Brain Spots on Imaging Tests
To Be or Not to Be Concerned

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CT and MRI

2 most common forms of brain imaging today

- As with any diagnostic test
  - Risks of imaging have to be weighed against benefits of identifying treatable disease
    - With acceptable sensitivity and specificity
CT

• Used to be modality of choice for non-invasive assessment of the brain
  – Now study of choice mainly in cases
    • Trauma
    • Acute neurologic emergencies
      – Acute Stroke
      – Intracranial hemorrhage
      – Intracranial or spinal trauma
      – Detection of fine bone detail and skull fractures
• Advantage
  – Faster than MRI
    • Study of choice in acute situations

• Disadvantages
  – 15X more radiation than a chest x-ray
  – Less contrast resolution for soft tissue abnormalities or normal structures than MRI
  – Requires contrast injection for angiography
MRI

• Advantages
  – No radiation exposure
  – Does not require contrast injection for angiography
  – More sensitive for detection of
    • Normal brain anatomic structures
    • CNS and intracranial lesions
    • Cranial nerves
    • Posterior fossa structures
    • Pituitary
    • Acute and chronic bleeding in the brain
MRI (2)

• More sensitive for detection of (cont.)
  • All soft tissue abnormalities
    – FLAIR images allow better discrimination between solid tissue and edema
    – DWI images improve
      » detection of acute ischemic stroke
      » differentiating acute stroke from other processes that cause acute neurologic events

• Also excels at detecting brain lesions in asymptomatic individuals
• Has replaced CT in brain imaging
  – Except in patients with contraindications to MRI
• Contraindications to MRI:
  – Metallic fragments, clips or devices in the brain, eye, spinal cord
    • Includes intracranial clips
  – Magnetically activated implanted devices:
    • Cardiac pacemakers, insulin pumps, neuro-stimulators, cochlear implants
• Metal outside the brain and eye is NOT a contraindication:
  – Cardiac valves, inferior vena cava filters, biliary and vascular stents, IUD's, metallic prostheses
MRI (5)

- Disadvantages due to its increased use and superior tissue definition/resolution
  - Studies in sick and healthy persons both show MRI to be oversensitive
    - Displays even incidental white matter foci without underlying pathology
    - Other incidental findings
Definition:
Incidental findings on brain imaging are defined as previously undetected abnormalities of potential relevance

- Unexpectedly discovered
- Unrelated to the purpose of the imaging
Case #1

40 yom  $750,000 Term

• on NBExam noted dizziness for the past few years for which an MRI was done as part of the w/u

• 1/11 MRI: Impression: **Solitary indeterminate right frontal white matter abnormal foci.** *This is nonspecific but could represent focal gliosis from prior inflammation or possibly vasculitis, the sequelae of migraine headaches and less likely demyelination or atypical infection.* O/w normal MRI.

• episodic confusion, problems focusing and confused, panic sensation, may pass out. Sx remain intermittent and similar thru end of APS 1/12.

• EEG, MRA, w/u for inflammatory dis all neg, no history of seizures
Case 2

38 yof, $500,000 Term
- 1/10 c/o headaches, paresthesias left side of face, vision blurred with focus on small objects
- APS notes thru 6/11 with no recurrence of symptoms
- also hx of obesity, impaired glucose tolerance, hypertension poorly controlled in ’10 but better since.
- 1/21/10 MRI: 3 foci of hyperintense T2 signal in the white matter of the left frontal lobe measuring 3 mm in size. Nonspecific in etiology of the type often seen in neurologically asymptomatic patients, demyelinating disease, small vessel vascular change, migraine headaches.
Case #3

50 yom $20 million UL

• 9/11 MVA, concussion, dizziness, hard to read, vertigo
  – Bilateral high frequency hearing loss, ENG abnormal, less reactive left labyrinth
  – EBCT score +25

• 10/11 MRI: *a few punctate scattered non-specific supratentorial white matter abnormalities*
• 2000 participants
  – Ages 45-96 (mean 63.3)
  – 54.7% female
    • Ages 45-59: 94.6% were found to have asymptomatic “white matter changes”
    • >age 75: increased to 98%
  – 272 (13%) were found to have incidental findings other than “white matter changes”
– Other than “white matter changes include:
  • Asymptomatic stroke
    – Lacunar infarct > cortical infarct
  • Aneurysms
  • Benign tumors (esp. meningiomas)
  • Arachnoid cysts
  • Cavernous hemangiomas
  • 1 urgent finding
    – possible low grade glioma
• 15, 559 participants
• Incidental finding in 1 out of every 37 asymptomatic people scanned (2.7%)
  – 2.0% non-neoplastic
  – 0.7% incidental neoplastic findings
• These 420 incidental findings are in addition to already excluded
  – White matter hyperintensities
  – Microbleeds
  – Silent infarcts
Trends in Both Studies

• Increasing prevalence of all neoplastic incidental brain findings with age
  – Probably related to meningiomas

