

No difference was seen between anteromedial or anterolateral approaches in a cadaver study when performed by orthopaedic trainees, and there was an 80% success rate of being intra-articular with both approaches [6].

The risk of bacterial contamination of the joint after aspiration has not been studied. There is some literature discussing septic arthritis after corticosteroid injection. One report indicated an incidence of 0.5% in a population of patients with rheumatoid arthritis on immunosuppressant medication [7]. In the general population, infection after cortisone injection is reported to range between 1 in 3,000 to 1 in 16,000 [8,9]. It is generally thought to be very rare when a basic sterile technique is used.

We recommend that the site of ankle aspiration is wiped with alcohol and then prepared with the use of another antiseptic agent, such as povidone-iodine or chlorhexidine. Although not absolutely necessary, the site of aspiration may be isolated with the use of sterile towels. The aspiration may be performed in the office setting or the operating room suite, depending on the infrastructure in each facility.

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## QUESTION 6: Should aspiration of the ankle with an antibiotic spacer be performed prior to reimplantation?

**RECOMMENDATION:** We recommend that aspiration of the ankle with an antibiotic spacer prior to a second-stage reimplantation should be strongly considered. Available studies indicate that a positive culture of the aspirate in this setting is predictive of residual infection, while a negative aspirate culture does not rule out infection and should be interpreted in light of other clinical indicators and laboratory values.

**LEVEL OF EVIDENCE:** Consensus

**DELEGATE VOTE:** Agree: 92%, Disagree: 8%, Abstain: 0% (Super Majority, Strong Consensus)

## RATIONALE

There have been no studies in the total ankle arthroplasty (TAA) literature that have evaluated the utility of aspiration of an antibiotic spacer as part of a two-stage revision for infected total ankle arthroplasty. In a review article, Alrashidi et al. stated that reimplantation should only be undertaken once the infection is eradicated as indicated by clinical history and examination, serological testing and synovial fluid aspiration [1]. However, no references or evidence is cited to support this assertion. Two large series on the treatment of infected TAA each included two-stage revision with use of an antibiotic spacer as a treatment strategy [2,3]. However, neither study included preoperative aspiration of the antibiotic spacer in the methodology. Of note, Myerson et al. did routinely perform intraoperative examination of tissue and fluid by microscopy during definitive reconstruction surgery in order to evaluate for the presence of polymorphonuclear (PMN) leukocyte count > 5 per high power field or the presence of organisms on Gram stain [2]. If either criterion was met, repeat debridement with antibiotic cement spacer exchange was performed and the definitive reconstruction was deferred.

There have been numerous studies in the total hip and knee replacement literature investigating the utility of aspiration of antibiotic spacers. While these have provided valuable data, it should be noted that these studies were largely retrospective and non-uniform.

The definition of the presence of infection was also not clear in some of these studies, and positive culture was considered by many studies as the gold standard. Some studies also correlated the results of the aspiration and intraoperative findings with the ultimate success or failure following reimplantation. The studies also have significant variability in the duration of antibiotic treatment as well as variability in the presence/absence and duration of an antibiotic holiday.

Studies regarding aspirate cultures of antibiotic spacers for infected total knee arthroplasty reported generally better specificity than sensitivity. Specificity ranged from 61 to 100% while sensitivity ranged from 0 to 83% [4-8]. Positive predictive value ranged from 0 to 100% while negative predictive value ranged from 74 to 97% [4-8]. Aside from cultures, additional aspiration tests have been evaluated for accuracy. There is significant variability across reported cut-off values and sensitivity and specificity rates for white blood cell count and PMN% of preoperative aspirates [9-12].

One argument for routine aspiration of an antibiotic spacer of the hip or knee prior to reimplantation revolves around the relatively low cost, simplicity and low risk of the procedure. However, in the setting of a temporary antibiotic spacer of the ankle, there is no evidence regarding the success rate of attempted aspirations.

