Cerebral aneurysms

A case study

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Our Patient

• 57yr old woman
• History of migraines
• Presents with persistent headache
  – several months duration
  – different from her usual headache

Need to rule out intracranial abnormality
Menu of tests for initial cerebral imaging

- **Computed tomography (CT)**
  - Fast and readily available
  - Excellent for detection of acute hemorrhage
- **Magnetic resonance imaging (MR)**
  - Higher soft tissue resolution/contrast
  - Multiplanar capability
- **(Plain film)**
  - Shows the skull, but reveals few brain abnormalities
Our Patient

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Test of choice: HEAD CT
Normal Head CT

Check:
• Blood, acute
  – High attenuation (bright)
• Midline
  – Is symmetry preserved?
• Ventricles
• Cisterns
• Sulci
• Grey/white matter
• Soft tissues
• Bones
• Sinuses

BIDMC PACS system

R = Right, L = Left
W = White Matter, Gr = Grey Matter

R Frontal lobe
L Lateral Ventricle
R Occipital lobe
W = white matter
Gr = grey matter
Our Patient’s Head CT (no contrast)

Film Findings:
- Spherical mass
- Smooth margined
- High attenuation
- Slight mass effect
- Located just anterior to the Circle of Willis

- No acute hemorrhage, edema, infarct
DDx: Cerebral mass

- Tumor
- Hematoma
- Abscess
- Arterio-venous malformation (AVM)
- Aneurysm
Work-up: Cerebral mass

- Computed tomography (CT) + IV contrast
- Magnetic resonance imaging (MRI)
Our Patient’s Head CT (with contrast)

2 brightly enhancing round lesions suggestive of cerebral aneurysms
Lets review the anatomy of the Circle of Willis

- Communicating system of vessels that supplies blood to the brain
- Anterior portion fed by the internal carotid arteries
- Posterior portion fed by the vertebral arteries

http://www.strokecenter.org/education/ais_vessels/ais048.html
Circle of Willis in our Patient

Film findings: C/W cerebral aneurysms.
Menu of tests for evaluating suspected: Cerebral aneurysms

- Computed tomography (CT) + contrast
- Magnetic resonance imaging (MRI)
- Magnetic resonance angiography (MRA)
- Cerebral angiography

*Patient Plan: Come to the ER for immediate MR imaging!*
Our Patients sagittal MR (T1 sequence)

- **T1 sequence**
  - *Fat is bright (high signal)*
  - *CSF is dark (low signal)*

- **Mass characteristics**
  - Low signal emission
    - “flow void”
    - moving blood is dark
  - Position adjacent to ICA

*BIDMC PACS system*
Our Patients Axial MR (T2 sequence)

T2 sequence: CSF is bright (“high signal”)

Round lesions with flow void confirmed
Menu of tests for evaluating suspected: Cerebral aneurysm

- Computed tomography (CT) + contrast
- Magnetic resonance imaging (MRI)
- Magnetic resonance angiography (MRA)
- Cerebral angiography
Magnetic Resonance Angiography (MRA)

- MR technique for imaging vessels
  - Uses MR pulse sequences (“Time of Flight”) that can turn flowing blood into a strong signal (“white blood”)
- Does not require contrast; non-invasive
- Can convert a stack of contiguous MR slices into a 3D angiographic model
  - Excellent visualization of the Circle of Willis and aneurysm characterization

*Note: Traditional angiography is the Gold Standard*
MRA - Circle of Willis

Our Patient

Anatomic Diagram

Internal carotid artery aneurysms

http://www.strokecenter.org/education/ais_vessels/ais048.html

BIDMC PACS system
Our patients diagnosis

• Right *giant* suprasellar internal carotid artery (ICA) aneurysm (2.6cm)

• Left supraclinoid internal carotid artery aneurysm (13mm)

Patient was booked for definitive treatment in 5 days
Treatment options

Broadly include:

1. Surgical clipping
2. Angiographic embolization
Let's review a little on Cerebral aneurysms

- Dilatations or outpouchings of the arterial wall
  - Saccular (“berry”) or fusiform (dilated and elongated)
  - Mycotic, neoplastic, traumatic

- **Saccular aneurysms** form secondary to a weakness in the media and elastica of the arterial wall
  - typically occur at vessel bifurcations/branchings
Saccular aneurysms

• Frequency: 3.6-6% of the population
  – 15-20% multiple aneurysms
• Most common locations: Circle of Willis
  – Anterior communicating artery 30-35%
  – Posterior communicating artery 30-35%
  – Bifurcation of the middle cerebral artery 20%
  – Basilar tip 5%
Saccular aneurysm

• Risk factors
  – Female gender
  – Family history
  – Polycystic kidney disease (ADPKD)
  – Connective tissues disorders
  – Smoking (cardiovascular risk factors?)

