J Shoulder Elbow Surg (2020) 29, e325–e329

ELSEVIER

Journal of Shoulder and Elbow Surgery

www.elsevier.com/locate/ymse

ONLINE ARTICLES

Antibiotic cement spacer retention for chronic shoulder infection after minimum 2-year follow-up

Kevin J. Cronin, MD[a,*], Christopher B. Hayes, MD[a], Kaveh R. Sajadi, MD[b]

[a]*Department of Orthopaedic Surgery and Sports Medicine, University of Kentucky, Lexington, KY, USA*
[b]*Kentucky Bone and Joint Surgeons, Lexington, KY, USA*

Hypothesis: The treatment of periprosthetic shoulder infections and proximal humerus osteomyelitis is challenging. The outcomes of antibiotic cement spacer retention are poorly defined in the literature. The purpose of this study was to review long-term functional and patient-reported outcomes data of patients with retained antibiotic cement spacers. We predict reasonable functional outcomes and minimal pain.

Methods: We identified 22 patients of the senior author who have been treated with definitive antibiotic spacer placement. All patients were originally offered a 2-stage revision and declined. Twelve patients had a minimum follow-up of 2 years and were included in our cohort. Mean age was 70.7 (range 59-81), 8/12 patients were female, and the average body mass index was 27.8 (range = 17-45). Functional outcome assessments included the Standardized Shoulder Assessment Form, the Quick Disabilities of the Arm, Shoulder, and Hand Score (QuickDASH), and visual analog scale (VAS) along with clinical range of motion examination.

Results: The patients were followed up for a mean of 5.6 years. Eight patients had spacer placement for chronic shoulder arthroplasty infections, whereas 4 patients had spacer placement for chronic osteomyelitis of the proximal humerus. No patients were currently being treated with suppressive antibiotics. One patient had negative cultures at the time of antibiotic spacer placement. The most common organisms were *Cutibacterium acnes* (6), *Staphylococcus epidermidis* (6), and methicillin-resistant *Staphylococcus aureus* (4), with 4 patients growing more than 1 species. The average ASES score was 54 (range = 27-73), QuickDASH was 45 (range = 14-89), and VAS score 2.8 (range = 0-8). Average active range of motion was 68° of forward elevation and 35° of external rotation.

Conclusions: Retention of antibiotic cement spacer is a viable option in the treatment algorithm for chronic shoulder infections. Long-term antibiotic cement spacer may be considered for those patients who are unwilling or unable to undergo a 2-stage revision. Patients can expect a reasonable amount of function and little to no pain with an antibiotic cement spacer.

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

Keywords: Shoulder arthroplasty; revision arthroplasty; reverse total shoulder arthroplasty; total shoulder arthroplasty; infection; osteomyelitis; antibiotic spacer

Osteoarthritis of the shoulder is a common problem and can significantly affect both function and quality of life. It remains the most common diagnosis when performing total shoulder arthroplasty (TSA) in the United States.[7] Given the high prevalence of osteoarthritis, and recent advances in technique, the incidence of total shoulder arthroplasty continues to rise. From 2000 to 2008, we saw a 3.5-fold

Institutional Review Board approval was received from Baptist Health Lexington (BHL-18-1510).

*Reprint requests: Kevin J. Cronin, MD, Orthopaedic Surgery & Sports Medicine, University of Kentucky, 740 S Limestone, K403, Lexington, KY, 40536, USA.

E-mail address: KevinCronin88@gmail.com (K.J. Cronin).

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https://doi.org/10.1016/j.jse.2020.01.065

increase in the number of total shoulder arthroplasty procedures performed in the elderly population.[8] A similar increase was seen from 2007 to 2015, and the growth of shoulder arthroplasty is expected to outpace the growth of hip and knee arthroplasty.[4] With the increasing prevalence of shoulder arthroplasty, this will inevitably lead to an increased amount of complications. From 1993 to 2007, the rate of revision shoulder arthroplasty increased from 4.5%-7%.[4] The estimated rate of deep periprosthetic infection reported in the literature ranges from 0.7%-1.8%.[1,5,15] This is even higher in the revision setting, 4%-15.4%.[3,5,13]

The treatment of periprosthetic shoulder infections and proximal humerus osteomyelitis is challenging and can be the cause of significant morbidity. Goals of treatment include eradication or suppression of the infection. Secondary goals are restoration of function and decreased pain.[6] Treatment options include retention of implant with antibiotic suppression, arthroscopic or open débridement, 1-stage revision, 2-stage revision with a temporary antibiotic spacer, long-term retention of antibiotic cement spacer, arthrodesis, and amputation.[10,13] Two-stage revision is the gold standard in hip and knee arthroplasty and is well studied in the shoulder.[2,9,14] However, there is no consensus standard of care for a chronically infected shoulder. Stine[16] described the use of an antibiotic impregnated cement spacer without a subsequent second-stage revision arthroplasty in medically frail patients and found acceptable functional outcomes. This technique of retention of an antibiotic cement spacer is poorly described in the literature.[11] There are few retrospective and prospective cohort studies with varying results and no randomized controlled trials.[2,6,10,11]

The purpose of this study was to review long-term follow-up of patients with retained antibiotic cement spacers to determine functional and patient-reported outcome measures. We hypothesize that patients treated definitively with antibiotic cement spacers would achieve satisfactory functional and patient-reported outcomes with low rates of recurrent infection and need for further surgery.

