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Acute Neurology
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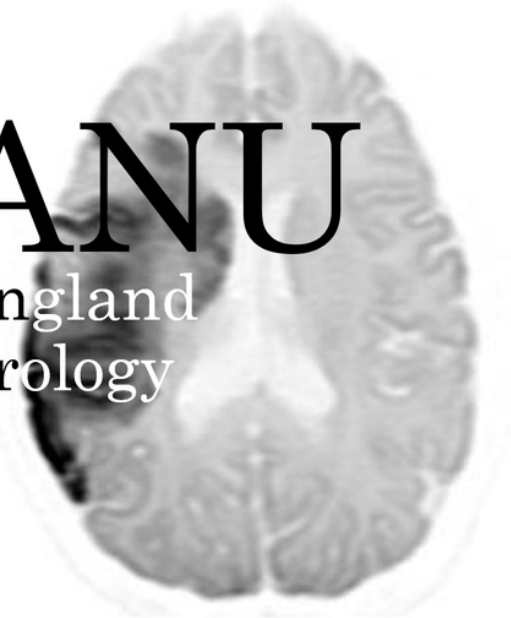

Neuroimaging

Matt Jones

Chris Kobylecki

MANCHESTER 1824
The University of Manchester

Manchester Centre for Clinical Neurosciences

Salford Royal NHS Foundation Trust

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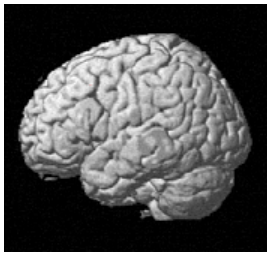
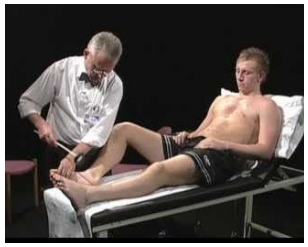
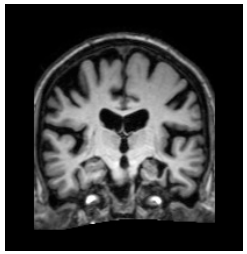
The Basics

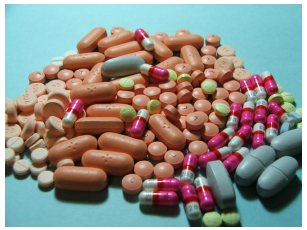
Theory → History → Exam → Investigation → Treatment

Symptoms:
Headache
Dizziness
Tingling
Weakness
Blackout
Confusion…..









Differential Diagnosis

Precise Diagnosis

The Basics

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> Different from all other medical specialties, save perhaps psychiatry, the neurologist is heavily dependent on listening to and interpreting what the patient tells us… If you don't know what is happening by the time you get to the feet you are in real trouble

Jerome M Posner, 2013[4]

Why do we image?

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- To confirm a clinical diagnosis
- To rule out something serious
- To aid prognosis or treatment
- Are there any downsides to imaging?

VOMIT and BARF

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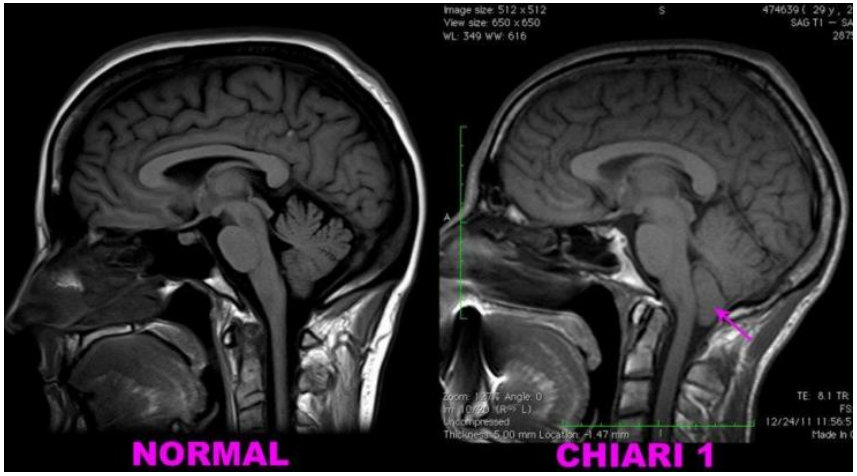
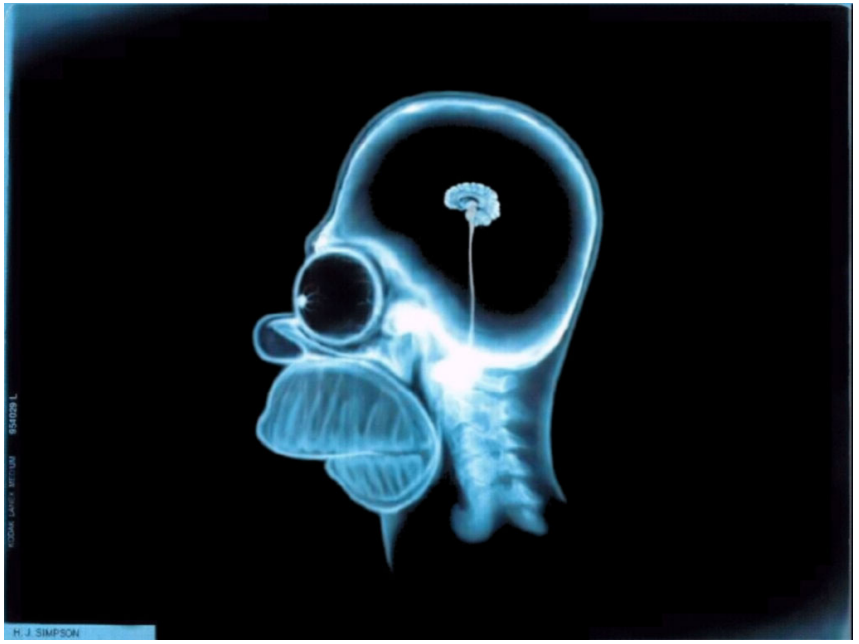
Victim Of Modern Imaging Technology



Brainless Application of Radiologic Findings



Case 1

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- 42 year old female
- Sudden onset severe occipital headache
- Vomiting, photophobia
- Still present 2 hours post onset

What more information do you need?

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- Never normally has headaches
  - Severe episode of sudden onset headache 2 weeks before
- Pain intensity 10/10
- Past medical history
  - Hypertension, on ramipril
  - Smokes 15/day
- No family history acute headaches/ICH/stroke

History is critical!

Examination

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- Airway ok, resps 20/min, BP 180/90, HR 55/min
- GCS 15/15, responding appropriately
- Photophobic++, neck stiffness
- Cranial nerves normal
- Tone normal, power 5/5 all 4 limbs
- Reflexes symmetrical ++, plantars downgoing

What is the differential diagnosis?

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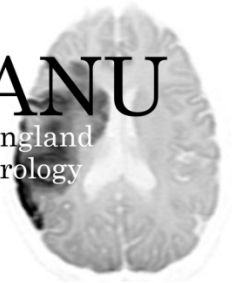

- Subarachnoid haemorrhage
- Other secondary headache
- Primary headache disorder

What is the next step?

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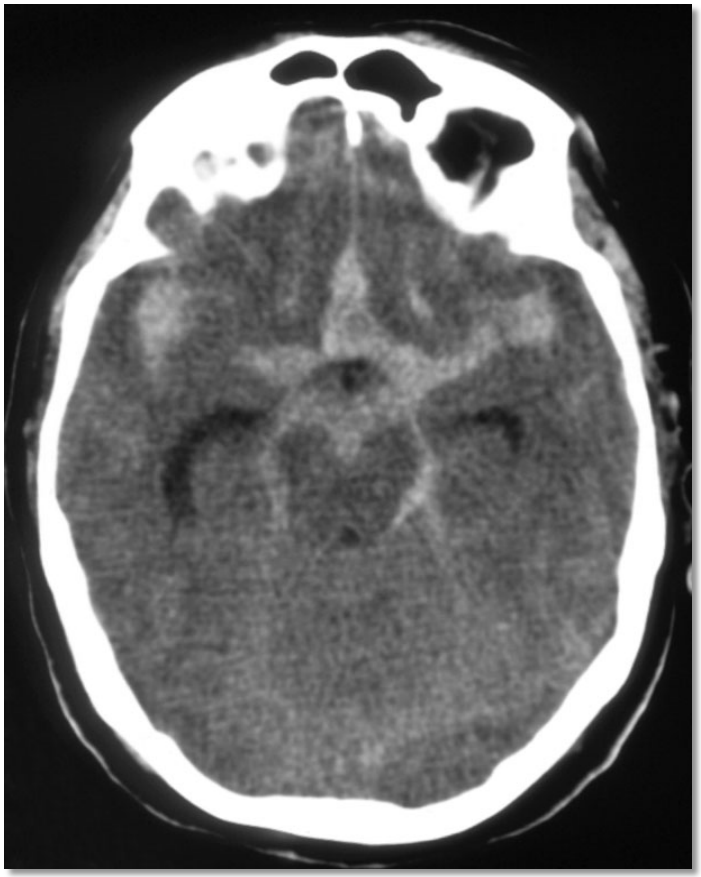

Investigation of suspected SAH

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- Urgent CT brain
  - Sensitivity >95% in first 24 hours
  - 50% after 5-7 days
- Confirm diagnosis
- Assess for complications
  - ICH, IVH
  - hydrocephalus

Lumbar puncture in suspected SAH

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- Lumbar puncture **mandatory** if CT negative
- Possibility of other diagnosis eg meningitis
- Should be performed >12 h after ictus
  - Fresh sample for microbiology, protein, glucose
  - CSF spectrophotometry (protect from light)
  - Opening pressure (differential diagnosis includes CVST and intracranial hypotension)

Thunderclap headache

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Cause	Clinical	Brain CT	LP	Brain MRI
RCVS	Recurrent thunderclap headaches	Normal or convexity SAH	Mild increase in WBC	Multifocal narrowing on MRA
Carotid/ vertebral dissection	Neck pain, features of stroke, Horners syndrome	Normal or ischaemic stroke	Normal	Dissection on MRA
CVST	Focal neurological deficits, altered mental status	Normal Hyperdense sinus Venous haemorrhage	Elevated opening pressure	Normal Venous infarct/ haemorrhage
Spontaneous intracranial hypotension	Postural headache	Normal Subdural collection	Low opening pressure	Meningeal enhancement

Adapted from Schwedt TJ, *Continuum* 2015;21:1058-71.

