G72: Is there a role for sonication of implants obtained during revision surgery?

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Response/Recommendation: The use of sonication of implants retrieved during revision arthroplasty may present potential benefits in improving the detection of infective pathogens. However, further research is needed to validate the efficacy of this technique.

Level of Evidence: Moderate

Delegate Vote:

Rationale:

Implant-related infections, including periprosthetic joint infections (PJIs), remain a significant cause of failure and morbidity after orthopedic surgeries, particularly in the context of revision procedures.[1, 2] Two-stage exchange arthroplasty is the most commonly employed treatment

protocol for chronic infection of total joint arthroplasties (TJAs). The diagnosis of PJIs is complicated by the presence of biofilms, which protect bacteria from conventional antibiotic therapies and immune responses.[3, 4] The ability to reliably identify the presence of biofilms on retrieved implants or cement (polymethyl methacrylate/PMMA) spacers can significantly impact patient management, including the decision to perform additional surgical procedures or to tailor the delivery of effective antibiotic therapy.

Sonication, which involves the use of high-frequency sound waves to dislodge adhered pathogens from surfaces, has gained attention as a potential tool for improving the detection of biofilms on implants or cement spacers.[5-15] Sonication of the implants retrieved during revision total joint arthroplasty is an option currently available, as an adjunct to tissue cultures to detect the adhered microorganisms that colonize the implants. [5-15] Studies indicate that sonication of explanted implants can increase the detection of pathogens and thus predict persistent infection compared to traditional intraoperative culture methods, which may fail to detect biofilm-related infections.[14, 16] Multiple studies have shown that sonication is as specific as, but more sensitive than, traditional cultures in detecting pathogens on orthopedic implants.[15, 17-22] Additionally, sonication of removed implants from patients undergoing revision surgery increased the detection of microbial growth, particularly in cases of PJI, where biofilm is attached but not identified via conventional methods. [15, 17-22]

The utilization of sonication as an adjunct to PJI diagnostics is reasonable. [23] Biofilm-related infections are notoriously difficult to treat due to the protection biofilms offer against antibiotics and the immune system. [3, 4] An accurate method to efficiently detect microbial growth and biofilm formation on implants after revision surgery is highly desirable to avoid placing a new prosthesis in an eventually infected environment.[24] The ability to more accurately identify potential infections during revision surgery has the advantage of guiding the surgeon to a more effective and targeted treatment, possibly leading to better patient outcomes. Studies have highlighted that the combination of sonication with tissue culture could improve the identification of infections that would otherwise have been assigned to aseptic revisions, enabling a more fitting antibiotic treatment and avoiding unnecessary surgical procedures.[25]

While sonication has shown promise in improving diagnostic accuracy, its role in routine clinical practice is not yet fully established.[26] In a meta-analysis of 12 studies, the pooled sensitivity, specificity, positive likelihood ratio, and negative likelihood ratio for detecting PJI by using sonication fluid cultures (SFC) were 0.82 (CI, 0.76 to 0.87), 0.94 (CI, 0.85 to 0.98), 14.2 (CI, 5.4 to 37.8), 0.19 (CI, 0.14 to 0.25), for joint arthroplasty.[14] Sonication techniques are not universally utilized and may require additional training and equipment. [27]Moreover, some studies suggest variability in its effectiveness depending on the type of implant, the pathogens involved, the specimen utilized for sonication (implant versus spacer) and the methods used for sonication. It has been reported that sonication works particularly well on detecting infections in certain types of metal implants, such as titanium or chrome cobalt, but has been less effective for others, such as ceramic, cement spacers, or other composite materials. [28]

Additionally, while sonication has the potential to reduce the incidence of undiagnosed infections, it does not address the underlying subsequent challenges of treating chronic biofilm-related infections. Chronic biofilm-related infections are highly resistant to standard treatments, and new therapeutic strategies, such as biofilm-disrupting agents, are needed in conjunction with better diagnostic tools like sonication to improve patient outcomes. Therefore, while sonication may be an initial tool for detection, the subsequent treatment of infection remains. Finally, the role of sonication in aseptic revisions also appears to have lower clinical value as the sensitivity and specificity of predicting future PJI is only moderately successful.[29-31]

In conclusion, sonication of explanted implants obtained during revision surgery seems to be a reasonable approach to enhance the detection of biofilms and improve the diagnosis of PJIs. While studies support its utility with a high sensitivity and specificity equal to or superior to conventional tissue cultures, further research is needed to refine and standardize protocols, address variability in effectiveness, and evaluate its impact on clinical outcomes. In addition, sonication should be considered as an adjunct rather than a sole diagnostic approach. This technique should be part of a broader approach to the management of infected implants, including improved infection prevention strategies and targeted antibiotic treatments. However more prospective research is needed to develop standardized protocols for comparison across studies.

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