Limited improvement and high rate of complication in patients undergoing reverse total shoulder arthroplasty for previous native shoulder infection

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Abstract: BACKGROUND The outcomes of reverse total shoulder arthroplasty (RTSA) surgery for the sequelae of former septic native joint shoulder arthritis are unknown but might be inferior to patients without prior bacterial arthritis. METHODS We performed a single-center case-control study embedded in our prospective RTSA cohort. We matched all patients with prior infections in a 1:1 ratio with patients who underwent RTSA for other indications. The matching variables were indication for surgery, age, sex, dominant/nondominant shoulder, and body mass index. We evaluated outcomes by Constant score and active function. RESULTS Among 1249 patients in the RTSA cohort, 14 were operated for sequelae of previous native shoulder joint infections. Although both groups significantly improved from preoperative to postoperative values, the outcome of postinfectious patients was clearly inferior in comparison with the control group (absolute [38 ± 17 vs. 75 ± 8, P < .01], relative Constant score [47 ± 19 vs. 88 ± 9, P < .01], Constant pain score [11.0 ± 3.1 vs. 14.3 ± 1.3, P < .01], subjective shoulder value [43 ± 26 vs. 85 ± 10, P < .01], abduction [70 ± 43 vs. 148 ± 29°, P = .001], and elevation [82 ± 49° to 131 ± 16°, P = .02]). Moreover, in the postinfectious group, overall surgical complications occurred in 36%, with the need for revision in 21%. There was, however, no recurrence of infection in any of the patients’ shoulders. CONCLUSION RTSA for end-stage postinfectious joint disease is associated with a high number of complications and reoperations. Clinical outcomes are inferior to those without past infection.

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Limited improvement and high rate of complication in patients undergoing reverse total shoulder arthroplasty for previous native shoulder infection

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Background: The outcomes of reverse total shoulder arthroplasty (RTSA) surgery for the sequelae of former septic native joint shoulder arthritis are unknown but might be inferior to patients without prior bacterial arthritis.

Methods: We performed a single-center case-control study embedded in our prospective RTSA cohort. We matched all patients with prior infections in a 1:1 ratio with patients who underwent RTSA for other indications. The matching variables were indication for surgery, age, sex, dominant/nondominant shoulder, and body mass index. We evaluated outcomes by Constant score and active function.

Results: Among 1249 patients in the RTSA cohort, 14 were operated for sequelae of previous native shoulder joint infections. Although both groups significantly improved from preoperative to postoperative values, the outcome of postinfectious patients was clearly inferior in comparison with the control group (absolute [38 ± 17 vs. 75 ± 8, \(P < .01\)], relative Constant score [47 ± 19 vs. 88 ± 9, \(P < .01\]), Constant pain score [11.0 ± 3.1 vs. 14.3 ± 1.3, \(P < .01\)], subjective shoulder value [43 ± 26 vs. 85 ± 10, \(P < .01\)], abduction [70 ± 43 vs. 148 ± 29\(^\circ\), \(P = .001\)], and elevation [82 ± 49\(^\circ\) to 131 ± 16\(^\circ\), \(P = .02\)]. Moreover, in the postinfectious group, overall surgical complications occurred in 36\%, with the need for revision in 21\%. There was, however, no recurrence of infection in any of the patients’ shoulders.

Conclusion: RTSA for end-stage postinfectious joint disease is associated with a high number of complications and reoperations. Clinical outcomes are inferior to those without past infection.

