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Supratentorial Cystic Meningioma Resembling Pilocytic Astrocytoma: A Case Series and Literature Review

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Abstract

Background: Cystic meningioma is a rare subtype of meningioma. Various brain tumors may mimic cystic meningioma in imaging appearances.

Objectives: Herein, we reported a series of cases with cystic meningiomas primarily misdiagnosed as pilocytic astrocytoma due to a similar radiological appearance.

Methods: This case-series study included 20 patients with cystic meningiomas admitted to the Ghaem Hospital, Mashhad, Iran, between 2012 and 2019. The findings of magnetic resonance imaging (MRI), computed tomography, and neurological examination were recorded preoperatively. All patients underwent surgery, and biopsies were obtained, confirming the histopathological diagnosis of the tumor.

Results: The patients' mean age was obtained at 40.7±12.5 years, and 11 and 9 subjects were men and women, respectively. Most of the patients presented with headaches (50.0%), and hemiparesis (60.0%) was the most found in the neurological examination. The results of all neuroimaging studies revealed solid-cystic supratentorial tumors, in which cysts were intratumoral, larger than solid components, and eccentric relative to them. Most of the cysts were located in the frontal lobe. The signal intensity of T2-weighted MR images showed hypointense lesions in 25.0% of the cases; however, 45.0% of the patients were hyperintense and 30.0% of them were isointense to grey matter. After contrast injection, the tumor's solid and periphery experienced a homogeneous enhancement. The most common histopathological finding was meningothelial cells (30.0%) followed by fibroblastic cells (25.0%).

Conclusion: Cases with an initially diagnosed pilocytic astrocytoma in the imaging can turn out to show cystic meningioma after pathological assessments, which deserves clinicians' notice.

Keywords: Astrocytoma, Magnetic resonance imaging, Meningioma, Supratentorial neoplasms

1. Background

Meningioma, as the most prevalent tumor of the central nervous system (CNS), accounts for almost one-third of primary spinal and brain tumors (1). Despite the benign nature of most meningiomas, there also exist malignant and atypical meningiomas. Meningioma is more common among women and its incidence rises with aging. As a rare subtype, cystic meningiomas is responsible for 1.6-10% of all types of meningiomas (2).

Based on magnetic resonance imaging (MRI), meningiomas are dural-based extra-axial masses with hyperintense or isointense signal-intensity on T2-weighted and proton density sequences and with hypointense or isointense signal-intensity relative to gray matter on T1-weighted sequences. On computed tomography (CT), a typical meningioma refers to a well-defined extra-axial mass, displacing the normal brain. It is adjacent to the dura, has a smooth contour, and may be multilobulated or calcified. Despite these typical imaging features, an associated cyst may challenge the diagnosis of meningiomas in radiologic evaluations. Cystic meningiomas on MRI can be misdiagnosed as more commonly occurring intracranial cystic lesions, such as malignant glioma (3) and pilocytic astrocytoma (4).

Cystic meningiomas can be distinguished from other cystic tumors by several radiologic findings. On T1-weighted (T1W) contrast MRI, cystic meningiomas are characterized by the dural tail sign and are presented as highly enhanced masses, findings that are not commonly observed in lower-grade gliomas. Moreover, cystic meningiomas are located extra-axially, compared to other cystic tumors (5). Despite various reports on the radiologic mimickers of cystic meningiomas, few case reports have addressed pilocytic astrocytoma as a misleading diagnosis for cystic meningioma (4, 6).

2. Objectives

Herein, we described radiologic and intraoperative findings of 20 cystic meningioma cases primarily diagnosed as pilocytic astrocytoma in pre-operative evaluations.

3. Methods

In this retrospective observational study, we reported 20 patients with cystic meningioma admitted to the neurosurgery ward of the Ghaem Hospital, Mashhad, Iran, between 2012 and 2019. All

the patients provided informed written consent before entering the study. The Ethics Committee of the Mashhad University of Medical Sciences, Mashhad, Iran, confirmed the study (approval number: IR.MUMS.REC.1399.578).

The eligible patients were those with solid-cystic tumors that had enhanced solid components with the same imaging features of meningioma and pilocytic astrocytoma tumors during a radiological examination. Furthermore, personal satisfaction was another criterion for entering the study. On the other hand, the individuals who contraindicated for gadolinium injection and those without final pathology according to cystic meningioma were excluded from the study. An experienced neurologist performed a complete medical and surgical history and thorough neurological examinations for all the patients. All patients underwent unenhanced CT with an Aquilion 64 multislice detector tomography scanner (Toshiba Medical Systems, Japan) and MRI with an Avanto 1.5T system (Siemens, Germany) to assess the pre-operative characteristics of the tumor. Unenhanced axial, sagittal T1W or T2W, and coronal MR images were obtained for all patients. Moreover, gadolinium-enhanced T1W images were taken for all participants in axial, coronal, and sagittal planes.

