cles, review papers, technique papers, non-human studies, biomechanics or basic science papers, articles that discussed only hip and or knee arthroplasty PJI. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were used manage the data of this review. The initial search produced 213 abstracts, all of these were excluded as they did not contain any details or evaluation of the question under investigation. Therefore, there are no current studies to reference the impact or effects of cement removal or autograft bone removal in the setting of shoulder arthroplasty PJI for acute, subacute or chronic infection.

There is no current literature to guide an evidence-based recommendation regarding how to manage autograft bone or cement that was placed at the time of primary shoulder arthroplasty and has become infected. Additionally, what is unknown is how or if complete removal of this material is necessary to eradicate shoulder PJI. The goal of surgical intervention in the setting of PJI to debride any material that may result in retained biofilm that, if not removed, may result in a recurrent infection. Complete removal of autograft bone or cement at times can be extremely difficult and can result in significant bone loss especially if bone graft was used to reconstruct bone deficiency of the glenoid. A long stem cemented well-fixed humeral stem can at times require a long humeral osteotomy or cortical windows for complete cement removal which adds significant additional morbidity to the revision procedure.

The significance of retaining these materials is unclear and investigation is needed to understand the risks associated with incomplete removal of cement or bone graft, and what risks of recurrent PJI are associated with this practice to avoid the morbidity that may come with complete removal of these materials. Additionally, it is unknown how retention of this material requires a change in the postoperative antibiotic recommendations for the type, method of delivery or duration of treatment. Finally, it is also unknown how the species of the bacterial pathogen may influence the successful treatment and risk of recurrent PJI, where some less virulent pathogens (such as *C. acnes*) may be more difficult to eradicate with retention of cement or bone graft because of the slow growing nature. Future investigation related to the impact of type of bacteria can provide data to develop a treatment algorithm for which cases can predictably be successful with retention of cement or graft and for which settings require complete removal of all graft and cement materials.

3.4. TREATMENT: COMPONENT RETENTION

Author: Michael Khazzam

QUESTION 1: Is there a role for irrigation and debridement (I&D) with implant retention when treating acute shoulder periprosthetic joint infection (PJI)?

RECOMMENDATION: There is insufficient high-quality evidence to support or discourage the use of I&D with implant retention to treat acute shoulder PJI.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 96%, Disagree: 4%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

There is little data demonstrating the outcome or infection-free implant survivorship for the treatment of acute shoulder PJI with I&D and implant retention. To date, there are only 37 patients (38 shoulders) with outcomes following this procedure reported in the literature [1–4]. These studies were all grade IV level of evidence (LOE) retrospective case series and demonstrated a 50% failure rate (defined as continued infection) and requiring additional treatment. Three of four studies treated acute, subacute and chronic infections using this technique, but the sample size was too small to analyze how time of infection influences outcomes [1,3,4]. For example, Jacquot et al. found that 1 of the 2 shoulders classified as chronic PJI, 2 of 4 subacute, and 2 of 7 acute had recurrent infection requiring additional treatment [3].

Dennison et al. was the only study found specifically investigating the efficiency of acute (surgery within 6 weeks following index arthroplasty and less than 3 weeks of symptoms) and "delayed onset/delayed acute" (more than 6 weeks following index arthroplasty with symptoms less than 3 weeks) [2]. This retrospective LOE IV case series examined 9 patients (10 shoulders) and found 3 of 10 had recurrent infection requiring resection arthroplasty (mean follow up 4.1 years range 0.58-12.8 years). The method of I&D varied in this study with 3 performed arthroscopically and 7 open. All of the subjects requiring resection had their I&D performed open; the numbers were too small to perform any meaningful analysis of how this may influence outcomes or infection free survivorship. Additionally, 6 of 10 shoulders were maintained on chronic suppressive antibiotics indefinitely without explanation of why the authors selected this treatment.

