

# Mid- to Long-Term Outcomes After Deep Infections After Arthroscopic Rotator Cuff Repair



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**Purpose:** To review clinical and subjective outcomes in patients with deep infections after arthroscopic rotator cuff repair. **Methods:** All patients in whom deep infections developed after arthroscopic rotator cuff repair at a single center between 2002 and 2016 were retrospectively reviewed. Demographic data, clinical and microbiological findings, and treatment were analyzed. Clinical and subjective outcomes included the Constant score, visual analog scale score for pain, American Shoulder and Elbow Surgeons score, and Simple Shoulder Test score. **Results:** Thirty patients could be identified and included in the study. The most commonly isolated pathogens were *Staphylococcus epidermidis* (36.7%) and *Cutibacterium acnes* (30.0%). In 26 of 30 patients (86.7%), the infection was treated initially with an open surgical approach, whereas 4 patients (13.3%) underwent arthroscopic revision. A transosseous rotator cuff repair could be performed in 20.0% of patients. A single reoperation was sufficient in 80% of patients, whereas 13.3% required 2 revisions and 6.7% required 3. At the final follow-up of 8.3 years (range, 4-14 years), 26 patients (1 woman and 25 men) were available for outcome evaluation. Significant improvement from the initial surgical procedure to final follow-up was detected in the Constant score (25.7 vs 65.7,  $P < .001$ ), visual analog scale score for pain (7.0 vs 1.7,  $P < .001$ ), American Shoulder and Elbow Surgeons score (38.0 vs 76.7,  $P < .001$ ), and Simple Shoulder Test score (4.0 vs 8.3,  $P < .001$ ). **Conclusions:** Patients with deep infections after arthroscopic rotator cuff repair showed moderate mid- to long-term outcomes. **Level of Evidence:** Level IV, therapeutic case series.

Over the past 2 decades, shoulder arthroscopy has become a widely accepted and successful surgical procedure for patients with rotator cuff pathology.<sup>1-4</sup> Arthroscopic rotator cuff repair is generally regarded as a safe procedure with relatively few complications and good clinical outcomes.<sup>5-9</sup> Nonetheless, complications do occur with arthroscopic rotator cuff repair. Although the incidence of infection after arthroscopy is

very low, ranging from 0.03% to 3.4%, septic arthritis represents a potentially devastating postoperative complication.<sup>2,7,8,10</sup> The shoulder is the second most affected joint, after the knee.<sup>11</sup> Septic arthritis requires immediate treatment to prevent accelerated joint degeneration or early arthroplasty with significant morbidity and potentially life-threatening conditions.

Diagnosis of septic arthritis can be challenging but is mostly based on the clinical presentation, physical examination, laboratory tests, imaging, and joint aspiration to complete the diagnosis.<sup>12</sup> Although all ages can be affected, septic arthritis occurs significantly more often in elderly individuals.<sup>13</sup> Thus, with an aging population, the incidence of infections is on the rise. Other risk factors previously described in the literature include male sex, duration of surgery greater than 90 minutes, osteoarthritis, immunosuppression, diabetes mellitus, rheumatoid arthritis, intravenous drug use, and previous intra-articular corticosteroid injection.<sup>2,14-18</sup> Commonly involved organisms include *Staphylococcus epidermidis*, *Cutibacterium acnes* (formerly known as *Propionibacterium acnes*<sup>19</sup>), and *Staphylococcus aureus*, as well as other gram-positive bacteria.<sup>2,11,20,21</sup>

The literature contains a scarcity of reports regarding the outcomes and long-term results of patients with

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infections after arthroscopic rotator cuff repair. Thus, the aim of this study was to review the clinical presentation, surgical and antibiotic treatment, and clinical outcomes in patients with deep infections after arthroscopic rotator cuff repair. We hypothesized that the mid- to long-term clinical scores of patients with infections after arthroscopic repairs would be significantly improved compared with baseline.

## Methods

The ethics committee of St. Vincent Hospital Vienna (Austria) approved this retrospective analysis (No. 201709\_EK09/1). All patients who presented with an infection after arthroscopic shoulder surgery performed in our department between 2002 and 2016 were considered for inclusion in the study. The criteria for exclusion were initial open surgery, previous ipsilateral shoulder surgery, history of joint infection, known chronic infection, or patient refusal. Chart reviews were performed to collect the demographic data of all patients, including age, sex, involved side, and dominant-shoulder side. Data collected during hospital stays included details regarding indications, surgical procedures, duration of the initial surgical procedure, bacteriologic findings, antibiotic treatment, and length of hospital stay. The clinical records included the Constant score before the initial surgical procedure and that at latest follow-up. Subjective outcome data included the American Shoulder and Elbow Surgeons (ASES) shoulder score, Simple Shoulder Test (SST) score, and pain graded from 0 (no pain) to 10 (greatest pain) on a visual analog scale (VAS) for pain; these were obtained using a shoulder-specific questionnaire during clinic visits.

