

MAJOR ARTICLE

The Value of Suction Drainage Fluid Culture during Aseptic and Septic Orthopedic Surgery: A Prospective Study of 901 Patients

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There are no guidelines on the value of suction drainage fluid culture (SDC), and it is difficult to determine whether the organisms cultured from suction drainage fluid samples are pathogenic or simply contaminants. We performed 2989 cultures of suction drainage fluid samples obtained, during a 1-year period, from 901 patients who underwent aseptic or septic orthopedic surgery (946 operations). The culture results were analyzed to evaluate their ability to detect postoperative infection after aseptic operations or to detect either a persistent or new episode of sepsis in patients known to have infection. For aseptic operations, the sensitivity of SDC was 25%, the specificity was 99%, the positive predictive value was 25%, and the negative predictive value was 99%. For septic operations, the sensitivity of SDC was 81%, the specificity was 96%, the positive predictive value was 87%, and the negative predictive value was 94%. We conclude that, for aseptic orthopedic surgery, SDC is not useful in detecting postoperative infection. However, for septic orthopedic surgery, it is of clinical importance.

Despite advances in surgical technique, a better understanding of the pathogenesis of wound infection, and widespread use of antibiotic prophylaxis, postoperative infection continues to be a major source of morbidity and mortality for patients undergoing surgical procedures. In orthopedic surgery, isolation of microorganisms from bone culture is the standard for determining whether a bacterial infection is present. In aseptic orthopedic surgery, it can be difficult to deter-

mine whether organisms that are isolated from drains placed near the bone or inside the joint are pathogenic, or simply contaminants [1, 2]. During septic orthopedic surgery, the value of suction drainage fluid culture (SDC) to predict new or persistent sepsis is unknown [3, 4], and SDC is expensive (US\$27 per culture). We conducted a prospective study of SDC to evaluate its efficacy in the detection of postoperative infection after aseptic orthopedic operations, or persistent or new sepsis after septic operations.

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PATIENTS AND METHODS

Patients. All consecutive patients undergoing orthopedic surgery at Raymond-Poincaré Hospital from December 1, 1998 to December 1, 1999 constituted the study population. Nine hundred one patients (469 males and 432 females) were included in the study. The

mean age (\pm SD) of the patients at the time of surgery was 49 ± 20 years (range, 15–98 years). The surgical procedures performed included internal fixation of fractures (532 [56%] of 944 procedures), prosthetic implant (261 procedures [28%]), septic surgery (66 procedures [7%]), and others (e.g., resection of heterotopic bone, osteotomy, and spine surgery; 85 procedures [9%]).

Among patients who underwent septic orthopedic surgery, the clinical characteristics were diverse and nonspecific, including fever, fistula, pain, and loss of function. For 42 patients, the symptoms were of acute onset (duration, <4 weeks), and, for 22 patients, they were chronic. The most frequent sites where surgery was performed were the femur, hip, and tibia.

For patients who had undergone aseptic surgery without the use of an implant, the duration of follow-up was 1 month. For all other patients, the duration of follow-up was 1 year after surgery. At each follow-up examination patients were evaluated for infection or sepsis (see the subsection Definitions of Infection, below).

Drainage system. The drainage system consisted of 3 components: a flat drainage tube, a connecting tube, and a reservoir. At the time of surgery, the drainage system was removed from its sterile packaging with use of an aseptic technique. The flat drain was placed near the bone or inside the joint. The holes in the drain were located at its end and hence were always deep within the fascia and not in the subcutaneous space. They were away from the superficial wound, and the drain was of no value in detecting a superficial infection. With use of a scalpel, a stab wound was made through the skin at a site separate from the incision to allow the drain to exit from the wound. The connecting tube was secured to the skin with a braided nylon suture. When no more fluid could be collected, the drains were removed.

Microbiological study. The reservoir of the drainage system was changed twice weekly (on Monday and Thursday) under sterile conditions, and the accumulated drainage fluid was cultured on blood agar plates with use of standard aerobic and anaerobic methods. Plates were incubated at 37°C and were examined after 48 h and on day 7. Gram-negative bacteria were isolated on Drigalski plates, and gram-positive bacteria were isolated on Chapmann plates (Pasteur Diagnostics). The isolated bacteria were identified with use of the API Identification System (bioMérieux Diagnostics) and were subjected to susceptibility testing. SDC results were considered negative if all culture bottles had negative results. If a single culture result was positive, the patient was classified as having a positive SDC result.

