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Association between suction tip culture and surgical site infection in elective clean orthopedic lower limb surgeries

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ABSTRACT

Background: Surgical site infections (SSIs) can be caused by various factors, including contamination of the surgical field. Perioperative cultures can be employed in clean orthopedic procedures to detect bacterial contamination that may occur during surgery. **Aims and Objectives:** The study aimed to evaluate the correlation between suction tip cultures and surgical wounds in clean orthopedic surgeries. **Materials and Methods:** A cross-sectional study was conducted at Yenepoya Medical College Hospital, Mangalore, Karnataka, with 250 patients in whom drain tips were sent for culture and followed up for 3 months to assess for SSI. Skin commensals from the nasal and groin samples were analyzed for the presence of bacteria. **Results:** A total of 250 patients meeting the inclusion and exclusion criteria were included. Thirty patients were positive for drain tip culture, and 12 (4.8%) patients had SSI during the 3rd month follow-up period, showing a statistically significant relationship between drain tip culture and SSIs (P=0.001). Skin commensals constituted 67% (nasal) and 100% in the groin of perioperative contaminants, accounting for 4.8% of SSIs. **Conclusion:** Suction drain tip culture and skin commensal analysis may be good predictors of SSIs. Intraoperative surgical site contaminants can be identified using perioperative cultures. Timely administration of suitable antibiotics and local wound care for perioperative contamination can help minimize the incidence of SSI.

Key words: Surgical site infection; Drain tip; Culture; Commensal

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INTRODUCTION

Surgical site infections (SSIs) are clinically and epidemiologically critical in orthopedic surgery, as they lead to several complications that affect the quality of life of patients.[1] In orthopedics, infections necessitate extensive treatment as they involve multiple interventions, such as implant removal, antibiotic therapy, and hospitalization, which can last for an extended period. Various factors can complicate these procedures, potentially resulting in elevated morbidity and mortality rates.[1] Multiple studies have highlighted the importance of hygiene in the operating room by demonstrating the colonization of surgical tools and airborne particles and their association with SSIs.[2] A commonly utilized tool in numerous orthopedic surgeries during the post-operative phase is the closed suction drain.[3] The primary objective was to prevent hematoma formation, thereby facilitating uncomplicated wound healing. The process of surgical wound lavage, typically performed before wound closure, is thought to lower the quantity of bacterial load present at the surgical site. This is achieved by ridding the area of dead or injured tissue, metabolic waste, and wound exudate, which can serve as breeding ground for microorganisms, ultimately reducing the risk of SSI.[4] Even though surgical wound lavage is a common practice in most orthopedic surgeries; specific guidelines regarding its optimal timing have not been established. Utilizing lavage fluid culture enables the effective identification of intraoperative contamination.[5] Most of these infections are thought to be of bacterial origin, which may originate from

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contamination at the time of operation, by the endogenous flora[6] present in the nasal mucosa and skin, or from external sources, most commonly mobile phones, as they are indispensable devices that are not often cleaned properly and colonized bacteria may be transmitted to the patient.

Similar to other surgical instruments, suction tips are prone to colonization. It has been proposed that a favorable drain tip culture could aid in the prediction of SSI, while a negative culture would practically eliminate the likelihood of SSI.[7] Identifying intraoperative bacterial contamination indirectly might be feasible using surgical wound lavage fluid and post-operative drain tip cultures as substitutes. Indeed, numerous studies have observed an association between the presence of surgical drainage and SSI, as well as between the duration of drainage and the incidence of SSI.[8] The risk of infecting surgical wounds with pathogenic microorganisms during surgery can arise from contamination of the suction tip, which may lead to late infections during clean surgical procedures.[9] Several investigations into the application of suction drainage following orthopedic surgery have produced findings regarding the outcomes of suction drain tip culture; however, the correlation between a positive tip culture and the occurrence of SSIs remains a topic of debate.[10] With this background, this study hypothesized and evaluated the association between body (skin and nasal) commensals acting as external sources of infection and drain tip cultures, which could lead to subsequent SSIs in clean orthopedic surgeries. By conducting perioperative cultures, it is possible to identify early-stage surgical site contamination and initiate appropriate antimicrobial therapy.

Aims and objectives

To evaluate the correlation between suction tip cultures and surgical wounds in clean orthopaedic surgeries.

