

CURRENT CONCEPTS REVIEW

Preoperative Aspiration Culture (PAC) for the Diagnosis of Infection in a Prosthetic Knee Joint

E. Carlos Rodriguez-Merchan, MD, PhD

Research performed at the Department of Orthopaedic Surgery, La Paz University Hospital, Madrid, Spain

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Abstract

Background: Periprosthetic infection is the most serious joint replacement complication, occurring in 0.8-1.9% of total knee arthroplasties (TKAs).

This review aims to define the role of preoperative aspiration culture (PAC) for diagnosis of TKA infection.

Methods: A PubMed (MEDLINE) search related to TKA infection and PAC was analyzed. The main criteria for selection were that the articles were focused in the aforementioned question.

Results: Twenty articles were found, but only fourteen were selected and reviewed because they were deeply focused on the topic. PAC has shown an average sensitivity of 67.6% (range, 28% to 100%) and an average specificity of 98.4% (range, 96% to 100%).

Conclusion: PAC has moderate to high sensitivity and very high specificity for diagnosing TKA infection.

Level of evidence: III

Keywords: Arthroplasty, Aspiration, Culture, Infection, Knee, Preoperative

Introduction

Periprosthetic infection is the most serious knee replacement complication, occurring in 0.8-1.9% of total knee arthroplasties (TKAs) (1-5). Preoperative identification of the infecting microorganism is of paramount importance in the treatment protocol for chronic periprosthetic knee infections, as it enables selection of the most appropriate antibiotic treatment (6). Preoperative aspiration culture (PAC) has a controversial role in the diagnosis of an infected TKA (7). The purpose of this review is to define the current role of PAC in TKA infection.

Materials and Methods

A review has been performed on role of PAC in patients with suspected TKA infection. The search engine was

MEDLINE (PubMed). The keywords used were: knee, aspiration, and culture. Twenty articles were found, but only fourteen were selected and reviewed because they were deeply focused on the topic.

Results

Seventy-two joint arthroplasties undergoing total hip or total knee surgery were studied by Levitsky et al with PAC (8). The test had a sensitivity of 67% and a specificity of 96% and, therefore, appeared to be a useful single test in the workup of a painful TKA.

Sixty-four revision arthroplasties were performed on 55 patients by Duff et al (9). The PAC of the prosthetic knee joint had a sensitivity of 100%, specificity of 100%, and accuracy of 100%. To Duff et al PAC of the knee was

Corresponding Author: E. Carlos Rodriguez-Merchan, Department of Orthopaedic Surgery, La Paz University Hospital-IdiPaz, Paseo de la Castellana, Madrid, Spain
Email: ecrmerchan@hotmail.com



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the most helpful study for the diagnosis or exclusion of infection in a prosthetic knee joint.

Twenty-nine infected TKAs were operated by Gacon et al (10). PAC was of great help for diagnosis in difficult chronic cases.

Teller et al evaluated PAC during revision TKA. Preoperative aspirate culture was only 28% sensitive (11).

Mont et al prospectively followed sixty-nine patients who were treated for a culture-proven deep infection at the site of a TKA (12). PAC, grown after discontinuation of antibiotic treatment and before reimplantation of the components, helped to identify the patients with infection at the site of a TKA in whom the infection might recur. The performance of PAC resulted in a substantial improvement in the clinical outcome.

Fifty TKA in 45 patients requiring revision surgery were retrospectively analyzed by Kordelle et al (13). The sensitivity of PAC was 0.5, the specificity 1.0, and the positive and negative prediction values were 1.0 and 0.5.

Baré et al reviewed 295 patients who underwent revision TKA to establish the clinical value of the most commonly performed investigations used to diagnose sepsis (14). Routinely performed preoperative investigations include erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), microbiology, PAC, and intraoperative tissue bacteriology cultures. Of the investigations, the ESR had a sensitivity of 0.63, a specificity of 0.55, a positive predictive value of 0.39, a negative predictive value of 0.77, and an accuracy of 0.57. The respective values for CRP were 0.6, 0.63, 0.45, 0.76, and 0.62, and 0.53, 0.94, 0.75, 0.85, and 0.83 for intraoperative tissue culture. There was no preoperative investigation accurate enough to be solely relied on for diagnosing infection. The authors believed that clinical findings and the routine use of simple tests such as CRP, ESR, and PAC yield predictable results.

Gollwitzer et al reviewed in 2006 published data evaluating the available diagnostic tools of periprosthetic infection of the knee (15). PAC proved high specificity for periprosthetic infection. However, an average of 20% of infected cases remained undetected. Nevertheless, PAC was widely recommended for preoperative isolation of the infecting organism.

