Overview

• Anatomy
• General Principles
• Large vessel Thromboembolism
  – Anterior Circulation
  – Posterior Circulation
  – Watershed Syndromes
• Lacunar Syndromes

CEREBROVASCULAR ANATOMY
Stroke Type   | Typical Features
-------------|------------------
Intraparenchymal Hemorrhage | • Gradual progression over minutes-hours
                               • Focal symptoms progressing to headache, nausea/vomiting, somnolence, and eventually coma
                               • Precipitated by drugs, exertion, or other causes of HTN
Subarachnoid Hemorrhage | • Abrupt onset of severe headache, neck pain, nausea/vomiting, photophobia
                               • Focal neurological deficits less common
                               • Often have relevant family history
Ischemic (Thrombotic) | • Stuttering recurrent or progressive symptoms with periods of improvement
                               • May occur over hours to days
                               • Large vessel thrombosis may be perfusion dependent
Ischemic (Embolic) | • Sudden onset of symptoms
                               • Deficits maximum at onset, may improve quickly
                               • May have deficits in single or multiple vascular territories depending on source

Classification of Ischemic Stroke Subtypes

- TOAST
  - Large artery atherosclerosis
  - Cardioembolism
  - Small vessel occlusion
  - Stroke of other determined etiology
  - Stroke of undetermined etiology
    - Two or more causes identified
    - Negative evaluation
    - Incomplete evaluation
### Large Vessel Atherothrombosis

- **Location:**
  - Carotid bifurcation
  - ICA siphon
  - Proximal M1
  - Intracranial vertebral
  - Vertebral origin

- **Mechanism:**
  - Atherosclerosis

### Small Vessel Cardioembolism

- **Location:**
  - Thalamus
  - Basal ganglia
  - Pons
  - Cerebellum

- **Mechanism:**
  - Atrial fibrillation
  - LA/LV thrombus
  - Recent MI

### Cardioembolism

- **Location:**
  - Distal ICA
  - MCA
  - Gray-white junction
  - Watershed

- **Mechanism:**
  - Mechanical valve
  - EF<30%
  - Dilated cardiomyopathy (PFO)

### Large Vessel Thromboembolism

- **Anterior Circulation Strokes**
  - Symptomatic stenosis
    - Hemodynamic: transient deficits (motor, sensory, language, limb shaking) with global hypoperfusion or increased demand
    - Embolic: amaurosis fugax, other TIA or strokes
    - Progressive cognitive decline
  - Dissection
    - Headache, carotidynia
    - Horner’s syndrome
    - Other cranial neuropathy (hypoglossal)
Anterior Choroidal Artery

- Motor
  - Contralateral hemiparesis (posterior limb of internal capsule)
- Sensory
  - Contralateral hemianesthesia (VPM of thalamus)
- Vision
  - Homonymous hemianopia (LGN of thalamus)

Anterior Cerebral Artery

- Motor
  - Contralateral leg weakness
  - Distal>proximal
- Sensory
  - Light touch, pin, proprioception
• Extrapyramidal
  – Asterixis, hemiparkinsonism

• Cognitive/affective
  – Gait apraxia
  – Akinetic mutism/abulia

• Collosal disconnection syndromes
  – Left hand ideomotor apraxia, agraphia, tactile anomia
  – Left body part agnosia
  – Alien hand

Middle Cerebral Artery

<table>
<thead>
<tr>
<th>Superior Division</th>
<th>Inferior Division</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor</td>
<td>Contralateral face, arm&gt;leg</td>
</tr>
<tr>
<td></td>
<td>(Primary, secondary motor cortex)</td>
</tr>
<tr>
<td>Sensory</td>
<td>Homonymous hemianopia or</td>
</tr>
<tr>
<td></td>
<td>quadrantanopia (Optic radiations)</td>
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<tr>
<td>Vision</td>
<td>Homonymous hemianopia or</td>
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<tr>
<td></td>
<td>quadrantanopia (Optic radiations)</td>
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<tr>
<td>Language</td>
<td>Expressive aphasia (dominant</td>
</tr>
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<td></td>
<td>hemisphere, Broca’s area)</td>
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<td></td>
<td>Receptive aphasia (dominant</td>
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<tr>
<td></td>
<td>hemisphere, Wernicke’s area)</td>
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<tr>
<td>Prosody</td>
<td>Prosodic apraxia (non-dominant</td>
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<tr>
<td></td>
<td>hemisphere)</td>
</tr>
<tr>
<td>Other</td>
<td>Constructional apraxia (non-</td>
</tr>
<tr>
<td></td>
<td>dominant hemisphere)</td>
</tr>
</tbody>
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• Malignant MCA Stroke
  – ICA or M1 occlusion
  – Massive edema within 2-5 days leading to midline shift and uncal herniation
  – Early signs:
    • Decreased level of consciousness
    • Ipsilateral pupillary dilation
    • Ipsilateral hemiparesis
  – Decompressive hemicraniectomy increases likelihood of surviving with mRS≤4 if done within 48 hours
Posterior Circulation Strokes

Lateral Medullary (Wallenberg) Syndrome

Lateral medullary syndrome of wallenberg
• Vestibulocerebellar
  – Vertigo (inferior vestibular nucleus)
  – Ipsilateral ataxia and hypotonia (inferior cerebellar peduncle)
  – Nystagmus, diplopia, ocular torsion
• Crossed sensory loss to pain and temperature
  – Ipsilateral face (descending spinal nucleus)
  – Contralateral body (spinothalamic tract)

