CT and MRI findings of atypical meningiomas

Poster No.: C-1830
Congress: ECR 2013
Type: Educational Exhibit
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Keywords: Neoplasia, Computer Applications-Detection, diagnosis, Computer Applications-3D, MR, CT, Neuroradiology brain
DOI: 10.1594/ecr2013/C-1830

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Learning objectives

To illustrate the imaging findings of atypical meningiomas or unusual locations of typical meningiomas that mimicked other intracranial lesions.
Background

Meningiomas represent approximately 15% of all symptomatic and roughly one third of all incidental (asymptomatic) intracranial neoplasms \(^{(2, 3)}\), with a higher incidence of up to 35.2% among Asians and Africans \(^{(4)}\). True meningiomas arise from meningothezial cells (arachnoid "cap" cells), and the tumors occur more frequently where these cells are most numerous \(^{(1)}\).

Their typical appearance is that of a homogeneous, extra-axial mass, that enhances strongly with contrast, usually located in the cerebral convexity, parasagittal region or in the planum sphenoidale. Up to 10% of meningiomas are, however, atypical or malignant and may present with unusual imaging findings. Some of them may even mimic other neoplastic and non-neoplastic CNS lesions.
Imaging findings OR Procedure details

We conducted an analysis of the computed tomography (CT) and magnetic resonance imaging (MRI) of patients with meningiomas with atypical imaging findings or unusual locations for the last 2 years.

Atypical Findings:

- "En plaque" meningiomas (figure 1) represent a morphological subgroup defined by a carpet or sheet-like lesion that infiltrates the dura and occasionally invades the bone (6). Histopathological features of en plaque meningiomas are similar to that of usual meningiomas; however, it is sometimes difficult to predict their behavior in an individual basis. The en plaque variants commonly involve fronto-parietal, orbital, sphenoid wing, diffuse calvarial or rarely spinal region (8). These tumors are also more prone to develop malignant change (11%) when compared to intracranial meningiomas (2%) (7, 8).

Fig. 1 on page 8

- Intradiploic meningioma (figure 2) represents less than 1 % of all meningiomas. They arise within the intradiploic space, from the outer table of the skull, in the overlying skin, inside the pananasal sinuses, in the parotid gland, or from the parapharyngeal space. Theories to explain these abnormal sites of origin include origin from the arachnoid around the cranial nerve sheaths or from ectopic inclusions of arachnoid cells disseminated during the formation of the skull (1).

Fig. 2 on page 8

- Cystic meningioma. (figures 3, 4) Cystic meningiomas are quite rare, accounting for 2% to 4% of all intracranial meningiomas (10). The cysts can be located within the tumor mass, either centrally or eccentrically; outside and adjacent to the edge of the tumor; and, occasionally, inside the adjacent brain parenchyma. They may mimic metastatic neoplasms, hemangioblastomas, and glial tumours with cystic components (glioblastoma multiforme, or cystic astrocytoma). Benign meningiomas with heterogeneous enhancement that contain small nonenhancing areas of cystic change or necrosis occur much more frequently (up to 8%-23% of cases) (1, 2). An additional uncommon feature of cystic meningiomas is that they are more frequent in the pediatric age, a group where meningiomas are not usual. These unusual clinical
features may contribute to a misdiagnosis of a cystic or necrotic glioma \(^{(10)}\). Various explanations for cyst formation have been offered, including that intratumoral cysts are due to tumor necrosis or degeneration. A peripheral cyst, on the other hand, may represent either peripheral degeneration or an arachnoid cyst. Although the imaging differentiation between a peripheral (neoplastic) intratumoral cyst and an extratumoral (reactive) arachnoid cyst may be suggested when ring enhancement is seen surrounding the fluid collection, histologic analysis, demonstrating neoplastic cells in the cyst wall, may be required for confirmation.

