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ORIGINAL ARTICLE

Surgical complications of extraspinal tumors in the cervical spine: a report of 110 cases and literature review

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Abstract

Purpose To assess the safety of surgical intervention for extraspinal tumors in the cervical spine.

Methods 110 consecutive patients were enrolled and followed-up at least 12 months or until death. The complication rates and risk factors were documented and analyzed.

Results The quality of life in the surviving patients was significantly improved. The overall local recurrence rate was 17.3%. Twenty percent of patients developed distant metastasis. The perioperative mortality rate (30 days after surgery) was 0.9%. The complication related mortality was 1.8%. The rates of overall complication and major complication were 41.8% and 20.9%, respectively. The independent predictors for overall complications were Karnofsky score <60, multisegmental resection, and operation time >3 h. The independent predictors of major complications were comorbidity, tumor location at C1–C2, and combined approach.

Conclusions Surgery for cervical spine tumor could improve the quality of life, though it might be accompanied with high morbidity and mortality. It is a highly demanding procedure; however, it can be performed to an acceptable degree of safety.

Keywords Spine tumor · Cervical · Surgery · Complication · Mortality

Introduction

The complication rate of spinal tumor surgery is relative high [1, 2]. It is essential for spine surgeons to specifically focus on the complications of spinal tumor surgeries. It was 10.4% (3269/31,380) of overall spine surgery in the Japanese 2011 nationwide survey, while the incidences of intraoperative and postoperative complication in primary malignant tumor, primary benign tumor, and metastatic tumor were 22.0% (18/82), 15.3% (103/674), and 18.3% (71/389), respectively [2]. The majority of previous studies focused on complications in the thoracolumbar spine or whole spine [1–19]; however, few were specialized in the cervical spine. As reported by the Thomas Jefferson University Hospital, the overall incidence of early postoperative complication in 121 consecutive cases with cervical spine diseases was 47.1%, among these, the incidence in patients with tumors was even higher, up to 70.0%, compared to 48.4% in patients with traumas, 44.0% in patients with degenerative diseases, and 40.0% in patients with infections [20].

This study aimed to assess the effectiveness and safety of cervical spine tumor surgeries of our tertiary hospital.

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Patients and methods

The inclusion criteria were cervical spine tumor (extraspinal lesion) surgery under general anesthesia performed between January 2012 and April 2015 with a minimum 12-month follow-up or follow-up until death. The exclusion criteria were only biopsy and mini-invasive treatments, such as percutaneous radiofrequency ablation and percutaneous vertebral augmentation (vertebroplasty or kyphoplasty).

Collection of demographic, operative, and follow-up data included sex, age, diagnosis, comorbidity, previous treatment(s), tumor location, surgical record, adjuvant therapy, pain (a 10-point visual analog scale, VAS), neurologic status according to the Frankel scale, Karnofsky performance status score, Eastern Cooperative Oncology Group (ECOG) score, complication(s), local recurrence (LR), and date and cause of death. Postoperatively, all patients were followed-up for 3, 6, 9, and 12 months, and then regularly according to the pathology. Data were obtained from the surgical databases.

Complications were classified as major and minor. Any complication that appeared to substantially alter an otherwise smooth and expected course of recovery was described as a "major" complication, while others were defined as "minor" complications [21]. Complications were divided into intraoperative, early postoperative (within the first 30 days after surgery), and late postoperative (after 30 days). Perioperative mortality was determined on the basis of the World Health Organization definition (within 30 days of surgery). Prolonged postoperative endotracheal intubation was defined as the need for postoperative ventilator support after operation [22]. The planned sacrifices of important structures, such as nerve root resections performed for oncological purposes were not considered as complications. Cases were defined as "non-intact cases" when a previous open biopsy had been performed or there was evidence of tumor recurrence; all other cases were classified as "intact cases". Local recurrence was confirmed by magnetic resonance imaging (MRI) or positron emission tomography–computed tomography [11].

Surgeries

Lesions were evaluated in accordance with the Weinstein-Boriani-Biagini (WBB) staging system [23] and the Enneking staging system. Intralesional excision and *en bloc* resection were defined as described by Boriani et al. [1, 23]. "Extracapsular intralesional" refers to the piecemeal removal of the entire tumor including the peripheral healthy tissue.

