Spinal Cervical Meningiomas: The Challenge Posed by Ventral Location

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■ OBJECTIVE: **To evaluate the incidence, clinical presentation, operative techniques, and long-term outcome of spinal cervical meningiomas after surgery.**

■ METHODS: **Twenty-two patients harboring spinal meningiomas on cervical region were treated between 2004 and 2014 in our department. Diagnosis was made via magnetic resonance imaging and confirmed histologically. Microsurgical resection was performed through different surgical approaches according to location of the tumor. To remove the tumor, the posterior, far-lateral, and combined approaches were used, respectively, in 13 patients (56%), 8 patients (35%), and 2 patients (9%).**

■ RESULTS: **The mean follow-up was 40 ± 26.5 months. The most common site of dural attachment of meningioma was ventral or ventrolateral to the spinal cord. Macroscopic resection was considered complete in 55% of cases. Neurologic improvement was observed in 60% of cases. The rate of operative mortality and morbidity was high (26.5%). Five patients underwent postoperative radiotherapy according to the actual recommendation, and the overall recurrence rate was 9%.**

■ CONCLUSIONS: **Spinal meningiomas are benign tumors for which advances in imaging tools and microsurgical techniques have yielded better results. The goal of surgery should be the total resection, which significantly decreases the risk of recurrence with an acceptable morbidity. Cervical locations represent a challenge particularly for ventro and ventrolaterally located tumors. Despite the difficulty of performing a complete resection, the results obtained in this work advocate for the use of the far-lateral approach to manage meningiomas locate anterior to the neural axis.**

INTRODUCTION

Spinal meningiomas account for 25%–46% of primary spinal cord tumors.[1,2] They usually are benign, slow-growing, and occupy the intradural extramedullary space.[3,4] Between 15% and 30% are found in cervical locations.[5,6] Many classifications for spinal meningioma have been proposed to help guide the surgeon in choosing the best surgical approach and in understanding the relationship between the tumor and critical anatomical structures.

Either the posterior or far-lateral and, much more rarely, anterior surgical approaches, is used to remove this benign tumor.[7] In the cervical spine, local anatomy poses unique challenges, limiting the feasibility of aggressive resection. Contrary to the foramen magnum meningiomas, the extension of the surgical approach to the skull base is not necessary. This aspect, together with the aim of achieving a curative total excision of the tumor, makes the selection of the most appropriate surgical approach for cervical meningiomas (CMs) a significant challenge.

In the literature, no series has focused only on the cervical segment, there are no series focused only on meningiomas of the cervical segment, and the results of comprehensive series are not specifically interpreted by spinal segment. Therefore, the purpose of this work is to present our experience in the surgery of CMs and to determine the best surgical approach according to the level of the dural insertion and to the cord location.

In the present retrospective study, we report the experience of a single neurosurgical center (National Hospital for Neurology and

Key words
- Cervical
- Outcome
- Meningioma
- Surgical approach
- Tumor

Abbreviations and Acronyms
CM: Cervical meningioma
MRI: Magnetic resonance imaging
WHO: World Health Organization

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Neurosurgery, Queen Square, London, United Kingdom) on a series of CMs operated on during a consecutive period of 10 years (2004–2014). Our primary objective was to assess the clinical and radiologic outcomes in patients treated surgically. We discuss which factors (those one that can affect the extent of tumor resection) should be taken in account before a specific surgical approach is adopted.

MATERIALS AND METHODS

From June 2004 to June 2014, a total of 67 patients with spinal meningiomas were treated surgically at our institution. Among these, 44 were thoracic, 23 cervical, and 3 lumbar. We have analyzed retrospectively the clinical notes and the radiologic findings only for those patients diagnosed with a CM. Surgical outcomes were measured by the use of the Karnofsky Performance Scale score and a scoring system proposed by McCormick et al.[8] All forms of neuroimaging, including magnetic resonance imaging (MRI), computed tomography scans, computed tomography angiograms, and digital subtractive angiography, were taken into consideration.

