A comprehensive literature review was performed to identify all studies examining the use of intrawound antiseptics and antibiotic powder in shoulder arthroplasty. Searches for the terms "intrawound antiseptics shoulder" (0/0), "antibiotic powder shoulder" (3/0), "betadine shoulder" (8/0), "irrigation solution shoulder" (18/1) and "shoulder irrigation infection" (81/0) were performed using the search engines PubMed and Scopus, which were searched through February 2018. Inclusion criteria for our systematic review were all English language studies (Level I-IV evidence) that reported on use of intrawound antiseptics or antibiotic powder in primary or revision shoulder surgery. 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. We identified zero articles from PubMed and zero articles from Scopus that met all criteria. Given the limited number of articles identified with the search terms used, searches were separately performed to identify studies on intrawound antiseptic and antibiotics powder outside of the shoulder literature.

Of note, the Centers for Disease Control and Prevention released a recommendation on the use of vancomycin in 1995. Due to concerns for development of antimicrobial resistance, routine utilization of vancomycin in prophylaxis has been discouraged. Instead, use of vancomycin is believed to be acceptable for "prophylaxis for major surgical procedures involving implantation of prosthetic materials or devices at institutions that have a high rate of infections caused by methicillin-resistant *Staphylococcus aureus* or methicillin-resistant *S. epidermidis*. A single dose of vancomycin administered immediately before surgery is sufficient unless the procedure lasts greater than six hours, in which case the dose should be repeated. Prophylaxis should be discontinued after a maximum of two doses." This position statement has not been updated recently or amended to include a discussion of vancomycin powder.

REFERENCES

[1] Hey HW, Thiam DW, Koh ZS, Thambiah JS, Kumar N, Lau LL, et al. Is intraoperative local vancomycin powder the answer to surgical site infections in spine surgery? Spine. 2017;42:267–274. doi:10.1097/BRS.0000000000001710.

[2] Ghobrial GM, Cadotte DW, Williams K, Fehlings MG, Harrop JS. Complications from the use of intrawound vancomycin in lumbar spinal surgery: a systematic review. Neurosurg Focus. 2015;39:E11. doi:10.3171/2015.7.FOCUS15258.

[3] Yan H, He J, Chen S, Yu S, Fan C. Intrawound application of vancomycin reduces wound infection after open release of post-traumatic stiff elbows: a retrospective comparative study. J Shoulder Elbow Surg. 2014;23:686–692. doi:10.1016/j.jse.2014.01.049.

[4] Riesgo AM, Park BK, Herrero CP, Yu S, Schwarzkopf R, Iorio R. Vancomycin povidone-iodine protocol improves survivorship of periprosthetic joint infection treated with irrigation and debridement. J Arthroplasty. 2018;33:847–850. doi:10.1016/j.arth.2017.10.044.

[5] Chang FY, Chang MC, Wang ST, Yu WK, Liu CL, Chen TH. Can povidone-iodine solution be used safely in a spinal surgery? Eur Spine J. 2006;15:1005–1014. doi:10.1007/s00586-005-0975-6.

[6] Cheng MT, Chang MC, Wang ST, Yu WK, Liu CL, Chen TH. Efficacy of dilute betadine solution irrigation in the prevention of postoperative infection of spinal surgery. Spine. 2005;30:1689–1693.

[7] Newton Ede MP, Philp AM, Philp A, Richardson SM, Mohammad S, Jones SW. Povidone-iodine has a profound effect on in vitro osteoblast proliferation and metabolic function and inhibits their ability to mineralize and form bone. Spine. 2016;41:729–734. doi:10.1097/BRS.0000000000001332.

[8] Tomov M, Mitsunaga L, Durbin-Johnson B, Nallur D, Roberto R. Reducing surgical site infection in spinal surgery with betadine irrigation and intrawound vancomycin powder. Spine. 2015;40:491–499. doi:10.1097/BRS.0000000000000789.

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QUESTION 3: Do surgical drains influence the risk of infection in patients undergoing primary or revision shoulder arthroplasty?

RECOMMENDATION: There is no evidence to support routine use of closed-suction drains in patients undergoing shoulder arthroplasty for the prevention of periprosthetic joint infection (PJI).

LEVEL OF EVIDENCE: Limited

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

RATIONALE

We conducted literature search of PubMed for all articles published on closed surgical drains after anatomic total shoulder arthroplasty (TSA) and reverse total shoulder arthroplasty (RTSA) in the primary and revision settings. The exact search queries performed included the following keywords: "surgical drain in shoulder arthroplasty" in Medical Subject Headings (MeSH) Terms, "closed wound drainage in shoulder arthroplasty," "surgical wound drainage in shoulder arthroplasty" on Title/Abstract and in combination. The initial search produced five articles, including both shoulder and elbow arthroplasty, but after reviewing the elbow arthroplasty-related studies, all of these deemed to not provide information relevant for the purposes of this review and were excluded. This left two articles, both of which had their entire manuscripts analyzed thoroughly for relevance and inclusion.

There is a paucity of literature regarding the use of postoperative closed-suction drains and the relationship to infection and PJI after shoulder arthroplasty [1].

There are no current American Academy of Orthopaedic Surgeon (AAOS) clinical practice guidelines (CPG) which comment on the use of a postoperative drain following TSA or RTSA. While very limited literature is available regarding postoperative drain use in TSA or RTSA, there are several studies that have evaluated blood loss, change in hemoglobin, clinical outcomes and complication rates related to the use of drains after total knee arthroplasty (TKA) and total hip arthroplasty (THA) [1].

