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Imaging characteristics, histopathological features and surgical considerations regarding aggressive meningiomas. Case series and review of the literature

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ABSTRACT

Meningiomas are tumors of the meninges that arise primarily from arachnoid cap cells, but they can also occur rarely as primary tumors in other localizations, such as within the ventricles. They stand for 24-30% of primary intracranial tumors and affect mostly women in their middle age or later adult life [1, 2]. Meningiomas can be classified, according to World Health Organization (WHO) classification of Central Nervous System (CNS) tumors, as benign (grade I, most frequently encountered type), atypical (grade II) or anaplastic (grade III), based mostly on histopathological criteria known to be associated with tumor progression, recurrence risk and survival. Since meningioma grading based on the WHO classification is the most important factor determining therapeutic management and tumor prognosis, there has been an increasing interest in adding new criteria for better characterization of these tumors. Thus, the 2016 edition of WHO classification recognized brain invasion as an independent criterion for atypical (grade II) meningioma diagnosis [3]. However, meningiomas that display aggressive features such as rapid growth and higher recurrence rate, can also involve blood vessels and bone. Hence, the authors aim to describe a different entity, aggressive meningiomas, not previously listed as a tumor

Keywords

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phenotype in the WHO classification of meningotheial-cell tumors, with regard to pre-, intra- and postoperative methods for diagnosis and explore the implications on surgical strategies and adjuvant therapy.

MATERIALS AND METHODS

We performed a single-center retrospective study. We reviewed the files of all patients diagnosed with primary intracranial meningioma at the 4th Clinical Department of Neurosurgery, Bagdasar-Arseni Clinical Emergency Hospital, between January 2013 and December 2018 and identified the cases of aggressive meningiomas, characterized by either: invasion into the brain parenchyma, involvement of the major blood vessels, cranial vault bone lysis without involvement of the outer table of the skull or complete bone destruction and aesthetic deformity, as showed by preoperative imaging and confirmed by histopathological examination.

RESULTS

We identified 291 patients with tumors meeting the required imagistic/histopathological criteria, from which we selected 2 representative cases for the current articles, aiming to better describe this tumor entity regarding pre-, intra- and postoperative aspect and therapeutic strategy.

FIRST CASE

A 65-year-old male was admitted to our department complaining of refractory headache ongoing for more than 3 months. His past history consisted of high blood pressure, permanent atrial fibrillation, type 2 diabetes mellitus, grade II obesity and chronic anticoagulant treatment. He denied any episodes of seizures or loss of consciousness, limb weakness, paresthesia, visual deficits, speech disturbances or vomiting. Clinical examination showed a small swelling in the right frontal region. Neurological examination showed no deficits.

Contrast-enhanced CT scan revealed a large hyperdense extra-axial lesion in the right frontal region, measuring 64/46 mm in cranio-caudal diameter, with a small area of important contrast uptake and associated bone lysis, producing mass effect on midline structures that appear displaced 6 mm to the left side.

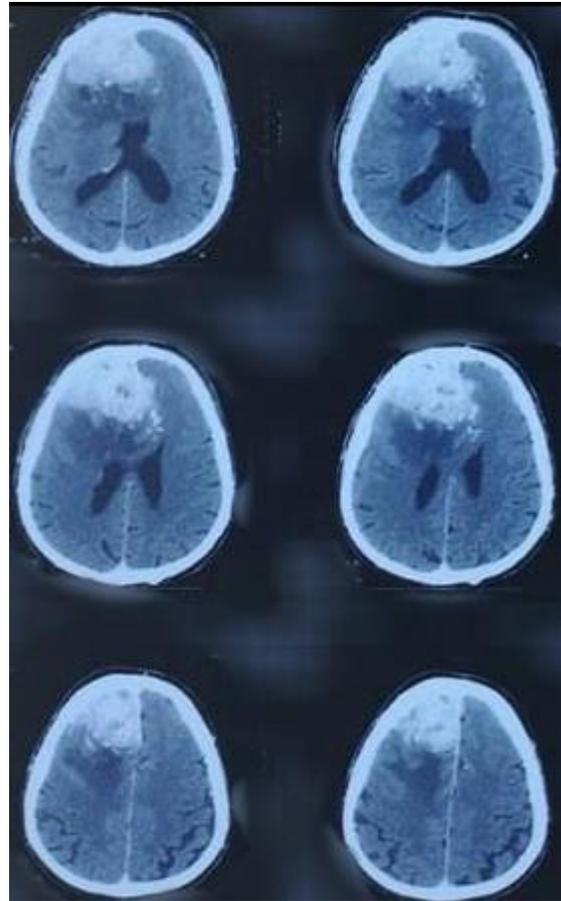


Image 1. Contrast-enhanced CT scan, axial section, showing a large hyperdense extra-axial lesion in the right frontal region, with a small area of important contrast uptake, bone lysis, and mass effect displacing midline structures.