MATERIALS AND METHODS

This cross-sectional study was conducted at Yenepoya Medical College Hospital, Derelakatte, Mangalore, Karnataka, India. Samples were collected from October 2020 to April 2021 after ethical committee clearance. Any clean orthopedic lower limb surgeries of patients with a drain *in situ* were included in the study, and patient co-morbidities were recorded. Patients diagnosed with infectious diseases, immune-compromised patients, metabolic and genetic disorders, and those who underwent previous surgery at the same site were excluded from the study. Before the procedure, nasal and groin cultures were recorded to determine the endogenous bacterial fauna in the patient. Following surgery, the criteria for drain removal were as follows: (1) collection <50 mL; (2) serous; (3) drain not working; and (4) in cases of extensive soft tissue dissection, drain retention for 72 h if found to be working. The drain tip was collected under strict aseptic conditions and sent for culture and sensitivity measurement. A report of the culture was recorded, the patient was followed up, and a wound inspection was performed on the day of discharge and after 3 months to clinically assess for any infection. Statistical Package for the Social Sciences (SPSS), version 20 software (IBM SPSS Statistics, IBM Corp., Armonk, NY, USA, released 2011) was used for statistical analysis. Data were entered into an Excel spreadsheet. Descriptive statistics of the explanatory and outcome variables were calculated using means and standard deviations for quantitative variables and frequencies and proportions for qualitative variables. Yate's Chi-square test was used to test the correlation between drain tip culture and SSI.

Statistical analysis

SPSS version 20. Software (IBM SPSS Statistics, IBM Corp., Armonk, NY, USA, released 2011) was used for statistical analysis. Data were entered into an Excel spreadsheet. Descriptive statistics of the explanatory and outcome variables were calculated using means and standard deviations for quantitative variables and frequencies and proportions for qualitative variables. Yate's Chi-square test was used to test the correlation between drain tip culture and SSI.

Ethical considerations

The study was conducted in accordance with the Declaration of Helsinki and approved by the Ethical Committee at Yenepoya Medical College, Yenepoya University, Mangalore, Karnataka (YEC2/652).

RESULTS

This cross-sectional study included 250 consecutive patients (112 males and 138 females) who underwent clean orthopedic lower limb surgeries. The mean age of the patients at surgeries was 56.21±13.757 years, with 140 (56%) patients who underwent right-sided surgery, and 110 (44%) who underwent left-sided surgeries. The most prevalent comorbidity associated with these patients was hypertension in 30 patients (12%), followed by diabetes in 24 patients (9.6%). Approximately, 118 (47.2%) patients underwent total knee replacement, 62 (24.8%) underwent hemiarthroplasty, 50 (20%) underwent a total hip replacement, and 20 (8%) underwent plating. The duration of surgery was 2 h in 236 (94.4%) patients, 3 h in 12 (4.8%) patients, and 1 h in 2 (0.8%) patients. Intraoperative antibiotics were repeated in 198 (79.2%) patients. Among 250 (100%) patients who underwent orthopedic surgery, 14 (5.6%) had SSI, and 4 (1.6%) died during surgical site suture removal. A total of 6 (2.4%) patients died during the follow-up phase in the 3rd month, 2 due to infection and 1 due to systemic complications. Drain tips were sent for culture approximately 24/48/72 h following surgery and were routinely sent for culture, while these patients were screened for organisms from the nose and groin preoperatively (Table 1).

Among the 250 patients, 30 showed positive results for drain tip culture, with the most common organisms cultivated being Methicillin-resistant *Staphylococcus aureus* (MRSA), *Acinetobacter baumannii*, and *Burkholderia cepacia* in 6 (2.4%) patients each, respectively; Micrococci in 2 (0.8%); *Escherichia coli* in 4 (1.6%), *Klebsiella* species in 2 (0.8%); *Pseudomonas aeruginosa* in 2 (0.8%); and *Staphylococcus epidermidis* in 2 (0.8%) patients. Among the 250 patients, 134 were positive for organisms in the nasal culture and 118 were positive for organisms in the groin culture, with MRSA being the most common organism in both cultures (Table 2).

