Stroke, Cerebrovascular Imaging, and Anatomy

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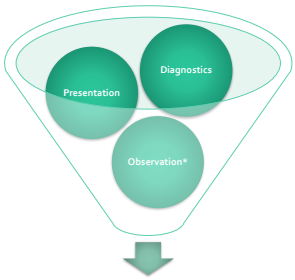
AGENDA



Provisional diagnosis → Care requirements Predictive

DIAGNOSTIC TESTING: REASONING

- Allows prompt diagnostic information
- Correlates/confirms physical presentation (functional location)
- To rule in/out pathology or disease process
- Guides care, practice, conversation

- Common stroke diagnostic imaging includes: CT, MRI (and their variants), digital subtraction angiography (DSA), PET, SPECT

- We have come a long way.....The 1st DSA included injections of petroleum, quicklime and mercury

Diagnostic tests

Considerations prior to determining test:

- Need to determine:
  - the pre-test probability of the disease-how likely the patient has something
  - if the test will change the decision to treat
  - what test provides the *best information with the least harm*
  - cost
  - skill set of the reader/quality of the image
- 50% of all acquired personal radiation exposure comes from diagnostic imaging

Diagnostic Timing

Mr. S. is a 72 yr. old male admitted for ER via ambulance after collapsing on the street. On his way to ER he loses his airway. Upon arrival, his pupils are large, the (L) unreactive. During your assessment his (R) pupil 'blows'. His BP is 280/124. He is urgently treated with Mannitol/3% prior to his DI.

- The decision to treat *without* a DI is based upon:
  - High probability his has high ICP
  - The medication benefit outweighs the risk
- A CT is ordered because:
  - CT is sensitive to rapid neurological deterioration
  - The result will change the decision to treat and type of treatment required

DI = diagnostic image

CNS Imaging: CT and MRI

Question

Plain CT of head is always ordered first on a potential stroke patient because:

A. Most institutions have a CT and can administer timely TPA
B. CTs always shows areas of ischemic infarction
C. CTs rule out/in non-ischemic causes of stroke
D. CTs allow clear visualization of the whole brain

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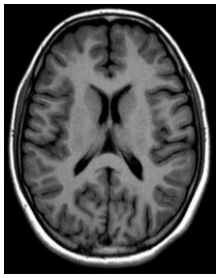
Diagnostic Test	Good for	Not great for	Benefits or limitations
CT: plain	**acute blood,** trauma, edema, acute stroke evaluation worsening of neurology	**parenchyma** definition, limited ability in early ischemia	B: available, rapid, cheap, tolerated, can be used to determine treatment options, high reliability L: poor visualization of Bst and post fossa
CTA/MRA	**vascular imaging** MRA better for large vessels (carotids)		Can be used to guide treatment
MRI	**parenchyma**, previous infarction micro-hemorrhage (GRE) worsening of neurology (ICP)	**acute blood** (can be confusing)	B: can determine age of hemorrhage L: less tolerated, less available, may exclude some patients (pacemaker)
Diffusion-weight image (DWI)	**ischemic changes** visual within minutes of stroke onset (can separate out acute and chronic stroke)	can be falsely positive	>90% reliability L: may be positive in non-stroke (migraine, seizures, acute MS, TIA)
Cerebral angiography	**vascular requiring finite image** can be used singularly or in conjunction with other treatments (clot retrieval, embolization)		L: small risk of stroke, side effects, invasive, inconvenient for patient

Test Type

Axial CT-plain



Axial MRI-plain (T1)

Cat Scan

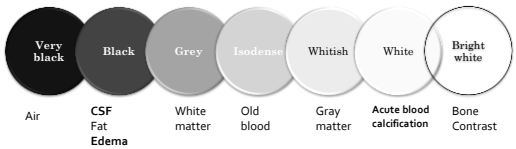
CAT SCAN (CT): 3D X-RAYS

Overall principles

- X-rays are absorbed by different degrees by different tissues
- The 'colour' of the tissue produced is the result of attenuation (rate at which the x-ray passes through the tissue or how much the radiation is absorbed)
- Produces a 3D image
- CT language = 'density' 'dens----See--tee' (CT)
  - 'hypodensity', 'hyperdensity'
- Limitations:
  - Beam hardening: when high density tissue abuts low density tissue in a small space (post fossa)
  - Volume averaging: pictures produced include a variety of tissues with different densities (early stroke)