An experienced neurosurgeon assessed the MR images to determine the association of the cystic components with the tumors, subarachnoid space, and the cerebral parenchyma. The locations of all cysts were accurately determined preoperatively.

All patients underwent surgical resection of the tumors, through which both intra- and peri-tumoral cystic components and the cyst wall were excised. The surgical approach and the extent of resection were roughly similar in all patients. If the cyst had trapped cerebrospinal fluid (CSF) adjacent to the tumor, the interface was identified between the extra tumoral arachnoid component and the tumor borders, and the tumor was resected while the cyst was only drained. Intraparenchymal cysts were not resected. Intraoperative biopsy samples were obtained to determine the histologic type of the tumors using hematoxylin and eosin staining.

4. Results

A total of 20 patients were studied, of whom 11 (55.0%) and 9 (45.0%) cases were male and female, respectively. The patients had a mean age of 40.7±12.5 years. Table 1 summarizes the patients' essential clinical and histotype characteristics, imaging features, and demographic data.

Table 1. Demographic data, clinical presentation, radiological features, and histological findings of the study participants

characteristics	Gender	age	Location	symptoms	Neurological findings	Histologic pattern	T2 signal intensity	T1 signal intensity	dural tail	csf cleft
Patient 1	F	24	Right frontal parasagittal	Seizure, headache	Left hemiparesis	Fibroblastic	Low signal	Low signal	+	+
Patient 2	M	48	Left sphenoid wing	Vertigo, headache	papilledema	Meningothelial	Low signal	Low signal	+	+
Patient 3	F	34	Right occipital parasagittal	Headache	Left paresis	Angioblastic	High signal	Low signal	_	_
Patient 4	M	52	Right frontal	Seizure, visual disturbance	Left paresis	Meningothelial	Low signal	Iso signal	+	+
Patient 5	F	50	Left parietal	Headache	Right paresis, papilledema	Fibroblastic	Low signal	Low signal	+	+
Patient 6	F	33	Left frontal	Headache, personality disorder	Right paresis	Angioblastic	High signal	Low signal	_	_
Patient 7	M	47	Right frontal	Seizure	Left paresis, papilledema	Fibroblastic	Low signal	Iso signal	+	+
Patient 8	F	33	Left frontal	Headache, hyposmia	Papilledema	Meningothelial	Iso signal	Low signal	_	_
Patient 9	M	55	Right frontal	Headache, Seizure	Left paresis	Transitional	Iso signal	Low signal	+	+
Patient 10	M	62	Left frontoparietal parasagittal	Seizure	Right paresis	Transitional	Low signal	Low signal	_	_
Patient 11	F	23	Right parietooccipital	Seizure, headache	Left paresis	Fibroblastic	Iso signal	Low signal	_	_
Patient 12	M	44	Right occipital	Seizure	Visual deficit	Meningothelial	Low signal	Low signal	_	_
Patient 13	F	28	Right temporal	Headache	Visual deficit	Transitional	High signal	Low signal	+	_
Patient 14	M	60	Right tentorial	Left paresis	Visual deficit	Angioblastic	Iso signal	Low signal	+	+
Patient 15	F	50	Left frontoparietal	Personality disorder	Right paresis	Transitional	High signal	Low signal	+	+
Patient 16	M	28	Right sphenoid wing	Visual disturbance	Visual deficit	Meningothelial	Iso signal	Low signal	+	+
Patient 17	M	28	Left parietooccipital	Personality disorder	Right paresis	Meningothelial	Low signal	Low signal	+	+
Patient 18	M	49	Right frontal	Seizure	Left paresis	Fibroblastic	High signal	Hypersignal	_	_
Patient 19	F	26	Right temporoparietal	Headache	No neurological deficit	Meningothelial	Iso signal	Low signal	_	_
Patient 20	M	40	Right frontal	Seizure	No neurological deficit	Transitional	High signal	Iso signal	+	+

The tumors were mostly located in the frontal lobe. Most of the patients presented with two symptoms, namely headache and seizure. The most common neurological deficit was hemiparesis. However, two of the patients had no neurological deficit.

In terms of MRI findings of the tumors, the solid part of the tumor's signal intensity on T2-weighted MR images was hypointense in 5 (25.0%) patients, whereas 9 (45.0%) subjects showed hyperintense tumors. Moreover, the tumor's signal intensity was isointense to grey matter in 6 (30.0%) participants. The tumor's signal intensity on T1 weighted images was iso to low, the cystic component had CSF-like intensity in all sequences unless hemorrhage, and high protein content was present.

