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Suction Drain Tip Cultures in Predicting a Surgical Site Infection

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Study Design: Retrospective study.

Purpose: This study aimed to evaluate the prognostic value of drain tip culture after spinal surgery with a large number of participants.

Overview of Literature: The routine culture of suction drain tips that are placed in the surgical site of spinal surgeries has been performed in many institutions to detect surgical site infection (SSI). However, few reports have evaluated drain tip culture as a prognostic for SSI after spinal surgery.

Materials and Methods: This study retrospectively included 1,415 consecutive patients who underwent spinal surgery between January 2016 and December 2021. Patients diagnosed with infectious diseases were excluded. Prophylactic antibiotics were administered intraoperatively and 24 hours postoperatively. Drains were removed when the volume of postoperative fluid drainage was <50 mL and <100 mL in patients who underwent cervical and thoracic surgery and lumbar surgery in the preceding 24 hours, respectively, and cultures were made. We evaluated the correlation between the results of positive drain tip culture and SSI.

Results: Positive drain tip cultures were found in 51 cases (3.6%). SSI was identified in 34 cases (2.4%). The most frequently isolated microorganism was methicillin-resistant *Staphylococcus epidermidis* (61.8%). The sensitivity, specificity, and positive, and negative predictive values of drain tip culture were 50.0%, 97.4%, 32.1%, and 98.8%, respectively. The same bacteria were isolated from the surgical lesion in 16 of 17 SSI cases with a positive drain tip culture, thereby giving a bacteria matching rate between tissue culture and drain tip culture of 94.1%. The number of surgery levels, drain remaining period, and drain tip culture positivity were significantly increased in the SSI group.

Conclusions: Drain tip cultures might be useful for predicting SSI. Drain tip culture had a high positivity rate in the SSI group, and the coincidence rate for the causative pathogen was high.

Keywords: Spine; Surgical wound infection; Drain tip culture

Introduction

Surgical drains, including closed suctions devices, are used in spinal surgeries in many institutions. Suction drainage can reduce hematoma formation, thereby minimizing the risk of postoperative neurological deficits from spinal neural tissue compression [1]. Additionally, drainage decreases the likelihood of prolonged discharge from the wound. Suction drainage can reduce infection rates, resulting in a more benign and uncomplicated postopera-

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tive course because wound hematoma is an ideal medium for bacterial colonization and postoperative surgical site infection (SSI) [2,3]. However, the use of closed suction drainage after spinal surgery remains controversial. Increasingly more randomized controlled studies indicate that closed suction drainage does not reduce the incidence of wound complications [4-7].

SSIs remain major surgical complications [8]. SSI after spinal surgery is a devastating complication that is often difficult to treat, with high associated morbidity, and mortality, thereby incurring a substantial cost to the healthcare system [9,10]. Drain tubes that are kept near the bone or implants may be the ideal "swabs" to promptly detect infection. Suction drainage at the spinal surgical site is an established principle of management for preventing infection, and wound drain culture has been used as an early detection method for SSI [11].

Numerous studies on the postoperative use of suction drainage have reported the results of suction drain tip culture after orthopedic surgery, but the relationship between a positive tip culture and SSI remains controversial [12-16]. However, few reports have evaluated whether drain tip culture is prognostic for SSI after spinal surgery [15-17].

This study retrospectively evaluated the prognostic value of drain tip culture after spinal surgery with a large number of participants.

Table 1. Characteristics of the patients (N=1,415)

Characteristic	Value
Age (yr)	64.9±12.6
Gender	
Male	693 (49.0)
Female	722 (51.0)
Location of operation	
Cervical spine	212 (15.0)
Thoracic spine	104 (7.3)
Lumbosacral spine	1,099 (77.7)
Pathology	
Degeneration	1,213 (85.7)
Trauma	158 (11.2)
Neoplasm	44 (3.1)
Approach	
Anterior	115 (8.1)
Posterior	1,287 (91.0)
Anterior/posterior	13 (0.9)
Surgery level	
1	769 (54.3)
2	407 (28.8)
≥3	239 (16.9)

Values are presented as mean±standard deviation or number (%).

