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ORIGINAL STUDY

Joint needle aspiration compared to tissue samples in septic arthritis of the native knee

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Culture of the causative infectious agent is the only definitive method of diagnosing septic arthritis and can be identified by culture of synovial fluid (SF) or by tissue cultures (TC) obtained at surgery. The aim of this study is to compare the cultures of joint needle aspiration (JNA) with tissue cultures obtained at surgery. 52 patients treated for a suspicion of a septic arthritis of the native knee were retrospectively reviewed. In 84% tissue cultures were equal to joint needle aspiration. Median Gächter classification was 1.0 (range 1-3). 60% of the patients underwent multiple procedures. All patients were successfully treated with an average of 2.0 (range 1-6) arthroscopies. Our results showed that if a patient with a clinical suspicion of septic arthritis is treated, starting antibiotic therapy prior to surgery can be considered, but only after joint needle aspiration to obtain samples for bacteriologic culture. Arthroscopic surgery must be the treatment of choice in Gächter stage 1 to 3, although it might be necessary to perform multiple procedures.

Keywords : septic arthritis of the knee ; joint needle aspiration ; tissue cultures.

INTRODUCTION

Septic arthritis is the most severe form of acute arthritis, and one of the few clinical emergencies in orthopaedics. Serious complications as permanent disability due to subchondral bone loss and a mortality rate up to 15% have been reported *(8,9,3)*. Success rates of 90-100% can be achieved when treating septic arthritis *(1)*, but appropriate antibiotic treatment and removal of any purulent material is essential. This should be started within 24 to 48 hours *(8,13,14,11)*.

Patients presenting with a hot, swollen joint always should be considered having a septic arthritis since diagnostic accuracy of history, physical examination or serum markers is low *(12,3)*. White-cell count, erythrocyte sedimentation rate, and serum C-reactive protein concentration can be helpful, but culture of the causative infectious agent is the only definitive method of diagnosing septic arthritis *(14,3)*.

Staphylococcus aureus is responsible for 50-60% of infections, with streptococci being the second most common cause *(19,16),* and can be identified by

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Table 1. — Gächter classification

Stage I	Opacity of fluid, redness of the synovial membrane, possible petechial bleeding, no radiological alterationsradiological alterations
Stage II	Severe inflammation, fibrinous deposition, pus, no radiological alterations
Stage III	Thickening of the synovial membrane, compartment formation, no radiological alterations
Stage IV	Aggressive pannus with infiltration of the cartilage, undermining the cartilage, radiological signs of subchondral osteolysis, possible osseous erosions and cysts

culture of synovial fluid or tissue samples. If joint needle aspiration (JNA) is performed for synovial fluid analysis, sensitivity can be as low as 57% *(10)*. Therefore, when decision for surgical drainage has been made, antibiotic therapy is regularly postponed to obtain tissue samples for culture, resulting in a delay in treatment associated with an increase in morbidity and mortality *(19,3)*.

Controversy still exists in the manner of drainage of purulent material, and is strongly dependent by the discipline. When treated by a rheumatologist, surgical intervention is only performed in 37% of the cases and shows no advantage over recurrent closed needle aspiration *(19,9,5)*. In orthopaedics, arthroscopy is preferred over closed needle aspiration in septic arthritis of the shoulder and knee because of more adequate irrigation and better visualization of the joint *(15,8)*. However, the way of surgical drainage should be dependent on the stage according to the criteria of Gächter (Table 1) *(7)*. In stage 1 to 3, arthroscopy is the treatment of choice, especially when symptoms exists for a brief period *(20,2,18)*. The number of surgical interventions and therapy success rate dramatically decrease when time to intervention is minimised *(6)*. This could be due to the irrigation of the joint or starting with administration of intravenous antibiotics. If the infectious agent can be identified by joint needle aspiration alone, antibiotic treatment could be started prior to surgery, thereby eradicating at least one delaying factor.

The aim of this study is to compare the cultures of JNA with the tissue cultures (TC) obtained at surgery.

MATERIALS AND METHODS

A retrospective analysis was performed of patients undergoing surgery because of a high suspicion of a septic arthritis of the knee at our department of Orthopaedic Surgery between July 2007 and December 2016. As Prosthetic Joint Infection (PJI) requires a different strategy, these patients were not included. 21 patients were excluded because no synovial fluid or tissue samples were collected during hospitalisation. Of the remaining patients, clinical presentation data were reviewed.