Among the 250 patients, 14 (46.7%) had growth at the clean site, and 16 (53.3%) had growth at the infected surgical site, suggesting SSI at the time of suture removal. Eighteen (60%) patients had growth at the clean site, and 12 (40%) patients had growth at the infected surgical site at the 3-month follow-up. This study observed features suggestive of a progressive risk of SSI, with prolongation of the drain tip being maintained *in situ* at the surgical site (P=0.005). At the 3-month follow-up, MRSA was detected in nasal cultures from all clean surgical sites (12/40%), dead patients (4/13.3%), and infected surgical sites (22/73.3%). There was only one clean surgical site in which *Pseudomonas* sp. was found. *Acinetobacter* was detected in all clean (4/13.3%), dead (4/13.3%), and infected surgery sites (2/6.7%) in the groin culture after 3 months. The only surgical location of infection (2/6.7%) had MRSA (Table 3).

Table 1: Characteristics of the patients and bacteria isolated in the drain tip and at the surgical site (n=250)

Variables	No (%)
Sex of the patients	
Male	112 (44.8)
Female	138 (55.2)
Side operated	
Left	110 (44)
Right	140 (56)
Associated Co-morbidities	
Asthma	6 (2.4)
CKD	6 (2.4)
Diabetes	24 (9.6)
Hypertension	30 (12.0)
Hypothyroidism	4 (1.6)
Parkinsonism	4 (1.6)
Nil	176 (70.4)
Surgeries done	
Hemiarthroplasty	62 (24.8)
Plating	20 (8.0)
Total hip replacement	50 (20.0)
Total knee replacement	118 (47.2)
Duration of surgery (hours)	
1	2 (0.8)
2	236 (94.4)
3	12 (4.8)
Intraoperative antibiotics repeated	
No	198 (79.2)
Yes	52 (20.8)
Drain tip removal time (hours)	
24	20 (8.0)
48	196 (78.4)
72	34 (13.6)
Drain tip culture	
Growth	30 (12)
No Growth	220 (88)
Surgical site suture removal	
Clean	232 (92.8)
Infection	14 (5.6)
Death	4 (1.6)
Surgical site 3rd month	
Clean	232 (92.8)
Infection	12 (4.8)
Death	6 (2.4)

CKD: Chronic kidney disease

DISCUSSION

The utilization of a post-operative suction drain tip can be regarded as an indicator of intraoperative contamination, given that it offers a direct sample from the surgical site itself. The role of host defense is pivotal in determining whether intraoperative contamination will progress to clinical infection, with the initial hours being particularly crucial.[11] This was a cross-sectional study with a sufficiently large cohort of patients who were monitored for 3 months. We cultured the suction-drain tip samples and determined their significance. We firmly believe that our approach of acquiring three distinct samples, at least 24, 48, and 72 h apart, during the drain tip removal process adequately accounted for this critical aspect. It is generally believed that surgical wounds are prone to some degree of contamination,[11] and studies have reported contamination rates ranging from 23% to 63%,[12] which was 12% (30/250) in our study. This finding is similar to that reported by Santoshi et al., where contamination of surgical wounds was observed in 10.1% (39/384) of the study population.[13]

The comparatively low intraoperative contamination rate noted in the current study could be attributed to the utilization of surgical wound lavage. This technique has been demonstrated to effectively flush away contaminants and reduce the inoculum size by diluting it. We hypothesize that variations in sampling techniques could also contribute to the observed differences. In our study, the SSI rate observed was 4.8%, which was deemed high for clean

Table 2: Types of bacteria isolated from the nasal and groin site

Commensal	Drain tip (No. %)	Nasal (No. %)	Groin (No. %)
No growth	220 (88)	116 (46.4)	-
MRSA	6 (2.4)	90 (36.0)	32 (12.8)
Pseudomonas sp.	-	22 (8.8)	-
Pseudomonas aeruginosa	2 (0.8)	-	-
Staphylococcus aureus	-	22 (8.8)	-
Acinetobacter	-	-	24 (9.6)
Normal flora	-	-	132 (52.8)
Propionibacterium	-	-	20 (8.0)
Staphylococcus epidermidis	2 (0.8)	-	14 (5.6)
Staphylococcus hominis	-	-	28 (11.2)
Klebsiella species	2 (0.8)	-	-
Escherichia coli	4 (1.6)	-	-
Contaminants grown Micrococci	2 (0.8)	-	-
Burkholderia cepacia	6 (2.4)	-	-
Acinetobacter baumannii	6 (2.4)	-	-

MRSA: Methicillin-resistant *Staphylococcus aureus*

Table 3: Bacterial growth at the surgical site at suture removal, after 3-month follow-up, at the time of drain removal, and at the surgical site after 3-month follow-up in nasal and groin culture

