

Thunderclap headache/SAH

Is CT scan enough?

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Case

- 48 years old patient (district nurse) develops sudden severe headache (9-10/10) while changing dressing on patients leg ; normal mental status and neuro exam; negative (normal)CT scan of the head <6h from onset of headache.
- Would you do LP?

There is no certainty

- Since nothing is ever 0% or 100% what miss rate for SAH would you be happy with?

The Art of War (Sun Tzu)

- Hence the saying: if you know the enemy and know yourself, you need not fear the result of a hundred of battles. If you know yourself but not the enemy, for every victory gained you will also suffer a defeat. If you know neither the enemy nor yourself, you will succumb in every battle.
- Thus, though we have heard of stupid haste in the battle, cleverness has never been seen associated with long delays.

The beast

- Aneurysmal SAH : incidence 3-25 per 100 000 population; prevalence 0.4% - 6%, estimated overall 2%.
- 5283 patients, headache peaking within 1 hour, 329 (6%) patients had SAH
- In a series of 2131 patients with acute onset of headache : 132 with SAH = 6.2%
- Prospective study , 148 patients with sudden and severe headache: SAH 25% overall and 12% if headache was the only symptom.
- 107 patient with “worst headache in my life”: 20 (18%) had SAH.
- Aneurysmal SAH accounts for 4-12% of ED patients with TCH.
- **average case fatality rate is 51% (10% die before reaching hospital, 25% die within 24 hours, 40 - 45% die within 30 days)**
- **of those surviving app 30% will have severe disability.**
- Mean age at onset is 55 years. Most aneurysmal SAH occur between 40-60 years of age.

Sudden onset – what does that mean?

- very severe headache with abrupt onset that reaches its maximum intensity **within 1 minute or less** from onset.
- 2131 patients , acute onset peaking **within 1 hour**, 132 SAH (6.2%) , interobserver agreement about sudden was only fair;
- 6 of 132 (4.5%) with SAH had a time to peak headache intensity up to 1 hour.
- Care must be taken in defining sudden.
- Is this the worst headache of your life? The “worst headache of your life requires evaluation for SAH. Always ask, however, have you had many other “worst headaches of your life”?

Symptoms

- 30 % occurring at night
- 97% sudden , severe headache- “worst headache of my life”; 75% within a few seconds; up to 40% headache solitary symptom
- 30% headaches is lateralized, predominantly to the side of aneurysm
- Impaired LOC ~65% with 50% of these have coma(Cameron); coma is unusual(UpToDate); seizure <10-15%; focal neurological deficit 25% (nearly any neurological sign may be present); nausea and vomiting 75%; neck pain or stiffness 75%.

Increased odds

- Impaired consciousness
- Seizure
- Focal neurology
- Neck stiffness/pain
- Occipital headache
- Nausea , vomiting
- Exertion or Valsalva immediately preceding TCH
- Elevated BP

Risk factors

- Cigarette smoking -most important preventable factor
- Hypertension
- Alcohol – moderate to heavy consumption
- **Genetic risk:** autosomal dominant polycystic kidney disease, glucocorticoid-remediable aldosteronism, Ehler-Danlos sy
- Sympatomimetic drugs
- Estrogen deficiency
- Antithrombotic therapy
- Statins

Ottawa SAH rule

- Age ≥ 40 years
 - Neck pain or stiffness
 - Limited neck flexion on examination
 - Witnessed LOC
 - Onset during exertion
 - Thunderclap headache (instantly peaking pain)
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- Sensitivity = 100; Specificity = 15%
 - Application of this rule would have eliminated the need for evaluation in only 14% of patients.

CT scan <6 hours post onset of headache

- 882 articles reviewed, 5 articles met inclusion criteria
- 8907 patients, 13 missed SAH = 0.15%
- Stroke 2016, March;47(3):750-5

- 5022 publications identified, 122 articles underwent full review, 22 were included
- Noncontrast cranial CT scan <6 h **accurately ruled in** SAH (LR+ = 230; 95%CI=6 to 8700) and **ruled out** SAH (LR- = 0.01; (95% CI = 0 - 0.04).
- Acad.Emerg.Med. 2016 Sept;23(9), 963-1003

Perry et al Study

BMJ 2011;343:d4277

- Multicentre prospective cohort study from Canada.
- Headache peaking within 1 hour of onset
- SAH defined as : SAH on unenhanced CT; visible xanthochromia in CSF; RBC $>5 \times 10^6/L$ in final tube of CSF; aneurysm identified on cerebral angiography;
- 240/3123 patients or 7.7% had SAH overall.
- 953 patients had CT in **<6 hours**; all 121 patients with SAH were identified by CT.
- 2179 had CT **>6 hours** after onset; 119 pts diagnosed with SAH; 102 (85%) had +ve CT scan
- 17/119 pts had **-ve CT but +ve LP** : 6 had neurosurgical intervention; 10 no cause for bleeding found; 1 bleed secondary to brain tumor.
- CAVEATS: Only 1546 pts (49.4%) got LP. LP was performed at the discretion of treating physician, according to usual practice. 1/4 of patients lost for follow up.
- BOTTOM LINE: **0** cases of death or -ve outcome at 3 months if CT head negative and performed **<6** hours symptoms onset. Modern thin sliced CT is highly sensitive for SAH when performed within 6 hours of headache onset and interpreted by an experienced radiologist – sensitivity, specificity, PPV and NPV all 100%.

