Role of craniofacial surgery in oral and maxillofacial tumors involving the skull base: A retrospective analysis of 126 patients

Le Yang, DDS,[a] Jing-Yuan Li, DDS,[a,1] Yu-Dong Xiao, DDS,[a] Wei Deng, DDS,[a] Yong-Jie Qiao, DDS,[a] Yu-Jie Liang, MD, PhD, DDS,[b] and Gui-Qing Liao, MD, PhD, DDS[c]

Objectives. Oral and maxillofacial tumors involving the skull base (SB) are rare and complex, making treatment difficult and controversial. The purpose of the present study was to evaluate the treatment efficacy of craniofacial surgery (CFS).

Study Design. Patients who underwent CFS for these tumors between May 2000 and November 2017 were retrospectively analyzed. Clinicopathologic and treatment modality data were collected and follow-up was recorded. Kaplan-Meier and log-rank tests and Cox-regression model were used for survival analysis.

Results. In total, 126 patients were enrolled (70 males and 56 females; 97 malignant tumors). Squamous cell carcinoma accounted for the majority of tumors. The lip−submandibular−neck approach was most frequently applied. Through-and-through SB bone or partial dura resection was performed in 42 cases. A pathologic positive margin was found in 18 cases. Of the included patients, 80 underwent simultaneous craniofacial reconstruction. The postoperative complications rate was 11.1%. Estimated 1-year, 3-year, and 5-year overall survival rates were 78.8%, 68.2%, and 54.4% respectively; and the 1-year, 3-year, and 5-year recurrence-free survival rates were 77.4%, 66.8%, and 63.8%, respectively. Multivariate analysis indicated postoperative complications, radiotherapy, recurrence, and metastasis status had a negative impact on survival ($P < .05$).

Conclusions. Although tumors involving the SB had various clinicopathologic characteristics, with interdisciplinary cooperation, CFS is an optimal option. (Oral Surg Oral Med Oral Pathol Oral Radiol 2020;130:496−504)

Tumors originating from the oral and maxillofacial region can grow extensively, involving the skull base (SB). Extracranial tissue extensive encroachment and middle SB invasion are usually noted in these tumors.[1] Such tumors may go undetected for a long time or may present as extensive primary or recurrent neoplasms at the time of admission. They may usually extend to the middle SB, followed by the anterior SB.[2] Because of its complexity and significant function, this anatomic area was previously called "no man's land" in surgical therapy.[3,4] With advancements in imaging and surgical techniques, reconstructive options, and multidisciplinary collaboration, craniofacial surgery (CFS) has become an increasingly important component of the treatment strategy for SB tumors.[5-7]

CFS, which consists of the transfacial approach, resection, and construction, can provide clear exposure to enable en bloc resection with a clear margin, making a minimal impact on the brain. It was pioneered by Schloffer, Cushing, and Hirsch in the early 20th century,[8] and its application in the modern era began in the 1950s with the contribution of Dandy's work.[3] It was not until 1963 that Ketch et al.[9] reported the first series of patients who underwent CFS for malignancy. As part of the multidisciplinary team, oral and maxillofacial surgeons can play a vital role in performing CFS for these tumors.[5,10-13] Surgeons do, or can be easily trained to, carry out CFS, including obtaining a wide access to the SB, facilitating standard oncologic resection and reconstruction by using soft and hard tissues. However, oral and maxillofacial tumors involving the SB are relatively rare and histologically diverse. Because of these factors, there is not only limited literature evaluating CFS for these tumors in a large patient cohort but also no consensus on treatment guidelines or strategies.[14-16]

Therefore, in this study, we retrospectively investigated cases with oral and maxillofacial tumors involving the SB in a relatively large number of cases treated with

Statement of Clinical Relevance

Craniofacial surgery, as a part of multidisciplinary treatment, can play an important role in oral and maxillofacial tumors involving the skull base, with favorable results in a relatively large cohort of Chinese patients. Postoperative complications, radiotherapy, recurrence, and metastasis status were found to have a negative impact on survival.

