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Retrospective Study

Role of joint aspiration before re-implantation in patients with a cement spacer in place

Abstract

BACKGROUND

The usefulness of a mandatory joint aspiration before re-implantation in patients with a cement spacer already in place is unclear.

AIM

To evaluate the role of culturing synovial fluid obtained by joint aspiration before re-implantation in patients who underwent a two-stage septic revision.

METHODS

A retrospective observational study was conducted, including patients that underwent a two-stage septic revision (hip or knee) from 2010 to 2017. After the first stage revision and according to intraoperative culture results, all patients were treated with an antibiotic protocol for 6-8 wk. Following two weeks without antibiotics, a culture of synovial fluid was obtained. The results of these cultures were recorded and compared with cultures obtained during re-implantation surgery.

RESULTS

Forty-one patients (20 hip and 21 knee spacers) were included in the final analysis. In 39 cases, the culture of synovial fluid was negative while in the remaining two cases (knee

spacers) no analysis was possible due to dry tap. In five of the patients, two or more intraoperative cultures taken during the re-implantation surgery were positive.

CONCLUSION

We found no evidence to support mandatory joint aspiration before re-implantation in patients with a cement spacer in place.

INTRODUCTION

Periprosthetic joint infection (PJI) remains a challenging complication for all orthopaedic surgeons. Despite the increase of a one-stage revision strategy, two-stage revision surgery remains the gold standard procedure for chronic PJI. Two-stage procedures using antibiotic-loaded cement spacers have reported eradication rates of over 73%^[1-4]. To determine the optimal time to perform the second stage of the revision surgery, many parameters and diagnostic methods had been analysed. Synovial fluid culture after a joint aspiration seems to be a reasonable test to evaluate the presence of microorganisms in the joint^[5-7]. However, the effectiveness of this diagnostic test is unclear. Despite the lack of validation, synovial aspiration is a common practice before prosthesis reimplantation.

The purpose of our study was to evaluate the role of joint aspiration and synovial fluid culturing before re-implantation in patients with a cement spacer in place.

MATERIALS AND METHODS

A retrospective observational study was conducted. We analysed all patients that underwent a two-stage revision surgery at our institution between 2010 and 2017 (inclusive).

The following variables were recorded for all patients: demographic parameters, results of first stage cultures, cultures of the synovial fluid between stages, results of second stage cultures, and the need for new procedures after the second stage.

All patients to whom arthrocentesis before the second stage of the surgery was not performed or the intraoperative cultures for the two stages of the surgery were not correctly analysed were excluded from this study.

Treatment protocol

Our arthroplasty two-stage exchange protocol consisted of a first surgery where the prosthesis was explanted, as well as all the cement and forage implants. A radical debridement was performed and 5-7 samples were taken and analysed by the microbiology laboratory. A cement spacer loaded with antibiotics (vancomycin and gentamicin), usually preformed (Vancogenx®-Space, Tecres), was then placed. After surgery, an empirical intravenous antibiotic treatment (teicoplanin, rifampin, and amikacin) was started and continued until definitive results for the microbiological cultures were obtained. Once the causative microorganisms were isolated, antibiotic therapy was tailored to its sensitivity. This antibiotic treatment was then continued for 6 to 8 wk; after which, antibiotics were stopped for two weeks (antibiotic holidays) and an arthrocentesis was performed. Blood tests were performed to quantify acute phase reactants, such as C-reactive protein (CRP). If the patient remained afebrile, without local clinical signs of infection, and with normalised serum CRP levels, we assumed that the infection was controlled and proceeded to the ²second stage. During the second-stage surgery, the cement spacer was removed and submitted to the microbiology laboratory for sonication. Another thorough debridement and sampling were performed before implantation of the definitive prosthesis. After the second stage surgery, patients received antibiotic therapy based on the sensitivity of the infecting organisms for 6 mo for total knee arthroplasty or 3 mo for total hip arthroplasty.

