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Correlation of factors associated with postoperative infection in patients with malignant oral and maxillofacial tumours: a logistic regression analysis

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Abstract

Patients with oral and maxillofacial malignant tumours have a relatively high incidence of postoperative infections. We have analysed the risk factors and the distribution of pathogens in infected patients to try and find out how to prevent them. We recruited 312 patients over 60 years old with malignant oral and maxillofacial tumours and investigated their incidence of postoperative infection between January 2007 and December 2017. Some factors were included in one way and multifactorial logistic analyses to find out which risk factors were likely to be associated with postoperative infections. Thirty-nine of the 312 (12.5%) developed postoperative infections, mainly at the surgical site (n = 21) and in the lower respiratory tract (n = 14). Pathogens were isolated from all patients and comprised aerobic (n = 4) and anaerobic (n = 5) bacteria, together with mixed infections (n = 30). Univariate analysis showed that age, size and site of tumour, body-mass index (BMI), diabetes, and duration of operation were risk factors. Multivariate logistic analyses, however, showed that BMI, the presence of diabetes, duration of operation, and American Society of Anesthesiologists (ASA) score were the main independent risk factors for postoperative infection. We conclude that there are abundant risk factors for postoperative infection in these patients, and it is important that they are evaluated preoperatively so that suitable postoperative treatments can be given.

Keywords: Oral and maxillofacial region; Malignant tumors; Post-op infection; Risk factor

Introduction

The oral and maxillofacial region is susceptible to tumours - mostly carcinomas, but also sarcomas. Most are squamous cell carcinomas (SCC) and a few are adenocystic carcinomas. Because the oral and maxillofacial cavity is part of the patient's face, there are stringent requirements for keeping its morphology and function as normal as possible during treatment.[1,2] Malignant tumours in these regions are most likely to be found in middle-aged and elderly patients, and there are various subtypes in oral mucosal lesions (such as malignant tumours of the buccal mucosa, gingiva, tongue, and floor of the mouth) most of which spread through the blood and lymph nodes to infiltrate other tissues, and cause distal metastases and rapid progression of disease.

Surgery is the main approach for the treatment of these tumours, but it also results in a relatively high incidence of postoperative infection.[3,4] Although the oral cavity has the

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potential for potent self-cleaning, the lack of complete sterilisation during operation allows an imbalance of bacteria or pathogenic bacterial contamination, which frequently leads to infections at the operative site. These infections compromise surgical efficacy, retard healing, and extend the duration of hospital stay. Infection of the operative field is a common postoperative complication, in particular in cancer surgery that involves oral SCC, and correlates with the colonisation of aerobic and anaerobic strains of bacteria, extended duration of operation for repair after resection of the tumour, and direct exposure of the injury to secretions of the respiratory or digestive tract.[5,6]

Previous studies have shown that operative injury, invasive manipulation, and decreased resistance are risk factors that govern the incidence of these postoperative infections. Because of the frequent use of preventive tracheal intubation, which destroys the innate defensive barriers in the respiratory tract, the extended duration of such operations to remove these tumours further increases the incidence of postoperative infection.

The surgical approach should be optimised based on the range of the primary lesion and the properties of the tumour. Because there are commonly lymph node metastases in the early stages of SCC of the oral cavity, radical surgery requires the removal of lymph nodes from the neck, which results in major surgical trauma and severe tissue damage and leads to an even higher incidence of postoperative infection.[7,8] The prediction of such infections in these patients has been widely studied.

Patients and methods

Patients

We recruited 312 patients (all over 60 years old) who had malignant tumours in the oral and maxillofacial region, and retrospectively analysed their data for risk factors for postoperative infection and the distribution of related pathogens to identify and prevent these pathogens preoperatively, and provide the necessary evidence for postoperative treatment. Information about various characteristics was collected to analyse whether they had any correlation with postoperative infection (Table 1).

Malignant tumours in all 312 patients with oral and maxillofacial lesions were confirmed by histopathological examination. The inclusion criteria were: over 60 years old and no history of tumour-related diseases. There were 202 male and 110 female patients whose mean (SD) age was 64 (3) years, range 61 to 78. Diagnosis of nosocomial infection followed the guidelines stipulated by the Ministry of Health, China, in 2001.

The study was approved by the Ethics Committee of our hospital. (Approval Number: 20170716-11). Informed consent was obtained from all individual participants included in the study.

Table 1
Factors for analysis.