[a]Resident, Department of Oral and Maxillofacial Surgery, Guanghua School of Stomatology, Hospital of Stomatology, Guangdong Provincial Key Laboratory of Stomatology, Sun Yat-sen University, Guangzhou, China.
[b]Associate Professor, Department of Oral and Maxillofacial Surgery, Guanghua School of Stomatology, Hospital of Stomatology, Guangdong Provincial Key Laboratory of Stomatology, Sun Yat-sen University, Guangzhou, China.
[c]Professor and Chief, Department of Oral and Maxillofacial Surgery, Guanghua School of Stomatology, Hospital of Stomatology, Guangdong Provincial Key Laboratory of Stomatology, Sun Yat-sen University, Guangzhou, China.
[1]Contributing equally to the first author, this author was listed as the co-first author.
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CFS at a tertiary hospital. Analyses of treatment efficacy and survival in these cases were performed cases.

MATERIALS AND METHODS

We conducted a retrospective study on patients with oral and maxillofacial tumors involving the SB, treated with CFS at the Hospital of Stomatology, Sun Yat-sen University (Guangzhou, China), between May 2000 and November 2017. This study was approved by the institutional review board of our hospital (ERC-[2017]-28).

A preoperative diagnosis was based on the patient's history, physical examination, and radiology findings. The pathologic diagnosis was confirmed by paraffin section and/or immunohistochemical analysis. The main inclusion criteria were diagnosis of the oral and maxillofacial tumors involving the SB and craniofacial surgical treatment at our hospital. Both benign and malignant tumors were included. The exclusion criteria were the pathologic entity being a primary brain tumor; treatment with chemotherapy or radiotherapy only (without surgery); and presence of distant metastasis.

The medical records were evaluated for patients' demographic characteristics, clinicopathologic features, operative procedures, postoperative complications, adjuvant therapies, and follow-up information. On the basis of the preoperative magnetic resonance imaging (MRI) and intraoperative findings, the original or exact locations of tumors in both the oromaxillofacial and subcranial regions were evaluated. The SB invasion types were divided into the following 3 categories: (1) invasion of subcranial soft tissue, (2) partial or through-and-through cranium, and (3) dura mater or brain parenchyma. Craniofacial approaches to the SB were divided into the following 4 basic types: (1) anterior midface approaches (Weber-Ferguson-Dieffenbach cheek flap); (2) lateral approaches (preauricular of retroauricular incision); (3) transoral or direct approaches; and (4) lip−submandible−neck approaches (Figure 1). On the basis of the extent of tumor, comprehensive surgical resection was carried out, and resection was classified into the following 4 groups: resection of (1) soft tissue, (2) partial SB bone, (3) complete SB bone, and (4) partial of the dura. Surgical margin was determined on the basis of intraoperative frozen section. Reconstruction strategy was based on the integrated analysis of tissue loss and the subsequent treatment plan. The multidisciplinary treatment plan, including adjuvant therapy, was discussed before surgery. Regular follow-up was conducted every 3 months in the first 3 years. Subsequently, the interval was extended to every 6 months.

Overall survival (OS) and recurrence-free survival (RFS) rates were analyzed by using the Kaplan-Meier method and compared by using the log-rank test statistically. Potential prognostic factors were identified by performing univariate analysis. Independent prognostic factors were determined by a Cox regression model for the multivariate hazard ratios (HRs). A P value less than .05 was considered statistically significant. Statistical analyses were performed with the software SPSS version 19.0 (SPSS Inc., Chicago, IL).