Learning points

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- CT is the investigation of choice for thunderclap headache
- LP is indicated if CT is normal
- If SAH excluded, MR more sensitive for alternative causes

Case 2

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- A 20 year old female attends MAU due to worsening headache over 2 days.
- She has generalised head and neck pains that are worse when she moves about. She has been sick twice. She felt increasingly hot and tired so came to A+E with a friend
- She is normally fit and well; her only medication is the oral contraceptive pill

Decisions, decisions…

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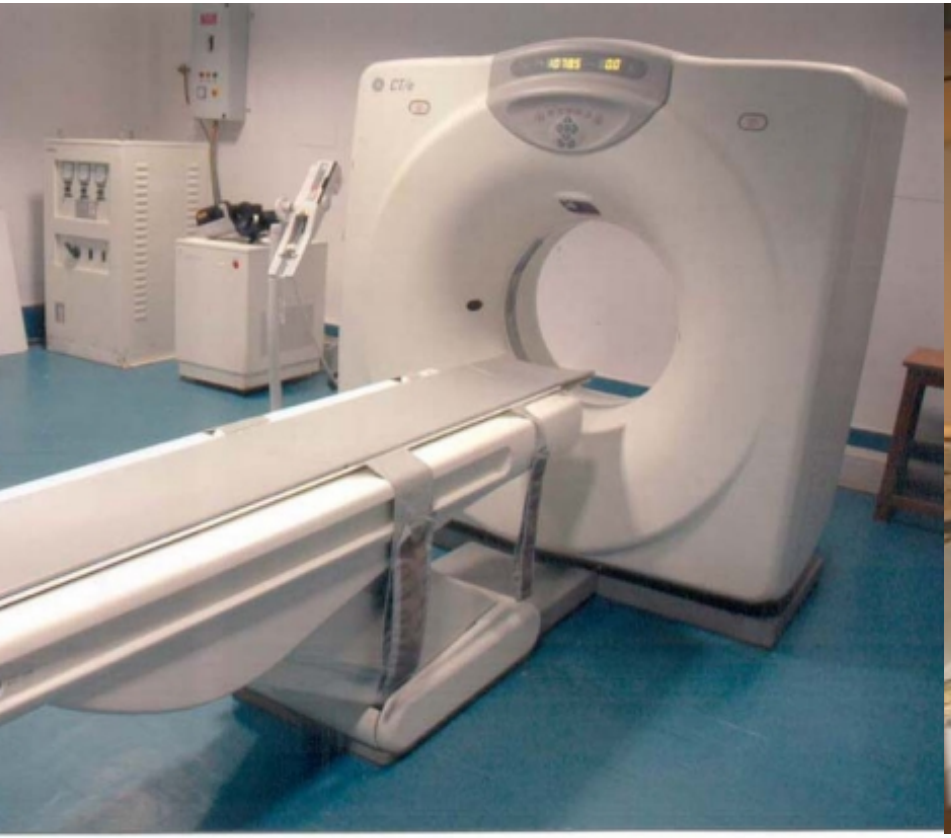
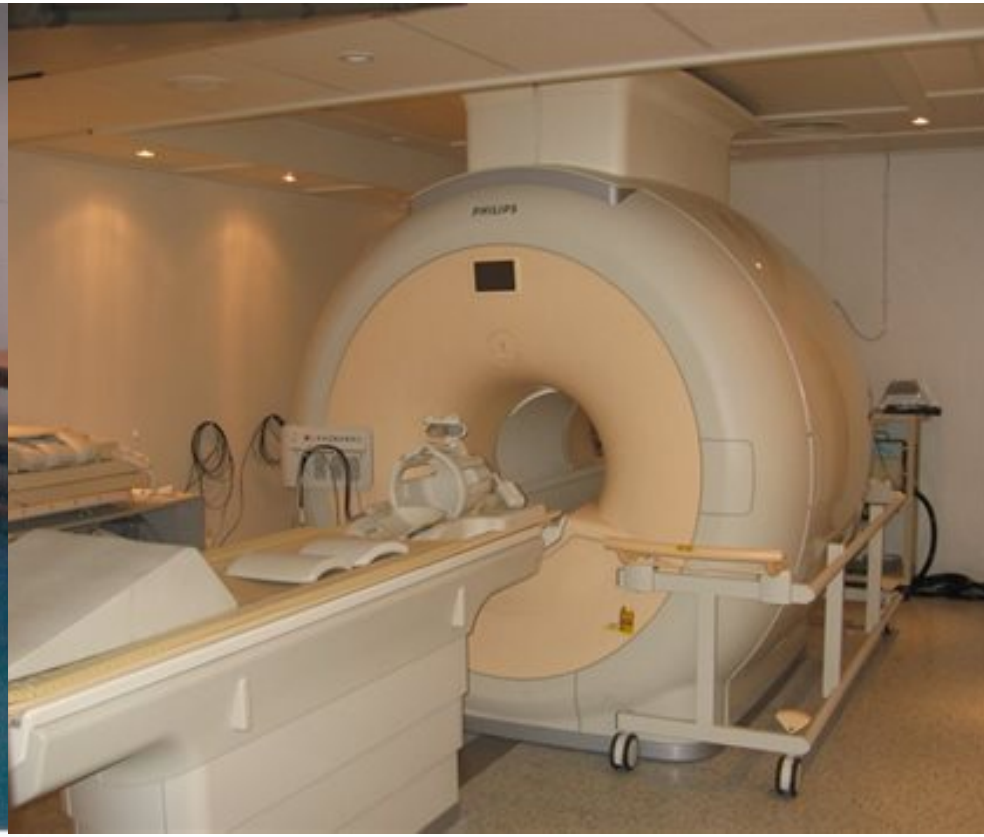
CT



MRI



Structural Imaging

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CT

- Quick
- Cheap
- Convenient

- Involves radiation

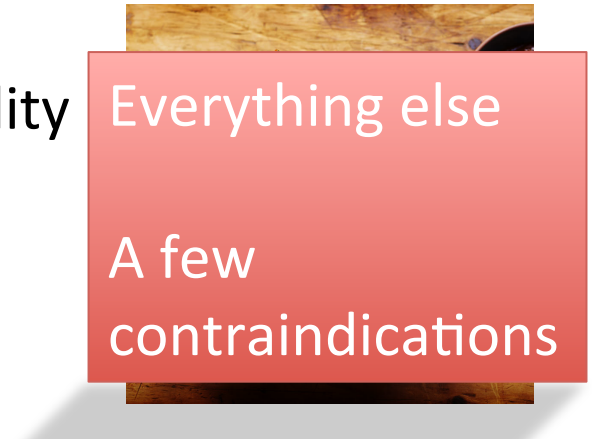
- Poor quality

MRI

- Slow
- Expensive
- Bit more effort…

- No radiation

- High quality



Case 2

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Update

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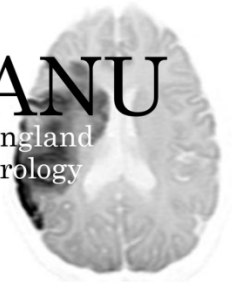

- What are the other important features from the history that you want to know?

- What important physical signs will you be looking for on examination?

Case 2 ctd

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- Felt feverish all day. No recent illnesses or contacts
- Worsening throbbing headache with pain in neck and sensitivity to light
- GCS 15, but slightly drowsy, will answer Qs
- Temp 38.3^{o}C, Pulse 98bpm, BP 105/70, sats 96%, no rash
- Neck stiffness, no papilloedema. Normal CN, UL and LL

What do we think?

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- Likely diagnosis:
  - Viral meningitis
  - Bacterial meningitis
  - Cerebral venous sinus thrombosis
  - Viral encephalitis
  - Migraine

What do we think?

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- Next steps:
  - CT brain
  - MRI brain
  - Lumbar puncture
  - Blood cultures

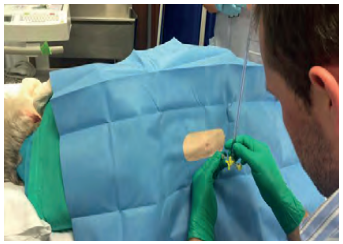
British Infection Association | Public Health England | The Royal College of Emergency Medicine | intensive care society | Association of British Neurologists | sam | Meningitis Research Foundation

Early Management of Suspected Meningitis and Meningococcal Sepsis in Immunocompetent Adults

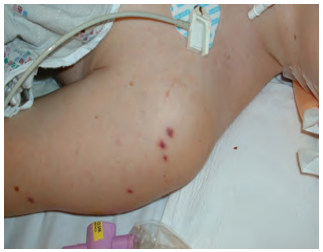
3rd Edition
Jan 2016

Early recognition is crucial

Consider meningitis or meningococcal sepsis if ANY of the following are present:



- Headache
- Fever
- Altered Consciousness
- Neck Stiffness
- Rash
- Seizures
- Shock



Immediate Action

- **A**irway
- **B**reathing - Respiratory rate & O_2 saturation
- **C**irculation - Pulse; capillary refill time; urine output; blood pressure (hypotension occurs late)
- **D**isability - Glasgow coma scale; focal neurological signs; seizures; papilloedema; capillary glucose
- **S**enior review +/- Critical Care review if any Warning Signs are present

Warning Signs

The following signs require urgent senior review +/- Critical Care input:

- Rapidly progressive rash
- Poor peripheral perfusion
  - Capillary refill time > 4 secs, oliguria or systolic BP < 90mmHg
- Respiratory rate < 8 or >30 / min
- Pulse rate < 40 or >140 / min
- Acidosis pH < 7.3 or Base excess worse than -5
- White blood cell count < 4 x 10^9/L
- Lactate > 4 mmol/L
- Glasgow coma scale <12 or a drop of 2 points

Suspected Meningitis

(meningitis without signs of shock, severe sepsis or signs suggesting brain shift)

- Blood cultures
- Lumbar puncture
- Dexamethasone 10mg IV
- Ceftriaxone OR Cefotaxime 2g IV immediately following LP* (see also alternative initial antibiotics)
- CT scan normally not indicated
- Careful fluid resuscitation (avoid fluid overload)

*If LP cannot be done in the first hour, antibiotics must be given immediately after blood cultures have been taken