**Fig. 3** on page 9

**Fig. 4** on page 10

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*High grade meningioma.* (figures 3, 4, 5, 6, 7) Between 4.7% and 7.2% of meningiomas are grade II, and up to 2% are grade III \(^{(12)}\). Neuroimaging features, such as heterogeneous appearance, heterogeneous enhancement, marked perilesional edema, irregular cerebral surface, mushrooming on the outer edge of the lesion, and bone destruction, are not unique or reliable for diagnosing atypical/malignant meningiomas \(^{(5,17)}\). Vasogenic edema within the white matter of the brain is a common feature of intraaxial masses like glioma, metastatic disease, and abscess. However, mild to moderate intraaxial vasogenic edema is also seen around meningiomas (which are extraaxial masses) in up to 75% of cases \(^{(15)}\). Some theories implicate active fluid production (secretion or excretion) by the tumor, with "flow" through the thinned contiguous cortex. Others have suggested that the tumor injures the brain mechanically (by means of direct compression) or ischemically (from parasitization of the cortical arteries, compression of the cortical veins, or frank involvement of the dural sinuses). *Atypical and anaplastic meningioma* display lower apparent diffusion coefficient (ADC) values than their benign counterparts, which is likely related to the higher cellularity and lower water content in high-grade lesions \(^{(5,12)}\). Similarly, perfusion-weighted MRI shows higher rCBV values in high grade meningiomas in comparison with their benign counterparts \(^{(12,16)}\).

**Fig. 5** on page 11

**Fig. 6** on page 12

**Fig. 7** on page 13
- **Intraventricular meningioma.** (figure 8) arise from the tela choroidea or the stroma of the choroid plexus itself. Approximately 80% arise in the lateral ventricles with a preference for the left trigone, 15% occur in the third ventricle, and about 5% within the fourth ventricle \(^{(1,2)}\). Overall, intraventricular meningiomas account for approximately 2%-5% of intracranial meningiomas \(^{(14)}\). Meningioma is the most common trigonal intraventricular mass in an adult.

Fig. 8 on page 14

- **Lipoblastic meningioma.** (figure 9) a variant in which there is a metaplastic change of meningotheial cells into adipocytes, through the accumulation of fat (mostly triglycerides) within their cytoplasm \(^{(13)}\). The evidence against the lipoblastic meningioma representing either a true intracranial lipoma or a "collision" tumor (between fat and a meningioma) lies in the recognition of a spectrum of cells, ranging from typical meningotheial cells, through those containing various amounts of intracellular lipid, to cells that have been transformed into adipocytes \(^{(13)}\). The lipoblastic meningioma may have an imaging appearance of a fatty tumor, with low negative attenuation on CT scans and a short T1 relaxation time with high signal intensity on T1-weighted MR images.

Fig. 9 on page 15

**Locations unusual:**

- **Tuberculum sella meningioma.** (figure 10). They represent 3% to 10% of all meningiomas \(^{(18)}\). They may be associated with hyperostosis of the sphenoid ridge and may be very invasive, spreading to the dura of the frontal, temporal, orbital, and sphenoidal regions. Medially, this tumor may expand into the wall of the cavernous sinus, anteriorly into the orbit, and laterally into the temporal bone.

Fig. 10 on page 16

- **Optic nerve sheath meningiomas** (figure 11) are rare tumors of the anterior visual pathway and constitute approximately 2% of all orbital tumors and 1-2% of all meningiomas \(^{(18)}\). Without treatment, continued growth most often results in progressive visual acuity decline, color blindness, and finally complete loss of vision \(^{(19, 20)}\). Around 90% of meningiomas arise from within the intraorbital nerve sheath.
Dorello’s canal meningioma. (figure 12) Dorello’s canal is an osteofibrous canal at the apex of the petrous bone containing the abducens nerve and the inferior petrosal sinus. In patients with a compressive or space-occupying lesion in this region, using MRI can assess the anatomic relationship between the abducent nerve and the lesion.
Fig. 1: Menigioma en plaque of woman. CT scan and MRI shows extensive hyperostosis and destruction of the frontal and parietal calvaria. bone(a) and brain-window CT (b) shows an extraaxial falcine mass with infiltration and destruction along the inner table of the calvaria. T1-W MR with gadolinium (c,d) shows the soft tissue component to better advantage. Note enhancing mass infiltrating the scalp. This lesion mimicking a Paget's disease or multiple myeloma.