Materials and methods

Patients with retained antibiotic spacers were retrospectively identified from the senior author's (K.R.S.) shoulder arthroplasty database. At the time of original treatment, all patients were offered the option for 2-stage revision shoulder arthroplasty and declined. All antibiotic spacers were originally placed between October 2008–June 2015 by the senior author.

Infection was diagnosed in patients with elevated laboratory markers, including white blood cell count, erythrocyte sedimentation rate, and C-reactive protein. Aspiration was performed in all but 4 patients who had draining sinuses. If aspiration was negative, intraoperative findings included gross purulence or positive frozen sections in the presence of prosthetic loosening. All surgeries were performed through a deltopectoral approach. Attempts were made to preserve the remaining rotator cuff tissue when possible. In cases of prior arthroplasty, subscapularis takedown was performed via tenotomy when present. The prior humeral head implant was removed, when modular, followed by the humeral stem. Previous cement, when present, was removed using an ultrasonic cement device or broken apart and removed piecemeal. The glenoid component and any accompanying cement were then removed. In cases of osteomyelitis of the proximal humerus, a subscapularis tenotomy was performed. The humeral head was then osteotomized as per standard arthroplasty technique. Cultures were taken from the synovium, from within the humeral canal after removal of the stem, and from the glenoid vault after removal of the glenoid components. In cases of osteomyelitis without prior arthroplasty, multiple synovial cultures were obtained as well as bone cultures from the humeral head. The humeral canal and glenoid vault were thoroughly débrided. The glenohumeral joint was then irrigated with a solution containing bacitracin and betadine diluted in saline. A prefabricated commercial spacer (Exactech, Gainesville, FL, USA) was chosen in all cases from 2 available sizes. The prefabricated spacer consists of a threaded Steinmann pin coated in polymethylmethacrylate impregnated with gentamycin. The spacer was loosely cemented into the humerus with cement impregnated with vancomycin as well. A doughy consistency was achieved before placing it around the spacer and inserting into the humerus. Rotator cuff and subscapularis repair was performed with heavy nonabsorbable suture when possible. The deltopectoral interval was loosely approximated using monofilament, and nylon sutures were used to close the skin. Intravenous antibiotics were prescribed and managed by an infectious disease consultant for a minimum of 6 weeks, with some continuing on oral antibiotics for up to 1 year after surgery, also at the discretion of the infectious disease consultant.

After a query of our shoulder arthroplasty database, 22 patients were identified with retained antibiotic spacers. Information extracted from the medical record included patient age, sex, body mass index, medical comorbidities, tobacco use, initial diagnosis, prior surgical history, indication for antibiotic spacer placement, and infectious history. Physical examination and range of motion data were taken from the patient's most recent clinical visit and recorded by the senior author (K.R.S.). Patients were then contacted via telephone by a member of our research team (K.J.C.). Pain numeric rating scale, American Shoulder and Elbow Surgeons Functional Score (ASES) score, and the Quick Disabilities of the Arm, Shoulder, and Hand (QuickDASH) score were recorded.

For statistical purposes, continuous variables were reported as means and standard deviations while categorical variables were reported as frequencies and percentages.

Results

We identified 22 patients in the senior author's shoulder arthroplasty database who have retained antibiotic spacers. Twelve patients had a minimum of 2 years follow-up and were available to participate in the study (Table I). Of the 10 patients who were not included in the final analysis, 2 were deceased and 8 had insufficient follow-up. The final cohort consisted of 8 females and 4 males. Our mean age at time of antibiotic spacer placement was 70.7 years (range:

