Ventricular Neurocysticercosis: A Neuroradiological Diagnosis

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Agenda

Case investigation

Differential diagnosis, with revisions

Review of menu of appropriate tests; view relevant images

Radiologic-pathophysiologic correlation

Companion patient imaging

Evidence-based imaging

Evidence-based treatment
Social Context:
Rural Central America

- Rural community
- 6 hours to nearest hospital
- Tenuous access to water
- Precipitous mountains

Photo courtesy Cassandra Peitzman
Social Context:
BIDMC, Boston

- Vast menu of radiologic tests
- Increasingly globalized patient population
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Our patient: Initial H&P

• 29 yo woman c/o headaches x 10 days
• Dizziness and N/V x 3 days
• Syncopal event on day of presentation
• No seizures, fevers, wt loss, neck stiffness, weakness, trauma
• Born in Western Guatemala, emigrated in 2001
• No h/o TB or TB contacts
• No IVDU
• Packages scallops for seafood company
• Exam normal
• HIV -
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Our Patient: Conceptual Differential Diagnosis

- **Infectious**
  - *Anatomical region*: encephalitis, meningitis, abscess
  - *Causative agent*: parasitic, bacterial, viral, fungal
- **Neoplastic**
  - *Origin*: primary, metastatic
- **Vascular**
  - *Mechanism*: aneurysm, vasospasm, vasculitis, thrombosis, hypertension, pseudotumor cerebri
  - *Headache syndromes*: migraine
  - *Intracranial bleeds*: subdural hematoma, subarachnoid hemorrhage
- **Primary neurological**
  - *Electroconductive disorder*: nonconvulsive status epilepticus
  - *CSF flow abnormality*: hydrocephalus
- **Metabolic**
  - *Ingestion*: toxic overdose, withdrawal, CO poisoning
  - *Electrolyte abnormality*: hyponatremia, DKA
Approach to Headache: When to be Concerned?

- “Danger signs”:
  - Sudden onset
  - “First” or “worst”
  - Worsening pattern
  - Focal neuro findings
  - Associated fever
  - Change in MS, personality, consciousness, N/V
  - Occurred with strenuous exercise
  - Spread to neck, shoulders
  - Age <5 or >50
  - HIV+, h/o cancer, Lyme infection,
  - Intra-or post-partum

- Subarachnoid hemorrhage
- Mass lesion, subdural hematoma, med overuse, AV malformation
- Infection, other serious abnormality
- Carotid dissection, intracranial hemorrhage
- Meningeal irritation
- Accordingly associated complications
- Cortical vein or venous sinus thrombosis, carotid dissection, pituitary apoplexy

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Approach to Headache: When to Image?

• **Meta-analysis:** abnormalities detected on CT or MRI in only 2.4% of patients w/ normal neurological exam
  
  *Neurology.* 1994;44(7):1353-4

  
  • Neuroimaging should be considered if nonacute headache w/ unexplained neurological deficit
  
  • Evidence insufficient to make specific recommendations for patients with any other “danger signs”
  
  • Evidence insufficient regarding relative specificity of CT versus MRI
# Menu of Radiologic Tests

*ACR Appropriateness Criteria “Headache, suspect meningitis/encephalitis”*

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI head w/o and w/ contrast</td>
<td>8</td>
<td>CT vs MRI depends on preference, availability.</td>
<td>0</td>
</tr>
<tr>
<td>CT head w/o contrast</td>
<td>8</td>
<td>To exclude signs of increased ICP, mass, mass effect</td>
<td>☢☢</td>
</tr>
<tr>
<td>MRI head w/o contrast</td>
<td>6</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>MRA head w/ or w/o contrast</td>
<td>6</td>
<td>MRV should also be performed.</td>
<td>0</td>
</tr>
<tr>
<td>CT head w/ and w/o contrast</td>
<td>6</td>
<td>MRI preferable, depending of availability</td>
<td>☢☢</td>
</tr>
<tr>
<td>CTA head</td>
<td>3</td>
<td>Useful for problem solving or if there is a strong suspicion of vascular disease</td>
<td>☢☢</td>
</tr>
</tbody>
</table>

Rating scale: 1, 2, 3 Usually not appropriate; 4, 5, 6 May be appropriate; 7, 8, 9 Usually

Accordingly, our patient underwent both CT and MR imaging.