Definitions of infection. “Postoperative infection” was defined as infection that developed at the site of surgery within 30 days after the surgical procedure, if there was no implant

present, or within 1 year after the surgical procedure, if an implant was present. “Superficial infection” was defined as infection that involved only the skin or subcutaneous tissue at site of the surgical incision; “deep infection” was defined as infection that involved the deep soft tissues (fascial and muscle layers) at site of the surgical incision [5]. Prior positive culture results were used to define infection in those patients who later developed signs of infection and who had a deep infection diagnosed on the basis of surgical findings.

“Persistent sepsis” after septic orthopedic surgery was defined by a relevant clinical finding, such as fever, tachycardia, or chills, and the presence of the same bacteria that had been isolated during surgery. “New sepsis” was defined by a relevant clinical finding with the presence of bacteria different than those isolated during surgery. A case of new or persistent sepsis required an additional operation and/or a modification of antibiotic therapy.

Statistical analysis. Data were prospectively collected by the attending physician with use of a specially designed case-report form (1 form per patient). The following data were recorded in an electronic spreadsheet (Microsoft Excel): date and type of operation, date and number of SDCs with positive results, date of diagnosis of any postoperative infection, and type of bacteria isolated from the infection. The sensitivity, specificity, positive predictive value, and negative predictive value of SDC to detect a persistent or new infection were calculated on the basis of individual operations, not patients. Statistical analysis was performed using Statview 5 (SAS). Values for continuous variables were presented as means and SDs, and categorical variables as counts and percentages. Results are presented for the subgroups of patients with and without bone-associated sepsis at the time of surgery.

RESULTS

SDC results. There were 880 aseptic orthopedic operations performed for 843 patients, for whom 2434 SDCs were performed. There were 12 cases of deep infection following surgery. Negative results were noted for 2409 (99%) of 2434 SDCs (corresponding to 868 operations and 831 patients). Of this group of patients, 9 developed a postoperative infection. Positive results were noted for 25 SDCs (1%) after 12 operations, and 3 of these operations were followed by infection. For aseptic orthopedic surgery, the sensitivity of SDC to detect postoperative infection was 25%, the specificity was 99%, the positive predictive value was 25%, and the negative predictive value was 99%.

There were 66 septic orthopedic operations performed for 58 patients, for whom 555 SDCs were performed. Negative SDC results were noted for 429 (77%) of 555 SDCs (corre-

Table 1. Details of positive suction drainage fluid culture (SDC) results for 901 patients who underwent orthopedic surgery.

| Organisms isolated | No. of operations with positive SDC results, by type | |
|----------------------------------|--|----------------|
| | Aseptic | Septic |
| MRSA | 2 ^a | 7 ^a |
| MSSA | 0 | 0 |
| <i>Pseudomonas aeruginosa</i> | 1 ^a | 1 ^a |
| Coagulase-negative staphylococci | 5 | 2 |
| <i>Streptococcus</i> species | 1 | 1 ^a |
| Gram-negative bacilli | 3 | 1 ^a |
| >1 type of organism | 0 | 3 ^a |
| Total | 12 | 15 |

NOTE. MRSA, methicillin-resistant *Staphylococcus aureus*; MSSA, methicillin-sensitive *S. aureus*.

^a Operations that were followed by infection: 3 aseptic operations, 13 septic operations.

sponding to 51 operations in 46 patients). Three (6%) of these 46 patients had evidence of persistent clinical sepsis and underwent an additional operation. Positive SDC results were seen after 15 operations. Of these 15 operations, 13 (87%) were associated with sepsis (10 [67%] associated with persistent sepsis and 3 [20%] with new sepsis); all of these instances of sepsis were deep infections. Of these 15 septic orthopedic operations with positive SDC results, 3 required an additional operation only, 8 required a change in the antibiotic regimen only, 2 required an additional operation and a change in antibiotic regimen, and 2 required neither an additional operation nor a change in antibiotic regimen. For septic orthopedic surgery, the sensitivity of SDC to detect a persistent or new infection was 81%, the specificity was 96%, the positive predictive value was 87%, and the negative predictive value was 94%.

Identification of bacteria. During aseptic orthopedic operations, the most frequently identified bacterial organisms were coagulase-negative staphylococci (in 41% of operations

with positive SDC results) and enterobacteriaceae (in 25%). In these cases, there was no postoperative infection. *Staphylococcus aureus* was identified in 2 cases and *Pseudomonas aeruginosa* in 1 case; all 3 of these cases were followed by infection.

