Bacterial growth on suction drain tips

Prospective study of 489 clean orthopedic operations

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The study included 489 clean orthopedic operations with implantation of major foreign materials (joint replacements and internal fixations of fractures). Specimens for culture were taken from the suction drainage system, either from the drain fluid or from the drain-tube tip or from both. Six superficial and five deep infections were seen following the operations. Only two cultures of drain fluid were positive, and neither of these became infected. Positive drain-tip cultures were seen after 56 operations, and of these, five were followed by infection. The risk of infection was increased if *Staphylococcus aureus*, Enterobacteriaceae, or *Streptococcus faecalis* was cultured from drain tips. Drain-tip cultures growing only coagulase-negative staphylococci, nonhemolytic streptococci, and corynebacteria were not correlated with increased risk of infection. There was a not significant tendency towards fewer infections if positive drain-tip cultures with virulent bacteria were treated with specific antibiotics.

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Submitted 91-03-02. Accepted 91-06-13

In recent decades, it has been realized that the majority of postoperative wound infections are due to bacterial contamination during the operation (Cruse and Ford 1973, Lidwell et al. 1983). However, such contamination is much more frequent than indicated by the rate of postoperative infection (Fitzgerald et al. 1973, Benediktsdottir and Hambraeus 1983); and for the majority of wounds, the local defense reactions alone or combined with prophylactic antibiotics are able to eliminate the bacteria. It seems reasonable to assume that if bacteria are detectable in the wounds in the days following surgery this is a sign of insufficient bacterial elimination and increased risk of infection.

We investigated whether or not bacterial growth in suction drain fluid and on suction drain tips following clean orthopedic operations was correlated with the risk of contracting a postoperative wound infection.

Materials and methods

Since January 1, 1985, all the operations performed at the Department of Orthopedics at Frederiksberg Hospital have been continuously recorded by electronic data processing as to type, date, and duration of operation; use of prophylactic antibiotics; date of diagnosis of the postoperative wound infection, if any; and type of bacteria isolated from the infection.

The present study is based on these recordings of 283 internal fixations of trochanteric and femoral neck fractures (sliding screw and plate), 101 hemiarthroplastic replacements for femoral neck fractures (Moore's prosthesis), 197 total hip and 26 total knee replacements performed in the 2-year period from January 1, 1985 to December 31, 1986. A total of 607 of these operations were performed. However, 118 operations were excluded from the study, as no cultures were taken from the suction drain system (see below).

All the operations were performed in theaters with laminar ventilation. Antibiotic prophylaxis was used for all the total hip and knee replacements, and from July 1986, also for all the hip fracture operations. One gram of dicloxacillin was given at the beginning of the operations and repeated after 6 and 12 hours. In all the total joint replacements, bone cement containing gentamicin was used. A closed suction drainage system (Drevac) was applied in all the operations. The drain tube was placed in contact with the implant and brought out through a separate skin incision. The drain was removed when the drainage was less than 20 mL per day.

After removal of the drain tube, 5 cm of the inner part of the tube was cut off and put into a sterile transport tube, and a sample of the drain fluid was aspirated from the drain-fluid container. The skin surrounding the drain tube was not disinfected before the drain tube had been removed.

Table 1. Operations included in the study

Type of operation	Operations (number)	Infections (number)		Percentage infection
		Superficial	Deep	
Internal fixation of trochanteric and femoral neck fractures	201	1	2	2
Hemiarthroplastic replacement of femoral neck fractures	74	1	0	1
Total hip replacements	189	4	3	4
Total knee replacements	25	0	0	0
Total	489	6	5	2.2

Table 3. Number of operations and infections distributed with regard to result of drain-tip cultures

Drain-tip culture	Operations	Infections
Positive with virulent bacteria	20	4
Positive with only low virulent bacteria	36	1
Negative	422	6

Comparison of risk of infection: $P < 0.00001$.
Risk of infection in cases of positive drain-tip culture with virulent bacteria compared with cases with negative culture: $P = 0.001$.
Risk of infection in cases of positive drain-tip culture with low virulent bacteria compared with cases with negative culture: $P = 0.9$.