As we view images from both, we’ll examine normal studies and review the relevant anatomy.
Normal Study:
Head CT

Axial view, C-

Gray matter

White matter

Bone

Ventricular system
(CSF)

Midline
(alignment/shift)

Degree of sulcation
(atrophy, edema)

Basal ganglia
(caudate nucleus)

Calcified choroid plexus
Our Patient:

R Frontal and 4th Ventricular Lesions on Head CT

1. R frontal lobe lesion with hyperdense peripheral rim that enhances w/ contrast. No significant surrounding edema.

2. Dilatation of ventricular system; cystic expansile lesion of the fourth ventricle.
Anatomy Checkpoint: Ventricular System

Clinical Correlate
Hydrocephalus can result from:
1. Obstruction (mass lesion)
2. Impaired CSF absorption (inflammation of subarachnoid villi)
3. Excessive CSF production (functional choroid plexus papilloma)
Normal Studies: Head MRI (T1 and T2)

1. Improved white/gray differentiation
2. Finer parenchymal detail
3. Multiple sequences help characterize pathology

CSF is BLACK
CSF is WHITE
Normal Studies:
Head MRI (T2 and FLAIR)

- **Axial view, w/o contrast**
  - **T2 FLAIR**
    - Fluid-sensitive: CSF and all other fluid is BRIGHT
  - **FLAIR**
    - Fluid-attenuated: CSF is DARK, other (pathological) fluid is BRIGHT
Anatomy Checkpoint: Gray Matter Structures

- Head of caudate
- Putamen
- Thalamus
- Globus pallidus
- Primary visual cortex

Axial view, w/o contrast

T2

December 2010
PACS, BIDMC, Accessed 12/10/10
Our Patient:
R Frontal Lesion on Head MRI

1. **R frontal lobe lesion with peripheral enhancement.**
2. **Central area of T2 hyperintensity** that may represent a scolex from neurocysticercosis.
Our Patient: 4th Ventricular Lesion on Head MRI

1. Cystic lesion within fourth ventricle with expansion of fourth ventricle. Rim is hyperintense on FLAIR image.
2. Cystic fluid is not completely suppressed (not black) on FLAIR, ruling out a simple cyst.
3. Susceptibility artifact in anterolateral border of lesion, likely “cyst with dot” appearance of neurocysticercosis with visualization of scolex.
1. Cystic lesion within fourth ventricle with expansion of fourth ventricle; lesion hyperintense compared to CSF.

2. Obstructive hydrocephalus above 4th ventricle causing dilatation of the third ventricle and dilatation of the aqueduct of Sylvius.
Our Patient: Differential Diagnosis Redux

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Our Patient: Revised Differential Diagnosis

- **Neurocysticercosis** ("cyst with dot" pathognomonic)
- **Echinococcosis** (most commonly CSF attenuation; does not enhance)
- **Tuberculoma** (negative PPD, rare in patients without miliary TB or TB meningitis, rarely cystic)
- **Pyogenic brain abscess** (most commonly presents w/ T2 hypointense rim)
- **Metastatic brain tumor** (no associated sx, lesion not at gray-white border)
Our Patient: Absolute Criteria for Diagnosis

1. Demonstration of cysticerci by histologic or microscopic examination of biopsy material

2. Visualization of the parasite in the eye by funduscopy

3. Neuroradiologic demonstration of cystic lesions containing a characteristic scolex

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Cysticercosis: A Closer View

- Caused by larval stage of pork tapeworm, *Taenia solium*
- Most commonly affects brain, CSF, skeletal muscle, eye
- Onset of symptoms peaks at 3-5 years following infection, but can delay until >30 years
- In many endemic countries, cysticercosis is the most common cause of adult-onset seizures
Cysticercosis: Geographic Prevalence

Estimated world prevalence: 50 million (likely underestimate)

Cysticercosis:
Two Manifestations of Infection

Cysticercosis:
Organism often detected only radiographically or in pathology specimens

Taeniasis:
Organism detected in stool

Centers for Disease Control and Prevention, Neurocysticercosis, http://www.cdc.gov/parasites/cysticercosis/, accessed 12/10/10
Cysticercosis:
Cyst Localization

- Parenchymal >60%
- Encephalitic symptoms:
  - Seizures
  - Headache

- Extraparenchymal (Subarachnoid, ventricular) <40%
- Obstructive symptoms:
  - Headache
  - Nausea/vomiting