Materials and Methods

This retrospective observational study included 1,415 consecutive patients (693 males, 722 females) who underwent spinal surgery at Gangneung Asan Hospital between January 2016 and December 2021. Patients with an infectious disease, such as discitis, were excluded. The mean age at surgery was 64.9 years, and 212 patients underwent cervical surgery, 1,099 underwent lumbosacral surgery, and 104 underwent thoracic surgery (Table 1).

All surgeries were performed under the same aseptic conditions using povidone-iodine for skin disinfection. Additionally, double gloving, and antimicrobial film were used. Prophylactic antibiotics were administered until 24 hours postoperatively. Patients received ceftezol at 1 g intravenously for 30 minutes before the skin incision, every 4 hours intraoperatively, and 12 hours postoperatively. A drain was placed below the deep fascia near the exposed dura before wound closure after surgery. The drain was removed when the amount of fluid that drained from the operative site was <50 mL and <100 mL in patients who underwent cervical and thoracic surgery and lumbar surgery, respectively. The surrounding skin was disinfected with 0.5% chlorhexidine gluconate solution before removal. The inner drain tip was cut approximately 2 cm from its far end with sterile scissors, and it was sent to the microbiological laboratory for cultural analysis.

SSIs were defined according to the criteria of the Centers for Disease Control and Prevention [18]. Any signs of infection, such as wound discharge, or dehiscence, fever, chills, or chronic pain, were recorded. Additionally, the culture outcome, and bacteria identification were recorded in all patients. Wounds were followed up for a minimum of 6 months. The study was approved by the institutional review board of Gangneung Asan Hospital (IRB GNAH, 2022-10-014). The requirement for informed consent from individual patients was omitted because of the retrospective design of this study.

Statistical analysis was performed using the SPSS ver. 12.0 (SPSS Inc., Chicago, IL, USA). Fisher's exact test and the chi-square test were used for categorical variables. An independent *t*-test was used for normally distributed data and the Mann-Whitney *U* test for non-normally distributed data for continuous variables. A *p*-value of <0.05 was considered statistically significant.

Results

SSIs were identified in 34 (2.4%) of 1,415 patients. Bacteria were isolated from the surgical site in 33 cases (97%). Bacteria were isolated by surgery in 23 cases, wound swap culture in six cases, and blood in four cases. Table 2 shows the characteristics of the bacterial isolates in the SSI group. The most frequently isolated bacteria were methicillin-resistant *Staphylococcus epidermidis* (MRSE) (61.8%). Of 34 SSIs, five and 29 were superficial and deep, respectively. There were 24 acute SSIs (within 3 weeks) and 10 chronic SSIs (range, 4–240 days; mean, 27 days). Acute and chronic SSI had no significant correlation with drain tip culture results (p=0.49).

Table 2. Types of bacteria isolated from the surgical site

Bacteria	No. of cases of bacterial isolates at surgical sites
Methicillin-resistant *Staphylococcus epidermidis*	21
Methicillin-sensitive *Staphylococcus aureus*	5
Coagulase-negative *Staphylococci*[a]	2
Methicillin-resistant *Staphylococcus aureus*	2
Enterococcus	2
Corynebacterium	1
Unkown	1
Total	34

[a]Except *Staphylococcus epidermidis*.

Positive drain tip cultures were found in 133 cases (9.4%). The most frequently isolated microorganism was MRSE (28 cases, 21.1%). No additional therapy was performed in any cases with a positive drain culture with no other signs of SSI. The sensitivity, specificity, and positive, and negative predictive values of drain tip culture were 58.8%, 91.8%, 15.0%, and 98.9%, respectively (Table 3).

Positive drain tip cultures were found in 51 cases (3.6%) if a minimum of 20 growth colonies was considered significant to reduce the contamination effect [19]. The most frequently isolated microorganism was MRSE (28 cases, 54.9%). The sensitivity, specificity, and positive, and negative predictive values of drain tip culture were 50.0%, 97.4%, 32.1%, and 98.8%, respectively (Table 4).

Table 5 shows the demographic characteristics of patients in the SSI group (SSI [+]) and non-SSI group (SSI [−]). Age, sex, surgical site, operative approach, pathology, and use of surgical instrumentation were not significantly different between the two groups. The number of surgery levels, drain removal period, and drain tip culture positivity were significantly increased in the SSI (+) group than in the SSI (−) group.

