International Journal of Surgery 33 (2016) 172–176

Contents lists available at ScienceDirect

International Journal of Surgery

journal homepage: www.journal-surgery.net

Original research

Prognostic factors affecting the surgical outcome of anterolateral benign tumors in the foramen magnum region

Chuanyuan Tao [a, 1], Xiaowei Liu [a, 1], Yuekang Zhang [a], Fan Liu [b, **], Chao You [a, *]

[a] Department of Neurosurgery, West China Hospital, Sichuan University, Chengdu, China
[b] Department of Critical Care Medicine, Neurosurgical Intensive Care Unit, West China Hospital, Sichuan University, Chengdu, China

HIGHLIGHTS

- This study firstly investigates the prognostic factors of all types of benign tumors located anterolateral to FM region.
- Far lateral approach was an independent predictor of postoperative neurological deficits.
- The role of the suboccipital approach to the anterolateral FM tumor may be underestimated and should be further evaluated.

ARTICLE INFO

Article history:
Received 10 June 2016
Received in revised form
25 July 2016
Accepted 5 August 2016
Available online 12 August 2016

Keywords:
Prognosis
Foramen magnum tumor
Far lateral approach
Surgical outcome

ABSTRACT

Introduction: Anterior and anterolateral tumors in foramen magnum region are rare and surgically challenging although most of them are benign. The optimal approach is debatable and prognostic factors affecting surgical outcome remains unclear. We aimed to identify factors including surgical approach determining postoperative outcome.

Methods: The data of 49 patients diagnosed benign tumors involving the anterior and anterolateral foramen magnum were retrospectively analyzed in our institution from January 2009 to January 2015. The demographic, clinicoradiological, surgical and follow-up information were collected. Primary surgical outcome was new neurological deficits. A multivariate analysis was performed to determine predictors of postoperative neurological deficits.

Results: Patients were operated on either via suboccipital (31 cases, 63.3%) or far lateral (18 cases, 36.7%) approach. Newly developed neurological deficits occurred in 11 (22.4%) patients, improved over time in 6 (12.2%) patients. 2 (4.1%) patients died within 3 month after operation and 2 (4.1%) suffered tumor recurrence. 44 (93.6%) out of 47 survivors had good functional outcome (postoperative Karnofsky performance score $\geq$80) at last follow-up period. Patients with postoperative new neurodeficits harbored tumors which tended to more frequently involve lower third clivus ($p = 0.083$), to be meningiomas ($p = 0.059$), were more likely to be removed through far lateral approach ($p = 0.010$) and have extradural extension ($p = 0.024$). Multivariate analysis showed that the far lateral approach was the sole predictor independently related to postoperative neurological deficits ($p = 0.029$).

Conclusions: The far lateral approach to benign tumors anterolateral to foramen magnum experienced higher rate of immediate new neurological deficits compared to suboccipital approach. The role of the suboccipital approach may be underestimated and should be further evaluated.

1. Introduction

The foreman magnum (FM) region is defined from lower third of the clivus to upper edge of the body of C2 anteriorly, jugular tubercles to upper aspect of C2 laminas laterally, and anterior edge of the squamous occipital bone and C2 spinous process posteriorly [1,2]. This site is a potential location of many tumors such as

* Corresponding author.
** Corresponding author.
E-mail addresses: tzy106@126.com (C. Tao), tcywjj106@163.com (X. Liu), zjneurosurg@163.com (Y. Zhang), liufan_ICU@126.com (F. Liu), tcy106@163.com (C. You).
[1] These authors contributed equally to this work.

http://dx.doi.org/10.1016/j.ijsu.2016.08.011
1743-9191/

meningioma, neurinoma, chordoma, and other uncommon entities including neurenteric cyst and metastatic tumor [3–6]. FM can be divided into anterior and posterior compartments by the dentate ligament [7]. Tumors located anterolaterally, anteriorly, posterolaterally, and posteriorly in the FM region account for 70%, 15%, 10%, and 5% of the patients, respectively [7,8]. Tumors posterior or posterolateral to the FM region can be safely resected through a midline suboccipital approach [9].

Although FM tumors seem to represent a disparate subgroup of diseases, they share many common anatomic features intimately related to surgical procedures. For instance, they mainly locate in front of the cervicomedullary junction, proximity to or involvement of the brainstem, the vertebral artery, the lower cranial nerves, upper cervical cord and the first two cervical nerve roots [5]. Therefore, FM tumors, especially those anteriorly/anterolaterally situated, should be discussed as a whole since they all are quite difficult to expose adequately, operate on and share similar symptoms, surgical approach and complications [10]. However, anterolateral benign tumors in FM region, mainly meningiomas and neurinomas, were usually described separately in previous studies [6,11–13].