RESULTS

Demographic characteristics and clinicopathologic characteristics

After searching through the records, a total of 126 patients (70 men and 56 women; mean age 46.4 years; range 7−82 years) with oral and maxillofacial tumors involving the SB who underwent CFS in our hospital were identified. Patient demographic characteristics and characteristics are listed in Table I. Most of the patients were not addicted to tobacco (81.7%) or alcohol (92.9%). Only 13 (10.3%) had systemic diseases, such as high blood pressure and diabetes. Cranial nerve involvement was noted in 19.3% of cases at the time of diagnosis. The most commonly involved one was cranial nerve VII, which was detected in 39.1% cases. Half the tumors (54.8%) were first treated at our institution, and the remaining tumors were recurrent or had been unsuccessfully treated at other institutions.

The clinicopathologic characteristics of the tumors are listed in Table II. Of the 126 tumors, 97 (77%) were malignant tumors, and 29 (33%) were benign tumors. Among them, epithelial tumors and adenoid tumors represented the largest proportion in this study (30.2%). The top 9 pathologic diagnoses are shown in Table II, with squamous cell carcinoma (28.6%) and

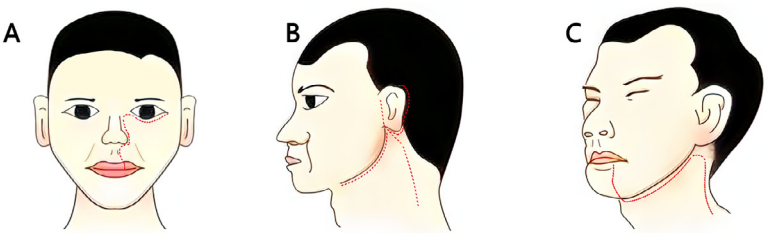

Fig. 1. Craniofacial approaches to the skull base. **(A)** Anterior midface approach. **(B)** Lateral approach. **(C)** Lip−submandible−-neck approach

Table I. Demographic characteristics and characteristics of patients

Characteristics	*No. of patients (%)*
Mean age (year)*	46.4 ± 16
Sex	
Male	70 (55.6)
Female	56 (44.4)
Smoking	
Yes	12 (9.5)
No	103 (81.7)
Cessation	11 (8.8)
Alcohol	
Yes	7 (5.6)
No	117 (92.9)
Cessation	2 (1.5)
Systemic disease	
Yes	13 (10.3)
No	113 (89.7)
Cranial nerve involvement	
Yes	23 (19.3)
II	5 (21.7)
V	6 (26.2)
VII	7 (30.5)
VIII	2 (8.7)
II, III, IV	1 (4.3)
V, VII	1 (4.3)
II, V, VII	1 (4.3)
No	103 (80.7)
Prior treatment	
Primary	69 (54.8)
Recurrent	51 (40.5)
Residual	6 (4.7)

*Presented as mean ± standard deviation.

Table II. Clinicopathologic characteristics of tumor

Characteristics	*No. of patients (%)*
Tumor classification	
Benign	29 (23)
Malignant	97 (77)
Tumor original site	
Maxilla	48 (38.1)
Mandible	15 (11.9)
Salivary gland	19 (15.1)
Oral mucosa	11 (8.7)
Paranasal sinus	5 (4)
Facial skin	5 (4)
Subcranial fossa	16 (12.7)
Facial bone	4 (3.2)
Neck	3 (2.3)
Tumor size (n = 116 cases)	
≤ 4 cm	44 (37.9)
> 4 cm and ≤ 8 cm	55 (47.4)
> 8 cm	17 (14.7)
Pathology	
Squamous cell carcinoma	36 (28.6)
Adenoid cystic carcinoma	19 (15.1)
Osteosarcoma	7 (5.6)
Ameloblastoma	6 (4.8)
Pleomorphic adenoma	5 (4)
Fibrosarcoma	5 (4)
Mucoepidermoid carcinoma	4 (3.2)
Acinic cell carcinoma	4 (3.2)
Ameloblastic carcinoma	4 (3.2)
Others	36 (28.6)
Location in skull base	
Anterior	7 (5.6)
Middle	116 (92.1)
Anterior and middle	3 (2.3)
Tumor invasion	
Subcranial soft tissue invasion	63 (50)
Partial or through-and-through bone invasion	56 (44.4)
Dura mater or brain parenchyma invasion	7 (5.6)

