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Surgical outcomes of craniocervial junction meningiomas: A series of 22 consecutive patients

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ABSTRACT

Objective: We present our experience in managing craniocervical junction meningiomas and discuss various surgical approaches and outcomes.
Methods: We retrospectively reviewed 22 consecutive cases of craniocervical junction meningiomas operated on between August 1995 and May 2012.
Results: There were 15 female and 7 male patients (mean age: 54 years). Meningiomas were classified based on origin as spinocranial (7 cases) or craniospinal (15 cases). Additionally, the tumors were divided into anatomical location relative to the brainstem or spinal cord: there were 2 anterior tumors, 7 anterolateral, 12 lateral, and 1 posterolateral. Surgical approaches included the posterior midline suboccipital approach (9 cases), the far lateral approach (12 cases) and the lateral retrosigmoid approach (1 case). Gross-total resection was achieved in 45% of patients and subtotal in 55%. The most common post-operative complications were cranial nerve (CN) IX and X deficits. The mortality rate was 4.5%. There have been no recurrences to date with a mean follow-up was 46.5 months and the mean Karnofsky score at the last follow-up of 82.3. In this series, spinocranial tumors were detected at a smaller size ($p = 0.0724$) and treated earlier ($p = 0.1398$) than craniospinal tumors. They were associated with a higher rate of total resection ($p = 0.0007$), fewer post-operative CN IX or X deficits ($p = 0.0053$), and shorter hospitalizations ($p = 0.08$).
Conclusion: Our experience suggests that posterior midline suboccipital or far-lateral approaches with minimal condylar drilling and vertebral artery mobilization were suitable for most cases in this series.

1. Introduction

Meningiomas are generally benign tumors that generally carry a good prognosis. Craniocervical junction (CCJ) meningiomas account for 1.8–3.2% of all the meningiomas [1]. These lesions are often large at the time of diagnosis [2]. Tumor involvement of neighboring neurovascular structures poses significant technical challenges for surgeons. The tumor often encases the vertebral or basilar artery, and the lower cranial nerves, and may invade the bony structures of the craniocervial junction. Surgical management includes tumor resection and stabilization of the CCJ when necessary. In our report, two main surgical approaches, the posterior midline suboccipital approach and the far lateral approach, were used to facilitate resection and limit post-operative morbidity. We present our experience in the past 17 years and discuss the factors that dictate the surgical approach to adopt, that determine surgical outcome, and that affect the resectability of the tumor.

2. Patients and methods

From August 1995 to May 2012, a total of 22 patients with CCJ meningiomas were treated surgically at our institution. Clinical notes, operative notes, and radiological findings were evaluated. The study was approved by the Johns Hopkins Institutional Review Boards located in Baltimore, MD. For surgical outcomes, the Karnofsky Performance Scale (KPS) score and a scoring system proposed by Samii et al. [3] were employed. Preoperative imagining consisted of magnetic resonance imaging (MRI) or computer tomographic (CT) scans. In some cases, CT angiogram and

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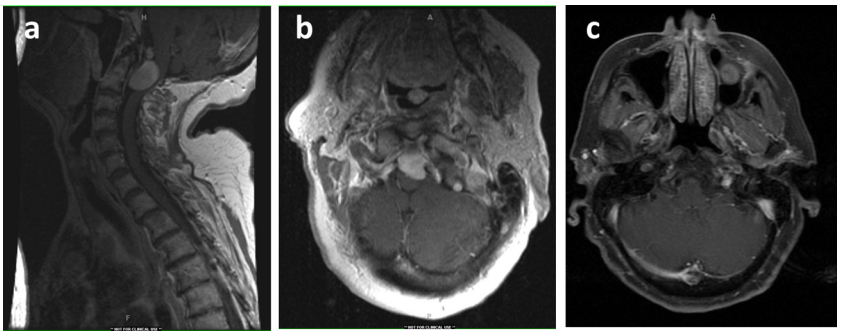

Fig. 1. This 84-year-old female patient experienced a significant deterioration for her neurological condition several months pre-op and presented with neck pain, dysesthesias and was unable to walk properly. MRI scans (a–b) revealed a large spinocranial anterior meningioma (2.3 cm × 1.3 cm × 1.5 cm) displacing neuroaxis posteriorly. She underwent a posterior suboccipital midline approach with C1 and C2 laminectomy. Post-operatively, she had a very good recovery, with headache and dysesthesias resolved and was able to walk normally. MRI (c) at follow-up showed complete excision of the tumor.

magnetic resonance angiogram (MRA) were also used pre-operatively and intra-operatively.

