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Suction drain tip culture in orthopaedic surgery: a prospective study of 214 clean operations

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Abstract We conducted a prospective cohort study in order to determine whether suction drain specimen cultures from orthopaedic surgery predicted an early wound infection. We included 218 consecutive clean orthopaedic operations requiring drains in one unit over a period of 1 year. The suction drain tip, drain fluid and wound discharge specimens were cultured, and the surgical wound was followed up for 3 months. There were six deep and two superficial wound infections. Wound infection was significantly related to positive suction tip culture but not to positive drain fluid culture. Following our methodology for culture, a positive drain tip culture predicts wound infection in 50% and a negative culture virtually excludes the possibility of a deep infection.

Résumé Nous avons conduit prospectivement une étude de cohorte pour déterminer si les cultures d'un échantillon du produit de drainage aspiratif peuvent être prédictives précocément d'une infection. Nous avons inclus 218 opérations orthopédiques propres consécutives, exigeant un drainage, sur une période d'une année. L'extrémité du drain, le liquide de drainage, et des prélèvements opératoires étaient mis en culture et la cicatrice chirurgicale surveillée pendant 3 mois. Il y avaient 2 infections superficielles et 6 pronfondes. L'infection était en rapport significatif avec la culture du drain mais sans rapport avec celle du liquide de drainage. En suivant notre méthodologie, une culture positive de l'extrémité du drain prédit l'infection de la blessure dans 50% et une culture négative exclut la possibilité d'une infection profonde.

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Introduction

Wound infection in orthopaedic surgery carries high morbidity and mortality. Most of these infections are thought to originate from bacterial wound contamination at the time of operation, the incidence of which has been reported to be as high as 58% [7]. The majority of these bacteria are removed by local wound defence mechanisms. Prophylactic antibiotics may also have a role in this bacterial clearance [10–12]. The presence of bacteria in the wound during the early hours following surgery may be due to their incomplete elimination and may be viewed as a high risk factor for subsequent wound infection [15]. Drain tubes that are kept in close proximity to the bone or implants may be the ideal "swabs" for early detection of these organisms. There is considerable debate over the use of suction drains in orthopaedic surgery. Many surgeons consider wound haematoma to be an ideal medium for bacterial colonisation and post-operative infection. In their views, suction drainage is the best method to get rid of any blood that may accumulate in surgery involving the medullary bone [18]. However, recent studies question the role of drains in uncomplicated orthopaedic operations, and some surgeons consider them unnecessary [1, 6, 8]. In spite of this controversy, drains are still widely used in orthopaedic surgery. The aim of this study was to determine whether culturing the suction drain tip or drain fluid in orthopaedic surgery could predict an early wound infection.

Patients and methods

All clean orthopaedic operations using suction drains performed in one orthopaedic unit in our hospital over a period of 1 year were included in this prospective study (Table 1). Those patients in whom removal of a plaster slab or cast or opening a window for disinfection of skin before drain removal was contraindicated were excluded. The prophylactic antibiotic used was intravenous cefotaxime given 1 h before skin incision and continued for two more doses 8 and 16 h post-operatively. This study was approved by the ethical committee of the institution, and additional expenses were met by the departments of orthopaedics and microbiology.

The decision to insert drains at surgery was based purely on the operating surgeon's anticipation of continued bleeding and wound haematoma formation. The perforated ends of the drain tubes were placed as close to the likely source of bleeding as possible or in direct contact with the implant. The tubes were brought out through separate skin puncture wounds made from within. A commercially available sterile compressible plastic container attached to the outer end of inter-connecting tube provided suction. The drains were removed by the junior residents in charge, who were blinded to avoid bias in exclusion and drain removal criteria, when the fluid drained in the preceding 24 h was less than 100 ml. The surrounding skin was disinfected with 10% aqueous povidone iodine solution before drain removal [16]. Five centimetres of the inner part of the tube(s) and 5 ml of the drain fluid, collected under full aseptic precautions, were transported in separate tubes containing Robertson cooked meat medium. The samples were incubated in our microbiology department. Here, the drain tips were rolled four times on blood agar and McConkey agar plates (the rollover technique) [2, 5]. These were incubated at 37°C aerobically and with 5% CO_2 anaerobically for 4 days and examined at 24, 36, 48, 72 and 96 h for growth. When present, bacteria were identified, and their in vitro antibiotic sensitivities were tested. A minimum of 20 colonies growing was considered significant [13]. Drain fluid samples and any discharge from the wound were also cultured in a similar manner. We used the criteria defined by Sorensen et al. for defining wound infection [15]. Infection occurring within 3 months of operation was defined as early wound infection. Subcutaneous infections were considered superficial infections. Infections around the bone or the implanted foreign materials were deep infections. The wounds were followed up for a minimum of 3 months.

