Cystic meningiomas: a clinicoradiological study

STEPHEN DELL, M.D., S. RAMAIH GANTI, M.D., ABE STEINBERGER, M.D., AND JAMES McMACURTRY III, M.D.

Departments of Neuroradiology and Neurosurgery, Neurological Institute, Columbia-Presbyterian Medical Center, New York, New York

A group of eight cystic meningiomas is considered, with particular reference to preoperative radiological evaluation. Computerized tomography (CT) scanning alone is inadequate for diagnosis, and the authors offer an assessment of the current methods for preoperative identification of cystic supratentorial tumors, while reviewing the multiple etiologies suggested for the CT appearance. No single process explains all the aspects of peri- or intratumoral cyst formation in meningiomas.

KEY WORDS  •  cystic meningioma  •  cystic tumor  •  radiology  •  computerized tomography

It has long been known that meningiomas may be cystic, and exert a compressive effect disproportionately to their size.10,12 Xanthochromic cyst formation occurs at the periphery of the mass, usually without evidence of tumor degeneration. Even small convexity tumors may produce marked pressure symptoms due to cerebral edema. Several authors have described this unusual phenomenon in case reports or larger series,20,42,45 with infra- and supratentorial lesions,31 alone or associated with other tumors,36 among children (in whom it is a frequent form of meningioma) as well as adults.2,17,20,31,39,45,52-55

The introduction of computerized tomography (CT) has not eliminated diagnostic error.8,11,19,32,35,39,40,42-45 We have studied a group of cystic meningiomas with the purpose of developing radiological diagnostic criteria. We also review the suggested etiologies of cyst formation.

Summary of Cases

Eight cases of cystic meningioma are presented with summaries of the clinical features, laboratory investigations, and operative details and pathology (Tables 1 to 3). In this series, only four lesions were correctly diagnosed prior to surgery, despite a relatively high index of suspicion.

Few specific clinical features distinguish the cystic from the noncystic meningioma. The rate of progression of symptoms does not appear particularly rapid, as might be expected of a fast-growing cyst. In our series, the onset of symptoms ranged between 6 weeks and 2 years before diagnosis. These cysts produce a mass as large as the meningioma itself (Figs. 1 to 4). All but two of the tumors in this series were less than 3 cm in maximum dimension. Their clinical effects were characteristic of much larger lesions (Table 1).

In four cases the tumors were located in the parasagittal region. Angiography confirmed the diagnosis in all cases, and surgical separation was possible around a sharply demarcated cyst. Coronal CT helped visualize the attachment of the enhancing nodule to the falk (Fig. 1). One pterional lesion was mistakenly interpreted as a cystic astrocytoma or metastasis. Angiography demonstrated an avascular suprasylvian mass. In retrospect, the CT scan shows an enhancing lesion lying against the inner table of the calvaria, with a cyst located medially (Fig. 2). A sphenoid wing meningioma was correctly diagnosed preoperatively to have a cyst on its ventral aspect (Fig. 3).

In two parietal tumors, CT and angiography revealed intra-axial lesions; in one case the lesion was eroding extra-axially. Both were initially thought to be glioma, sarcoma, or metastasis (Fig. 4).

In Cases 1, 2, 3, and 7, the cyst appeared to be a loculated subarachnoid space. In Case 1, it had a CT density of 18 Delta scan units. The other cysts (in Cases 4, 5, 6, and 8) contained extremely xanthochromic fluid, and the capsule was clearly not arachnoidal. Pathologically, the cyst walls appeared gliotic in Cases 4, 5, and 8, and fibroblastic in Cases 1, 6, and 7.
Cystic meningiomas

Fig. 1. Upper: External carotid arteriogram, anteroposterior (left) and lateral (right) views. A tumor stain fed by the branches of the middle meningeal artery is seen in the parasagittal region. Lower: Computerized tomography with injection of contrast material. The axial scan (left) shows an enhancing nodule surrounded by a sharply demarcated lucent area (cyst) along the falx. The ill-defined area of lucency peripheral to the cyst represents the edema. The coronal scan (right) shows the enhancing lesion attached to the falx, indicating its extra-axial location (meningioma) relative to the cyst.