- Spinal cord
- Ocular
- Extraneural (muscular)

Cysticercosis: Radiologic Patterns of Cyst Degeneration

- Living cysticerci
  - Well-demarcated
  - Scolex often present
- Nodular, hyperdense rim
  - Disk-enhancement
  - No signal

OUR PATIENT’S LESIONS

Vesicular
↓
Colloidal

Nodular-granular
↓
Calcified

2-10 years

- Ill-defined
  - Ring-enhancement
  - Acute encephalitic phase
- Dead scolex
  - No edema/enhancement
  - Not visualized on MRI


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Evidence-based treatment
We will now view the imaging studies of different companion patients to demonstrate the radiographic stages of cyst degeneration.
Companion Patient 1: Vesicular Neurocysticercosis on Head MRI

Axial view, T2

Axial view, T1 post gadolinium

Axial view, FLAIR

Subarachnoid cyst appears similar to CSF
Scalp evident
Does not enhance

No surrounding edema on fluid-attenuation

Companion Patient 2: Colloidal Neurocysticercosis on Head MRI

Axial view, T1

Cystic lesion of left precentral gyrus
Hyperintense compared to CSF

Axial view, T2

Surrounding edema present

Companion Patient 3: Granular Neurocysticercosis on Head CT

Axial views

C- Enhancing disk lesion with perifocal edema (arrow)

C+ Enhancing disk lesion with perifocal edema (arrow)

CNS Imaging in Neurocysticercosis (Medscape), www.emedicine.medscape.com, accessed 12/10/10
Companion Patient 4: Calcified Neurocysticercosis on Head CT

Axial view, C+

Calcified lesions

Companion Patients 5-7: Gross Specimens

Gross specimen with multiple parenchymal and subarachnoid cysts, many of which display evidence of a scolex

Gross specimen with cisternal neurocysticercosis in the prepontine cistern

Gross specimen with intraventricular cyst

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Treatment Objectives

- **Symptomatic**
  - Antiepileptics (AEDs)
    - No trials; most reports describe use of phenytoin or carbamazepine
    - Recommended if seizures have occurred or if marked inflammation on neuroimaging (Neurology. 2002;59(11):1730-4).
  - Surgical relief of obstructive hydrocephalus

- **Antiparasitic**
  - Albendazole showed radiographic resolution in 64% of patients (and in 55% of control patients); does not interact with AEDs (Ann Intern Med. 2006;145(1):43-51).
  - Praziquantel shows similar efficacy; problematic p450 metabolism (Expert Rev Anti Infect Ther. 2008;6(3):295-8).

- **Antiinflammatory**
  - Corticosteroids w/ antiparasitics results in better seizure control, faster radiologic resolution (J Infect. 2006;53(1):65-9).
Our Patient:
Ventricular Lesion Before and After Treatment on Head MRI

1. Cyst absent
2. Previously noted hydrocephalus has resolved

Sagittal views, MPRAGE post gadolinium

4th ventricle cyst resection
Dexamethasone
Praziquantel
(6 months)
Our Patient:

Frontal Lesion Before and After Treatment on Head MRI

Axial views, T1 post gadolinium

Previously noted ring-enhancing lesion in right frontal lobe resolving; no evidence of calcifications on CT (not shown)

4th ventricle cyst resection
Dexamethasone
Praziquantel
(6 months)
Learning Points

- Neuroimaging (both CT, MRI) for headache is most appropriate if **focal neuro findings** are present.
- While CT can demonstrate the presence of cystic lesions w/ resulting hydrocephalus, MRI helps characterize the cyst.
- Neurocysticercosis is most often diagnosed radiologically with the “cyst with dot” appearance.
- The **stage** of the cysticercus can be determined radiographically.
- Treatment consists of **symptomatic, antiparasitic, and anti-inflammatory** measures.
References (1)


- Garcia HH, del Brutto OH. Imaging findings in neurocysticercosis. Acta Tropica 2003; 87:71-78.
References (2)

Acknowledgements

BIDMC Radiology:
• Dr. Rafael Rojas
• Dr. Sachin Pandey
• Dr. Gillian Lieberman
• Emily Hanson
• My classmates

BIDMC Neurology:
• Dr. Courtney McLlduff

Partners in Health:
• Dr. Daniel Palazuelos
• Lindsay Palazuelos
Thanks!

Photo courtesy Cassandra Peitzman