Gadolinium-enhanced MRI scan revealed a large right fronto-basal extra-axial lesion displaying central necrosis and displacing the right lateral ventricle, anterior cerebral artery, falx cerebri and the superior sagittal sinus.



Image 2. Gadolinium-enhanced T1-weighted MRI scan, sagittal section, showing a large fronto-basal extra-axial lesion eroding into the adjacent bone.

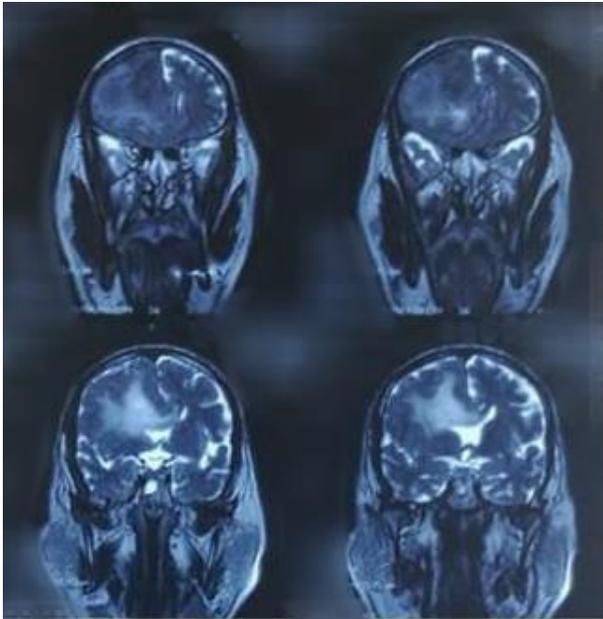


Image 3. Non-enhanced T2-weighted MRI scan, coronal section, showing a right frontal lesion with extensive perilesional edema and displacement of the midline structures.

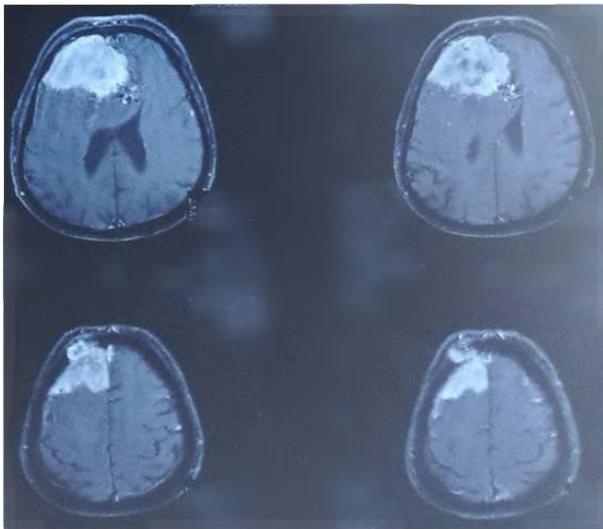


Image 4. Gadolinium-enhanced T1-weighted MRI scan, axial section, showing a large frontal extra-axial lesion eroding into the adjacent bone.

The lesion produced erosion of right frontal bone and showed homogenous gadolinium uptake. Angiography was performed in order to better describe the vascular supply of the tumor.

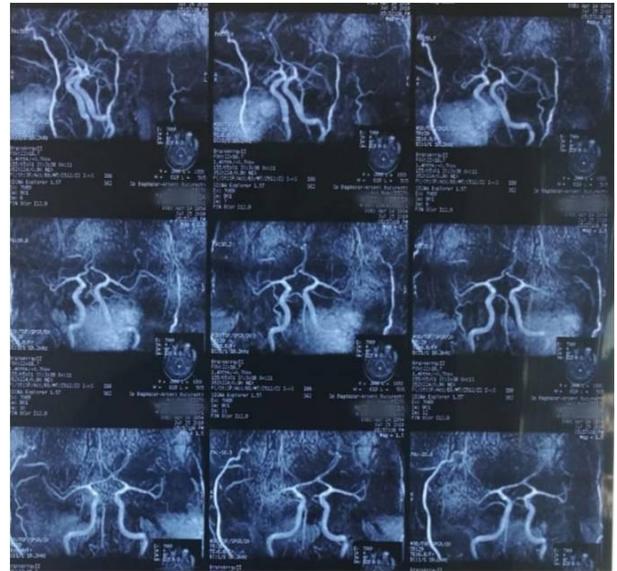


Image 5. Digital-subtraction angiography showing prolonged vascular blush.