adenoid cystic carcinoma (15.1%) being the 2 most common. Details of the pathologic diagnoses are provided in Table S1. More than half the tumors were greater than 4 cm in diameter (n = 116). The most frequent diagnosis was adenoid-derived tumor for tumors less than 4 cm in size, whereas epithelial-derived tumor was the diagnosis for those greater than 8 cm in size. Of the total tumors, 38.1% originated in the maxilla, followed by those originating in the salivary gland region. Almost all of the tumors (92.1%) were located in the middle SB region. In terms of SB involvement, 56 tumors (44.4%) invaded the SB bone partially or through and through, whereas the dura mater or the brain parenchyma was involved in 7 cases (5.6%).

Treatment

After preoperative discussion regarding multidisciplinary treatment, all of the patients underwent gross total craniofacial resection of tumors; the characteristics of treatment are listed in Table III. The lip−submandibular−neck approach was the most frequently applied (37.3%). Through-and-through SB bone resection and dura resection were performed in 31 (24.6%) and 11 (8.7%) patients, respectively. For malignant neoplasms, an intraoperative frozen section was routinely performed for acquisition of safe margins and subsequent treatment planning. Pathologic positive margin was found in 18 cases (18.6%). A total of 80 patients (63.5%) underwent simultaneous craniofacial reconstruction with either local flaps or vascularized free flaps for the defects of SB soft and hard tissues, of which the anterolateral thigh myocutaneous flap ranked first (31.3%). For those with dura impairment, free flaps and fascia lata and dura substitutes were used for preventing leakage of cerebrospinal fluid and for dura mater repair. Tracheotomy was performed in 59 cases (46.8%). Postoperative complications were detected in 14 cases (11.1%). Cerebrospinal fluid leakage occurred in 3 patients, who were transferred to the neurosurgery department of the First Affiliated Hospital of Sun Yat-sen University for further treatment. Wound infection was found in 7 cases, whereas hospital-acquired pneumonia occurred in 3 cases, which ranked the first and second most common complications, respectively. A total of 23 patients (18.3%) received postoperative radiotherapy, and 4 patients received chemotherapy after surgery. Chemoradiotherapy was administered to 19 cases (15%). Because

Table III. Treatment characteristics

Characteristics	*No. of patients (%)*		
	All(N = 126)	*Malignant(n = 97)*	*Benign(n = 29)*
Surgery time (hour)*	7.1 ± 0.3	7.0 ± 0.4	4.2 ± 0.4
Amount of bleeding (mL)*	1361.2 ± 120	1332 ± 96.2	1231 ± 380.7
Surgical approach			
Anterior midface approach	29 (23)	23 (23.7)	6 (20.7)
Lateral approach	38 (30.2)	26 (26.8)	12 (41.4)
Transoral approach	12 (9.5)	11 (11.3)	1 (3.4)
Lip−submandible−neck approach	47 (37.3)	37 (38.2)	10 (34.5)
Surgical margin†			
Negative	79 (81.4)	79 (81.4)	–
Positive	18 (18.6)	18 (18.6)	–
Skull base resection			
Soft tissue resection	39 (31)	26 (26.8)	13 (44.8)
Partial bone resection	45 (35.7)	39 (40.2)	6 (20.7)
Through-and-through bone resection	31 (24.6)	24 (24.7)	7 (24.1)
Partial dura resection	11 (8.7)	8 (8.2)	3 (10.3)
Reconstruction			
No	46 (36.5)	31 (32.0)	15 (51.7)
Yes	80 (63.5)	66 (68.0)	14 (48.3)
Type of flap‡			
Temporalis myofascial flap	9 (11.3)	6 (9.1)	3 (21.4)
Anterolateral thigh myocutaneous flap	25 (31.3)	24 (36.4)	1 (7.1)
Pectoralis major myocutaneous flap	6 (7.5)	6 (9.1)	0 (0)
Fibular osseomyocutaneous flap	4 (5)	2 (3)	2 (14.3)
Sternocleidomastoid myocutaneous flap	11 (13.8)	9 (13.6)	2 (14.3)
Titanium mesh only or combined with flap	7 (8.8)	4 (6.1)	3 (21.4)
Others	18 (22.3)	15 (22.7)	3 (21.4)
Tracheotomy			
No	67 (53.2)	46 (47.4)	21 (72.4)
Yes	59 (46.8)	51 (52.6)	8 (27.6)
Complication			
No	112 (88.9)	83 (85.3)	29 (100)
Yes	14 (11.1)	14 (14.7)	0 (0)
Hospitalization (day)*	26.5 ± 1.2	27.1 ± 1.3	23.4 ± 2.5
Adjuvant therapy			
No or lost contact	80 (63.5)	51 (52.6)	29 (100)
Radiotherapy	23 (18.3)	23 (23.7)	0 (0)
Chemotherapy	4 (3.2)	4 (4.1)	0 (0)
Radiotherapy + Chemotherapy	19 (15)	19 (19.6)	0 (0)

