Radiologic evaluation of the young patient with stroke

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Outline

• Menu of tests for a young patient with stroke
• Normal brain anatomy on axial magnetic resonance imaging (MRI)
• Imaging for index case
• Differential diagnosis (DDx) of a young adult with stroke
  – Imaging to narrow the DDx
  – Back to the patient!
  – Companion patients
Our patient: clinical presentation

• Mr. S is a 37 year old man

History of present illness (HPI):
• new onset weakness in his left arm and leg
• new onset psychosis
• fell while trying to change a lightbulb and was unable to stand back up

Past medical history (PMH):
• remote intravenous drug use (IVDU) and bipolar disorder treated with lithium.
Normal workup of suspected stroke in a young adult

• Computed tomography (CT) without contrast to evaluate for hemorrhagic stroke
• MRI with diffusion to rule out other possible etiologies and evaluate the extent of the lesion(s)
• Further imaging evaluation to determine the etiology of the stroke
Neuroanatomy on MRI – midaxial plane

http://www.med.harvard.edu/AANLIB/cases/caseM/mr3_t/031.html

AXIAL MRI T1
Vascular territories diagram – midaxial plane

ACA = anterior cerebral artery
LSA = lenticulostriate artery
AChA = anterior choroidal artery
MCA = middle cerebral artery
PCA = posterior cerebral artery
Neuroanatomy on MRI – just above midaxial

caudate body

central sulcus

corona radiata

precentral gyrus

postcentral gyrus

cingulate gyrus

cuneus

http://www.med.harvard.edu/AANLIB/cases/caseM/mr3_t/034.html

AXIAL MRI T1
Neuroanatomy on MRI – superior poles of the lateral ventricles

http://www.med.harvard.edu/AANLIB/cases/caseM/mr3_t/036.html

AXIAL MRI T1
Vascular territories diagram – superior poles of the lateral ventricles

ACA = anterior cerebral artery
LSA = lenticulostriate artery
AChA = anterior choroidal artery
MCA = middle cerebral artery
PCA = posterior cerebral artery

Our patient: initial imaging

- Head CT without contrast
- Diffusion-weighted MRI (DW-MRI) with apparent diffusion coefficient (ADC) map
Our patient: head CT – midaxial plane

Cingulate gyrus (ACA)
Our patient: head CT – just above midaxial

Cingulate gyrus (ACA)
Our patient: head CT – superior poles of the lateral ventricles

Cingulate gyrus (ACA)
Our patient: brain DW-MRI – midaxial plane

Frontal lobe (MCA)
Caudate (LSA)
Parietal lobe (MCA)
Occipital lobe (PCA)
Our patient: brain DW-MRI – just above midaxial

Frontal lobe (MCA)
Caudate (LSA)
Cingulate gyrus (ACA)
Parietal lobe (MCA)
Occipital lobe (PCA)
Our patient: brain DW-MRI – superior to the lateral ventricles

Frontal lobe (MCA)
Cingulate gyrus (ACA)
Parietal lobe (MCA)
Our patient: brain ADC map – midaxial plane

Frontal lobe (MCA)
Caudate (LSA)
Parietal lobe (MCA)
Occipital lobe (PCA)
Our patient: brain ADC map – just above midaxial

- Frontal lobe (MCA)
- Caudate (LSA)
- Cingulate gyrus (ACA)
- Parietal lobe (MCA)
- Occipital lobe (PCA)
Our patient: brain ADC map – superior to lateral ventricles

Frontal lobe (MCA)
Cingulate gyrus (ACA)
Parietal lobe (MCA)
Our patient: interpretation of initial imaging

- Head CT and DW-MRI showed multiple regions of likely ischemic stroke
  - ACA, MCA, and PCA vascular territories involved

- Hyperenhancement on DW-MRI with hypoenhancement on ADC strongly suggestive of ischemic stroke
Causes of ischemic stroke in a young patient:

• Atherosclerotic large vessel disease
• Small vessel disease
• Cervical arterial dissection
• Patent foramen ovale (PFO)
• Hypercoagulability
• Primary CNS vasculitis

Note: disease entities may overlap or coexist
Risk factors in a study of 203 young adults with ischemic stroke