Variables analyzed

Variables were analyzed as follows: age (<65 or ≥65-years-old), sex (male or female), origin of tumors (metastatic or primary), comorbidity (no or any comorbidity), intactness (intact or non-intact), radiotherapy (yes or no), chemotherapy (yes or no), preoperative Karnofsky score (<60 or ≥60) [24], tumor location (C1–C2 or C3–C7), number of resected segments (1 or >1), surgical approach (single or combined approach), surgery (tumor curettage/debulking or *en bloc*/extracapsular intralesional excision), operation time (≤3 or >3 h), and intraoperative blood loss (≤500 or >500 ml). A Karnofsky score of 60 implies that the patient needs occasional assistance, but is able to care for most of their personal needs. The operation time and intraoperative blood loss were grouped by the medians as the cut-off values.

Statistical analysis

All data analyses were performed using SPSS version 18 (SPSS Inc., Chicago, IL, USA). The Kolmogorov–Smirnov test was used to access the normality of distribution. Summary statistics were reported as medians with interquartile ranges (IQRs) for data with abnormal distribution or as mean ± standard deviations for data with normal distribution. Statistical analysis was performed by Chi-square test or Fisher's exact test for discrete variables. The non-parametric Wilcoxon test was used to evaluate the difference between paired samples. Kaplan–Meier method was used to analyze local recurrence and overall survival. Risk factors of complications were analyzed using binary logistic regression with backward elimination. Univariate analysis was performed and covariates with a value of $P < 0.10$ were enrolled in the multivariate model. A value of $P < 0.05$ was considered significant.

Results

In total, 162 consecutive patients with cervical spinal tumors were treated by the same team: 42 only had biopsy, 6 had percutaneous radiofrequency ablation or percutaneous vertebroplasty, 1 had both cervical and lumbar spine tumor surgeries, 3 with metastases were lost to follow-up after discharge; and only 110 patients were eligible for this study.

Histologic analysis

There were 68 (61.8%) primary tumors and 42 (38.2%) metastatic tumors (Table 1). The most common primary tumors were chordoma (18 cases), osteoblastoma (12

Table 1 The clinical features of the 110 patients who received surgical treatment for cervical spine tumors

Variable	Value[a]
Age (years)	50.5 (28.0–61.0)
Male	63 (57.3)[b]
Comorbidity	33 (30.0)[b]
Non-intact case	7 (6.4)[b]
Radiotherapy	48 (43.6)[b]
Chemotherapy	20 (18.2)[b]
Pathologic fracture	44 (40.0)[b]
Karnofsky score <60	21 (19.1)[b]
Visual analog scale score	6 (3–8)
Primary tumor	68 (61.8)[b]
Surgery	110 (100.0)[b]
Benign tumor	14 (12.7)[b]
Tumor curettage/debulking	14 (100.0)[b]
Aggressive benign/Malignant tumor	54 (49.1)[b]
Intralesional *en bloc* excision	6 (11.1)[b]
Extracapsular intralesional excision	32 (59.3)[b]
Tumor curettage/debulking	16 (29.6)[b]
Metastatic tumor	42 (38.2)[b]
Extracapsular intralesional excision	2 (4.8)[b]
Tumor curettage/debulking	40 (95.2)[b]
Multisegmental resection	38 (34.5)[b]
Approach	110 (100.0)[b]
Anterior	28 (25.5)[b]
Posterior	46 (41.8)[b]
One staged combined	5 (4.5)[b]
Two staged combined	31 (28.2)[b]
Operation time (minutes)	180.5 (108.8–359.3)
Intraoperative blood loss (ml)	500.0 (187.5–1625.0)
Reconstruction	110 (100.0)[b]
Anterior mesh with plate	28 (25.5)[b]
Posterior screw rod system	45 (40.9)[b]
Both anterior and posterior fixation	34 (30.9)[b]
No fixation	3 (2.7)[b]
Follow-up time (months)	14.5 (13.0–24.3)

[a] Median (interquartile range)

[b] Number of patients (%)

cases), and giant cell tumor of the bone (11 cases). The most common metastatic tumors originated from lung (12 cases), thyroid (8 cases) and plasmocytoma (7 cases).