All CMs arising from C1 to C7 were included in this study. The spino-cranial meningiomas originating from the spinal canal and extending rostrally into the cranial cavity and the cranio-spinal meningiomas originating from the skull base and extending into the spinal canal through the foramen magnum were excluded from this study. These locations, although requiring a posterior cranial fossa opening, were considered in our experience as different pathologic entities from upper spinal CMs.[9]

Neuroimaging variables that were evaluated included tumor location in the cervical spine, cord edema, extent of spinal cord compression, and calcification. According to the location in the cervical region, CMs were classified into 2 groups; C1–C2 meningiomas and C3–C7 meningiomas. We categorized the meningiomas on the basis of the origin of the tumor matrix or dural insertion. The tumors were further categorized by their relative location to the myelon in the axial plane: anterior (tumor mass predominantly anterior to the spinal cord), anterolateral, lateral, posterolateral, and posterior.

Somatosensory-evoked potentials and motor-evoked potentials were monitored routinely during the surgical procedure in all patients. The posterior midline approach was performed for lateral and posterolateral meningiomas and for some anterolateral meningiomas when the tumor mass displaced the spinal cord very laterally. For most anterior and anterolateral tumors and especially for lesions occupying the entire width of the spinal canal, a far-lateral approach was chosen.

Postoperatively, every patient underwent an MRI scan to assess the extent of the resection, detect any residual tumor, and determine any postoperative complication. A follow-up MRI scan was obtained at 1 year to detect the presence of any growth of the residual tumor or recurrence. The extent of tumor removal and the resection status of the tumor were judged objectively according to the postoperative MRI within 2 weeks and defined as total (absence of residual tumor or dural enhancement), subtotal (<10% of residual tumor), and partial (>10% of residual tumor). Surgical approach, extent of resection (according to Simpson), invasion of the arachnoids/pia mater, nerve root involvement, tumor type and grade, and type of complications also were recorded. Additional follow-up information was obtained by regular clinic outpatient follow-ups. Clinical and radiologic characteristics of all patients are summarized in Table 1.

RESULTS

Demographic and Baseline Data

The current series includes 23 patients (16 female and 7 male patients, sex ratio = 2.3) who underwent surgery for resection of CMs between June 2004 and June 2014. Mean age was 64 years (minimum 17 years; maximum: 81 years; median: 60 years). The mean follow-up was 40 ± 26.5 months. Clinical presentation was mostly slow spinal cord compression, with a weakness or a motor deficit found in 72% of cases. The interval between onset of symptoms and imaging diagnosis was less than 1 year in 72% of cases. A preoperative sensorimotor deficit was noted in 80% of the cases: gait disability or a difficulty in walking occurred in 93% of patients. Tumor distribution according to the topography and preoperative volume according to the same topography is represented in Table 1. Other preoperative clinical variables also are presented in Table 1.

Surgical Treatment

Preoperative embolization was achieved in 4 patients. Postoperative characteristics of surgical variable are detailed in Table 2. In one, a V2 segment of the left vertebral artery occlusion was performed to allow a complete excision. A posterior midline approach was performed in 13 cases (Figure 1), a far-lateral approach in 8 cases (Figure 2), and 2 combined approach (posterior laminectomy and fixation + corporectomy and posterior laminectomy + far-lateral approach; Figure 3). The far-lateral approach was used for C1–C2 anterior meningiomas and also in 3 cases of anterior C3–C7 extended meningiomas.

For these, the lateral position (park bench) generally was used with a paramedian vertical incision. The incision was started few centimeters lower from the top of the mastoid process and continued downward along the front edge of the sternocleidomastoid muscle depending on the level of the meningioma. Subperiosteal paravertebral muscle stripping was then performed to expose the beginning of spinal process, lamina, and the facet joint. Unilateral hemilaminectomy and sometime partial facetectomy was performed to expose the posterolateral dura, and then the dura was opened on the lateral wall of the thecal sac exposing the tumor and the cervical roots.

For the upper cervical level, adequate surgical removal of the tumor could be achieved without the need of any partial condyle or occipital resection. The surgical approach for CMs according to the Simpson resection Grade I and II is represented in Table 3.

In a restricted number of cases, because of the extent of the bone and ligamentous removal to access and debulk the tumor, surgical instrumented fusion of the segment was used. Two patients required lateral mass screws after a total facetectomy; 1 patient underwent a circumferential stabilization after complete removal of an extensive lesion located ventrolaterally in the upper cervical segment; in 2 patients, laminoplasty was performed.

Gross total resection was achieved in 14 (61%) patients, partial resection (remaining tumor <10%) in 6 (34%), and debulking