



Stratification of predictive factors to assess resectability and surgical outcome in clinoidal meningioma



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ABSTRACT

Objective: Meningiomas of the clinoidal region pose significant surgical challenges due to their close proximity and intimate relation with surrounding critical neurovascular structures. Our aim was to describe our institution's experience with the management of clinoidal meningiomas, identify predictive factors and develop a comprehensive grading system to assess the extent of resection.

Methods: The medical records of 36 consecutive patients underwent surgery from 1995 to 2015 with clinoidal meningiomas were retrospectively reviewed. Using selected clinical features and tumor characteristics, a grading scale was devised and utilized to assess a degree of tumor resectability. The factors included: preoperative visual status (no visual loss = 0, visual loss = 1), tumor volume: small (<13.5 cm³ = 1), moderate (13.5–30 cm³ = 2), and large (>30 cm³ = 3), relationship with the internal carotid artery (no displacement = 0, displacement = 1, encasement = 2, stenosis = 3 and bilateral involvement = 4) tumor extension into the cavernous sinus (yes = 1, no = 0) and invasion into the optic canal (yes = 1, no = 0), (defined as tumor beyond the falciform ligament). A grading system was designed using the total scores (10) in this classification and separating patients into two groups: group 1 with scores of 5 or less, group 2 with scores more than 5.

Results: The patients mean age at the time of intervention was 61 years. The tumor involved the cavernous sinus in 38.9% of patients and invaded the optic canal in 36% of cases. The patient presented with visual impairment in 89% of cases. Vision improved in 28% and remained stable in 63% of cases. The mean volume of a tumor was 16.99 cm³. The most common approach involved pterional with or without anterior clinoidectomy. After stratification, group 1 consisting of 22 patients and in group 2, 14 patients. Gross total resection (Simpson Grade I or II) was achieved in 75% of surgeries and subtotal and partial resections were achieved in 25% of cases. Group 1 patients had higher gross total resection rate than group 2 ($p = 0.009$). Only optic canal involvement was significantly associated with the extent of resectability in a univariate analysis ($p = 0.03$). Four patients developed tumor recurrence with median recurrence duration of 89 months (53–204 months). Three patients underwent GKRS and one patient underwent repeat surgery at the time of recurrence.

Conclusions: A grading system can be employed in patients who present with clinoidal meningiomas and serve as an aid in planning an appropriate treatment strategy and establishing the prognosis. Radical resection can be planned in patients with favorable tumor criteria (groups 1) while a less aggressive surgical approach followed by stereotactic radiosurgery may be better suited for patients with less favorable tumor characteristics (group 2).

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Abbreviations: A1, anterior cerebral artery proximal part; CS, cavernous sinus; GKRS, Gamma knife radiosurgery; GOS, Glasgow outcome scale; Gray, Gy; ICA, internal carotid artery; M1, middle cerebral artery proximal part; MCA, middle cerebral artery; MRI, magnetic resonance imaging; WHO, World health organization.

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1. Introduction

Meningiomas arising from the anterior cranial fossa floor constitute about 40% of all intracranial meningiomas [10]. Such tumors may involve and extend along the dura of the olfactory groove, planum sphenoidale, anterior clinoid process, diaphragma sellae, orbital roof and tuberculum sellae. In reported series of sphenoidal meningiomas, the incidence of clinoidal meningiomas constitutes 34–43.9% [3,24] of cases. Surgical resection of clinoidal menin-

Table 1
Individual score of all predictive factors.

Prognostic factors	Group:1 (Score = <2), Group: 2 (Score = 2-5), Group: 3 (Score = >5)				
Vision loss	No=0	Yes=1			
Tumor size	<13.5 cm ³ = 1	13.5–30 cm ³ = 2	>30 cm ³ = 3		
Internal carotid artery	No displacement = 0	Displacement = 1	Encasement = 2	Narrowing = 3	Bilateral = 4
Cavernous sinus involvement	No=0	Yes = 1			
Optic canal invasion ^a	No=0	Yes = 1			

^a Tumor beyond falciform ligament.

giomas is challenging due to the close association of the tumor with critical neurovascular structures such as the internal carotid artery, the anterior cerebral artery, the anterior communicating artery complex and associated perforators, the optic apparatus and the pituitary gland and infundibulum. The objective of this study was to critically analyze our series of 36 surgically treated clinoidal meningiomas and assess the predictive factors individually as well as collectively for extent of resection.