Table 2. Bacteria isolated from 56 drain tips with positive cultures

Bacteria	Number of drain tips	Number of Infections
Staph. aureus	7	0
Staph. aureus + group A streptococci + corynebacteria	1	0
Staph. aureus + Enterobacteriaceae	1	1[a]
Enterobacteriaceae	4	1[b]
Strep. faecalis	4	1[b]
Strep. faecalis + coagulase-negative staphylococci	1	1[b]
Strep. faecalis + nonhemolytic streptococci + Enterobacteriaceae	1	0
Strep. faecalis + corynebacteria + *Acinetobacter*	1	0
Coagulase-negative staphylococci	27	1[b]
Coagulase-negative staphylococci + nonhemolytic streptococci	3	0
Nonhemolytic streptococci	6	0
Total	56	5

[a]Only *Staphylococcus aureus* was isolated from infection.
[b]Same species was isolated from infection.

Table 4. Number of operations and infections with positive drain-tip cultures distributed with regard to whether antibiotics were given (+) or not (–). The antibiotics were in each case based on the sensitivity of the bacterial strains isolated from the drain tip

Bacteria isolated	+ Antibiotics		– Antibiotics	
	Operations	Infections	Operations	Infections
Virulent bacteria	11	1	9	3
Low virulent bacteria	2	0	34	1
Total	13	1	43	4

Table 5. Number of operations, positive drain-tip cultures, and infections distributed with regard to drainage time

Drainage time (days)	Operations	Positive cultures	Infections
0–2	83	9	2
3–4	213	21	3
5–6	131	14	2
7–8	45	9	3
9–12	6	3	1
Total	478	56	11

At the Department of Clinical Microbiology, broth was added to the tube containing the drain tip, and the tube was shaken. Samples of this broth and of the drain fluid were spread on agar plates (10 percent blood agar and anaerobic agar) that were incubated at 35 °C aerobically and anaerobically. Tubes containing thiogluconate were inoculated with the drain fluid and incubated at 35 °C. The plates and tubes were examined after 24 and 48 hours, and all the isolates were identified by routine methods.

The criteria for infection were purulent matter in the wound drained spontaneously or by incision, serous discharge from the wound with growth of bacteria, or signs of infection with growth of bacteria at reoperation. Subcutaneous infections were classified as superficial infections, and infections around the implanted foreign material were classified as deep infections. There was a follow-up period of 2 years for all the patients.

For the statistical analyses, Fisher's exact test and the chi-square test were used.

Results

Eleven infections were seen following the 489 operations (Table 1). Among the 118 operations excluded, two infections were seen (one superficial and one deep). The infections were diagnosed from 1 week to 1 year after the operations. Cultures from the drainage fluid were performed after 195 operations, but only two were positive, and neither of these 2 patients developed infections. Six infections were found following the 193 operations where drainage-fluid cultures were negative.

Drain tips were cultured after 478 operations, and bacteria were detected in 56 cases. Five infections were seen following the operations where the drain-tip culture was positive (Table 2). In these five infections, the same bacterial species was isolated from the wound and the drain tip (Table 2), except for 1 case where both *Staph. aureus* and Enterobacteriaceae were found on the drain tip, but only *Staph. aureus* was isolated from the wound.

Prophylactic antibiotic (dicloxacillin) was given in 155 of the hip fracture operations (internal fixation or hemiarthroplasty), and drain-tip cultures were positive in 9 of these. Positive drain-tip cultures were seen after 22 of the 115 fracture operations where a prophylactic antibiotic was not given ($P < 0.005$). The bacterial strains cultured from the drain tips after these operations were more frequently sensitive to dicloxacillin if a prophylactic antibiotic had not been given (17/21 compared with 6/15, $P < 0.05$).