Level of evidence: Level III; Retrospective Cohort Comparison; Treatment Study

Keywords: Postarthritis sequelae; reverse total shoulder arthroplasty; outcomes; group comparisons; handicap; septic arthritis

Postinfectious sequelae of the native shoulder joint are frequently associated with poor clinical function and pain as well as diminished quality of life for affected patients.\textsuperscript{8,19,25} Because of concomitant cartilage and rotator cuff degeneration with severe scarring, few therapeutic options are available. Reverse total shoulder arthroplasty (RTSA) can theoretically address these associated degenerative changes. RTSA is being increasingly used worldwide for multiple indications.\textsuperscript{23,27} Most patients have good outcomes. Risk factors for decreased clinical outcomes...
include male sex, young age, obesity, diabetes mellitus, active smoking, rheumatoid arthritis, or revision surgery.\textsuperscript{3,13,17,20,21,31,34} Periprosthetic joint infections may occur to 1.1\%-3.8\%,\textsuperscript{6} with higher numbers in septic revision cases. Theoretically, a postinfectious native shoulder might also be considered as a risk factor for new or recurrent infection after RTSA.

It was the purpose of this study to evaluate the clinical outcomes, surgical complications, and revision rates of patients undergoing RTSA, comparing those with prior bacterial arthritis with those with arthropathies for non-septic reasons. We hypothesized that postinfective shoulder joints (1) would have a higher risk of reinfection and (2) would have inferior functional outcomes.

Methods

After institutional review board approval, our prospective RTSA cohort was queried to identify patients with previous infection (>1 months in the past) of the shoulder in remission. We excluded episodes with active infections and patients with prior arthroplasties to the affected shoulder. We performed a single-center case-control study embedded in our prospective RTSA cohort and matched all patients with prior infections in a 1:1 ratio to RTSA for other reasons. Our matching variables were indication for surgery (Cuff tear arthropathy, rotator cuff tear, osteoarthritis, posttraumatic, instability), duration of follow-up, age, gender, dominant/nondominant shoulder, and the body mass index. We evaluated primary outcomes by clinical reinfection after RTSA, Constant-Murley score,\textsuperscript{5,9} subjective shoulder value (SSV),\textsuperscript{10} range of motion (ROM), and pain. Secondary outcome measures were any surgical complications, reoperations, and revisions. Every patient scheduled for RTSA received a standard preoperative clinical examination (Constant score [CS], ROM, and SSV) and for preoperative planning radiological evaluation, including 3 standard radiographs (standard anterior-posterior, lateral Neer view, and axial view) and computed tomography. Postoperatively, the patients were clinically (CS, ROM, and SSV) and radiographically (3 standard radiographs) re-examined after 1-2 years, and then all 2 years after surgery.

Surgical techniques

The technique was standardized throughout the study period. All patients were treated using a Zimmer Anatomical Shoulder Inverse/Reverse or a Trabecular Metal Reverse Shoulder System (Zimmer, Warsaw, IN, USA) prosthetic joint. In 1 patient, the Aequalis Reverse Glenoid Component (Medica Wright Tornier, Memphis, TN, USA) with long peg was used. We preferred the deltopectoral approach, leaving the cephalic vein laterally. The humeral head was resected and the stem inserted in 0° to 20° of retroversion. Additional cementation was decided on the intraoperative assessment, depending on bone quality and press-fit stem fixation (5 cementations in the prior infected group and 9 in the controls). We prepared the glenoid component by reaming and insertion of the base plate at a caudal position on the glenoid, with neutral version and neutral to slightly inferior inclination not exceeding 10°, and performed a transosseous subscapularis refixation using No. 2 FiberWire (Arthrex, Naples, FL, USA) in 10 patients in the postinfectious group and in 13 patients in the matching cohort. Standard antibiotic prophylaxis with intravenous Zinacef 1.5 g parenterally was started 30 minutes before skin incision and was administered 2 times postoperatively. Depending on the surgeons’ decision, 5 patients did receive only those 3 doses, 8 received oral antibiotics (co-amoxicillin) until negative test results, and 1 patient received antibiotics for a fixed period of 6 weeks. Mobilization was started at the first perioperative day with passive external and internal rotation and continued with active-assisted elevation for 6 weeks.