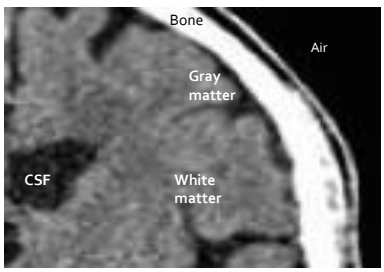
CT DENSITY

Low attenuation → High attenuation



Air | **CSF** Fat **Edema** | White matter | Old blood | Gray matter | **Acute blood calcification** | Bone Contrast

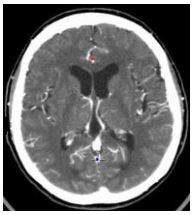
Hypodense → Hyperdense



Bone is bright white: takes longer to 'shoot through'
Air is very black: very quick to shoot through
CSF: is black- like shooting through chicken broth*

CT Variation

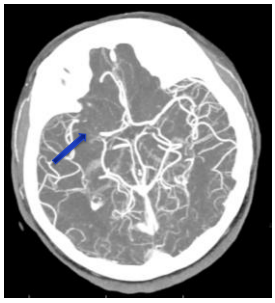
CT plain
Good for looking at 'stuff'
Great for blood, deterioration



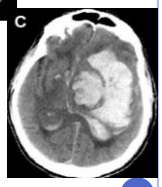
CT with contrast: is iodine-based
Good for abscess, compromised BBB

CTA (is contrast): great for blood vessels

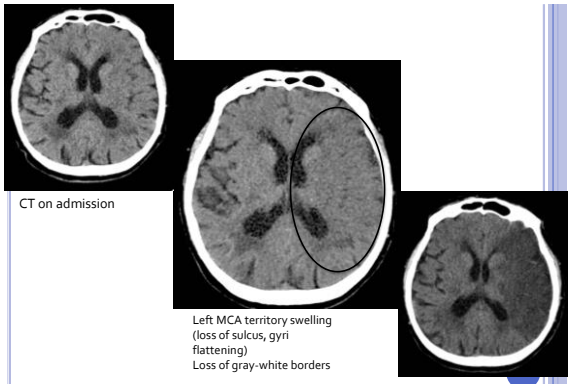
CTA



Spot Sign



The presence of contrast enhancement within ICH, visible on CTA . Suggests active, dynamic hemorrhage. Is a predictor of ICH growth and poorer outcomes.



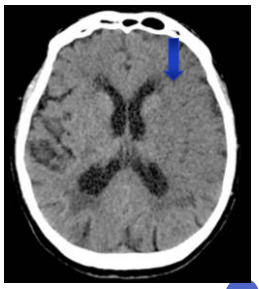
CT on admission

Left MCA territory swelling (loss of sulcus, gyri flattening)
Loss of gray-white borders

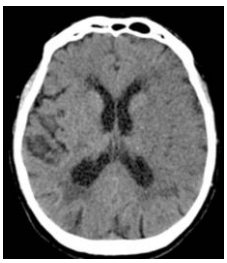
24 hours post stroke-hypodensity

Stroke and CT

- Stroke involves both gray and white matter
- Deprived of blood, cells will take on water (cytotoxic edema)
- Gray matter takes on water faster (more metabolically active)
- Water influx into cells begins at 6 hours
- Leads to lose of gray-white differentiation
- a 1% increase in water content will reveal hypodensity
- 60% of infarcts are seen within 3-6 hours (all seen within 24)



