Quality of Life After Craniovertebral Junction Meningioma Resection: Shaping the Real Neurologic and Functional Expectancies About These Surgeries in a Contemporary Large Multicenter Experience

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■ OBJECTIVE: **Craniovertebral junction (CVJ) meningiomas are one of the most surgically complex conditions in neuro-oncologic surgery. The aim of this work is to correlate our data with clinical outcome to outline factors leading to a worse functional prognosis.**

■ METHODS: **We analyzed sex, age, clinical presentation, topography, surgical approach, Simpson grade resection, postoperative lower cranial nerve deficits, consistency, histology, site of origin, presence of a capsule, and radiologic and clinical follow-up at 1, 6, and 12 months of 61 patients affected by CVJ meningiomas, operated on in our institution from 1992 to 2014.**

■ RESULTS: **78.7% of patients were women (mean age, 52.85 years); the onset symptom was pain in 65.5% of cases. The mean preoperative Nurick grade of the sample was 3.78; the most frequent histologic type was endotheliomatous (42.8%). We treated 22 patients with a posterior median approach (5 with lateral and 17 with posterolateral axial topography); in 39 cases (30 anterolateral and 9 anterior) we performed a posterolateral approach. Gross total removal was achieved in 85.2% of cases. We recorded a final follow-up step overall neurologic improvement in the cohort (average preoperative Nurick grade, 3.81, and at 12 months, 2.13). Twenty-nine patients presented with lower cranial nerve deficit (permanent or transient) and no statistically significant association was found between surgical approach and temporary or permanent postoperative complications.**

■ CONCLUSIONS: **We selected, in our experience, some predictors of worse outcome: preoperative sphincter impairment, absence of a capsule, cranial site of origin, a poor preoperative functional status, and firm consistency of the tumor.**

INTRODUCTION

Craniovertebral junction (CVJ) meningiomas account for 1.8%–3.2% of central nervous system (CNS) meningiomas,[1-3] and for up to 3.9% of the meningiomas involving the skull base.[4] They prefer the fifth or sixth decades of life[2,3,5-9] although they also occur in children.[10] Surgical management of these lesions is complex because of their tendency to encase/dislocate vital structures such as the vertebrobasilar complex and the lower cranial nerves (LCNs)[1,2,5-9,11,12]; they can also cause severe alterations of the bony anatomy of the CVJ, thus compromising the stability of the Co-C2 articular complex.[3,12] Advances in neuroimaging techniques,[13] intraoperative neurophysiology,[14] neuroanesthesiology, and a deeper knowledge of the surgical anatomy of the CVJ have significantly improved the neurologic and functional prognosis of this surgery and made gross total

Key words
- Atlas
- Craniospinal junction
- Meningioma
- Spine
- Tumors

Abbreviations and Acronyms
ANOVA: Analysis of variance
CN: Cranial nerve
CSF: Cerebrospinal fluid
CVJ: Craniovertebral junction
GTR: Gross total removal
KPS: Karnofsky Performance Status
LCN: Lower cranial nerve
MRI: Magnetic resonance imaging
NS: Nurick Scale
PLA: Posterolateral approach
PMA: Posterior midline approach
T1W: T1-weighted
VA: Vertebral artery

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removal (GTR) a more commonly achievable target,[2,8,12,15,16] although radical surgery cannot always be safely performed, and complications related to the procedure, which can seriously impair quality of life, are frequent and mortality is increased.[6,17,18]

In the present work, we analyze the short-term to mid-term results and discuss the salient clinical remarks of a cohort of patients with CVJ meningiomas, operated on in our institutional affiliated hospitals, to identify factors leading to a poor functional and neurologic outcome. This study addresses the increasing concern of surgeons and patients for precise preoperative assessment of the risk of neurologic sequelae and functional worsening after resection of a these surgically complex lesions to make patients aware of their postoperative quality of life, especially in the short-term to mid-term, at 1 year.

METHODS

Between December 1992 and July 2014, 69 patients with CVJ meningioma were operated on in the Divisions of Neurosurgery of our institution.

We excluded from the data collection patients with:

1. Intracranial extension of the disease over the lower third of the clivus (global extension of the clivus was measured on the sagittal T1-weighted (T1W) preoperative magnetic resonance imaging [MRI] scan);
2. Extensive involvement of the cervical spine below the upper limit of C3;
3. Incomplete clinical and surgical report or patients lost to follow-up.