Van den Bekerom and Stuyck analyzed 70 revision TKAs from 69 patients. PAC has a positive predictive value of 71% and a negative predictive value of 74% (16). The authors stated that when the aspiration sample yields a positive culture, the chances are high that the prosthetic knee is infected. When aspiration is negative, infection cannot be ruled out. The study suggested that, in such cases, a coagulase negative Staphylococcus (CNS) infection has to be considered.

One hundred five consecutive painful TKAs were evaluated for the presence of infection by DellaValle et al (17). A synovial fluid white blood cells (WBC) count of greater than 3000 was the most precise test with a sensitivity of 100%, specificity of 98%, and accuracy of 99%. A rational approach to perioperative testing

for sepsis includes a screening ESR and CRP, and if elevated, aspiration with synovial fluid WBC count or an intraoperative frozen section.

Meermans and Haddad followed 56 TKAs with suspected infection of the implant. All patients had PAC and biopsy (18). The sensitivity was 83% for PAC, 79% for biopsy, and 90% for the combination of both techniques. The specificity was 100% for PAC and biopsy and the combination. The overall accuracy was 84%, 81%, and 90%, respectively. The data of this study suggested tissue biopsy alone offers no clear advantage over PAC. However, the combination of both techniques provides improved sensitivity and accuracy. The authors of the study recommended the use of tissue biopsy as an adjunct to PAC in the diagnosis of TKA infection.

PAC has proven to have a broad range of sensitivity values and the frequency of dry aspirations has not been well assessed. In such dry-tap cases a biopsy sample could be an option. Corona et al assessed the diagnostic accuracy of percutaneous interface biopsy (PIB) in isolating the infecting organism in cases of chronic periprosthetic joint infection and dry-tap event (5). The basic technique was to harvest and culture a sample from the periprosthetic interface membrane by a percutaneous technique in the preoperative period. A study was done involving 24 consecutive patients suspected of periprosthetic joint infection and where no fluid was obtained from the joint. Culture results from a PIB were compared with intraoperative tissue cultures at the time of revision surgery. The sensitivity was 88.2%; specificity was 100%. Positive predictive value was 100%, while negative predictive value was 77.9%. Accuracy was 91.6%. No technique-related complication was observed. The authors of the study concluded that PIB is a useful test for preoperative isolation of the infecting organism and could play a role in cases with dry-tap joint aspirations.

According to Del Arco and Bertrand the most useful preoperative diagnostic test for the diagnosis of periprosthetic knee infection is the aspiration of synovial joint fluid to obtain a total and differential cell count and culture (1).

In a meta-analysis Qu et al evaluated PAC for diagnosing prosthetic joint infection in TKA (19). The sensitivity and specificity were 0.78 and 0.96, respectively. PAC has moderate to high sensitivity and very high specificity for diagnosing periprosthetic joint infection.

Discussion

Periprosthetic infection occurs in 0.8-1.9% of TKAs (1). Preoperative identification of the infecting micro-organism is of paramount importance (2-4, 6). PAC, however, has a controversial role in the diagnosis of an infected TKA.

In this review the mean sensitivity of PAC was 67.6% (range: 28% to 100%) while the average specificity was 98.4% (range: 96% to 100%) (8, 9, 11, 13, 18, 19) [Table 1].

The data of the study reported by Meermans and

Table 1. Percentages of sensitivity and specificity of preoperative aspiration culture (PAC) for the diagnosis of an infected total knee arthroplasty (TKA) in the literature

| Author | Sensitivity (%) | Specificity (%) |
|--------------------------|-----------------|-----------------|
| Levitsky et al (6) | 67 | 96 |
| Duff (7) | 100 | 100 |
| Teller (9) | 28 | --- |
| Kordelle (11) | 50 | 100 |
| Meermans and Haddad (16) | 83 | 100 |
| Qu et al (17) | 78 | 96 |

Haddad suggested tissue biopsy alone offers no clear advantage over PAC (18). However, the combination of both techniques provides improved sensitivity and accuracy. The authors of the study recommended the use of tissue biopsy as an adjunct to PAC in the diagnosis of TKA infection.

In conclusion, PAC has moderate to high sensitivity (67.6%) and very high specificity (98.4%) for diagnosing

periprosthetic knee infection.

E. Carlos Rodriguez-Merchan MD PhD
Department of Orthopaedic Surgery, La Paz University
Hospital-IdiPaz, Paseo de la Castellana, Madrid, Spain

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