CT Limitations

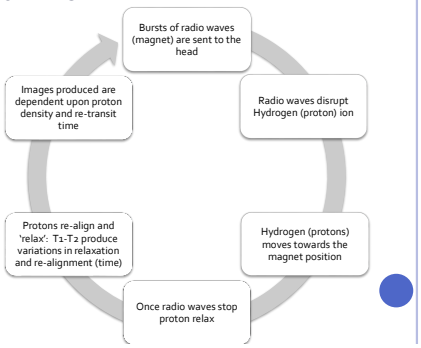


Volume averaging: tissues of different densities look the same

Beam hardening: stuff is jammed in together

MRI

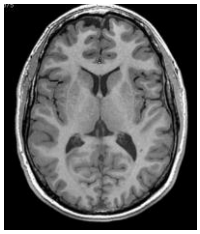
MRI: RADIO WAVES



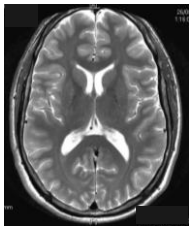
MRI COLOURS

MRI	Bright White	White	Gray	Black	Very black
T1	Bone Gadolinium	Fat Orbits Blood (with contrast only)	Light: white matter Dark: Gray matter	Water Fluid (edema) CSF dense bone, Calcium Eye globes Most lesions	Air
T2	CSF	Water, fat Fluid New blood Most lesion	Light: Gray matter Dark: white matter	Blood vessels Dense bone, calcium Flow	Air

Common types of MRI



T1 CSF is 'black', white matter is white

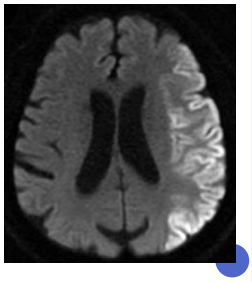


T2 CSF is white and white matter is black

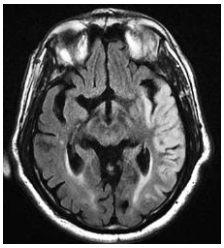
Produces picture of *intensity* (not density)

MRI: DWI (diffusion weighted image)

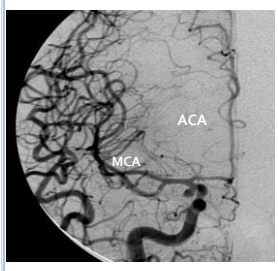
- Is the most sensitive sequence
- Image is the result of the loss of Brownian motion of water (water that can move freely has no signal)
- Swollen tissue (cytotoxic edema) has restricted-no movement = signal
- Can be positive within minutes of stroke
- Produces a high intensity signal for 7 days, then settles
- Maximizes b/w 7-30 days (positive in early stages, the fades)
- Can be positive for MS and migraine



Fluid attenuation inversion recovery : Flair

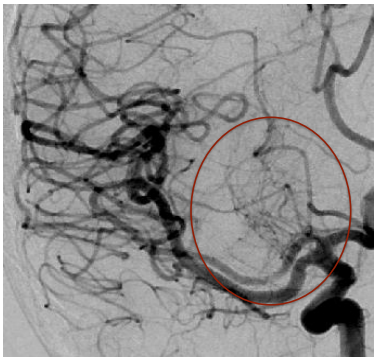


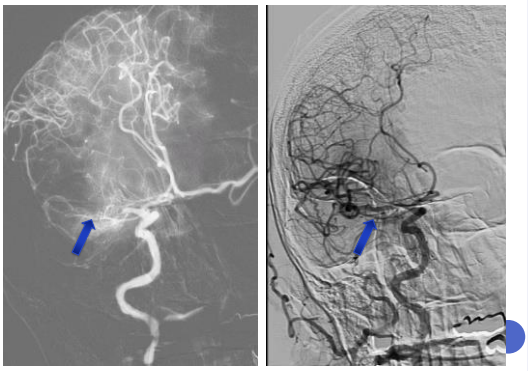
Digital Subtraction Angiogram (DSA)

