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Review article

Preoperative aspiration culture (PAC) for the diagnosis of infection in a prosthetic knee joint

ABSTRACT

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

Purpose: 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%).

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

Key words: knee, arthroplasty, infection, preoperative, aspiration, culture

Introduction

Periprosthetic infection (PPI) is the most severe complication following total knee arthroplasty (TKA), taking place in 0.8-1.9% of TKAs (1-4). In the management of chronic PPI it is paramount to identifying the infecting bacteria. This way, we will select the most adequate antibiotic treatment (5). Preoperative aspiration culture (PAC) has a controversial role in the diagnosis of an infected TKA. 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 TKA were studied by Levitsky et al (6) with PAC. 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 (7). In PPI of a TKA, PAC has a 100% sensitivity, specificity and accuracy. To Duff et al PAC of the knee joint is the most valuable study for the determination or elimination of infection in revision TKA.

Twenty-nine infected total knee arthroplasties were operated by Gacon et al (8). PAC was of considerable help for diagnosis in intricate chronic cases.

Teller et al evaluated PAC during revision TKA. Preoperative aspirate culture was only 28% sensitive (9).

In a series of 69 patients with PPI after TKA, Mont et al analyzed the role of PAC (10). The found that PAC was paramount to detect the patients in whom the infection may reappear. The efficiency of PAC resulted in a considerable betterment in the clinical result.

Fifty TKA in 45 patients requiring revision surgery were retrospectively analyzed by Kordelle et al (11). The sensitivity of PAC was 0.5, the specificity 1.0, the positive prognostication value 1.0, and the negative prognostication value 0.5.

Baré et al analyzed 295 patients who went through TKA to determine the clinical value of the most regularly made studies utilized to diagnose sepsis (12). They carried out the following preoperative studies: erythrocyte sedimentation rate (ESR), C-reactive protein (CPR), microbiology, PAC, and intraoperative tissue bacteriology cultures. They found that the sensitivity of ESR was 0.63 and that its specificity was 0.55. The positive predictive value was 0.39 and the negative predictive value 0.77. The accuracy of ESR was 0.57. The corresponding figures 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. No preoperative study was precise enough to be individually relied on for diagnosing PPI. The authors assumed that clinical findings and the regular utilization of simple tests such as CRP, ESR, and PAC produce foreseen results.

Gollwitzer et al reviewed in 2006 published data evaluating the available diagnostic tools of PPI of the knee (13). PAC proved high specificity for PPI. 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 TKA from 69 patients. They found that PAC had a positive predictive value of 71%, while its negative predictive value of was of 74% (14).The authors stated that when PAC gives a positive culture, the possibilities are high that the TKA is infected. When PAC is negative, infection cannot be eliminated. The analysis insinuated that, in such cases, a coagulase negative Staphylococcus (CNS) infection has to be contemplated.

One hundred five consecutive painful TKA were evaluated for the presence of infection by DellaValle et al (15). The most accurate exam was a synovial fluid WBC count higher than 3000. Its sensitivity was of 100%, its specificity of 98% and its accuracy of 99%. The authors stated that the logical way to perform the perioperative study of a potential PPI should include ESR and CRP. Then, if they were elevated, PAC should be performed to carry out synovial fluid WBC count. Intraoperative frozen section should also be performed.

Meermans and Haddad followed 56 TKA with suspected infection of the implant. All patients had PAC and biopsy (16). The results of this study insinuated that tissue biopsy alone was not clearly advantageous with respect to PAC. However, the combination of PAC and biopsy ameliorated both sensitivity and accuracy. As a result, the authors suggested to using both techniques in the diagnosis of PPI in TKA.

PAC has demonstrated to have an ample range of sensitivity values and the incidence of dry aspirations has not been well evaluated. In such dry-tap cases a biopsy sample could be an alternative. Corona et al evaluated the diagnostic accuracy of percutaneous interface biopsy (PIB) in isolating the infecting bacteria in cases of chronic PPI and dry-tap circumstance (5). Preoperatively, they percutaneously yielded and cultured a sample from the periprosthetic interface membrane. A study was done involving 24 consecutive patients suspected of PPI 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 PPI in TKA 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 PPI in TKA (17). The sensitivity and specificity were 0.78 and 0.96, respectively. PAC has moderate to high sensitivity and very high specificity for diagnosing PPI.

Discussion

PPI occurs in 0.8-1.9% of TKAs [1]. Preoperative identification of the infecting micro-organism is of paramount importance (2-5). PAC, howewer, 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%) (6,7,9,11,16,17] (TABLE 1).

The data of the study reported by Meermans and Haddad suggested that tissue biopsy alone had no advantages with respect to PAC (16). However, using both techniques together, sensitivity and accuracy improved. Therefore, they recommended the combination of both tests when suspecting PPI of a TKA.

In conclusion, for diagnosing PPI of a TKA, PAC has modest to elevated sensitivity (67.6%) and very high specificity (98.4%) .

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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