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QUESTION 2: Is there a role for antibiotic therapy in the management of acute shoulder periprosthetic joint infection (PJI) with an indolent organism (e.g., *C. acnes* or Coagulase Negative *Staphylococcus*) after irrigation and debridement (I&D)?

RECOMMENDATION: Antibiotic therapy following I&D for management of acute shoulder PJI with an indolent organism has not been well-studied in the literature. The limited data available suggests treatment should consist of antibiotic therapy; however, the optimal antibiotic, route of administration and duration of treatment are unknown.

LEVEL OF EVIDENCE: Consensus

DELEGATE VOTE: Agree: 100%, Disagree: 0%, Abstain: 0% (Unanimous, Strongest Consensus)

RATIONALE

Treatment strategies for PJI include chronic antibiotic suppression, irrigation and debridement with or without component retention, one or two-stage revision, placement of antibiotic spacer, resection arthroplasty, or arthrodesis. These strategies have been adopted from the hip and knee arthroplasty experience and literature. Most of the data published specifically addressing acute PJI commingles shoulder PJIs with hip and knee PJIs with very little data specific to treatment of acute shoulder PJI alone. The role of antibiotic, the ideal duration or specific antibiotic are not well described. PubMed, Google Scholar, Ovid-Medline, Cochrane and Web of Science were all searched for the following keywords: "shoulder," "infection," "periprosthetic," "arthroplasty," "antibiotic" to identify relevant articles through a title screen, abstract review and, finally, a full text review to identify the relevant manuscripts.

After an extensive review of the literature, we identified a case series of 10 shoulders in 9 patients treated with I&D and antibiotics for acute PJI.

In 2017, Dennison et al. [1] published a retrospective case series of acute PJI treated at the Mayo clinic. They defined acute PJI as any infection requiring I&D within 6 weeks of the index arthroplasty or within 3 weeks of symptoms from a delayed-onset acute hematogenous infection. Anything outside of this time frame was excluded.

They found 10 shoulders in 9 patients with 4 acute postoperative and 6 delayed-onset acute hematogenous infections. Five of the shoulders had a positive culture for indolent bacteria, the other 5 cultured more virulent bacteria. No patient underwent component exchange. The postoperative antibiotic treatment ranged from 3 to 6 weeks with a mean of 5.2 weeks. Antibiotics were determined by an orthopaedic infectious disease specialist based on organism susceptibility and host factors. Nine of the 10 shoulders underwent additional oral antibiotic therapy, which included trimethoprim-sulfamethoxazole with or without rifampin, penicillin or a combination of trimethoprim-sulfamethoxazole with penicillin. Chronic suppression was maintained in 6 shoulders. Of the 10 shoulders, 3 had failure requiring resection arthroplasty. The authors concluded that I&D with antibiotics allowed component retention in 70% of patients treated for acute PJI, although nearly all were prescribed chronic antibiotic suppression.

No studies reported on duration of therapy specific to acute shoulder PJI caused by indolent organisms. Publications reporting on acute shoulder PJI caused by both virulent and indolent organisms describe a wide duration of therapy from 2 weeks to 3 months with poorly described "additional" periods of antibiotics or indefinite therapy. There is conflicting literature regarding the importance of combining therapy with rifampin.

Given the limited nature of the data available, the exact role and protocol for antibiotic treatment after I&D for the treatment of acute shoulder periprosthetic joint infection caused by indolent organism remains unclear. Further studies are required to determine the optimal treatment. Nevertheless, postoperative antibiotics are traditionally prescribed as part of the treatment of acute PJI. Treatment types and length varied; both intravenous and oral regimens were employed, and treatment lengths ranged from 13 days to chronic lifetime suppression [1,2]. Most studies used a four to six-week protocol of postoperative antibiotic therapy [1,3,4]. By consensus we believe that cases of acute shoulder PJI treated with irrigation and debridement should followed by a course of antibiotic therapy.

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QUESTION 3: Is there a role for nonoperative suppressive treatment in the management of subacute or chronic shoulder periprosthetic joint infection (PJI)?

