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QUESTION 2: How many exchange arthroplasties are reasonable before a salvage operation (such as amputation or arthrodesis) should be considered?

RECOMMENDATION: Patients with a failed two-stage exchange arthroplasty that undergo a repeat two-stage exchange arthroplasty demonstrate poor outcomes. Failure of the repeat two-stage exchange arthroplasty appears to be dependent on the host grade and status of the extremity. Surgeons thus should consider the patient's comorbidities and expectations when deciding whether to subject the patient to repeat two-stage exchange arthroplasties. The outcomes of a third or fourth two-stage exchange arthroplasty are dismal.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 88%, Disagree: 10%, Abstain: 2% (Super Majority, Strong Consensus)

RATIONALE

Two-stage exchange arthroplasty remains the preferred method of treatment for chronic periprosthetic joint infections (PJIs) in the United States. The reported success rate of two-stage exchange arthroplasty is variable with rates ranging from approximately 70 - 90%. However, there is significant morbidity and mortality associated with undergoing multiple surgeries for management of PJIs [1,2]. Furthermore, these patients are often very fragile and poor hosts.

There are several studies in the literature demonstrating poor outcomes after the initial failed two-stage exchange arthroplasty. Kheir et al. found that in patients undergoing a second two-stage exchange arthroplasty, reimplantation occurred in only 65% of cases and successful outcomes occurred in only 61.6%. Furthermore, of the 14 cases that were not reimplanted, there was a high rate of retained spacers (n = 6), amputations (n = 5), PJI-related mortalities (n = 2), and arthrodesis (n = 1) [3]. Kalra et al. reported on a similar cohort where success was achieved in 36.4% (4/11) of patients that underwent re-revision after a prior failed two-stage exchange arthroplasty [4].

Azzam et al. demonstrated that recurrent or persistent infections after a failed two-stage exchange was found in 4 out of 18 patients (22.2%) [5]. In this series, two patients underwent a third two-stage exchange arthroplasty and both were infection-free at two years. Furthermore, Fehring et al. found that in 45 patients undergoing a second two-stage exchange arthroplasty, 22 (49%) had another revision for reinfection [6]. The latter study also evaluated the risk factors for failure and found that poor host and extremity grades were associated with an increased risk of failure. When stratified by host grade, revisions for reinfections were performed in 30% of the uncompromised hosts (type A), 48% of the medically compromised hosts (type B) and 75% of the very medically ill patients (type C). In addition, Backe et al. also investigated the outcomes of 12 patients that failed an initial two-stage exchange arthroplasty, including 9 patients treated with a repeat two-stage and 3 patients treated with an arthrodesis. While there were no instances of reinfections in either group, the three solid fusion patients were dissatisfied with their stiff limb despite its good position [6]. In patients with a failed repeat two-stage exchange arthroplasty, the organism identified is most often different than that identified in the initial two-stage exchange [6].

While the outcomes of a second two-stage exchange arthroplasty are well known, there is minimal literature regarding the expected outcomes of a third and fourth two-stage exchange arthroplasty. However, understanding the risk factors for failure after an initial two-stage exchange arthroplasty may help determine which patients are optimal candidates for additional two-stage exchange arthroplasty attempts. In patients with increased comorbidities, infection with resistant organisms, or an organism associated with

poor outcomes (e.g., fungal or enterococcus PJIs) salvage procedures should be considered.

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QUESTION 3: What are surgical alternatives to hip disarticulation in patients with persistent joint infections?

RECOMMENDATION: Surgical alternatives to hip disarticulation include resection arthroplasty when reconstruction of the joint with the use of a megaprosthesis is not possible. Hip disarticulation should be reserved for patients with systemic sepsis and/or extreme soft tissue infections of the extremity, in whom the surgery is performed as part of a life-saving procedure.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 93%, Disagree: 4%, Abstain: 3% (Super Majority, Strong Consensus)

RATIONALE

Hip disarticulation is considered a last-resort option for non-neoplastic indications including necrotizing soft tissue infections, gas gangrene and life-threatening infections [1]. Fenelon et al. [2] reported on 11 cases of hip disarticulations performed as a result of failed arthroplasties due to severe infections of soft tissues and bones, bone stock losses or vascular injuries.

The extensive loss of bone stock from failed arthroplasty procedures and revisions is a major challenge with or without infection. Fountain et al. [3] identified 14 patients who had a total femoral arthroplasty as a limb salvage procedure after complications following revision arthroplasty surgery over a 25-year period. The indications for treatment included eradication of prosthetic joint infection (PJI), treatment of infected periprosthetic fractures, massive bone loss precluding the use of stemmed prosthesis, recurrent dislocation or a combination of these factors. Six patients had no complications. Three patients developed an infection and five patients sustained repeated postoperative dislocations. Eight patients had no pain, whereas eight other patients had persistent pain necessitating prolonged opioids. There was an overall improvement in function in all patients with four patients achieving a 75% improvement.

Parvizi et al. [4] reviewed 48 patients who received a modular megaprosthesis with or without bone grafting. There were good functional outcomes in 22 patients, fair results in 10 patients and poor results in 11 patients. Three patients had died before the minimum 2-year follow-up had elapsed. They concluded that for patients with severely compromised bone stock precluding the use of conventional prostheses due to inability to achieve adequate fixation, this might be a viable salvage procedure for these patients.

Smolders et al. [5] reviewed 25 patients in a retrospective study treated with the Modular Universal Tumor and Revision System (MUTARS®); Implantcast GmbH, Buxtehude, Germany). Harris Hip Scores improved from 28 points preoperatively to 81 points postoperatively, with 24% of patients developing complications.

Berend et al. [6] reported on 59 patients that had total femoral arthroplasties for salvage of end-stage prosthetic diseases. Indications for the procedure included numerous revision total hip or knee arthroplasties, failed periprosthetic femur fractures or recurrent infections treated with multiple radical debridement surgeries. Mean follow-up was 4.8 years. The average Harris Hip Pain Score was 34 out of 44 points. Good function was achieved with 98% able to ambulate and 43% using an assistive device or cane. There were 18 complications or subsequent surgeries (30.5%). Infection occurred in eight patients and dislocations in seven patients.

Shih et al. [7] evaluated 12 patients with massive proximal femoral deficiencies who received a proximal femoral megaprosthesis for failed total hip arthroplasty (THA). They had a mean follow-up of six years. Eight (67%) patients had satisfactory results, one had a fair result and three had poor results. The complication rates were high with dislocations in five (42%), deep infections in four (33%), ectopic ossifications in one (8%), one displacement of the greater trochanter and one case of aseptic loosening. Three patients had permanent resection arthroplasty procedures for recurrent infection.

Artiaco et al. [8] reported on five patients with severe femoral bone loss and infection using a megaprosthesis in the revision of infected THA. They compared their results to four studies using megaprosthesis for a severe femoral bone loss and infection. One of the studies was inadequate for data and three were used for comparison. Their results were four out of the five patients had eradication of their infection and Harris Hip Mean Score of 74 points compared to 20 cases from three literature studies of 75 points. The literature review group had 6 (33%) patients with recurrent infections and overall complications in 8 of 20 (40%). They stated that revision with a megaprosthesis in cases of infected total hip arthroplasties with severe femoral bone loss have a high risk of complications and should be carefully evaluated and used in selected patients when other surgical procedures are not feasible.