A level III, case-control study compared 64 patients who underwent TSH and RTSA without the use of a closed-suction drain to 304 patients that had a drain placed. This study found that drain usage was associated with lower postoperative hemoglobin, longer length of stay and lower postoperative simple shoulder test scores [1]. There was no clinically significant difference in the transfusion rates, superficial wound infections or deep infections. As is sometimes reported in the parallel TKA and THA literature evaluating closed suction drainage, there was no mention of hematoma

formation or analgesic requirements when comparing patients with and without drain use [1].

In 2007, a Cochrane Database Systematic Review evaluated 36 studies regarding the use of closed suction surgical wound drainage after orthopaedic surgery and reported only one study specific to shoulder surgeries by Gartsman et al. [2]. This level II, randomized trial evaluated length of hospital stay, wound dehiscence, infection, reoperation rates and hematomas in patients undergoing TSA, hemiarthroplasty, rotator cuff repair and anterior shoulder instability surgery and found no differences between patients who did or did not receive a drain [3].

Overall, there are few available studies, and these are not sufficiently powered to detect a difference in infection rates after shoulder arthroplasty.

REFERENCES

[1] Erickson BJ, Campbell K, Jain A, et al. Are post-operative drains beneficial in total and reverse total shoulder arthroplasty? Orthop Res Traumatol Open J. 2016;1(1):22-27.
[2] Gartsman GM, Milne JC, Russell JA. Closed wound drainage in shoulder surgery. J Shoulder Elbow Surg. 1997;6:288–290.
[3] Parker MJ, Livingstone V, Clifton R, McKee A. Closed suction surgical wound drainage after orthopaedic surgery. Cochrane Database Syst Rev. 2007:CD001825. doi:10.1002/14651858.CD001825.pub2.

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QUESTION 4: What is the role of tranexamic acid (TXA) during primary or revision shoulder arthroplasty (SA) in decreasing the risk of periprosthetic joint infection (PJI)?

RECOMMENDATION: There is no evidence to support routine use of TXA in patients undergoing shoulder arthroplasty for the prophylaxis of PJI.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

Patients undergoing SA may experience variable degrees of perioperative bleeding and blood loss, which in the most severe cases, may result in complications including hematoma formation [1], acute symptomatic anemia and the need for blood transfusions [2–4]. It has been suggested that there is an association between blood transfusion and wound hematomas with postoperative morbidity, including periprosthetic infection [5,6]. While hematomas requiring surgery are uncommon with a reported rate of 0.3% [5], blood transfusions are more common with a reported rate of 4.3% to 6.7%. [3,4,7,8] Besides the costs, allogeneic blood transfusion is associated with rare but serious complications, including allergic and immune-mediated reactions, hemodynamic overload and risk of blood borne infections [9]. In addition, allogeneic blood transfusions may have an immunomodulatory effect [10] that may predispose to increased risk of periprosthetic infection rate, as seen in total hip or total knee arthroplasty [11] as well as in SA [6].

TXA is a synthetic anti-fibrinolytic agent that has been shown to be a successful and cost-effective agent for reducing blood loss and transfusion requirements for patients undergoing total hip arthroplasty (THA) and total knee arthroplasty (TKA) [12]. Two recent meta-analyses [13,14] of TXA use in patients undergoing primary SA found that TXA is an effective intervention to decrease blood loss as measured by drain output, change in hemoglobin (Hb) and total calculated blood loss. Nevertheless, the effectiveness of TXA in reducing transfusion rates after SA has been conflicting. One meta-analysis reported a benefit of TXA [14] in reducing blood transfusion while a second reported no differences in the transfusion rate when TXA was used perioperatively [13]. Possible reasons for conflicting results are (1) the inclusion of non-randomized studies with biased methodology, (2) a high rate of included studies with zero events of transfusion that were excluded from the calculation of the pooling effect and (3) when there are findings that are not conclusive, there is a lack of an additional analysis to further determine the conclusiveness of the results given the low rate of events. As a result, in order to evaluate the effectiveness of TXA to reduce transfusion rates, we performed a new systematic review and meta-analysis that included only randomized controlled trials (RCT), which compared the use of TXA compared to placebo in patients undergoing SA. This meta-analysis considered the primary outcomes to be the effect of TXA upon transfusion rates, formation of hematomas and thromboembolic events. Secondary outcomes included blood loss as measured by drain output, change of Hb and calculated total blood loss.

Methods

The methodology described in the Cochrane Handbook for Systematic Reviews of Interventions [15] was followed to conduct this review and was reported in accordance to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [16]. Cochrane Central Register of Controlled Trials, Embase and Medline were searched up to March 15, 2018. Four RCTs [17–20] involving 375 patients undergoing primary SA were included. The risk of bias of the included studies was assessed and the pooled risk estimates were calculated with random-effect models. For the primary outcomes (transfusion rate and thromboembolic complications), as most of the trials had no events in the tranexamic acid or control group (zero-event studies), a 0.5 continuity correction was used to include data from those RCTs [21]. A trial sequence analysis was conducted to assist in the interpretation of the conclusiveness of the meta-analysis for the effect of TXA in the risk of blood transfusions. The quality of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) approach.

Results

This meta-analysis confirmed previous meta-analysis results and found that TXA is associated with significantly lower perioperative blood loss compared with placebo and that there is no higher risk of thromboembolic events with TXA (Table 1). However, this meta-analysis found that there was no significant difference for the risk of