The surgical approach was aimed at gross total resection, as well as obtaining enough tissue sample for an accurate histopathological diagnosis with subsequent appropriate adjuvant therapy. A right fronto-temporal craniotomy was performed, revealing a reddish, well vascularized, firm tumor. Postoperative CT-scan (Image 6) showed gross total resection of the right fronto-basal meningioma.

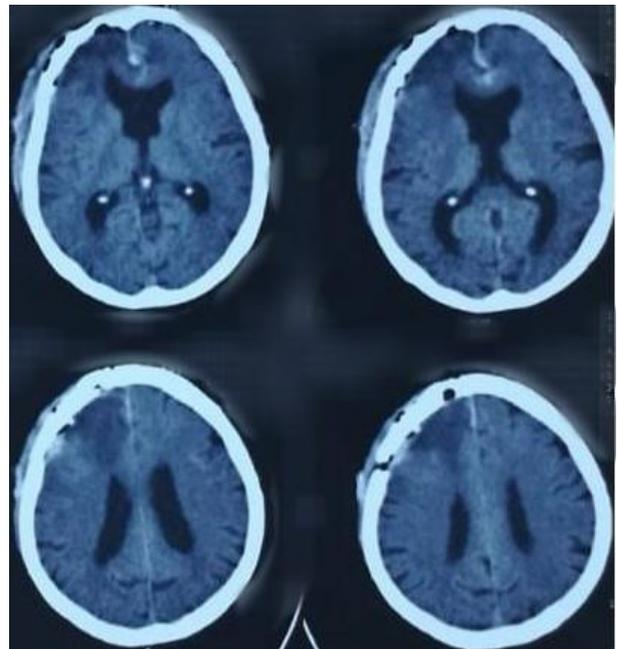


Image 6. Non-enhanced CT scan showing a right fronto-temporal craniotomy and no tumoral remnant.

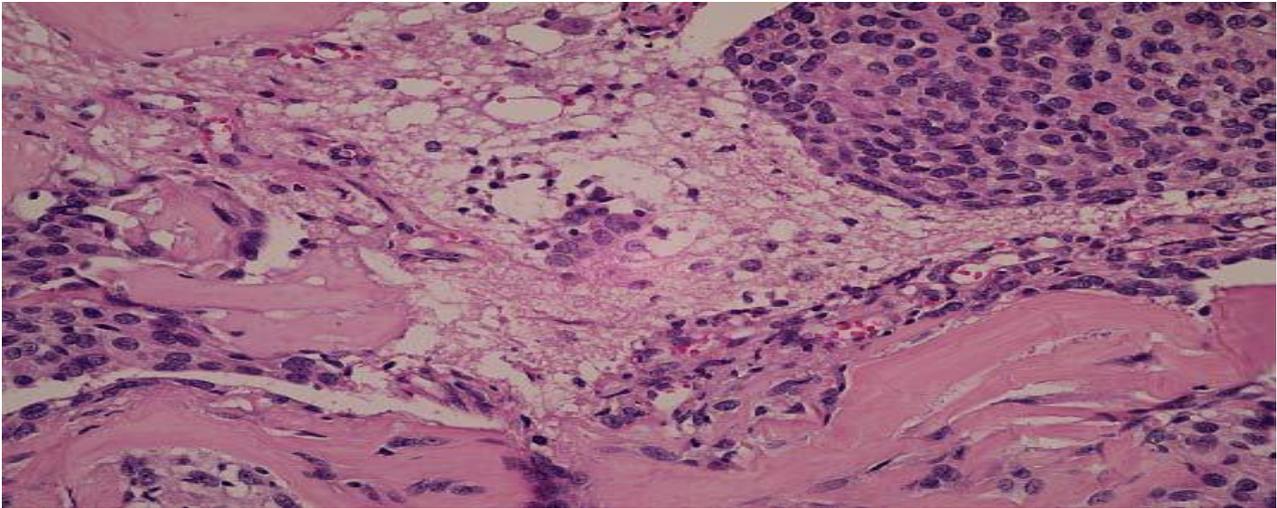


Image 7. Optic microscopy view of the intraoperative tumor sample, showing meningioma cells with atypical features and invasion into the adjacent parenchima and bone.