Suspected meningitis with signs suggestive of shift of brain compartments secondary to raised intracranial pressure

- Get Critical Care input
- Secure airway, high flow oxygen
- Take bloods including Blood Cultures
- Give Dexamethasone 10mg IV
- Give Ceftriaxone OR Cefotaxime 2g IV immediately after blood cultures taken
- Delay LP
- Arrange neurological imaging (once patient is stabilised)

Signs of severe sepsis or a rapidly evolving rash

(with or without symptoms and signs of meningitis)

- Get Critical Care input
- Secure airway and give high flow oxygen
- Fluid resuscitation
- Blood Cultures
- Ceftriaxone OR Cefotaxime 2g IV immediately after blood cultures taken
- Delay LP

Follow Surviving Sepsis Guidelines at: http://www.survivingsepsis.org/guidelines

- Poor response to initial fluid resuscitation

Delay LP

if any of the following are present:

- Signs of severe sepsis or rapidly evolving rash
- SEVERE respiratory/ cardiac compromise
- Significant bleeding risk
- Signs suggesting **shift of brain compartments** (CT scan before LP is warranted, as long as patient is stable)
  - Focal neurological signs
  - Presence of papilloedema
  - Continuous or uncontrolled seizures
  - GCS ≤12

Alternative initial antibiotics

Journal of Infection (2016) 72, 405—438

ELSEVIER

BIA
British Infection Association

www.elsevierhealth.com/journals/jinf

The UK joint specialist societies guideline on the diagnosis and management of acute meningitis and meningococcal sepsis in immunocompetent adults☆

F. McGill [a,b,c,d,*,x], R.S. Heyderman [e,x], B.D. Michael [a,f,y], S. Defres [a,c,v,x], N.J. Beeching [a,b,c,g,x], R. Borrow [h,ab], L. Glennie [w,ac], O. Gaillemin [j,aa], D. Wyncoll [q,z], E. Kaczmarski [k,ab], S. Nadel [m,n,ac], G. Thwaites [p,u,x], J. Cohen [t,x], N.W.S. Davies [i,y], A. Miller [a,l,x], A. Rhodes [o,z], R.C. Read [r,s,x], T. Solomon [a,b,c,f,y]

Box 5. Indications for neuroimaging before lumbar puncture (LP) in suspected meningitis*.

- **Focal neurological signs**
- **Presence of papilloedema****
- **Continuous or uncontrolled seizures**
- **GCS ≤ 12*****

*to exclude significant brain swelling and shift that may predispose to cerebral herniation post LP.
**inability to view the fundus is not a contraindication to LP, especially in patients who have had a short duration of symptoms.
*** LP without prior neuroimaging may be safe at levels below this.

Is raised ICP a contraindication to LP?

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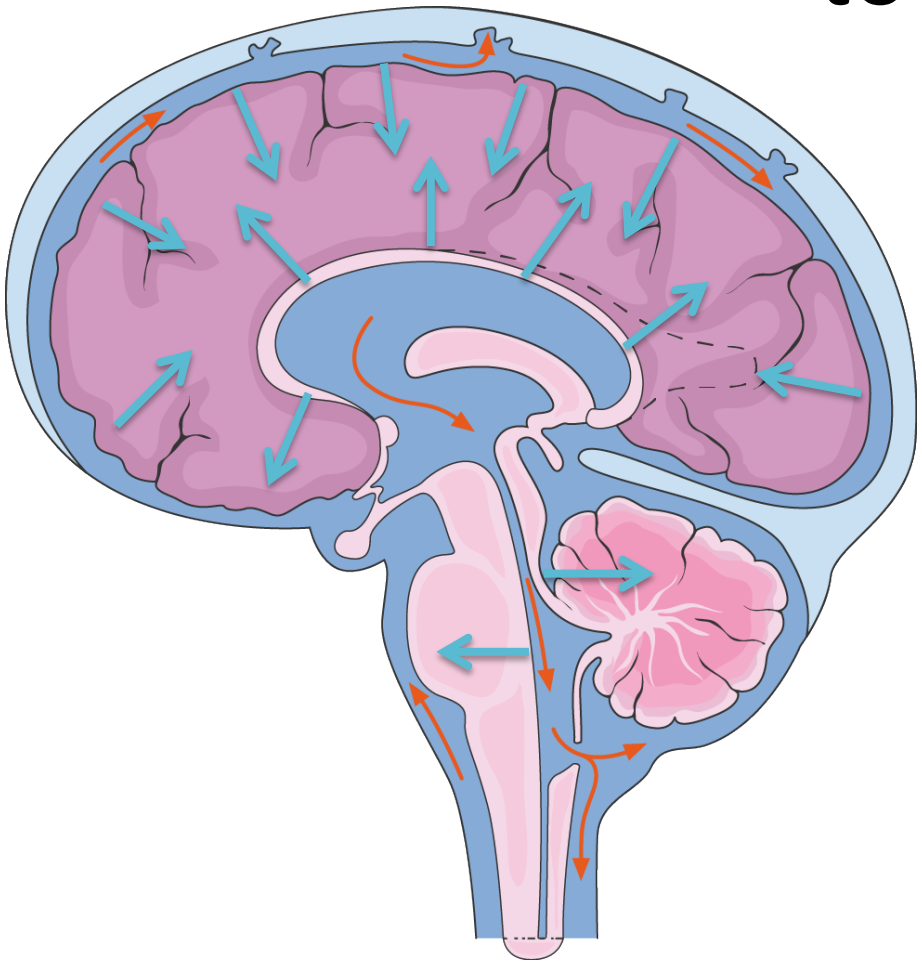

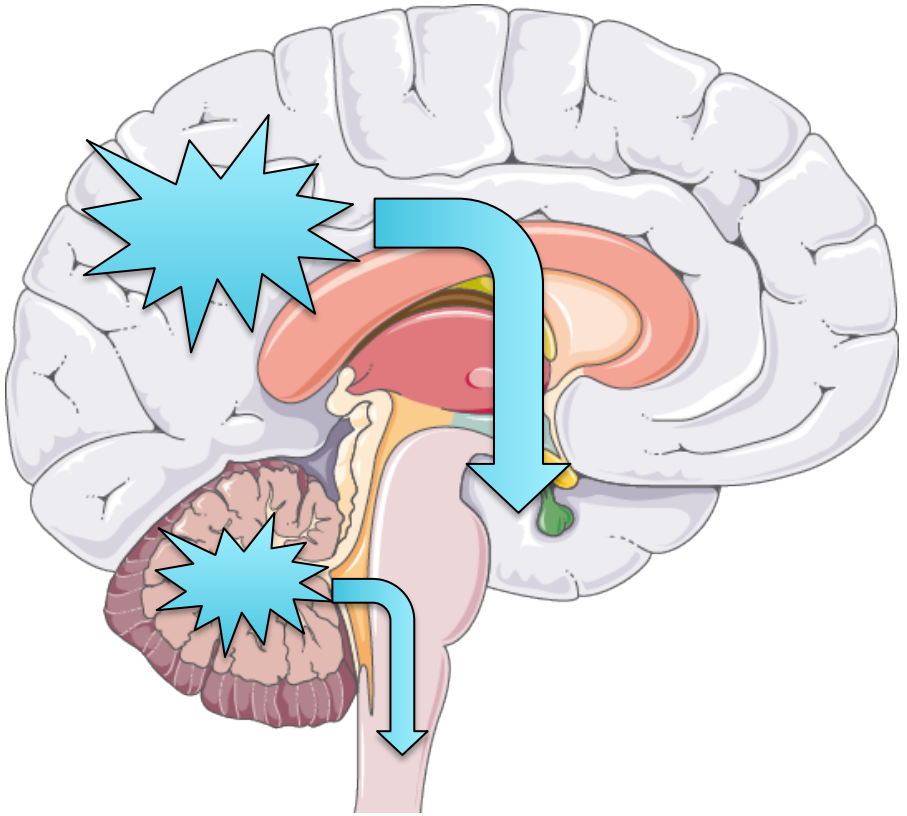

Why can't we do a LP if they're having seizures?

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- Headache
- Fever
- Meningism

→ Defines meningitis

+

- Seizures
- Confusion

→ Defines encephalitis

Case 3

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- 45 year old male
- 4 day history worsening headache
- Present on waking
- Worse on lying down/coughing/ Valsalva
  - Intermittent blurred vision at those times

What more information do you need?

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- Never normally has headaches
- Past medical history
  - Ulcerative colitis, recent flare
  - Takes sulphasalazine/prednisolone
  - Non-smoker
- No family history acute headaches/ ICH/stroke
  - No family history VTE

Examination

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- Airway ok, resps 12/min, BP 140/85, HR 85/min
- GCS 14/15, intermittently confused
- No meningism
- Both optic discs swollen
- Tone normal, power 5/5 all 4 limbs
- Reflexes brisk, plantars flexor

What is the differential diagnosis?

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- Raised ICP syndrome
- Cerebral venous sinus thrombosis
- Space-occupying lesion
  - But would expect focal neurology
- Meningeal based process
  - Infective, inflammatory, malignant

What is the next step?

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- CT brain normal

- Now what?