• Increasing prevalence of “white matter changes” with age

• Extremely small number of incidental findings that required specific treatment
  – MRI has been available for 20-30 yrs
    • Long term prognosis of some incidental findings not fully known yet
White Matter Hyperintensities

• Most frequent incidental findings in brain MRIs

• Common finding on neuro-imaging associated with
  – Aging
  – Medical illness
  – Some invasive medical procedures
  – Hypertension
  – Migraine headaches
  – Multiple sclerosis
White Matter Hyperintensities (2)

• Most important to consider in context and with the significant differentiating elements
  – Number
  – Size
  – Location
  – Presence or absence of edema
  – Reaction to contrast medium
    • Including Gadolinium
  – Evolution in time
White Matter Hyperintensities (3)

• Have been concluded to be associated with increased risk of
  – Overall increased risk of cerebrovascular events
  – Dementia and faster decline in cognitive function

• However, they can not be considered in isolation from clinical data and other diagnostic test results
  – Think of them more as a predictive test like an EBCT or carotid IMT (Intima Media Thickness)
    • Than as an indicator of a specific problem to be treated now
Conclusions

• Circle back to the case studies in light of the information about
  – Frequency of incidental findings of white matter hyperintensities without relationship to specific disease or need for specific treatment
  – Possibility that these incidental white matter hyperintensities constitute a risk factor rather than a marker of a specific disease entity
Advantages MRI over CT

- Better defines intracerebral hemorrhages
  - old and new.

- More sensitive than CT for the early diagnosis of brain infarction.

- Better determines the precise location and size of the infarction and

- Better follows the lesion over time.
• Advantages MRI over CT (p.2)
  – Lacunar infarcts and small cortical strokes are seen with higher sensitivity.
  
  – FLAIR images show infarcts earlier after onset of symptoms.
  
  – DWI images are useful in distinguishing acute from chronic ischemic changes
• Does a normal CT or MRI rule out stroke?
  – No.
    • It is important to remember that in patients with ischemia who do not yet have infarction, both CT and MRI may be normal.

• Repeating the scan in 48 hours will most likely demonstrate the stroke lesion.

• Sub-acute infarct (1 to 8 weeks):
  – Contrast enhancement slowly decreases in time but can persist for 8 weeks, with decreasing mass effect and abnormal signal intensity.
TIA vs CVA

- Transient Ischemic Attack
  - Acute episode of temporary neurologic dysfunction
    - Resulting from focal cerebral, spinal or retinal ischemia
    - Not associated with permanent cerebral infarction
  - Sudden onset
  - Duration < 24 hours
    - Clinical symptoms typically last < 1 hour

- CVA and not TIA if:
  - Clinical signs or symptoms last >24 hours
  - Evidence of infarction on imaging
Cerebrovascular Lesions

- Subclinical vascular pathologic changes
  - Silent cortical infarcts
  - Lacunar infarcts
  - White Matter Hyperintensities
- Linked to
  - Increased risk of stroke
  - Cognitive decline
- Acute ischemic stroke patients
  - 11-29% found to have unrelated additional infarcts
Cerebrovascular Lesions (2)

• Silent infarct:
  – Incidentally found lesions with appearance typical of infarction
  – Without clinical history compatible with clinical stroke
  – Strong relationship with age and other stroke risk factors
    • Suggests they may themselves be risk factors for significant cerebrovascular disease
  – Important risk factor for
    • Further stroke
    • Dementia
Global cognitive function significantly worse
- With silent brain infarcts on baseline MRI than without
Lacunar stroke

- Small deep infarcts that result from occlusion of a penetrating artery
- Account for about a quarter of all ischemic strokes
- Commonly had been regarded as benign vascular lesions with a favorable long-term prognosis
- Recent studies have shown that is only the case early in the disease course but in the years after the infarct:
  - increased risk of death, mainly from cardiovascular causes.
  - risk of recurrent stroke after lacunar infarct is similar to that for most other types of stroke
  - increased risk of developing cognitive decline and dementia.
Conclusions

• MRI more sensitive than CT for detection of all cerebrovascular ischemic abnormalities
  – Symptomatic CVA
  – Silent CVA
  – Lacunar infarct

• MRI detects acute infarct earlier
  – If not seen on initial MRI
    • Repeat may be warranted in 48 hours if neurologic deficit persists without adequate alternative explanation
Conclusions (2)

• Infarct/CVA not necessarily ruled out (or TIA ruled in) with negative (even negative repeat) imaging if symptoms last >24 hours

• Silent infarcts, lacunar infarcts and white matter hyperintensities increase the risk for additional cerebrovascular insults/cognitive decline
American Heart Assn. guidelines for unruptured cerebral aneurysms

• Taking into consideration
  – Age
  – Past history of cerebral aneurysm
  – Family history
  – Genetic/familial conditions
Aneurysms (2)