	Factors
Epidemic	Age, sex, tooth status, smoking history, Body Mass Index
Tumour	Size, site, clinical stage, primary or recurrence
Complication	Hypertension, diabetes, heart disease, Chronic obstructive airways disease
Perioperative	Treatment approach (operation, with/without auxiliary chemotherapy or radiotherapy), repair of deficit (direct suture, free flap, focal flap, regional flap), duration of operation (over six hours), with or without tracheal incision, blood transfusion

Bacterial strain and drug sensitivity assay

Samples were collected from a sampling site after the operation from infectious patients that was chosen by the clinicians. Samples were stored in sterile containers for assay, which followed the manufacturer's guidelines.

Statistical analyses

IBM SPSS Statistics for Windows (version 19.0, IBM Corp) was used for analysis. For univariate analysis we used the chi squared or Fisher's exact test, as appropriate, and for multivariate analysis we used a logistic stepwise regression method and the regression coefficients were standardised. Statistical significance was set at $p < 0.05$.

Results

Our univariate analysis showed that the following factors were significant: age ($p < 0.001$), Body Mass Index (BMI) ($p = 0.001$), size of tumour ($p = 0.004$), site of tumour ($p = 0.006$), diabetes ($p = 0.021$), deficit repair ($p = 0.042$), American Society of Anesthesiologists (ASA) grade ($p < 0.001$), Charlson Comorbidity Index (CCI) ($p = 0.006$), duration of operation ($p < 0.001$), blood transfusion ($p < 0.001$), and clearance of neck lymph nodes ($p = 0.014$).

Multivariate analysis showed that BMI ($p = 0.01$), diabetes ($p = 0.01$), duration of operation ($p < 0.001$), ASA grade ($p = 0.01$), and the approach for repair of the deficit ($p = 0.016$) were significant factors.

Distribution of infection sites postoperatively

Among the 312 patients with oral and maxillofacial tumours, 39 (12.5%) developed postoperative infections, most of which were a mixture of aerobic and anaerobic bacteria

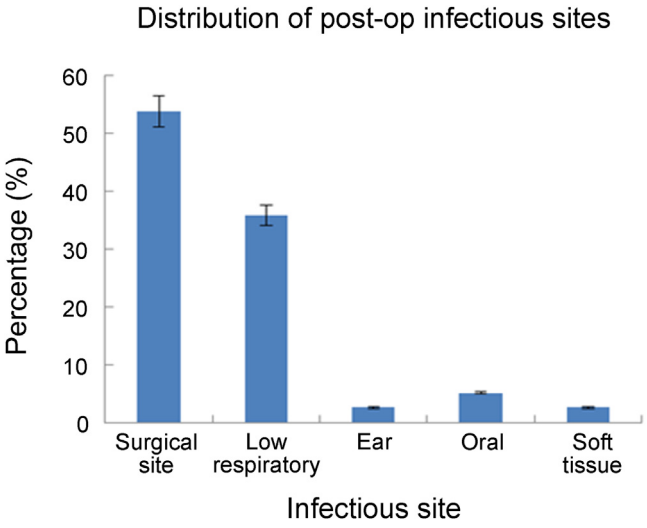

Fig. 1. Distribution of postoperative infection in patients with malignant oral and maxillofacial tumours.

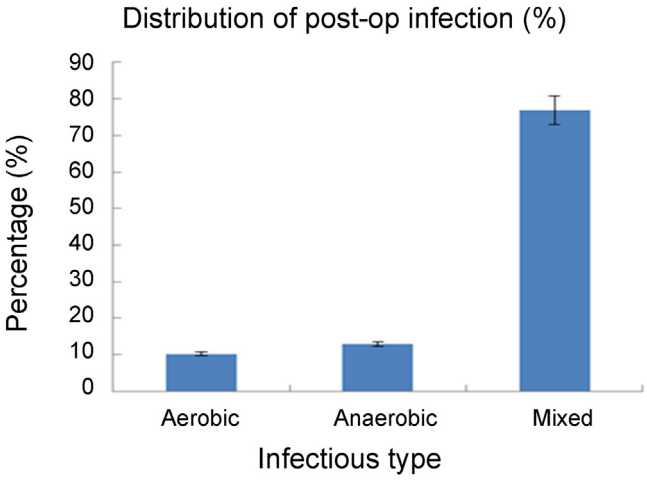

Fig. 2. Distribution of all types of infection after removal of malignant oral and maxillofacial tumours.

(30/39). The main infection sites were the surgical wound (21/39) and the lower respiratory tract (14/39) (Fig.1).