Postoperative evolution was favorable and the patient was discharged 7 days later

Second case

A 74 years old female was admitted to our department for progressive right upper and lower limb weakness. Her past history consisted of high blood pressure, ischemic heart disease, grade II obesity and bilateral lower limb venous insufficiency. She denied any episodes of seizures or loss of

consciousness, visual deficits, speech disturbances or vomiting. Neurological examination showed right hemiparesis. Contrast-enhanced CT scan revealed a left parasagittal parietal extra-axial lesion, partially calcified and displaying homogeneous contrast uptake, measuring 56/33 mm in diameter, with perilesional edema that displaced median structures 6,65 mm towards the right side. The lesion seemed to be inserted on the meninges and determining osteosclerosis of the surrounding bone (Image 8).

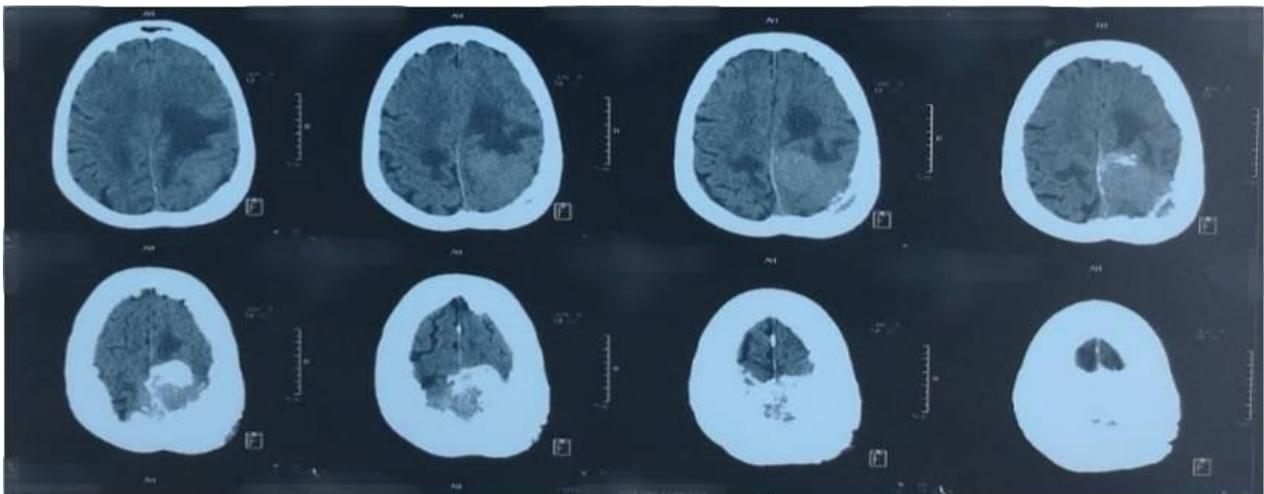


Image 8. CT scan showing a left parietal extra-axial lesion, partially calcified, with perilesional edema and displacement of the midline structures towards the right side.

MRI scan revealed a large left parietal lesion extending towards the right side, with perilesional edema, left lateral ventricle displacement and adjacent bone invasion (Image 9).