Joint aspiration protocol

The knee is a superficial joint where, after adequate skin disinfection and with proper sterility measures, we performed an arthrocentesis at the outpatient clinic. Synovial fluid obtained was sent for microbiological study. On the other hand, hip arthrocentesis

was performed at the operating room with the assistance of sedation by the anesthesiologist and fluoroscopic aid to localise the correct space for joint puncture (Figure 1). Sterility measures and microbiological studies were the same as for the knee joint.

Microbiological protocol

Following the sampling protocol at our hospital, we took between 5 and 7 intraoperative samples. Each one was taken using a clean scalpel and clamp to avoid cross-contamination. Tissue samples were introduced in sterile plastic containers and sent to the microbiological laboratory without culture media. Once received in the laboratory, the tissue samples were homogenized in thioglycolate broth (TB) before plating in the following culture media (bioMérieux Marcy-l'Étoile, France): (1) 5% blood sheep agar: 7 d at 37°C in 5% CO₂ atmosphere; (2) Chocolate agar: 7 d at 37°C in 5% CO₂ atmosphere; (3) McConkey agar: 2 d in a normal atmosphere; (4) Sabouraud agar: 5 d at 37°C in a normal atmosphere; (5) Anaerobic agar: 7 d in an anaerobic atmosphere; and (6) Thioglycolate broth: systematic spread after 5 d of incubation in a normal atmosphere, in 5% sheep blood agar, chocolate agar, and anaerobic agar with the incubation time previously described.

When the consistency of the samples did not allow homogenization, they were covered with TB and plated on agar plates (not in TB) after overnight incubation at 35°C. Gram stains were performed from synovial fluid samples and then inoculated into a BacT/ALERT bottle (bioMérieux Marcy-l'Étoile, France) incubated for 7 d.

Results interpretation

The results of intraoperative cultures during first-stage surgery and synovial fluid were recorded and compared with cultures obtained during re-implantation surgery. According to culture results during the second stage, patients were classified as persistent infection, when second stage cultures were positive for the same microorganism that was isolated during the first stage even if only one single culture

was positive. Reinfection was considered when two or more of the second stage cultures were positive for the same microorganism but differ from the ones isolated during the first stage. The presence of only one positive culture from intraoperative samples for a low virulent microorganism not isolated in the first stage was considered as a contaminant.

RESULTS

A total of 50 patients diagnosed with PJI treated with a two-stage arthroplasty revision surgery were analysed, 9 patients were excluded because joint aspiration was not performed, or the sample of synovial fluid was not correctly processed. The remaining 41 patients (20 hip and 21 knee joints) were included in the final analysis.

The mean age of patients was 70.4 years (range 40-85 years). Twenty-four of them were females (61%) and 16 were males (31%). In 39 patients, the synovial fluid culture was negative. In the remaining two cases, both knee spacers, no analysis was possible due to dry tap. Five patients had two or more positive intraoperative cultures during re-implantation surgery (Table 1). Only one patient, number 3, had a persistent infection. In this patient, the synovial fluid culture before the second-stage surgery failed to identify the infection. The other four cases had a reinfection and in all of them, the synovial fluid was negative. Three of these five patients (60%) required further surgeries after the second stage, and it was due to an infection in two cases (40%) (patients 1 and 2).

Thirty-six patients (87.8%) had negative cultures or one positive culture from a minimum of five intraoperative samples (considered contamination) during the second stage of the revision surgery. Of these patients, 17 (47.22%) needed new interventions after the second stage, and 12 of them (70.59%) were due to septic causes.

DISCUSSION

PJI is a challenging complication following orthopaedic surgery. Two-stage revision surgery was first described by Insall *et al*^[8] and it is considered the gold standard

treatment for chronic PJI. The precise time to perform the second stage of the revision surgery remains uncertain. A combination of serum markers and synovial aspiration results is considered the best test for determining the presence of PJI persistence^[5-7,9].

