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Original article

# Two-stage revision shoulder prosthesis vs. permanent articulating antibiotic spacer in the treatment of periprosthetic shoulder infections

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## ARTICLE INFO

## ABSTRACT

*Introduction:* Periprosthetic shoulder infections (PSIs) represent a serious complication following shoulder arthroplasty. No consensus exists regarding the optimal option. We conducted a retrospective case-control study to compare the outcomes of 2-stage revision shoulder arthroplasty and those of definitive articulating antibiotic spacer implantation with regards to eradication of the infection, improvement of pain and shoulder function.
*Materials and methods:* Thirty patients treated for an infected shoulder arthroplasty were retrospectively reviewed after a mean follow-up of 8 years (range, 2–10 years). Nineteen underwent definitive articulating antibiotic spacer implantation and 11 underwent 2-stage revision arthroplasty. Mean age at surgery was 68.8 years. Assessment included Constant-Murley score, visual analog scale pain score, objective examination, patient subjective satisfaction score as well as standard radiographs.
*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 preoperative values ($p < 0.001$). Radiographs did not show progressive radiolucent lines or change in the position of the functional spacer. No statistically significant differences were reported between the two groups concerning Constant-Murley and VAS scores, while average forward flexion and abduction were significantly higher in patients undergoing 2-stage revision surgery.
*Conclusions:* Both surgical procedures provided infection eradication and satisfying subjective functional outcomes. Functional results were superior in patients treated with revision shoulder prosthesis, although a higher rate of complication was reported in this cohort of patients, thus suggesting the use of permanent spacer in high-risk or low-demanding elderly patients.
*Level of evidence:* III, Retrospective case-control study.

## 1. Introduction

Periprosthetic shoulder infections (PSIs) represent a serious complication following shoulder arthroplasty [1,2]. No consensus exists regarding the optimal option [3].

Operative treatments include debridement and chronic antibiotic therapy, 1- or 2-stage revision surgery, permanent articulating antibiotic spacer, and excision arthroplasty [4–16].

Patients undergoing two-stage revision for PSIs are advocated to have greater postoperative range of motion compared with pre-revision values [16]; however, their effect on functional outcomes has been variable [11,17–19], and they may lead to further complications, thus being unfit for high-risk patients or subjects with bone defects.

Therefore, in order to overcome complications related to re-surgery, the use of a permanent antibiotic-impregnated cement spacer in the septic shoulder after arthroplasty has been proposed [8].

We conducted a retrospective case-control study to compare the outcomes of 2-stage revision shoulder arthroplasty and those of definitive articulating antibiotic spacer implantation in terms of eradication of the infection, improvement of pain and shoulder function.

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**Table 1**
Patient demographics and anthropometric data.

|  | Revision prosthesis | Permanent spacer |
| --- | --- | --- |
| Age at surgery (SD) (yr) | 66.6 (SD:11.4) | 70.2 (SD:10.2) |
| Gender |  |  |
| Male | 8 | 10 |
| Female | 3 | 9 |
| Operations before revision surgery |  |  |
| TSA | 6 | 12 |
| Reverse TSA | 3 | 5 |
| Hemiarthroplasty | 1 | 2 |
| Type of infection |  |  |
| Delayed (<2 year) | 4 | 7 |
| Late (>2 year) | 7 | 12 |

SD: standard deviation; TSA: total shoulder arthroplasty.

## 2. Methods

Between 2007 and 2014, 37 patients were treated for an infected shoulder prosthesis. Thirty of them were successfully recontacted and were included in the study.

Nineteen underwent definitive articulating antibiotic spacer implantation and 11 underwent 2-stage revision arthroplasty.

Infection was evoked, properatively, through clinical examination, evidence of radiographic loosening and laboratory tests (erythrocyte sedimentation rate, serum white blood cell count and C-reactive protein) then confirmed by analysis of intraoperative cultural examination.

Infections were classified as delayed or late according to Zimmerli et al. [20]. Mean age at presentation with PSI was 68.8 years (range, 64–80 years). The operative side was right in 20 of 30 patients (67%). The PSI involved anatomic total shoulder arthroplasty (TSA) in 19 of 30 patients, reverse TSA in 8 and hemi-arthroplasty in 3 cases (Table 1). All surgeries were performed by one single senior surgeon.

The treatment strategy was selected after careful evaluation of patient expectations, compliance, presence of comorbidities and radiographic findings. Two-stage revision surgery was proposed to younger patients with higher functional requests and with no evidence of radiographic bone defects, while elderly, low-demanding patients were more likely to prefer definitive spacer implantation.

Among those being elected for 2-stage revision surgery, three patients refused to undergo prosthesis re-implantation since they experienced pain relief and acceptable functional outcomes following spacer implantation, and were therefore included in the first group.

