


UNIVERSITY OF ALBERTA

DEPARTMENT OF RADIOLOGY & DIAGNOSTIC IMAGING
FACULTY OF MEDICINE & DENTISTRY

Headaches and imaging



September 25, 2023

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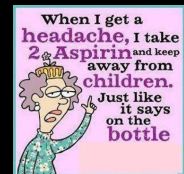
MIC Radiologist
No other disclosures

Objectives:

- Non-traumatic headache - red flags and when to image
- Trauma – Canadian CT head rule
- Best first imaging test for headache
- Common incidental findings

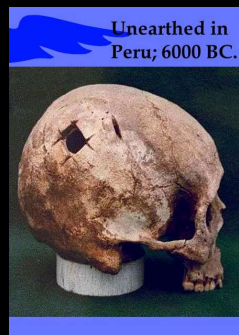
Top 3 messages:

- Target imaging to red flags and other symptoms, not the headache
- MRI for suspected infection or CSF leak (probably needs specialist referral too)
- CT head best first test for almost all other indications



Headache, part of the human condition:

- Trepanation of skull (6000 BC)
- Ebers Papyrus formally described headache (1500 BC)
- Hippocrates described migraine (400 BC)
- Aretaeus classification of headaches (200 AD)¹



Headache, part of the human condition:

- 3rd amongst worldwide cause of disability (by years of life lost)
- 3rd biggest cause of chronic pain (after lower back and knee)¹
- 96% = Lifelong prevalence of headache
- 40% = Global prevalence of tension headache
- 10% = Global prevalence migraine²
 - 76% of headache presenting to primary care

Headache:

- 96% = Lifelong prevalence of headache
- 40% = Global prevalence of tension headache
- 10% = Global prevalence migraine¹
- <1% = lifetime risk of developing a primary malignant tumour of the brain
- 0.016% = yearly incidence of brain tumours
- 1% = Proportion of primary brain tumours with sole complaint of headache²
- 0.00016% = yearly incidence brain tumour presenting with sole complaint of headache

Headache, why do we image:

Meta-analysis - 3026 with sole complaint of headache, 1440 classified as migraine¹

- Stroke = 1.2%
- Brain tumour = 0.8% (0.3%)
- Aneurysm = 0.1% (0.07%)
- Vascular malformation = 0.2% (0.07%)
- Subdural hematoma = 0.2%
- Hydrocephalus = 0.3%
- Incidental white matter abnormalities in migraine = 12-46%



Headache, why do we image:

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- Aneurysm? = 0.1% (0.07%)
- Vascular malformation? = 0.2% (0.07%)
- Subdural hematoma? = 0.2%
- Hydrocephalus? = 0.3%

Evans RW. 1996. Meta-analysis - 3026 with sole complaint of headache (1440 classified as migraine)¹



Headache, why do we image:

- Defensive medicine
 - 2008 Massachusetts survey: 20-30% of imaging and referrals "primarily defensive"¹
 - 2005 Pennsylvania survey: 96% of "high risk" physicians report practicing defensively
- Habit and "community standard of care"
- Desire to avoid patient dissatisfaction
- Self-interest/financial motivation

Headache, why should we image?



Choosing Wisely initiative of the American Board of Internal Medicine :

- "no imaging in patients with uncomplicated headache"

The American Headache Society:

- "does not recommend neuroimaging for stable headaches meeting criteria for migraine"

Choosing wisely Canada:

- "don't order neuro or sinus imaging in patients who have a normal clinical examination, who meet diagnostic criteria for episodic migraine, and have no 'red flags' for a secondary headache disorder"

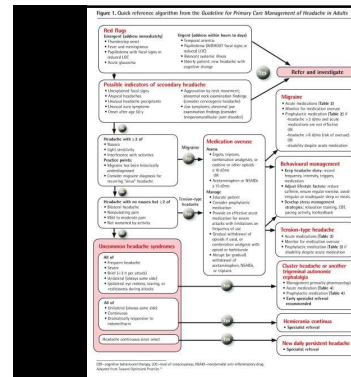
International Classification of Headache Disorders, 3rd Edition (ICHD-III) criteria for migraine:

Attacks last between 4 and 72 h, and have at least two of the four following criteria:

1. unilateral location
2. pulsating pain
3. moderate to severe intensity
4. aggravated by routine physical activity

