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Management of periprosthetic shoulder infections with the use of a permanent articulating antibiotic spacer

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Abstract

Introduction Management of periprosthetic shoulder infections (PSIs) still remains challenging. We conducted a retrospective case study to assess the outcomes of definitive articulating antibiotic spacer implantation in a cohort of elderly, low-demanding patients. We hypothesized that in patients with low functional demands seeking pain relief with chronic PSIs, treatment with a definitive articulating antibiotic spacer would lead to satisfying results concerning eradication of the infection, improvement of pain, and improving shoulder function.

Materials and methods 19 patients underwent definitive articulating antibiotic spacer implantation for the treatment of an infected shoulder arthroplasty. Mean age at surgery was 70.2 years. Patients were assessed pre-operatively with functional assessment including Constant-Murley score, and objective examination comprehending ROM, visual analog scale pain score, and patient subjective satisfaction (excellent, good, satisfied, or unsatisfied) score. Radiographs were taken to examine signs of loosening, and change in implant positioning.

Results At the most recent follow-up, none of the patients had clinical or radiographic signs suggesting recurrent infection. Most patients reported satisfying subjective and objective outcomes. Follow-up examination showed significant improvement of all variables compared to pre-operative values ($p < 0.001$). Radiographs did not show progressive radiolucent lines or change in the position of the functional spacer. In one case, glenoid osteolysis was reported, which did not affect the clinical outcome.

Conclusions In selected elderly patients with low functional demands seeking pain relief with infected shoulder arthroplasty, definitive management with a cement spacer is a viable treatment option that helps in eradicating shoulder infection and brings satisfying subjective and objective outcomes.

Level of Evidence Case series, Level IV.

Keywords Infected shoulder arthroplasty · Periprosthetic shoulder infection · Antibiotic spacer · Elderly patients

Introduction

Periprosthetic shoulder infections (PSIs) are challenging to treat and often result in significant patient morbidity.

Treatment goals include resolution of the infection, pain relief, improvement of function.

Surgical options include debridement and chronic antibiotic suppression, 1- or 2-stage revisions, definitive articulating antibiotic spacer, and excision arthroplasty [1–5] Current literature regarding the optimal treatment remains controversial [6].

Proubasta et al. proposed the use of a permanent antibiotic-impregnated cement spacer in the septic shoulder after arthroplasty. They stated that this could be a valid treatment option in an elderly, low-demand patient [7].

We conducted a retrospective case study to assess the outcomes of definitive articulating antibiotic spacer implantation in a cohort of elderly patients with low functional demands seeking pain relief.

We hypothesized that in patients with chronic PSIs, treatment with a definitive articulating antibiotic spacer would lead to satisfying results concerning eradication of the infection, improvement of pain and shoulder function.

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Methods

Twenty-three patients underwent definitive articulating antibiotic spacer implantation for the treatment of an infected shoulder arthroplasty from 2007 to 2014. Nineteen of them (10 men and 9 women) were available at follow-up and were included in the study.

Infection was diagnosed through clinical examination, erythrocyte sedimentation rate (ESR), serum leucocyte count and C-reactive protein (CRP), and evidence of radiographic loosening on preoperative radiographs. All cases presented with actively synovial cutaneous fistula.

All patients were elderly, low-demanding patients, with reduced functional requests, with a reduced compliance and radiographic evidence of bone defects (e.g., loss of bone stock on the glenoid surface). All of them had undergone previous shoulder surgery at least once before primary prosthetic implant (between one and three procedures); no previous revision surgeries were performed.

Three of them were elected for 2-stage revision surgery, but since they experienced pain relief and acceptable functional outcomes without signs of recurrent infection following spacer implantation, patients were told that a second stage was not recommended. Therefore, following initial satisfying results, in the remaining patients, implantation of the antibiotic spacer was proposed as a definitive treatment.