CT venogram

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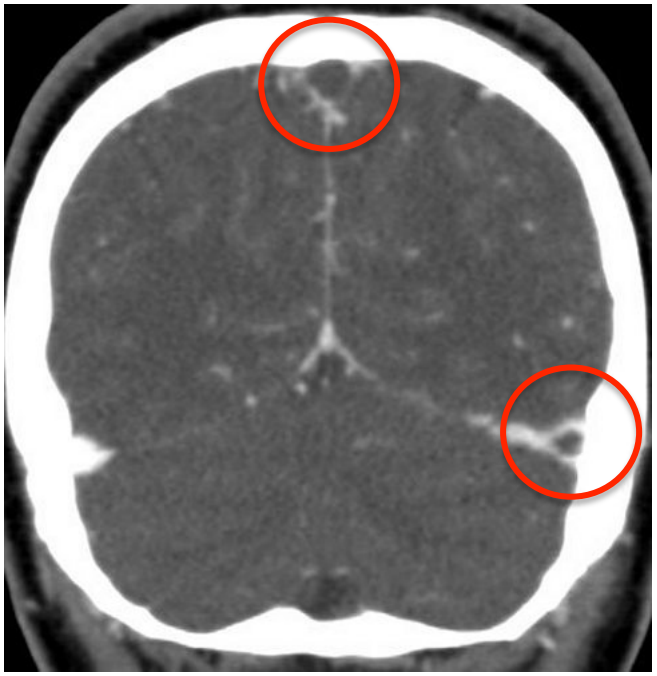

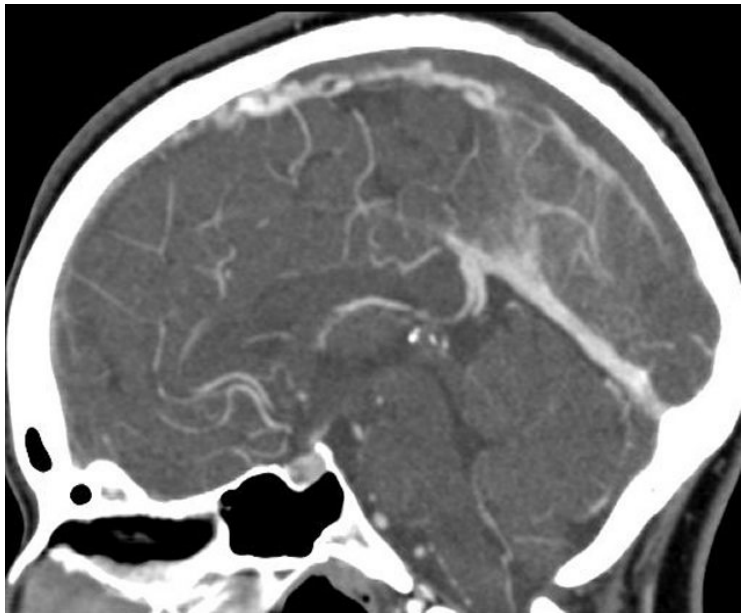

Courtesy of Dr Amit Herwadkar, Consultant Neuroradiologist

Cerebral venous sinus thrombosis: aetiology

- Pregnancy/post-partum
- Local infection
  - Mastoiditis, sinusitis
- Dehydration
- Thrombophilia
- Haematological malignancy
- Drugs
  - Oral contraceptives
- Inflammatory conditions
  - **IBD**
  - SLE
  - Behçet's disease
- Head injury
- Recent neurosurgery

Presentation of CVST

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- Acute (<48 hrs)
  - 56% patients
- Sub-acute (48 hrs to 30 days)
  - 37%
- Chronic (>30 days)
  - 7%

Presentation of CVST

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- Raised intracranial pressure (80%)
  - Headache (isolated in <25%)
  - Papilloedema
  - Diplopia (false localising sign)
  - Reduced conscious level, coma

Presentation of CVST

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- Focal neurological symptoms/signs
  - Hemi motor-sensory symptoms
  - 'mass effect' pressure
  - Seizure
  - Higher cortical signs
  - Coma
- Mixed raised ICP/focal signs

Examination findings

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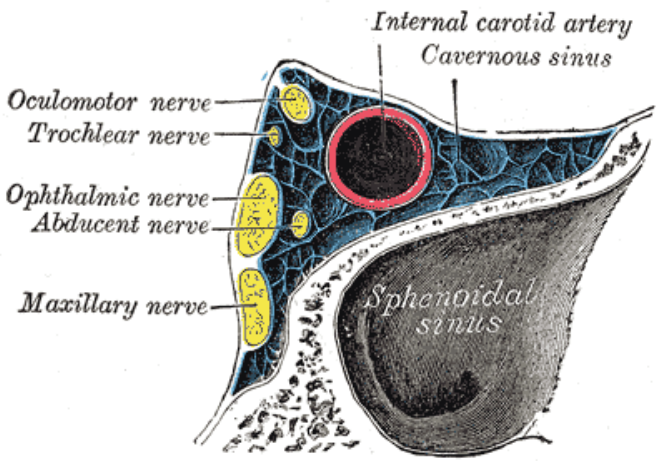
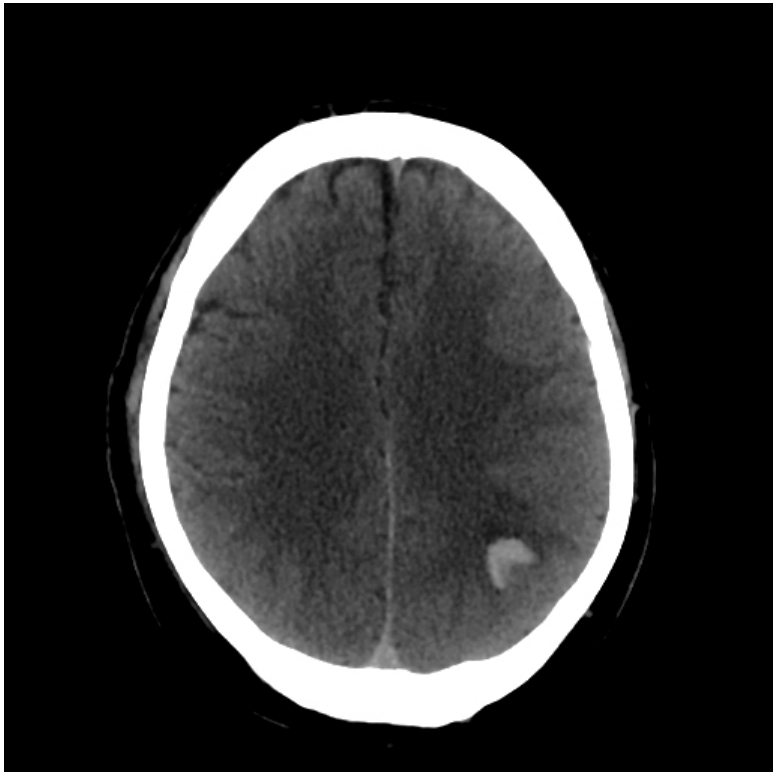
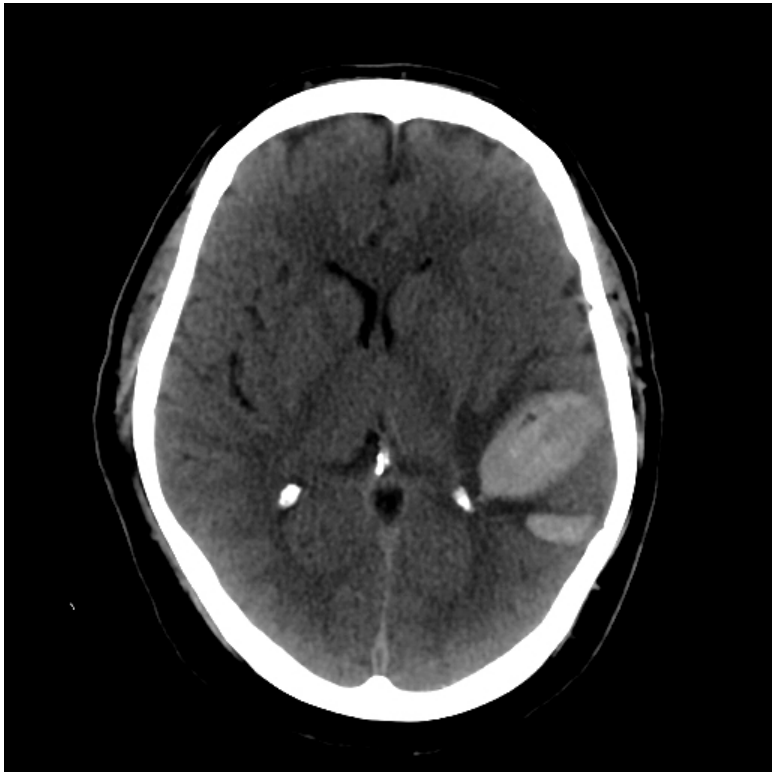
- Raised ICP
  - Papilloedema
  - Isolated VI nerve palsy
- Cavernous sinus thrombosis
  - Unilateral chemosis, proptosis
  - Ophthalmoplegia
  - CN Va, Vb involvement
- Pathophysiology
  - Cerebral vein thrombosis – local dysfunction
  - Large sinus thrombosis (esp transverse) – raised ICP



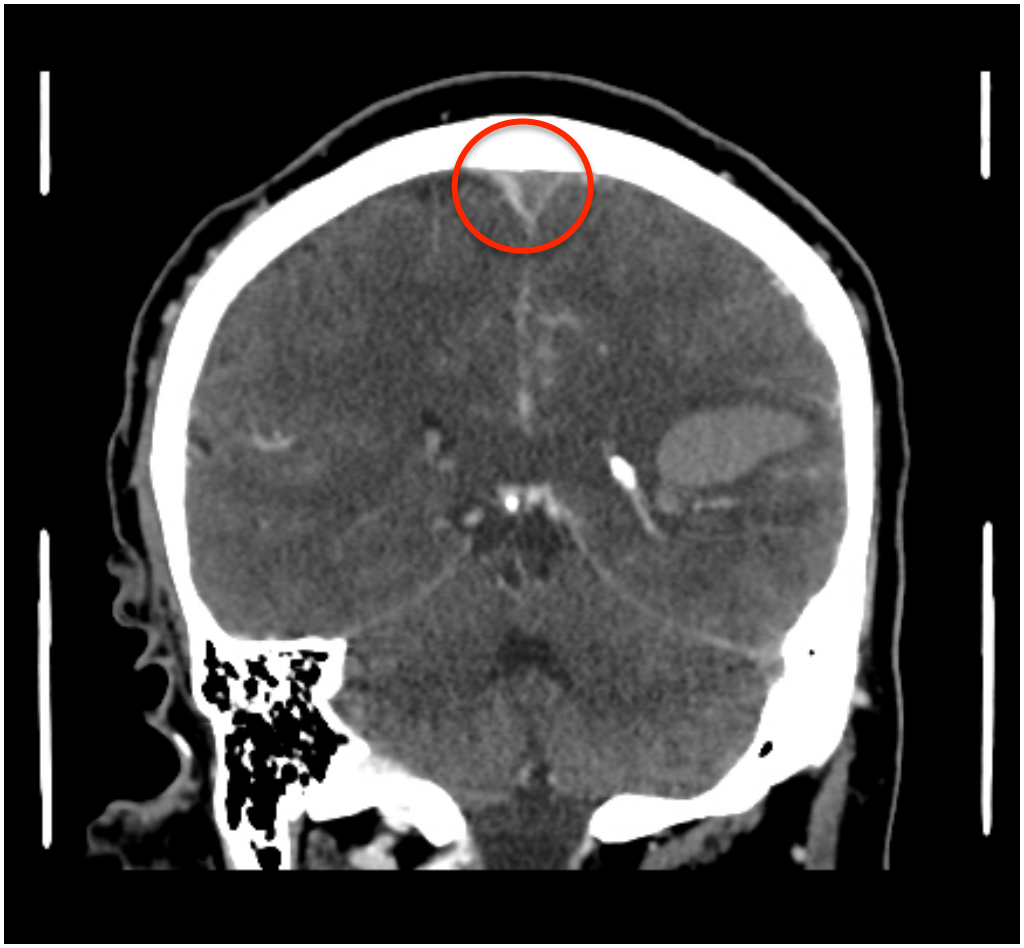
Imaging in CVST





Plain CT often normal but..