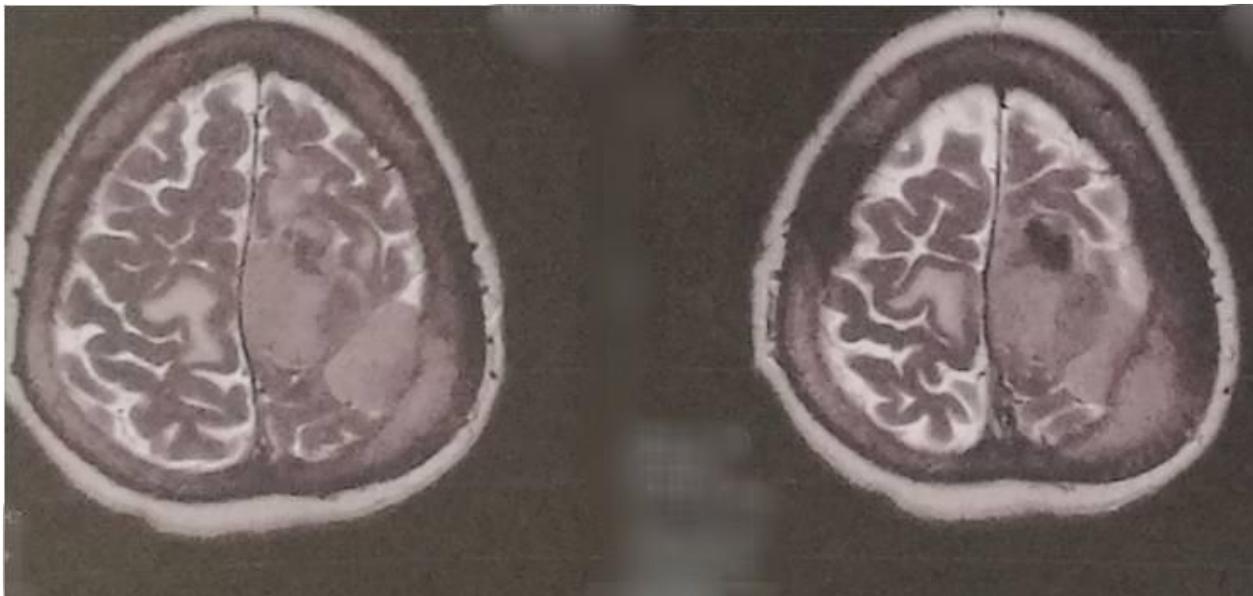


Image 9. T2-weighted MRI scan, axial section, showing a large left parietal lesion extending towards the right side, with perilesional edema, left lateral ventricle displacement and adjacent bone invasion.

Histopathological examination showed atypical meningioma cells, with invasion into the nervous and destructive infiltration of adjacent bone tissue (Image 10).

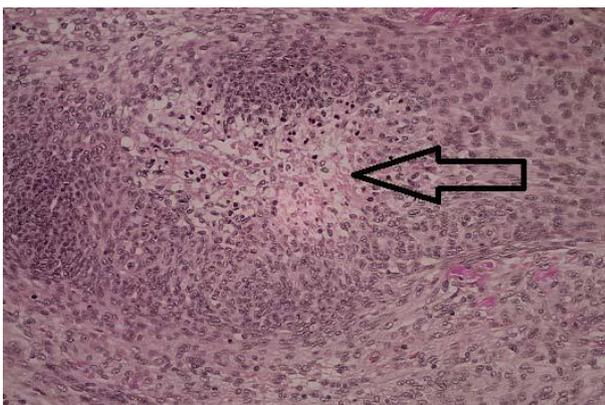


Image 10. optic microscopy view of the intraoperative tumour sample, showing meningioma cells with atypical features and direct invasion into the adjacent brain parenchyma and bone.

Postoperative evolution was favorable and the patient was discharged 7 days later.

DISCUSSION

Meningiomas are a heterogenous group of lesions that can be classified, based mostly on histopathological criteria, as benign (grade I, most frequently encountered type), atypical (grade II) or anaplastic (grade III), according to WHO classification

of CNS tumors. However, other characteristics have started to be recognized as independent criteria for diagnosing higher-grade meningiomas. Nazem *et al.* studied the genomic alterations supposed to be encountered in many meningiomas patients, such as losses on chromosome 22 (WHO grade I), losses on chromosomes 1p and 14q (WHO grade II) or modifications on chromosome 9p and 17q (WHO grade III), but these changes have yet to be listed as independent diagnostic criteria (4). The 2016 edition of WHO classification stated that brain invasion can be considered an independent criterion for atypical (grade II) meningioma diagnosis (3). Meningiomas that display aggressive features such as rapid growth and higher recurrence rate, can also involve adjacent blood vessels and bone. Karabagli *et al.* reported that no distinct histopathological feature could be used to predict the recurrence rate of meningiomas (5). Behling *et al.* reported that intraoperative detection and histopathological assessment of CNS invasion can be an independent prognostic factor for recurrence, giving a better risk-adapted tumor classification (6). However, aggressive meningiomas, a tumor phenotype, characterized by rapid growth and involvement of adjacent brain tissue, blood vessels and bone, was not previously recognized as a separate entity in the WHO Classification of CNS tumors of the meninges. The involvement of so many important adjacent structures makes it more difficult to achieve a gross total resection, thus

making this type of tumors more prone to recurrence.

CONCLUSIONS

Aggressive meningioma, a different phenotype of tumor, characterised by rapid growth and involvement of adjacent brain tissue, blood vessels and bone, although not previously mentioned in the WHO classification, has a distinct pattern of evolution and postoperative recurrence rate. Surgical procedures are challenging due to the implication of various tissues and the outcome depends on the location, size, grade of invasion and associated pathology.

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