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QUESTION 6: Is there a role for sonication of retrieved shoulder implants in the diagnosis of shoulder periprosthetic joint infection (PJI)?

RECOMMENDATION: There is currently no evidence to support routine sonication of the retrieved shoulder implant in the diagnosis of shoulder PJI.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

PubMed and Embase were searched from 1980 to January 2018 to identify studies evaluating the role of sonication of retrieved implants in shoulder PJI. A secondary search of the references of included studies was also conducted. Prior work has evaluated the role of sonication of retrieved implants in hip and knee arthroplasty. In some of these scenarios, sonication of implants has been used to improve PJI culture sensitivity via disruption of bacterial biofilms (see Hip and Knee, Section 2.4. Pathogen Isolation, Culture Related Matters, Question 6 for full discussion of available literature and recommendations from the International Consensus Meeting (ICM) on musculoskeletal infection) [1–7]. Our search identified two studies that have evaluated the role of implant sonication specifically in the setting of shoulder PJI [3,5].

Piper et al. compared periprosthetic tissue culture and implant sonication followed by sonicate fluid culture from 136 shoulder arthroplasty revisions performed for any indication between 2004 and 2008 [5]. For the sonicate fluid culture, a cutoff of > 20 colony forming units per milliliter was used to exclude contaminants. Thirty-three cases had a definite shoulder PJI and 2 had probable shoulder PJI. The sonicate fluid culture showed slightly better sensitivity for detecting shoulder PJI compared with periprosthetic tissue culture (66.7% vs. 54.5%, p = 0.046). There was no difference in specificity (98% vs. 95.1%, p = 0.26). The authors concluded that sonication improved the diagnosis of shoulder PJI.

Grosso et al. compared intraoperative tissue and fluid culture to sonication fluid culture for 53 revision total shoulder arthroplasty procedures, of which 25 were identified as shoulder PJI [3]. The sensitivity and specificity of the intraoperative cultures were 96% and 75%, respectively. Using a cutoff of > 20 colony forming units per milliliter, the sonication fluid culture had sensitivity and specificity of 56% and 93%, respectively. While the sensitivity was greater for intraoperative culture than sonication (p = 0.001), there was no difference in specificity (p = 0.07). The authors concluded that implant sonication had no benefit in comparison to standard intraoperative cultures for shoulder PJI diagnosis.

The Piper et al. and Grosso et al. studies differed in several ways including the diagnostic criteria for shoulder PJI (2 positive cultures vs. 1 positive culture with other signs of infection), length of culture (7 days vs. 12 to 14 days) and the sonication methods. Overall, the conflicting results of these two limited studies make it unclear whether sonication can improve diagnosis of shoulder PJI.

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QUESTION 7: Should preoperative antibiotics be held until after cultures are obtained in revision shoulder arthroplasty (RSA)?

RECOMMENDATION: Recent studies have shown that preoperative antibiotic prophylaxis does not adversely affect intraoperative culture results. We do not recommend routinely holding preoperative antibiotics in RSA.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

In a systematic review using the Cochrane Library, Medline, Embase and CINAHL (Cumulative Index to Nursing and Allied Health Literature) databases, it has been reported that intravenous antibiotic prophylaxis reduces the risk of absolute infection by 8% and the risk of relative infection by 81% in patients who underwent a primary or revision total hip replacement or total knee replacement [1]. On the other hand, it has been shown that the identification of pathogen and pathogen-specific antibiotic therapy are extremely important in the treatment of periprosthetic joint infection (PJI) [2,3]. In the Report of the Third International Consensus Meeting, withholding preoperative antibiotics was not routinely recommended for the operative treatment of the knee and hip PJI [4,5]. However, it has been stated that antibiotics might be held in cases where the pathogen is not identified preoperatively [4]. In contrast to bacteria with high antigenicity that cause suppurative infection and sepsis clinically, low virulence *C. acnes* (*Cutibacterium acnes*) is responsible for the majority of shoulder PJI [6,7]. The culture sensitivity is poor for this pathogen [6]. It may be helpful to utilize implant sonication [8], next-generation sequencing and polymerase chain reaction (PCR) technologies to increase the sensitivity of detecting this low-virulence bacterium [3]. However, those techniques are not used routinely in current clinical practice due to fact that they are not cost-effective and require additional equipment [9]. Given these difficulties, it is important to anticipate whether preoperative intravenous antibiotic prophylaxis will reduce culture sensitivity. Pottinger et al. [10] evaluated the effects of antibiotic prophylaxis on the culture positivity in patients who underwent RSA with a diagnosis of shoulder PJI (at least 2 cultures being positive). In the patient group for which antibiotics were held, the cultures were more than twice as likely to be positive for *C. acnes* and other organisms versus the group of patients where antibiotics had not been held. However, this is a retrospective study and the decision to hold antibiotics was dependent on the operating surgeon. There might be bias on holding antibiotics for a case that the operating surgeon thought might be infected rather than not. There is insufficient literature in this regard with limited evidence. In the majority of RSA studies, although the effect of antibiotic prophylaxis on culture positivity has not been directly examined, it has been observed that clinicians have a tendency to hold preoperative antibiotic prophylaxis in revision shoulder arthroplasty [10–13]. However, in the Clinical Practice Guideline issued by the Infectious Diseases Society of America, the importance of evaluating preop PJI risk was emphasized in the decision to hold antibiotic prophylaxis. If the history, examination, erythrocyte sedimentation rate, C-reactive protein level and preoperative aspiration suggest that the risk of PJI is low, preoperative antibiotic holding is not recommended. Preoperative antibiotic holding is only recommended in cases where the infection is strongly suspected [14].

A study directly examining the effect of preoperative antibiotics on culture results in RSA was performed recently by Anagnostopoulos et al. The authors assessed the influence of antibiotic prophylaxis within 30 to 60 minutes before surgery on time to positivity of intraoperative cultures and the proportion of positive intraoperative cultures [15]. One-hundred-ten patients who underwent revision shoulder, hip or knee arthroplasty were included in the study. Seventy-two patients underwent RSA and the culture of *C. acnes* was evaluated directly. Among the 64 patients with *C. acnes* infection, the proportion of culture positivity was 71.6% (95% confidence interval (CI) 64.1-79.1) in the patients without perioperative prophylaxis, whereas the proportion of culture positivity was 65.9% (95% CI 55.3-76.5) in the patients with perioperative prophylaxis. This was not a statistically significant difference ($p = 0.39$).

In a study by Matsen et al. [16], intraoperative positive cultures for *C. acnes* could be obtained even when using intravenous antibiotic prophylaxis in the setting of a primary shoulder replacement. Similar to Matsen et al., Phadnis et al. [17] reported obtaining positive culture for *C. acnes* from the shoulder dermis despite skin preparation and prophylactic antibiotics.

Based on the available limited literature, considering that the importance of protecting the newly implanted hardware and avoiding surgical field infection are of utmost importance, we recommend that preoperative antibiotics should not be held until after cultures are obtained in RSA.

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