Distribution of tumors

There were 36 (32.7%) tumors located in C1–C2, and 74 (67.3%) in C3–C7, including 3 lesions extending to T1, 2 lesions extending to T2, and 1 lesion extending to T3. There were 31 (28.2%) lesions that involved the anterior column (WBB zones 4–9), 12 (10.9%) lesions were located in the posterior column (WBB zones 1–3, 10–12), and 67 (60.9%) lesions involved both anterior and posterior columns. Sixty-seven (60.9%) lesions involved a single vertebra, 24 extended to 2 adjacent vertebrae, 14 to 3 vertebrae, 4 to 4 vertebrae and 1 involved 5 vertebrae. Eighty-four (76.4%) tumors extended into the epidural space (Layer D) and 85 (77.3%) extended into the paraspinal space (Layer A).

There were 39 primary benign tumors, 13 of which were classified as Stage 2 and 26 were classified as Stage 3. In the 29 primary malignant tumors, 1, 18, 1, and 9 tumors were of Stage IA, IB, IIA, and IIB, respectively.

Clinical evaluation

The preoperative VAS score was 7–10 in 52 patients, 5–6 in 20 patients, 1–4 in 25 patients and 0 in 13 (11.8%) patients. The preoperative Frankel grades were E in 51 patients, D in 50 patients, C in 5 patients, and B in 4 patients. The preoperative Karnofsky scores were ≥80 in 47 patients, between 60 and 80 in 42 patients, and <60 in 21 patients. The ECOG scores were 1, 2, 3, and 4 in 57, 40, 3, and 10 patients, respectively.

Surgery

The details of surgery, the approach and stability of reconstruction are shown in Table 1. In the 36 C1–C2 lesions, 25 underwent a single posterior approach; 11 had combined approaches including a one-stage posterior-transoral approach and 10 two-stage combined approaches (including 3 posterior-transoral, 2 posterior-transoral-submandibular, 4 posterior-submandibular and 1 posterior-transmandibular approach).

C1–C3 nerve root resection was performed for oncological reasons in 7 cases with C1–C2 spinal tumors.

Outcome of surgery

At the final follow-up, 89 (80.9%) patients were alive and 21 (19.1%) were dead. The median VAS score declined significantly from 5 (IQR 3–8) preoperatively to 0 (IQR 0–3) postoperatively ($P < 0.001$). The neurological status (Table 2) was improved in 27 (30.3%) patients after surgery, unchanged in 58 (65.2%), and deteriorated in 4 (4.5%) patients. The median Karnofsky score increased significantly from 70 (IQR 60–80) preoperatively to 90 (IQR 70–90) postoperatively ($P < 0.001$). Patients' functions improved by one or more Karnofsky functional scale in 69.7% (62/89), remained the same in 20.2% (18/89), and deteriorated in 10.1% (9/89). The ECOG score was

Table 2 Preoperative and postoperative Frankel grades of 89 living patients at final follow-up

Post-op	Pre-op				
	B	C	D	E	Total
B	0	0	1	1	2 (2.2%)
C	0	0	1	0	1 (1.1%)
D	0	2	15	1	18 (20.2%)
E	2	1	22	43	68 (76.4%)
Total	2 (2.2%)	3 (3.4%)	39 (43.8)	45 (50.6%)	89 (100.0%)

decreased in 42 (47.2%) cases, unchanged in 44 (49.4%) and increased in 3 (3.4%) cases.

Complications

Of the 110 patients, there were 81 complications in 46 (41.8%) patients, including 17 intraoperative complications in 15 patients, 54 early postoperative complications in 38 patients and 10 late postoperative complications in 5 patients (Table 3).

Twenty-nine (26.4%) patients had a single complication, whereas 17 (15.5%) had >1 complication, including 2 complications in 10 patients, 3 complications in 4 patients, and 5, 7, and 8 in 1 patient each.

There were 45 major complications observed in 23 (20.9%) patients, and 36 minor complications in 29 (26.4%) patients. Only 12 (10.9%) of patients had one major complication, whereas 10.0% (11/110) patients presented with more than one major complication, of these, 6 had 2 major complications, 2 had 3 major complications, 2 had 4 major complications, and 1 had 7 major complications.

The most relevant major complications were deaths in two instances. For instance, one 53-year-old man with C2 chordoma (WBB zones 4–10, stage IB, Case 1) had preoperative radiotherapy and intralesional debulking through two-stage posterior-transoral combined approach, and had intraoperative VA injury. He was surgically treated for pharyngeal wound infection, wound dehiscence and delayed VA bleeding, then suffered from titanium mesh exposure and hemorrhagic shock, and died as a consequence of VA injury 38 days after the tumor resection.