Table I Complete demographic data

Patient	Age	Sex	BMI	Diagnosis	Index procedure	Follow-up, d	ASES	QuickDASH	Pain score	Active FF	Active ER	Complications
1	80	F	25.6	Proximal humerus fracture	Hemi	1407	48.3	54.6	4	70	50	None
2	67	F	37.2	Proximal humerus fracture	Hemi	2290	66.6	31.8	0	20	10	None
3	75	M	25.5	CTA	rTSA	2941	55.8	47.7	0	90	40	None
4	60	F	17.6	Rheumatoid arthritis	rTSA	1923	26.6	88.6	6	40	20	Spacer exchange
5	76	F	27.4	Osteoarthritis	TSA	2892	56.5	50	2	110	30	None
6	59	F	22.3	Osteoarthritis	TSA	1920	48.3	40.9	3	30	20	Spacer exchange
7	66	M	32.1	Osteoarthritis	TSA	2270	66.6	29.6	4	120	60	None
8	81	M	28.8	Osteoarthritis	TSA	2192	30	54.6	8	20	0	None
9	62	M	26.6	Osteomyelitis	Antibiotic spacer	2011	60	56.8	0	20	40	Spacer exchange
10	79	F	23.6	Osteomyelitis	Antibiotic spacer	2038	46.6	47.7	3	70	40	None
11	69	F	45.2	Osteomyelitis	Antibiotic spacer	1605	70		0	100	70	None
12	74	F	24.9	Osteomyelitis	Antibiotic spacer	1044	73.3	13.6	4	120	60	None

F, female; *M*, male; *BMI*, body mass index; *rTSA*, reverse total shoulder arthroplasty; *TSA*, total shoulder arthroplasty; ASES, American Shoulder and Elbow Surgeons Functional Score; *QuickDASH*, Quick Disabilities of the Arm, Shoulder, and Hand Score; *FF*, forward elevation; *ER*, external rotation.

59-81 years) and average body mass index was 27.8 (range: 17-45). The mean follow-up time was 5.6 years (range: 2.9-8.1). Two patients had type 2 diabetes and 1 patient actively used tobacco. Eight patients underwent placement of antibiotic cement spacers for chronic periprosthetic infections whereas 4 patients had spacer placement for diagnosis of chronic osteomyelitis of the proximal humerus. Of the patients with chronic periprosthetic infection, 4 had TSA for osteoarthritis, 2 had hemiarthroplasty for proximal humerus fracture, 1 had reverse total shoulder arthroplasty (rTSA) for cuff tear arthropathy, and 1 had rTSA for a diagnosis of rheumatoid arthritis.

Positive cultures were identified in all but 1 patient at the time of antibiotic cement spacer placement. Two patients had 2 species identified in final isolates. The most common bacteria identified were *Cutibacterium acnes* (4 isolates), *Staphylococcus epidermidis* (4 isolates), and methicillin-resistant *Staphylococcus aureus* (MRSA) (3 isolates). *Pseudomonas aeruginosa* and methicillin-sensitive *S aureus* (MSSA) were each identified in 1 isolate (Table II). The patient with negative cultures was originally treated at an outside institution with rTSA 6 years prior that was complicated by acute infection (also culture negative) and treated with incision and drainage and polyethylene exchange along with intravenous and oral antibiotics. On presentation to our institution, he had elevated inflammatory markers and aspiration was performed that was consistent with chronic infection (elevated white blood cell count). Intraoperative frozen section was positive, and the humeral stem was loose.

Active forward elevation and active external rotation were recorded at the most recent clinic visit. Average forward elevation was 67° (range: 20°-120°) and average external rotation was 35° (range: 0°-70°). The ASES; Quick Disabilities of the Arm, Shoulder, and Hand; and pain scores were recorded via telephone. The average ASES score was 54 (range: 26-74); Quick Disabilities of the Arm, Shoulder, and Hand score was 45 (range: 13-89); and pain score was 2.8 (range: 0-8).

Three patients required revision of their antibiotic spacer because of continued pain and positive cultures on joint aspiration after completion of antibiotics, resulting in a reoperation rate of 25%. The patients requiring revision spacer placement are further described in Table III. All revision antibiotic spacers have greater than 5 years' follow-up without need for further procedures. There were no episodes of instability requiring intervention. No patient remained on chronic suppressive antibiotics and there were no clinical signs of infection in any patients at the time of final follow-up. Serial radiographs were also obtained and no signs of loosening or failure of the prosthesis was noted at final clinical follow-up.

Table II Complete pathogen data

Pathogen	Number of patients
Cutibacterium acnes	4
Methicillin-sensitive *Staphylococcus aureus* (MSSA)	1
Staphylococcus epidermidis	4
Methicillin-resistant *Staphylococcus aureus* (MRSA)	3
Pseudomonas aeruginosa	1
Culture negative	1

Discussion

We present a cohort of 12 patients with long-term follow-up of retained antibiotic cement spacers for diagnosis of periprosthetic joint infection and chronic osteomyelitis. To the authors' knowledge, this is the first study of retained antibiotic cement spacers with greater than 5 years' average follow-up. Our patients obtained reasonable functional outcomes, had minimal pain, and no recurrence of infection. In the appropriately selected patient, retention of an antibiotic cement spacer is a viable option for those with chronic infection of the shoulder girdle.