2. Materials and methods

After obtaining local institutional review board approval, and in compliance with Health Insurance Portability and Accountability Act (HIPAA) regulations, we retrospectively reviewed the medical records, neuroimaging studies, and pathology reports of all patients who underwent resection of clinoidal meningiomas from 1995 to 2015 in our institute. There were 36 patients identified with clinoidal meningiomas. All patients were evaluated with gadolinium-enhanced MRI of the brain prior to surgery. Tumor volume was measured using the BrainLab Iplan software (Brainlab, Munich, Germany). Patients with small tumors (volume <13.5 cm³) were recommended resection only if they presented with preoperative symptoms of vision loss or if there was evidence of progressive tumor growth on serial imaging. The extent of resection was assessed using gadolinium enhanced MRI in the postoperative period. Gross-total resection was defined using the Simpson criteria [30]. The overall neurological outcome was assessed according to the Glasgow Outcome Scale (GOS) rating at the most recent follow-up visit. Median follow-up duration was 15 months (range 3–204 months) and mean was 33 months. Predictive factors were selected based on clinical, radiological and intraoperative findings. The factors included preoperative visual status (no visual loss=0, visual loss=1), tumor volume: small (<13.5 cm³ = 1), moderate (13.5–30 cm³ = 2), and large (>30 cm³ = 3), relationship with the internal carotid artery (displacement = 1, encasement = 2, stenosis = 3 and bilateral involvement = 4), tumor extension into the cavernous sinus (yes = 1, no = 0) and invasion into the optic canal (yes = 1, no = 0), defined as tumor beyond the falciform ligament [27] (Table 1). The score of each factor was added for each patient to get the final score. A grading system was designed using the total scores (10) in this classification and separating patients into two groups: group 1 with score 5 or less than 5, group 2 with scores more than 5. Score > 5 suggests moderate volume tumor (2), visual involvement (1), carotid artery encasement (2) with laterally, cavernous sinus involvement (1) and/or medially, optic canal extension (1). All these factors are equally important to take a decision for resection of clinoidal meningioma.

Statistical analysis was performed using the SPSS software (version 21, SPSS, Inc.). Statistical analyzes of categorical variables were performed using the chi square and Fisher exact tests, as appropriate. Univariate and multivariate analyzes were done to assess for the association between individual predictive factors and extent of resectability. Probability values <0.05 indicated statistical significance.

3. Results

A total of 36 consecutive patients of clinoidal meningioma were recruited for outcome analysis. The mean age at surgery was 61 years (range 33–82 years). Twenty-six patients were female and 10 patients were male. Twenty-one meningiomas were located on the left and 15 were on the right. Presenting symptoms included visual impairment (89%), headache (72%), memory deficits (<1%) and seizures (<1%) (Table 2). The mean volume of a tumor was 16.99 cm³. The most commonly utilized surgical approaches included a pterional approach with or without anterior clinoidectomy or a fronto temporalorbitozygomatic (FTOZ) approach. All WHO grade I meningioma were included in this study. Table 1 shows the detailed scoring of predictive factor. Twenty two (22) patients (score 5 or less than 5) were stratified in group 1 and 14 patients (score > 5) in group 2.

Thirty-four patients had a GOS rating of 5 at the most recent follow-up, and one patient had GOS rating of 4. One patient died in the perioperative period due to severe vasospasm following dissection of encased internal carotid artery. Of the three patients who presented with seizures, two became seizure-free after surgery. One patient developed seizure postoperatively, controlled with antiepileptic medications. Two patients developed postoperative hydrocephalus and required ventriculo-peritoneal shunt placement. One patient had mild hemiparesis following surgery and improved at follow up.

Thirty two patients (89%) had visual dysfunction before surgery. Following surgery, the improvement was noted in 9 patients (28%). Visual status remained unchanged in 20 patients (63%). Three patients (9%) had visual deterioration following surgery. One of those patients had the infiltrative tumor at one point of the optic nerve and other two had a long duration of optic nerve compression leading to diminution of vision before surgery. Two patients

Table 2
Patients' demographic details.

Variables	Value
Total patients	36
Age	
Mean	61 years
Range	(33–82 years)
Gender	
Male	10 (28%)
Female	26 (72%)
Side	
Right	15 (41.6%)
Left	21 (58.3%)
Clinical features	
Visual loss	32 (89%)
Headache	26 (72%)
Confusion	3 (<1%)
Seizure	2 (< 1%)
Vomiting	1 (<1%)
Facial numbness	2 (<1%)

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