*Presented as mean ± standard deviation.
†Refer to the malignant tumors only.
‡Refer to the cases with construction.

of the large proportion of recurrent cases, 4 patients were reirradiated despite their previous radiotherapy history.

Follow-up and survival analysis

Except for the 18 patients who were lost to follow-up at the beginning of hospital discharge, a total of 108 patients were regularly followed up and included in the survival analysis (Figure 2). The mean follow-up period in our series was 38 months (range 1-192 months). In the course of the present study, 37 patients died as a result of the disease. Nine of them died as a result of severe general disease caused by dysphagia, and 6 died as a result of unknown causes. The remaining patients experienced progression of tumor, 3 experienced distant metastases, and 19 experienced local and regional recurrence. Kaplan-Meier analysis showed the estimated 1-year, 3-year, and 5-year OS rates as 78.8%, 68.2%, and 54.4%, respectively. The median time to recurrence was 35.5 months (range 1−192 months). A total of 28 patients developed recurrence, and 21 of them had local recurrence, whereas the remaining patients had regional recurrence. The estimated 1-year, 3-year, and 5-year RFS rates were 77.4%, 66.8% and 63.8%, respectively.

In our series, because the OS rates between benign and malignant tumors were significantly different (Figure 3; $P < .05$), patients with malignant neoplasms were separated for further analysis of the OS and RFS rates. On univariate analysis of OS in all of the patients (Table IV), tumor classification, sex, reconstruction,

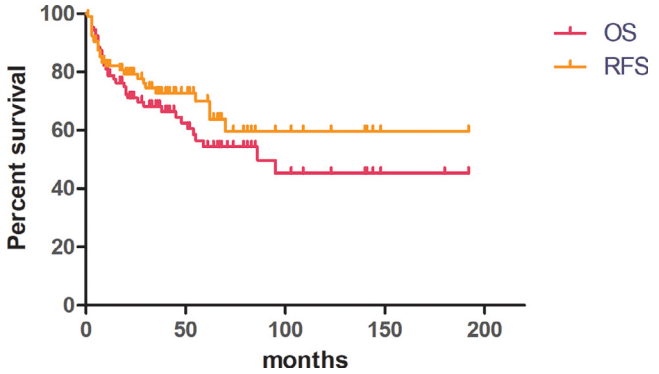

Fig. 2. Overall survival and recurrence-free survival of the patients who underwent craniofacial surgery. Analysis by the Kaplan-Meier method. *OS,* overall survival; *RFS,* recurrence-free survival.