RECOMMENDATION: Although there is a role for suppressive antibiotic treatment of selected cases of periprosthetic infection of the shoulder, there are only a few shoulders included in the published literature. The vast majority of published cases describe initial irrigation and debridement, and these are not well separated in the literature from the small number of cases of patients treated with antibiotics alone. No patient treated with antibiotics alone for shoulder PJI has had antibiotics stopped and remained infection-free, thus concerns related to efficacy, long-term toxicity and development of resistant strains are paramount with this strategy. No recommendations can be given on indication, type and duration of suppressive antibiotic treatment.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 96%, Disagree: 0%, Abstain: 4% (Unanimous, Strongest Consensus)

RATIONALE

A literature search (Medline, PubMed) was performed including terms "periprosthetic infection," "PJI," "shoulder arthroplasty," "suppressive treatment," "chronic antibiotic treatment," "ICOAS" to identify studies on suppressive treatment of periprosthetic joint infection of the shoulder. The vast majority of published studies are retrospective, and in total eight shoulder cases were identified (five successful, three failures). Most studies reported on suppressive antibiotic treatment after initial surgical procedure like debridement or emptying abscesses.

Five studies, evaluating suppressive antibiotic treatment included cases of infected shoulder arthroplasty (eight shoulders). Prendki et al. [1] reported on 38 patients with a minimum suppressive treatment of 6 months for a periprosthetic infection (24 hips, 13 knees, **1 shoulder**). Sixty percent of the patients were on antibiotics and without relapse of infection (including the shoulder) at 24 months. There were six failures and nine deaths. Some of these patients had a surgical procedure before initiating suppressive treatment. It is unclear how many patients that were treated without initial surgery.

Wouthuyzen-Bakker et al. reported on a retrospective study of 21 patients (**2 shoulders**) with median follow up of 21 months [2]. They reported 90% success if the patients had a standard prosthesis but only 50% success in patients with a tumor prosthesis. One shoulder case was successful and one was a failure. Only six patients were treated without initial debridement and four had a successful outcome.

Pradier et al. [3] reported on 78 patients (**2 shoulders**) treated with oral tetracyclines as suppressive treatment with a minimum follow up of 2 years. All patients had surgical debridement. Twenty-two patients failed to respond to treatment. Both shoulders were failures. Three cases had acquisition of tetracycline resistance of the initial pathogen.

Prendki et al. [4] reported on a larger series of joint infections, 136 patients. Seventy-nine (58%) had some type of initial surgical procedure. There were **2 shoulders** and both were successfully treated with suppressive antibiotic treatment. It is unclear whether these 2 patients had initial surgery. Prendki et al. also reported on 21 patients (2017) in another study including **1 shoulder** (successful). Of these 21 patients, 5 had fistulas before starting chronic suppressive antibiotic treatment. Forty percent of the patients were free of clinical signs of infection after 2 years [4].

Multiple other studies have included PJI of other joints, primarily hip and knee arthroplasty.

Segreti et al. [5] reported on prolonged suppressive treatment in 18 patients (12 knees and 6 total hip arthroplasties). Eight had acute infection and 10 had chronic infection. All had surgical debridement before antibiotic treatment. Duration of oral antibiotic suppressive treatment varied from 4-103 months. Overall 14 patients remained asymptomatic. Twenty-two percent of the patients had complications related to antibiotic treatment. The authors concluded that suppressive treatment can be an alternative for patients who cannot or will not undergo major surgical revision.

Rao et al. [6] reported on 36 patients (15 hips, 19 knees and 2 elbows). Fouty-seven percent had acute onset (less than 4 weeks) and 53% were chronic infection. All patients had open debridement. Mean duration of treatment was 52.6 months (range 6-128 months). They reported favorable results (retention of a functioning prosthesis) in 86% with a mean follow up of 5 years. Eight percent had complications related to antibiotic treatment.

In 2004, Pavoni et al. reported on 34 patients (again, no shoulders included) with infection. Fourteen had surgical debridement [7]. Seventeen patients had no relapse of infection during the time of this study (11 of these patients had no initial surgical debridement).

Siqueira et al. [8] reported on 92 patients (no shoulders). They compared patients undergoing surgical debridement followed by a short period of antibiotics to prolonged suppressive antibiotic treatment. The five-year infection-free prosthetic survival rate was 68.5% for the antibiotic suppression group compared to 41.1% in the non-suppression group. Hip infections had lower rate of failures, and the suppression group results were better, if there was a *Staphylococcus aureus* infection.

Shelton et al. [9] reported a case of curing of a draining sinus tract in a hip infection. After suppressive treatment the patient discontinued antibiotic treatment and had no relapse of infection or fistula for a period of 8 years.

In summary, a review of the literature demonstrates that there is role for suppressive treatment in periprosthetic joint infection in the hip and knee in patients with stable implants and that cannot,