There is an abundance of available literature on the treatment options for infected total shoulder arthroplasty. However, most of this research focuses on single and 2-stage revision arthroplasty. Levy[10] described a technique for a functional antibiotic cement spacer by coating a small humeral stem with antibiotic-loaded cement while leaving the cobalt chromium head free. This provides antibiotic elution while eliminating the theoretical potential for pain caused by the cement-glenoid articulation. They reported their results on 9 patients with 2-year follow-up and found no recurrent infections, a mean visual analog scale pain score of 2.0, and an 89% patient satisfaction rate. These results are similar to ours and show that varying techniques for antibiotic cement spacers yield acceptable patient outcomes.

An additional study with an average follow-up of 4 years and using a technique very similar to ours reported on the outcomes of 9 patients with retained antibiotic spacers.[11] These authors report results nearly identical to ours. The mean ASES score was 57 and mean forward elevation 67°, compared with our mean ASES score of 54 and mean forward elevation of 67°. In their conclusions, the authors state that their findings are similar to the published results for 2-stage revision arthroplasty and challenge the necessity of this second surgical procedure.

A recent systematic review attempted to establish the gold standard for treatment of infected total shoulder arthroplasty with the primary outcome of eradication of infection.[6] The authors included studies with at least 6 months of follow-up and more than 5 patients who were treated for an infected total shoulder arthroplasty with either single-stage exchange, 2-stage exchange, resection arthroplasty, or permanent antibiotic spacer. Eight studies with 368 patients were included. Though retention of an antibiotic spacer yielded the highest infection cure rate at 95.6%, the difference between the other treatment options was not statistically significant. This is consistent with our present study, which shows a 100% infection cure rate. The results of this systematic review contrast the literature for total hip and total knee arthroplasty, which clearly establishes 2-stage revision arthroplasty as the gold standard treatment for infection.[9,14]

A similar systematic review by Namdari[12] included 30 publications with at least 12 months of follow-up after treatment for infected total shoulder arthroplasty. These authors were unable to identify a clear gold standard for treatment when using infection cure rate as a primary outcome. They did report patients undergoing single-stage revision arthroplasty to have a statistically significant increase in their Constant score compared with other treatment options; however, the difference was within the minimal clinically important difference compared with 2-stage revision arthroplasty. The authors also reported on the organisms isolated at the time of revision. They found a 38.9% rate of *Cutibacterium acnes*, which was double that of the next most common organisms—*S aureus* 14.8% and *S epidermidis* at 14.5%. This differs from our results, which showed an equal proportion of *C acnes*, *S epidermidis*, and *S aureus*. This is important to note in the context of our acceptable outcomes given that 3 of our 12 patients were

Table III Patients requiring exchange of antibiotic spacer

Patient	Diagnosis	Index procedure	Time from index procedure to spacer, d	Pathogen	Time from spacer placement to revision, d	Final follow-up after revision spacer, d
4	Rheumatoid arthritis	rTSA	1932	MRSA	200	1923
6	Osteoarthritis	TSA	315	Pseudomonas, *Staphylococcus epidermidis*	714	1920
9	Osteomyelitis	–	–	MRSA	98	2011

rTSA, reverse total shoulder arthroplasty; *TSA*, total shoulder arthroplasty; *MRSA*, methicillin-resistant *Staphylococcus aureus*.

successfully treated with an antibiotic spacer in the setting of methicillin-resistant *S aureus*. However, 2 of these patients did require revision antibiotic spacer placement for ultimate eradication.

Our study is not without limitations. Most notably, this includes the retrospective nature of our data collection. Our sample size is also small. However, this is to be expected when studying such a relatively uncommon problem. We also recognize that contacting patients via telephone is not the most ideal method for data collection; however, we found this to be the most reliable method of reaching our patient population. This population is spread over a large geographic area and the patients have limited mobility, so this was a limitation we accepted. To the authors' knowledge, our study provides the largest cohort of patients studied with retained antibiotic cement spacers.[10,11] All procedures were also performed by a single shoulder and elbow fellowship–trained orthopedic surgeon, which may limit the generalizability of our results. Ideally, future well-designed randomized controlled trials will be able to determine the ideal treatment for infected total shoulder arthroplasty and proximal humerus osteomyelitis.

Conclusion

Retention of an antibiotic cement spacer is a viable option in the treatment algorithm for chronic shoulder infections. Long-term antibiotic cement spacer may be considered for those patients who are unwilling or unable to undergo a 2-stage revision. Patients can expect a reasonable amount of function, little to no pain, and low risk of recurrent infection.

Disclaimer

The authors, their immediate families, and any research foundations with which they are affiliated have not received any financial payments or other benefits from any commercial entity related to the subject of this article.

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