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Incidence and Risk Factors of Recipient Surgical Site Infection in Oral and Maxillofacial Reconstruction with Vascularized Fibular Bone Grafts

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Abstract:

Objective: To determine the incidence and risk factors of recipient surgical site infection (RSSI) after oral and maxillofacial reconstruction with vascularized fibular bone grafts (VFBG).

Material and Methods: This retrospective study was performed in patients who underwent oral and maxillofacial reconstructive surgery, with VFBG, at the Dental Hospital, Faculty of Dentistry, Prince of Songkla University. Demographic, preoperative, intraoperative and postoperative data were recorded. Any infection at the recipient site occurring within 30 days post-operatively, by criteria from the Center of Disease Control, was defined as RSSI. Statistical analysis was performed by chi-square test, Student's t-test and Pearson's correlation coefficient with statistical significance was set at 0.05.

Results: There were twenty-one patients who met the eligibility criteria. The incidence of RSSI after oral and maxillofacial reconstruction with VFBG was 47.6% (10/21 patients), and the success rate of VFBG was 95.2%. American Society of Anesthetics (ASA) physical status class II and oral contamination were significant risk factors for RSSI (p-value=0.004 and p-value=0.031, respectively). Length of hospital stay was significantly higher in the RSSI group (p-value<0.001).

Conclusion: The incidence of RSSI after oral and maxillofacial reconstruction with VFBG was high, and ASA physical status class II and oral contamination were significant risk factors for RSSI.

Keywords: risk factor, surgical site infection, vascularized fibular bone graft

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Introduction

Vascularized fibular bone grafts (VFBG) are the gold standard for mandibular reconstruction, because they have several advantages over other grafts, including potential reconstruction of long span defects, their bicortical properties; which can assist in placement of dental implants, the availability of muscular cuff and good quality skin paddle for soft tissue reconstruction, long and large vascular pedicle, two team approach and low donor site morbidity.[1-3] However, microvascular reconstruction with VFBG is a major operation; operative time and blood loss are increased, which in turn results in a greater risk of postoperative complications. Surgical site infection (SSI), especially at the recipient site, is a common complication after head and neck cancer surgery with microvascular free flap reconstruction.[4,5] The adverse outcomes of SSI include prolonged hospitalization, delayed wound healing, increased risk of free flap failure and delayed postoperative treatment with chemotherapy and radiotherapy.[5,6] There are several risk factors for SSI in head and neck surgery, such as comorbidities, smoking and alcohol consumption, poor oral hygiene, American Society of Anesthetics (ASA) physical status (PS) classification, and body mass index (BMI).[4,5,7-10] Therefore, oral and maxillofacial surgeons need to understand the incidence and risk factors of SSI, for prevention and improvement of treatment outcomes. In so saying, the incidence and risk factors of SSI after head and neck surgery varies among studies, and included both recipient and donor sites.[4,5,7-9,11] Additionally, most of the previous SSI studies focused on the overview of head and neck cancer and reconstructive surgery; rather than specific oral and maxillofacial regions. No previous studies have investigated SSI after performing a single osteomyocutaneous free flap, especially the VFBG in oral and maxillofacial regions. The aims of this study were to determine the incidence and risk factors for SSI, focusing on recipient site after oral and maxillofacial reconstruction with vascularized fibular bone grafts.

Material and Methods

This retrospective study included patients whom underwent oral and maxillofacial reconstruction with VFBG, from 2009 to 2017, at the Dental Hospital, Faculty of Dentistry, Prince of Songkla University. The study was approved by the research ethics committee, Faculty of Dentistry, Prince of Songkla University. Inclusion criteria were patients who underwent VFBG for oral and maxillofacial reconstruction by the same surgeon during this period, having complete medical records. Data collection was performed by abstracting information from inpatient medical records, including (1) demographic characteristics; (2) preoperative data including oral hygiene status, systemic disease, ASA PS classification, heavy smoking status (≥25 cigarettes per day)[12], heavy alcohol consumption (for women, ≥8 drinks per week ; for men, ≥15 drinks per week)[13], prior treatment with radiotherapy and chemotherapy, perioperative steroid use, drug abuse, BMI, timing of reconstruction, cause(s) of defect, Boyd's classification of mandibular defect[14], Brown's classification of maxillary defect[15], and use of prophylactic antibiotics; (3) intraoperative data; including oral contamination (any intraoral wound that had contact with any extraoral surgical wound), volume of blood loss, blood transfusion, size of skin paddle, operation time, number of fibula segments used, length of defect and type of drain; (4) postoperative data, including length of hospital stay and final results of VFBG. Any infection at the recipient site occurring within 30 days postoperatively was classified as recipient SSI (RSSI), which was categorized as superficial incisional, deep incisional and organ/space by criteria for diagnosis of surgical site infection by the United States Center of Disease Control.[16] Additional data recorded for all patients included: the date, type, and severity of infection, treatment (empirical anti-

