

Diagnosis and Treatment of Infected Shoulder Arthroplasty: Current Concepts Review

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Abstract

Keywords

- infection
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Periprosthetic shoulder infection (PSI) is an emerging pathology which requires many improvements in diagnosis and treatment to obtain a satisfying success rate. Different approaches have been described. This article summarizes current concepts of diagnostic process and main treatments described in the literature.

Introduction

The number of shoulder arthroplasty performed every year shows how this procedure is becoming increasingly common in the field of prosthetic surgery. In 2015, 8,180 primary total shoulder arthroplasty and 8,181 hemiarthroplasty were performed in the Emilia Romagna Region of Italy.¹

Orthopaedic surgeons are now facing the main complications of shoulder arthroplasty, above all infections. Several reviews and original articles have been published in the literature regarding the management of periprosthetic shoulder infection (PSI).

Diagnosis

PSI represents a major complication with a reported incidence rate between 1 and 4% in primary arthroplasty and even higher after revision surgery. However, there is still a lack of consensus about the diagnostic and therapeutic strategies.^{2–5} Diagnosis is not always easy and mostly consists of a combination of clinical signs and history, laboratory tests, and radiological investigation, such as conventional

radiography, microbiological swabs, and in selected cases, scintigraphy.⁶ Some comorbidities, such as diabetes mellitus, lupus erythematosus, and rheumatoid arthritis increase susceptibility to infection. In addition, immunosuppressive chemotherapy, systemic or locally-injected steroid therapy or previous operations of the affected shoulder are considered as predisposing factors to infections in shoulder arthroplasty.^{5,7,8}

Most patients with infected shoulder prosthesis refer pain and/or limited range of motion.⁹ However, not always signs and symptoms of infection are clearly present. Therefore, there is a consensus in considering each painful shoulder joint as potentially infected to perform a detailed diagnostic investigation.⁹ Time of onset of clinical signs of infection is relevant since it will influence treatment choice (► **Table 1**).

Patients should be evaluated with high-quality radiographs, in anteroposterior and axillary lateral projections to rule out different causes of shoulder pain and dysfunctions that can mimic or coexist with periprosthetic shoulder infection.¹⁰ Laboratory examination should include a complete blood count (CBC) with differential, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP).^{3,11,12} X-rays will

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Table 1 Classification of periprosthetic shoulder infection¹⁸

Type of infection	Time period of infection
Type I	Positive cultures at time of revision
Type II	Acute infection within 30 days of surgery
Type III	Acute hematogenous infection > 30 days
Type IV	Chronic infection

be often normal in case of early infection while periprosthetic osteopenia, osteolysis, or pseudosubluxation of the humeral head component could appear in case of subacute or late infection.¹³ MRI or ultrasonography can be used to detect surrounding osteomyelitis or abscesses. Scintigraphy should be reserved to doubtful cases only. Peripheral leucocyte count is usually within normal range, as is the neutrophil cell distribution. ESR and CRP should be critically evaluated, since they are aspecific markers of inflammation and may be not elevated in case of a *Propionibacterium Acnes* infection. As a rule, in case of a high clinical suspect for deep infection, aspiration of glenohumeral joint should be performed. Synovial fluid analysis should include cell count with differential; gram stain, cultures for aerobes, anaerobes, fungi, and mycobacteria. Some bacterial specimen, such as *P. acnes*, can take up to 3 to 4 weeks for positive cultures.¹⁴ Gram stain is positive in 75% of proven cases of infection, cultures are positive in 80% of cases. A negative gram stain or culture from an aspiration; however, does not rule out infection.^{3,11,15}

Microbiology

Weber et al⁹ found out that intraoperative swabs of all patients of his case series showed positive cultures identical to preoperative swabs and sustained that joint aspirations are important but antibiotic treatment needs to be stopped at least 14 days prior to aspiration in order not to influence cultures results. The most common bacterial specimens identified within cultures were: *Staphylococcus epidermidis*, *P. acnes*, *Staphylococcus aureus* (methicillin-sensitive), *Streptococcus agalactiae*, and *Enterococcus faecalis*.⁹ Threshold values for diagnostic synovial leukocyte count are still an active area of debate.¹⁶ Bauer et al suggested that a periprosthetic synovial fluid white blood-cell count of > 500 cells/mL is suggestive of infection.¹⁷ Pottinger et al demonstrated

that male sex, cloudy synovial fluid, humeral osteolysis and loosening, glenoid wear, and periprosthetic membrane formation are associated to an increase of *P. acnes* positive culture growth.¹⁴

Therapeutic Options

Since infection is a main cause for shoulder arthroplasty failure, it is important to plan the operative treatment. First patient's medical history and current medical status should be investigated to assess the eligibility to undergo one or more surgical procedures. Treatment options include antibiotic suppression, irrigation, and debridement with prosthesis retention, resection arthroplasty, one-stage exchange, or two-stage reimplantation (use of antibiotic spacer and delayed reimplantation).¹⁰

Treatment choice depends on several factors, such as timing of diagnosis, virulence of the bacterial species, patients' overall health, soft tissue and bone integrity, patient's age, and expectations. The ideal outcome after surgical treatment would be infection eradication with minimal loss of function or residual pain.¹⁸