The complication with the highest incidence was neurologic deficit (16/110, 14.5%) followed by prolonged postoperative endotracheal intubation (12/110, 10.9%), vertebral artery (VA) injury (7/110, 6.4%), pneumonia (6/110, 5.5%), and wound infection (5/110, 4.5%).

Predictors of complications

Overall complication The significant risk factors included preoperative Karnofsky score <60, metastasis, combined approach, multisegmental resection, curettage/debulking, operation time >3 h, and intraoperative blood loss >500 ml (Table 4). The independent predictors were preoperative Karnofsky score <60, multisegmental resection and operation time >3 h (Table 5).

Major complication Significant risk factors were comorbidity, C1–C2, combined approach, operation time >3 h and intraoperative blood loss >500 ml (Table 4). The independent predictors were comorbidity, C1–C2, and combined approach (Table 5).

Neurologic deficit Postoperative neurologic deficit occurred in 16 patients and was characterized by motor weakness and/or sensory abnormality. Of these, 2 patients with monoplegia had partial recovery 12 months after operation, and 1 patient with C5 palsy remained unchanged; 13 patients with transient neurologic deficits recovered completely after a mean period of 2.5 ± 2.0 months (median 3 months; range 1 week–6 months). Metastasis, combined approach, multisegmental resection, curettage/debulking and operation time >3 h were significant risk factors for neurologic deficit. By multivariable analysis, operation time >3 h (OR = 11.30, 95% CI 2.37–53.99, $P = 0.002$) and C1–C2 (OR = 0.18, 95% CI 0.04–0.87, $P = 0.033$) were independent predictors.

Prolonged postoperative endotracheal intubation Twelve (10.9%) patients had postoperative extubation at a median of 24 h (IQR 19.3–48.0 h; range 15–120 h) after the index operation and the others (89.1%) within less than 30 min of surgery. Prolonged postoperative endotracheal intubation was accompanied with pneumonia in four cases and tracheal intubation blockage followed by tracheotomy in one instance. This was associated with lower Karnofsky score (Karnofsky score <60 vs. ≥60; 6/21, 28.6% vs. 6/89, 6.7%; OR = 5.33, 95% CI 1.57–19.47, $P = 0.010$), and higher comorbidity (comorbidity vs. non comorbidity; 7/33, 21.2% vs. 5/77, 6.5%; OR = 3.88, 95% CI 1.13–13.29, $P = 0.041$).

VA Injury In the 7 cases with VA injuries, 6 were detected intra-operatively and successfully treated by suture or titanium clipping without sequelae; only one was identified postoperatively after a local deep infection and wound dehiscence, which caused delayed VA bleeding, hemorrhagic shock and finally death (Case 1). C1–C2 lesions had a higher risk of VA injury, compared with C3–

Table 3 Distribution of complications

Complications	*N* (%)
Intraoperative	17 (21.0)
Major	
VA injury	7
Monoplegia	1
Minor	
Transient neurologic deficit	5
Dura tear	3
Pleural tear	1
Early	54 (66.7)
Major	
Prolonged postoperative endotracheal intubation	12
Pneumonia	6
Sepsis	3
Wound infection requiring surgical debridement	3
Tracheal intubation blockage needed tracheotomy	2
C5 palsy	1
Monoplegia	1
Pulmonary embolism	1
Respiratory failure necessitating intubation	1
Death	1
Minor	
Transient neurologic deficit	8
Transient hypoxia	3
Urinary tract infection	3
Cerebral-spinal leakage	2
Wound infection	2
Asthma attack	1
Deep venous thrombosis	1
Laryngeal edema	1
Spinal epidural hematoma	1
Transitory liver incompetence	1
Late	10 (12.3)
Major	
Titanium mesh exposure	3
Death	1
Delayed VA bleeding requiring reoperation	1
Hemorrhagic shock	1
Minor	
Screw loosening	3
Urticaria	1
Total	81 (100.0)

VA vertebral artery

C7 lesions (C1–C2 vs. C3–C7; 5/36, 13.9% vs. 2/74, 2.7%; OR = 5.81, 95% CI 1.07–31.56, $P = 0.037$).

Wound infection There were five deep wound infections. One patient with C6 tumor had posterior wound infection, which required surgical debridement and the other four patients had infections in C1–C2 region. One patient had pharyngeal wound infection that led to delayed VA bleeding and death, 1 pharyngeal-submandibular wound infection was surgically debrided, and 1 pharyngeal and 1 posterior wound infection were cured by conservative treatment with antibiotics.

