Author: Surena Namdari

QUESTION 5: Should well-fixed glenoid components be removed during surgical treatment for subacute or chronic shoulder periprosthetic joint infection (PJI)?

RECOMMENDATION: Based on the higher rate of reinfection with component retention, we recommend removal of even well-fixed glenoid components in cases of single-stage revision for suspected subacute/chronic PJI. Certainly, there may be cases (i.e., high-risk surgical patients) where the patient and surgeon may choose to accept the higher failure rate with component retention in order to avoid surgical morbidity introduced by removing well-fixed components.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

A comprehensive literature review was performed to identify all studies on surgical treatment of subacute and chronic shoulder PJI. Previously, we have performed a systematic review on shoulder PJI treatment. In that study, we searched for the terms "shoulder arthroplasty infection" and "shoulder replacement infection" using the search engines PubMed and Embase through April 2014. Inclusion criteria were titles that specified periprosthetic infection of the shoulder (if "Periprosthetic infection" was mentioned, but no joint was specified, the article was included for further review) and articles pertaining to revision shoulder arthroplasty. Exclusion criteria were duplicate titles, review articles, editorials, technique articles without reported patient outcomes and instructional course lecture articles. Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria were followed. For this question, the same search terms were used and the dates between May 2014 and February 2018 were searched in order to update the previous systematic review. The prior systematic review identified 663 titles, and an additional 243 were evaluated for the updated review.

In this updated systematic review, three additional studies were identified that met inclusion and exclusion criteria and added to the data from the prior systematic review by Nelson et al. [1] that involved a search until April 2014. Only the study by Jacquot et al. [2] defined a subset of patients treated for subacute or chronic PJI, and the other studies grouped both acute and chronic cases. Based on the available data (all retrospective), there is clearly a higher failure rate of treatment when components are retained (31.3%) as opposed to exchanged via a one-stage or two-stage procedure (< 10%) [1]. Because of this, one must recommend for treatment of subacute/chronic shoulder PJI with removal of all, even well-fixed, components. However, it should be noted that these studies were all based on retrospective review of patients treated according to surgeon preference, and the features of the particular infections are not well documented (bacteria, antibiotic sensitivity, etc.). It is possible, perhaps even probable, that patients treated with implant retention versus removal may have had different infectious presentations that led the treating surgeon to their chosen approach. Further comparative research is needed on this topic. In addition, there may be cases (i.e., high-risk surgical patients) where the patient and surgeon may choose to accept the higher failure rate with component retention in order to minimize surgical morbidity.

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TABLE 1. Updated systematic literature review

Study	Date	Study Design	# Treated w/ I&D and Component Retention	# Failed Treatment (%)	# Treated w/ One-stage Revision	# Failed Treatment (%)	# Treated w/ Two-stage Revision	# Failed Treatment (%)
Nelson [1]	2016	Systematic Review	35	11	282	28	97	6
Stone [3]	2017	Retrospective Case Series	15	4	45	2	19	4
Marcheggiani Muccioli [4]	2017	Systematic Review	27	8	77	3	98	14
Jacquot [2]	2015	Retrospective Case Series	6	3	n/a	n/a	n/a	n/a
Total			**83**	**26 (31.3%)**	**404**	**33 (8.2%)**	**214**	**24 (11.2%)**

I&D, irrigation and debridement

[2] Jacquot A, Sirveaux F, Roche O, Favard L, Clavert P, Molé D. Surgical management of the infected reversed shoulder arthroplasty: a French multicenter study of reoperation in 32 patients. J Shoulder Elbow Surg. 2015;24:1713–1722. doi:10.1016/j.jse.2015.03.007.
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Authors: Richard Page, Akin Cil, Gokhan Karademir

QUESTION 6: Is there a role for routine exchange of all well-fixed implants in revision shoulder arthroplasty without clinical or radiographic signs of infection?

RECOMMENDATION: Unknown. Even in the setting of possible subsequent unexpected positive cultures, there is sparse literature on the routine exchange of well-fixed implants in revision shoulder arthroplasty.

LEVEL OF EVIDENCE: Limited

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

RATIONALE

Periprosthetic shoulder infection is one of the most challenging complications of shoulder arthroplasty [1,2]. The difficulty of diagnosis and treatment is attributed to *Cutibacterium acnes* which is a microorganism with low antigenicity [3]. Unlike knee and hip PJI, laboratory tests may be inadequate for diagnosing indolent infection caused by this agent [2]. The prevalence of *Cutibacterium acnes* has been reported to be as high as 50% of intraoperative cultures obtained at the time of revision surgery for a painful and stiff total shoulder arthroplasty [1]. This determination led to the definition of a new clinical entity: "Unexpected positive intraoperative cultures." Due to the fact that this bacterium is a member of the normal skin flora of the shoulder region, it is unknown whether a positive culture should be interpreted as a contamination or a definitive infection [4,5]. Due to the inadequacy of gram stain and frozen-section, and long incubation time; it is difficult to make a decision regarding implant removal during revision surgery [2]. Moreover, in the case of the well-fixed implants, the explant procedure can be difficult and have associated morbidity [5–7].

There is lack of evidence regarding the role for revision of well-fixed implants in revision shoulder arthroplasty without clinical or radiographic signs of infection [2,8]. In a study by Pottinger et al., [8] it has been reported that implants may need to be removed in patients who have risk factors for positive culture. McGoldrick et al. [9] have suggested single-stage reimplantation in the presence of loose implants. However, the authors have not commented on well-fixed implants. Similarly, Grosso et al. [6] have reported low recurrence with the removal of all components and single-stage reimplantation in the patients with unexpected positive intraoperative cultures. On the other hand, Topolski et al. [10] and Kelly et al. [11] reported high recurrence with the retention of implants. Lutz et al. [12] have evaluated infection with *Cutibacterium acnes* in the patients who underwent osteosynthesis or arthroplasty in the shoulder, knee or hip regions and reported that the absence of sepsis findings could not exclude the infection. The authors emphasized that the removal of the implants was important in the success of the treatment of *Cutibacterium acnes* infection of prosthetic material.

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