Diagnosis of infection directly related to arthroscopic rotator cuff repair was defined as follows: clinical presentation to our institution within 3 months of the index surgical procedure with signs of localized (e.g., pain, redness, swelling, or heat) or systemic (e.g., fever) infection, in combination with either purulent or culture-positive joint aspiration findings, an open or fistulated wound in communication, positive intraoperative culture results, or positive histopathologic evaluation findings. Samples were routinely incubated on Columbia agar (plus 5% sheep blood), chocolate agar, Schaedler agar (plus vitamin K, hemin, and 5% sheep blood), and thioglycolate broth at 36°C. Prior to 2010, all samples were cultured for only 5 days, whereas in 2010 and later, all samples were routinely cultured for a minimum of 21 days.

## Surgical Details

All initial and revision surgical procedures were performed by fellowship-trained shoulder surgeons. Depending on the surgeon's preference, patients were positioned in either the modified beach-chair position

or lateral decubitus position under general anesthesia and an interscalene nerve block. At the time of initial surgery, all patients underwent removal of hair around the surgical field and the axilla with a medical clipper on the morning of surgery, according to the long-standing clinical practice in our department. Surgical-site disinfection was performed with an alcohol-based skin disinfectant (Kodan; Schulke & Mayr, Norderstedt, Germany) while the specified mandatory minimum application time was accounted for.

The routine administration of perioperative prophylaxis was introduced for arthroscopic rotator cuff repairs in our department in 2010 and has been maintained since. The administered perioperative antibiotic regimen routinely consisted of a first-generation cephalosporin (2,000 mg of cefazolin intravenously), whereas a lincosamide (900 mg of clindamycin intravenously) was given in case of allergies to penicillin or cephalosporins. Antibiotics were administered intravenously within 30 minutes of skin incision. At the time of revision surgery, antibiotics were administered after microbial samples had been obtained from within the joint and subacromial space.<sup>22</sup>

For arthroscopic revision surgery, a standard posterior viewing portal was established for diagnostic arthroscopy. Additional portals were established as necessary to address all intra- and extra-articular structures. Thorough debridement, removal of all implants, and extensive lavage were performed if the procedure was performed strictly arthroscopically.

In cases of open surgical revision, a mini-open deltoid-split approach was used. All implants were removed, and thorough debridement including extensive lavage was performed. If a sufficient remnant rotator cuff was present at the time of revision, a transosseous repair with nonabsorbable suture materials was attempted. Drains were kept in place for the first 24 hours postoperatively. All patients were immobilized in a sling for 4 to 6 weeks postoperatively.

## Statistical Analysis

Descriptive statistics were used to present demographic data. Continuous data were described by means and standard deviations. Paired *t* tests were used to analyze differences between preoperative and postoperative outcome scores. Independent *t* tests were used for group comparisons. Statistical significance was reported at  $P < .05$  (2-sided). All statistical analyses were performed using SPSS software (version 21; IBM, Armonk, NY).

## Results

During the study period, a total of 4,480 all-arthroscopic rotator cuff repairs were performed. Thirty consecutive patients, including 2 female and 28 male patients, with an average age of  $62.7 \pm 10.4$  years

(range, 38-79 years) who had infections after arthroscopic rotator cuff repair (15 right and 15 left shoulders) were identified and included in this study, corresponding to an overall infection rate of 0.7%. Patients presented with clinical signs of infection at an average of  $27.9 \pm 15.2$  days (range, 7-78 days) after the initial arthroscopic rotator cuff repair. Further demographic data regarding the index surgical procedure are listed in Table 1.

In 26 of 30 patients (86.7%), the infection was treated initially with an open surgical approach, whereas 4 patients (13.3%) underwent arthroscopic revision to remove all anchors and suture materials, together with thorough debridement and lavage. At the time of revision for infection, an open transosseous rotator cuff repair could be performed in 20.0% of the patients. A single reoperation was sufficient in 80.0% of patients, whereas 16.7% and 3.3% of patients required second and third revision surgical procedures, respectively (Table 2).