Mean age at presentation with PSI was 70.2 years (range 67–80 years). The operative side was right in 13 of 19 patients (68%), and all but 2 patients were right-hand dominant. The PSI involved anatomic total shoulder arthroplasty (TSA) most commonly (13 of 19), followed by reverse TSA in 5 and hemiarthroplasty in 2 cases (Table 1). All surgeries were performed by one single senior surgeon.

Table 1 Patient demographics and anthropometric data

Age at surgery (SD) (year)	70.2 (SD:10.2)
Gender	
Male	10
Female	9
Operations before spacer implantation	
Hemiarthroplasty	2
TSA	13
Reverse TSA	5
Type of infection	
Delayed (< 1 year)	3
Late (> 1 year)	16

SD standard deviation, *TSA* total shoulder arthroplasty

Surgical technique

After explantation of all previously implanted components and cement and extensive surgical débridement and irrigation of soft tissues, with removal of all possibly infected and inflammatory tissue, a prefabricated antibiotic-impregnated cement spacer was used in 12 patients (Vancogenx, Tecres, Sommacampagna, Italy), while in 7 patients, the spacer was manually molded around the stem using Gentamicin-loaded revision cement with clindamycin added (Refobacin, Biomet, Warsaw, Indiana). The type of antibiotic spacer was based on cultural examination whenever possible (pre-operative pathogen identification on synovial cutaneous fistula), otherwise a broad-spectrum antibiotic was used. As the cement began to cure and the consistency became firm, but still moldable, the spacer was placed into the humeral canal and fixed to the metaphyseal bone of the humeral shaft, tight enough to prevent stem motion.

Post-operative rehabilitation

In all patients, antibiotic therapy was carried out for 6 weeks, according to specific microorganism isolation.

After surgery, patients were placed into a shoulder immobilizer for 3 weeks, then started performing. When the immobilizer was discontinued, patients were instructed to perform pendulum exercises, supine stretching and were allowed to resume daily living activities.

Outcome measures

Clinical outcomes were evaluated for each patient before the first-stage procedure and at the most recent follow-up. Primary outcome was clinical and radiographic signs of infection eradication. Secondary outcomes included range of motion as measured with a goniometer, Constant-Murley Score, visual analog scale (VAS) pain score, and patient subjective satisfaction (excellent, good, satisfied, or unsatisfied) score according to Neer.

Anteroposterior and axillary radiographs were examined for signs of loosening, osteolysis, and change in implant position.

Statistical analysis

Data were analyzed using the program SPSS Version 19.0 (SPSS Inc., Chicago, IL, USA). Paired t-test (two sided test and $\alpha = 0.05$) was utilized to compare pre-operative

Table 2 Overview of the results of clinical assessment

	Pre-operative	Post-operative	*p* value
Constant-Murley score (mean, SD)	21.4 (SD:15.1)	38.3 (SD: 16.3)	$p < 0.001$
VAS pain score (mean, SD)	6.4 (SD: 2.1)	1.5 (SD: 1.7)	$p < 0.001$
Active forward flexion (mean, SD)	41.2° (SD:29.2)	59.2° (SD:24.8)	$p < 0.001$
Active abduction (mean, SD)	38.1° (SD: 23.7)	52.5° (SD:21.4)	$p < 0.001$