### 2.1. Surgical technique of definitive functional spacer implantation

After explantation of all previously implanted components and cement and extensive surgical debridement 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 Refobacin revision cement with Clindamycin and Gentamycin (Biomet, Warsaw, Indiana). The type of antibiotic spacer was based on cultural examination whenever possible (preoperative pathogen identification on synovial cutaneous fistula), otherwise a broad-spectrum antibiotic was used.

### 2.2. Surgical technique of two stage revision arthroplasty

A standardized 2-stage protocol was used to treat the 11 patients included in this cohort. The first stage was the same for permanent spacer implantation.

**Table 2**
Pathogens isolated intraoperatively.

| Pathogen | Number (%) |
| --- | --- |
| MRSA | 8 (26.6) |
| CNS | 6 (20.0) |
| Propionibacterium acnes | 2 (6.6) |
| No isolation | 14 (46.6) |

MRSA: methicillin-resistant *Staphylococcus aureus*; CNS: coagulase-negative *staphylococci*.

In this cohort of patients prefabricated cement spacers (Vancogenx) were used in all patients.

Once the infection was considered successfully eradicated, reimplantation of the arthroplasty was allowed. Standard radiograph and CT scans were performed in order to assess bone stock and glenoid erosion. According to radiographic evaluation, whenever allowed, revision prosthesis implantation was performed: reverse TSA (Delta, DePuy) was implanted in 8 patients (73%), while hemiarthroplasty (CTA, DePuy) was implanted in 3 subjects (27%). The mean period between the removal of the spacer and the implantation of the revision arthroplasty was 3.2 months (range, 2 to 4 months).

### 2.3. Microorganisms isolation

Bacteria were isolated intraoperatively in approximately 53% of patients (16 on 30 patients), most of them being methicillinresistant *Staphylococcus aureus* (MRSA) and coagulase-negative *staphylococci* (CNS) (Table 2).

### 2.4. Postoperative 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 2 to 3 weeks, then started performing passive motion exercises, supine stretching and were allowed to resume activities of daily living with a 2-pound weight restriction. At 12 weeks postoperatively, patients were allowed to resume activity without restriction.

### 2.5. Outcome measures

Clinical outcomes were evaluated preoperatively and at the most recent follow-up and included clinical and radiographic signs of infection eradication, range of motion, Constant-Murley Score [21], visual analog scale (VAS) pain score, and patient subjective satisfaction (excellent, good, satisfied, or unsatisfied) score according to Neer [22]. Anteroposterior and axillary X-rays were examined for signs of loosening, osteolysis, and modifications in implant position.

### 2.6. 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 preoperative and follow-up status as well as the differences of the outcomes between the two surgical techniques. Differences with a $p$ value < 0.05 were considered statistically significant.

## 3. Results

After a mean follow-up of 8 years (range, 2–10 years), none of the 30 patients had clinical or radiographic signs suggesting recurrent infection. One patient underwent revision surgery with conversion from rTSA to hemiarthroplasty due to prosthesis dislocation.

**Table 3**
Overview of the results of clinical assessment.

|  | Preoperative | Postoperative | p value |
|---|---|---|---|
| Constant-Murley score (mean, SD) | 21.7 (SD:18.1) | 39.5 (SD: 18.5) | p < 0.001 |
| VAS pain score (mean, SD) | 6.5 (SD: 2.4) | 1.5 (SD: 1.8) | p < 0.001 |
| Active forward elevation (mean, SD) | 42.1° (SD:28.8) | 69.2° (SD:24.9) | p < 0.001 |
| Active abduction (mean, SD) | 38.8° (SD: 24.1) | 62.5° (SD:23.1) | p < 0.001 |

VAS: visual analog scale; SD: standard deviation.

Both functional and pain scores significantly improved. Detailed overall clinical outcomes are reported in Table 3.

Patient satisfaction, scored according to Neer, yielded 14 patients who reported good (47%), 14 (47%) reporting satisfying and 2 (6%) poor results. Standard radiographs did not show progressive radiolucent lines or loosening of the components.

No statistically significant differences were reported between the two groups concerning VAS scores, while Constant score as well as average forward flexion and abduction were significantly higher in patients undergoing 2-stage revision surgery (Table 4).

## 4. Discussion

The most important finding of the present study was that none of the subjects had clinical or radiographic signs suggesting recurrent infection, either following the implantation of definitive functional antibiotic spacer or following two-stage exchange arthroplasty.

Most patients in both groups reported subjective and objective satisfying outcomes at an average follow-up of 8 years.

Patients undergoing 2-stage revision arthroplasty reported improved functional outcomes compared to spacer implantation. We observed a 9% major complication rate (one dislocation of rTSA). No statistically significant differences were reported in terms of subjective outcomes.

According to a recent review of literature, no statistically significant difference in outcomes were reported between patients treated with permanent spacer and patients receiving a two-stage revision arthroplasty [3].