We analysed the association between drain specimen culture positivity and the incidence of surgical-site infection. We also looked into the association between duration of drainage and wound infection and the role of low virulence bacteria and anaerobes in orthopaedic infections. Fischer's exact test was used for statistical analysis. Values of continuous variables are presented as means with standard deviation and categorical variables as counts and percentages.

Table 1 Type of operations

Type of operation	Number
Total hip replacement	20
Total knee replacement	21
Hemiarthroplasty of hip	24
Open reduction and fixation of lower extremity fractures	65
Open reduction and fixation of upper extremity fractures	49
Osteotomy lower extremity	5
Others	34
Total	218

Results

There were 218 operations in 218 patients out of which one patient died on the 6 post-operative day from myocardial infarction and two were lost to follow-up. In one patient, the drain tube came out in the post-operative recovery room and was therefore excluded from the study. This left us with 214 operations in 214 patients that included 124 women and 90 men aged between 18 and 88 years (inter-quartile range 43–59 years). None of the patients were excluded due to inability to remove the plaster or open a window safely for skin disinfection at the time of drain removal. Two drain tubes were used in 118 cases and one in 96 cases. Overall, the drains were removed at 24 h in 68 cases and at 48 h in 146 cases.

Suction tip cultures were positive in 12 cases, and drain fluid cultures were positive in seven cases. Both were never positive simultaneously. There were six deep and two superficial wound infections. Six out of the 12 tip culture-positive wounds developed deep wound infection. In each of these six infections, culture from the wound and suction tip yielded growth of the same bacterial species with similar antibiotic sensitivity. Suction tip cultures had sensitivity of 75%, specificity of 97%, positive predictive value of 50% and negative predictive value of 99% in detecting a wound infection. The association between the incidence of suction tip culture positivity and the incidence of wound infection was statistically significant (Table 2). One out of the seven drain fluid culture-positive wounds developed a superficial wound infection. Another superficial infection occurred with sterile suction drain cultures. No deep infection occurred when the drain fluid cultures were positive. Drain fluid cultures had a sensitivity of 12.5%, specificity of 97%, positive predictive value of 14% and negative predictive value of 96.6% in detecting a wound infection. The association between the incidence of drain fluid culture positivity and the incidence of wound infection was not statistically significant (Table 3).

Wound infection was frequent when more virulent bacteria were isolated from the drain tips (Table 4). This difference in infectivity with the virulence of the organism was statistically significant. Anaerobic organisms were never cultured from the drain samples or wound swabs.

Table 2 The relation between suction drain tip culture and wound infection

Suction tip culture	Number of wounds infected	Number of wounds not infected
Positive	6	6
Negative	2	200
Total	8	206

Table 3 The relation between cultures of drain fluid specimens and wound infection

Drain fluid culture	Number of wounds infected	Number of wounds not infected
Positive	1	6
Negative	7	200
Total	8	206

In deep wound infections, two drains were kept for 24 h and four for 48 h. Both drains in the superficial wound infection group were removed at 24 h. No drains were kept for more than 48 h. There was no significant correlation between wound infection and the duration of drainage.

In both the superficial infections caused by *Staphylococcus aureus*, the surgical wound healed by systemic antibiotics alone. In all the six deep infections, surgical debridement was needed along with antibiotics for 48–85 days (inter-quartile range 58.9 days). Four of these healed well by secondary intention, and in each of the other two, a discharging sinus persisted. All the remaining 206 wounds healed well by primary intention with no evidence of infection at 3 months follow-up.

Discussion

No definite conclusion can be derived from available literature to date whether to culture suction drain tips in orthopaedic surgery or not, and to our knowledge, no institution does this even in high-risk operations. Ours was a prospective cohort study with a sufficiently large number of patients, and we followed up the patients for 3 months. We cultured suction tips and drain fluid samples separately and determined the significance of each. We found 50% positive predictive value and more than 99% negative predictive value for suction tip culture in predicting a future wound infection. Interestingly, in all the deep infections suction tip cultures were positive. Drain fluid culture was of no value in predicting wound infection.