We categorized the meningiomas based on the origin of the tumor matrix or dural insertion. Craniospinal meningiomas originate from the skull base and extend into the spinal canal through the foramen magnum; spinocranial meningiomas, in contrast, originate from the spinal canal and extend rostrally into the cranial cavity. The tumors were further categorized by their relative location to the medulla in the axial plane: anterior (tumor mass predominantly anterior to the neuraxis, displacing it dorsally) (Fig. 1a–c), lateral (Fig. 2a–f), anterolateral (Fig. 3a–f), posterior and posterolateral. The anterior and anterolateral tumors are located ventral to the dentate ligament while the posterior and posterolateral tumors are dorsal to the dentate ligament. The extent of tumor resection was categorized into complete or subtotal. Complete tumor resection was defined as total removal of the tumor mass, including the capsule.

Post-operatively, every patient underwent an MRI scan immediately after surgery to detect edema, hemorrhage, or residual tumor. Typically, another MRI scan was obtained post-operatively at 2 months, 6 months and 1 year in order to determine the resection status of the tumor, pseudomeningocele, and monitor for growth of the residual tumor. Further scans were obtained if new clinical symptoms developed. If the tumor remained stable, patients were instructed to undergo annual MRI scans. Additional follow-up information was obtained by regular outpatient follow-ups and telephone calls. Clinical and radiological characteristics of all 22 patients are summarized in Table 1.

Means plus or minus the standard deviation are presented. For statistical analysis, Student's *t*-tests were used for continuous variables, and the Chi-squared test for categorical variables. A difference was considered significant with a *p*-value less than 0.05.

Table 1
Clinical and radiological characteristics of 22 patients.

Pt. no.	Tumor type	Tumor location	VA/CN involvement	Surgical approach	Condyle drilling	VA transposed	Extent of removal	Complications	Karnofsky score (pre/post-op)
1	CS	Lat, IE	VA	FL	Partial	No	Sub	–	90, 95
2	SC	AL, I	–	FL	Partial	No	Total	–	80, 100
3	SC	Lat, I	–	PM	No	No	Total	–	80, 90
4	SC	Lat, IE	VA, CN	FL	No	No	Total	–	70, 90
5	CS	Lat, I	VA, CN	FL	Partial	No	Sub	Infection, dysphagia	70, 80
6	CS	Lat, I	VA, CN	FL	Total	No	Sub	Dysphagia, vocal cord paralysis, new CN VI, VII, XII deficits	60, 95
7	CS	Lat, I	VA, CN	FL	Partial	No	Sub	Dysphagia, vocal cord paralysis, motor sensory deficit, bladder disturbance, quadriplegia	40, 0
8	SC	Lat, I	CN	FL	No	No	Total	–	70, 85
9	SC	Ant, I	–	PM	No	No	Total	–	70, 100
10	CS	Lat, I	CN	FL	Partial	No	Sub	Dysphagia, new CN XI, XII deficit	65, 80
11	SC	PL, I	–	PM	Total	No	Total	New CN deficits,	80, 85
12	CS	AL, I	–	PM	No	Yes	Total	New muscle weakness	70, 90
13	CS	Al, IE	CN	FL	Partial	No	Sub	Dysphagia,	60, 80
14	CS	AL, I	CN	Lat	Partial	No	Total	Dysphagia, vocal cord paralysis	85, 90
15	SC	Lat, I	VA, CN	PM	No	No	Total	Infection, new CN VI deficit, CSF leak	75, 75
16	CS	AL, I	VA, CN	PM	No	Yes	Sub	Dysphagia, new muscle weakness, balancing difficulty	80, 70
17	CS	Ant, I	CA, CN	FL	Partial	Yes	Sub	Balancing difficulty	70, 90
18	CS	AL, I	VA, CA, CN	PM	No	No	Sub	Dysphagia, vocal cord paralysis, new CN XI, XII deficits, brain infarction	70, 75
19	CS	Lat, IE	VA, BA, CA, CN	FL	Partial	Yes	Sub	Infection, meningitis, hydrocephalus, Dysphagia, CSF leak, respiratory failure	70, 75
20	CS	Lat, I	VA, CN	PM	No	No	Sub	Dysphagia, motor sensory, new CN XI deficit, respiratory failure, quadriplegia	50, 20
21	CS	AL, IE	VA, CA, CN	PM	No	No	Total	Dysphagia, vocal cord paralysis,	75, 85
22	CS	Lat, I	VA, CA	FL	No	No	Sub	Infection, meningitis, hydrocephalus	N/A

CS, craniospinal; SC, spinocranial; Lat, lateral; Ant, anterior; AL, anterolateral; PL, posterolateral; I, intradural; IE, intraextradural; VA, vertebral artery; CN, cranial nerve; CA, cerebellar artery; BA, basilar artery; FL, far lateral approach; PM, posterial midline suboccipital approach; Lat, lateral approach; sub, subtotal removal.