Discussion
In 1932, Penfield wrote that, "only in rare cases is there cyst formation" in meningiomas. Unlike the usual glial tumor, meningiomas do not degenerate in a circumferential pattern. Claveria, et al., reviewing an early series of 71 cases, showed "major" cysts in three patients and "minor" cysts in another three; of the former cases, two were misdiagnosed. Russell, et al., achieved 93% correct diagnoses on CT criteria alone. Of nine missed diagnoses (lipoma, ischemic necrosis), four were due to the tumoral cyst, and half of these were corrected by angiography. Thus, CT scanning alone will lead to 5% to 10% false negative diagnoses.

Among meningiomas, cysts may lie inside or around the tumor. Intratumoral macroscopic cysts arise from secretory or degenerative changes, but are rare. Henry, et al., reported three such cases simulating astrocytoma. These CT-lucent areas can be

Fig. 2. Computerized tomography scans. Left: Plain scan showing a sharply demarcated lucent lesion (cyst). There is edema medial to the cyst, with midline shift and mass effect on the frontal horn. Right: Scan after contrast medium injection showing enhancement lateral to the cystic lesion along the inner table of the calvaria.
### TABLE 1
Clinical features in eight cases of cystic meningioma

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Tumor Location</th>
<th>History</th>
<th>Findings on Examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>49, M</td>
<td>lt frontotemporal convexity</td>
<td>psychosocial deterioration for 10 yrs; paraparesis, double incontinence for 2 wks</td>
<td>inattentive, dysarthric, decreased memory, obeying simple commands; papilledema; rt central facial weakness; mild spasticity; mild appendicular coordination deficits</td>
</tr>
<tr>
<td>2</td>
<td>68, M</td>
<td>lt frontal convexity</td>
<td>personality, judgment changes for 1 yr; fluctuating rt hemiparesis for 1 mo</td>
<td>rt hemiparesis, more in lower than upper extremity; long-tract signs, rt cortical sensory deficit; lt olfactory loss; variable but declining consciousness</td>
</tr>
<tr>
<td>3</td>
<td>46, F</td>
<td>lt frontotemporal convexity</td>
<td>increasing word-finding deficits for 2 yrs</td>
<td>papilledema, worse on right side; mild rt hemiparesis; mild lt stereognosis deficit</td>
</tr>
<tr>
<td>4</td>
<td>39, F</td>
<td>rt frontal parasagittal</td>
<td>progressive moderate lt hemiparesis for 2 mos</td>
<td>after steroid therapy: mild lt hemiparesis with corticospinal deficits</td>
</tr>
<tr>
<td>5</td>
<td>64, F</td>
<td>rt posterior frontal parasagittal</td>
<td>lt hemiparesis for 3 years; one episode of speech arrest; urinary incontinence for 6 mos</td>
<td>mild hypertension; moderate lt spastic hemiparesis with corticospinal deficits; poor lt appendicular coordination</td>
</tr>
<tr>
<td>6</td>
<td>55, M</td>
<td>lt parietal convexity</td>
<td>moderate rt hemiparesis, ataxia for 1 mo; mild rt hemisensory deficit for 2 weeks; dysphasia, lt parietal deficits for 3 days</td>
<td>dysphasia, rt-lt disorientation; rt visual field extinction; lt parietal sensory deficits; lt arm dysesthesia</td>
</tr>
<tr>
<td>7</td>
<td>25, M</td>
<td>lt sphenoid wing</td>
<td>10 yrs after gross total removal of non-cystic lt frontal meningioma: decreased lt visual acuity for 3 mos; headaches; several grand mal seizures</td>
<td>bilateral optic atrophy (rt: 20/100, lt: hand movements)</td>
</tr>
<tr>
<td>8</td>
<td>58, M</td>
<td>rt posterior parietal convexity</td>
<td>rt parietal protrubance for 1 yr; depression, confusion for 3 months; lt visual field changes for 1 mo</td>
<td>depressed, confused; lt homonymous hemianopsia</td>
</tr>
</tbody>
</table>