Statistical analyses and literature review

We performed all statistical analyses with SPSS software v23.0 (IBM, Armonk, NY, USA). We tested the normal distribution of variables with the Shapiro-Wilk test and compared preoperative and postoperative scores with the paired t-test (parametric data) or the Wilcoxon rank sum test (nonparametric distribution). Because of the paucity of numbers in the group with prior septic arthritis, we did not complete any multivariate analysis. For the literature review in PubMed and the internet, we used the following medical subject headings terms in English language (with corresponding translations in German and French): postinfectious, sequelae, arthritis, and RTSA.

Results

General results

Between September 2005 and January 2017, we performed 1249 RTSAs in our tertiary referral hospital. We identified 14 episodes in 14 patients with previous bacterial arthritis in their shoulders and ultimately undergoing RTSA for chronic, postinfectious, and symptomatic sequelae. In detail, these mechanical sequelae could be further broken down to the following main problems: massive rotator cuff tears (8 patients; 57%), osteosynthesis failures (4 patients; 29%), osteoarthritis (1 patient; 7%), and chronic instability (1 patient; 7%). The mean follow-up time after RTSA was 5.0 years (range, 1.0-12.0 years).

All prior septic arthritis had been treated by various numbers of lavages and prolonged antibiotic administration for different causative microorganisms (Table I). The persistence of infection was ruled out before RTSA implantation by the absence of fever, night sweats, local redness or heat, normal serum C-reactive protein values (<10 mg/L) and white blood cell count (>2 G/L and <10 G/L), a negative joint aspiration,\textsuperscript{12} and finally by negative intraoperative microbiological assessments in several samples.

We matched those 14 individuals to an equal number of RTSA patients without a previous history of infection (Table II).
Other authors treated joint replacements, only 4 studies

Our findings are in line with this literature.

shoulder value (43 vs. 148

49 vs. 88

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There was no recurrence of prior infection, or a new surgical site infection, in the postinfectious RTSA group. In this group, however, 5 patients (36%) showed complications, and 3 (21%) required revision surgery (see Table IV). One patient had arthroscopic scar tissue resection. Another patient received arthroscopic débridement and in a second surgery polyethylene liner replacement for prosthetic instability. Another one had an open reduction and internal fixation of a greater tuberosity fracture with revision due to malunion. There were no signs of infection during revision surgery, which was proven by negative tissue samples in all the cases.

In the control group, 2 patients (14%) showed complications: 1 postoperative ulnar nerve neuropathy and 1 conservatively treated acromion fracture. No revision surgery was necessary. At the last radiological follow-up, there were no signs of loosening or relevant heterotopic ossifications. Notching occurred in 4 patients in the postinfectious group (29%) and 7 patients in the control group (50%).

Discussion

According to this retrospective analysis of a prospectively enrolled patient cohort, RTSA for postinfectious shoulder sequelae is associated with a high number of surgical complications (36%) and revisions (21%). Previous septic arthritis did not correlate with increased risk of reinfection in this cohort.

The clinical outcome of the investigated study group was, however, unexpectedly poor with a high rate of complications and reoperations. We are not able to draw causative conclusions from the available data, and explanations for this unsatisfying outcome remain hypothetical. The sequelae of the previously infected joint with poor tissue and bone quality and excessive scar tissue might, however, explain this inferior outcome compared with a gender, age, and indication matched control group.

In contrast, for postinfectious hip\cite{22,24,27,26,30} and knee\cite{1,2,14,16,23,29,30} joint replacements, only 4 studies investigated the functional outcome after RTSA (Table V).\cite{18,22,25,28} Our findings are in line with this literature. Morris et al\cite{22} studied 8 RTSA patients with a surgical complication risk of 37.5%. Despite multiple revisions, they reported a significant improvement regarding postoperative pain (Constant score pain, 11.8 ± 5), postoperative American Shoulder and Elbow Surgeons Shoulder score (78.4 ± 15.2), and absolute Constant-Murley scores (56.2 ± 19.4).\cite{22} Other authors treated postinfectious shoulder arthropathies with 14 RTSA, 1 anatomic total shoulder arthroplasty, and 2 hemiarthroplasties and detected poor outcomes (Constant pain score of 4.6 ± 2.3 and a postoperative American Shoulder