In all patients, the cysts were intratumoral, larger than solid components, and eccentric relative to them. After contrast injection, the tumor's solid, and periphery had a homogeneous enhancement. In 6 (30%) cases, the solid component was implanted on the adjacent dura. The dural tail sign was positive in 12 (60%) patients, and the CSF cleft sign was positive in 11 (55%) subjects (Figure 1). As shown in Table 1, the most common histopathological type was found to be meningothelial (Figure 2)

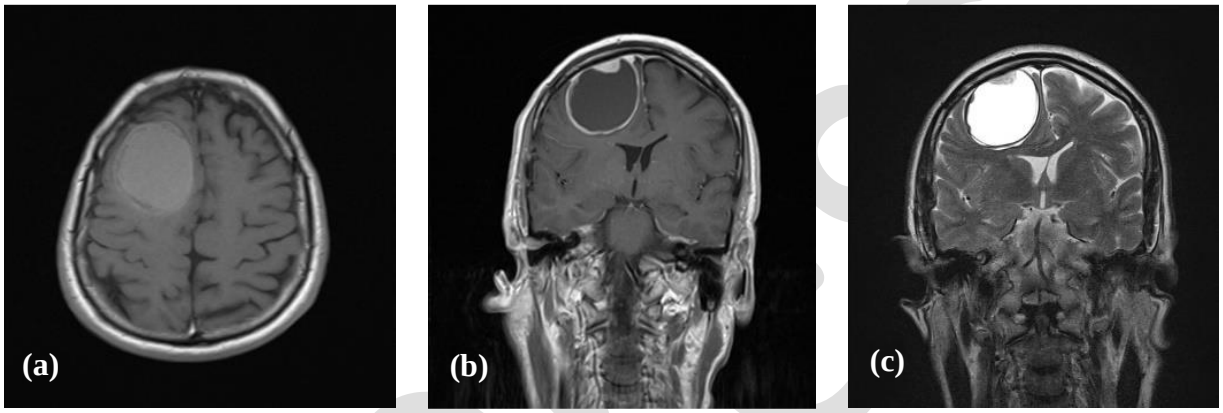

Figure 1. (a) Unenhanced T1-weighted axial magnetic resonance image showing a hyperintense mass located in the right frontal lobe with subfalcine herniation; (b) Contrast-enhanced coronal T1-weighted, intense enhancement of the solid component, the peripheral wall, and the base of implantation; and (c) Coronal T2-weighted image, extra-axial hyperintense mass with a significant cystic component, and mass effect overlying the right frontal area

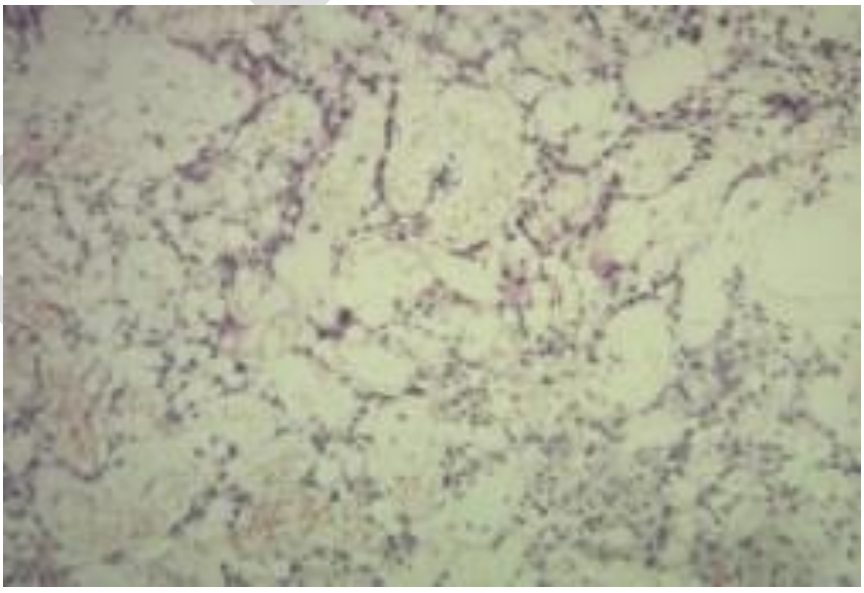

Figure 2. Histopathologic examination following staining with eosin and hematoxylin demonstrating meningothelial cell tumor in the cyst wall with increased mitotic activity in the cyst (100X, magnification)