• Bulbar muscle weakness
  – Ipsilateral palate, pharynx, larynx weakness → dysphonia, dysphagia, hiccups (nucleus ambiguus)
• Respiratory dysfunction
  – Failure of automatic respiration during sleep (Ondine’s curse, medullary reticular formation)
• Autonomic dysfunction
  – Ipsilateral Horner’s syndrome (descending sympathetics)

Medial Medullary (Dejerine) Syndrome
- Contralateral hemiparesis (pyramidal tract)
- Contralateral loss of light touch, vibration, proprioception (medial lemniscus)
- Ipsilateral tongue weakness (hypoglossal fibers)

PICA Infarct

- May involve vermis, medial, or lateral inferior cerebellum
- 20% involve dorsolateral medulla
- Symptoms
  - Vertigo, dizziness, nystagmus
  - Nausea/vomiting, headache
  - Ipsilateral ataxia, truncal ataxia, truncal lateropulsion
  -
• Pseudotumoral cerebellar infarction
  – Seen in first 2-5 days after full territory PICA infarction
  – Headache, vomiting, somnolence → stupor and coma due to hydrocephalus, downward tonsillar, and upward central herniation
  – Early signs: horizontal gaze palsy, bilateral Babinski
  – Requires suboccipital decompressive craniectomy

Basilar Artery Syndromes

Infarcts most commonly involve perforators supplying the paramedian base or tegmentum of pons
• Syndromes
  – Inferior medial pontine syndrome (Foville)
  – Ventral pontine syndrome (Millard-Gubler, Raymond)
  – Lateral pontine syndrome (Marie-Foix)
  – Locked-in syndrome

• General rules:
  – Paramedian base contains descending motor tracts and crossing cerebellar tracts
  – Paramedian tegmentum contains oculomotor pathways
  – Lateral pons contains sensory and vestibular nuclei and tracts (relatively spared)

• Motor
  – Contralateral hemiparesis
  – Mild ipsilateral weakness, hyperreflexia, adventitial movements

• Bulbar
  – Facial weakness, dysarthria, dysphagia, dysphonia
  – Often bilateral
  – Palatal myoclonus
  – Pseudobulbar affect

• Severe bilateral corticospinal and corticobulbar involvement results in “locked-in” syndrome

• Oculomotor
  – Horizontal gaze palsies (Lateral, INO, one-and-a-half syndrome)
  – Skew deviation, ocular bobbing
  – Pinpoint pupils

• Sensory
  – Not common, but may involve contralateral loss of light touch, vibration, and proprioception (medial lemniscus)
Top of the Basilar

- Embolic occlusion of cranial basilar causing ischemia of midbrain, thalami, temporal, and occipital lobes

- Oculomotor/Pupillary (Parinaud syndrome)
  - Vertical gaze palsy, setting sun sign
  - Convergence-retraction nystagmus
  - Mid position fixed pupils

- Altered mentation
  - Hypersomnolence, abulia
  - Peduncular hallucinations
  - Anterograde or retrograde amnesia

PCA Infarct

- Vision loss
  - Contralateral hemianopia
  - Macular sparing

- Sensory
  - Contralateral paresthesias, anesthesia
  - Delayed neuropathic pain (Dejerine-Roussy)
• Left PCA Stroke
  – Alexia without agraphia (left occipital lobe + splenium of corpus collosum)
  – Gerstmann syndrome (acalculia, agraphia, finger agnosia, right-left confusion)

• Right PCA Stroke
  – Prosopagnosia
  – Visual neglect
  – Visuospatial disorientation

• Bilateral PCA strokes
  – Balint syndrome (optic ataxia, ocular apraxia, asimultagnosia)
  – Anton syndrome (denial of cortical blindness, visual hallucinations)

Bonus

• Artery of Percheron
  – Single thalamic perforator arising from one PCA
  – Occlusion results in bilateral thalamic infarcts
  – Hypersomnolence, language, and memory disturbance

Watershed Syndromes
• Inadequate perfusion of areas at the border between two vascular territories  
  – ACA-MCA, PCA-MCA  
  – Symmetric or asymmetric  
  – Cortical and subcortical regions  
• Low cardiac output states: shock, heart failure, arrhythmia  
• Large vessel stenosis: atherosclerosis, dissection, vasospasm  

• Bilateral visual loss (optic radiations)  
• Stupor  
• Proximal arm and leg weakness sparing the face, hands, and feet (man-in-a-barrel)  

LACUNAR SYNDROMES
- Lipohyalinosis of small, penetrating vessels
  - Lenticulostriate
  - Artery of Heubner
  - Thalamoperforant
  - Paramedian basilar
- Progressive or stuttering course over hours to days
- Lack of cortical signs (aphasia, agnosia, apraxia, anopia, neglect)

- Pure motor hemiparesis (~50%)
  - Weakness of face, arm, and leg
  - Capsular warning syndrome
  - Internal capsule, corona radiata, pons
- Sensorimotor (15-20%)
  - Weakness and numbness of face, arm, and leg
  - Posterolateral thalamus and internal capsule
- Pure sensory (~15%)
  - Numbness of face, arm, and leg
  - Thalamus, corona radiata

- Ataxic hemiparesis (~10%)
  - Ipsilateral weakness and ataxia
  - May have dysarthria, nystagmus, gait deviation
  - Internal capsule or pons
- Clumsy hand-dysarthria (~5%)
  - Facial weakness, dysarthria, dysphagia, slight weakness and clumsiness of one hand
  - Pons

- Questions?