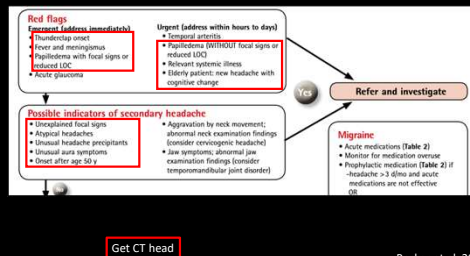
There must also have at least one of the following:

1. nausea and/or vomiting
2. photophobia and phonophobia



Guideline for primary care management of headache in adults. Can Fam Physician. Becker et al. 2015

- Neuroimaging is **not** indicated in recurrent headache with features of migraine, normal neurologic examination, and no red flags



Becker et al. 2015

Headache and brain tumour:

- <1% = Proportion of primary brain tumours with sole complaint of headache³
- 0.016% = yearly incidence of brain tumours⁴
- 0.00016% = yearly incidence brain tumour presenting with sole complaint of headache

Migraine:

- 76% of headache presenting to primary care²
- 0.18% prevalence of sinister (neoplastic + non-neoplastic) on imaging for migraine with normal neurologic exam
- WM abnormalities in 12-46% of migraine

The yield of neuroimaging in patients with typical recurrent migraine attacks is very low. Any imaging study, particularly MRI, can identify incidental findings of no clinical significance which may lead to patient anxiety and further unnecessary investigation. For patients with typical migraine and a normal clinical examination who desire reassurance, careful explanation of the diagnosis and patient education may be more advisable.

Headache in the ER:

- ~2-4% of all ER patients report headache unrelated to trauma⁴
- Secondary (pathologic) cause found in 4% of all ER headaches
- Pathologic cause in >14% with sudden-onset severe headaches

Headache, why should we image?

Red flags for secondary cause:

- thunderclap onset
- fever and meningismus
- papilledema (increased ICP)
- unexplained focal neurological signs
- unusual headache attack precipitants
- new headache onset after age 50 (or 60 depending on guideline)

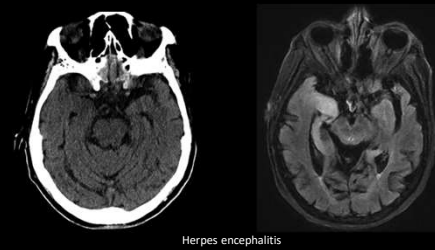
Thunderclap headache:

- maximum intensity within 60sec of onset
- Pathologic cause >14% ER patients with thunderclap headaches⁴
- CT 98-99% sen for SAH



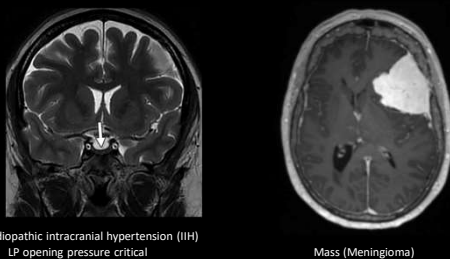
Fever and meningismus:

- Meningitis, encephalitis, cerebritis, abscess
- Headache common but often other neurologic symptoms
- MRI and LP, unenhanced CT head often negative



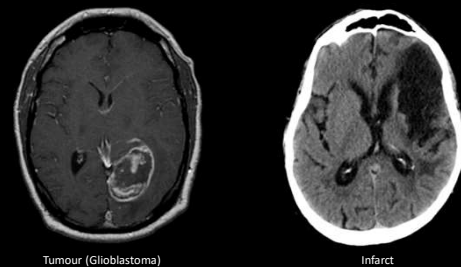
Papilledema:

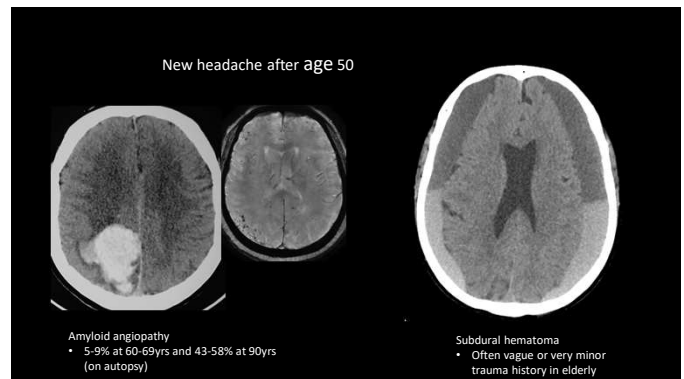
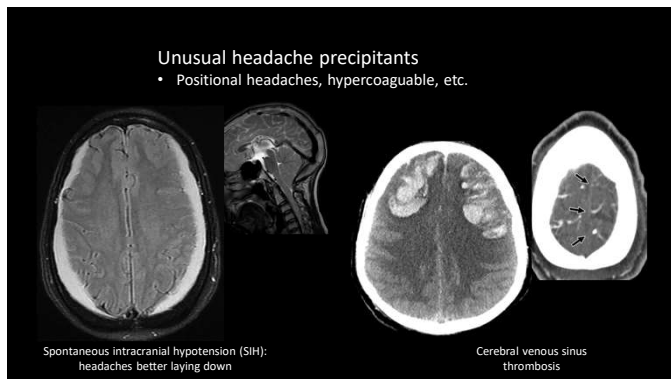
- Increased intracranial pressure