VAS visual analog scale, *SD* standard deviation

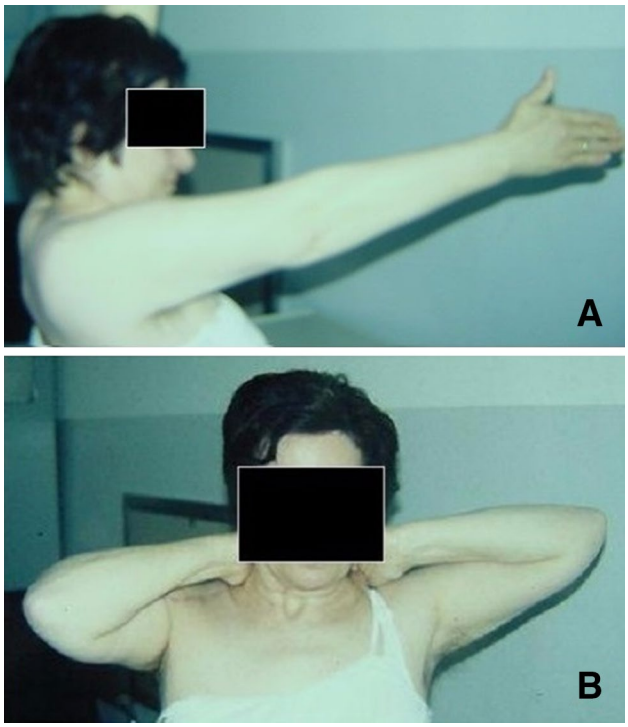

Fig. 1 Patients showing maximum active forward flexion (1°) and maximum active abduction (**b**) following definitive spacer implantation

and follow-up status. Differences with a p value < 0.05 were considered statistically significant.

Results

After a mean follow-up of 8 years (range 2–10 years), none of the 19 patients had clinical or radiographic signs suggesting recurrent infection, which included the absence of positive ESR and CRP, synovial cutaneous fistula, and loosening of the components on standard X-rays.

Overall clinical outcomes are reported in Table 2.

Both functional and pain scores improved significantly. The overall mean VAS score decreased from 6.4 (SD: 2.1) pre-operatively to 1.5 (SD: 1.7) after infection treatment ($P < 0.001$); the mean calculated Constant score increased from 21.4 (SD:15.1) pre-operatively to 38.3 (SD: 16.3) post-operatively ($P < 0.001$), with an active forward flexion and abduction recorded at follow-up of, respectively, 59.2° (SD:23.7°) and 52.5° (SD:21.4°) (Fig. 1).

Table 3 Pathogens isolated intraoperatively

Pathogen	Number (%)
MRSA	5 (26.3%)
CNS	4 (21.1%)
Propionibacterium acnes	2 (10.5%)
No isolation	8 (42.1%)

MRSA methicillin-resistant *Staphylococcus aureus, CNS* coagulase-negative staphylococci

The self-reported global patient satisfaction, scored according to Neer, yielded nine patients who reported good (47%), 9 (47%) reporting satisfying and 1 (6%) poor results.

Causative pathogens were identified in approximately 57% of patients (11 on 19 patients) intraoperatively, with methicillin-resistant Staphylococcus aureus (MRSA) and coagulase-negative staphylococci (CNS) being the most commonly isolated bacteria. (Table 3).

Radiographs did not show progressive radiolucent lines or change in the position of the functional spacer. In one case, glenoid osteolysis was reported, which did not affect the clinical outcome.

Discussion

The most important finding of the present study was that following the implantation of definitive functional antibiotic spacer in a cohort of elderly, low-demanding patients with PSI, none of the subjects had clinical or radiographic signs suggesting recurrent infection. Second, most patients reported subjective and objective satisfying outcomes at an average follow-up of 8 years.

The current findings suggest that removal of the infected prosthesis, followed by irrigation and debridement and subsequent insertion of a cement spacer, can be a relatively successful treatment option in appropriately selected patients. After a mean follow-up of 8 years, this study reported 0% recurrence of infection in the 19 study patients.

Although a literature search found few clinical data on the use of cement spacers as definitive treatment in patients with infection, previous series reported an overall reinfection rate of 5%.

