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Loose glenoid components in revision shoulder arthroplasty: is there an association with positive cultures?

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Background: Glenoid loosening is one of the most common causes of total shoulder failure. High rates of positive cultures of *Propionibacterium* and coagulase-negative staphylococcus have been found among shoulders having surgical revision for glenoid loosening. This study reviewed the culture results in a series of surgical revisions for failed total shoulder arthroplasty to determine the relationship between glenoid loosening and positive cultures.

Methods: The medical records of 221 patients without obvious evidence of infection who underwent revision total shoulder arthroplasty were reviewed to examine the association between the security of fixation of the glenoid component and the results of cultures obtained at revision surgery.

Results: Of the revised shoulders, 53% had positive cultures; 153 of the shoulders (69%) had a loose glenoid component, whereas 68 (31%) had secure glenoid component fixation. Of the 153 loose glenoid components, 82 (54%) had at least 1 positive culture and 44 (29%) had 2 or more positive cultures of the same microorganism. Similarly, of the 68 secure glenoid components, 35 (51%) had at least 1 positive culture ($P = .77$) and 14 (21%) had 2 or more positive cultures of the same microorganism ($P = .25$). Explanted glenoid components that were loose had a higher rate of culture positivity (56% [24/43]) in comparison to explanted glenoid components that were well fixed (13% [1/8]) ($P = .05$).

Conclusion: *Propionibacterium* and coagulase-negative staphylococcus are commonly recovered in revision shoulder arthroplasty, whether or not the glenoid components are loose.

Level of evidence: Level IV; Case Series; Prognosis Study

Keywords: Failed glenoid component; total shoulder; *Propionibacterium*; revision arthroplasty; culture positive; periprosthetic infection

Investigation performed at the University of Washington, Seattle, WA, USA. This study was approved by the Institutional Review Board of the University of Washington (No. 49278).

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Glenoid component loosening is one of the most common causes of total shoulder arthroplasty failure.[10] Multiple factors have been associated with glenoid component loosening, including the type of arthritis, sex,[10] glenoid morphology, quality and quantity of host bone,[14] surgical technique,[1,2,4,7,10,16,18] use of metal-backed or keeled glenoid components,[13,17] eccentric loading of the glenoid leading to the "rocking horse"

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Table I Characteristics of loose and stable glenoid components

	Loose glenoid	Stable glenoid
No.	153	68
Age at revision	65 (32-86) years	61 (27-82) years
Percentage male	70% (108/153)	59% (40/68)
Average time to revision	8.6 years (0.7-37.9 years)	5.6 years (0.5-25.6 years)
Average number of cultures	4.35 (range, 1-12 cultures)	3.69 (range, 1-11 cultures)
Percentage of shoulders with positive cultures	54% (82/153)	51% (35/68)
Shoulders with cultures positive for *Propionibacterium*	33% (51/153)	35% (24/68)
Shoulders with cultures positive for coagulase-negative staphylococcus	29% (45/153)	15% (10/68)
Shoulders with 2 or more cultures positive for the same organism	29% (44/153)	21% (14/68)

phenomenon,[5] component malposition,[7] osteolysis due to polyethylene wear debris,[4] and infection.[15]

Recent studies have documented the presence of slow-growing bacteria from the patient's skin, such as *Propionibacterium* and coagulase-negative staphylococcus, in as many as half of the patients undergoing revision shoulder arthroplasty.[8,11,12] These investigations suggest a relationship between glenoid component loosening and positive cultures for *Propionibacterium* and coagulase-negative staphylococcus obtained at the time of surgical revision.[6,15] The objective of this study was to investigate a large series of surgical revisions for failed total shoulder arthroplasty to re-evaluate the relationship between glenoid loosening and positive cultures.

Materials and methods

We reviewed the medical records of 722 patients having revision total shoulder arthroplasty between January 1997 and January 2015 for pain, stiffness, or component loosening but without obvious infection. In 501 cases, complete data were unavailable, leaving 221 cases (204 patients) of revision total shoulder arthroplasty for the final analysis. It is to be noted that this study adds 137 cases to the 84 revised total shoulders analyzed in a prior report by Pottinger et al.[15] Patient and procedure characteristics are summarized in Table I.

Sample acquisition

Prophylactic antibiotics are withheld before surgery until all culture samples have been obtained. Early in the study period, 1 to 3 samples were typically obtained for culture, and the cultures were observed for 2 weeks. Since 2005, our practice has been to obtain at least 4 samples of explants or tissue from different locations within the surgical field of the revision arthroplasty and to observe these cultures for 4 weeks. Specimens are obtained with separate sterile rongeurs opened from a peel pack immediately before specimen acquisition. All specimens are placed immediately into a sterile specimen cup and sealed. We specifically target membranes around the humeral and glenoid components as a source for culture tissue, including the collar membrane, which often develops underneath the modular humeral head. We also submit any foreign material, such as suture material or anchors from previous surgery. Finally, we culture all explanted components, which are vortexed in 3 mL of sterile saline to obtain bacteria present in an explant biofilm.

Culture methods

Our method of culturing samples has previously been described.[9] Specimens are processed by the laboratory within 1 hour after surgery in a class 2 laminar flow biologic safety cabinet. Fluid and homogenized tissue specimens are inoculated onto the following microbiologic media: blood agar (trypticase soy agar with 5% sheep blood), chocolate agar, Brucella agar (with blood, hemin, and vitamin K), and brain-heart infusion broth. All media, with the exception of the Brucella agar, are incubated at 37°C with 5% CO_2 for 28 days. Brucella agar plates are incubated anaerobically at 37°C for 28 days. Plates are sealed in a manner that allows sterile aeration without desiccation. Media are examined daily for growth visually but are opened only if growth is noted. All bacteria that are isolated receive a full species-level identification by means of 16S rDNA sequencing, as described previously.[3]

The culture data were analyzed to determine the number of cultures obtained, the source of the cultures (fluid, tissue, explant), the number of positive cultures, and the organisms grown.

Statistical analysis

Descriptive statistics were used to characterize patient and procedure characteristics. Fisher exact test was used to compare culture-positive rates between patients with and without loose glenoid components. Culture results were also correlated with number of samples obtained, duration for which the cultures were incubated, and patient demographic factors.

Results

Of the revised shoulders, 53% (117/221) had positive cultures (Table I). Of the 221 revision total shoulder arthroplasties studied, 153 (69%) had a loose glenoid component, whereas 68 (31%) had a secure glenoid component; 26% (58/221) of the revision surgeries had 2 or more positive cultures with the same microorganism. Of the 153 loose glenoid components, 82 (54%) had at least 1 positive culture and 44 (29%) had 2 or more positive cultures of the same microorganism (Fig. 1). The results were not significantly different for the 68 secure glenoid components: 35 (51%) had at least 1 positive culture ($P = .77$) and 14 (21%) had 2 or more positive cultures of the same microorganism ($P = .25$).

A total of 917 specimens were submitted for culture from the 221 cases; 314 (34%) were culture positive. Of these, com-