Unexplained focal neurologic signs:

- ie. assymetric weakness, visual field loss, aphasia





Headache, how should we image when needed?
American College of Radiology (ACR) Appropriateness Guidelines

Procedure	Appropriateness Category	Relative Radiation Level
Anteroposterior conventional	Usually Not Appropriate	0
MRA head with IV contrast	Usually Not Appropriate	0
MRA head without and with IV contrast	Usually Not Appropriate	0
MRA head without IV contrast	Usually Not Appropriate	0
MRI head with IV contrast	Usually Not Appropriate	0
MRI head without and with IV contrast	Usually Not Appropriate	0
MRI head without IV contrast	Usually Not Appropriate	0
CT head without and with IV contrast	Usually Not Appropriate	0
CT head without IV contrast	Usually Not Appropriate	0
CTV head with IV contrast	Usually Not Appropriate	0
CTV head without IV contrast	Usually Not Appropriate	0

Headache, how should we image when needed?
American College of Radiology (ACR) Appropriateness Guidelines

Summary:

- MRI best for suspected infection, intracranial hypotension, and trigeminal neuralgia (referral +/- LP also may be needed)
- unenhanced CT reasonable first test in all other cases accessible, cheap, quick

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Anteroposterior conventional	Usually Not Appropriate	0
MRA head with IV contrast	Usually Not Appropriate	0
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MRA head without IV contrast	Usually Not Appropriate	0
MRI head with IV contrast	Usually Not Appropriate	0
MRI head without and with IV contrast	Usually Not Appropriate	0
MRI head without IV contrast	Usually Not Appropriate	0
CT head without and with IV contrast	Usually Not Appropriate	0
CT head without IV contrast	Usually Not Appropriate	0
CTV head with IV contrast	Usually Not Appropriate	0
CTV head without IV contrast	Usually Not Appropriate	0

Variant 1: Sudden onset severe headache that reaches maximal severity within one hour. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
CT head without IV contrast	Usually Appropriate	0
CTA head with IV contrast	May Be Appropriate	0
Anteroposterior conventional	Usually Not Appropriate	0
MRA head with IV contrast	Usually Not Appropriate	0
MRA head without and with IV contrast	Usually Not Appropriate	0
MRI head with IV contrast	Usually Not Appropriate	0
MRI head without and with IV contrast	Usually Not Appropriate	0
MRI head without IV contrast	Usually Not Appropriate	0
CT head without and with IV contrast	Usually Not Appropriate	0
CT head without IV contrast	Usually Not Appropriate	0
CTV head with IV contrast	Usually Not Appropriate	0
CTV head without IV contrast	Usually Not Appropriate	0

Variant 4: Headache with features of intracranial hypertension (eg, papilloedema, pulsatile tinnitus, visual symptoms worse on Valsalva). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI head without IV contrast	Usually Appropriate	O
CT head without IV contrast	Usually Appropriate	***
CT head with IV contrast	O	
MRV head without and with IV contrast	May Be Appropriate	O
MRV head without IV contrast	May Be Appropriate	O
MRV head with IV contrast	May Be Appropriate	O
CTV head with IV contrast	May Be Appropriate	***
Anterography cervicocerebral	Usually Not Appropriate	***
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRA head with IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	***
CT head without and with IV contrast	Usually Not Appropriate	***
CTA head with IV contrast	Usually Not Appropriate	***

Variant 6: Headache with new onset or pattern during pregnancy or peripartum period. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without IV contrast	Usually Appropriate	O
CT head without IV contrast	Usually Appropriate	***
MRV head without IV contrast	May Be Appropriate	O
CTV head with IV contrast	May Be Appropriate	***
Anterography cervicocerebral	Usually Not Appropriate	***
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRV head with IV contrast	Usually Not Appropriate	O
MRV head without and with IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	***
CT head without and with IV contrast	Usually Not Appropriate	***
CTA head with IV contrast	Usually Not Appropriate	***