Table 6 shows the associations among the drain removal period, drain tip culture positivity, and occurrence of SSI. The frequency of positive drain cultures increased with a longer drain removal period (p=0.001). Additionally, the frequency of SSI increased with a longer drain removal period (p=0.01)

Table 7 shows the microorganisms that were cultured from the drain tips and their relationship with SSIs. Drain tip cultures (over 20 colonies) were positive in 16 cases in the SSI (+) group. The same bacteria were isolated from

Table 3. Relationship between SSI and drain tip culture

	SSI (+)	SSI (-)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Drain tip culture (+)	20	113	58.8	91.8	15.0	98.9
Drain tip culture (-)	14	1,268				

SSI, surgical site infection; PPV, positive predictive value; NPV, negative predictive value.

Table 4. Relationship between SSI and drain tip culture (a minimum of 20 growth colonies)

	SSI (+)	SSI (-)	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
Drain tip culture (+)	17	34	50.0	97.4	32.1	98.8
Drain tip culture (-)	17	1,347				

SSI, surgical site infection; PPV, positive predictive value; NPV, negative predictive value.

the surgical lesion in 16 of 17 SSI cases with a positive drain tip culture, thereby giving a bacteria matching rate between tissue culture and drain tip culture of 94.1%.

Table 5. Demographic and operative characteristics of the SSI group and non-SSI group, and risk factors for SSI

Characteristic	SSI (+)	SSI (-)	*p*-value
No. of cases	34	1,381	
Age at surgery (yr)	61.3±17.0	64.9±12.5	0.2
Sex			0.16
Male	21	672	
Female	13	709	
Surgical site			0.84
Cervical	6	206	
Thoracic	3	101	
Lumbar	25	1,074	
Approach			0.18
Anterior	0	115	
Anterior/posterior	0	13	
Posterior	34	1,253	
Pathology			0.147
Trauma	4	154	
Degeneration	27	1,186	
Neoplasm	3	41	
Surgery levels	2.44±1.52	1.73±1.1	0.000
Instrumentation	28 (82.4)	1,004 (72.7)	0.21
Diabetes mellitus	7 (20.6)	343 (24.8)	0.69
Drain removal period (day)	4.29±1.6	3.44±1.1	0.004
Drain tip culture positive	20 (58.8)	113 (8.2)	0.000
Drain tip culture positive (over 20 colonies)	17 (50.0)	34 (2.5)	0.000

Values are presented as number, mean±standard deviation, or number (%).
SSI, surgical site infection.

Discussion

Several studies have investigated the relationship between drain tip culture and the occurrence of SSI, especially in joint surgery [11,14,20-23]. However, a few reports investigated the utility of drain tip culture in spinal surgery [15-17,24]. Yamada et al. [15] reported that drain tip cultures had a sensitivity of 0% for detecting bacteria in 1,240 spine cases using a sterile method. Kawabata et al. [16] reported that drain tip cultures had a sensitivity of 29.8% for detecting bacteria in 4,573 spine cases using a nonsterile method. Our study revealed a relatively high sensitivity of 50.0%. Furthermore, the concordance rate between bacteria from the drain culture and those from the tissue culture was 94.1%. This finding indicates that the cultures from the drain can provide helpful information for SSI treatment after spinal surgery if an SSI is present and the drain tip culture is positive, such as selecting an appropriate antimicrobial agent. The difference between our results and other studies may depend on the procedure used to remove the drain. Yamada et al. [15] reported a positive drain tip culture rate of 4.4% when using a sterile method with povidone-iodine solution and Kawabata et al. [16] reported a positive drain tip culture rate of 8.4% when using a nonsterile method, whereas our study reported a rate of 3.6% using a sterile method with chlorhexidine gluconate. This may be because a skilled physician assistant sterilizes the wound with chlorhexidine not to contact the drain before removal in our study.

