Headaches and Dizziness
Effective Use of Imaging

Jodi Hiland Schielke, DO
UNECOM – Class of 2007
Personal Disclosures

- I have no real or apparent conflict of interest in relation to this program/presentation or that may have any direct bearing on the subject matter.

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Objectives

- Identify indications for imaging in the workup of headache or dizziness
- Discuss the ACR Appropriateness Criteria for each
- Recognize when to use CT or MRI to help answer the clinical question
- Understand what information can be gained from IV contrast administration
- Review cases of common imaging findings in both clinical scenarios
Introduction: Headaches

- Approximately ½ of the adult population worldwide meets criteria for a headache disorder
- Differentiating **primary** (tension-40%, migraine-10%, cluster-1%) from **secondary** headaches
- Most headache diagnoses are based entirely on patient history – rarely does exam provide clues to diagnosis
- International Headache Society Diagnostic Criteria
  (http://www.ihs-headache.org/ichd-guidelines)
Primary Headaches

- Patients at low risk for serious headache do not require neuroimaging
- 897 pts: CT for migraine, only 4 cases with serious pathology (0.4% yield)
- **Tension**: Bilateral mild to moderate pressure without other symptoms, F>M, 78% of general population over lifetime, no imaging if normal neuro exam
- **Migraine**: Nausea, photophobia, phonophobia, worse with activity, POUND mnemonic, +/-aura
- **Cluster**: Brief episodes of severe head pain (15-180 minutes), unilateral orbital, supraorbital, or temporal, ipsilateral autonomic sx (tearing, nasal congestion, sweating, miosis, edema), usually delayed diagnosis, link to co-morbidities (depression-24%, pituitary macroadenomas), M>F
- **Other**: Medication changes, caffeine withdrawal, social hx
Criteria for Low Risk Headaches

- <30 years old
- Features typical of primary headaches
- History of similar headache
- No high-risk co-morbidities
- No change in history or physical exam

NO IMAGING REQUIRED
Secondary Headaches

- Atypical features, change in headache type, risk factors

- Yearly incidence of brain tumors in US: 46/100,000
- SAH incidence: 9/100,000
- Intracranial saccular aneurysm: 5% of population by imaging and autopsy
- AVM: 1/10 as frequent as saccular aneurysm
- 48% of patients with primary or met tumor had headache in retrospective review
- Approximately 60% of children with tumors have headache, usually posterior fossa tumors

Red Flags: Secondary Headache

- Focal neurologic exam – AVM, vascular, mass
- Papilledema – *increased intracranial pressure*
- Neck stiffness - *meningitis*
- Immunocompromised patient/Co-morbidities – *infection, mass*
- Sudden onset of worst headache of life – *SAH, infection*
- Personality changes – *parenchymal bleed, infection, mass*
- Headache after trauma - *bleed*
- Headache worsened by exercise/exertion – *mass, SAH*
- OCPs/During/After pregnancy – *DVT/CVT, dissection, pituitary apoplexy*
- New headache > age 50 – *Mass, temporal arteritis, anticoagulated*
Why We Image

- Detection of clinically significant lesions
- Relieve patient anxiety – improve satisfaction of care
- Medicolegal concerns
- Prospective review of 293 CT scans⁶:
  - 49% to rule out tumor
  - 9% to r/o SAH
  - 17% patient expectation or medicolegal concern

- **Risks**: false positives/negatives, risks of contrast allergy
- **Costs**: ~$400 CT, ~$900 MRI
- **US Headache Consortium consensus-based management principles⁹**
Imaging Headache Without Neurologic Symptoms

Large review of 3026 patients with headache (1977-1996)\textsuperscript{5}:

- 0.8% brain tumors
- 0.2% AVM
- 0.3% hydrocephalus
- 0.1% aneurysm
- 0.2% SDH
- 1.2% stroke – including chronic ischemic disease
To CT or MRI...that is the question

- Insufficient Comparison Data
- Depends on **WHAT YOU ARE LOOKING FOR**
- ER: CT will be first line
- Non-acute Headache: Consider MRI first
- Think: costs, claustrophobia, and radiation
- Narrow clinical suspicion and CALL radiologist if questions
- Know that the radiologist can and will change your order if not clinically appropriate – pending insurance authorization
ACR Appropriateness Criteria