Eight patients were excluded from this study (7 patients lost to follow-up and 1 incomplete preoperative and postoperative clinical report), leading to a final cohort of 61 patients. All patients included were undergoing their first CVJ surgery.

All patients underwent preoperative MRI of the cervical spine with T1W, T2-weighted, and T1W with gadolinium sagittal, coronal, and axial sequences; a cervical spine and CVJ computed tomography scan with angiographic reconstructions to investigate the course of the vertebral arteries was routinely added.

According to the preoperative imaging, an axial slice of the MRI scan centered on C1 was divided in a cross fashion to define if the maximum extension of the tumor was anterior, anterolateral, posterior, posterolateral, or lateral.

For each case we recorded age, sex, sequence of presentation, and duration of preoperative symptoms; preoperative neurologic assessment of motor, sensory, and sphincter functions was coded with the aid of the Nurick Scale (NS).[19] The functional conditions were assessed using the Karnofsky Performance Status (KPS).

For statistical purposes, preoperative KPS and NS grade were furthermore classified as dichotomous variables (KPS $\geq$70 and NS grade $\geq$3). Overall, improvement in KPS and NS as the variation between preoperative and 1-year follow-up NS and KPS evaluations was added to the final database.

Clinical follow-up consisted of clinical reevaluations performed at the outpatient service of our hospitals at 30 days and 6 and 12 months. In cases of clinical reevaluation after 12 months follow-up (which occurred in 16 patients), follow-up was prolonged but the last evaluation was not added to the clinical records because the primary end point of the study was the short-term to mid-term results to avoid inhomogeneity of follow-up.

Surgical complications, their management, and postoperative mortality were systematically recorded. LCN postoperative deficits, the precise impact of which on quality of life is not always easy to assess, were recorded as the coherent complication occurred (e.g., dysphagia, dysphonia, or aspiration pneumonia). Postoperative deficits were classified as stable or transient (as a dichotomous variable), and their management (mainly nasogastric tube feeding and tracheostomy) and time to resolution were recorded.

All patients were operated on with posterior approaches to the CVJ. A posterior midline approach (PMA), made performing a median suboccipital craniotomy with C1 laminectomy; a C2 laminotomy was chosen if the bulk of the tumor was purely posterior/posterolateral.

A posterolateral approach (PLA) made performing a paramedian suboccipital transcondilar craniotomy plus C1 and C2 hemilaminectomy was chosen if the bulk of the tumor was purely anterior/anterolateral. In PLA, no more than the posterior third of the condyle is resected to avoid postoperative CVJ instability.[3,6,7,20]

Ultrasonic Aspirator debulking was performed to avoid any traction on the spinal cord, nerve roots, and vascular structures.

Routine intraoperative neuromonitoring was introduced in 1998.

Resection was stopped if:

1. According to the experience of a senior surgeon, the risk of vertebral artery (VA) intraoperative rupture or cranial nerve (CN) deficits was deemed too high to pursue a GTR.
2. Intraoperative neuromonitoring (for procedures performed after 1998) outlined an evident risk of postoperative motor, sensory, or LCN new deficit.

The rationale for stopping the resection is that CVJ meningiomas are typically slow and indolent lesions, so it is generally advisable to leave a remnant rather than compromise the function.

We also recorded sagittal and axial topography of the lesion and histology. Axial topography was further classified as dichotomous variable anterior/anterolateral versus posterior/posterolateral.

Meningiomas were further classified as encapsulated and en plaque.

Sagittal topography was dichotomously coded in relation to intraoperatively detected site of origin of the meningioma as craniospinal or spinocranial. The site of origin was routinely registered in the surgical records. Craniospinal lesions originate intracranially (on the lower third of the clivus) and extend downward, whereas spinocranial lesions are meningiomas that originate in a spinal site and extend upward.

Intraoperatively, consistency of the tumor (classified as soft or firm) was always recorded and later reported in the surgical record. Aspirable lesions were soft, whereas lesions that needed progressive Cavitron Ultrasonic Aspirator debulking were firm.

The radiologic follow-up consisted of a CVJ radiographic dynamic study and MRI scan performed 30 days after surgery, then a

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