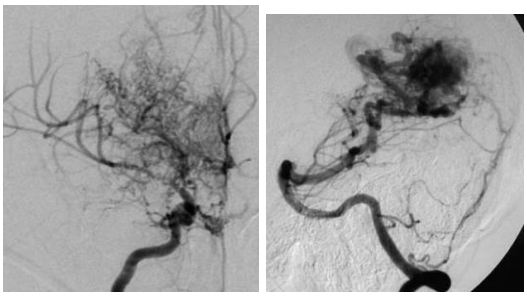


ACA infarct

MCA infarct







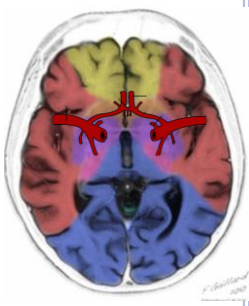
Moyamoya Disease

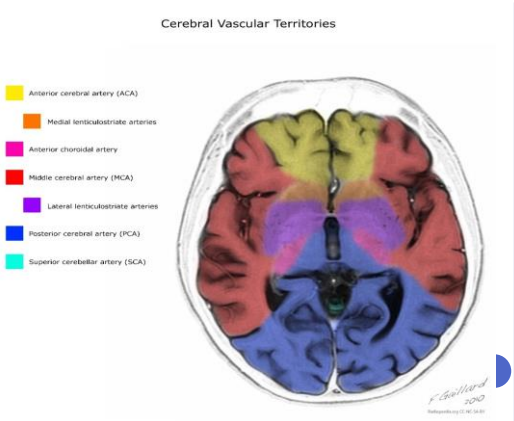
AVM

Vascular anatomy and presentation

Anatomy

- Managing a patient with vascular disease requires an understanding of where that vessel goes and areas that vessel supplies
- Allows predictability, care, and knowing when patient's are running into trouble
- Remember that:
  - BV variations are common and frequently non-pathological
  - Significant anastomosis exist
  - Presentation is related to functional disturbance, not always to the cause of the disturbance





1. Clyde is 2-days post clipping of an asymptomatic p.comm aneurysm. On rounds, the student nurse informs you that the patient has a 'blown' pupil on the same side.

2. Susan is admitted for a right parietal AVM resection. She is experiencing changes in proprioception, agnosia and acalculia

3. Rahmin has been diagnosed with a thalamic hemorrhagic stroke. He has difficulty keeping awake and is experiencing allodynia

4. Michael is admitted with a PCA ischemic stroke. He is suffering from significant nausea, is disoriented to place and year

Which one of the above vignette(s) is correct:

A. One of them
B. Two of them
C. Three of them
D. All of them
E. None of them

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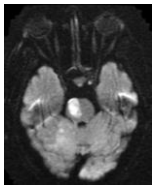
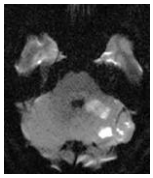
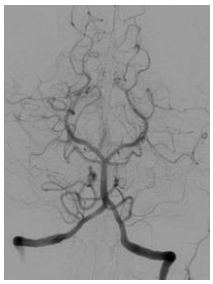
Which one of the above vignette(s) is correct:

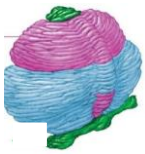
A. One of them
B. Two of them
C. Three of them (2-left side for math and face)
D. All of them
E. None of them

Case Presentation

- Carol is a healthy 42 yr. old female that was at the shopping mall with her husband and children. Carol had a 15 minute neck massage at a pop-up massage place. Shortly after, Carol experienced a bad headache and dizziness. By the time she met her husband, Carol was a bit off-balance and nauseated. When not better 5 hours later, they went to the hospital, thinking Carol had a bad virus.
- In ER, Carol's BP was 182/97. Neurologically, Carol was found to have 6th nerve palsy, a small pupil and facial weakness on the right, ataxia, dysdiadochokinesia left upper extremity, and difficulty with word articulation (NIHSS 10).

'Shower' into her brainstem and cerebellum



Cerebellum: Body coordination, muscle tone
- Upper: Axial equilibrium
- Middle: Peripheral coordination and planning (sides)
- Bottom: Ear, eye balance

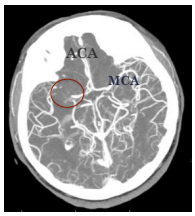
Brain stem: functional presentation location dependent
- information relay (tracts), CN function, RAS, cardiac respiratory center coordination, processing of visual and auditory data

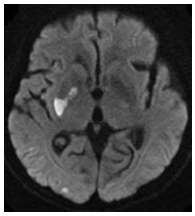
Case Presentation

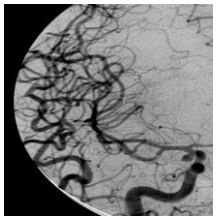
Mary is a 78 year old female driving in CDN tire parking lot. Was noted to be hitting parked cars. Stopped car. Police/ambulance were called. Upon arrival Mary when she was found to be densely hemiplegic on left side. Speech normal. No past history.