- Headache in Immunocompromised: MRI +/- C
- > 60 with suspected TA: MRI head +/- C
- Headache in suspected meningitis: MRI head +/- C
- Severe HA in pregnancy: MRI C-, CT C- (depends on facility and suspicion of hemorrhage)
- Severe unilateral HA with ? dissection: MRI +/- C, MRA head/neck or CTA head/neck
- Chronic HA, no new features, normal exam: MRI C+ or C- (may be appropriate)
- Chronic HA with new features: MRI +/- C, 2nd choice: CT or MRI C-
- HA with trigeminal features: MRI +/- C
ACR Appropriateness Criteria

- Skull base, orbital, periorbital HA: **MRI** head and orbits +/- C
- HA with suspected sinus or mastoid complication or maxillofacial origin: **MRI** head +/- C, may need TMJ sequences
- Positional or exertional HA: **MRI** head +/- C
- Post-traumatic HA: **CT Head C-**
- Worst HA of life: **CT Head C-**, CTA head C+, MRA C +/- or MRI C-

https://acsearch.acr.org/docs/69482/Narrative/
When to CT: *In General*

- Ruling out post-traumatic or early bleed
- When you need a quick answer – cheaper and faster
- Any bony lesions
- Negative Head CT needs LP if ruling out SAH
- MRI for most else
- $ vs benefit of patient knowing results
- If CT is negative, think MRI in persistent symptoms, especially for posterior fossa/skull base
When to use IV Contrast: *In General*

- Infection/Abscess
- Malignancy/Mass
- Vascular

**Contraindications:**
- Contrast induced nephropathy
- Allergy (pre-tx)
- Impaired renal function

https://radiopaedia.org/articles/neurocysticercosis
MRI Changes in Primary Headache Disorder

- White matter abnormalities in 12-46% of migraine patients
- Loose association of cluster headaches and pituitary macroadenomas – need MRI +/- C

https://radiopaedia.org/articles/pituitary-macroadenoma-1

Migraine and stroke
Yonghua Zhang, Aasheeta Parikh, Shuo Qian
Stroke and Vascular Neurology May 2017
Don’t Forget The NECK

- Dissection can result in pain in face, neck, side of head
- Listen to your history: recently painting ceiling, sneeze onset, recent manipulation or fall
- Check for bruit
- Ipsilateral Horners –
  - Interruption of the oculo-sympathetic pathway
  - 68% presented with HA
  - May not have CVA sx
- Compressive neck lesion can cause increased ICP
Dissection

- Hyperintense crescent shaped signal around the vessel wall – methemoglobin
- Luminal narrowing, “string sign”

https://radiopaedia.org/images/3058950

Subarachnoid Hemorrhage

- “Thunderclap” Headache
- May have altered consciousness, nausea, vomiting
- CT is most sensitive in first 24 hours
- MRI is more sensitive if delayed presentation
- If imaging is negative, needs LP (3% +)
- Angio to r/o aneurysm

https://radiopaedia.org/articles/subarachnoid-haemorrhage
http://mriquestions.com/subarachnoid-blood.html
Aneurysm

- CTA versus MRA
- Consider radiation and contrast
- Conventional angio- is the gold standard
- Imaging of post-treatment is different – coiled or clipped

https://radiopaedia.org/images/21867
Reversible Cerebral Vasoconstriction Syndrome/PRES

- Multifocal segmental cerebral artery vasoconstriction
- No SAH
- Normal or near normal CSF
- Severe, acute headaches
- Reversible angiographic abnormalities within 12 weeks
- May have PRES on MRI

Multimodal Imaging of Reversible Cerebral Vasoconstriction Syndrome: A Series of 6 Cases
C.P. Marder, M.M. Donohue, J.R Weinstein and K.R. Fink
American Journal of Neuroradiology August 2012, 33 (7) 1403-1411; DOI: https://doi.org/10.3174/ajnr.A2964
Cerebral (Dural) Venous Sinus Thrombosis (CVST)

