for analysis results in the highest yield.^{1,14} Because of the fastidious nature of these bacteria, it is important to culture at least 4 to 5 samples grown on multiple media for a minimum of 10 to 17 days.^{4,15}

In planning for revision surgery in a shoulder with pain and stiffness without obvious signs of infection, a single-stage revision is a valid option.¹¹ However, the surgeon should take into account the potential persistence of biofilm and persistent infection if the entire prosthesis is not explanted. Clearing any potential infection is dependent on a number of different factors including appropriate debridement, removal of any biofilm-laden implants, and appropriate treatment with postoperative antibiotics. In these cases, it is likely that the surest way of preventing recurrent infection is a complete prosthesis exchange, culturing of multiple tissue samples and explant material, and culture-driven postoperative antibiotic therapy.

The major risk of not obtaining multiple cultures when approaching revision arthroplasty is that the appropriate type, route, and length of postoperative antibiotics will not be instituted. Prescribing antibiotics, such as oral doxycycline, after surgery while awaiting culture results is a way of initiating early treatment of infection. In most patients, coverage for *Propionibacterium* is adequate. More persistent organisms, such as *mecA*-positive coagulase-negative *Staphylococcus*, may be resistant to multiple antibiotics and, if missed, may lead to recurrent failure of the revised arthroplasty.³⁰ One approach to antibiotic administration after revision surgery is to provide oral or intravenous (IV) antibiotics immediately after surgery for several weeks while cultures are pending. If the cultures are negative, the antibiotics can be discontinued. Multiple positive cultures should prompt 6 weeks of IV antibiotic therapy with consideration of a longer course of oral antibiotics.¹¹ Although the cutoff for IV antibiotic administration may vary at different institutions, the literature supports sending a minimum of 5 cultures for analysis and diagnosing infection if 2 of these cultures are positive for the

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