- All symptomatic aneurysms should be treated
- Incidental aneurysms
  - <10 mm without history of SAH should be treated conservatively
  - Anterior circulation aneurysms less likely to rupture
  - Small aneurysms approaching the 10-mm diameter size should be considered for treatment if:
    - Unique features
    - Family history of aneurysm or SAH
    - Past history of aneurysm or SAH
Aneurysms (3)

- Factors that favor surgery include
  - A young patient
  - Long life expectancy
  - Previously ruptured aneurysms
  - Family history of aneurysm
  - Large aneurysms
  - Symptomatic
  - Observed aneurysm growth
Aneurysms (4)

- Factors that favor conservative management include
  - Older patient age
  - Decreased life expectancy
  - asymptomatic small aneurysms
    - Especially anterior circulation
Subarachnoid Hemorrhage (SAH) with Negative Angiography

• Ruptured cerebral aneurysm is the most common cause of spontaneous SAH
• The aneurysm may not be visualized in up to 17.5% of cases where there is one due to
  – Small aneurysm size
  – Vascular spasm of the parent artery
  – Thrombosis of the aneurysm
• A second angiogram should be performed a week later
  – If negative
    • Risk of non-visualized aneurysm is low
    • Prognosis is good
Conclusions

- Increased sensitivities of MRIs will find more asymptomatic aneurysms
  - Not all unoperated aneurysms have the same mortality risk profile
    - Size
    - Location
    - Age
    - Family history
    - Past history
- One negative imaging study after SAH may not be adequate to rule out an underlying aneurysm
Venous angioma

- Currently called Developmental Venous Anomalies (DVA) in Medical Literature
- Still called Venous Angioma in UW Guides

Will be referred to as DVA in this presentation and in the Medical Records you obtain
DVA/Venous Angioma (2)

• Congenital anomalies of the intracranial venous drainage.

• Highest prevalence rate of all intracranial vascular malformations
  – Commonest intracranial vascular malformation seen at autopsy
  – Previously considered to be rare until the advent of CT and MRI scanning
  – Now considered to be NORMAL VARIANT of cerebral venous system
• Presentation (reason the scan was done) variable and non-specific
  – Most are incidental findings on MRI
  – Headache most common symptom prompting the MRI
  – Most of the symptoms prompting the scan not related to the lesion
• Isolated DVA represents no additional mortality risk
  – Because these anomalies provide a useful and important blood draining function, in no case should they be excised or radiated
    – Do not require routine removal
• UW Manuals suggest a different risk profile between supratentorial vs infratentorial lesion
  – Due to different risk profile from bleeding in the brainstem (infratentorial) region
  – May not be consistent with latest medical literature findings
- **cerebrum**
The cerebrum (supratentorial or front of brain) is composed of the right and left hemispheres.

- **brainstem**
The brainstem (midline or middle of brain) includes the midbrain, the pons, and the medulla.

- **cerebellum**
The cerebellum (infratentorial or back of brain) is located at the back of the head.
• **cerebrum**
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The cerebellum (infratentorial or back of brain) is located at the back of the head.
• Often associated with Cavernous Angiomas
  – (also known as Cavernous Hemangiomas)

• Cavernous Angiomas should be treated
  – If >10 mm in size
  – Multiple lesions
  – If any evidence of prior bleed
    • Including hemosiderin deposition
    • Infratentorial location
  – If possible leaving associated DVA intact
Multiple Sclerosis on MRI

• Classic MS brain lesion
  – T2 hyperintense lesion
    • Called plaques
    • Can be new, old or reactivated lesions

  – If Gadolinium contrast used
    • Differentiates new or reactivated lesions
      – By contrast “enhancement”
        » Enhancement lasts 4-6 weeks
    • Also picks up very new lesions not yet hyperintense
• Diagnosis of MS
  – Neurological disturbance of kind seen in MS
    • Minimum duration 24 hours
  – 2 or more MRI lesions

Or

– Asymptomatic
– 1 Gadolinium enhancing lesion or 9 hyperintense MRI lesions
While repeated scanning has become routine for asymptomatic (and incidental) meningioma

- 94% remain asymptomatic
- 63% do not grow

Factors to consider

- Location
- Stability
- Age of applicant
- Size
History of resected meningioma

MRI f/u:

Pre and postcontrast brain MRI

• Findings:
  – Again identified are post surgical changes. Right frontal craniectomy/cranioplasty, right frontal lobe surgical cavity with residual T2/FLAIR signal abnormality, stable residual right frontal dural enhancement

• Stable brain MRI findings since prior MRI. No recurrent tumor
Conclusions:

• Additional MRI incidental findings:
  – Isolated DVA produces no additional mortality risk
  – Findings suggestive of MS need to be taken in context as described
    • And diagnostic criteria followed before diagnosis or risk profile for MS attached
  – Post-op changes on the MRI f/u of a resected meningioma should not be confused with recurrent tumor