- Peri-partum
- Clotting Disorders/Malignancy
- Oral Contraceptives
- Obesity
- Intracranial Hypotension
- Other systemic processes – IBD, SLE
- Idiopathic - 12.5%
- Can result in hemorrhage or venous infarct

https://radiopaedia.org/articles/dural-venous-sinus-thrombosis
Other Hemorrhage: SDH, epidural, IVH, parenchymal


https://neurowiki2012.wikispaces.com/Intracranial+Hematoma

Meningioma

http://casemed.case.edu/clerkships/neurology/Web%20Neurorad/Meningiomatemp.htm
Other Brain Tumors

Glioblastoma: most common adult primary intracranial neoplasm

Primary CNS Lymphoma

CNS Metastases
Temporal Arteritis

- Large/Medium arteries of the Head – usually external carotid artery
- > age 50
- ESR >60mm/h
- Can result in blindness/CVA
- Biopsy is definitive

https://radiopaedia.org/cases/giant-cell-arteritis-1
Meningitis

- Inflammatory/infectious infiltration of the pia, arachnoid, and CSF
- Acute pyogenic (bacterial), lymphocytic (viral) and chronic (TB or granulomatous)
- Clinical, not imaging diagnosis
- Leptomeningeal enhancement
- Hematogenous, direct spread from sinuses/mastoid, postsurgical, or penetrating trauma

http://www.aocr.org/page/z67
Complications of Paranasal Sinus Disease

- Epidural abscess from direct extension of paranasal sinus disease
- Like with epidural bleed, they are lenticular in shape, confined by sutures, and may cross midline
- Abscesses enhance peripherally, show variable restricted diffusion, and may have associated cerebritis
- Requires Abx +/- surgical drainage

http://www.aocr.org/page/z67
Idiopathic Intracranial Hypertension - Pseudotumor

- Usually chronic, but can present acutely
- Nausea and vomiting
- Visual disturbances (70% can be permanent)
- Papilledema and obesity in young females
- Increased CSF pressures
- Rule out brain abnormality before LP

Post-traumatic Headache

- MVA, sports injuries
- Usually presents within 7 days of event
- Resolves within 3 months
- ?LOC, GCS < 13, amnesia for >48 hours
- CTE – neurodegenerative tauopathy from mild, repetitive head trauma; DAI
- Advanced MRI techniques for persistent sxs: SWI, fMRI, DTI

The Benefits of MRI for Sports-related Concussion from Shields MRI
Posted by Eric Schwartz, M.D.,
http://info.shields.com/mri_concussion_bike-injury
Introduction: Dizziness

- Affects approximately 30% of people over age 65, 90 million Americans\textsuperscript{12}
- 3-5% of primary care presentations, 4% of ER visits\textsuperscript{2}
- Broad DDX and complex diagnostic approach
- Relies on vestibular function, vision, and proprioception
- Vertigo, light-headedness, imbalance, and pre-syncope
- Cardiovascular, endocrine, meds, psychiatric, central or peripheral causes
- Structural abnormalities of the brain and c-spine are common in both dizzy and non-dizzy subjects
- Meds were to blame in 23% of older pts in the PC setting\textsuperscript{10}
- Role of imaging is controversial
Dizziness

- Benign paroxysmal postional vertigo (BPPV) is the most common cause in adults (93%)⁸
- Many other peripheral causes: Meniere’s Disease, Vestibular neuronitis
- Check orthostatics
- Cardiac, Psych and Neuro exams, Dix-Halpike, nystagmus
- Are you dealing with something peripheral or central (5-11% of cases)?

- Can your patient walk?
- In general, IF YOU IMAGE: MRI with gadolinium is the most common modality to evaluate patients with dizziness
- CT: Better evaluates BONE (congenital, trauma, post-op, erosions)
Imaging of Middle/Inner Ear

CT
- Osseous: erosion, fracture, misplacement

MRI +/-C
- Fluid containing structures of the perilymphatic and endolymphatic spaces
- Vestibular nerves

https://www.slideshare.net/sameerpeer5/imaging-of-temporal-bone
Central Vestibular Pathways

- Vestibular nuclei in medulla
- Rostral midbrain
- Oculomotor nuclei
- Cerebellum
- Thalamus
- Cortex
- Medial and lateral vestibulo-spinal tracts