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Fig. 2: Intradiploic meningioma. CT bone-window scan (a) and MRI, coronal fluid-attenuated inversion-recovery (FLAIR) (b), and T2-weighted (c, d). demonstrates completely intraosseous meningioma with marked hyperostotic reaction of the frontal bone and anterior aspect of the parietal bone without peritumoral edema.

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**Fig. 3:** Cystic meningioma. Sagittal MRI T1-weighted (a), T2-weighted (b), T1-weighted sagittal and axial with gadolinium (c, d). Mass right frontal meningioma and a large intratumoral cyst with rim enhancement after contrast injection.

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Fig. 4: Cystic meningioma same patient as the figure 3. Apparent diffusion coefficient (ADC) (a) map shows relatively low diffusivity and perfusion relative cerebral blood volume (rCBV) (b) map shows a hypervascular tumor with maximum relative rCBV of 16.2. These two parameters are directly related to the Ki-67 (high grade meningiomas) (12)

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Fig. 5: High grade meningioma patient 39 years old, 33 weeks pregnant. MRI Sagittal T1-weighted (a), axial SWI (b), axial T2-weighted (c), axial T1-weighted (d), axial T1-weighted with gadolinium (e) patient shows homogeneous enhancing, markedly lobulated extraxial tumor, with moderate edema. MIP venous phase (f) demonstrates the great vascularity of meningioma.

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Fig. 6: Figure 6. Atypical Meningioma same patient as the figure 5. Map of perfusion in T2* (a), ADC (b) map shows relatively low diffusivity, T2-weighted (c), rCBV (d) map shows a hypervascular tumor with maximum relative rCBV of 131.5, rCBV curves (e) compatible with tumor extraaxial, fused image map of perfusion and T1 (f). These parameters are directly related to high grade meningiomas (12)

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Fig. 7: High grade meningioma. MRI T1-weighted with gadolinium (a, b) and coronal FLAIR (c,d) reveals a broad-based, homogeneously enhancing mass in the right parietal region with extensive peritumoral edema of the white matter.

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Fig. 8: Intraventricular meningioma. 14 years male. CT scan, without (a) and with contrast (b) shows left intraventricular tumor with heterogeneous calcifications, displacing the parietal lobe. MRI T1 (c), T1 with gadolidum axial (d) and coronal (e), and FLAIR (f), show intraventricular tumor that strongly enhances after contrast injection, with perilesional edema. Mimicking a PNET or germinoma extrapineal, by the large tumor is difficult to determine its origin.

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**Fig. 9:** Lipoblastic meningioma. CT scan (a,b) show tumor left frontal cerebral falx hypodense, heterogeneous. MRI T1-fatsat (c) shows loss of mass signal, SWI (d) there is significant magnetic susceptibility, T1-weighted with gadolinium (e) mass extraxial in cerebral falx strongly enhance after contrast injection, T2 with mild edema peritumoral. Findings consistent with lipoblastic meningioma, mimicking a dermoid tumor in CT.

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Fig. 10: Tuberculum sella meningioma. Planum sphenoidal meningioma with intrasellar extension, mimicking a macroadenoma.

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Fig. 11: Optic nerve sheath meningiomas right optic nerve mimicking optical glioma.

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Fig. 12: Dorello's canal meningioma, through the left canal, mimicking a schwannoma.

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Conclusion

Meningiomas usually present with typical radiological features. However, cases with atypical imaging findings and/or unusual locations, may render their diagnosis challenging or even mimic other disorders.
References


