



Objectives:

- Non-traumatic headache red flags and when to image
- Trauma Canadian CT head rule
- Best first imaging test for headacheCommon 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</p> 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: 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%

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
- 2008 Massachusetts survey. 20-50% of magin 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

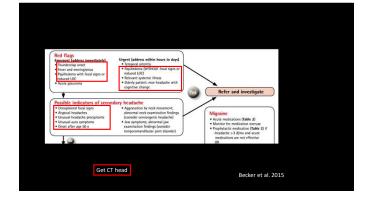
- There must also have at least one of the following:
- nausea and/or vomiting
 photophobia and phonophobia





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



- Headache and brain tumour:

 <1% = Proportion of primary brain tumours with sole complaint of headache³

 0.015% = yearly incidence of brain tumours⁴

 0.00016% = yearly incidence brain tumour presenting with sole complaint of headache

- Migraine: 76% of headache presenting to primary care ² 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.

Thunderclap headache: maximum intensity within 60sec of onset Pathologic cause >14% ER patients with thunderclap headaches⁴ • CT 98-99% sen for SAH -RCVS (reversible cerebral vasoconstriction syndrome) = 90% completely self limited Aneurysm = 85% nontraumatic SAH

Papilledema:

Idiopathic intracranial hypertension • LP opening pressure critical • Imaging mostly to exclude mass

Increased intracranial pressure

nsion (IIH)

Headache in the ER: • ~2-4% of all ER patients report headache unrelated to trauma ⁴ · 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

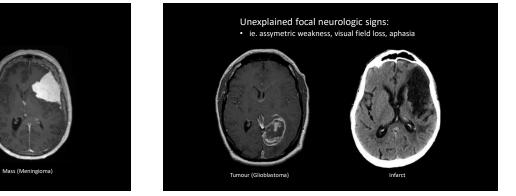
Fever and meningismus:

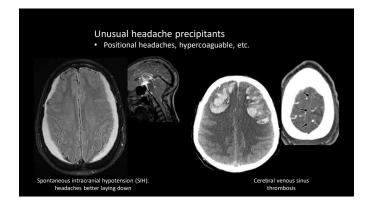
- fever and meningismus
 papilledema (increased ICP)
 unexplained focal neurological signs
 unusual headache attack precipitants
 new headache onset after age 50 (or 60 depending on guideline)

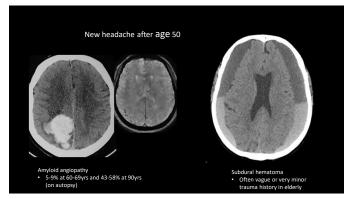
Meningitis, encephalitis, cerebritis, abscess
 Headache common but often other neurologic symptoms

• MRI and LP, unenhanced CT head often negative

Herpes encephalitis







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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

	American Coll	ege of Radiolog	(ACR) Appropriate	eness Guide	elines	
eriant 2: Primary migrains a	e teninn-type hendache. Normal neuro	logic examination. Initial imaging.				
Precolure	Appropriatoness Category	Relative Radiation Level				
Anonography conviccounteral	Usually Not Appropriate	999	Variant 8:	Handacks without an	n of the following "red flags": sudden o	and Othersheeler's feature of
MRA head with IV contrast	Usually Not Appropriate	0	CARDINE IS	intracruatel hyperte	axies or hypotension, new case! as	r pattern during prognancy of
MRA head without and with IV contrast	Usually Not Appropriate	0			increasing frequency or neverity, four impromise, older age (>50 years) of non-	
MRA bead without IV contrast	Usually Not Appropriate	0		imaging.		
MRI head with IV contrast	Usually Not Appropriate	0	Fre	codure	Appropriateness Category	Relative Radiation Level
MRI head without and with TV contrast	Usually Not Appropriate	0	Atteniography convice	central	Unsally Not Approximit	777
MRI head without IV comment	Usually Not Appropriate	0	MRA head with IV or	rited	Unsaffy Net Appropriate	0
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MRV head without IV contrast	Usually Not Appropriate	0	MRI head with IV on	Intrad	Unsulty Not Appropriate	0
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CT head without and with IV contrast	Usually Not Appropriate	999	MRI head without IV	contrast	Usually Nor Appropriate	0
CT hand without IV contrast	Deadly Not Appropriate	444	MRV head with IV or	etrud .	Usually Not Appropriate	0
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			CT head without IV of	ovitrani	Usually Not Appropriate	000
			CTA head with PV or	ritud .	Usually Not Appropriate	999
			CTV head with IV on	the state	Usually Not Appropriate	000

Procedure	Appropriateness Category	Relative Radiation Leve
CT head without IV contrast	Usually Appropriate	***
CTA head with IV contrast	May Be Appropriate	888
Arteriography cervicocerebral	Usually Not Appropriate	888
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	Uszally 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
MRV head with IV contrast	Usually Not Appropriate	0
MRV head without and with IV contrast	Usually Not Appropriate	0
MRV head without IV contrast	Usually Not Appropriate	0
CT head with IV contrast	Usually Not Appropriate	888
CT head without and with IV contrast	Usually Not Appropriate	000
CTV head with IV contrast	Usually Not Appropriate	666