- CT for blood/stroke in ER
- MRI otherwise modality of choice

https://radiopaedia.org/cases/lateral-medullary-infarct
Outpatient Imaging for Peripheral Causes: Vestibular Schwannoma

https://radiopaedia.org/articles/acoustic-schwannoma-1
https://en.wikipedia.org/wiki/Vestibular_schwannoma
Outpatient Imaging for Peripheral Causes: Dehiscence of SCC

- Defect in the arcuate eminence covering the superior semicircular canal
- Tullio’s phenomenon: vertigo and nystagmus induced by loud noises
- Can be diagnosed by CT or MRI, but need thin slices
- Can be surgically repaired

http://www.neurology.org/content/82/11/1010/F1.expansion.html
Outpatient Imaging of Central Causes: Posterior Fossa Tumor

- Posterior fossa intra-axial neoplasm – direct pressure or increased ICP
- Kids: medulloblastoma, pilocytic astrocytomas, or ependymoma
- Adults: Mets
- Hereditary or acquired cerebellar degeneration
- Multiple sclerosis
- Migrainous vertigo is the most common central cause of vertigo (38% of migraine pts)
- Chiari I malformation
- Intracranial hypotension or hypertension
- Superficial siderosis

https://www.frontiersin.org/articles/10.3389/fonc.2014.00176/full
Outpatient Imaging of Central Causes: Superficial Siderosis

- Rare condition with hemosiderin deposition in the sub-pial layers of the brain and spinal cord due to recurrent bleeding into the subarachnoid space
- Present in adulthood with hearing loss and progressive gait ataxia
- Often idiopathic
- Need GRE/SWI sequence MRI

https://radiopaedia.org/cases/superficial-siderosis-1
Outpatient Imaging of Central Causes: Multiple Sclerosis

- Inflammatory disease of the CNS of unknown etiology
- Advances in Tx, but no cure
- Cerebellar ataxia is common in progressive disease
- Involvement of cerebellum at disease onset is a bad prognostic indicator
- Nystagmus and Tremor

Acute Dizziness: ER Work-up

- 4% have acute stroke (usually PICA, AICA or SCA infarcts)
- If negative w/u, two-fold higher risk of vascular event on 3-yr follow-up
- 2/3 of acute central vestibular syndromes do not have neuro signs that would be apparent to the non-neurologist
- Sensitivity of CT vs MRI for acute stroke: 16% v 83%

[Diagram of posterior fossa vascular anatomy]
Hypertensive Cerebellar Hemorrhage

- Hypertension is the most common cause of intracerebral hemorrhage
- 40,000 of people in US/year\(^1\)
- Basal ganglia, thalamus, and pontine are all more common than cerebellar hemorrhage (10%)
- Microaneurysms from long standing, poorly controlled HTN
- Cavernomas

https://radiopaedia.org/articles/cerebellar-haemorrhage
ACR Appropriateness Criteria

- Hearing Loss +/- Vertigo: *CT Temporal Bone C-
- Known Cholesteatoma or Neoplasm with Inner Ear extension: *CT Temporal Bone C-
- Congenital Hearing Loss/Deafness: *CT Temporal Bone C-
- Sensorineural Hearing Loss, Mixed Conductive/Sensorineural Hearing Loss: *MRI Head/IACs +/- C
- Episodic Vertigo, with or without hearing loss or tinnitus, Persistent Vertigo with or without neuro sx's: *MRI Head/IACs +/- C
Suspected BPPV
Menieres/Migrainous vertigo
Viral Neuronitis or Labyrinthitis

No Atypical Features

Unilateral hearing sxs

ACUTE ONSET CENTRAL SXS

No IMAGING

MR BRAIN/IACS with CONTRAST

MRI BRAIN +/- CT IN ACUTE SETTING
ACUTE OR CHRONIC OTITIS MEDIA

CT TEMPORAL BONE +/- MRI WITH CONTRAST

MENINGITIS

MRI BRAIN WITH IV CONTRAST

SUSPECTED SCC DEHISCENCE/NOISE INDUCED VERTIGO/HISTORY OF TRAUMA OR SURGERY

CT TEMPORAL BONE
TAKE HOME MESSAGE

- In order to make the most of your imaging study, try to narrow down what you are looking for
- Make your history the **BEST** it can be – your radiologist will **THANK YOU!**
- Imaging can be tailored, but we have to know what you are looking for
- When in doubt, *call your radiologist*

References


Thank you!