Demographic data collected included patient age, American Society of Anesthesiologists (ASA) classification, sex, body mass index (BMI), and side of surgery. Routine serum laboratory values included leukocyte count, erythrocyte sedimentation rate (ESR), and C-reactive protein (CRP) concentration. Body temperature recorded at presentation was noted. Pre-operative Kellgren and Lawrence scale was obtained. Medical history was reviewed including smoking status, diabetes, rheumatoid arthritis, congestive heart failure, kidney failure, gout, HIV, history of alcohol abuse and intravenous drug use.

The results of the cultures of the samples obtained by joint needle aspiration or during surgery, were evaluated. Antibiotic intake prior to joint aspiration and surgery was recorded. We collected the type and number of surgical procedures performed, the Gächter classification, the time from onset of symptoms to surgery, the total duration of antibiotic administration and the length of the hospital stay.

An official approval of the Medical Ethical Committee was not required as the Medical Research Involving Human Subjects Act (WMO) did not apply to our study.

Statistical analysis

Data was collected using Castor EDC *(4)* and exported to SPSS for statistical analysis (SPSS 24.0.0 ; SPSS, Chicago, Illinois, USA). Data are tested for normal distribution, and equal variances. Normally distributed continuous data are described as mean with standard deviations. Not normally distributed data are expressed as median and ranges.

Univariable and multivariable logistic regression analyses were used to assess associations between risk factors and the need for multiple surgeries to eradicate the infection. Differences were considered significant at a value of $p<0.05$.

RESULTS

Fifty-two patients (32 male, 20 female) with a mean age of 53.1±20.3 years were included in this study. All patients underwent arthroscopic surgery. One patient had combined open and arthroscopic surgery because of a plate fixation of a tibial plateau fracture which was removed during surgery. The right knee was involved in 26 patients (50%). The median body mass index was 25.6 (range 19.5-41.8) kg/m^2. Demographic data are presented in table 2.

At presentation, mean body temperature was 38.0±0.8 degrees of Celsius. Preoperative median serum leukocyte count was 11.4 (range 5.8-29.3) $\times 10^9$ cells/L, erythrocyte sedimentation rate 56.0 (range 5-129) mm/h, and C-reactive protein concentration 176.0 (range 35-423) mg/L. Median duration from onset of symptoms until surgery was 3.0 (range 0-28) days.

On average, 2.0 procedures were needed to eradicate the infection (range 1-6). In 21 patients, a single procedure was required for successful treatment (40%). 17 (33%) patients required surgery twice, 8 (15%) patients had surgery three times, four (8%) patients had four procedures, while respectively five and six interventions where necessary in one patient each (Table 3).

During surgery, the intra-articular status was evaluated using the Gächter classification, resulting in a median stage of 1.0 (range 1-3). Hypertension was the only risk factor for eradicating the infection by multiple procedures (p=0.039, OR 0.256, 95% CI 0.071-0.931). In multivariate analyses, there were no significant associations between risk factors and multiple surgeries.

In two cases JNA tested positive for staphylococcus epidermidis, however, TC remained negative. No antibiotic therapy was given prior to surgery, thus these cases were considered as contaminated. In 42 cases (84%) tissue cultures were equal to joint needle aspiration. Twenty-nine cultures (56%) of tissue samples collected during surgery showed a micro-organism. The most frequent cultured organisms were S. aureus and Streptococcus species. The results from the material sent for culture are shown in Table 4. Seven patients received antibiotic therapy prior to joint needle aspiration and surgery. In six patients, antibiotics were administered after JNA and before surgery. The antibiotic treatment was initiated by the family physician or medical specialist.

All patients were successfully treated with a mean hospital stay of 15.2±9.6 days. Median duration of antibiotic treatment was 41 (range 1-92) days. We report a mortality rate of 0% in this study.