| Table I | Detected pathogens and lavages in the current series |
|---------|-----------------------------------------------------|
| ID | Pathogens | Treatment of infection |
| 1 | Staphylococcus aureus | 2 × arthroscopic débridement |
| 2 | Peptostreptococcus | 1 × arthroscopic débridement |
| 3 | No species isolated | 2 × arthroscopic débridement |
| 4 | Cutibacterium acnes | 1 × arthroscopic débridement |
| 5 | Staphylococcus aureus | 1 × arthroscopic débridement |
| 6 | Staphylococcus aureus, Peptostreptococcus | 3 × open débridement |
| 7 | Coagulase-negative staphylococci | 1 × arthroscopic débridement |
| 8 | Cutibacterium acnes | 3 × open débridement |
| 9 | Cutibacterium avidum | 3 × open débridement |
| 10 | Staphylococcus aureus, Cutibacterium acnes, Peptostreptococcus, Staphylococcus haemolyticus | 1 × open débridement |
| 11 | Serratia marcescens | 1 × open débridement |
| 12 | Cutibacterium acnes, Staphylococcus epidermidis | 2 × arthroscopic débridement |
| 13 | Staphylococcus aureus | 1 × arthroscopic débridement |
| 14 | Staphylococcus aureus | 3 × arthroscopic débridement |

| Table II | Displays characteristics of the 2 studied groups, postinfectious and matched pairs |
|---------|----------------------------------------------------------------------------------|
| | Healed-up infections | Control group | P value |
| Numbers | 14 | 14 |
| Follow-up (yr) | 5.0 ± 4 | 5.0 ± 3 | .6 |
| Age (yr) | 64 ± 8 | 67 ± 8 | .1 |
| Sex | Male | Male n = 7 (50%) | .7 |
|  | n = 6 (43%) | Female |
|  | Female n = 8 (57%) | n = 7 (50%) |
| Shoulder | Right n = 6 (43%) | Right n = 8 (57%) | .5 |
|  | Left n = 8 (57%) | Left n = 6 (43%) |
| Dominant arm | Right n = 12 (86%) | Right n = 11 (79%) | .6 |
|  | Left n = 2 (14%) | Left n = 3 (21%) |
| BMI | 26 ± 5 | 25 ± 4 | .6 |

BMI, body mass index.
Table III: Comparison of preoperative and postoperative values between the 2 studied groups