Screw loosening There were three cases of screw loosening. All happened at sites of anterior reconstructions. One was caused by a pharyngeal wound infection 7 months after the surgery and had no significant effect on spinal stability with solid fusion. One was due to local recurrence 21 months after surgery. One was caused by osteoporosis 2-month postoperatively. The last two cases were treated by Halo-vest for postoperative instability.

Local recurrence and metastasis

The overall rate of local recurrence was 17.3% (19/110) (Fig. 1). The median interval time of LR was 6 months (IQR 3–15 months; range 3–35 months) after surgery. Additional surgeries were required by 21.1% (4/19) of patients. Four out of 7 non-intact cases with primary tumors had LR.

Twenty percent (22/110) of patients developed distant metastasis, including 4 patients with primary tumors and 18 with metastatic tumors. In these 22 cases, 2 had LR before distant metastasis, including 1 with primary tumor and 1 with metastatic tumor.

Mortality

Death occurred in 21 (19.1%) patients (Fig. 1) with a mean follow-up of 9.0 ± 7.2 (range 1–25) months after the index surgery. The perioperative mortality rate was 0.9% (1/110). Two (1.8%) patients with C1–C2 chordoma died 6 and 38 days after surgery with major complications. There were 19 (17.3%) deaths from the disease with a mean follow-up of 9.8 ± 7.1 (range 2–25) months: 16 patients with metastatic tumors died of distant metastasis after a mean interval of 10.1 ± 7.3 (range 2–25) months, 1 patient with chordoma died of lung metastasis 2 months after surgery, 1 patient with a huge primitive neuroectodermal tumor (PNET) died of local recurrence 6 months after surgery, for tumor debulking, but refused to take radiotherapy or chemotherapy, and 1 patient with giant cell tumor of bone died of distant metastasis 16 months after surgery.

We reviewed the morbidity, perioperative mortality and LR following surgery for spinal tumors in the literature [1, 3–19] (Table 6). Inclusion criteria were cervical spine tumor, surgery and complication(s). Exclusion criteria were studies fewer than 30 cases, follow-up less than 3 months and publication before 2007.

Table 4 Risk factors for complications by univariable analysis

Variable	Overall complication				Major complication			
	Yes (%)	No (%)	OR (95% CI)	*P*	Yes (%)	No (%)	OR (95% CI)	*P*
Age ≥65-years-old	4 (8.7)	11 (17.2)	0.46 (0.14–1.54)	0.200	2 (8.7)	13 (14.9)	0.54 (0.11–2.60)	0.733
Male	26 (56.5)	37 (57.8)	0.95 (0.44–2.04)	0.893	15 (65.2)	48 (55.2)	1.52 (0.59–3.97)	0.386
Comorbidity	15 (32.6)	18 (28.1)	1.24 (0.54–2.82)	0.613	11 (47.8)	22 (25.3)	2.71 (1.05–7.01)	0.036
Karnofsky score <60	13 (28.3)	8 (12.5)	2.76 (1.04–7.35)	0.038	7 (30.4)	14 (16.1)	2.28 (0.79–6.56)	0.140
Radiotherapy	24 (52.2)	24 (37.5)	1.82 (0.84–3.92)	0.126	14 (60.9)	34 (39.1)	2.43 (0.95–6.22)	0.061
Chemotherapy	5 (10.9)	15 (23.4)	0.40 (0.13–1.19)	0.092	2 (8.7)	18 (20.7)	0.37 (0.08–1.70)	0.236
Non-intact	5 (10.9)	2 (3.1)	3.78 (0.70–20.42)	0.127	2 (8.7)	5 (5.7)	1.56 (0.28–8.62)	0.635
Metastasis	10 (21.7)	32 (50.0)	0.28 (0.12–0.65)	0.003	6 (26.1)	36 (41.4)	0.50 (0.18–1.39)	0.179
C1–C2	19 (41.3)	17 (26.6)	1.95 (0.87–4.36)	0.104	12 (52.2)	24 (27.6)	2.86 (1.12–7.36)	0.025
Combined approach	24 (52.2)	12 (18.8)	4.73 (2.01–11.10)	<0.001	13 (56.5)	23 (26.4)	3.62 (1.40–9.37)	0.006
Multisegmental resection	25 (54.3)	13 (20.3)	4.67 (2.01–10.83)	<0.001	11 (47.8)	27 (31.0)	2.04 (0.80–5.19)	0.132
Curettage/debulking	22 (47.8)	48 (75.0)	0.31 (0.14–0.69)	0.003	11 (47.8)	59 (67.8)	0.44 (0.17–1.11)	0.076
Operation time >3 h	33 (71.7)	22 (34.4)	4.85 (2.13–11.04)	<0.001	16 (69.6)	39 (44.8)	2.81 (1.05–7.52)	0.035
Intraoperative blood loss >500 ml	30 (65.2)	22 (34.4)	3.58 (1.61–7.94)	0.001	16 (69.6)	36 (41.4)	3.24 (1.21–8.67)	0.016