Further research will be needed to determine how irrigation and debridement with implant retention plays a role in the treatment algorithm of PJI. Specific attention towards answering the questions regarding the effect of the pathogen and the antibiotic sensitivity profile; surgical approach (open or arthroscopic); timing from presentation and index arthroplasty; need for exchange of modular component parts; and type, duration, and method of delivery of antibiotics will be critical to guide these treatment decisions.

Methods

A systematic review was performed using MeSH terms: "I&D shoulder arthroplasty/shoulder replacement, single staged shoulder arthroplasty/shoulder replacement, implant retention revision shoulder arthroplasty/shoulder replacement, acute infection shoulder arthroplasty/ shoulder replacement" using search engines PubMed, Web of Science, and CINAHL. The inclusion criteria for

this systematic review were LOE I-IV, English language, shoulder arthroplasty studies that included patients who underwent treatment for PJI using I&D with component retention (polyethylene and or glenosphere exchange without stem or baseplate removal was included). Exclusion criteria were non-English language articles, review papers, technique papers, non-human studies, and studies that only presented data on one-stage or two-stage revision, hip or knee arthroplasty articles. The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were used manage the data of this review. Our initial search produced 66 abstracts; 61 were excluded, because they did not fulfill the inclusion criteria, and the remaining 4 manuscripts were obtained and reviewed to assure inclusion criteria. Additionally, the references of these manuscripts were reviewed to ensure no additional material would be missed. This left four studies for analysis, only one of which evaluated the role for I&D with implant retention for the treatment of acute shoulder PJI.

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Authors: Jeremy Somerson, William Levine

QUESTION 2: What are the indications for irrigation and debridement (I&D) with component retention in subacute or chronic shoulder periprosthetic joint infection (PJI)?

RECOMMENDATION: I&D with component retention alone for subacute/chronic shoulder PJI in the literature is less successful than component explant, but may play a role in select patients.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 96%, Disagree: 0%, Abstain: 4% (Unanimous, Strongest Consensus)

RATIONALE

A systematic review was performed using PubMed and Google Scholar databases in February 2018 to identify studies regarding the treatment outcomes after shoulder arthroplasty. The keywords included "shoulder AND (replacement OR arthroplasty) AND infection." This identified 46 articles with relevance to surgical treatment of shoulder PJI; 10 of which described treatment with debridement and implant retention for subacute/chronic infection.

I&D with component retention for shoulder PJI in the subacute and chronic setting has shown low rates of eradication of infection [1–10]. Of the 51 surgical cases identified in studies with a reported eradication rate, approximately half (n = 24, 47%) were successfully cured with debridement alone. The majority of these successful treatments were from two recent studies that integrated modular component exchange with partial component retention [1,2].

Stone et al. [1] reported on patients with shoulder PJI treated with one-stage partial component exchange compared to patients with one-stage complete hardware removal and two-stage revisions. The greatest success rate was with complete one-stage revisions (96% eradication of infection) compared to only 63% eradication for partial one-stage revisions. The authors concluded that there are some circumstances in which retaining a prosthesis may be preferred (such as well-fixed components), but that the surgeon must be aware of a higher risk of recurrent infection.

A French multicenter study reported on 32 patients who underwent revision for infection after reverse shoulder arthroplasty (RSA); of these, 13 patients underwent debridement, modular component exchange and partial component retention [2]. Only 7 patients (54%) were successfully cleared of infection with debridement alone. However, the 15% complication rate reported with debridement was lower than that reported for resection (33%), one-stage revision (20%) or two-stage revision (36%). The authors propose that initial debridement be considered for primary treatment of infected RSA given that more than half of patients were successfully treated with relatively few complications.

Primary treatment of subacute/chronic shoulder PJI with debridement, irrigation and component retention is an option, particularly in patients in which the risks of more aggressive surgery outweigh the potential benefits. However, patients and surgeons should be aware that the published rate of recurrence is substantially greater with this strategy compared to one- or two-stage revision.

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