Many issues including optimal surgical approach are still in debate and factors affecting the prognosis of patients with anterolateral FM benign tumors remains to be elucidated [9,14]. Current literature focused on FM meningioma (FMM) although FMM comprised no more than 50% of FM tumors [5,15] and cannot represent the full spectrum of disease in FM region. Additionally, very few was statistically analyzed to discuss the prognostic factors predicting the surgical outcome after FM tumor resection [5]. We performed a retrospective study to analyze factors determine the surgical outcomes in patients with benign tumors anterior/anterolateral to the FM region.

2. Material and methods

2.1. Patients

Forty-nine consecutive patients with benign tumors involving the anterior and anterolateral region of FM were included in this retrospective study between January 2009 and January 2015. All patients underwent tumor resection in our institution either via suboccipital midline or far-lateral approach. Patients undergoing biopsy only, with malignant lesions and with posterior or posterolateral FM lesions were also excluded from the present study. The demographic data, symptoms and signs, and duration of symptoms were collected from medical record. Tumor size, location, lower third clivus involvement, extradural extension were assessed from preoperative enhanced MRI scan. Tumor size was presented by the largest diameter of the tumor and tumor location was dichotomized as anterior and anterolateral. Surgical approach, tumor resection, severe adherence to vital neurovascular structures such as medulla, lower cranial nerves, vertebral artery, and upper cervical cord were evaluated from surgical record, among which the latter two indicators were collaborated by postoperative and preoperative MRI, respectively. Tumor type was gained from pathological report. Postoperative outcomes included immediate new neurological deficits, permanent neurological deficits, mortality and tumor recurrence during a mean follow up of 40.18 ± 21.24 months. Other surgical complications were observed as well. All these data were extracted from our electric records and entered into a computerized database. This study was approved by the Ethics Committee of West China hospital.

2.2. Surgical technique

The decision of which approach was selected depended on the individual condition and was made after a group discussion in our institution. As for far-lateral craniectomy, patients were placed in a park-bench position. An inverted “L” shape incision was created, beginning in the spinal process of the C4, ascending along midline to the inion and turning laterally to the base of mastoid, then vertically descending to the tip of the mastoid. After muscular dissection, VA was exposed and transposed. The range of craniectomy referred to the resection of posterior arch of atlas, the occipital resection resembling to the retrosigmoid craniotomy for cerebellar pontine access. The drilling of lateral mass or condyle depends on the extent of disease. Regarding the suboccipital approach, a linear midline incision was made from 1 cm above inion to the spinal process of C4. A small predominantly unilateral suboccipital craniotomy is followed by partial removal of the ipsilateral posterior atlas arch. Continuous monitoring of brainstem and lower cranial nerves electrophysiological function was performed in both surgical groups.

2.3. Statistics

Categorical variables were analyzed using χ^2 test, or Fisher's exact test. Unpaired *t*-test was used for parametric statistics. A multivariate analysis was performed to find independent predictors of postoperative neurological deficits using binary logistic regression analysis. Variables with P value < 0.1 in the univariate analysis were entered into the multivariate analysis model. A backward stepwise method was used and results with $P < 0.05$ were considered statistically significant. All data analyses were performed by using SPSS Statistics Version 22.

3. Results

3.1. Patients characteristics

The patients' data was summarized in Table 1 and Table 2. 19 male patients were identified and the age of patients was 48.6 ± 13.3 years on average ranging from 19 to 71 years. Cervical-occipital pain was the most frequent symptom followed by long tract sign and lower cranial nerve dysfunction. The mean duration of symptoms to admission was 19.8 ± 29.8 months. Tumor size varied from 10 to 64 mm with an average of 30 mm 19 (38.8%)

Table 1
Baseline and clinical variables related to postoperative neurological deficits.

Variable	Baseline (n = 49)	Neurodeficit (n = 11)	P
Age (years)	48.6 ± 13.3	50.9 ± 11.1	0.531
Male	19 (38.8)	6 (54.5)	0.298
Duration (months)	19.8 ± 29.8	18.5 ± 35.0	0.875
Tumor size (mm)	29.7 ± 12.3	33.8 ± 9.0	0.223
Location			
Anterior	19 (38.8)	6 (54.5)	0.298
Anterolateral	30 (61.2)	5 (45.5)	
Clivus involved	22 (44.9)	9 (81.8)	0.083
Extradural extent	13 (26.5)	0 (0)	0.024
Vital structure	10 (20.4)	4 (36.4)	0.201
Approach			
Suboccipital	31 (63.3)	3 (27.3)	0.010
Far lateral	18 (36.7)	8 (72.7)	
Resection degree			
Total	42 (85.7)	9 (81.8)	0.798
Subtotal	3 (6.1)	1 (9.1)	
Partial	4 (8.2)	1 (9.1)	
Pathology			
Meningioma	26 (53.1)	10 (90.9)	0.059
Neurinoma	14 (28.6)	1 (9.1)	
Neurenteric cyst	4 (8.1)	0 (0)	
Others	5 (10.2)	0 (0)	