OR odds ratio, *CI* confidence interval

Table 5 Significant risk factors for complications by multivariable analysis

Variable	OR (95% CI)	*P*
Overall complication		
Karnofsky score <60	4.41 (1.35–14.42)	0.014
Multisegmental resection	4.32 (1.70–10.93)	0.002
Operation time >3 h	6.14 (2.35–16.00)	<0.001
Major complication		
Comorbidity	5.33 (1.65–17.17)	0.005
C1–C2	5.50 (1.73–17.48)	0.004
Combined approach	5.00 (1.71–14.58)	0.003

OR odds ratio, *CI* confidence interval

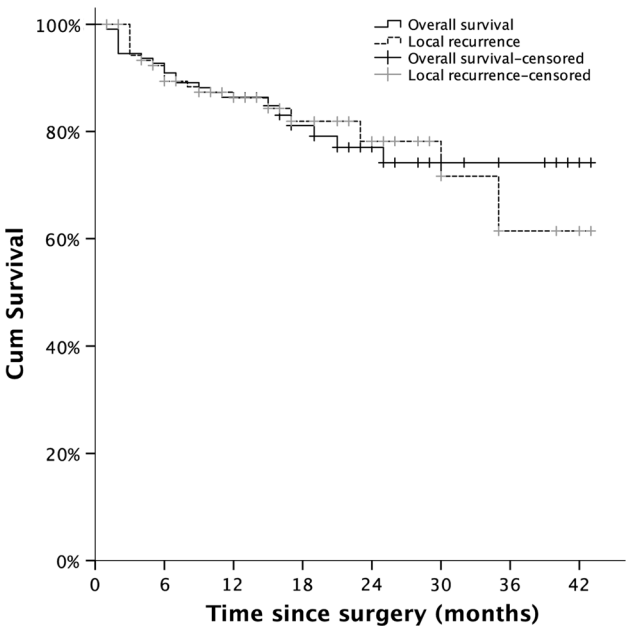

Fig. 1 The Kaplan–Meier graph of local recurrence-free survival and overall survival

Discussion

The complication rate of surgery for spine tumors was quite high, and ranged from 13.6 to 46.2% in the literature [1, 3–19]. The overall complication rate was 41.8% in the present study. The complication rate was mainly related to poor preoperative performance status (Karnofsky score <60) and the complexity of the tumor resection (multisegmental resection and operation time >3 h). Karnofsky score ≤60 was an independent predictor of any morbidity of splenectomy for hematological disorders [24]. Multisegmental resection was an independent predictor of major complication following *en bloc* resections in the spine [25]. Levels involved ≥3 was an independent predictor for overall complication following surgery for spinal metastasis [26]. A combined approach, neoadjuvant radiotherapy and neoadjuvant chemotherapy were independent predictors for surgical complications of *en bloc* resections [1].

In our study, the incidence of a major complication was 20.9%, though this varied in different surgeries and different studies. Boriani et al. reported that the major complication incidence was 32.9% (71/216) after *en bloc* resection for spinal tumors [1]. An international

Table 6 Morbidity, perioperative mortality and LR of spinal tumor surgery in the literature