Suction tip culture has been done before with contrasting results. Studies by Girvent et al., Willemen et al. and Overgaard et al. who analysed 72, 41 and 81 orthopaedic operations, respectively, found no relation between positive tip culture and wound infection [9, 14, 17]. But Sorensen et al. analysing 489 cases found a positive correlation between the two [15]. Lindgren et al. also reported similar results [12]. Even in these studies where we found a positive correlation, the strength of association between culture and infection was not sufficiently high to recommend its routine usage. The significant association between suction tip culture and wound infection we found in this study is perhaps due to the major differences in methodology. First, our criterion for drain removal was drainage less than 100 ml in 24 h, since we felt that at a rate below this the probable risk of wound infection due to bacterial migration along the drain with time outweighed the risk of developing a wound haematoma [17]. These migrating bacteria, the numbers of which are bound to increase with longer duration of drainage, might give false-positive suction tip cultures before they actually infect the wound [7, 17]. Following the above-mentioned criterion, we could remove all the drains within 48 h. Second, we disinfected the skin surrounding the drain before removing it. These two modifications might have excluded the "contaminating" bacteria found in previous studies [9, 14, 17]. Third, we kept the drain tube clamped throughout its removal thereby including the fluid column inside the drain tip, termed "the deep aspirate" by Willett et al., in all the culture specimens [18]. This might have increased the yield of bacteria from culture significantly.

As in our study, Sorensen et al., Bernard et al. and Berthelot et al. analysing 489, 880 and 723 clean orthopaedic operations, respectively, found no significant correlation between drain fluid culture positivity and wound infection [3, 4, 15]. This may be due to high concentrations of the prophylactic antibiotic in the

Table 4 Bacteria isolated in drain specimens and wound infections

Isolated bacteria	Number of positive cultures		Number of infections	
	Suction tip	Drain fluid	Superficial	Deep
Staphylococcus aureus	5	2	2	4
Pseudomonas aeruginosa	2	1	0	1
Klebsiella pneumoniae	2	0	0	1
Acinetobacter anitratus	2	1	0	0
Coagulase-negative staphylococci	1	3	0	0
Total	12	7	2	6

container fluid inhibiting bacterial growth. Contamination of the fluid by bacteria resistant to this antibiotic, when the suction container is opened to re-apply negative pressure, may explain its low positive predictive value. The correlation between infection and duration of suction drainage is uncertain. Willemen et al. found increased wound infection that parallels the duration of drainage [17]. It is not clear whether this is due to wound infection caused by bacterial migration or primarily infected wounds draining longer. Zamora et al. and Overgaard et al. found no correlation between the two [14, 19]. In our study, infected wounds did not drain longer, but we are unable to draw a definite conclusion on the association between the two. There are concerns that with the use of large implants, less virulent bacteria may also be important in orthopaedic wound infections [12]. In our study, low virulence bacteria isolated were mere contaminants. Sorensen et al. and Bernard et al. also reported similar observations [3, 15]. Anaerobic organisms were not isolated in our study, probably due to lack of strict anaerobic conditions in orthopaedic wounds.

We understand that our study has limitations. We have not analysed how much earlier suction tip cultures can predict a wound infection and whether earlier institution of treatment will actually improve the outcome in infected orthopaedic surgery. Also, we followed up the wounds for only 3 months when orthopaedic infections can occur later, but these, being late infections, were beyond the scope of this study. We also understand that routine culture of all suction drain tips is expensive and hence may not be cost effective [3]. However, 50% positive predictive value and 99% negative predictive value of suction tip culture in detecting wound infections found in our study may be utilised in operations with increased risk for wound infection. This includes those patients with diabetes mellitus or rheumatoid arthritis, those who are on steroids or other immunosuppressants and those who undergo revision operations. In these patients, we recommend early drain removal using the above mentioned criteria, disinfection of the skin and culture of suction drain tips that contain the deep aspirate. A negative culture report virtually rules out the possibility of infection while a positive report will enable the treating team to keep a close watch on the wound behaviour and intervene earlier, if necessary. Further studies are required to determine whether culture of drain tips can predict late infections and to analyse the benefits of early intervention in infected surgery.

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