Hackett et al¹⁸ drafted an algorithm about management of PSI depending on the type of infection (► **Table 2**). If positive cultures are isolated at time of revision the indication is the treatment with organism specific antibiotic and close observation. If the infection appears within 30 days after surgery, a surgical debridement with polyethylene exchange is appropriate. In case of acute hematogenous infection 30 days or more after surgery, surgical debridement with implant removal, resection arthroplasty, revision with one-stage or two-stage procedure with antibiotic spacer, followed by species directed antibiotic administration are treatment choices.^{3,9,11,15,19–26} Finally, in case of chronic infection in low demanding patients or patients not eligible for implant revision, surgical debridement with implant removal, antibiotic spacer placement, or simple resection arthroplasty should be the definitive treatments.^{9,20,27}

PSI are commonly treated with a two-stage procedure being the solution with the best compromise between a reliable eradication of the infection and a satisfying functional outcome after surgery.²¹ In patients with PSIs, especially those with low virulence infections, a two-stage revision represents a viable treatment option for eradicating infection and restoring function. However, it is important to consider the risk of recurrent infections and postoperative complications in this challenging patient population.²⁸ One-

Table 2 Treatment options for periprosthetic infections¹⁸

Type of infection	Treatment
Type I	Organism specific antibiotic treatment with close observation
Type II	Surgical debridement with retention of prosthesis
Type III	Surgical debridement with retention of implants or two-stage treatment with antibiotic spacer
Type IV	Surgical debridement with implant removal, temporary antibiotic spacer placement and delayed reimplantation

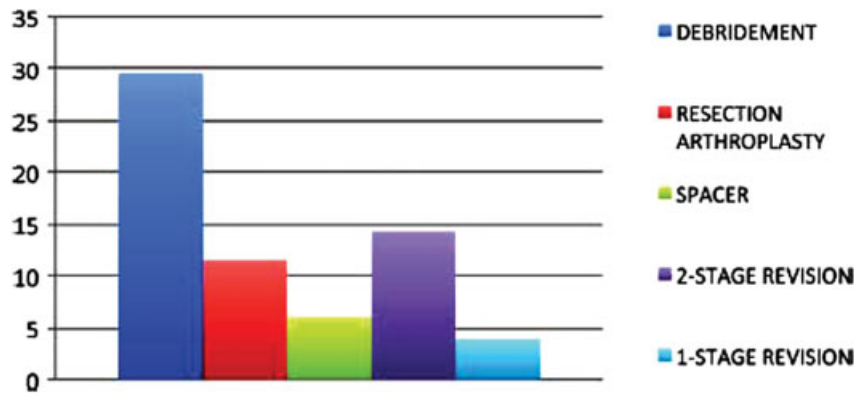


Fig. 1 Persistent infection rate after different surgical treatment of infected shoulder prosthesis.²⁹

stage revision shoulder arthroplasty is usually performed in super-specialized centers with dedicated surgical theaters and specialized departments for infected arthroplasty treatment.²¹ Most studies on one-stage revision surgery reported high reinfection rates while successful elimination of infection is achieved with a two-staged procedure. This event could be explained with the lack of organism identification prior to reimplantation.¹⁸ Marcheggiani Muccioli et al analyzed persistent infection rate after different surgical treatment of infected shoulder arthroplasty.²⁹ These results showed how debridement has significantly higher rates (29.6%) than almost any other procedure (→ Fig. 1).

Revision reported better functional outcomes compared with nonrevision procedures. Moreover, timing of debridement is controversial. Although, early serial washouts (< 2 weeks postoperatively) were reported to eradicate infection and preserve motion,³ the high risk of persistent infection with debridement should be considered.³⁰ Debridement in late infections (> 12 months) was shown to be ineffective.³ Based on these results, debridement with retention of the prosthesis is not recommended in the treatment of infected shoulder arthroplasty. Rispoli et al³¹ reported high rates of patient dissatisfaction (89%) when treated with resection arthroplasty, although they reported no persistent infections with a mean of 8.2-year follow-up. Therefore, it was concluded that pain relief could not be guaranteed with this procedure. Resection arthroplasty is often considered as an end stage procedure when all other options failed.⁹

Even though permanent spacers have a poor functional outcome and a low patient satisfaction, this procedure was found to have a high success rate in infections treatment. Permanent spacers are still a viable option as a salvage procedure for unresponsive PSIs and for low-demanding patients or patients not eligible for complex revision surgeries.²⁹

Conclusion

PSI is an important complication after shoulder arthroplasty and is often associated to high morbidity. It poses a great burden to the patient and a significant technical challenge to the surgeon. Patients with a painful shoulder or limited range of motion should be carefully investigated to rule out a possible

infection. With the increasing awareness of *P. acnes*, as the organism responsible for periprosthetic infections, shoulder surgeons have become more concerned with patients who present with a painful shoulder following arthroplasty.⁹ While some investigators reported good results with one-stage revisions, more reproducible results have been shown with the two-stage revision. As diagnostic criteria and identification of organisms prior to explant improves, one-stage revisions may show more promise in the future.

Conflict of Interest

None declared.

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