Although the majority of studies confirm low sensitivity for joint aspiration fluid culture before reimplantation surgery^[10-14], some as low as our data 0%, other studies like Preininger's *et al*^[15] and Newman's *et al*^[16] reported higher rates (21 and 30% respectively) with a maximum sensitivity of 83% in Meermans' *et al*^[17] study. All studies agree on its high specificity, above 90%^[10-17].

Mont *et al*^[18] and Aalirezaie *et al*^[19] consider joint aspiration and synovial fluid culturing a useful tool. However, we found similarities in our results with other authors and agreed to not perform mandatory synovial fluid aspiration before the second stage^[11-13,15].

An antibiotic-free interval before joint aspiration (antibiotic holiday) and the time until the culture result is available (a minimum of two weeks) extends the duration between the first and second stage of the two-stage revision surgery. However, active antibiotic treatment can result in false negatives. In all the cases of our series, the cultures of the first stage, second stage, and synovial fluid obtained from joint aspiration were performed in patients without active antibiotic treatment. Despite this condition, we did not have any positive culture.

To reduce the time between stages, some authors as Mühlhofer *et al*^[10] and Boelch *et al*^[11] recommend performing reimplantation surgery without antibiotic holiday.

There are some explanations for not having obtained any positive result in the synovial fluid culture in our patients. In the first place, the small sample size and the low sensitivity of the joint aspiration could explain our results. Secondly, the low bacterial load in the synovial fluid at the time of the joint aspiration and thirdly, the presence of local antibiotics due to elution of the antibiotic present in the cement spacer^[20].

It is important to emphasise the differences between the knee and hip joint aspiration procedures. Knee joint aspiration is a much easier procedure as it is a more accessible

joint and does not require guidance by fluoroscopy or ultrasound techniques. In some centers, when no fluid is obtained after joint aspiration, sterile saline is injected into the joint and then aspirated to obtain fluid to analyse. Injection of saline fluid ¹ into a joint that did not yield any synovial fluid (dry tap) was not recommended during the 2018 International Consensus Meeting on musculoskeletal infection.

The main limitations of our study are its retrospective nature and the limited number of cases. There are few articles published in the literature concerning the value of synovial aspiration before re-implantation surgery with a cement spacer in place. These papers present heterogeneous data and an inconsistent antibiotic-free interval, making them difficult to compare.

CONCLUSION

Although synovial fluid culture ⁵ may provide useful information regarding the infection status of the joint, we found no evidence to support mandatory joint aspiration before re-implantation in patients with a cement spacer in place.

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Figure 1 Hip arthrocentesis procedure. A: Hip arthrocentesis setup; B: Hip arthrocentesis.

Table 1 Patients with more than two intraoperative cultures positive during second-stage surgery

Patient	Microorg. 1 st stage	Spacer joint aspiration	Microorg. 2 nd stage	Reinfection/Persistence	Reoperation after 2 nd stage	Microorg. reoperation
1	Negative	Negative	<i>S. epidermidis</i> ; <i>S. capitis</i>	Reinfection	Yes (Multiple)	<i>Klebsiella</i> <i>spp</i>
2	Negative	Negative	<i>S. epidermidis</i> ; <i>S. cohnii</i>	Reinfection	Yes (Debridement)	Negative
3	<i>S. epidermidis</i> ; <i>S. lugdunensis</i>	Negative	<i>S. epidermidis</i>	Persistence	No	-
4	Negative	Negative	<i>S. epidermidis</i> ; <i>S. haemolyticus</i>	Reinfection	Yes (Periprosthetic fracture)	-
5	Negative	Negative	<i>S. epidermidis</i> ; <i>C. acnes</i>	Reinfection	No	-

S. epidermidis: *Staphylococcus epidermidis*; *S. lugdunensis*: *Staphylococcus lugdunensis*; *S. haemolyticus*: *Staphylococcus haemolyticus*; *S. capitis*: *Staphylococcus capitis*; *S. cohnii*: *Staphylococcus cohnii*; *C. acnes*: *Cutibacterium acnes*.

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