During septic orthopedic operations, the most frequently identified bacterial organism was *S. aureus* (in 44% of operations with positive SDC results; 17 isolates were methicillin-resistant strains and 4 were methicillin-susceptible strains), followed by *P. aeruginosa* (in 23% of operations with positive SDC results). For all cases in which *S. aureus* or *P. aeruginosa* were isolated, persistent or new infection was detected. Coagulase-negative staphylococci were identified in 2 cases in which neither persistent nor new infection was detected. The microorganisms isolated from positive SDCs are listed in table 1.

Time to positive SDC result. For aseptic orthopedic surgery, the mean time (\pm SD) to obtain a positive SDC result was no different for operations followed by infection (11 ± 6 days) than it was for operations not followed by infection (9 ± 8 days). The mean time (\pm SD) to obtain a positive SDC result was significantly shorter for septic orthopedic operations followed by infection (3 ± 1 days) than it was for aseptic orthopedic operations followed by infection (10 ± 8 days; $P < .01$).

DISCUSSION

Our study found that for the majority of patients (75%) in whom infection developed after aseptic orthopedic surgery, SDCs had negative results. For the few patients (2%) with positive SDC results, the mean time to obtain a positive culture result was 10 days (range, 2–13 days). The majority of bacteria isolated from SDCs were coagulase-negative staphylococci and enterobacteriaceae (66% of isolates); in patients from whom these organisms were isolated, postoperative infection did not develop. After a positive SDC result was obtained, a second sample of fluid from the drain was cultured, and in only 3 cases were the results of the second culture positive. Therefore,

Table 2. Summary of studies that have examined whether culture of suction drain tip and/or suction drainage fluid (SDC) has value for detection of postoperative infection in patients who undergo aseptic orthopedic surgery.

| Reference | No. of patients | Type of culture | Culture has value for detection of postoperative infection? |
|-------------------------|-----------------|-------------------|---|
| Lingren et al. [1] | 107 | Drain tip and SDC | Yes |
| Zamora-Navas et al. [6] | 32 | Drain tip and SDC | No |
| Willemens et al. [7] | 48 | Drain tip and SDC | Yes |
| Lindhall et al. [8] | 6 | SDC | Yes |
| Overgaard et al. [9] | 78 | Drain tip and SDC | No |
| Sorensen et al. [10] | 489 | Drain tip | No |
| Present report | 843 | SDC | No |

leaving the suction drainage in place does not have diagnostic utility.

A few studies have shown that isolation of bacteria from fluid obtained from either a drain or the tip of a drain placed near the bone or inside the joint has value in detecting infection after aseptic orthopedic surgery, but the numbers of patients in reported series are too low to form a definitive conclusion ([1, 6–10]; table 2). Our study also shows that SDC results were not able to predict infection after aseptic surgery. However, the risk of infection in cases for which SDCs yielded virulent bacteria was higher than the risk in cases for which SDCs yielded low-virulence bacteria. Postoperative infection developed in 3 cases for which early SDCs yielded highly virulent bacteria (*S. aureus*, 2 cases; *P. aeruginosa*, 1 case).

With regard to aseptic orthopedic surgery, opinions differ as to the risk of an infection developing when suction drainage is used, and guidelines and indications are unclear [11, 12]. Experimental and clinical studies have shown that use of closed suction drainage reduces the retrograde migration of bacteria along the drain tract and, therefore, reduces the frequency of infection, compared with the use of simple conduit drains [13, 14]. If drainage is maintained for longer periods, the risk of bacterial contamination following aseptic surgery also is not clear. Zamora et al. [6] found that there was no correlation between the length of time that a drainage tube remained in place and contamination of the surgical site. However, Willemen et al. [7] found just the opposite correlation. In these studies [6, 7], the numbers of patients were too low (32 and 41 patients, respectively) to allow meaningful conclusions to be drawn. Our study of 843 patients confirms that closed suction drainage is clearly not the source of infection, because we found no correlation between isolation of bacteria from drainage fluid and the development of postoperative sepsis.

For patients who undergo septic orthopedic surgery, positive clinical findings (e.g., fever, tachycardia, or chills) usually indicate that an additional operation is required to determine the source of the persistent sepsis; this finding establishes that SDC has an important role in patient management. We found that, for patients who have undergone septic orthopedic surgery, SDC has high positive and negative predictive values for postoperative sepsis, because there is a good correlation between the bacteria isolated from the drainage fluid (from drains placed deep in the fascia) and the bacteria isolated from the site of the infection (in cases of deep infection). In conclusion, our

study clearly indicates that a positive SDC result is not useful for the detection of infection following aseptic orthopedic surgery, but is highly predictive of persistent sepsis, relapse of the primary sepsis, or new infection acquired after septic orthopedic surgery.

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