HK66: Should all foreign material be removed during resection arthroplasty for patients with chronic periprosthetic joint infection (PJI)?

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Response/Recommendation:
Yes, whenever possible. Complete surgical debridement of the joint with removal of all components and implants should be ultimate goal in patients with chronic PJI. However, there may be specific situations where the morbidity associated with the removal of well-integrated components (usually revision components) outweighs the benefits of their removal. In these specific cases, and in the absence of concrete evidence, retaining parts of implants may be acceptable.

Level of Evidence: Limited

Rationale:

A key characteristic of periprosthetic joint infections (PJI), unlike other osteoarticular infections, is the presence of a foreign and permanent material in the surgical site (implant). The interaction between this foreign material, the host, and the bacteria creates conditions where a lower bacterial inoculum is required to cause infection. Once the implant is colonized, its removal is often necessary to cure the infection. This phenomenon is well-documented and is driven by bacterial adhesion to the implant surface and subsequent biofilm formation. Despite extensive research into methods for biofilm eradication, no safe and effective *in vivo* method exists to remove mature biofilm from an implant. This inability to effectively eliminate mature biofilm necessitates the removal of all implants (in one or two stages) to manage chronic infections.

In order to answer this question, we performed a comprehensive review of the literature using the MeSH terms developed by librarians. A total of 651 studies were identified initially which were screened by two independent delegates. This resulted in 15 studies meeting the final inclusion criteria. These studies were then reviewed in full for data extraction.

Suzuki et al. (1) reported an increased risk of postoperative infections when prior fixation materials were not fully removed. Similarly, Pfang et al.(2) observed that 16.4% of extracted implants were contaminated, though these were not septic cases. Some authors have reported successful outcomes in retaining implants for acute periprosthetic fractures with infections. However, Karczewski et al.(3) found that retaining cerclage wires during septic revision was associated with a significantly higher reinfection risk by the same microorganism (22.2% vs. 1.1%) and earlier recurrence (11.1% vs. 1.1%).

Although the ability of pathogens to adhere and form biofilm on implant surfaces is well-documented, some researchers argue that osseointegration is a protective factor against bacterial colonization and adhesion. Therefore, properly integrated implants might not be colonized by bacteria, and only components in contact with the joint space

may need removal. Nonetheless, Doub et al.(4) recently analyzed biofilm localization in explants from chronic PJI cases and found biofilm present at the bone-implant interface in 100% of cases, irrespective of osseointegration, while only 40% had biofilm in the joint space.

The increasing frequency and complexity of revisions have led to more cases involving septic revisions with fully integrated revision implants, intraosseous osteosynthesis remnants, or patients with poor biological health, where the surgical morbidity of complete implant removal may far exceed the potential benefits. Subradical resection arthroplasty has been tried in some of these patients with acceptable outcome. The latter is subject matter of another question in the ICM and will not be covered here extensively.

Shi et al.(5) achieved a 100% infection control in 14 high-comorbidity patients undergoing two-stage partial revision (9 femoral components, 5 acetabular components). However, this study excluded cases with resistant, polymicrobial bacteria or fistulas. Studies not achieving 100% success did not provide a rationale, but analysis revealed similar patient characteristics, including significant comorbidities (6) and resistant bacterial infections(7,8). Chen et al.(8) reported an 81.3% success rate in 16 patients with a longer follow-up (70 months), consistent with results from El-Husseiny et al.(9) (18 patients, 3 failures) and Yishake et al. (29 patients). It is important to note that the study by Yishake et al.(10) attributed the success to the use of antibiotics throughout the surgical process and for at least three months postoperatively to prevent opportunistic infections. In that sense, the largest series published by Crawford et al.(11) (41 patients) observed 8 failures, with a success rate of 80%. However, 15% of patients requiring suppressive treatment. Both, Chen et al.(8) and Crawford et al.(11) attributed higher reoperation rates to high-virulence organisms and uncontrolled infection, necessitating the removal of residual implants.

Studies included patients with negative cultures and MRSA, as well as those with previous failed two-stage treatment, resulting in lower success rates (8,12). Studies with careful patient selection and exclusion of high-risk individuals generally reported lower failure rates, highlighting the importance of adhering to established selection criteria (well-fixed implant, susceptible bacteria to antibiofilm therapy), for partial two stage treatment

The possibility of retaining cement fragments has been widely debated. McDonald et al.(13) reported 3 recurrences among 7 patients when cement was retained, compared to 8 recurrences among 75 patients when all cement was removed. Some researchers have proposed a cement-in-cement septic revision technique, provided the cement is pre-loaded with antibiotics. However, Leijtens et al.(14) observed poor outcomes with this approach, achieving only a 20% cure rate.

In summary, most published studies involving partial septic revisions are highly selective, involving scenarios where complete removal posed significant surgical morbidity. The infections in these cases were caused by susceptible bacteria, excluding difficult-to-treat pathogens. Thus, in the absence of concrete evidence we recommend that the basic principle of revision surgery for infection, namely removal of all foreign material and meticulous debridement be adhered to. However, there may be exceptional cases where the morbidity associated with the removal of well-integrated components

(usually revision components) outweighs the benefits of their removal. In these specific cases, and in the absence of concrete evidence, retaining parts of implants may be acceptable.

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