Variant 4: Headache with features of intracranial hypertension (eg. papilledema, pulsatile tinnitus, visu symptoms worse on Valsalva). Initial imaging.			
Procedure	Appropriateness Category	Relative Radiation Level	
MRI head without and with IV contrast	Usually Appropriate	0	
MRI head without IV contrast	Usually Appropriate	0	
CT head without IV contrast	Usually Appropriate	999	
MRV head with IV contrast	May Be Appropriate	0	
MRV head without and with IV contrast	May Be Appropriate	0	
MRV head without IV contrast	May Be Appropriate	0	
CTV head with IV contrast	May Be Appropriate	888	
Arteriography cervicocerebral	Usually Not Appropriate	888	
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	
CT head with IV contrast	Usually Not Appropriate	999	
CT head without and with IV contrast	Usually Not Appropriate	999	
CTA head with IV contrast	Usually Not Appropriate	666	

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	0			
CT head without IV contrast	Usually Appropriate	888			
MRV head without IV contrast	May Be Appropriate	0			
CTV head with IV contrast	May Be Appropriate	888			
Arteriography cervicocerebral	Usually Not Appropriate	888			
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			
MRV head with IV contrast	Usually Not Appropriate	0			
MRV head without and with IV contrast	Usually Not Appropriate	0			
CT head with IV contrast	Usually Not Appropriate	999			
CT head without and with IV contrast	Usually Not Appropriate	999			
CTA head with IV contrast	Usually Not Appropriate	999			

fever or neurologic d	or more of the following "red flags": eficit, history of cancer or immunocom tic onset. Initial imaging.	
Procedure	Appropriateness Category	Relative Radiation Leve
MRI head without and with IV contrast	Usually Appropriate	0
MRI head without IV contrast	Usually Appropriate	0
CT head without IV contrast	Usually Appropriate	000
Arteriography cervicocerebral	Usually Not Appropriate	000
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
MRV head with IV contrast	Usually Not Appropriate	0
MRV head without and with IV contrast	Usually Not Appropriate	0
MRV head without IV contrast	Usually Not Appropriate	0
CT head with IV contrast	Usually Not Appropriate	888
CT head without and with IV contrast	Usually Not Appropriate	000
CTA head with IV contrast	Usually Not Appropriate	888
CTV head with IV contrast	Usually Not Appropriate	000

Variant 3: Primary trigeminal autonomic cephalalgias (eg. cluster headache). Initial imaging.				
Procedure	Appropriateness Category	Relative Radiation Level		
MRI head without and with IV contrast	Usually Appropriate	0		
MRI head without IV contrast	May Be Appropriate	0		
Arteriography cervicocerebral	Usually Not Appropriate	888		
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		
MRV head with IV contrast	Usually Not Appropriate	0		
MRV head without and with IV contrast	Usually Not Appropriate	0		
MRV head without IV contrast	Usually Not Appropriate	0		
CT head with IV contrast	Usually Not Appropriate	999		
CT head without and with IV contrast	Usually Not Appropriate	888		
CT head without IV contrast	Usually Not Appropriate	999		
CTA head with IV contrast	Usually Not Appropriate	888		
CTV head with IV contrast	Usually Not Appropriate	000		

Variant 5: Headache with features of intracranial hypotension (eg, positional, worse when upright, bett when lying down). Initial imaging.				
Procedure	Appropriateness Category	Relative Radiation Level		
MRI head without and with IV contrast	Usually Appropriate	0		
MRI thoracic spine with IV contrast	May Be Appropriate (Disagreement)	0		
MRI thoracic spine without and with IV contrast	May Be Appropriate	0		
MRI thoracic spine without IV contrast	May Be Appropriate	0		
Arteriography cervicocerebral	Usually Not Appropriate	999		
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 IV contrast	Usually Not Appropriate	0		
MRV head with IV contrast	Usually Not Appropriate	0		
MRV head without and with IV contrast	Usually Not Appropriate	0		
MRV head without IV contrast	Usually Not Appropriate	0		
CT head with IV contrast	Usually Not Appropriate	999		
CT head without and with IV contrast	Usually Not Appropriate	***		
CT head without IV contrast	Usually Not Appropriate	999		
CTA head with IV contrast	Usually Not Appropriate	999		
CTV head with IV contrast	Usually Not Appropriate	999		

Head trauma, should we image? Canadian CT head rule $^{\rm 8}$ 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

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

Exclusion criteria: • anticoagulant medication or bleeding disorder • age <16 years • seizure

- 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

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

Common incidental findings:

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

Summary Recommendations:

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



- Headache and Neuroimaging: Why We Continue to Do It. Jordon et al. AJNR. 2020.
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