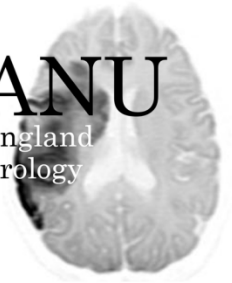
Imaging in CVST



Delta sign
Δ

Modailty	Advantages	Disadvantages
Plain CT	Quick, inexpensive	Insensitive
MR venogram	Sensitive to blood Does not require contrast	Artefacts Acquisition time Difficult in acutely unwell patients Contraindications Expensive
CT venogram	Can be added to plain CT Inexpensive Relatively quick Monitoring of critically ill patients	Radiation dose Requires contrast Contraindicated in pregnancy

Management in Greater Manchester



- Encourage contact early with neurology team
- Early transfer of patient to neurosciences centre
- Improve access to early observation and monitoring
- Potential to improve LOS/Outcomes

Learning points

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- Subacute headache+raised ICP (+/- focal neurology) – think CVST
- Plain CT is insensitive so consider CT or MR venogram
- Early diagnosis and treatment =potential for better outcomes

Case 4

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Update

- 23 year old male
- Presents to ED
- Episode of loss of consciousness
  - Preceded by abdominal sensation
  - Tonic phase, then shaking in all 4 limbs for 2 min
  - Confused, combative afterwards

What do you need to know?

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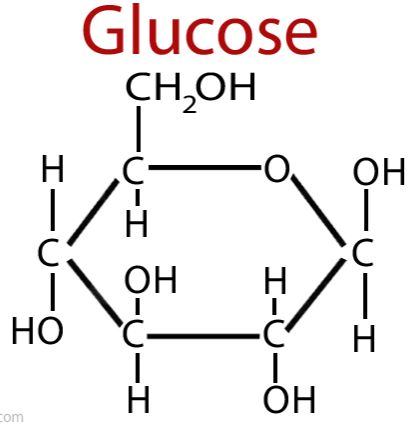
- Normally well, no history of epilepsy
- No medication changes, drug use
- Febrile seizures as a child

- Afebrile, BP 130/80, HR 70
- Capillary blood glucose 5.4
- Neurological exam normal



What is the next step?

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Indications for urgent imaging

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- Focal neurological deficits
- Persistent headache
- Fever
- Cognitive changes
- Recent head trauma
- Immune compromise

- Not a usual seizure in established epilepsy!

Urgent imaging

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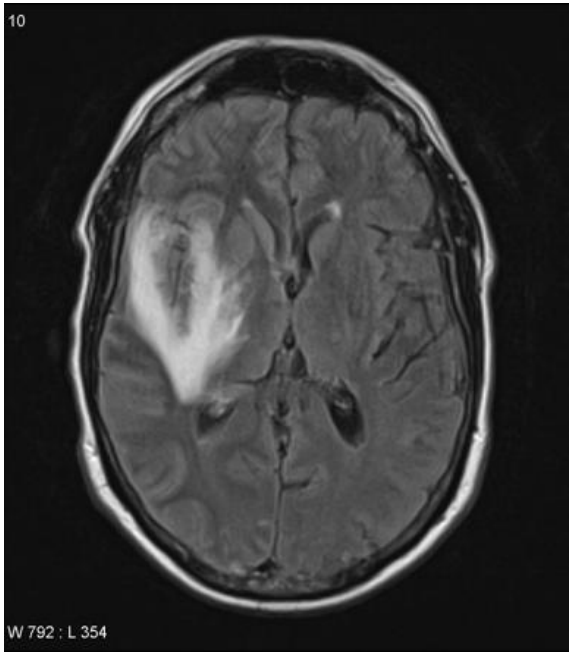
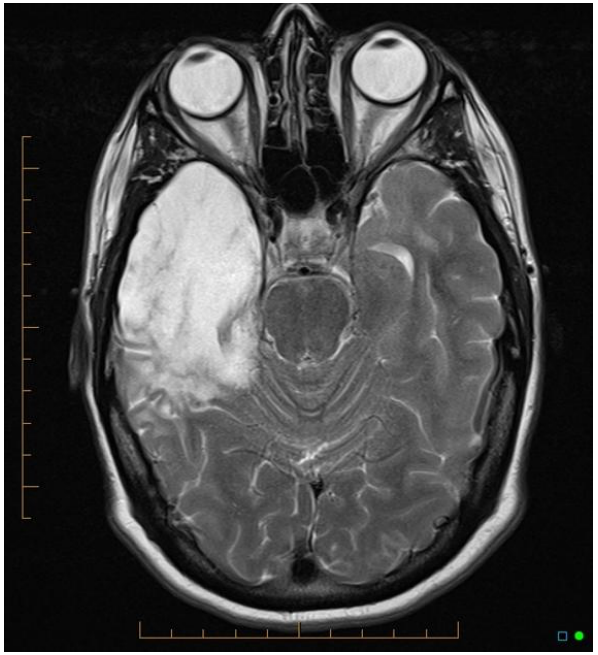
- CT in sick patient, prior to LP

- MRI more sensitive for most lesions
  - Encephalitis
  - Mass lesion
  - Infection in immunocompromised e.g. toxoplasmosis
  - Consider CVST (CT/MR venogram)

- "Any adult with a seizure in the context of febrile illness…must be investigated for possible CNS infection"





Non-urgent imaging

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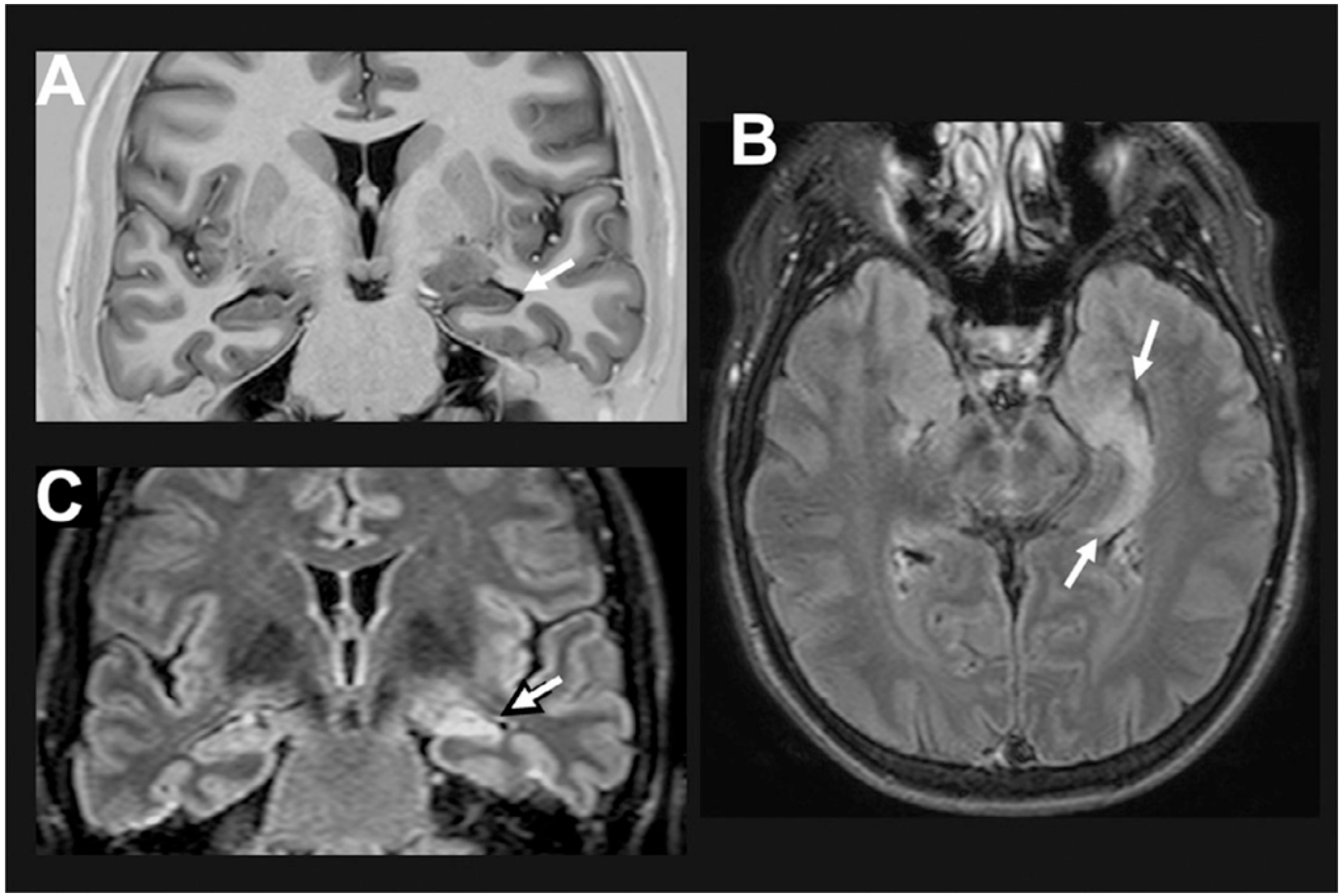
Update

- Stable patient, no red flags
- CT insensitive for most lesions causing seizures
- Outpatient MR investigation of choice



Mesial temporal sclerosis

Cendes F *et al. Handb Clin Neurol*2016;136:985-1014.