Variant 2: Headache with one or more of the following "red flags": increasing frequency or severity, fever or neurologic deficit, history of cancer or immunosuppression, older age (>50 years) of onset, or posttraumatic onset. Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI head without IV contrast	Usually Appropriate	O
CT head without IV contrast	Usually Appropriate	***
Anterography cervicocerebral	Usually Not Appropriate	***
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRV head with IV contrast	Usually Not Appropriate	O
MRV head without and with IV contrast	Usually Not Appropriate	O
MRV head without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	***
CT head without and with IV contrast	Usually Not Appropriate	***
CTA head with IV contrast	Usually Not Appropriate	***
CTV head with IV contrast	Usually Not Appropriate	***

Variant 3: Primary trigeminal autonomic cephalalgias (eg, cluster headaches). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI head without IV contrast	May Be Appropriate	O
Anterography cervicocerebral	Usually Not Appropriate	***
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRV head with IV contrast	Usually Not Appropriate	O
MRV head without and with IV contrast	Usually Not Appropriate	O
MRV head without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	***
CT head without and with IV contrast	Usually Not Appropriate	***
CT head without IV contrast	Usually Not Appropriate	***
CTA head with IV contrast	Usually Not Appropriate	***
CTV head with IV contrast	Usually Not Appropriate	***

Variant 5: Headache with features of intracranial hypotension (eg, positional, worse when upright, better when lying down). Initial imaging.

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI thoracic spine with IV contrast	May Be Appropriate (Disagreement)	O
MRI thoracic spine without and with IV contrast	May Be Appropriate	O
MRI thoracic spine without IV contrast	May Be Appropriate	O
Anterography cervicocerebral	Usually Not Appropriate	***
MRA head with IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
MRV head with IV contrast	Usually Not Appropriate	O
MRV head without and with IV contrast	Usually Not Appropriate	O
MRV head without IV contrast	Usually Not Appropriate	O
CT head with IV contrast	Usually Not Appropriate	***
CT head without and with IV contrast	Usually Not Appropriate	***
CT head without IV contrast	Usually Not Appropriate	***
CTA head with IV contrast	Usually Not Appropriate	***
CTV head with IV contrast	Usually Not Appropriate	***

Head trauma, should we image? Canadian CT head rule⁸

Inclusion criteria:

- loss of consciousness
- GCS 13-15
- confusion
- amnesia after the event

Exclusion criteria:

- anticoagulant medication or bleeding disorder
- age <16 years
- seizure

High risk factors:

- GCS <15 two hours post injury
- suspected open skull fracture
- sign of base of skull fracture
- vomiting more than twice
- age >65 years

Medium risk factors:

- amnesia post event >30 min
- dangerous mechanism of injury
- pedestrian struck by motor vehicle
- occupant ejected from motor vehicle
- fall from >3 feet or 5 stairs

Meets inclusion criteria + lack of risk factors = no imaging (80-100% sen for significant findings)

Common incidental findings:

"Nonspecific" WM hypodensities or T2 FLAIR hyperintensities

- Small vessel ischemic change, leukoariosis, microangiopathy
- "Normal" to have one spot per decade
- Commonly ischemic (if vascular risk factors) and/or migraine

Mucus retention cysts (sometimes called polyps) in sinuses (not nasal cavity)

- Ignore
- Nearly ubiquitous, most often asymptomatic

Paranasal sinus fluid

- Sometimes called "acute sinusitis", but usually not
- Up to 50% asymptomatic people have fluid +/- mucosal changes in sinuses

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"Nonspecific" WM hypodensities or T2 FLAIR hyperintensities

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- Ignore
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Paranasal sinus fluid

- Sometimes called "acute sinusitis", but usually not
- Up to 50% asymptomatic people have fluid +/- mucosal changes in sinuses

Summary Recommendations:

- Non-traumatic headache without red flags = no imaging needed
- With red flags unenhanced CT head is almost always best 1st test



1. Headache and Neuroimaging: Why We Continue to Do It. Jordon et al. AJNR. 2020.
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4. American Cancer Society. Online source. 2023.
5. The worldwide incidence and prevalence of primary brain tumors: a systematic review and meta-analysis. De Robles et al. Neuro Oncol. 2015.
6. Acute Headache in the Emergency Setting. Guryildirim et al. Radiographics. 2019.
7. Guideline for primary care management of headache in adults. Becker et al. Can Family Physician. 2015.
8. The Canadian CT Head Rule for Patients with Minor Head Injury. Stiell et al. Lancet. 2001.