Table 2. — Patient demographics

Patient demographics (n=52)	**n (%)**
Age in years, mean ± SD	53.1±20.3
Sex	
- Male	32 (62%)
- Female	20 (38%)
ASA, median (range)	2.0 (1.0-4.0)
Side	
- Left	26 (50%)
- Right	26 (50%)
BMI, median (range)	25.6 (19.5-41.8)
Smoking	
- Yes	5 (10%)
- No	47 (90%)
Temperature, mean ± SD	38.0±0.8
Laboratory results, median (range)	
Leucocytes ($\times 10^9$ cells/L)	11.4 (5.8-29.3)
ESR (mm/h)	56.0 (5-129)
CRP (mg/L)	176.0 (35-423)
Kellgren Lawrence scale, median (range)	1.0 (0-4)
Gächter classification, median (range)	1.0 (1-3)
Time from onset of symptoms until surgery in days, median (range)	3.0 (0-28)
Hospital stay in days, mean ± SD	15.2±9.6

Table 3. — Number of procedures

Number of procedures (n=52)	**n (%)**
Median (range)	2.0 (1-6)
1	21 (40%)
2	17 (33%)
3	8 (15)
4	4 (8%)
5	1 (2%)
6	1 (2%)

Table 4. — Culture results of tissue samples

Organism	n (%)
Staphylococcus Aureus	12 (41)
Streptococcus sp.	8 (28)
Streptococcus group B	4 (14)
Streptococcus group A	2 (7)
Streptococcus pneumoniae	2 (7)
Staphylococcus Epidermidis	7 (24)
Micrococcus luteus	1 (3)
Propionibacterium acnes	1 (3)

DISCUSSION

Septic arthritis is a medical emergency and culturing the causative agent is essential for targeted antibiotic treatment. This can be done by either joint needle aspiration or tissue cultures obtained at surgery. A diagnostic dilemma arises when antibiotic treatment is administered before cultures are obtained. In our study, in 84% of the cases results of JNA were equal to TC. In these cases, targeted antibiotic treatment would have been appropriate if antibiotic therapy was started prior to surgery.

Only 40% of the patients underwent a single procedure to eradicate the infection. This is in contradiction to the study of Dave et al. *(6),* where it is stated that in 77% of the cases a second procedure is not necessary. This could be due to the fact that arthroscopic treatment alone was used in 36 cases (69%), compared to 98% in this study. Secondly, our hospital protocol is different. Patients are often planned from the start for a standard second procedure and thus not because of persisting or deteriorating clinical signs of infection. According to the literature, in our study all patients underwent arthroscopic treatment as they were classified with a maximum Gächter stage of 3. In Gächter stage 4, open debridement remains the treatment of choice *(20,2)*.

Wirtz et al. *(20)* stated that arthrotomy with wide resection of all inflammatory and necrotic tissues must be performed if the infectious symptoms have lasted more than 5 days. We treated all patients successfully with arthroscopic debridement alone, even in cases were symptoms lasted up to 28 days. Univariable logistic regression analysis for duration of symptoms as a risk factor for multiple surgeries did not reach statistical significance.

Septic arthritis has been categorized by Newman and adjusted by Gupta et.al. It can be classified as category A : clinical diagnosis with bacteria isolated from the joint, and category B : clinical diagnosis with turbid SF aspirated from the joint and/or bacteria isolated from other sites *(17,10)*. In our study, 29 patients were classified as Newman grade A. In 44% of the positive cultures obtained during surgery, S. aureus was the causative agent. This is slightly lower than in the literature, reporting that in 50-60% S. aureus is responsible for infections *(19,16)*. Notable is that a positive tissue culture of Staphylococcus epidermidis was seen in seven patients (24%). S. epidermidis is a gram-positive, coagulase-negative species that is a part of our normal flora that can cause infections following surgery or in immune compromised patients. In three out of these seven patients (43%) septic arthritis occurred after surgery, and only one patient was immunocompromised due to leukopenia. There were no records of HIV infections or drug abuse.

One of the limitations of this study is the retrospective design. Furthermore, seven patients already received antibiotic therapy prior to JNA. In six of these cases, results of TC were identical to JNA.

Our results showed that if a patient with a clinical suspicion of septic arthritis is treated, and surgical intervention is postponed, starting antibiotic therapy prior to surgery can be considered, but only after joint needle aspiration to obtain samples for bacteriologic culture. Arthroscopic surgery must be the treatment of choice in Gächter stage 1 to 3 despite the duration of symptoms, although it might be necessary to perform multiple procedures to eradicate the infection.

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