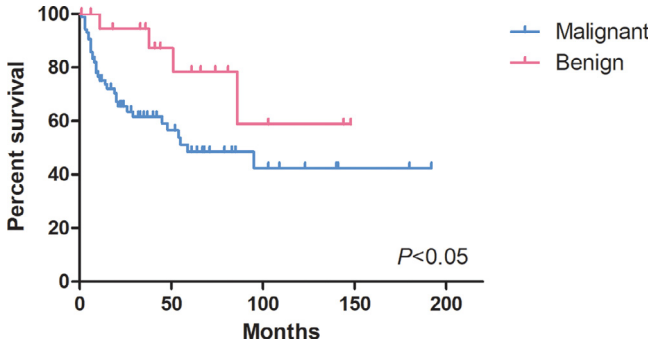

Fig. 3. Kaplan-Meier analysis of overall survival according to the tumor classification. Analysis by the Kaplan-Meier method and log-rank test.

and postoperative complications were the prognostic factors for survival ($P < .10$). Reconstruction and postoperative complications were independent predictors on multivariate analysis ($P < .05$). In the malignant group (Table V), sex, reconstruction, postoperative complications, postoperative radiotherapy, recurrence, and metastasis were potentially predictable for OS ($P < .10$). Statistically, after multivariate analysis, postoperative radiotherapy, recurrence, and metastases were the independent predictors ($P < .05$). For the RFS rate of all of the patients, tumor invasion, reconstruction, and postoperative complications were found to be the potential risk factors on univariate analysis ($P < .10$), whereas postoperative complications were the only independent risk factor ($P < .05$). In the malignant group, reconstruction, postoperative complications, and postoperative radiotherapy were the potential prognostic factors for RFS ($P < .10$). The latter 2 factors were found to be the independent factors on multivariate analysis of RFS ($P < .05$).

DISCUSSION

Oral and maxillofacial tumors involving the SB are rare and heterogeneous; thus, there is limited literature on studies with a relatively large population of patients. This study with 126 patients treated with CFS in a specialized tertiary hospital in southern China, during the 17-year period from 2000 to 2017, aimed to analyze the clinicopathologic characteristics of these tumors, treatment efficacy of CFS, and the potential risk factors that may impact OS and RFS.

Management of tumor heterogeneity can be challenging, not to mention dealing with vital structures and surgical access to the SB during CFS. These tumors in the oral and maxillofacial region can be epithelial, adenoid, osteogenic, and of other origins, resulting in different behaviors.[5,11,13] In our study, malignant neoplasms derived from the epithelium or a gland showed a significant predominance, which was in accordance with some previous articles. An international collaborative study of 1307 patients established the benchmark for CFS in the treatment of malignant SB tumors.[14] As shown by its results, tumor-related variables, such as histologic type, adversely impact survival. Shah et al.[17] also showed that tumor pathology is an important indicator of treatment outcomes. However, in our analysis, pathology was not related to OS or RFS. However, we did identify that compared with tumors of other origins, epithelial tumors had a worse prognosis, with shorter survival times and higher relapse rates.

Tumor resection was guided by tumor extension or invasion. The deeper the intracranial extension, the