### TABLE 2
Radiographic investigations in eight patients with cystic meningioma

<table>
<thead>
<tr>
<th>Case No.</th>
<th>X-Ray Films</th>
<th>Computerized Tomography</th>
<th>Angiography</th>
<th>Other Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>frontotemporal lytic lesion</td>
<td>extra-axial cystic mass; midline shift</td>
<td>5 × 5-cm avascular mass; few ECA feeding vessels, herniation lt ACA, PCoA</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>—</td>
<td>3-cm frontal convexity lesion, midline shift, dilated contralateral ventricle, extensive cerebral edema (to pineal, 18 Delta units)</td>
<td>ECA feeding vessels</td>
<td>EEG: ipsilateral dysfunction; frontotemporal focal accentuation Echo: 16-mm shift LP: opening pressure 200 mm H2O; protein 176 mg%</td>
</tr>
<tr>
<td>3</td>
<td>—</td>
<td>posteromedial 4.5 × 3.3-cm lucency (4 Delta units); avascular temporoparietal mass, primarily cystic by CT units; midline shift</td>
<td>avascular middle suprasylvian mass</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>—</td>
<td>parietal lesion</td>
<td>bilateral ECA feeding vessels</td>
<td>EEG: continuous slowing, frontotemporal parasagittal region</td>
</tr>
<tr>
<td>5</td>
<td>—</td>
<td>high posterior frontal hypervascular lesion, no cyst seen</td>
<td>ECA feeding vessels</td>
<td>—</td>
</tr>
<tr>
<td>6</td>
<td>—</td>
<td>initial: large parietal increased density; subsequent (6 wks): ring-like enhancing lesion, midline shift</td>
<td>posterior parietal mass; ventrocaudal Sylvian displacement; neovascularity; early-draining veins (performed at time of 2nd CT)</td>
<td>—</td>
</tr>
<tr>
<td>7</td>
<td>—</td>
<td>sphenoid wing tumor; sharply demarcated lucency anteriorly</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>8</td>
<td>rt parietal sclerosis</td>
<td>rt posterior temporoparietal cyst adjacent to inner table; mild cyst wall enlargement</td>
<td>large intra-axial avascular mass posterior parietal area; ?intracranial extension</td>
<td>—</td>
</tr>
</tbody>
</table>

*ECA = external carotid artery; ACA = anterior cerebral artery; PCoA = posterior communicating artery; CT = computerized tomography; EEG = electroencephalography; Echo = echoencephalography; LP = lumbar puncture.*
## TABLE 3

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Preoperative Diagnosis</th>
<th>Operative Findings*</th>
<th>Pathology</th>
<th>Postoperative Course†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>glioma or metastasis</td>
<td>lt fronto-temporal craniotomy: partly cystic fibrous tumor</td>
<td>fibroblastic meningioma, collagen-producing; electron microscopy: large bizarre nuclei</td>
<td>improved speech, sociability; mild residual rt spastic hemiparesis</td>
</tr>
<tr>
<td>2</td>
<td>meningioma</td>
<td>lt fronto-temporal craniotomy: firm vascular tumor; adjacent green-gray thick-walled cyst containing colloid material, CSF, &amp; fresh blood</td>
<td>meningothelial meningioma, arachnoidal cyst free of tumor</td>
<td>independent, mild residual dysphasia</td>
</tr>
<tr>
<td>3</td>
<td>glioma</td>
<td>lt fronto-temporal craniotomy: fronto-temporal junction meningioma; Sylvian fissure cyst containing 20 cc xanthochromic fluid</td>
<td>meningoima, arachnoidal cyst free of tumor</td>
<td>normal neurological examination</td>
</tr>
<tr>
<td>4</td>
<td>meningioma</td>
<td>rt fronto-temporal craniotomy: encapsulated neovascular arachnoidal cyst containing proteinaceous xanthochromic fluid; small falx meningioma; gross total removal</td>
<td>meningoima, arachnoidal cyst free of tumor</td>
<td>single grand mal seizure; normal neurological examination</td>
</tr>
<tr>
<td>5</td>
<td>meningioma</td>
<td>rt frontoparietal craniotomy: parasagittal tumor, necrotic &amp; edematous brain; 10-cc xanthochromic cyst in necrotic brain with gliotic margins</td>
<td>meningoima, cortical necrosis</td>
<td>almost normal strength &amp; gait; persistent severe depressive psychosis</td>
</tr>
<tr>
<td>6</td>
<td>initial: infarction; subsequent: intraxial tumor, glioma or metastasis</td>
<td>lt parietal craniotomy: convexity &amp; parasagittal tumor; 15-cc proteinaceous cyst</td>
<td>fibroblastic meningioma</td>
<td>improved rt motor, sensory, &amp; rapid alternating movement performance</td>
</tr>
<tr>
<td>7</td>
<td>recurrent (cystic) meningioma</td>
<td>lt frontal craniotomy: planum sphenoidale-sphenoid wing tumor within huge xanthochromic cyst membrane; atrophic cortex</td>
<td>fibroblastic meningioma</td>
<td>no deficit</td>
</tr>
<tr>
<td>8</td>
<td>rt occipital glioma or sarcoma or metastasis</td>
<td>rt parieto-occipital craniotomy: tumor erosion through scalp; proteinaceous cyst with 3 x 4 cm tumor nodule; gross total removal of intracranial tumor</td>
<td>meningoima</td>
<td>improved lt homonymous hemianopsia</td>
</tr>
</tbody>
</table>