Surgical site at suture removal	Growth (%)	No growth (%)	Total (%)	P-value
Clean	14 (46.7)	218 (99.1)	232 (92.8)	0.001*
Infected	16 (53.3)	2 (0.9)	18 (7.2)	
Total	30 (100)	220 (100)	250 (100)	
Surgical site after 3 months				
Clean	18 (60.0)	214 (97.3)	232 (92.8)	0.001*
Infected	12 (40)	6 (2.7)	18 (7.2)	
Total	30 (100)	220 (100)	250 (100)	
Time of drain removal				
24	2 (6.7)	18 (8.2)	20 (8.0)	0.05*
48	18 (60.0)	178 (80.9)	196 (78.4)	
72	10 (33.3)	24 (10.9)	34 (13.6)	
Total	30 (100)	220 (100)	250 (100)	

Nasal culture	Surgical site after 3 months			
	Clean	Death	Infection	Total
MRSA	12 (40.0)	4 (13.3)	6 (20.0)	22 (73.3)
No growth	2 (6.7)	0 (0.0)	2 (6.7)	4 (13.3)
Pseudomonas sp	4 (13.3)	0 (0.0)	0 (0.0)	4 (13.3)
Total	18 (60.0)	4 (13.3)	6 (26.7)	30 (100)

Groin culture	Surgical site after 3 months			
	Clean	Death	Infection	Total
Acinetobacter	4 (13.3)	4 (13.3)	2 (6.7)	10 (33.3)
Methicillin resistant *Staphylococcus aureus*	0 (0.0)	0 (0.0)	2 (6.7)	2 (6.7)
Normal flora	12 (40.0)	0 (0.0)	2 (6.7)	14 (46.7)
Propionibacterium	0 (0.0)	0 (0.0)	2 (6.7)	2 (6.7)
Staphylococcus hominis	2 (6.7)	0 (0.0)	0 (0.0)	2 (6.7)
Total	18 (60.0)	4 (13.3)	8 (26.7)	30 (100)

MRSA: Methicillin-resistant *Staphylococcus aureus*

orthopedic procedures. Reported SSI rates for such surgeries in developed countries range from 1% to 6.2%. In contrast, developing countries have reported SSI rates of up to 15%.[14] According to Santoshi et al., the incidence of SSIs in the lower extremities was 16% (37 out of 231), accounting for 82% of all SSI cases. 13 This trend of a higher rate of SSI in the lower extremities has also been observed in other studies as well.[15]

Skin preparation is an important consideration, as skin commensals account for 67% of intraoperative contaminants in the nasal region and 100% in the groin area, accounting for 4.8% of SSIs. This may also indicate inadequate cleaning as well as sanitization protocols in the operating room, as bacterial loads on the surface of the operating table or equipment used during surgery can lead to cross-contamination and SSIs. The microorganisms responsible for SSI in this study were similar to those previously reported.[13,16-18] Al-Mulhim et al.,[16] Rajkumari et al.,[17] and Maksimović et al.,[18] have provided reports on the incidence of SSIs in orthopedic practice, covering both closed and open cases. In contrast, Lee and Ahn[12] focused specifically on SSIs occurring in clean orthopedic cases. *S. epidermidis* is the most prevalent bacterium among coagulase-negative staphylococci, frequently found on human skin and mucous membranes.[19] *S. epidermidis* has emerged as a prominent causative agent of SSIs following orthopedic implant surgeries.[20] A recent study indicated that 42.8% of SSIs were related to MRSA.[20] Drain tip culture is effective in identifying early SSI caused by methicillin-resistant bacteria.[21] Our study demonstrated that MRSA was the prevalent pathogen, accounting for 2.4% of drain tip cultures, 36% of nasal cultures, and 12.8% of groins. When MRSA is detected in the drain tip culture, it is essential to consider the possibility of SSI and closely monitor the wound's behavior, including initiating prompt intervention if necessary. Although surgical site contamination is a common occurrence, the precise timing of infection remains unclear.

In our study, we found that 30 suction drain tip cultures tested positive for bacteria. Suction tip culture has previously been performed, with contrasting results. Studies conducted by Girvent et al., Willemen et al., and Overgaard et al., revealed no association between positive tip culture and wound infection in 72, 41, and 81 orthopedic surgeries.[19-21] However, Sørensen and Sørensen analyzed 489 cases and found a positive association between the two.[22] Lindgren et al., reported similar results.[23] Even in these studies, in which we found a positive correlation, the strength of the association between culture and infection was not sufficiently high. However, there has been no attempt to be made in the literature to find associations between body commensals and nasal organisms with respect to drain tip culture and SSI; this study is the first.