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5. Discussion

Meningiomas are common CNS tumors, although cystic meningiomas are rare neoplasms (7). The gender predominance of cystic meningiomas was differently reported in the results of previous studies (5, 8, 9). Cystic meningiomas explain meningiomas with peritumoral or intratumoral cysts. An associated

cyst is an uncommon imaging feature for meningiomas that may make it difficult to distinguish between meningiomas and intra-axial primary glial tumors. Peri-tumoral edema might also be misleading. The particular cause of cyst formation is unknown; however, several reasons have been proposed regarding this, including tumor cell fluid secretion, loculated cerebrospinal fluid from scar tissue adjacent to or within the tumor, and cystic tumor degeneration (3, 4, 10, 11).

These tumors are classified into different histotypes based on histological parameters, with the most common histotypes being meningothelial, transitional, and fibroblastic meningiomas. Our findings showed the same prevalence pattern in the present study and the most common histotype was meningothelial followed by fibroblastic and transitional.

Histologically, meningothelial meningioma is characterized by densely packed cells arranged in sheets with no discernible cytoplasmic border (10, 12). Detailed histopathological study of the tumors can aid clinicians and surgeons in making a proper diagnosis. Common cystic meningiomas' features on MRI and CT scan are extra-axial solid-cystic mass lesions with broad dural attachment (dural tail sign) and mural nodule enhancement. Adjacent bony changes, especially hyperostosis, may also be observed on a CT scan. Imaging features showing an atypical subtype are narrow-based attachments to the dura and heterogeneous enhancement. Accurate diagnosis has improved with the application of multi-planar MRI up to 80%, instead of using CT scan alone. The accurate diagnosis of cyst-like cerebral lesions is required for subsequent medical and surgical planning by clinicians. Although magnetic resonance spectrometry is a useful tool to distinguish between tumors and other cerebral lesions, limitations exist regarding the accurate identification of the tumor type. However, a diagnosis based on imaging findings can be unreliable, compared to those made according to the histopathology of tumors, because the image characteristics of cystic meningioma are similar to those of other glial tumors, such as pilocytic astrocytoma. A review of the literature revealed only one case of pilocytic astrocytoma in supratentorial that was mimicking cystic meningioma and misleading on preoperative imaging (3, 4, 6, 7). Particularly, cystic meningiomas in type II Nata's classifications (5), when the intratumoral cystic component is more significant than the solid part and locates peripherally in association with peripheral enhancement, can mimic pilocytic astrocytoma. This radiological resemblance could be the reason behind the fact that all patients in our report were primarily misdiagnosed as pilocytic astrocytoma. Therefore, clinicians and neurosurgeons should pay attention to atypical imaging features of cystic meningioma and typical ones to reduce the chance of misdiagnosis.

Treatment options and prognosis depend on some variables, including histotype, tumor location, age, and associated comorbidities. Serial imaging studies, mainly MRI, examine small meningiomas of asymptomatic cases to determine interval growth. Depending on location and accessibility, benign tumors mostly undergo total resection with an extremely low recurrence rate of about 6%. Angiography and arterial embolization can occasionally be used preoperatively to control the arterial supply of the tumor. Radiation therapy may be used to control tumor growth and improve symptoms as palliation when surgery is not feasible, either due to the high-risk location of the tumor or the poor condition of the patient. In patients with atypical meningioma, radiotherapy alone or combined with chemotherapy, as an adjuvant to the surgical resection, can increase the median survival up to 3 years (10, 13). Our surgical treatment approach was similar to those adopted in the mentioned studies.

The most common locations for meningioma are reported to be falx and parasagittal, convexity, and sphenoid wing (14), which were in line with our findings. In contrast, the most common places for pilocytic astrocytoma are the cerebellum, brainstem, and basal ganglia. Moreover, it mainly affects children and young people (15). Like cystic meningioma, clinical features depend on the location; however, cerebellar and bulbar symptoms may be more observed (15). Clinicians should keep these differentiating clinical and epidemiological features and imaging particularities in mind when making a diagnosis to reduce the chance of misdiagnosis.

6. Conclusion

The most challenging issue regarding cystic meningiomas is an accurate pre-operative diagnosis, as neurological examinations and imaging techniques are often inaccurate and can be confusing for clinicians, misleading them toward other cystic brain tumors. However, neurosurgeons can make accurate diagnoses by paying attention to imaging features in atypical forms of this tumor, which can help them select an optimal surgical strategy. This can, in turn, lead to improvements in the outcome of these cases.

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None.

Footnotes

Conflicts of Interest: None.

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