

QUESTION 5: Is there a role for postoperative (pending culture results) antibiotics after revision shoulder arthroplasty without suspicion for infection?

RECOMMENDATION: In revision shoulder arthroplasty without clinical suspicion for infection, prolonged antibiotics are not routinely required.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

The prevalence of subclinical infections (unexpected positive culture (UPC)) is especially common with shoulder arthroplasty due to anatomic and demographic factors. The rate of positive cultures in primary and revision arthroplasty settings have been reported as high as 56% [1–3]. However, the significance and optimal treatment for UPCs remains unknown. There is limited data in the shoulder literature for or against any role for postoperative prophylactic/suppressive antibiotics after revision shoulder arthroplasty without clinical or radiographic signs of infection. While several studies described the use of prophylactic or suppressive antibiotics after revision shoulder arthroplasty, there was a lack of prospective randomized studies and none of the studies specifically evaluated their efficacy or included a comparative group.

Among published studies for outcomes specifically after revision shoulder arthroplasty with unexpected positive cultures, all were retrospective studies with differing and suboptimal methodologies [4–8]. None of the studies found a detrimental effect associated with not prescribing prolonged antibiotics postoperatively, although one study with no comparison group reported a 25% recurrence rate after UPC. For those studies that treated UPC with prolonged antibiotics, recurrence rates were low (0–3.5%). One systematic review confirmed a pooled true infection rate after UPC of 10.2% with antibiotic use not influencing the rate of occurrence of true infection after UPCs ($p = 0.498$) [9]. In the lower extremity arthroplasty literature, there was one randomized controlled study which found a limited benefit to prolonged oral antibiotic therapy after two-stage revision with negative cultures (5% versus 19%), although culture profiles from the reinfection tended to differ from the original infection organism profile [10].

One study used antibiotic cement and 24 hours of routine postoperative antibiotics with 1 superficial infection and no deep infections after revision shoulder arthroplasty [4]. Another study reported at least a 10% persistent infection rate after one-stage shoulder arthroplasty revision although antibiotic use and positive cultures did not influence the rate of true infections [5]. Another study reported a 23.9% UPC rate after revision shoulder arthroplasty with standardized UPC treatment of 6 weeks antibiotics or 2 weeks antibiotics at surgeon discretion. They found only 1 recurrent infection in the UPC group, 3.5% versus 3.4% in the non-UPC group [6]. Another study reported 8/28 (29%) UPC rate after revision shoulder arthroplasty and only treated one with antibiotics postoperatively for 4 weeks (due to superficial wound infection). Of 8 patients, 2 (25%) developed late clinical infection with *C. acnes* [7]. The last study reported a 49% positive culture rate after revision shoulder arthroplasty and treated patients based on a protocol of 6 weeks intravenous (IV) and 6 months of oral antibiotics if > 2 cultures were positive. No patients (0%) had recurrence of infection with this protocol for the positive culture group and

negative culture groups [8]. Two studies reported a 19–42% complication side-effect rate from prolonged antibiotic use which was seen in both oral and IV medication use [4,8]. The vast majority (> 80%) of UPCs were *C. acnes* or Coagulase-negative *Staphylococcus* organisms and, therefore, meaningful comparisons to other more virulent organisms could not be performed.

Recent recommendations from the World Health Organization and the Centers for Disease Control and Prevention suggest a single perioperative dose is adequate for clean and clean-contaminated procedures [11,12]. One meta-analysis included 69 randomized controlled trials and did not demonstrate a difference in the odds of surgical site infection with a single intraoperative dose compared to multiple doses of postoperative surgical antimicrobial prophylaxis (odds ratio (OR) 0.89; 95% confidence interval (CI) 0.77–1.03) [12]. Encompassing concerns regarding the potential adverse consequences of antimicrobial use, in particular the risk of antimicrobial resistance, the panel made a strong recommendation, based on moderate quality evidence, that surgical antimicrobial prophylaxis should not be extended beyond the completion of the operation [12]. The applicability to unexpected positive cultures was not addressed in the studies.

In aggregate, these retrospective studies show no supporting evidence for routine use of prolonged antibiotic use over no prolonged antibiotic treatment in the setting of UPC after revision shoulder arthroplasty. Specifically, there is no identified evidence to demonstrate earlier preemptive treatment of UPC will ultimately alter outcomes. Patients without true infection may be unnecessarily exposed to a significant course of prolonged antimicrobials. There are well-reported risks of antibiotic-related side-effects and less obvious risks of antibiotic resistance with widespread prescribing. Additionally, there is no supporting evidence that suggests that antibiotic treatment should differ between UPC organisms.

A comprehensive literature review was performed to identify all studies on prophylactic/suppressive antibiotics after revision shoulder arthroplasty. Searches for the terms “shoulder replacement,” “infection,” “antibiotics,” “postoperative” and “joint replacement” were performed using the search engines PubMed and Google Scholar, which were searched through February 2018. Inclusion criteria for our systematic review were all English studies (Level I-IV evidence) that reported on antibiotic prophylaxis, or lack thereof, in cases of revision shoulder arthroplasty. Exclusion criteria were non-English language articles, nonhuman studies, retracted papers, case reports, review papers, studies with less than < 10 patients in the sample size, studies without clinical follow-up/infection rates and technique papers without patient data. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were followed. Thirty articles met inclusion and exclusion criteria and were reviewed.