|                      | Preoperative | Postoperative | Absolute CS | 95% CI          | Relative CS | 95% CI          | SSV | 95% CI          | CS pain | 95% CI          | Flexion | 95% CI          | Abduction | 95% CI          | External rotation | 95% CI          |
|----------------------|--------------|---------------|-------------|----------------|-------------|----------------|------|----------------|---------|----------------|---------|----------------|-----------|------------------|------------------|------------------|
|                      |              |               | 24 ± 10 (19; 30) | 38 ± 17 (28; 48) | .01          | 33 ± 16 (24; 43) | 75 ± 8 (70; 80) | .001 | .01            | 0.01   | 38 ± 17 (28; 48) | 11.0 ± 3.1 | 11.0 ± 3.1 | 63 ± 38 (41; 85) | 11.0 ± 3.1 | 63 ± 38 (41; 85) | 11.0 ± 3.1 |
|                      |              |               | 29 ± 13 (22; 36) | 47 ± 19 (37; 58) | .01          | 41 ± 18 (30; 51) | 88 ± 9 (83; 93) | .001 | .01            | 0.01   | 47 ± 19 (37; 58) | 10.8 ± 3.1 | 10.8 ± 3.1 | 82 ± 31 (64; 100) | 10.8 ± 3.1 | 82 ± 31 (64; 100) | 10.8 ± 3.1 |
|                      |              |               | 24 ± 16 (16; 31) | 43 ± 26 (28; 59) | .02          | 29 ± 20 (18; 40) | 85 ± 10 (79; 90) | .001 | .03            | 0.03   | 43 ± 26 (28; 59) | 11.0 ± 3.1 | 11.0 ± 3.1 | 80 ± 40 (58; 104) | 11.0 ± 3.1 | 80 ± 40 (58; 104) | 11.0 ± 3.1 |
|                      |              |               | 5.9 ± 4.0     | 11.0 ± 3.1     | .01          | 6.7 ± 4.2      | 14.3 ± 1.3     | .001 | .002           | <.001  | 5.9 ± 4.0     | 11.0 ± 3.1 | 11.0 ± 3.1 | 70 ± 43 (45; 95) | 11.0 ± 3.1 | 70 ± 43 (45; 95) | 11.0 ± 3.1 |
|                      |              |               | (3.7; 8.2)    | (9.2;12.8)     | (4.3; 9.1)   | (13.5; 15.1)   |                |      |               |         | (3.7; 8.2)    | (9.2;12.8) | (4.3; 9.1) | (13.5; 15.1)   |                |                |
| Flexion              |              |               | 63 ± 38 (41; 85) | 82 ± 31 (64; 100) | .06          | 82 ± 49 (54; 110) | 131 ± 16 (122; 140) | .02  | .16            | <.014  | 63 ± 38 (41; 85) | 11.0 ± 3.1 | 11.0 ± 3.1 | 80 ± 40 (58; 104) | 11.0 ± 3.1 | 80 ± 40 (58; 104) | 11.0 ± 3.1 |
| Abduction            |              |               | 51 ± 25 (37; 67) | 80 ± 40 (58; 104) | .03          | 70 ± 43 (45; 95) | 148 ± 29 (131; 164) | .001 | .04            | <.001  | 51 ± 25 (37; 67) | 11.0 ± 3.1 | 11.0 ± 3.1 | 70 ± 43 (45; 95) | 11.0 ± 3.1 | 70 ± 43 (45; 95) | 11.0 ± 3.1 |
| External rotation    |              |               | 28 ± 28 (11; 44) | 18 ± 25 (3; 32) | .11          | 19 ± 21 (7; 31) | 35 ± 22 (22; 48) | .09  | .41            | <.001  | 28 ± 28 (11; 44) | 11.0 ± 3.1 | 11.0 ± 3.1 | 18 ± 25 (3; 32) | 11.0 ± 3.1 | 18 ± 25 (3; 32) | 11.0 ± 3.1 |

CS, Constant score; SSV, subjective shoulder value.
95% confidence interval within parentheses.

Table IV: Postinfectious patient’s data

| ID | Previous surgery | Sample to RTSA (yr) | Negative sample before RTSA | Complication | Revision surgeries | Cons. samples |
|----|------------------|---------------------|-----------------------------|--------------|--------------------|---------------|
| 1  | 4                | 1.2                 | Yes (TIS)                   | Scar tissue | 1                  | Neg           |
| 2  | 2                | 0.3                 | Yes (TIS)                   | 0            |                    |               |
| 3  | 5                | 1.6                 | Yes (TIS)                   | 0            |                    |               |
| 4  | 4                | 1.9                 | No sample                   | Neuropathy   | 0                  |               |
| 5  | 4                | 1.3                 | Yes (ASP, TS)               | 0            |                    |               |
| 6  | 5                | 2.0                 | Yes (ASP)                   | Neuropathy, HO | 0            |               |
| 7  | 4                | 4.1                 | No sample                   | 0            |                    |               |
| 8  | 8                | 2.2                 | Yes (ASP)                   | Instability  | 2                  | Neg           |
| 9  | 5                | 1.6                 | Yes (ASP)                   | 0            |                    |               |
| 10 | 2                | 0.5                 | Yes (ASP, TIS)              | 0            |                    |               |
| 11 | 3                | 0.1                 | Yes (TIS)                   | 0            |                    |               |
| 12 | 3                | 1.5                 | Yes (TIS)                   | 0            |                    |               |
| 13 | 1                | 0.5                 | Yes (TIS)                   | Fracture     | 2                  | Neg           |
| 14 | 3                | 10.6                | Yes (ASP, TIS)              | 0            |                    |               |