• Treatment options: Conservative or aggressive?
  – > 5-9mm increased risk of rupture

• Treatment options
  – Surgical clipping of the neck of the aneurysm
  – Aneurysm occlusion (angiography)  Choice for this patient
  – Proximal vessel occlusion
Unfortunately, our Patient returned....

- 4 days later, patient complained of headache and vomiting
- Arrived at the ER unresponsive

Concern: Subarachnoid Hemorrhage (SAH)
80% of SAH are due to rupture of saccular aneurysms
Our patients CT without contrast

*Acute blood is bright (high attenuation)*

High attenuation blood is present in dilated ventricles
Our patients CT without contrast

- Blood again seen in dilated ventricles
- Enlarged aneurysm with surrounding edema causing mass effect
Impression

• **Subarachnoid hemorrhage** following rupture of a right internal carotid artery aneurysm
  – Acute blood in cisterns and ventricles
  – Dilatation of ventricles (hydrocephalus)
  – Mass effect on right lateral ventricle
  – Midline shift

*Interventional radiological treatment was pursued.*
Let's review anatomy to understand how a ruptured aneurysm bleeds into the subarachnoid space.
THE MENINGES

Brain ventricles

- Cavities in the brain filled with CSF
- Open to subarachnoid space via foramen in the 4th ventricle
  - Foramina of Luschka
  - Foramen of Magendie

http://www.epub.org.br/cm/n02/fundamentos/ventriculos_i.htm
Plan: Transcatheter embolization

**Guglielmi Coiling**

- **Method**
  - Wall off the aneurysm from the circulation by filling it with platinum wire coils.

- **Benefits**
  - Utilizes standard angiography techniques
  - Less invasive than surgical clipping (craniotomy)
  - Can reach distal/inaccessible aneurysms

- **Risks**
  - Occlusion of parent artery by renegade coils
  - Perforation of aneurysm
  - Little information available on long term outcomes
Our patient’s Cerebral artery angiogram during embolization

- Femoral artery catheterization route to the internal carotid
- Inject contrast
- Continue moving catheter through the internal carotid towards the Circle of Willis
Our Patient’s Cerebral artery angiogram during embolization

- Locate aneurysm
- Estimate volume
- Thread a microcatheter through the main catheter to the aneurysm site
- Deliver fine, wound platinum coils through the microcatheter via a guide wire
- Release coils into aneurysm
- Pack until full
Our patients cerebral angiogram during embolization

Aneurysm partially filled with coils
Projected outcomes

• Guglielmi coil treated cerebral aneurysm
  – Best for aneurysms 4-10mm, narrow necks
  – Best for aneurysms difficult to access using surgical approaches
  – Best for patients for whom surgery is contraindicated
  – Problems: incomplete occlusion (rebleeding), potential complications (rupture, artery occlusion/coil migration)
  – Long term outcomes still unclear

• Surgically treated cerebral aneurysm
  – Classic approach - surgical clipping of aneurysm neck
  – Better occlusion of aneurysm

Carefully controlled randomized trials need to be done.
Our Patient was already unresponsive at the time of the angiographic embolization and died shortly thereafter.
Take home message

• Rule out intracranial abnormality?
  – Exam of choice: typically CT
  – *ALWAYS* do non-contrast CT to identify acute blood
  – Follow with contrast study, if indicated

• Cerebral mass?
  – MR to characterize further

• Putative aneurysm?
  – Cerebral artery angiography is the Gold Standard
  – MRA offers a convenient alternative; also CTA

• Treatment of aneurysm?
  – Surgical clipping or thrombosis
  – Considerations: Aneurysm location, size and neck shape
    Patient stability
References


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