All four infections following hip fracture surgery were seen after operations where a prophylactic antibiotic had not been given. Seven infections were seen following total joint replacements. In one of these, no bacteria were cultured from the wound. The bacterial strains isolated from the remaining six infections were sensitive to dicloxacillin or gentamicin or both in 5 cases.

Staph. aureus, Enterobacteriaceae, and *Strep. faecalis* (virulent bacteria) were isolated from 20 drain tips, and infections were seen in four of these. Coagulase-negative staphylococci, nonhemolytic streptococci, and corynebacteria (low virulent bacteria) were the only isolates from 36 drain tips, and an infection was seen in only one of these (Table 2). The infection rate following operations with positive drain-tip cultures was increased in cases where virulent organisms were cultured (Table 3).

Systemic antibiotics were administered according to the in vitro sensitivity of the bacteria cultured from the drain tip in 13 cases. The median duration of the treatment was 13 (2–74) days. In one of these a superficial infection with *Staph. aureus* developed (Table 4). The median drainage time was 4 (0–12) days (Table 5). The frequency of positive drain-tip cultures, as well as the risk of infection, increased if the drainage time was more than 6 days ($P < 0.05$ and $P < 0.01$, respectively).

Discussion

During the last 20 years, the infection rate following total joint replacements has declined to below 1 percent. The infection rate found in the present study was at this level for both total joint replacements and hip fracture operations.

The infection rate after operations with positive drain-tip cultures with virulent bacteria was lower in those cases where antibiotic treatment was initiated because of the in vitro sensitivity test for the isolated bacteria. This difference lacked significance, which, however, could be due to the small number of patients.

Culture of material from closed suction drainage systems following clean orthopedic operations has been investigated in a few previously published studies. Although a positive correlation between a positive culture and a risk of contracting an infection was not demonstrated in these studies, they seem to support our present study: Lindgren et al. (1976) cultured from drainage fluid and drain tips in 107 patients, and Waugh and Stinchfield (1961) and Willet et al. (1988) cultured from drain tips in 100 and 120 patients, respectively. Positive cultures were found in 35, 17, and 5 of the cases, respectively. One infection was seen in each of the first-mentioned two studies; and for both, the same bacterial species isolated from the infection was found on the drain (*Clostridium Welchi* and *Staph. aureus*, respectively). Lindgren et al. (1976) and Willet et al. (1988) found secretion, redness, swelling, and increased local temperature in 18

and 5 patients, respectively. These wound symptoms, called superficial infections by Willet et al. (1988), but not fulfilling the criteria of infection used in our study, were more frequent in patients with positive drain-tip cultures than in patients with negative cultures.

Closed suction drainage has become an established routine with the aim of preventing wound hematoma and thereby reducing the risk of infection. However, the benefit of closed suction drainage has never been evaluated in a prospective randomized study. In prospective, nonrandomized studies, Cruse and Foord (1973) and Waugh and Stinchfield (1961) found no difference in infection rates, whether closed suction drains were used or not. Similar findings were made in a retrospective study by Reilly et al (1986).

In animal experiments, retrograde migration of bacteria along the drain has been observed, increasing the risk of wound infection (Cerise et al. 1970, Raves et al. 1984). Further, the presence of a drain may weaken the defense reactions, and thereby the ability to eliminate contaminating bacteria (Magee et al. 1976).

We removed the drains when the yield was less than 20 mL per day. The frequency of positive drain-tip cultures increased if the drainage time exceeded 6 days. This could be explained by an increased risk of retrograde migration of bacteria from the skin, advocating early removal of the drains. However, another explanation could be that bacteria present in the wound may cause increased exudation, and thereby longer retention of the drain. This latter explanation is supported by the fact that antibiotics administered systemically for only 12 hours following hip fracture operations reduced the risk of a positive drain-tip culture. However, also with this explanation, early removal of the drains seems recommendable, as they may harm the host-defense reaction.

Acknowledgements

The statistical part of this study was supported by the National Research Council for Medical Sciences.

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