RTSA, reverse total shoulder arthroplasty; ASP, joint aspiration; TIS, intraoperative tissue sample; HO, heterotopic ossification; Cons., consecutively obtained samples in revision surgeries; Neg, negative sample.

and Elbow Surgeons Shoulder score of 57.6 ± 15.5). Their complication risk was 24% and the reoperation risk 12%, with albeit no recurrent infection.25 Schoch et al28 followed 23 postinfectious glenohumeral sequelae, treated with 11 anatomic total shoulder arthroplasties and 12 hemiarthroplasties, and found high reoperation and complication risks of 22% and 35%, respectively. The outcome was reported as unsatisfying in 52% of the patients.28 A previous study from the same institution also had revealed similar results with a complication rate of 42% and revision surgery in 25%. The outcome was satisfying in 50%.18

Besides its retrospective nature and coming from a single center, our study has additional limitations. (1) The study population is heterogeneous with different indications for RTSA in the control group. Despite successful matching over 5 key variables, we still compared a small group of postinfectious shoulder sequelae with a very heterogeneous group of origins for RTSA. (2) We lack information concerning the chronic antalgic medication and the individual physical therapy of the patients, which would also give some insights into the countermeasures against the poorer outcomes. Nevertheless, this study documents the poorer outcomes of RTSA in patients with prior infections. However, we currently cannot draw any further conclusions, regarding improvement of patient care. At the time of RTSA, the postinfectious sequelae were already established and all efforts of excessive scare débridement and correct implant positioning were made. The key could be in the prevention and treatment of initial septic arthritis. Although the number of surgical lavages,11,15,33 the degree of emergency for that lavage,15 or the duration of postsurgical antibiotics11,15,33 does not reduce the risk, or the severity, of postinfectious mechanical joint sequelae, maybe anti-inflammatory therapies during the acute phase of
inflammation do. Because there are so far no robust clinical data on corticosteroid therapy, we currently withstand with their use in this population.

**Conclusion**

Postinfectious arthritis to the shoulder joint is a devastating condition with poor outcomes and a high number of complications and revision surgeries after RTSA. Nevertheless, we are not aware of any viable alternative treatment option for these patients by now, and RTSA has at least the potential of moderate improvement and end result for subjective and objective outcome measures.

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**Table V** Currently available literature regarding total shoulder arthroplasty in postinfectious joints

| Study               | N  | Implant used | Re-Op (%) | Complication rate (%) | Re-infection (%) | ASES score | Pain score | FU |
|---------------------|----|--------------|-----------|-----------------------|-----------------|------------|------------|----|
| Padegimas et al (2018) | 14 | RTSA         | 12        | 24                    | 0               | —          | 58 ± 16    | 4 1 |
|                     | 1  | aTSA         |           |                       |                 | —          | 5 ± 10     |    |
|                     | 2  | Hemi         |           |                       |                 | —          | 5 ± 10     |    |
| Morris et al (2015) | 8  | RTSA         | 0         | 38                    | 0               | 38 ± 15    | 78 ± 15    | 4 4 |
| Schoch et al (2014) | 11 | aTSA         | 22        | 35                    | 9               | No clinical scores | 4.5/10 | 2.1/10 | 8 3 |
|                     | 12 | Hemi         | 25        | 42                    | 0               | No clinical scores | 4.8/10 | 2.5/10 | 9 7 |
| Mileti et al (2003) | 20 | aTSA         | 42        | 50                    | 0               | 48% satisfied | 50% satisfied |    |

*Impl*, implant used; *RTSA*, reverse total shoulder arthroplasty; *aTSA*, anatomic total shoulder arthroplasty; *Hemi*, hemiprosthesis; *Re-Op*, rate of reoperations; *Comp*, complication rate; *Re-Inf*, reinfection rate; *ASES*, American Shoulder and Elbow Surgeons Shoulder score; *FU*, follow-up in years.
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