Table IV. Prognostic factors for OS and RFS in all patients

Variables	*OS*					*RFS*				
	5-year, %	*Univariate*		*Multivariate*		*5-year, %*	*Univariate*		*Multivariate*	
		X^2	*P value*	*HR (95% CI)*	*P value*		X^2	*P value*	*HR (95% CI)*	*P value*
Tumor classification										
Benign	78.5					−−				
Malignant	48.4	4.14	**.042**	–	NS	–	–	–	–	–
Sex										
Male	48.0					57.7				
Female	62.2	2.75	**.097**	–	NS	69.9	0.37	.544		
Age										
< 60 y	62.3					54.2				
≥ 60 y	51.1	1.76	.185			37.6	0.40	.528		
Pathology										
Epithelial	39.5					44.3				
Adenogenous	61.8					66.5				
Others	60.0	4.26	.119			72.2	1.358	.507		
Tumor invasion										
Subcranial soft tissue invasion	63.6					74.1				
Partial or through-and-through bone invasion	49.4					58.9				
Dura mater or brain parenchyma invasion	30.0	1.29	.524			0.0	4.71	**.095**	–	NS
Skull base resection										
Soft tissue resection	61.7					68.1				
Partial bone resection	57.1					62.0				
Through-and-through bone resection	48.3					62.9				
Partial dura resection	48.6	0.91	.824			35.7	0.31	.958		
Reconstruction										
No	77.5					80.7				
Yes	42.5	6.99	**.008**	2.40 (1.03-5.60)	**.042**	51.1	3.20	**.074**	–	NS
Complications										
No	59.0					69.7				
Yes	0.0	30.22	**.001**	6.46 (2.57-15.74)	**0.001**	0.0	29.71	**.001**	8.88 (3.29-23.97)	**.001**
Postoperative radiotherapy										
No	53.4					61.8				
Yes	55.0	0.98	.323			65.7	1.46	.227		

Univariate analysis was tested with log-rank test. Multivariate analysis was tested with Cox regression model.
CI, confidential interval; *HR,* hazard ratio; *NS,* no significant; *OS,* overall survival rate; *RFS,* recurrence-free survival rate.

higher was the possibility of vital structures being excised, leading to a larger defect for reconstruction.[18] In agreement with the largest international cohort study, the findings by Ma et al.'s study[5] indicated that the extent of SB involvement was an independent adverse factor affecting OS. Likewise, we found that patients with thorough-and-thorough bone or dura mater invasion or resection had a shorter 5-year OS. Reconstruction with watertight dura closure and vascularized cover after CFS of an SB tumor was of great importance. With the reliable isolation of intra- and extracranial contents, CFS can help with postoperative wound healing, radiation tolerability, and cosmetic compensation.[19-21] In the Thakker et al.[22] study, vascularized flaps, such as radial forearm free flap, anterolateral thigh flap, and thoracodorsal artery perforator free flap, were suited for anterior or middle SB defects. The bulk of tissue required was larger in an oral and maxillofacial tumor involving the SB, making the anterolateral thigh flap being ranked the first-choice flap in our study. Our survival analysis showed that reconstruction was an adverse factor, which might have been the result of more severe diseases in these patients.

It cannot be overemphasized that obtaining a clear margin in the resection of malignant tumors is of great importance. CFS can provide 3-dimensional access to the SB, ensuring en bloc resection with a histologically

Table V. Prognostic factors for OS and RFS in patients with malignant tumors

Variables	*OS*					*RFS*				
	5-year, %	*Univariate*		*Multivariate*		*5-year, %*	*Univariate*		*Multivariate*	
		X^2	*P value*	*HR (95% CI)*	*P value*		X^2	*P value*	*HR (95% CI)*	*P value*
Sex										
Male	36.4					46.0				
Female	63.2	5.49	**.019**	–	NS	66.3	1.57	.211		
Age										
<60 y	47.1					60.4				
≥60 y	52.4	0.43	.515			37.0	0.10	.751		
Surgical margin										
Negative	51.1					60.1				
Positive	33.9	2.35	.125	–	–	36.4	2.21	.137		
Pathology										
Epithelial	39.5					44.3				
Adenogenous	61.9					66.9				
Others	43.6	2.995	.224			56.1	0.70	.705		
Tumor invasion										
Subcranial soft tissue invasion	49.8					57.8				
Partial or through-and-through bone invasion	50.0					54.4				
Dura mater or brain parenchyma invasion	33.3	0.36	.835			33.3	1.85	.397		
Skull base resection										
Soft tissue resection	44.5					44.4				
Partial bone resection	53.9					58.3				
Through-and-through bone resection	48.7					59.7				
Partial dura resection	34.3	0.63	.891			66.7	0.87	.833		
Reconstruction										
No	77.1					81.0				
Yes	34.4	5.50	**.019**	–	NS	41.2	3.50	**.061**	-	NS
Complications										
No	53.7					63.2				
Yes	0.0	22.45	**.001**	–	NS	0.0	23.34	**.001**	8.12 (2.87-22.95)	**.001**
Postoperative radiotherapy										
No	41.4					45.1				
Yes	55.0	4.164	**0.041**	0.03 (0.01-0.42)	**.008**	65.7	4.53	**0.033**	0.43 (0.19-1.00)	**.049**
Recurrence										
No	85.5					–				
Yes	17.0	38.56	**.001**	11.92 (2.59-54.83)	**.001**	–	–	–		
Metastases										
No	84.2					–				
Yes	22.2	6.35	**.012**	0.01 (1.49-28.54)	**.013**	–	–	–		

