Investigation of Surgical Site Infections and Bacteria Detected Following Neck Dissection in Patients with Oral Cancer

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Abstract

During dissection for oral cancer, there is a high probability of bacteria indigenous to the oral cavity migrating to the surgical field in the neck due to the opening of new pathways of communication with the oral cavity. The risk of postoperative surgical site infection (SSI) in such patients is high due to malnutrition arising from perioperative eating disorders and dysphagia. Neck infections after neck dissection in oral cancer patients were investigated to elucidate the development of SSIs and their relationship with the results of bacterial culture.

A total of 86 patients with oral squamous cell carcinoma who underwent neck dissection between January 2012 and December 2016 were enrolled. Ten factors were selected for investigation: (1) sex; (2) age; (3) primary site; (4) type of dissection; (5) whether or not there was a new pathway of communication between the oral cavity and the neck; (6) operative time; (7) blood loss; (8) number of drainage days; (9) amount of drainage at the time of drain removal; and (10) whether or not there was an SSI. Bacteria isolated from the catheter tip on drain removal were also investigated. Significant differences were observed between patients with and without SSIs (p=0.010) according to the presence of a new pathway of communication between the oral cavity and the neck (p=0.004); operative time (p=0.007); number of drainage days (p=0.029); or the amount of drainage at the time of drain removal. The present results indicate that selecting antibiotics appropriate to each patient and administering perioperative oral care are important in preventing SSIs.

Key words: OSCC — Neck dissection — SSI — Bacteria — Antibiotics
**Introduction**

Dissecting the neck in patients with oral cancer increases pathways of communication between it and the oral cavity, which heightens the probability of indigenous oral bacteria migrating to the former. In some patients, a reduction in perioperative oral ingestion can result in compromised nutrition, thus greatly increasing the risk of a postoperative surgical site infection (SSI). The purpose of this study was to investigate neck infections after neck dissection in oral cancer patients with the aims of elucidating the development of SSIs and their relationship with the results of bacterial culture.

**Patients and Methods**

1. Patients

A total of 86 study participants with oral squamous cell carcinoma were enrolled from among oral cancer patients who underwent neck dissection (including those in whom neck dissection only was performed for late cervical lymph node metastasis) at the Department of Oral Surgery at the Tokyo Dental College Chiba Hospital (currently, Tokyo Dental College Chiba Dental Center) during the 5-year period spanning January 2012 to December 2016. In all these cases, the catheter tip obtained when the continuous suction drain was removed postoperatively was subjected to a culture test. Patients with an underlying disease that could make them susceptible to infection, such as diabetes mellitus, and those taking steroids, were excluded.

This study was approved by the Ethics Committee of Tokyo Dental College (Approval number: 632).

2. Methods

Ten factors were used to determine the status of infection: (1) sex; (2) age; (3) primary site; (4) type of dissection; (5) whether or not there was a pathway of communication between the oral cavity and the neck; (6) operative time; (7) blood loss; (8) number of drainage days; (9) amount of drainage at the time of drain removal; and (10) whether or not there was an SSI. Correlations between these 10 factors were investigated. The presence of an SSI was determined in accordance with the Centers for Disease Control and Prevention Guideline for the Prevention of Surgical Site Infection (deep incisions), with an SSI taken to be present if at least one of the criteria listed was applicable (Fig. 1).

If an SSI was present, pus from the tip of the catheter from the drain removed after neck dissection was cultured and bacterial species identified to investigate their relation-
ship with it. The Mann-Whitney U-test and the chi-squared test were used for the statistical analysis. A p-value of \(< 0.05\) was taken as significant. Open-source statistical software R version 3.2.3 was used for the statistical analysis.

At our department, perioperative oral management is performed in all patients to prevent infection. It includes preoperative oral care performed by an oral hygienist; 2 g/day of cefazolin sodium (CEZ) administered intraoperatively and postoperatively for 3 days; the placement of 2 or 3, 15 Fr, portable low-pressure continuous suction systems (J-VAC®) approximately 10–15 cm into the cervical wound; and fixed sutures in the skin. The criteria for the removal of J-VAC® comprise drainage with a pale bloody color tone at a volume of \(\leq 20\) ml/day or the development of an SSI\(^1\).