The antibiotic regimen was adapted based on culture and antibiotic sensitivities. Intravenous antibiotics were continued during the length of the hospital stay. After discharge, oral antibiotics were administered according to the recommendations of a consulting infectious disease specialist. The median duration of intravenous

**Table 1.** Patient Demographic Data and Characteristics of Initial Surgery (N = 30)

	Data
Age, yr	62.7 $\pm$ 10.4
Shoulder: left/right	15 (50)/15 (50)
Follow-up, yr	8.4 $\pm$ 2.5
Sex: female/male	2 (6.7)/28 (93)
BMI	27.6 $\pm$ 3.7
Comorbidities: no/yes	12 (40)/18 (60)
IDDM	1 (3.3)
NIDDM	8 (26.7)
Obesity	6 (20.0)
Cardiovascular	6 (20.0)
Alcohol abuse	2 (6.7)
Smoking	7 (23.3)
Perioperative antibiotic prophylaxis: yes/no	8 (6.7)/22 (73.3)
Arthroscopic repair	
SSP	21 (70.0)
SSC	3 (10.0)
SSP + SSC	2 (6.7)
SSP + ISP	3 (10.0)
SSP + ISP + SSC	1 (3.3)
Concomitant procedures: yes/no	27 (90.0)/3 (10.0)
Subacromial decompression	26 (86.7)
Biceps tenotomy	12 (40.0)
Duration of surgery, min	81.7 $\pm$ 29.7

NOTE. Data are presented as number (percentage) or mean  $\pm$  standard deviation.

BMI, body mass index; IDDM, insulin-dependent diabetes mellitus; ISP, infraspinatus tendon; NIDDM, non-insulin-dependent diabetes mellitus; SSC, subscapular tendon; SSP, supraspinatus tendon.

**Table 2.** Characteristics of Infections and Revision Surgery (N = 30)

	n (%)
Pathogen detected	25 (83.3)
<i>Staphylococcus epidermidis</i>	11 (36.7)
<i>Cutibacterium acnes</i>	9 (30.0)
( <i>Propionibacterium acnes</i> )	
<i>Staphylococcus aureus</i>	3 (10.0)
<i>Actinomyces spp</i>	1 (3.3)
<i>Staphylococcus hominis</i>	1 (3.3)
No pathogen isolated	5 (16.7)
1/2/3 revision surgical procedures	24 (80.0)/5 (16.7)/1 (3.3)
Surgical approach of revision surgical procedure: open/arthroscopic	
First revision	26 (86.7)/4 (13.3)
Second revision	3 (10.0)/1 (3.3)
Third revision	2 (6.7)/0 (0.0)
Transosseous rotator cuff re-repair	6 (20.0)

and oral antibiotic use before cessation of symptoms and normalization of blood parameters was 4.5 days (range, 1-16 days) and 10 days (range, 4-90 days), respectively. The most commonly used antibiotic was clindamycin, both as an intravenous therapy and as an oral therapy, often in combination with cephalexin or ciprofloxacin.

Four patients were not included in the outcome analysis because 2 died before the mid- to long-term follow-up and the other 2 had no mid- to long-term follow-up available. The average time to final follow-up was  $8.4 \pm 2.5$  years (range, 4-14 years). All scores significantly improved from before the initial arthroscopic rotator cuff repair to final follow-up after surgical and antibiotic treatment for infection (Table 3).

Significantly better Constant scores at latest follow-up were detected in patients with only 1 revision procedure (n = 21,  $70.4 \pm 25.1$ ) compared with those with 2 or 3 revision procedures (n = 5,  $39.6 \pm 13.8$ ,  $P = .015$ ). No statistically significant differences could be found for VAS pain score ( $1.3 \pm 2.4$  vs  $2.8 \pm 1.9$ ,  $P = .209$ ), ASES shoulder score ( $84.5 \pm 19.5$  vs  $66.3 \pm 6.4$ ,  $P = .052$ ), or SST score ( $8.3 \pm 3.6$  vs  $8.6 \pm 3.1$ ,  $P = .880$ ). None of the outcome scores showed a statistically significant difference in patients with concomitant open transosseous rotator cuff repair (n = 6) versus those with no repair (n = 20) (Constant score,  $68.0 \pm 27.4$  vs  $63.4 \pm 27.4$  [ $P = .714$ ]; VAS pain score,  $1.3 \pm 2.4$  vs  $1.7 \pm 2.4$  [ $P = .759$ ]; ASES shoulder score,  $87.0 \pm 15.0$  vs  $79.2 \pm 20.1$  [ $P = .224$ ]; and SST score,  $9.0 \pm 3.1$  vs  $8.2 \pm 3.6$  [ $P = .454$ ]).

## Discussion

The most important finding of this study was that satisfactory clinical results can be achieved even in patients who have postoperative infections.

**Table 3.** Clinical and Subjective Parameters Before Initial Surgery and After Treatment for Infection at Final Follow-up (n = 26)

	Before Initial Surgery	After Treatment for Infection	P Value
Constant score			
Total	24.8 ± 12.0	64.5 ± 26.2	<.001
Pain	2.5 ± 3.5	11.2 ± 5.2	<.001
ADLs	7.6 ± 2.4	14.2 ± 5.9	<.001
ROM	10.6 ± 6.9	28.7 ± 11.8	<.001
Strength	4.0 ± 4.4	10.3 ± 7.5	<.001
VAS pain score	7.1 ± 1.3	1.7 ± 2.5	<.001
ASES shoulder score	37.8 ± 8.5	76.7 ± 16.3	<.001
SST score	3.9 ± 2.1	8.3 ± 3.5	<.001

NOTE. Data are presented as mean ± standard deviation.