Authors	Year	*N*	Location	Tumor	Mean FU months	Complication (%)	30-day mortality (%)	LR (%)
Zileli et al. [3]	2007	35	C	P	59.9	22.9	2.9	37.1
Ibrahim et al. [4]	2008	223	C/T/L/S	M	11.7[a]	21[b]	5.8	NR
Placantonakis et al. [5]	2008	90	C/T	P/M	21	26.7	0.0	NR
Choi et al. [6]	2010	97	Clivus/C	P	41[a]	6.2[c]	2.1	25.0
Arrigo et al. [7]	2011	200	C/T/L/S	M	8.0[a]	34.0	3.0	NR
Denaro et al. [8]	2011	46	C	M	27	21.7	NR	8.7
Kim et al. [9]	2011	57	C/T/L	M	4.3[a]	26.3	5.3	NR
Aizenberg et al. [10]	2012	51	C/T/L	M	8.1[a]	33.3	3.9	25.0
Cho et al. [11]	2012	46	C	M	16.9	10.9	0.0	39.1
Yasuda et al. [12]	2012	40	Skull base/C	P	56.5[a]	30.0	0.0	17.5
Liang et al. [13]	2013	92	C/T/L	M	22[a]	22.8	3.3	NR
Amendola et al. [14]	2014	103	C/T/L	P	NR	41.7	1.0	21.4
De et al. [15]	2014	60	C/T/L	M	10	36.7	NR	NR
Lee et al. [16]	2014	200	C/T/L/S	M	10.8	16.5	10.5	NR
Tatsui et al. [17]	2014	267	C/T/L/S	M	11.3[a]	13.1	3.4	15.4
Quraishi et al. [18]	2015	101	C/T/L/S	M	7.3	35.6	NR	NR
Petr et al. [19]	2015	166	C/T/L/S	M	16[a]	20.5	NR	6.0
Boriani et al. [1]	2016	216	C/T/L	P/M	45[a]	46.2	NR	15.2
Our study	2017	110	C	P/M	14.5[a]	41.8	0.9	17.3

LR local recurrence, *N* number, *C* cervical, *T* thoracic, *L* lumbar, *S* sarum, *P* primary, *M* metastatic, *FU* follow-up, *NR* not reported

[a] Median

[b] Major complication

[c] Cerebrospinal fluid leakage

multicenter prospective observational study reported the incidence of major complication in surgery for metastatic spinal tumors to be 21% [4]. A Korean study reported that the incidence was 12.3% (7/57) in surgery for nonambulatory patients with epidural spinal metastasis [9]. The incidence of a major complication might be affected by several factors and was higher in patients with C1–C2 tumors, combined approach surgeries and comorbidities. While a combined approach was an independent predictor for major morbidity of *en bloc* resections [1, 25], Charlson Comorbidity Index was the only independent predictor of complications within 30 days of surgery for spinal metastases [27].

Neurological complications (1.4%) were previously reported to be the second highest morbidity in all spinal surgeries [2], 4.3% (4/92) occurred in surgery for spinal metastases [13] and 10% (6/60) occurred in corpectomies for spinal metastases [15]. However, neurological complications were found to be the most frequent complication in this study (14.5%). To achieve ideal visualization and tumor-free boundary, traction and even resection of nerve roots are sometimes inevitable during tumor resection. Tumor location at C3–C7 and longer operative time had higher risk of neurologic deficit.

Prolonged postoperative endotracheal intubation was usually accompanied with an increased morbidity, such as sepsis, pneumonia, and multiorgan dysfunction [22, 28]. In our study, prolonged intubation led to 4 cases of pneumonia and 1 tracheotomy. Moreover, patients with a poor functional level or those with comorbidities tended to have higher risks of prolonged postoperative endotracheal intubation.

The incidence of VA injury was 6.4% in this study, higher than in the surgeries of degenerative cervical spinal diseases (0.20–1.96%) [29]. VA injuries did not cause permanent sequelae in 90% (99/110) of patients, but led to cerebellar infarcts in 5.5% (6/110) and death in 4.5% (5/110) patients [30]. Moreover, patients with C1–C2 tumors were more prone to VA injury than patients with C3–C7 tumors. Primary ligation and repair were the most effective methods of treating VA injury [29].

Limitations

There are several limitations of this research that should be acknowledged. This is a retrospective study lacking in randomization, and the absence of prospective data recalls did not allow us to identify precise rates of complications.

This study did not include enough patients to predict independent risk factors for each kind of complication. A prospective multicenter study would be appropriate.

Conclusion

Surgeries for cervical spine tumors could improve the quality of life by reducing pain, and improving neurological and functional levels. However, it might be accompanied with high morbidity and mortality. Surgery for cervical spine tumors is a highly complex procedure but can be performed to an acceptable degree of safety.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no competing interests.

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