3. Culture and identification of bacterial species

Each specimen was inoculated onto Brucella HK agar (RS) (KYOKUTO, Tokyo, Japan) and incubated at 35° for 48 hr in an anaerobic chamber (ESPEC, Osaka, Japan). The bacteria were then inoculated onto 2 Brucella HK agar plates (RS). One plate was cultured at 35° for 48 hr under anaerobic conditions and the other at 35° for 48 hr under aerobic and microaerophilic conditions. Identification of the aerobes and microaerophilic bacteria was carried out by conventional methods\(^1\). The microorganisms grown under anaerobic conditions were inoculated onto 4 types of culture media: Bacteroides agar (NIS-SUI, Tokyo, Japan); variant FM agar (NIS-SUI); Brucella HK (RS) agar; and BBE agar (KYOKUTO, Tokyo, Japan). The plates were cultured at 35° for 48 hr in an anaerobic chamber. Black-pigmented colony formation by \textit{Prevotella/Parphyromonas} species (spp.) was determined using Brucella HK (RS) medium. Fluorescent red and yellow colonies were subsequently identified as \textit{Prevotella/Parphyromonas} or \textit{Fusobacterium} spp, respectively, under UV irradiation. Detection of \textit{Bacteroides} spp. was performed in Bacteroides medium. Bacteria inducing browning of the medium following esculin decomposition in BBE medium were determined to be members of the \textit{Bacteroides fragilis} group. \textit{Fusobacterium} spp. were also identified by confirming growth on variant FM medium. All isolates from anaerobic cultures were identified by using Rapid ID ANA II (Thermo Fisher Scientific, Yokohama, Japan).

Results

The patients comprised 54 men and 32 women ranging in age from 22 to 87 years (mean age, 60.1 years). The primary site was the tongue in 40 patients, the mandibular gingiva in 28, the maxillary gingiva in 8, the buccal mucosa in 7, and the floor of the mouth in 3. The type of neck dissection was selective neck dissection in 45 patients, total neck dissection in 19, and bilateral neck dissection in 22. A single surgical field extended to both the oral cavity and the neck in 50 of these 86 patients. Mean operative time was 452 minutes; mean intraoperative blood loss, 503 ml; mean drain placement duration, 5.3 days; and mean amount of drainage at removal, 30.4 ml.

An SSI developed in 28 of the total of 86 patients, including in 23 of 50 patients in whom the single surgical field extended to the oral cavity and neck when the primary tumor and tissue to be dissected were resected en bloc; and in 5 of 36 patients in whom resection was performed separately for the primary tumor and tissue to be dissected or neck dissection only was carried out for late lymph node metastasis (Table 1). The primary sites in the 50 patients with new pathways of communication between the oral cavity and neck comprised mandibular gingival cancer in 22 patients and cancer of the tongue and floor of the mouth in 28 patients. An SSI was seen in 10 patients with mandibular gingival cancer and 13 with cancer of the tongue and floor of the mouth (Fig. 2). Factors found to have a significant association with an SSI comprised whether or not there was a new pathway of
In neck dissection in cases of oral cancer, the primary tumor and tissue to be dissected are resected en bloc, at which time, the surgical areas in the oral cavity and neck comprise a single surgical field. Many species of indigenous bacteria are present in the oral cavity, and exposing the neck surgical field to them is a risk factor for postoperative infection. Earlier studies have reported the incidence of SSIs to be 21.3% and 36.1%, showing no significant difference to that observed in the present study.

Preoperative management of oral hygiene in patients with oral cancer is reported to prevent the development of SSIs. The results of the present study showed a significant difference in the presence of infection in patients with new pathways of communication between the oral cavity and the neck. At our department, perioperative oral management includes preoperative oral care performed by a dental hygienist, but thorough perioperative oral care is also important, especially in cases where there is a single surgical field extending as far as the oral cavity. Instruction on scaling and brushing is given under our hygienist intervention program from the time of the first visit, and preoperative scaling is necessary right up to the day before the operation. Brushing (excluding at the site of the

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**Table 1 Patients’ characteristics and other factors examined**

| Patient characteristics                                      | 86 patients |
|---------------------------------------------------------------|-------------|
| Sex: male/female                                              | 54/32       |
| Mean age                                                      | 60.1 years old (22-87) |
| Primary site: tongue/mandibular gingiva/maxillary gingiva/ buccal mucosa/mouth floor | 40/28/8/7/3 |
| Neck dissection: selective/total/bilateral                    | 45/19/22    |
| Oral cavity — neck communication: yes/no                      | 50/36       |
| Mean operative time                                           | 452 min     |
| Mean intraoperative blood loss                                | 503 ml      |
| Mean no. of days of indwelling drain                          | 5.3 days    |
| Mean drainage volume at time of removal                       | 30.4 ml     |
| Infection: yes/no                                             | 28/58       |

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**Discussion**

communication between the oral cavity and the neck; operative time; number of drainage days; and amount of drainage at the time of drain removal (Table 2).