The patients (20%) who developed an infection following clean orthopedic surgery had MRSA isolated from nasal culture after 3 months of follow-up. *Pseudomonas* sp. was absent at the infection site, although it was present in the nasal culture following clean surgery. This coagulase-negative *Propionibacterium* species did not have a post-operative infection. Coagulase-negative staphylococci and *Propionibacterium* have frequently been associated with late-infected prostheses. However, none of our patients following clean surgery and an intraoperative wound culture positive for this organism showed any evidence of infection after 3 months of follow-up. In addition, six (20%) patients who developed an infection after a positive intraoperative culture did so with a different organism. *Acinetobacter*, MRSA, and *Propionibacterium* were present in 2 (6.7%) patients at the surgical site after 3 months of follow-up, even though MRSA was absent in the groin culture followed by clean surgery. The absence of bacterial growth does not necessarily indicate that the surgical field is sterile.

A sterile surgical field could explain the development of post-operative infection in 8 patients; however, two patients developed a post-operative infection with *Propionibacterium,* which was absent in the groin culture operating room, and we do not have a satisfactory explanation for this. Studies have evaluated the use of intraoperative deep wound cultures, cultures of wound suction drainage, or both for predicting infection following clean orthopedic surgery. Half of the studies reported that the results of such cultures could predict infection. In a recent study, we found that a positive suction drainage culture did not predict post-operative infection in clean orthopedic surgery but was highly predictive of persistent sepsis in septic orthopedic surgery.[24] Patients found to have positive SSIs, especially MRSA and *S. aureus*, showed positive cultures with the same organisms in nasal and groin bacterial isolates, indicating a clinical correlation. It is known that the longer the drain tip is kept at the surgical site, the greater the chances of SSIs, which was statistically proven in this study.

The significant association between suction tip culture and SSI found in this study may be due to the longer drain tip removal times (24, 48, and 72 h). The presence of migrating bacteria, whose numbers are likely to rise with prolonged drainage duration, could substantially increase the yield of bacteria from the culture. According to Sørensen and Sørensen,[22] early removal of the drain can decrease the risk of retrograde migration of bacteria from the skin and reduce the frequency of positive drain tip cultures. Moreover, if the drainage time exceeded 6 days, the risk of infection significantly increased. Prolonged drain placement can lead to a higher probability of bacterial contamination compared to a shorter duration. According to Kobayashi et al.,[25] the positivity rate was 33% for drains removed on day 5, which was higher than that on earlier days. Nevertheless, Lee and Ahn[12] failed to establish a significant association between wound infections and drainage duration.

This study included patients with comorbidities, and we recommend early drain removal, disinfection of the skin, and culture of suction drain tips that contain deep aspirates. We propose that leaving a drain in place for an extended period is not advisable for wound infections. Our research uncovered a substantial connection between the outcomes of drain tip culture and the drainage duration, as well as between SSI incidence and the drainage duration.

Limitations of the study

We did not examine the extent to which suction tip cultures can predict a wound infection in advance, nor did we investigate whether initiating treatment earlier would enhance the outcome of infected orthopedic surgery. Furthermore, we only monitored the wounds for a period of 3 months, even though orthopedic infections could potentially occur at a later stage. However, late infections were beyond the scope of the present study.

CONCLUSION

Our research findings indicate that intraoperative contamination, the use of suction drain tips, and the presence of commensal skin can contribute to the development of SSI. The employment of perioperative cultures during clean orthopedic operations proved effective in identifying intraoperative surgical site contamination, which, although prevalent, demonstrated a correlation with the emergence of SSI. Our findings imply that the analysis of suction drain tip culture can be a reliable indicator of SSI. A negative culture report virtually eliminates the possibility of infection, whereas a positive report enables the surgical team to closely monitor wound behavior and intervene earlier if needed. Timely administration of appropriate antibiotics and local wound care for perioperative contamination can effectively reduce the incidence of SSIs.

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AZ, JP, and **NH**- Contributed to the design and implementation of the research, to the analysis of the results, and to the writing of the manuscript.

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