Backes at al study

Stroke 2012;43:2115

- Single centre retrospective study from Netherlands.
- 1039 pts with clinical suspicion of SAH; **250** pts included in study
- Exclusion: GCS <15; transfer from other hospital; time of onset unknown; focal neurological deficit; >14 days between onset and CT; age <16; LP<1 months before presentation.
- **137 pts had CT <6 hours:**
- **69 pts CT -ve** and had LP: 68 -ve and 1 +ve – cervical AVM
- **68 pts CT +ve:** 56 SAH and 11 perimesencephalic bleed
- **113 pts CT >6 hours :**
- 37pts CT +ve (28 SAH; 8 PMH)
- 76 pts CT -ve ; LP : 5 +ve (SAH 4, AVM 1) and 71 -ve
- **CONCLUSION :** sensitivity of CT scan <6 hours after onset was 98.5% for all patients with SAH and PMH but not with cervical AVM. After exclusion of patients with an atypical presentation without headache, sensitivity, specificity, PPV and NPV were all 100%.

Block at a study

Neurology, May 12, 2015;84(19) 1927-32

- Multicentre **retrospective study** from Netherlands.
- **Inclusion criteria** : normal LOC ; no focal neurology; **CT scan <6 hours and reported -ve by staff radiologist**; subsequent CSF spectrophotometry.
- Two neuroradiologists and one stroke neurologist independently reviewed admission CT scans of patients with CSF results that were considered +ve for bilirubin.

- 760 patients included: CT scan <6 hours and LP >12 hours after onset of headache
- **52/760 (6.8%)** pts found to have **builirubin in CSF**

- 1/52 pts with SAH and -ve CT had perimesencephalic nonaneurysmal haemorrhage
- Other 51 pts with -ve CT and bilirubin on LP:
 - 23 did not have CTA,MRA or DSA performed based on “clinical grounds”.
 - 20 had no aneurysm on CTA,MRA or DSA
 - 8 had an aneurysm on CTA,MRA or DSA – 3 aneurysm were previously coiled; other 5 aneurysms were deemed non ruptured aneurysms.

- **CONCLUSION:** NPV for detection of SAH by staff radiologist working in non academic hospital is 99.9% (95% confidence interval 99.3%-100%).
- Authors believe that their results support the change of practice wherein a **LP can be withheld** in patients with a head CT performed <6 hours after headache onset and reported -ve for SAH by staff radiologist in described non-academic hospitals.

- **BOTTOMLINE:** 0 cases of death or -ve outcomes in patients presenting with sudden onset of headache and a -ve CT scan preformed <6 hours of symptoms onset.

Sayer et al study

Academic Emergency Medicine. 2015 Nov;22(11): 1267-73

- Observational study.
- Objective was to determine the incidence of SAH diagnosed by LP when the head CT was reported –ve for subarachnoid blood.
- 2248 patients included; **350 (15.6%) uninterpretable** (2 aneurysms were found on subsequent imaging).
- **1898 LP's suitable for analysis** (spectrophotometric detection of bilirubin, not by CSF RBC count or xanthochromia).
- **92 (4.8%) were +ve** for blood suggesting SAH– of these only **8 pt.'s (9.8% / 0.4%)** had aneurysm on further imaging and 1 had carotid cavernous fistula **No cause for SAH was found in >90% of +ve samples.**
- 204 LP's/ 1 identified vascular abnormality.
- **1507 (79.4%) were –ve.**
- **299 (15.6%) were inconclusive** (oxyhaemoglobin or methaemoglobin, no bilirubin); no vascular abnormalities were found on subsequent imaging.

- LP to diagnose or exclude SAH after –ve CT **has very low diagnostic yield**, due to low prevalence of disease and uninterpretable or inconclusive samples. A **clinical decision rule** may improve diagnostic yield by selecting patients requiring further evaluation by LP following nondiagnostic or normal CT brain.

- CAVEAT: no data provided on timing to CT or LP.