biotics, surgical intervention), gram stain, culture and sensitivity test. Data were presented descriptively, using means and standard deviations. Chi-square test was used for comparing categorical data and Student's t-test was used for comparing continuous data. The relationship between continuous variables was tested with Pearson's correlation coefficient and statistical significance was set at a p-value<0.05.

Results

Twenty-one patients were included in the study, eleven males (52.4%) and ten females (47.6%) with a mean age of 37.9±16.4 years (range 15-65 years). The mean BMI was 24.8±6.0 kilograms per square meter (kg/m^2), with a range of 16.4-39.4 kg/m^2. Seven patients had systemic diseases, with hypertension being the most common (20.8%), followed by diabetes mellitus, chronic hepatitis C, hyperthyroidism and psychotic depression. All primary diseases had a benign pathology. Ameloblastoma was the most common pathology of the jaws (66.7%), while the others were osteoradionecrosis (14.3%), ossifying fibroma (9.5%) and gunshot wound (9.5%). Distributions of preoperative, intraoperative and post-operative data are shown in Tables 1 and 2. Mandibular reconstruction with VFBG was performed in 18 cases (85.5%), while maxillary reconstruction was performed in 3 cases (4.8%). Table 3 shows the classification of maxillary and mandibular defects.

Table 1 Relationship between factors and recipient surgical site infection (categorical data)

Factor	Category	Number of patients (%) (n=21)	RSSI	p-value
Gender	Male	10 (47.6)	4	0.505
	Female	11 (52.4)	6	
Systemic diseases	Yes	7 (33.3)	4	0.537
	No	14 (66.7)	6	
ASA PS	Class I	9 (42.9)	2	0.044
	Class II	12 (57.1)	8	
Heavy smoking	Yes	3 (14.3)	2	0.476
	No	18 (85.7)	8	
Heavy alcohol consumption	Yes	6 (28.6)	4	0.269
	No	15 (71.4)	6	
Radiotherapy	Yes	3 (14.3)	3	0.050
	No	18 (85.7)	7	
Chemotherapy	Yes	1 (4.8)	1	NA
	No	20 (95.2)	9	
Steroid use	Yes	14 (66.7)	8	0.217
	No	7 (33.3)	2	
Oral hygiene	Fair	20 (95.2)	10	0.329
	Poor	1 (4.8)	0	
BMI (kg/m^2)	<23	10 (47.6)	3	0.123
	≥23	11 (52.4)	7	
Timing of reconstruction	Immediate	11 (52.4)	7	0.123
	Delayed	10 (47.6)	3	
Oral contamination	Yes	14 (66.7)	9	0.031
	No	7 (33.3)	1	

Table 1 (continued)

Factor	Category	Number of patients (%) (n=21)	RSSI	p-value
Blood transfusion	Yes	11 (52.4)	6	0.505
	No	10 (47.6)	4	
Type of drain	Penrose	17 (81.0)	7	0.234
	Vacuum	4 (19.0)	3	
Fibular osteotomy	Yes	18 (85.7)	9	0.593
	No	3 (14.3)	1	

RSSI=recipient surgical site infection, ASA PS=American Society of Anesthetics physical status, BMI=body mass index, kg/m^2=kilogram per square meter, NA=not available

Table 2 Relationship between factors and recipient surgical site infection (continuous data)

Factor	Mean±S.D.			p-value
	Overall (n=21)	No RSSI (n=11)	RSSI (n=10)	
Age (yr)	37.9±16.4	34.4±17.4	41.7±15.1	0.319
BMI (kg/m^2)	24.8±6.0	23.6±5.8	26.0±6.2	0.385
Length of defect (cm)	9.9±3.2	9.7±3.3	10.2±3.1	0.717
No. of fibular segment	2.3±0.8	2.2±0.8	2.5±0.9	0.374
Skin paddle size (cm^2)	24.1±15.4	28.8±20.6	20.6±9.8	0.307
Operation time (min)	800.0±122.3	770.9±131.3	832.0±109.0	0.263
Blood loss (ml)	778.6±165.5	781.8±157.0	775.0±183.0	0.928
Length of hospital stay (day)	17.7±6.7	13.3±2.0	22.5±6.8	0.001

RSSI=recipient surgical site infection, S.D.=standard deviation, yr=year, kg/m^2=kilogram per square meter, cm=centimeter, cm^2=square centimeter, min=minute, ml=milliliter

Overall, RSSI was found in 10 cases; thus the incidence of RSSI in this study was 47.6%. One fibular flap was totally lost due to venous thrombosis, following the data above the success rate for VFBG was 95.2%. Types of RSSI, gram stain, culture and empirical antibiotic treatments of RSSI are shown in Table 4.