The species of bacteria detected in the culture tests are shown in Table 3. Among the total of 86 patients enrolled, bacterial species detected in SSI patients only comprised *Peptostreptococcus* spp., obligate anaerobic Gram-positive, non-spore-forming rods, *Prevotella/ Porphyromonas* spp., and obligate anaerobic Gram-negative rods (Table 3). In patients with an SSI, *Prevotella/Porphyromonas* spp. were observed where the primary site of the tumor was the mandibular gingiva (Table 4).
surgical wound), guidance on oral cleaning around the wound, and guidance on gargling are also important postoperatively. Oral bacteria that have migrated to the cervical surgical field need to be fully eliminated by washing with saline prior to wound closure.\(^8,12\)

The risk of an SSI increases with longer operative time. Various factors, such as the extent of the dissection and metastatic lymph node adhesions, may be causes of longer operative times. In lengthy operations, twice the half-life of the antibiotic used is the indicator for re-dosing. The half-life of CEZ is approximately 1.7 hours. Therefore, when it is used in operations expected to last more than 4 hours, re-dosing every 4 hours intraoperatively is thought to be effective.\(^14\) In the present study, 1 g CEZ was administered at 12-hour intervals, regardless of the operation time. In future, however, we believe that re-administration every 4 hours will be necessary with extended operative times.

A continuous suction drain is placed in the wound after neck dissection. At our department, this is removed if the drainage has a pale bloody color and has a volume of approx-

### Table 2 Statistical analysis results

| Patient characteristics | SSI (−), N=58 | SSI (+), N=28 | p value |
|-------------------------|---------------|---------------|----------|
| Sex: male/female        | 36/22         | 18/10         | 0.842    |
| Mean age                | 62.2          | 57.2          | 0.077    |
| Primary site: tongue/mandibular gingiva/other | 26/17/15 | 14/11/3 | 0.252 |
| Neck dissection: selective/total/bilateral | 33/15/10 | 12/4/12 | 0.201 |
| Oral cavity — neck communication: yes/no | 27/31 | 23/5 | 0.004* |
| Mean operative time, min | 419          | 521           | 0.007*   |
| Mean intraoperative blood loss, ml | 437 | 639 | 0.082 |
| Mean no. of days of indwelling drain, ml | 5.0 | 5.9 | 0.029* |
| Mean drainage volume at time of removal | 58 | 47 | 0.010* |

* p<0.05

### Table 3 Detected bacterial species

| Gram-positive bacteria | Gram-negative bacteria |
|-----------------------|------------------------|
| **Cocci**             | **Bacilli**            | **Cocci** | **Bacilli** |
| α-Streptococcus       | 11                      | Acinetobacter | 3 |
| γ-Streptococcus       | 8                       | Haemophilus parainfluenza | 3 |
| β-haemolytic Streptococcus | 5  | Neisseria | 2 |
| Enterococcus faecalis | 2                       | Eikenella corrodens | 2 |
| Staphylococcus aureus | 1                       | Pseudomonas aeruginosa | 1 |
| *Number of isolates*  | *                      | Capnocytophaga | 1 |

*Anaerobic bacteria*

| Peptostreptococcus | 5 | Obligate anaerobic, non-spore forming rods |
|-------------------|---|-------------------------------------------|
| Gram-positive     | 3 |                                          |
| Gram-negative rods | 3 |                                          |

*Actinomyces* 3

| Prevotella/Parvimonas | 7 |
|----------------------|---|
| Enterobacter | 5 |
| Obligate anaerobic, Gram-negative rods | 3 |

| Serratia marcescens | 2 |

*Number of isolates*

Underlined: Bacterial species detected only in SSI cases
approximately 20 ml/day or less, or when an SSI occurs. Use of a drain catheter means there will be communication between the interior and exterior of a wound, which may provide a pathway for spread of infection. We believe that the longer the drain is left in place, the higher the risk of infection. In the present study, the results showed that infections tended to occur when the drains were in place for longer. However, the risk of an SSI is also higher in cases where there is a large amount of drainage at the time the drain is removed, and so the timing of drain removal needs to be determined by taking into account the status of both. When the amount of drainage is large, necessitating the drain has to remain in place for a protracted period of time, the administration of antibiotics needs to be prolonged, taking into consideration neck compression and the emergence of drug-resistant bacterial strains.

The risk of an SSI is thought to be high with surgeries involving mandibulotomy or jaw reconstruction for mandibular gingival cancer. In the present study, Prevotella/Parphyromonas spp. were only seen in patients with an SSI, suggesting the presence of β-lactamase-producing bacteria, and it is possible that the intraoperative and postoperative administration of CEZ was not effective. This suggests that, in patients with mandibular gingival cancer, administration of sulbactam/ampicillin or clindamycin needs to be considered in accordance with clinical practice guidelines for the use of appropriate antibiotics to prevent postoperative infection.

### Conclusion

A survey of SSIs following neck dissection was conducted. The results suggest that selection of antibiotics appropriate to each patient and perioperative oral care are important in preventing SSIs.

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