One challenge that exists is the interpretation of a dry aspiration. In the hip, consideration has been given to performing a saline

lavage in order to improve the yield of aspiration. Newman et al. reported that saline lavage predictably affected the results of synovial cell counts and their diagnostic utility but has a less substantial effect on culture results [11].

In the absence of concrete evidence, with reliance on the available data from the hip and knee literature and taking into account the simplicity of aspirating an ankle joint, we recommend that aspiration of the ankle with an antibiotic spacer be strongly considered prior to reimplantation. The analysis of the aspirate fluid, if obtained, will provide valuable data that can influence the intended procedure and the ultimate success and failure of reconstruction.

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## QUESTION 7: Is there a role for measuring synovial biomarkers for diagnosis of infected total ankle arthroplasty (TAA)?

**RECOMMENDATION:** Based on the hip and knee arthroplasty literature, measuring synovial biomarkers may play a role in the diagnosis of infected TAA. The diagnosis of periprosthetic joint infection (PJI) in the setting of a TAA can be confirmed with cultures, provided that a plausible pathogen is recovered in the context of a compatible clinical picture. In the absence of a positive culture, synovial biomarker analysis may help in establishing the diagnosis.

**LEVEL OF EVIDENCE:** Moderate

**DELEGATE VOTE:** Agree: 92%, Disagree: 8%, Abstain: 0% (Super Majority, Strong Consensus)

## RATIONALE

TAA has emerged as a successful procedure, improving both pain and function in patients with end-stage arthritis of the ankle, with reported rates of infection ranging from 0 to 4.6% [1]. A specific approach does not yet exist for the diagnosis of PJI in TAA. However, the traditional approach for the diagnosis of PJI in other joints involves joint aspiration and sampling of the synovial fluid for analysis involving synovial white blood cell (WBC) count and differential fluid culture, as well as serum WBC count, erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels [2,3].

Elevation of several synovial biomarkers has been identified as indicators of potential PJI, including WBC count, percentage of polymorphonuclear cells (PMN%),  $\alpha$ -defensin, leukocyte esterase (LE), interleukin IL-1a, IL-1, IL-6, IL-8, IL-10, IL-17, granulocyte colony-stimulating factor (G-CSF), vascular endothelial growth factor (VEGF), CRP, neutrophil elastase 2 (ELA-2), lactoferrin, neutrophil gelatinase-associated lipocalin (NGAL), resistin, thrombospondin and bactericidal/permeability-increasing protein (BPI) [4–6].

Among the previously-mentioned synovial biomarkers,  $\alpha$ -defensin is regarded as the most accurate single test for the diagnosis of PJI, with a sensitivity of 97% and a specificity of 96% [5]. There-

fore, the accuracy of  $\alpha$ -defensin is closest to the 2013 International Consensus Meeting (ICM) criteria for the diagnosis of PJI [6]. Alpha-defensin also appears to provide the most consistent results, regardless of the causative microorganism or its virulence. Its accuracy even remains unaffected in the setting of antibiotic administration to the patient prior to obtaining the synovial fluid sample [4,5,7]. IL-8 has been shown to follow  $\alpha$ -defensin in terms of performance, while the accuracy of synovial fluid culture has been shown to have a sensitivity of 62% and specificity of 94% [5]. Synovial fluid leukocyte count (sensitivity of 89% and specificity of 86%) and PMN percentage (sensitivity of 89% and specificity of 86%) both demonstrate accuracy in diagnosing PJI [5,6]. However, they are already part of the six minor criteria for the diagnosis of PJI according to the ICM 2013 definition of PJI [6]. There is great controversy regarding the cutoff point used for the synovial leukocyte count and PMN percentage, which prevents their use as stand-alone diagnostic tests [4,5,8–12].

LE, with a sensitivity of 77% and specificity of 95%, has the advantage of being inexpensive [5,13–16]. However, there is a level of subjectivity present with the interpretation of LE results, in addition to the possibility of the presence of blood in the fluid affecting the results.