* Gross total removal in all cases except Case 8. CSF = cerebrospinal fluid.
† A good result was obtained in all patients.

related to ischemic central necrosis, or the fat content in areas without necrosis. This has been confirmed by Russell and Rubinstein.45

Many other etiologies have been suggested for the CT appearance of peripheral “xanthochromic cysts.”12,38 When cerebral edema and a tumoral cyst coexist, their margins may be difficult to resolve, and contrast material (Conray 60) has been demonstrated to “leak” in both directions.34 Thus, the cystic appearance might simply be the end stage of adjacent intense cerebral edema.4

A loculation of the subarachnoid space may be seen on CT in these cases. This probably represents the “markedly widened” space (0 to 8 EMI units in density) reported by Sigel and Messina.50 The two cases of Becker, et al.,8 may also reflect loculated cerebrospinal fluid (CSF), with the appropriate moderate increase in protein content. Only a small minority of cystic meningiomas demonstrate low CT densities, and few of these contain CSF. While loculation is possible, the dilatation of the subarachnoid space in response to tumor is doubtful. Rengachary, et al.,43 have presented the arguments against this explanation.

Reactive gliosis or a fibroblastic proliferation may be the source of the cyst capsule. Glioma cells grown in vitro have been shown to elaborate extracellular protein,9 and most cysts contain protein concentrations as high as 3.5 mg/dl.3,43 Despite an arachnoidal origin, the presence of glial fibrillary acidic protein in the cyst wall has been documented in two cases.

Cases in which the astrocytic wall appears more hyperchromic and pleomorphic than would be explained by a gliotic process may represent the rare simultaneous occurrence of adjacent 5,7,16,19,21,23,33,35,37,44,56,67 or remote 1,15,27,29 meningioma and glioma. An adjacent well differentiated astrocytoma has provided the cystic CT appearance to an olfactory groove meni-
published cases, this figure may be improved. A combination of scintigraphy, angiography, and encephalography demonstrated detection rates of 100% for convexity meningiomas and of 88% to 90% for others. Pneumoencephalography may be valuable in the falk region. None of these techniques are comparable to CT scanning, but they have suggested the correct diagnosis when CT data were equivocal.

Coronal CT will provide additional information about attachment to the falk or inner table. Using high resolution scanners, the demarcation is usually visible between the area of enhancement and the inner table of the calvaria. Despite rare exceptions, the diagnosis of cystic meningioma can frequently be made by current techniques once it is suspected.

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Address reprint requests to: Stephen Dell, M.D., Department of Neurosurgery, Tufts-New England Medical Center, 171 Harrison Avenue, Boston, Massachusetts 02111.