CTA, MRA

- Use of multidetector CTA : sensitivity and specificity for aneurysm is both >97%, as well as improved detection of smaller (<4 mm in diameter) aneurysms.
- Both CTA and MRA can identify aneurysms 3-5 mm or larger with high degree of sensitivity, but they do not achieve resolution of conventional angiography.
- The sensitivity of CTA for detection of ruptured aneurysm , using conventional angiography or digital subtraction angiography (DSA) as gold standard, is 83-98%

LP/traumatic tap

- **LP is mandatory** if there is strong suspicion of SAH despite normal CT.
- **One possible exception** involves select patients with isolated headache, a normal examination, and a -ve CT scan performed within 6 hours from onset of headache and interpreted by an expert reviewer. (UpTo Date, Feb 2020)
- **Clearing of blood** from tube 1 to tube 4:
 - unreliable sign of traumatic tap
 - reliably exclude SAH only if in tube 1 substantial RBC count and final tube is normal.
 - 63% reduction in RBC count useful in distinguishing traumatic tap from SAH.
 - 70% reduction of RBC from the 1st to the 4th tube excluded SAH (BMJ 2015;350:h568)

LP/RBC count

- Fewer than 2000 RBC and no xanthochromia excluded SAH with sensitivity of 100% (BMJ 2015;350:h568)
- Fewer than 500 RBC in the 4th tube had 100% NPV for SAH
- <100 RBC in the CSF greatly decreased the likelihood of SAH (Acad Emerg Med 2013;20;247)

LP/xanthochromia

- Xanthos =yellow
- Blood cells haemolyse – **oxyhaemoglobin** within 4-10 hours of bleed – conversion - **bilirubin and sometimes methemoglobin** ; the time of conversion is uncertain – it has been reported to be 9-10 hours.
- Bilirubin is the only pigment that is produced **in vivo**, while oxyhemoglobin and methemoglobin can be produced **in vivo or in vitro**, for example, during CSF analysis.
- by 12 hours post onset 100% will have xanthochromia even if measured visually; lasts for 2-3 weeks.
- **Visual inspection:**
- indicated that blood has been in CSF at least 2 hours
- CSF proteins, systemic hyperbilirubinaemia, traumatic tap >100 000 RBC
- **Spectrophotometry:**
- **highly sensitive** for detection of bilirubin (>95%); each of 4 spectrophotometric definitions had only **moderate to poor specificity and thus unacceptably large false +ve rate** (Sayer et al; Academic Emergency Medicine 2015;22-000-000)
- more sensitive than visual but is not routinely recommended; as a practical matter it is rarely available;

CT followed by CTA

- Asymptomatic aneurysm which occurs in app 3% of the population.
- CT followed by LP is equivalent or better than CT/CTA approach.

Consideration for omitting LP in patients who have -ve CT within 6 hours of headache onset

Patient factors

- The time of onset of the headache is clearly defined
- The CT is performed within 6 hours of headache onset
- The presentation is an **isolated** rapid-onset headache (no primary neck pain, seizure, or syncope or other atypical presentation)
- There is no meningismus and the neurologic examination is normal

Radiologic factors

- The CT scanner is modern , 3rd generation or newer machine with thin cuts through the brain.
- The CT is technically adequate without significant motion artefact.
- The Hct level is >30%.
- The physician interpreting the scan is an attending-level radiologist(or has equivalent experience in reading brain CT scans).
- Radiologist should specifically examine the brain CT for subtle hydrocephalus, small amount of blood in dependant portions of the ventricles, and small amounts of isodense or hyperdense material in the basal cisterns.

Communication factors

- The clinician should communicate the specific concerns to the radiologist (egs. “severe acute headache ; rule out SAH”)
- After -ve CT result the clinician should communicate the post-test risk of SAH that persists (1 to 2 per 1000)

Etiologies of thunderclap headache

Most common causes

- SAH
- Reversible cerebral vasoconstriction syndromes (RCVS)

Conditions that **less commonly** cause thunderclap headache

- Cerebral infection
- Cerebral venous thrombosis
- Cervical artery dissection
- Spontaneous intracranial hypertension
- Acute hypertensive crisis
- Posterior reversible leukoencephalopathy syndrome (PRES)
- Intracerebral haemorrhage
- Ischaemic stroke

Conditions that uncommonly or rarely cause thunderclap headache

- Pituitary apoplexy
- Colloid cyst of the 3rd ventricle
- Aortic arch dissection
- Aqueductal stenosis
- Brain tumor
- Giant cell arteritis
- Pheochromocytoma
- Pneumocephalus
- Retroclival hematoma
- Spinal epidural hematoma
- Varicella zoster virus encephalopathy
- Vogt-Koyanagi-Harad syndrome

Disputed causes of thunderclap headache

- Sentinel headache (unruptured intracranial aneurysm)
- Primary thunderclap headache

So...

- In patient with history consistent with SAH, normal mental status, no focal neurological deficit, and negative CT scan performed within 6 hours, a shared decision strategy should be used as this is not 100% sensitive strategy, but should also be balanced with the risk of LP complications and false +ve/inconclusive results.



Thank you

And never give up, never surrender!