Mean follow-up Constant-Murley score in the current series was 38.3 (SD: 16.3), which is comparable to the findings of Klatte et al. [8] and Beekman et al. [1] who reported Constant-Murley scores of 51.1 and 55, respectively, in patients with 1-stage revision. Similarly, Loehr et al. reported satisfying outcomes following one-time exchange (post-operative Constant-Murley score of 46.1) [5]. Additionally, Coffey et [9] reported a mean ASES score of 74 and a mean Constant score of 57 in patients with 2-stage revision. Functionally, this cohort of patients had average forward flexion of 59.2°±24.8°, which as expected is less compared to the average forward flexion (66.4°±20.8°) reported by Sabesan et al. [10] in planned 2-stage revisions, who, on the other hand, reported a major complication rate of 35% following revision surgery.

Identification of pathogens with intraoperative microbiology examination could be done in 57% of patients, similar to other studies [11–13]. Encountered causative pathogens were consistent to those reported in literature, with a prevalence of MRSA and CNS, together with propionibacterium acnes [5, 12–14].

Romanò et al. [15] reported satisfying results with the use of permanent spacer implant and two-stage revision in the treatment of periprosthetic shoulder infection.

The utility of articulating, antibiotic-impregnated cement spacers to treat periprosthetic hip and knee infections is well-established, and that knowledge has been translated to the management of infected shoulder prostheses [7, 9, 16, 17]. However, the role of these implants as a definitive treatment modality is uncertain [18, 19].

The risk of humeral periprosthetic fracture and erosion of the medial glenoid as well as concerns about reduced function, may reduce the utility of definitive cement spacers in healthier patients who could undergo additional prosthetic replacement, however, definitive treatment with cement spacers may provide reasonable range of motion and satisfying functional outcomes in elderly patients with severe medical comorbidities and reduced functional requests.

Two-stage revisions have been shown to be effective for the treatment of infected shoulder arthroplasty; however, their effect on functional outcomes has been variable [11, 20–22], and in addition, they carry the risks of further complications and may not be indicated in high-risk patients or subjects with bone defects.

For these reasons, the achievement of infection eradication together with acceptable functional outcomes allows the use of a permanent functional spacer for the management of an infected shoulder arthroplasty. The use of a permanent spacer can be either planned pre-operatively or it can follow an originally planned 2-stage procedure when after first stage acceptable function and pain relief is achieved [23].

The long-term outcomes of definitive treatment with cement spacers compared with 1- and 2-stage revisions for infection warrant further investigation.

Limitations of the present study include its retrospective nature, the lack of a control group and the relatively small sample size. The limited number of patients is due to the fact that this approach requires adopting highly selective indications as criteria for patient selection. Further randomized clinical trials are needed to substantiate these findings.

Conclusion

In selected elderly patients with low functional demands seeking pain relief with infected shoulder arthroplasty, definitive management with a cement spacer is a viable treatment option that helps in eradicating shoulder infection and brings satisfying subjective and objective outcomes.

Compliance with ethical standards

Conflict of interest Each author discloses any financial and personal relationships (e.g., employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, grants or other funding) that might pose a conflict of interest in connection with the submitted article.

Ethical standards Each author certifies that his institution has approved the human protocol for this investigation and that all investigations were conducted in conformity with ethical principles of research, and that informed consent was obtained.

References

1. Beekman PD, Katusic D, Berghs BM, Karelse A, DeWilde L (2010) One-stage revision for patients with a chronically infected reverse total shoulder replacement. J Bone Joint Surg Br 92:817–822
2. Mook WR, Garrigues GE (2014) Diagnosis and management of periprosthetic shoulder infections. J Bone Joint Surg Am 96:956–965
3. Sabesan VJ, Ho JC, Kovacevic D, Iannotti JP (2011) Two-stage reimplantation for treating prosthetic shoulder infections. Clin Orthop Relat Res 469:2538–2543
4. Stine IA, Lee B, Zalavras CG, Hatch G 3rd, Itamura JM (2010) Management of chronic shoulder infections utilizing a fixed articulating antibiotic loaded spacer. J Shoulder Elbow Surg 19:739 – 48
5. Loehr J (2010) Surgical management of the infected shoulder arthroplasty. In: Cofield RH, Sperling JW (eds) Revision and complex shoulder arthroplasty. Lippincott Williams and Wilkins, Philadelphia, pp 214–223
6. George DA, Volpin A, Scarponi S, Haddad FS, Romanò CL (2016) Does exchange arthroplasty of an infected shoulder prosthesis provide better eradication rate and better functional