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>n (%)</th>
</tr>
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<tbody>
<tr>
<td>Men</td>
<td>108 (53)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>38 (19)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>4 (2)</td>
</tr>
<tr>
<td>Smoking</td>
<td>94 (46)</td>
</tr>
<tr>
<td>Hypercholesterolaemia</td>
<td>79 (39)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>3 (1)</td>
</tr>
<tr>
<td>History of transient ischaemic attacks</td>
<td>24 (12)</td>
</tr>
<tr>
<td>History of ischaemic stroke</td>
<td>8 (4)</td>
</tr>
<tr>
<td>History of amaurosis fugax</td>
<td>6 (3)</td>
</tr>
<tr>
<td>History of migraine without aura</td>
<td>37 (18)</td>
</tr>
<tr>
<td>C reactive protein level &gt;5 mg/l</td>
<td>73 (36)</td>
</tr>
<tr>
<td>Oral contraceptives</td>
<td>21 (22*)</td>
</tr>
</tbody>
</table>

*Per cent of the women.

Imaging workup of suspected stroke in a young adult

Stroke etiology in a study of 203 young adults

<table>
<thead>
<tr>
<th>Aetiology</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large artery atherosclerosis</td>
<td>8 (4)</td>
</tr>
<tr>
<td>Cardiac embolism</td>
<td>48 (24)</td>
</tr>
<tr>
<td>Small vessel disease</td>
<td>18 (9)</td>
</tr>
<tr>
<td>Other determined aetiology</td>
<td>61 (30)</td>
</tr>
<tr>
<td>Cervical artery dissection</td>
<td>48 (24)</td>
</tr>
<tr>
<td>Migrainous infarction</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Essential thrombocythemia</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Factor V Leiden deficiency</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Complication of catheter coronary angiography</td>
<td>2 (0.9)</td>
</tr>
<tr>
<td>Systemic lupus erythematosus</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Cocaine use</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Protein C deficiency</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Fabry’s disease</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Eclampsia</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Undetermined aetiology</td>
<td>68 (33)</td>
</tr>
</tbody>
</table>

Our patient: further workup

• MR angiography (MRA) of the head and neck to assess for dissection
• Transthoracic echocardiogram (TTE) and transesophageal echocardiogram (TEE) to assess for patent foramen ovale (PFO)
• Ultrasound (U/S) of the upper extremity and lower extremity and MR venogram (MRV) of the pelvis to assess for deep vein thrombosis (DVT)
• Cerebrospinal fluid (CSF) immunophenotyping to look for underlying malignancy
Our patient: Head and Neck MRA

Normal MR angiography with patent internal carotid and Circle of Willis arteries bilaterally
Our patient: findings on workup

• All negative except for TEE, which showed PFO.

• Suspected etiology:
  - Hypercoagulable state after his fall led to paradoxical embolization through his PFO
  - He showed significant improvement with physical therapy, suggesting a possible lesion in the premotor cortex
  - He was sent home on 81 mg aspirin therapy
Companion patients:

Companion patient #1
• 45 yo F with IVDU and endocarditis

Companion patient #2
• 47 yo F with Moyamoya disease

Companion patient #3
• 48 yo F with left-sided facial droop and ataxia
Companion patient #1: Head CT

Cerebellum (posterior inferior cerebellar artery (PICA) or anterior inferior cerebellar artery (AICA))
Companion patient #1: brain DW-MRI

Cerebellum (PICA or AICA)
Companion patient #1: brain DW-MRI - a more superior slice

Multiple cerebral infarcts

Etiology: repeated infarctions due to septic emboli from endocarditis
Companion patient #2: brain DW-MRI

Parietal and occipital lobes (MCA / PCA watershed)
Companion patient #2: brain ADC map

Parietal and occipital lobes (MCA / PCA watershed)

Etiology: watershed infarction due to Moyamoya disease

AXIAL ADC map
Companion patient #3: DW-MRI

Pons (Basilar)
Cerebellum (PICA or AICA)

Multiple infarctions due to hypercoagulability with PFO
Conclusion: approach to stroke in a young adult

- Perform stroke workup with imaging
- Develop a DDx based on history and imaging findings
- Use imaging and labs to determine underlying etiology
- Treat!
Acknowledgements

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References