The correlation between the duration of drainage and drain culture results or onset of SSI is unclear. Previously, Sørensen and Sørensen [11] reported that early drain removal decreases the risk of retrograde migration of bacteria from the skin, and the frequency of positive drain tip cultures and the risk of infection are substantially in-

Table 6. The association between drain removal period, positive drain tip culture, and SSI

Drain removal period	No. of cases	Positive tip culture	Positive tip culture (over 20 colonies)	SSIs
1 Day	14	0	0	0
2 Day	211	13 (6.2)	2 (0.9)	1 (0.5)
3 Day	526	39 (7.4)	14 (2.7)	9 (1.7)
4 Day	534	61 (11.4)	23 (4.3)	16 (3.0)
Over 5 day	130	20 (15.4)	12 (9.2)	8 (6.2)
Total	1,415	133 (9.4)	51 (3.6)	34 (2.4)

Values are presented as number or number (%).
SSI, surgical site infection.

Table 7. Bacterial isolates in drain tip and surgical site culture (a minimum of 20 growth colonies)

Bacteria	No. of cases of bacterial isolates in drain tip culture	SSI (-)	SSI(+)		
			Concordance	Discordance	Total
Methicillin-resistant *Staphylococcus epidermidis*	28	15	12	1	13
Coagulase-negative *Staphylococci*[a]	5	5	0	0	0
Enterococcus	5	4	1	0	1
Enterobacteriaceae	4	4	0	0	0
Methicillin-resistant *Staphylococcus aureus*	3	1	2	0	2
Corynebacterium	2	2	0	0	0
Methicillin-sensitive *Staphylococcus aureus*	1	0	1	0	1
Acinetobacter	1	1	0	0	0
Streptococcus	1	1	0	0	0
Lactobacillus	1	1	0	0	0
Total	51	34	16	1	17

SSI, surgical site infection.
[a]Except staphylococcus epidermidis.

creased if the drainage time is >6 days; thus, early removal of drains seems to be appropriate. A prolonged course of drain placement may result in a higher rate of bacterial contamination than a shorter duration [25,26]. Kobayashi [24] reported a positive rate for drains removed on day 5 at 33%, which was higher than that on earlier days. However, Ahn et al. [17] reported no significant correlation between wound infection and drainage duration. Our study revealed a significant association between drain tip culture positivity and drainage duration and between the rate of SSI and drainage duration. We suggest that long-term drain placement is undesirable in terms of wound infection.

Infections after spinal surgery are most commonly caused by Gram-positive organisms found on skin flora, most notably *Staphylococcus aureus*, and *S. epidermidis* [27]. *S. epidermidis* is the most prevalent bacterium among coagulase-negative staphylococci and is a common inhabitant of human skin and mucous membranes [28]. Recently, *S. epidermidis* has become a common cause of SSI after orthopedic implant surgery [29-32]. A recent study reported 42.8% of MRSE-related SSIs [32]. Drain tip culture is useful for early SSI detection caused by methicillin-resistant bacteria [24]. Our study revealed MRSE as the most common SSI pathogen (61.8%) and the most common microorganism in drain tip culture (54.9%). A possible SSI should be considered in a case with MRSE in the drain tip culture, and close monitoring of the wound behavior and early intervention is necessary in such cases. In Korea, the cost of drain tip culture is approximately 23 US dollars (USD) and the patient's copayment is approximately 6 USD. Performing a drain tip culture in all patients for early SSI diagnosis would be useful because of the low cost.

This study has some limitations. First, our study was retrospective in nature. However, we used the same method in all consecutive patients and did not use antibiotics according to the result of each culture, which may offset the drawback of the retrospective study design. Second, different types of surgery, and different types of approaches were included. Third, we only used a drain tip culture, and the drain fluid was not cultured. However, this study demonstrates the importance of drain tip culture through a large number of patients.

Conclusions

Drain tip cultures were not useful for predicting SSI because of low positive predictive value. Drain tip culture had a high positivity rate in the SSI group, and the coincidence rate for the causative pathogen was relatively high at 94.1%. The presence of SSI and the drain tip culture positivity can provide helpful information for SSI treatment after spinal surgery.

Conflict of Interest

No potential conflict of interest relevant to this article was reported.

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Study design: CK, JWP; data collection: MGS, HSC; data analysis: JWP; manuscript writing: CK, JWP; proofreading: CK, JWP; and final approval of manuscript: all authors.

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