Distribution of major pathogens in postoperative infections

We separated the pathogens from the samples of pus taken from all 39 infected patients. Aerobic bacteria were found in 4/39 samples. Among those, *Pseudomonas aeruginosa*, *Streptococcus viridans*, and Staphylococcus spp were the most common. Anaerobic bacteria were found in 5/39 of the samples. Among these, 3/5 were Gram-negative bacteria, the most common being Porphyromonas spp, and 2/5 were Gram-positive bacteria, mostly Peptostreptococcus spp (Figs. 2 and 3).

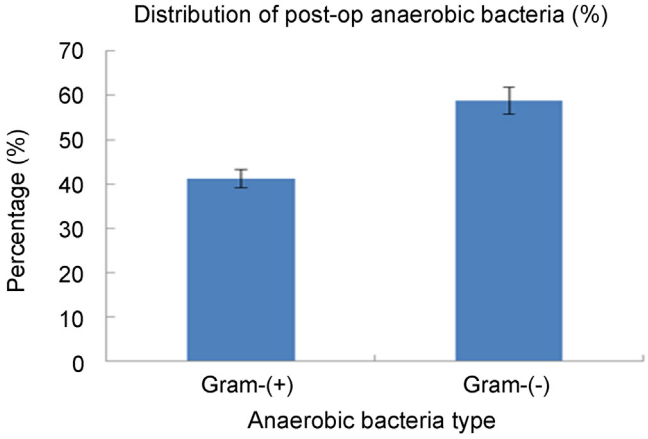

Fig. 3. Distribution of anaerobic bacteria after removal of malignant oral and maxillofacial tumours.

One way analysis of variance for risk factors of postoperative infection in patients with oral and maxillofacial malignant tumours

We did a univariate analysis for possible risk factors, including diseases, tumours, complications, and perioperative factors (Table 2).

Multivariate logistic regression analysis for risk factors of postoperative infection in patients with oral and maxillofacial tumours

Using significant factors obtained from the univariate analysis, some factors with relatively small probabilities as independent variables, and the development of postoperative infection as the dependent variable, we made an unconditional logistic regression analysis (Table 3).

Discussion

Malignant tumours often damage the complicated anatomical structures of the oral and maxillofacial region, and are associated with a high rate of neck lymph node metastases. [9,10] Most patients therefore require radical resection followed by insertion of a flap, which increases the duration of operation and the volume of blood lost, and these in turn increase the risk of bacterial contamination and postoperative infection.[11,12] Because the oral cavity cannot be completely sterilised before and during operation, patients with malignant tumours in the oral and maxillofacial regions have a relatively high risk of postoperative infection.[13,14] We found a postoperative infection rate of 12.5% among our 312 patients (n = 39). The main infection sites were the operative site and the lower respiratory tract, with a mixture of both aerobic and anaerobic bacteria.

After bacteria cultures and drug-sensitivity assays, the patients were given routine antibacterial drugs. Various studies have been conducted about such assays on aerobic

Table 2
One-way analysis of variance for risk factors of postoperative infection in patients with oral and maxillofacial malignant tumours.

Related factors	No.	No. (%) with infection	Chi squared	p value
Sex:				
Male	202	23 (11)	0.65	0.078
Female	110	16 (15)		
Age (years):				
>70	134	24 (18)	6.29	0.000
61–70	178	15 (8)		
BMI (kg/m^2):				
<20	126	26 (21)	9.23	0.001
≥20	186	13 (7)		
Smoking:				
Yes	109	16 (15)	0.73	0.067
No	203	23 (11)		
Tooth status:				
Good	74	11	0.50	0.098
Worse	238	28 (12)		
Tumour size (cm):				
≤4	220	19 (8)	10.18	0.004
>4	92	20		
Tumour site:				
Tongue	117	11 (7)		
Oral floor	59	6		
Gingival	76	11	12.34	0.006
Buccal mucosa	45	10		
Mandible	15	1		
Primary or recurrence:				
Primary	240	31 (13)	0.17	0.091
Recurrence	72	10		
Tumour stage:				
I,II	246	28 (11)	1.33	1.001
III, IV	66	11		
Diabetes:				
Yes	102	23	13.99	0.021
No	210	16		
Hypertension:				
Yes	200	28 (14)	1.15	0.060
No	112	11 (10)		
Heart disease:				
Yes	78	5	3.53	0.097
No	234	34 (15)		
COPD:				
Yes	34	6	0.92	0.081
No	278	33 (13)		
ASA score:				
1	67	3		
2	192	30 (16)	5.75	0.000
3	53	6		
CCI:				
0	130	12 (9)		
1	168	21 (13)	13.06	0.006
2	14	6		
Preoperative chemotherapy or radiotherapy:				
Yes	45	4	0.63	1.032
No	267	35 (13)		
Clearance of neck lymph node:				
Yes	78	15	4.30	0.014
No	234	24 (10)		
Deficit repair:				
Direct suture	87	4		
Focal flap	135	17 (13)	9.60	0.042
Region/free flap	90	18		

