REFERENCES

[1] Sethi PM, Sabetta JR, Stuek 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] Berríos-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

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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 "postoperative 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

cement in managing aseptic loosening with a one-stage prosthesis exchange. However, in the management of PJI, the role of antibiotic loaded cement choice may be dependent upon the type of operative revision: debridement and implant retention, one-stage revision, two-stage revision and resection arthroplasty.

Two publications [4,5] do report a series in which no recurrence of infection was noted following the use of antibiotic impregnated cement during one-stage revision of infected shoulder arthroplasty; however, the sample sizes were small with 16 patients in one cohort and 32 in the other. There was no comparative control group using plain cement, and, as all patients also underwent debridement and postoperative antibiotic therapy, no firm conclusions can be drawn regarding the independent relevance of the cement due to the presence of multiple confounding variables.

REFERENCES

[1] Bohsali KI, Bois AJ, Wirth MA. Complications of shoulder arthroplasty. J Bone Joint Surg Am. 2017;99:256–269. doi:10.2106/JBJS.16.00935.

[2] Nowinski RJ, Gillespie RJ, Shishani Y, Cohen B, Walch G, Gobezie R. Antibiotic-loaded bone cement reduces deep infection rates for primary reverse total shoulder arthroplasty: a retrospective, cohort study of 501 shoulders. J Shoulder Elbow Surg. 2012;21:324–328. doi:10.1016/j.jse.2011.08.072.

[3] Engesaeter LB, Lie SA, Espehaug B, Furnes O, Vollset SE, Havelin LI. Antibiotic prophylaxis in total hip arthroplasty: effects of antibiotic prophylaxis systemically and in bone cement on the revision rate of 22,170 primary hip replacements followed 0-14 years in the Norwegian Arthroplasty Register. Acta Orthop Scand. 2003;74:644–651. doi:10.1080/00016470310018135.

[4] Ince A, Seemann K, Frommelt L, Katzer A, Loehr JF. One-stage exchange shoulder arthroplasty for peri-prosthetic infection. J Bone Joint Surg Br. 2005;87:814–818. doi:10.1302/0301-620X.87B6.15920.

[5] Klatte TO, Kendoff D, Kamath AF, Jonen V, Rueger JM, Frommelt L, et al. Single-stage revision for fungal peri-prosthetic joint infection: a single-centre experience. Bone Joint J. 2014;96-B:492–496. doi:10.1302/0301-620X.96B4.32179.

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QUESTION 2: What is the role of topical intrawound antiseptics (dilute betadine lavage, acetic acid or antibiotics added to the irrigation solution) and antibiotic powder (such as vancomycin) during primary or revision shoulder arthroplasty?

RECOMMENDATION: Dilute povidone-iodine and/or vancomycin powder may have a role in patients considered at high-risk for periprosthetic joint infection (PJI) after primary or revision shoulder arthroplasty based on data extrapolated from other orthopaedic specialties.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

There is no data in the shoulder literature specific to the use of specific intrawound antiseptic agents, irrigation solutions or antibiotic powders. Because of this, expert recommendations will have to be inferred from data from spine surgery [1,2], elbow surgery [3] and lower extremity arthroplasty [4]. There are two randomized single-blinded studies that demonstrated the efficacy and safety of dilute betadine irrigation at reducing the risk of infection in spinal surgery [5,6]. Based on a review of this literature, there appear to be advantages associated with the utilization of dilute betadine and vancomycin powder in cases of primary surgery for prevention of surgical site infection and in cases of PJI treatment for prevention of recurrent PJI. However, the data does not consider the risks of development of antimicrobial resistance with use of vancomycin powder. Betadine may have a negative influence on osteoblast proliferation in vitro [7], and so utilization in cases of fracture may not be recommended. While data is lacking specifically for the shoulder, consensus from the hip/knee, trauma and spine groups provide the ability to make some generalized recommendations for primary and revision shoulder surgery.

TABLE 1. Characteristics of studies assessing intrawound agents, irrigation solutions or antiobiotic powders*

Study	Methods	Intrawound Product/Joint	Site	Result
Yan et al. [3]	Retrospective	Vancomycin powder	Elbow	Positive result: 6.4% SSI vs. 0% infection SSI
Riesgo et al. [4]	Retrospective	Dilute povidone-iodine lavage plus vancomycin powder	Lower extremity PJI	Positive result: 16.7% failed vs. 37% failed
Hey et al. [1]	Retrospective cohort comparative	Vancomycin powder	Spine	Positive result: 0.9% SSI vs. 6.3% SSI
Ghobrial et al. [2]	Meta-analysis	Vancomycin powder	Spine	Systematic review: confirms safety
Tomov et al. [8]	Retrospective	Vancomycin powder, betadine	Spine	Positive result: SSI rates were reduced by 50%

* None of these studies evaluated the shoulder specifically. SSI, surgical site infection; PJI, periprosthetic joint infection