Friesecke et al. [9] evaluated the results of total femur prostheses implanted during revision arthroplasty in 100 consecutive patients without infections. The mean duration of follow-up was five years. Sixty-five patients (68%) had no complications. Deep infection occurred in 12 patients (12%), material failure in 3 and peroneal palsy in one (1%.). The mean Enneking hip function score was 1.25 points preoperatively and improved to 3.29 points postoperatively. The mean preoperative Enneking knee score was 2.09 points and 3.29 points postoperatively. They concluded that total femur arthroplasty (TFA) is a useful implant for patients with extensive bone losses at revision arthroplasty. Although the infection rate was high, the overall functional results were rated better than good by the Enneking classification for the hip and knee.

Gebart et al. [10] reported on 45 patients undergoing revision surgeries using the MUTARS® (Implantcast GmbH, Buxtehude, Germany). The average follow-up was 39 months. Complications occurred in eight patients (18%) with one dislocation, two aseptic loosenings and five reinfections. The Harris Hip Score was 3.0 presurgical and 78 postsurgical. Castellanos et al. [11] reported on the results of 78 patients at 5-year follow-up with infected hip arthroplasties who underwent resection arthroplasty procedures. A total of 86% of patients had infections controlled and satisfactory pain relief was achieved by 83% of patients.

Ganse et al. [12] reported on 18 hips with a mean follow-up of 52 months. Thirteen hips had two-stage revisions and five patients had an excisional arthroplasties. They reported no differences in the Harris Hip Scores between the two groups, with a mean score of 60 points. Cordero-Ampuero et al. [13] reviewed the results of resection arthroplasty procedures in the literature concluding that there was wide variability in satisfaction ranging from 13-83%. Resolution of infection occurred in anywhere from 80-100% of patients. Risk factors for failure included rheumatoid arthritis, methicillin-resistant *Staphylococcus aureus* (MRSA) and enterococcal infections and retention of cement. Pain was reported as severe in 16-33% of patients, moderate in 24 - 53%, and mild in 76%. Twenty-nine percent were able to walk independently, and 45% of geriatric patients were unable to walk. Harris Hip Scores ranged from 25 to 64 points.

Korim et al. [14], in a systemic review of proximal femoral arthroplasty (PFA) for non-neoplastic conditions, reported on 14 studies with an average of follow-up of 4 years (range 0-14 years) describing 356 PFAs. Complications most commonly occurring were dislocation (15.7%) and infection (7.6%). The mortality rate ranged from 0 to 40%.

In conclusion, several alternatives to hip disarticulation exist, including the resection arthroplasty and the implantation of megaprosthesis such as proximal and total femoral arthroplasties with or without allograft. However, the efficacy and indications of these procedures remains unclear due to low-level evidence and short-term follow-up. Further higher-level studies are required to better guide treatment in these complex clinical settings.

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5.9. TREATMENT: ANTIMICROBIALS

Authors: Sujith Konan, Lars Frommelt, Christian Lausmann, Thorsten Gehrke, Andrea Volpin

QUESTION 1: What is the recommended duration of antibiotics after a single-stage exchange for periprosthetic joint infections (PJIs)?

RECOMMENDATION: In the setting of single-stage exchange arthroplasty, intravenous antibiotics should be administered for 10-14 days followed by oral antibiotics. Generally, the overall duration of antibiotics of 4-6 weeks is sufficient.

LEVEL OF EVIDENCE: Limited

DELEGATE VOTE: Agree: 73%, Disagree: 23%, Abstain: 4% (Super Majority, Strong Consensus)

RATIONALE

The two-stage exchange arthroplasty is the preferred method for treatment of chronic PJIs. However, the single-stage exchange procedure has been gaining popularity, demonstrates comparable outcomes regarding infection control and offers various benefits for

patients compared to two-stage exchange [1–3]. Unfortunately, there are limited studies examining the issues of antibiotic administration following one-stage exchange arthroplasty. In addition, the duration of antibiotic treatment after two-stage exchange arthroplasty is not well determined either.

Most studies related to one-stage exchange arthroplasty highlight the importance of preoperative identification of the infective organism [4–11]. This is important for numerous reasons, including the ability to add the appropriate antibiotics to polymethyl methacrylate cement during reimplantation as well as administering the appropriate antibiotics after the procedure. Antibiotic therapy following single-stage revision surgery usually starts with an intravenous agent based on the antibiogram of the infective agent. Intravenous antibiotics are usually administered for a few days and then replaced by oral agents if available. In the postoperative period, antibiotics are adjusted to the susceptibility reports from intraoperative samples. In a Similar fashion to two-stage exchange arthroplasty, antibiotics are selected in accordance with organisms and sensitivities and are subsequently continued for four to six weeks [6,10,12–14].

Some authors continued the antibiotic therapy until inflammatory markers (C-reactive protein (CRP) and erythrocyte sedimentation rate (ESR)) as well as nutritional markers, such as plasma albumin concentration, return to stable limits (levels normalized in 90% of cases) [10]. Normal levels for serological markers are thought to be an ESR of 30 mm/hour, CRP of 10 mg/L, and albumin of 35 to 50 gm/L.

Other investigators believe that the type, course and duration of antibiotic treatments for patients undergoing one-stage exchange arthroplasty needs to be determined by a designated infectious disease consultant [4]. In this study, the average duration of the antibiotic treatment was 14 days (range, 10-17 days). Duration was determined by wound healing and laboratory infection parameters. No prolonged oral antibiotic therapy was administered in all 70 cases.

The importance of the local delivery of antibiotics during one-stage exchange arthroplasty has not been well studied. Some surgeons, including those at the HELIOS ENDO-Klinik, believe that the addition of antibiotics to cement during reimplantation plays a major role in infection control. There are two studies that point to the potential importance of antibiotics in cement [12,15]. In the latter study, the infection free rate was under 60% for patients undergoing one-stage exchange arthroplasty. Culture-specific antibiotics were given for at least six weeks to all the patients, but the single-stage exchange arthroplasty was performed with cementless total hip arthroplasty without local antibiotics. It is important to mention that the findings of low infection control could relate to other factors (e.g., how the surgery was performed) and may not be related to local antibiotic delivery at all.

Despite the paucity of concrete evidence with no randomized clinical trials available on the subject of antibiotic treatment after one-stage exchange arthroplasty, the use of antibiotic therapy following single-stage revision procedure is a universal practice. However, there is a lack of evidence for the duration of therapy. Currently, the orthopaedic community feels that a few weeks of antibiotic treatment, following one- or two-stage exchange arthroplasty is needed. Whether this will stand the test of time remains to be seen. In the absence of evidence to the contrary, we believe that patients undergoing one-stage exchange arthroplasty for the management of PJIs should receive four to six weeks of antibiotic treatment, which can be started as intravenous for a few days and switched to oral antibiotics soon after. We also feel that the dose, duration and type of antibiotic therapy should be individualized for most patients based on numerous metrics that influence the outcomes of treatment of PJIs, including the host type, organism virulence, the complexity of the procedure and soft tissue status.

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