ADLs, activities of daily living; ASES, American Shoulder and Elbow Surgeons; ROM, range of motion; SST, Simple Shoulder Test; VAS, visual analog scale.

Arthroscopic rotator cuff repair proved successful in decreasing pain and restoring function of the glenohumeral joint. It has certain theoretical advantages compared with other procedures such as mini-open rotator cuff repair. Arthroscopy minimizes irritation of the deltoid and allows not only treatment of the glenohumeral joint but also visualization of extra-articular structures. Furthermore, smaller working portals leave the joint less exposed, thus reducing the probability of an infection. Hughes et al.<sup>23</sup> described a significantly lower infection rate in patients who underwent arthroscopic surgery compared with open rotator cuff repairs. Although septic arthritis after shoulder arthroscopy is relatively rare, it can be a serious problem for both patients and surgeons. Diagnosis and therapy can be challenging, with shoulder pain being the most prominent symptom, as well as being the only symptom present in all patients in a previous study.<sup>2</sup>

Multiple risk factors affecting infection rates have been described in the literature, such as older age and longer duration of surgery; these are in line with the findings of our infection group.<sup>2,24</sup> Furthermore, our study reflects previous findings implicating male sex as the predominant risk factor for infections after shoulder surgery, most likely based on differences in the distribution of *C acnes* on the skin between sexes.<sup>2,24-27</sup>

As in the study by Athwal et al.,<sup>25</sup> who looked at outcomes of infections after open rotator cuff repairs, *C acnes* was the most frequently found organism next to *S epidermidis* in cases of infection. However, after the introduction of routine perioperative antibiotic administration, the spectrum of identified pathogens changed to comprising solely *C acnes* and *S aureus*. There is a paucity of literature regarding the optimal intravenous and oral antibiotic regimen and duration after surgical revision. In our series, all cases of infection were discussed with an infectious disease specialist to find the most adequate antibiotic treatment scheme. Although the causative pathogens were mostly the same across cases, a variety of antibiotic combinations were used over the years, indicating that the optimal antibiotic

treatment is not yet clear. Nonetheless, despite the different antibiotic regimens, all patients responded reasonably swiftly and ultimately well to the treatment. In 5 patients who were treated for suspected infection, no pathogen could be identified. In these patients, the diagnosis of infection was made based on the clinical presentation and joint aspiration findings and, ultimately, evaluation of the intraoperative local situation. This might be a result of an insufficient length of culturing prior to 2010 at our institution, which might have underestimated the prevalence of *C acnes*.<sup>2</sup>

Regarding the approach of revision surgery, our retrospective analysis did not show any differences in final outcome between open and arthroscopic intervention. However, patients with arthroscopic revisions were more likely to need more than 1 revision surgical procedure. However, it is not clear whether immediate open revision in these cases would have resulted in further surgical procedures as well (e.g., because these were more severe cases of infection) or whether open is superior to arthroscopic debridement and lavage in eradicating infections. Because no data are available to reliably guide the decision-making process, on the basis of our clinical experience and the results of this investigation, for now we favor an open approach for revision of infections after rotator cuff repair. Ultimately, the surgeon needs to weigh the risks of repeated administration of general anesthesia and exposing the joint to infection for a longer period against the slightly higher invasiveness of open revision.

Because of insufficient remaining tissue, not all patients could undergo a rotator cuff re-repair at the time of revision. Clinical outcomes were not different, however, between patients who received transosseous cuff repair at the time of revision and those who did not. This is in contrast to the findings of Athwal et al.,<sup>25</sup> who showed better results in patients who had an intact rotator cuff repair at the time of first surgical debridement, whereas the outcomes of patients with partial or complete repair disruption were worse than our



results. However, the lack of similar findings might be due to the small sample size in our study.

### Limitations

This study has certain limitations that have to be considered. The study is subject to all disadvantages inherent to retrospective investigations. It cannot be guaranteed that all patients with infectious complications returned to our institution for treatment. Because of the rarity of infections after arthroscopic rotator cuff repair, the sample size in this retrospective study is small and treatment strategies showed considerable heterogeneity. The results of this study cannot be unconditionally transferred to other institutions because factors such as patient population, pathogen spectrum, or prophylactic and therapeutic strategy might vary.

### Conclusions

Patients with deep infections after arthroscopic rotator cuff repair showed moderate mid- to long-term outcomes.

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