outcome, compared to a permanent spacer or resection arthroplasty? A systematic review. BMC Musculoskelet Disord 17:52
7. Proubasta IR, Itarte JP, Lamas CG, Escribá IU (2005) Permanent articulated antibiotic-impregnated cement spacer in septic shoulder arthroplasty: a case report. J Orthop Trauma 19:666–668
8. Klatte TO, Junghans K, Al-Khateeb H et al (2013) Single-stage revision for peri-prosthetic shoulder infection: outcomes and results. Bone Joint J 95-B(3):391–395
9. Coffey MJ, Ely EE, Crosby LA (2010) Treatment of glenohumeral sepsis with a commercially produced antibiotic-impregnated cement spacer. J Shoulder Elbow Surg 19(6):868–873
10. Sabesan VJ, Ho JC, Kovacevic D, Iannotti JP (2011) Two-stage reimplantation for treating prosthetic shoulder infections. Clin Orthop Relat Res 469(9):2538–2543
11. Coste JS, Reig S, Trojani C, Berg M, Walch G, Boileau P (2004) The management of infection in arthro plasty of the shoulder. J Bone Joint Surg Br 86(1):65–69
12. Strickland JP, Sperling JW, Cofield RH (2008) The results of two-stage re-implantation for infected shoulder replacement. J Bone Joint Surg 90-B:460–465
13. Ince A, Seemann K, Frommelt L, Katzer A, Loehr JF (2005) One-stage exchange shoulder arthroplasty for peri-prosthetic infection. J Bone Joint Surg 87-B:814–818
14. Zeller V, Ghorbani A, Strady C, Leonard P, Mamoudy P, Desplaces N (2005) Propionibacterium acnes: an agent of prosthetic joint infection and colonization. J Infect 55(2):119–124
15. Romanò CL, Borens O, Monti L, Meani E, Stuyck J (2012) What treatment for periprosthetic shoulder infection? Results from a multicentre retrospective series. Int Orthop 36:1011–1017
16. Leonard HA, Liddle AD, Burke O, Murray DW, Pandit H (2014) Single- or two-stage revision for infected total hip arthroplasty? A systematic review of the literature. Clin Orthop Relat Res 472(3):1036–1042
17. Pivec R, Naziri Q, Issa K, Banerjee S, Mont MA. Systematic review comparing static and articulating spacers used for revision of infected total knee arthroplasty. J Arthroplasty
18. Zhang AL, Feeley BT, Schwartz BS, Chung TT, Ma CB (2015) Management of deep postoperative shoulder infections: is there a role for open biopsy during staged treatment? J Shoulder Elbow Surg 24(1):e15–e20
19. Mook WR, Garrigues GE (2014) Diagnosis and management of periprosthetic shoulder infections. J Bone Joint Surg Am 96(11):956–965
20. Sperling JW, Kozak TK, Hanssen AD, Cofield RH (2001) Infection after shoulder arthroplasty. Clin Orthop Relat Res (382):206–216
21. Bohsali KI, Wirth MA, Rockwood CA Jr (2006) Complications of total shoulder arthroplasty. J Bone Joint Surg Am 88(10):2279–2292
22. Ramsey ML, Fenlin JM Jr (1996) Use of an antibiotic-impregnated bone cement block in the revision of an infected shoulder arthroplasty. J Shoulder Elbow Surg 5(6):479–482
23. Jawa A, Shi L, O'Brien T et al (2011) Prosthesis of antibiotic-loaded acrylic cement (PROSTALAC) use for the treatment of infection after shoulder arthroplasty. J Bone Joint Surg Am 93:2001–2009