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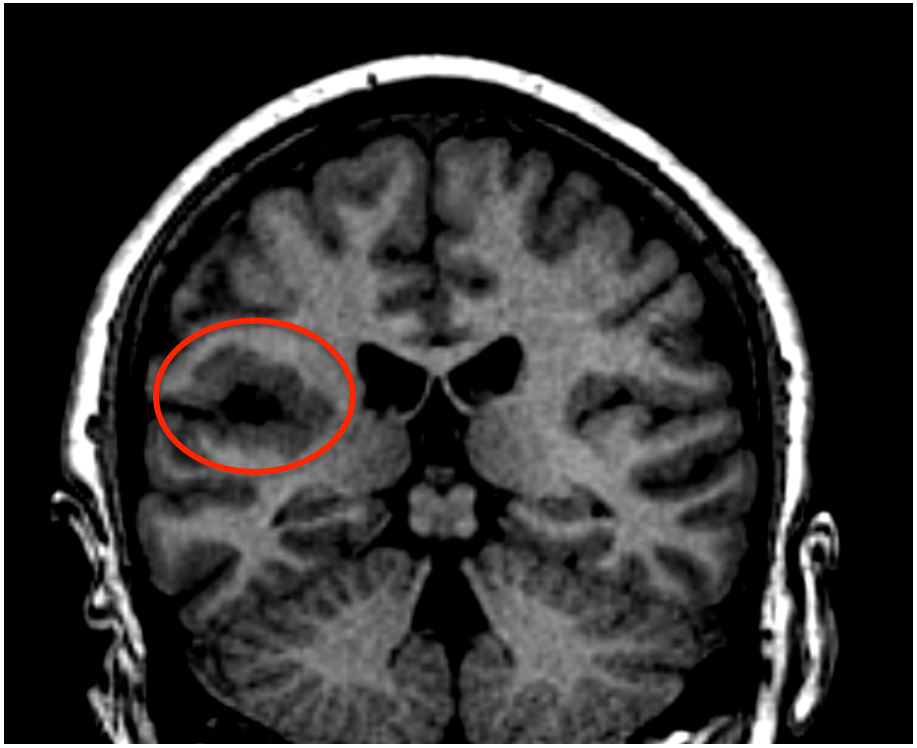

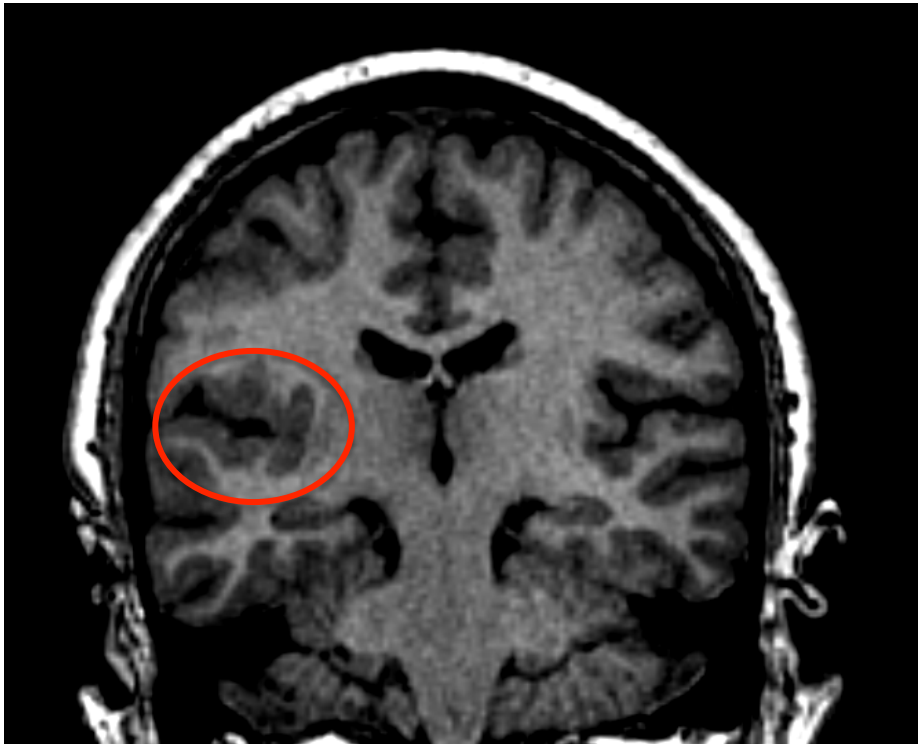

27 year old woman with focal seizures
CT brain unremarkable

Polymicrogyria

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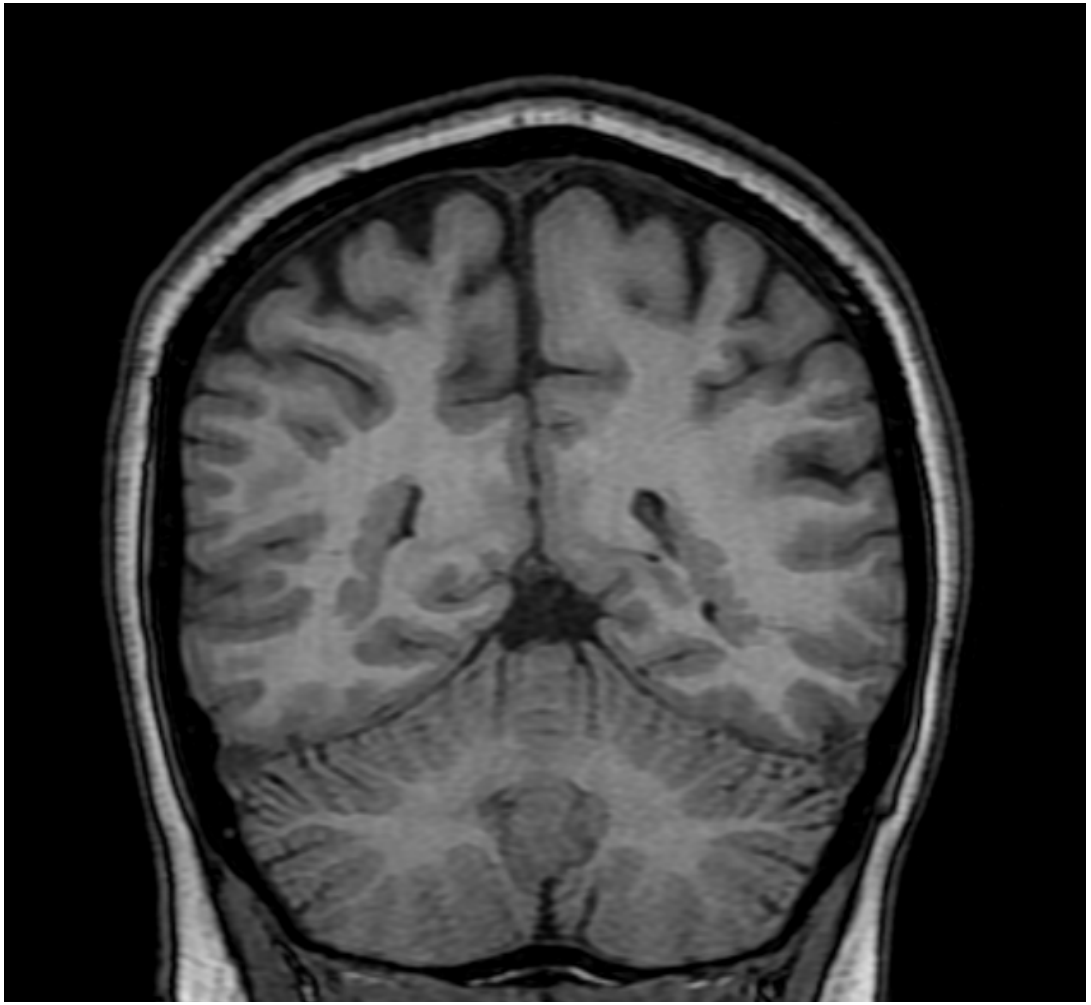
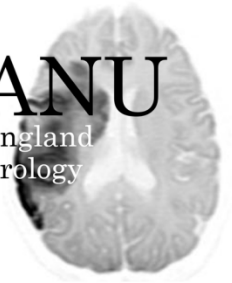


34 year old woman
Focal seizures with secondary generalisation
CT brain normal

Grey matter
heterotopia

Learning points



- Not all acute seizures require imaging
- Need to investigate treatable causes
- MR more sensitive for most causes
  - Acute lesions e.g. encephalitis
  - Chronic brain changes causing epilepsy

On the PTWR…

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Case 5

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35 yr old female
New onset of leg weakness and bladder problems … 2 days…

- Trouble with stairs, fallen at night
- Also has numbness and burning in legs
- Increased urinary frequency and urgency

And what do you think is wrong?

Cauda Equina…?

What fresh madness is this?

What are the examination findings?

Case 5

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Afebrile, obs normal
CN - normal
UL - normal
LL - tone normal, grade 4 weakness b/l, knee and ankle jerks normal, plantars up, patchy pin-prick alteration throughout LL, decreased vibr to waist
Gait – very unsteady, almost falling

Decisions, decisions

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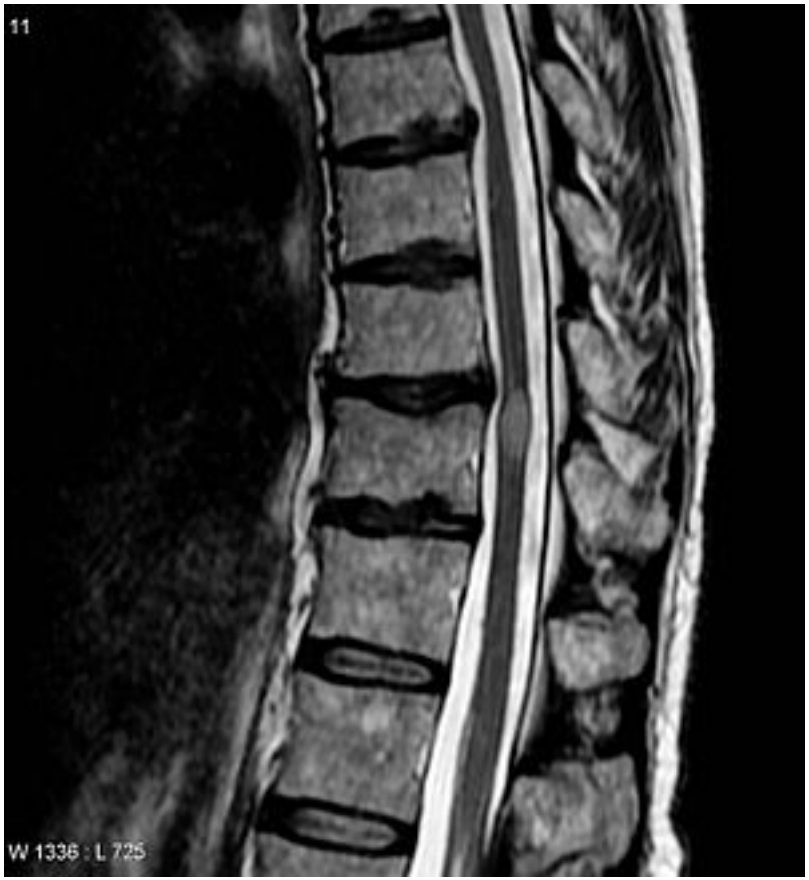
- CT brain
- CT spine
- MRI lumbosacral spine
- MRI cervicothoracic spine
- Lumbar puncture



