Diagnosis Of Periprosthetic Joint Infection By A Novel Multiplex PCR Of Joint Aspirate

Christian Morgenstern, Andrej Trampuz, Elena Maiolo, Sabrina Cabric, Anne-Kathrin Fietz, Carsten Perka
Charité Universitätsmedizin, Berlin, Germany

Introduction
Joint aspiration is the standard pre- and intra-operative procedure to diagnose or exclude periprosthetic joint infection (PJI). Culture of joint aspirate has limited sensitivity, especially for patients with prior antibiotic therapy. Polymerase chain reaction (PCR) is a non-culture-based molecular method. We evaluated a novel fully automated multiplex PCR for detection of most common PJI pathogens and their genotypical susceptibility.

Objectives
To assess the diagnostic accuracy of multiplex PCR of joint aspirate in comparison to current standard diagnostic methods for detection of hip and knee PJI.

Methods
In this prospective study, joint aspirates were obtained pre- and intra-operatively in all patients with suspected PJI of the hip or knee from October 2014 to April 2015 in our institution. Diagnosis of PJI was established when at least one of following criteria applied: macroscopic purulence, presence of sinus tract, acute inflammation in periprosthetic tissue, positive culture, positive cytology of joint aspirate (>2000 leukocytes/µl or >80% granulocytes). Joint aspirates were analyzed by multiplex PCR. Sensitivity, specificity and accuracy of each test were determined and McNemar’s Chi squared test was employed to find significant differences between the different diagnostic methods.
Results

56 patients were included (33 knee and 23 hip prosthesis). The median age (range) was 72 (42-87) years; 22 (39%) were males. Forty-one (73%) patients were diagnosed with PJI. Multiplex PCR (n=56 cases) was positive in 25 (61%) and joint aspirate culture (n=56 cases) in 21 (51%) patients with no significant differences between both methods (p=0.386). Aspirate cell count/differential (n=41 cases) obtained highest sensitivity 86%, high specificity 93% and accuracy 85%. Intra-operative tissue histology obtained sensitivity 82%, specificity 100% and accuracy 85%. Antimicrobial susceptibility corresponded to that of culture susceptibility testing. PCR detected following microorganisms: Coagulase-negative staphylococci (n=8), Staphylococcus aureus (n=3), E. coli (n=4), streptococci (n=5), P. acnes (n=3) and others (n=3). Compared to joint aspirate culture, PCR failed to detect E. faecalis (n = 1), Streptococci (n = 2) and E. coli (n = 1). The processing time for PCR was 5 hours, whereas cultures required a median of 48 hours (range 1-14 days).

Conclusions

Non-culture based methods (synovial aspirate cell count/differential, intra-operative histology) obtained highest sensitivity and accuracy but do not identify the microbiological agent. Sensitivity and accuracy of multiplex PCR of joint aspirate (61% and 71%, respectively) were similar to joint aspirate culture (51% and 64%, respectively. PCR provided highest specificity (100%) and fastest results (within 5 hours), including antimicrobial susceptibility. In addition, PCR allowed detection of non-viable bacteria of patients previously treated with antibiotics and detected low-grade agents that were not detected by aspirate culture. With further improvement of its sensitivity, multiplex PCR may replace cultures of joint aspirates for the preoperative diagnosis of PJI.

Keywords: Multiplex PCR, Periprosthetic Joint Infection, Joint Aspiration, Synovial Fluid