Nelson et al. [23] in a systematic review reported no difference in infection eradication between 1- and 2-stage revision surgery following PSI with similar postoperative Constant scores between the two groups. Similarly Beekman et al. [4] and Ince et al. [13] reported lower complication rates in 1-stage revision, suggesting that this treatment may result in less damage to bone and soft tissues and therefore be appropriate for patients whose medical conditions contraindicate two major operations.

Patients undergoing two-stage revision for PSIs are advocated to have greater postoperative range of motion compared with pre-revision values [16]; however, their effect on functional outcomes

has been variable [11,17–19], and they may lead to further complications, thus being unfit for high-risk patients or subjects with bone defects.

In our case series mean Constant scores were lower in patients undergoing permanent spacer implantation compared to those undergoing 2-stage revision surgery (p < 0.001).

In addition, our cohort of patients treated with permanent spacer had average forward elevation of 58.2° (SD: 22.1), which as expected was less compared to the average forward flexion 78.2° (SD: 30.2), of patients undergoing 2-stage revisions.

Results from our case series show that no difference exists in infection clearance or functional subjective outcome between definitive spacer implantation and 2-stage revision, although may suggest a higher complication rate for 2-stage revision, as reported by Sabesan [5].

Intraoperative microbiology examination allowed pathogens identification in 53% of patients, similarly 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 [7,12,13].

The overall functional results of our patients treated with revision shoulder prosthesis were similar to those reported for 2-stage revisions in the literature. Coffey et al. [10] reported a mean ASES score of 74 and a mean Constant score of 57 in patients with 2-stage revision.

Satisfying results following permanent spacer implantation and two-stage revision in the treatment of PSI have been reported [24].

The current findings suggest that after a mean follow-up of 8 years, insertion of a cement spacer, followed or not by revision prosthesis implantation, can be a relatively successful treatment option in patients with PSI, with 0% recurrence of infection in all patients.

Previous series reporting on the use of cement spacers as definitive treatment in patients with infection describe an overall reinfection rate of 5%.

Definitive cement spacers may not be suitable in active young patients who could undergo additional prosthetic replacement due to concerns of reduced function. However our results suggest that definitive treatment with cement spacers provides infection

**Table 4**
Overview of the results of clinical assessment between the two groups.

| Preoperative assessment | | | |
|---|---|---|---|
|  | Revision prosthesis | Permanent spacer | p value |
| Constant-Murley score (mean, SD) | 22.0 (SD:19.4) | 21.4 (SD:15.1) | p = n.s. |
| VAS pain score (mean, SD) | 6.6 (SD: 2.7) | 6.4 (SD: 2.1) | p = n.s. |
| Active forward elevation (mean, SD) | 43.0° (SD:27.4) | 41.2° (SD:29.2) | p = n.s. |
| Active abduction (mean, SD) | 39.5° (SD: 25.2) | 38.1° (SD: 23.7) | p = n.s. |

| Postoperative assessment | | | |
|---|---|---|---|
|  | Revision prosthesis | Permanent spacer | p value |
| Constant-Murley score (mean, SD) | 43.2 (SD: 17.2) | 37.8 (SD: 17.1) | p < 0.001 |
| VAS pain score (mean, SD) | 1.5 (SD: 1.9) | 1.6 (SD: 1.8) | p = n.s. |
| Active forward elevation (mean, SD) | 78.2° (SD:30.2) | 58.2° (SD:22.1) | p < 0.001 |
| Active abduction (mean, SD) | 68.1° (SD: 29.7) | 51.6° (SD:19.4) | p < 0.001 |

VAS: visual analog scale; SD: standard deviation.

eradication and satisfying subjective functional outcomes in elderly patients with reduced functional requests who cannot tolerate two major surgical procedures. A permanent spacer can be either planned preoperatively or it can follow an originally-planned 2-stage procedure when acceptable function and pain control are achieved after first stage [25].

Limitations of the present study include its retrospective nature, and the relatively small sample size. The limited number of patients is due to the fact that this is an unfrequent complications, and these approaches require adopting highly selective indications as criteria for patient selection. The limited study population may not have allowed for detection of small differences between groups. Some data were nearly significant in favor of 2-stage revision surgery. Further randomized clinical trials are needed to substantiate these findings.

## 5. Conclusion

Both definitive spacer implantation and two-stage revision surgery provide infection eradication and satisfying subjective functional outcomes in patients with PSI.

Functional results were superior in patients treated with revision shoulder prosthesis, although a higher rate of complication was reported in this cohort of patients, thus suggesting the use of permanent spacer in high-risk or low-demanding elderly patients.

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## Authors' contribution

A. Pellegrini: study design, manuscript production and revision.
C. Legnani: data collection and elaboration, manuscript production.
V. Macchi: data collection, manuscript production.
E. Meani: study design, manuscript production and revision.

## Disclosure 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.

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