Table 2 (*Continued*)

Related factors	No.	No. (%) with infection	Chi squared	p value
Tracheal incision:				
Yes	109	14 (13)	0.89	0.097
No	203	25 (12)		
Duration of operation (hours)				
≤6	209	13 (6)	22.83	0.000
>6	103	26 (25)		
Blood transfusion:				
Yes	94	26	28.26	0.000
No	218	13 (6)		

BMI = Body mass index; ASA: American Society of Anesthesiologists; CCI: Charlson Comorbidity Index; COPD = chronic obstructive airways disease.

Table 3
Multivariate logistic regression analysis for the risk factors of postoperative infection in patients with oral and maxillofacial tumours.

Parameter	Regression coefficient	Standard error	Wald chi square	*P*	OR	95% CI
BMI	0.864	0.365	3.582	0.010	2.372	1.161 to 4.848
Surgical duration(h)	1.213	0.512	4.589	0.000	3.364	1.233 to 9.172
Diabetes	0.986	0.416	3.782	0.010	2.680	1.186 to 6.058
Deficit repair	1.193	0.490	5.935	0.016	3.297	1.263 to 8.609
ASA score	0.586	0.212	7.642	0.010	1.797	1.186 to 2.722

BMI=body mass index; ASA=American Society of Anesthesiologists.

bacteria, but we know of little information on the distribution of anaerobic bacteria and their resistance to routine drugs. However, by neglecting cultures for anaerobic bacteria, clinicians can overlook an abundance of pathogens in clinical samples.[15,16] With the widespread use of antibiotics, anaerobic bacteria gradually develop drug resistance, and the separation of anaerobic from aerobic bacteria could provide information that would optimise treatment.

Some studies have shown that age is a prominent risk factor for postoperative infection within the surgical area in these patients, and patients over 65 years old had a higher infection rate than younger ones.[17,18] To evaluate the effect of age on postoperative infection in such patients, our study recruited only patients over 60 years old, and on univariate analysis we found a correlation between age and postoperative infection. Considering this correlation and the possible involvement of multiple factors, other systemic factors related to age might also have important roles, so we recruited significant factors and those with relatively small p values from the univariate analysis as independent variables, and the occurrence of postoperative infection as the dependent variable to be included in the unconditional logistic regression analysis.

Our results showed that BMI, diabetes, duration of operation, ASA score, and repair of the deficit were the independent risk factors for postoperative infection. Previous studies showed that CCI grade was important for predicting the risk of complications in these patients, and that ASA score was an even stronger predictor,[19–21] but we did not find when we evaluated the risks that the CCI had an independent role. Because diabetes is common in elderly patients, its effect on healing of the incision and the blood glucose concentrations during the perioperative stage should be carefully monitored.

BMI also correlates with postoperative infection in these patients, because malnutrition is one of the known risk factors. Increased duration of operation is also a risk factor, and creates a higher risk of exposure to pathogens and contamination of the surgical field. A more difficult operation is likely to take longer. In addition, because of the abundant cavity left in the oral and maxillofacial regions, plus the complicated anatomical structures, tissues might be severely damaged after resection of a dilated tumour, and the extended resection and exposure times, plus the complicating postoperative oedema and haematoma, increase the risk of infection.

We also found that the size and site of the tumour, the approach to repair of the deficit, preoperative chemoradiotherapy, and blood transfusion, are related risk factors. The multivariate analysis showed that the approach to repair of the deficit was a predictive factor for postoperative infection.

Various studies have been conducted on pathogenic bacteria and related factors, mainly analysing their distribution and drug resistance, and they showed that postoperative risk factors were mainly related to duration of operation, duration of stay in hospital, and tracheal intubation.[18–20] Among all related factors included, multivariate analysis showed that BMI, diabetes, ASA grade, and the approach to repair of the deficit were the independent risk factors for postoperative infection in addition to duration of operation. Blood glucose concentrations during the perioperative period should be carefully managed, particularly for elderly diabetic patients.

Conclusions

There are various risk factors for postoperative infection in patients with oral and maxillofacial tumours, and these should be carefully evaluated preoperatively to provide information about postoperative treatment.

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Conflict of interest

We have no conflicts of interest.

Ethics statement/confirmation of patients' permission

The study was approved by the Ethics Committee of our hospital. (Approval Number: 20170716-11). Patients' permission was obtained.

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