Cefazolin 1 g was administered intravenously as antibiotic prophylaxis in 20 patients, with one case receiving clindamycin 600 mg intravenously due to a history of penicillin anaphylaxis. The most common empirical antibiotics treatment for RSSI was cefazolin 1 g plus metronidazole 500 mg intravenously (40.0%), followed by penicillin G sodium 2 million units plus ceftriaxone 1 g (30.0%).

ASA PS class II and oral contamination were found to be significantly associated with increasing RSSI (p-value=0.004 and p-value=0.031, respectively). Patients with RSSI had a significantly longer length of hospital stay compared to those without RSSI (p-value<0.001). No significant correlation between any of the other variables was observed.

Table 3 Classification of maxillary and mandibular defects (n=21)

Classification of defect	Number (%)
Mandible	
LCL	6 (28.6)
LC	6 (28.6)
L	3 (14.3)
H	3 (14.3)
Maxilla	
IIb	2 (9.5)
IIIc	1 (4.2)

LCL=lateral-center-lateral, LC=lateral-center, L=lateral, H=hemimandible, IIb=low maxillary defect, not involving floor of orbit and cross midline, IIIc=high maxillary defect, involving floor of orbit, nearly total maxillectomy

Table 4 Recipient surgical site infection data and empirical antibiotic treatment

Variable	Number (%)
Type of SSI (n=10)	
Superficial incisional	2 (20.0)
Space/organ	5 (50.0)
Deep incisional	3 (30.0)
Gram stain (n=18)	
Gram-positive cocci	12 (66.7)
Gram-positive bacilli	1 (5.5)
Gram-negative cocci	1 (5.5)
Gram-negative bacilli	4 (22.3)
Cultures results (n=14)	
Streptococcus sp.	6 (42.9)
K. pneumoniae	2 (14.3)
Enterobactor sp.	1 (7.1)
Anaerobic gram-positive cocci	3 (21.5)
Anaerobic gram-negative bacilli	1 (7.1)
No growth	1 (7.1)
Empirical antibiotics (n=10)	
Cefazolin+Metronidazole	4 (40.0)
Penicillin G Sodium+Ceftriaxone	3 (30.0)
Cefazolin+Clindamycin	1 (10.0)
Clindamycin+Gentamicin	1 (10.0)
Penicillin G Sodium	1 (10.0)

SSI=surgical site infection, *K. pneumoniae*=Klebsiella pneumoniae, sp.=species

Discussion

SSI are frequent postoperative complications, especially in head and neck cancer surgery with microvascular free flap reconstruction.[4,5] Most studies reported incidences of SSI in head and neck cancer surgery ranging from 14.0-50.0%, with various risk factors depending on the study setting.[4-8,11,17-21] Those studies mentioned SSI in the context of overall head and neck cancer surgery, which used various techniques of soft and hard tissue reconstruction. Only one study reported the incidence of SSI (39.2%) in patients receiving bony free flap reconstruction to the head and neck, including the fibula, iliac and scapula.[9] Almost all previous reports included both recipient and donor site infections, for determining the incidence of SSI. In fact, the recipient site (head and neck) surgery, which is a class II (clean-contaminated) wound, has more risk of infection than the donor site surgery, which is a class I (clean) wound.[16] This retrospective study is the first study, to our knowledge, to report the incidence of SSI specific to the recipient site after oral and maxillofacial reconstruction with VFBG. Additionally, this present study also revealed that: oral contamination was a significant risk factor for RSSI, which is consistent with other studies.[4,5] Although, the incidence of RSSI in this study is within the range of previous reports[4-8,11,17-21], it seems to be high compared to most of these studies. This may be because microvascular reconstruction with VFBG is invasive, and entails a high risk of postoperative infection; especially in oral and maxillofacial surgery. These operations often create oral-cervical connected wounds and can expose the VFBG as well as cervical tissue to saliva, and the alimentary-tract or respiratory tract secretions.[7] Postoperatively, respiration, swallowing and coughing can result in wound dehiscence.[9] This allows oral microorganism to form infections in the recipients surgical wound in addition to the development of RSSI. We advise meticulous saline irrigation before closing the wound with a watertight seal, in order to reduce the risk of RSSI.