Case 6

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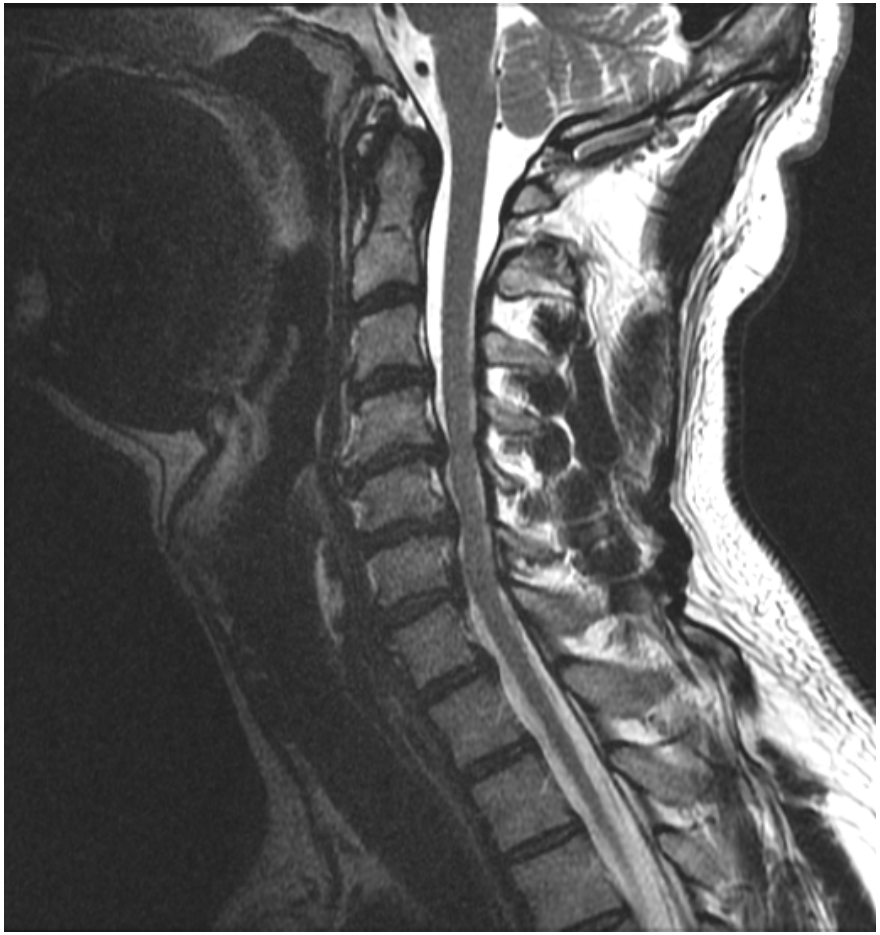
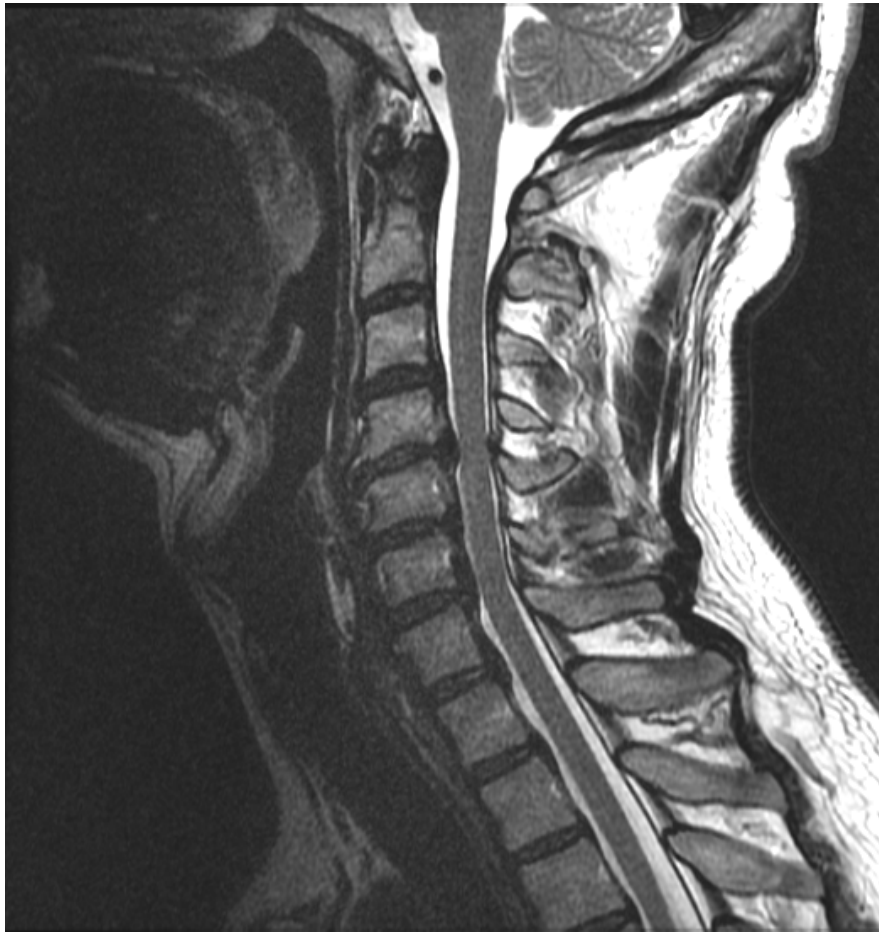
43 yr old man admitted from A+E

MR scan shows compression

Presented with increasing unsteadiness over 5 days

Awaiting transfer to spinal surgery





Any reason to linger…?

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Decisions… decisions…

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- Expedite transfer to spinal surgery
- MRI lumbosacral spine
- MRI brain
- Lumbar puncture
- Call a friend…

What actually happened…

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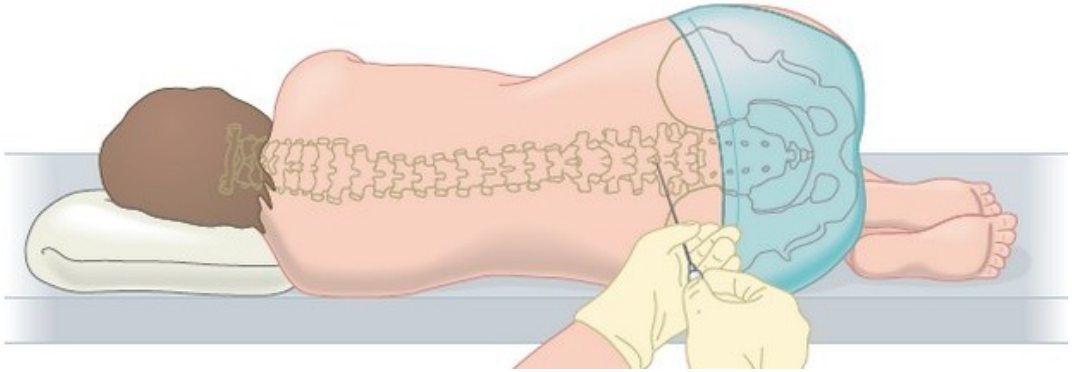