Transferred to stroke center at 14:40. NIHSS on arrival 13, right lateral gaze. BP 220/124.

CT plain at 1450-normal



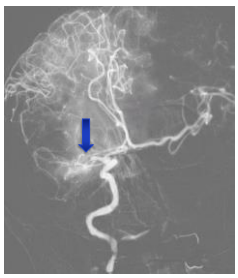




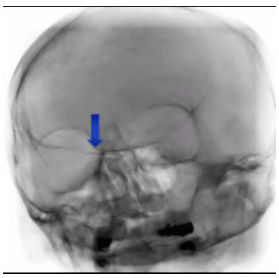
MCA supplies the greatest territory and is the most often occluded

? Why the left MCA more?

Mary: treated with TPA, off to radiology

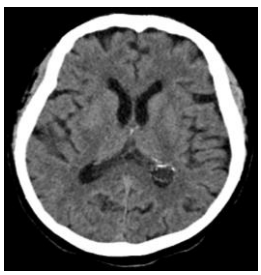


DSA



Thrombectomy wire

Post thrombectomy DSA



Post stroke CT

Case presentation

- Clyde is a 52 yr. old janitor with a known history of HTN. He is found with mild hemiplegia with hemianaesthesia and broca's aphasia. EMS is called. Clyde loses consciousness and requires airway support upon transfer to ER.
- On admission to ER his BP is 268/128, HR 110. GCS 6 (eyes 1, verbal 1, motor 4 (withdraws)

Question

What statement is ***true*** regarding thalamic hemorrhage?

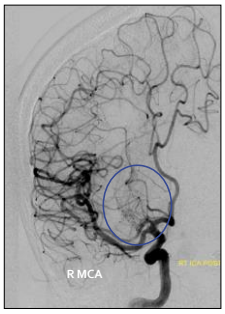
1. Left-sided hemorrhage is more common than right
2. Hallucinations, agitation and dementia can occur
3. Hemianaesthesia is the most common presentation
4. A significant percentage of patients have Type I or II diabetes

Question

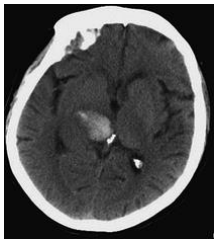
What statement is true regarding thalamic hemorrhage

1. Left-sided hemorrhage is more common than right (equal distribution)
2. **Hallucinations, agitation and dementia can occur**
3. Hemianaesthesia is the most common presentation (motor weakness)
4. A significant percentage of patients have Type I or II diabetes (approx. 10%)

- 4 thalamic stroke variations exist-symptoms location dependent (anterior-posterior), can also 'mimic' cortical function



Leticulostriate arteries

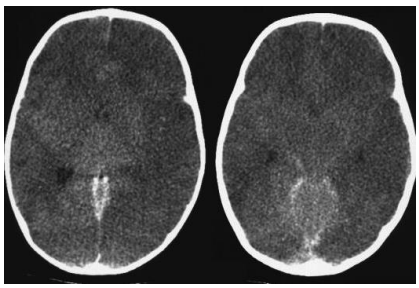


Thalamic Hemorrhage outcomes: Anterior > posterior or if associated with hydrocephalus

Case presentation

- Brittany is a 24 yr. receptionist at a dental. On Monday she doesn't show up for work. Her colleagues try to reach her, but to no avail. At 10:00 pm after continuing to be unsuccessful, her colleague goes to her apartment where her superintendent opens the door. Her history includes Type I DM. Brittany is on the floor unconscious. EMS is called. Her pulse is thready. Both pupils are large. She is provided airway support and transported to ER. GCS on arrival 4 (extension to pain)

Brain edema



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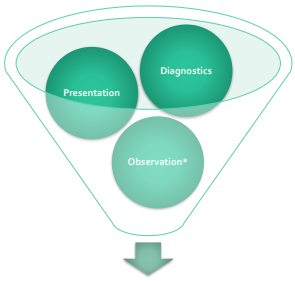

Provisional diagnosis → Care requirements
Predictive