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CORR Insights®: Sonication of Arthroplasty Implants Improves Accuracy of Periprosthetic Joint Infection Cultures

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Where Are We Now?

Prosthesis joint infection (PJI) after total joint replacement is a devastating complication that can result in serious morbidity and permanent functional impairment. PJI is generally classified as early postoperative, acute hematogenous, or chronic depending on the time interval

between surgery and onset of symptoms [8]. Managing this complication requires the accurate identification of causative organisms [2], and while early postoperative and acute hematogenous infections are normally caused by aggressive, fast-growing bacterial species [8, 14], chronic infections are frequently caused by slow-growing, less-virulent bacteria that are more difficult to identify [13].

There are a number of established diagnostic options for detecting the causative organisms in PJI, but preoperative arthrocentesis and intraoperative tissue cultures are the mainstays of diagnosis [10]. In recent years, biofilm-dislodging technologies like sonication [12] or chemical dis-

lodging using dithiothreitol [6] are gaining more-widespread use.

In their study, Rothenberg and colleagues examined the accuracy of sonication cultures during revision THA and TKA, and compared the results from preoperative arthrocentesis and intraoperative tissue cultures. The authors concluded that implant sonication cultures in arthroplasty revisions improves the detection of bacteria in both clinical and occult infections.

Where Do We Need To Go?

Synovial fluid leukocyte count and differential have a sensitivity and specificity for detecting PJI of over 95% in some series [4, 14]. But many of these samples remain culture negative because the sensitivity and specificity of microbial growth in synovial fluid is generally inferior to periprosthetic tissue and sonication cultures [4]. Modern synovial fluid markers like alpha defensin can help establish the diagnosis of PJI, but at present, biomarkers cannot identify the

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causative bacteria. Organism-specific antibiotic therapy is rendered more effective if the pathogen is identified before surgery. However, it is unclear whether postoperative antibiotic treatment initiated after detection of the causative organism results in a decreased likelihood of infection eradication when compared with immediate antibiotic therapy in the setting of two-stage revision surgery.

By contrast, single-stage revisions for PJI are quite different. It is critical to identify the pathogen if this approach is to be used since single-stage revision is unlikely to succeed if the involved bacterial species is resistant to rifampin or ciprofloxacin [2, 14, 15]. More research is needed to improve preoperative bacteria detection in one-stage revisions.

What should clinicians do with positive cultures in patients with suspected aseptic loosening? In these situations, bacteria generally are located in a biofilm atop the surface of the implant or in the immediately adjacent periprosthetic membrane/tissue [7]. Taking numerous intraoperative samples does not increase the accuracy of diagnostics [8]. Even after combining tissue samples and biofilm dislodging technologies, a small number of culture-negative PJIs are only identified by histopathology. Negative bacterial cultures could be related to inadequate sampling or processing of the samples.

Bacteria that require special culture conditions [9] or the presence of small colony variants [11] may also be missed. In other situations, it might be possible to detect causative bacteria in tissue samples [5] or sonication fluid [1] using polymerase chain reaction (PCR). The drawback of molecular methods like PCR is that no living bacteria can be cultured to detect antibiotic resistance, making it difficult (or even impossible) to use targeted antibiotic therapy. Future studies should focus on improving pre and intraoperative diagnostic algorithms with the goal of reducing the number of culture-negative PJIs.

How Do We Get There?

One potential approach for improving the detection of bacteria before surgery could be the use of sonication for samples obtained by arthrocentesis in the preoperative patient work-up. For example, a possible avenue of future inquiry might be to develop an ultrasound probe small enough to be inserted into a joint that could directly sonicate the joint to dislodge biofilm (and bacteria) from the arthroplasty surface in patients whose alpha-defensin tests are positive. Small ultrasound probes are already being manufactured, so an approach along this line may be possible.

There are other novel options for further refining diagnostics like the use of microcalorimetry [3] or matrix-assisted laser desorption ionization-time of flight mass spectrometry [4].

In the current study, Rothenberg and colleagues detected 16% of cases with unexpected bacterial growth in sonication cultures. Researchers should randomize these cases in a treatment and a no-treatment group to both compare patient-reported outcomes and determine the ideal threshold for distinguishing between aseptic loosening and PJI. Furthermore, prospective studies establishing thresholds for PJI in shoulder arthroplasty or ankle replacements as well as for osteosynthesis materials like nails and plates are still needed.

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