In this present study, ASA PS class II was also a risk factor for RSSI. However, no significant relationship between RSSI and the presence of systemic diseases, smoking status, alcohol consumption, and BMI was observed. Therefore, ASA PS score may be a good index for a comprehensive health assessment before VFBG.[7]

Although, the incidence of RSSI in this study was high, the failure rate of VFBG was very low. This is probably because of early diagnosis and treatment of RSSI in our hospital, and the high tolerance against infection of the vascularized flap. VFBG is a free tissue transfer with its own blood supply; hence, the immune cells and antibiotics are able to be distributed within and around the VFBG, this is turn helps prevent the spread of causative micro-organisms.

This study used cefazolin 1 g intravenously as a routine antibiotic prophylaxis and clindamycin 600 mg intravenously, for patients who had a history of penicillin allergies. Murphy et al.[9] found that the rate of RSSI with cefazolin used as an antibiotic prophylaxis for clean-contaminated head and neck osteomyocutaneous free flap was 25.0%; additionally there was no statistical difference observed between the number of SSI patients and non SSI patients. However, previous studies showed that the single use of cefazolin as an antibiotic prophylaxis in major head and neck surgery had a significantly higher rate of wound infections compared to the anaerobic coverage of antibiotics.[22,23] Veve et al.[24] and Chiesa-Estomba et al.[25] suggested that the appropriate antibiotics for prophylaxis in clean-contaminated head and neck surgery; especially for those combining free flap reconstruction, should cover gram-positive, enteric gram-negative and anaerobic bacteria. The recommended antibiotics, for Asian patients, are cefazolin 2 g in combination with 500 mg of metronidazole and 1.2 g amoxycillin/clavulanate. For patients with a history of anaphylaxis penicillin allergies, clindamycin alone is not recommended as an antibiotic prophylaxis. Yang et al.[6] investigated intraoral flora and SSI among high-risk head and neck cancer patients, who underwent resection and free flap reconstruction, and found rapid and significant increases in bacterial resistance to clindamycin. Additionally, some studies revealed that clindamycin prophylaxis alone was a risk factor for SSI in head and neck surgery.[9,10] This was probably because clindamycin did not cover gram-negative bacteria in these wounds. Therefore, clindamycin should be combined with a secondary drug, so as to cover gram-negative bacteria, or for the consideration of switching to a different antibiotic, such as vancomycin or clarithro-mycin.[25]

This study used dexamethasone as a perioperative steroid in a number of patients, but such use was not related to RSSI in this study. Howbeit, Kainulainen et al.[26] showed not only did the use of dexamethasone in oral cancer surgery with microvascular reconstruction not provide any benefits, it also entailed more complications; especially infections, occurring in patients within the control group. Due to the above factors, we suggest that perioperative steroids should not be used routinely. Previous studies also showed that preoperative radiotherapy was not only a risk factor for free flap failure[27], but that it was also a risk factor of SSI.[5,28] In our study, all three patients with a history of preoperative radiotherapy developed RSSI, but statistical analysis did not reveal that preoperative radiotherapy was a risk factor of RSSI. This result is in contrast to previous studies[5,28], this may have been due to the limited sample size of this study.

In our study, patients with RSSI were found to have a significantly higher length of hospital stay than the non-RSSI group, which is consistent with previous studies.[11,19] Prolonged length of hospital stay in this study may be attributed to most of our RSSI cases requiring extended use of antibiotics, daily irrigation and caring of the infected wound until it improved, as well as physiotherapy at the donor site. Since, prolonged hospitalization has been

shown to be related to an increased risk for hospital-acquired infections, and deep vein thrombosis as well as incurring higher costs[29], prevention of RSSI is important for reducing the length of hospitalization.

The limitation of this study was its small sample size, which may have limited the statistical significance of some variables. Therefore, studies with larger sample sizes should be conducted, for further investigation in this field.

Conclusion

The incidence of recipient site infections after oral and maxillofacial reconstruction with VFBG was high. ASA PS class II, and oral contamination are important risk factors for RSSI.

Conflict of interest

The authors declare that there are no conflict of interest regarding the publication of this paper.

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