REFERENCES

- [1] Sethi PM, Sabetta JR, Stueck SJ, Horine SV, Vadasdi KB, Greene RT, et al. Presence of *Propionibacterium acnes* in primary shoulder arthroscopy: results of aspiration and tissue cultures. *J Shoulder Elbow Surg.* 2015;24:796–803. doi:10.1016/j.jse.2014.09.042.
- [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] Brolin TJ, Hackett DJ, Abboud JA, Hsu JE, Namdari S. Routine cultures for seemingly aseptic revision shoulder arthroplasty: are they necessary? *J Shoulder Elbow Surg.* 2017;26:2060–2066. doi:10.1016/j.jse.2017.07.006.
- [4] Grosso MJ, Sabesan VJ, Ho JC, Ricchetti ET, Iannotti JP. Reinfection rates after 1-stage revision shoulder arthroplasty for patients with unexpected positive intraoperative cultures. *J Shoulder Elbow Surg.* 2012;21:754–758. doi:10.1016/j.jse.2011.08.052.
- [5] Foruria AM, Fox TJ, Sperling JW, Cofield RH. Clinical meaning of unexpected positive cultures (UPC) in revision shoulder arthroplasty. *J Shoulder Elbow Surg.* 2013;22:620–627. doi:10.1016/j.jse.2012.07.017.
- [6] Padegimas EM, Lawrence C, Narzikul AC, Zmistowski BM, Abboud JA, Williams GR, et al. Future surgery after revision shoulder arthroplasty: the impact of unexpected positive cultures. *J Shoulder Elbow Surg.* 2017;26:975–981. doi:10.1016/j.jse.2016.10.023.
- [7] Kelly JD, Hobgood ER. Positive culture rate in revision shoulder arthroplasty. *Clin Orthop Relat Res.* 2009;467:2343–2348. doi:10.1007/s11999-009-0875-x.
- [8] Hsu JE, Gorbaty JD, Whitney IJ, Matsen FA. Single-stage revision is effective for failed shoulder arthroplasty with positive cultures for *Propionibacterium*. *J Bone Joint Surg Am.* 2016;98:2047–2051. doi:10.2106/JBJS.16.00149.
- [9] Kim SJ, Kim JH. Unexpected positive cultures including isolation of *Propionibacterium acnes* in revision shoulder arthroplasty. *Chin Med J.* 2014;127:3975–3979.
- [10] Frank JM et al. The Mark Coventry, MD, Award: oral antibiotics reduce reinfection after two-stage exchange: a multicenter, randomized controlled trial. *Clin Orthop Relat Res.* 2017;475(1):56–61.
- [11] Berrios-Torres SI, Umscheid CA, Bratzler DW, Leas B, Stone EC, Kelz RR, et al. Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection, 2017. *JAMA Surg.* 2017;152:784–91. doi:10.1001/jamasurg.2017.0904.
- [12] Allegranzi B, Zayed B, Bischoff P, Kubilay NZ, de Jonge S, de Vries F, et al. New WHO recommendations on intraoperative and postoperative measures for surgical site infection prevention: an evidence-based global perspective. *Lancet Infect Dis.* 2016;16:e288–e303. doi:10.1016/S1473-3099(16)30402-9.



1.2. PREVENTION: INTRAOPERATIVE

Authors: Mark Falworth, Jeremy Somerson

QUESTION 1: Should antibiotic-impregnated cement be used during shoulder arthroplasty (primary and revision)?

RECOMMENDATION: There is insufficient evidence to determine whether antibiotic-impregnated cement should be used during primary or revision shoulder arthroplasty.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

A comprehensive review was performed to identify studies relating to the use of antibiotic impregnated cement in primary and revision shoulder arthroplasty. Searches for the terms “shoulder replacement,” “shoulder arthroplasty,” “prosthesis infection” and “post-operative infection” were undertaken using the search engines PubMed, Embase and Medline. Inclusion criteria included all systematic reviews, randomized controlled trials, cohort studies, case-controlled studies and case series with more than three patients with periprosthetic shoulder infections. Exclusion criteria consisted of case reports, case series with three or fewer patients with shoulder periprosthetic infection, expert opinions, articles relating to periprosthetic infections of joints other than the shoulder and publications not published in the English literature.

Periprosthetic joint infection (PJI) is relatively rare in shoulder arthroplasty (0.4–2.9%) but can be significantly higher in reverse shoulder arthroplasty [1]. PJI can have devastating implications for the patient and lead to significant cost and care provision challenges to the treating surgical teams. Minimizing the risk of infection is, therefore, imperative and optimization of cement fixation with the use of antibiotic-impregnated cement has been proposed as one such method [2]. Indeed, its use has long been suggested as an effective means of reducing the risk of lower limb arthroplasty infection [3].

In cemented primary shoulder arthroplasty, the choice of cement may be influential in the prevention of prosthetic joint infection. However, there is little reported in the literature on the effects of cement choice. Nowinski et al. [2] authored the only shoulder-specific publication in our literature review in which a primary reverse shoulder arthroplasty was cemented using either antibiotic loaded or plain cement. However, it was a retrospective study of 501 implants, divided into two groups (265 vs. 236), with four surgeons using three different antibiotic and cement combinations for differing primary pathologies. Deep infection was noted in 3% of the plain cement group, but none were reported in the antibiotic cement group. This was statistically significant ($p < 0.001$). However, there is a significant selection bias relating to these groups of patients as they were treated in different facilities by different surgeons, and there is, therefore, a substantial risk of confounding variables. In particular, the group without antibiotic-impregnated cement had over twice as many diagnoses of post-traumatic arthritis ($n = 37$) compared to the group in which antibiotics were used ($n = 16$). There were no cases of humeral loosening or osteolysis in the group with antibiotic-impregnated cement.

In revision shoulder arthroplasty, the revision procedure is often dictated by the cause of failure and the underlying pathology. There is no evidence regarding the use of antibiotic impregnated