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QUESTION 4: What is the most appropriate management of early (prior to complete wound healing) infection after fracture fixation with stable fixation?

RECOMMENDATION: The most acceptable treatment strategy for trauma patients with early postoperative infection is to perform proper irrigation and debridement, administer intravenous (IV) followed by oral antibiotic therapy and retain stable hardware in place.

LEVEL OF EVIDENCE: Moderate

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

RATIONALE

The definition and classification of early infection after isolated fracture fixation (IFF) is a dilemma among orthopaedic trauma surgeons [1–3]. However, the clinical picture of early infection including local (e.g., hematoma, wound discharge and dehiscence, erythema around the incision) and systemic (e.g., fever, lethargy) symptoms are usually diagnostic in most situations. Although it is not clear whether the biofilm formation process during the early postoperative infection period will be stopped or delayed with appropriate treatment, the goal of the treatment at this stage is to control the infection until complete union is achieved at the fracture site. After fracture healing, removal of the implant will help to eradicate the infection. This strategy is different than the typical treatment of a periprosthetic joint infection (PJI) in which the infected implant is replaced in two stages (spacer and then re-implantation of the total joint arthroplasty). The treatment strategy might be different based on the evaluation of the local and systemic clinical picture in each individual case. However, based on the available literature and our experience, it is possible to suggest some general recommendations.

The most significant difference between IFF and PJI is the higher chance of infection control and eradication by removing the implant during or after bone healing is complete for IFF cases. Therefore, especially in early postoperative IFF cases, infection control is the main goal of medical and surgical treatment [4,5]. The treatment options are described as ranging from simple antibiotic suppression to removal of the current implant to multiple stage revisions [4,5]. The most reasonable treatment strategy that is applicable to most cases is performing irrigation and debridement, retaining the stable fixation, and administering IV antibiotic therapy [4–7]. More than one washout or debridement may be necessary to clean the operative site and optimize wound healing [8,9]. Local antibiotic delivery (e.g., bead pouch, calcium sulfate beads) may be helpful. Proper soft-tissue coverage and aggressive debridement are the main principals of the surgical part of the treatment. Early flap coverage is critical if hardware is exposed [10].

The use of negative-pressure wound therapy coupled with continuous instillation of an antibiotic solution containing gentamicin and chymotrypsin has also been shown to facilitate a healthy wound bed for healing while maintaining fracture fixation with or without additional surgery for secondary closure [11]. In patients who are at high risk for wound healing problems, incisional negative-pressure therapy may be helpful following the washout [12,13].

Empiric systemic antibiotic therapy followed by organism susceptibility-based therapy should be started after early irrigation and debridement. Systemic antibiotic therapy can be curative or suppressive [14]. After a period of two weeks, IV antibiotic therapy can be replaced by appropriate oral therapy based on the available culture results [15–17]. It is recommended to continue the oral therapy for an additional four to six weeks to prevent chronic

osteomyelitis and suppress the infection [14,18]. In some situations, one may consider long-term oral suppressive therapy until union is achieved before considering implant removal.

Surgical intervention usually is needed to control the IFF. The main challenge is whether or not to remove any stable implants. Removal of stable internal fixation during the early postoperative period, especially in complex situations, will compromise bone healing. It has been shown in multiple studies that there is a strong correlation between fracture stability and bone healing [19–21]. Theoretically, proper irrigation and debridement in the early stage of the IFF can reduce the bacterial load and lower the speed of biofilm formation, which will also help the fracture consolidation process.

During initial debridement, local delivery of the antibiotic at the fracture site can be implemented by using absorbable or non-absorbable materials. However, there is no strong evidence to support the advantage of using local delivery systems as well as systemic antibiotic therapy. Aminoglycosides and vancomycin are the most commonly used antibiotics for local delivery [22]. Industrial premixed or hand-mixed polymethylmethacrylate bone cements are widely used to deliver antibiotics to the infection site by different techniques including molded beads or coated intramedullary nails [23]. The need for removal and less optimal release of the incorporated antibiotics are the main disadvantages of the antibiotic-loaded cements [24]. Good primary results are reported for resorbable materials such as calcium sulfate [25–28]. However, there is no high-quality study to show the superiority of these materials to the antibiotic-loaded cements in terms of clinical outcomes. Recently, hydrogels were introduced as an attractive and effective delivery vehicle for traumatic wounds with reasonable outcomes, which needs to be validated by further high-quality studies [22,29,30].

Although irrigation, debridement, and retention of the stable fixation device were reported as a successful treatment strategy for early IFF in a few studies, there is no strong evidence to support this treatment protocol, especially in the very early stage (before wound healing). Berkes et al. [6] reported a 71% fracture union rate in 121 patients with early postoperative (within 6 weeks) IFF after treatment with irrigation and debridement, implant retention, and culture-specific antibiotic suppression. Open fractures and the presence of an intramedullary nail were reported as the positive predictors of treatment failure. Rightmire et al. [7] reported a similar rate of bone healing (68%) with the same strategy for treatment of early IFF (within 16 weeks). However, there is no available evidence for the appropriate treatment of the infection in the postoperative period before wound healing occurs (two weeks).

Based on the available evidence and our experience, the most acceptable treatment strategy in trauma patients with early postoperative infection is proper debridement, antibiotic therapy (IV followed by oral) and retention of the stable hardware already in place.

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