Univariate analysis was tested with log-rank test. Multivariate analysis was tested with Cox regression model.
CI, confidential interval; *HR,* hazard ratio; *NS,* no significant; *OS,* overall survival rate; *RFS,* recurrence-free survival rate.

safe margin of bone, soft tissue, and nerve. Recently, endoscopic transnasal technique and robotic surgery have been proven to have the ability of extirpation of anterior and central SB tumors.[23,24] However, those tumors tend to be small and are located more anteriorly and centrally.[25,26] Thus, in the case of tumors in the maxillofacial region, flexible approaches, functional concerns, and facial aesthetics must be addressed by the multidisciplinary team. The craniofacial approach should be chosen on the basis of the location and extension of the SB tumor. The combination of 2 or more craniofacial approaches or neurosurgical and craniofacial approaches as a 2-stage method can sometimes be considered to gain 3-dimensional access.[10,27] Moreover, as Ma et al.[5] have indicated, such factors as the extent of SB invasion, margin status, and pathologic characteristics should be taken into consideration when performing CFS.

Management of postoperative complications should be kept in mind during the entire treatment. Although

the postoperative mortality rate was maintained at less than 5%, overall complication rates ranging from 25% to 65% were reported in a previous series.[5,11,28,29] Patients who have systematic diseases, preoperative radiotherapy, and more intracranial extension were more likely to suffer from postoperative complications, as indicated by an international collaborative study.[28] The lower postoperative complication rate in our study could be attributed to the small number of tumors invading the dura mater and the fact that most cases were primarily treated. Nonetheless, the complications were similar, with wound complications ranking the first. Because of the site of tumors and tracheotomy, dysphagia and aspiration developed easily in our patients, causing a higher rate of hospital-acquired pneumonia.

This study was performed in a retrospective setting with relatively high heterogeneity and a short follow-up period with the patients in a single center. We cannot fully account for the selection bias on the patient- or surgery-related variables in this study. In addition, about 16.7% of cases were lost to contact during the follow-up. Thus, although the number of patients enrolled was larger compared with those in similar previous studies, the survival analysis did not have strong enough statistical power to provide significant predictive factors. More standard retrospective and prospective multicenter clinical studies should be conducted to investigate the management of such SB tumors. Enrollment of patients and follow-up work should be continued, taking into consideration that quality of life is an added concern among these patients.

CONCLUSIONS

Oral and maxillofacial tumors involving the SB have various clinicopathologic characteristics. Postoperative complications, radiotherapy, recurrence, and metastasis have a negative impact on the survival. Although these tumors are diverse and complex, with interdisciplinary cooperation, the prognosis can be favorable with acceptable OS and RFS. Thus, cranial facial resection and reconstruction can be a safe and effective option for treating oral and maxillofacial tumors involving the SB.

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SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.oooo.2020.06.007.

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Reprint requests:

Gui-Qing Liao
Department of Oral and Maxillofacial Surgery
Guanghua School of Stomatology
Guangdong Provincial Key Laboratory of Stomatology
Sun Yat-sen University
56 Lingyuanxi Road
Guangzhou
510055
People's Republic of China
Drliaoguiqing@hotmail.com