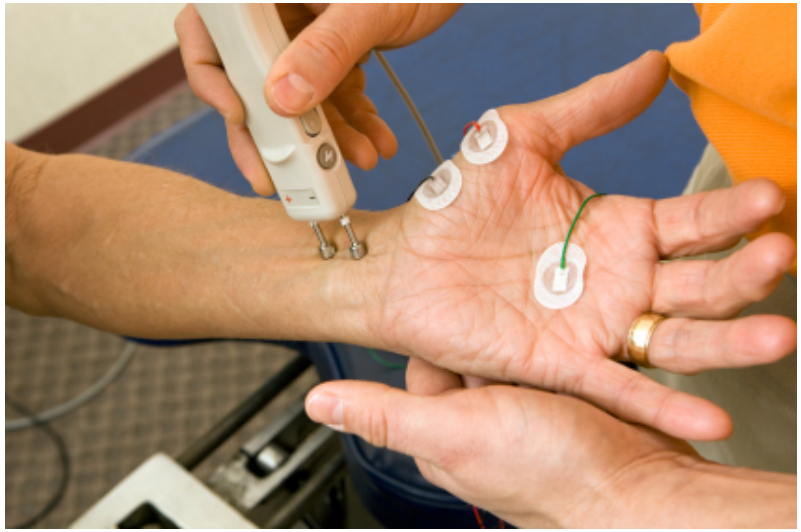

Worrying Neck Scans

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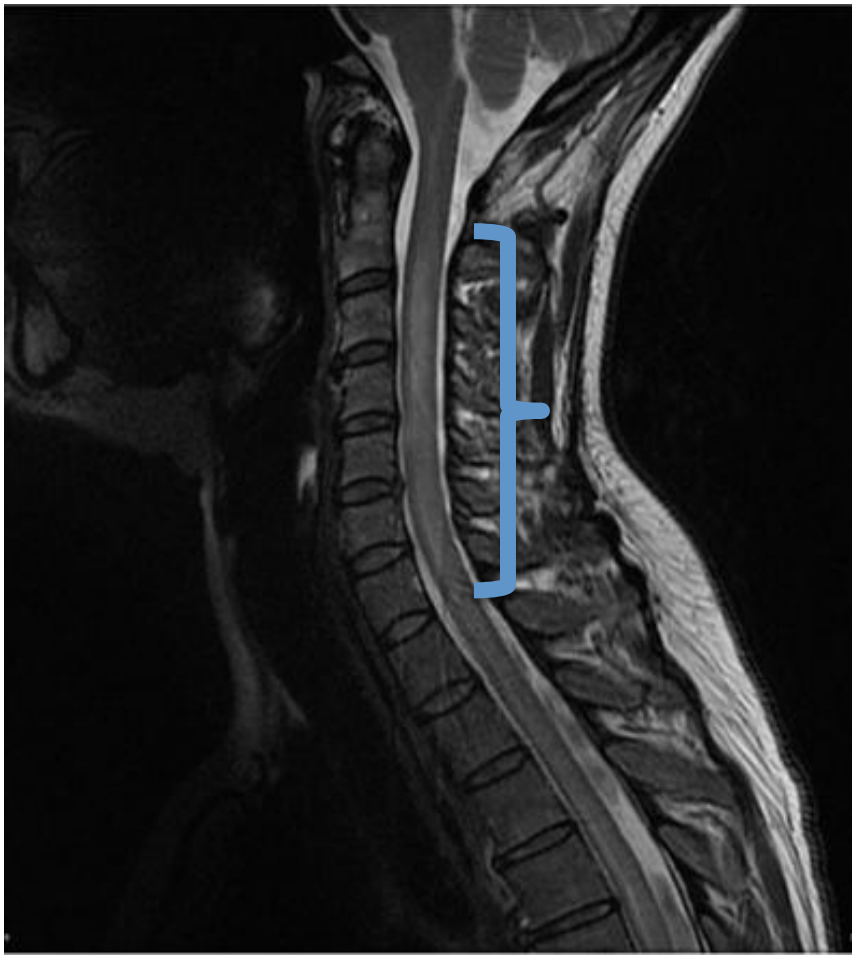
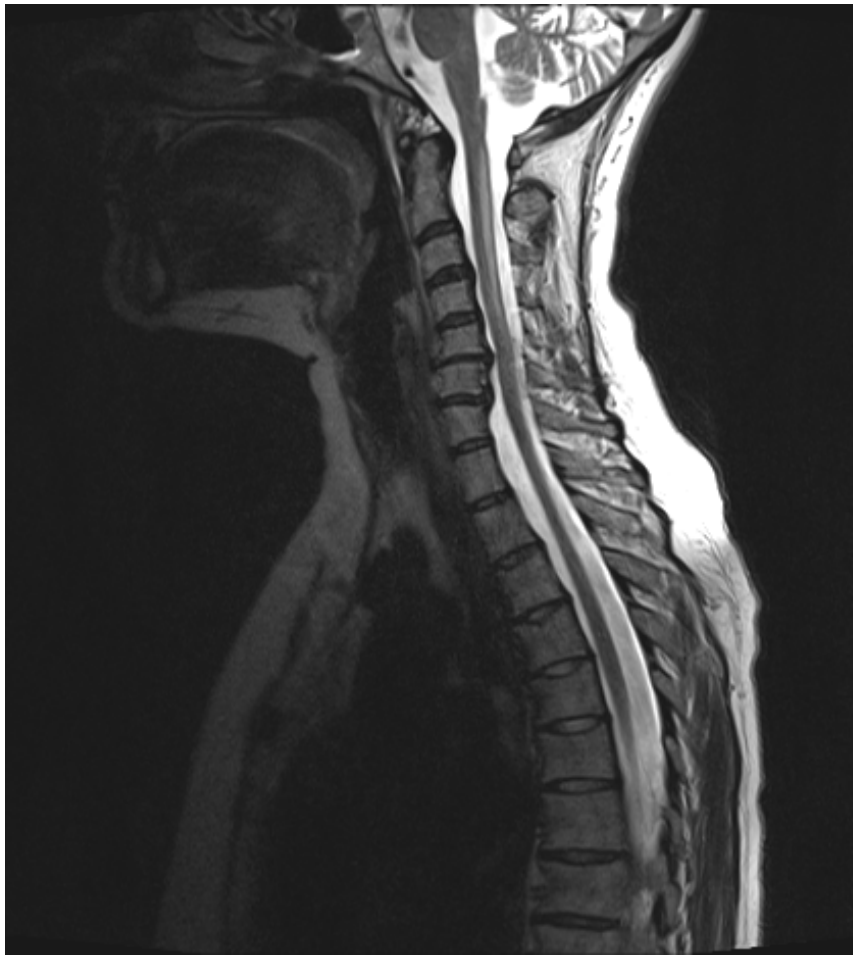


Neuromyelitis Optica (NMO / Devic's)



Posterior columns picked out…

Unsteady and falling…

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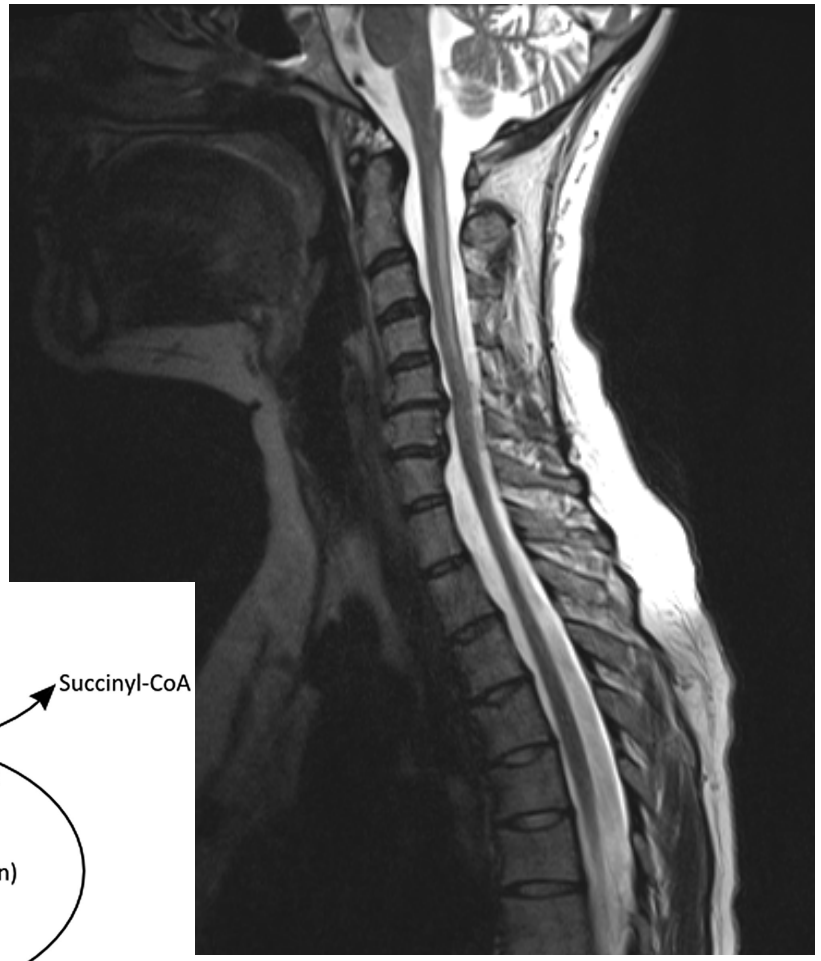
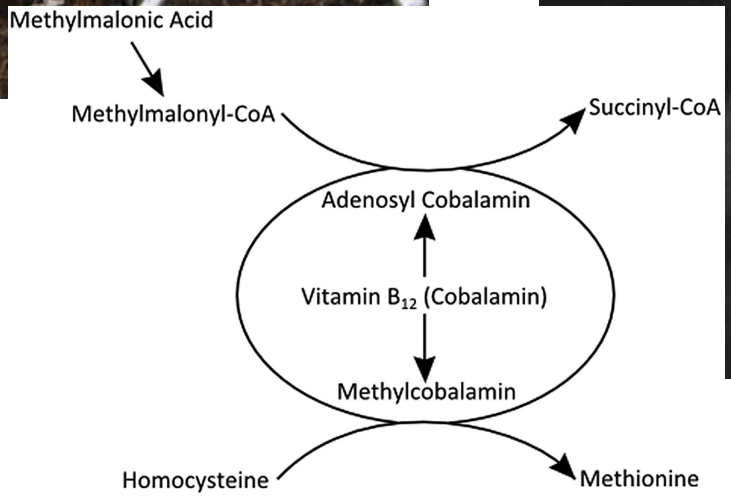
- B12 normal





Worrying Scenarios

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- Progressive limb Symptoms
- Sphincteric disturbance
- Increased tone
- Brisk reflexes
- Upgoing plantars
- Sensory levels

Scan Negative Myelopathy

Infarction
Dural AV fistula
B12, Copper, NO
HIV, syphilis, Hep B
Chronic Liver Disease
MS, NMO
Genetic

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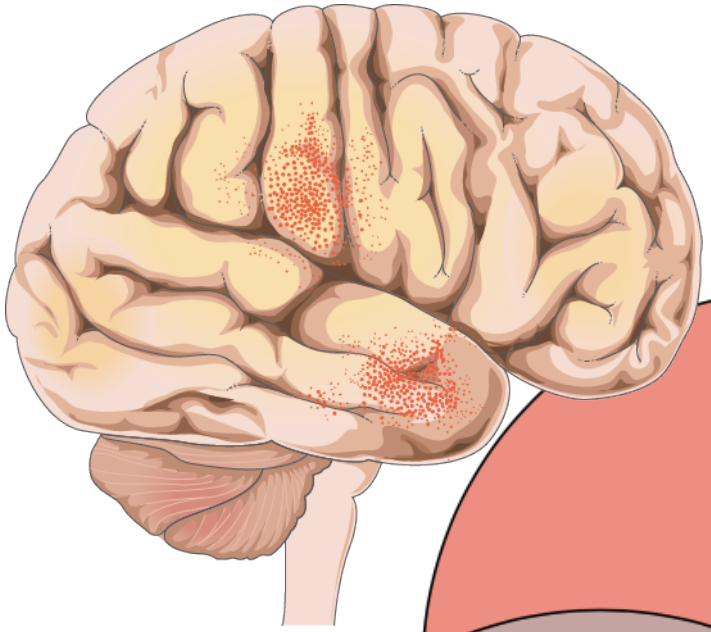
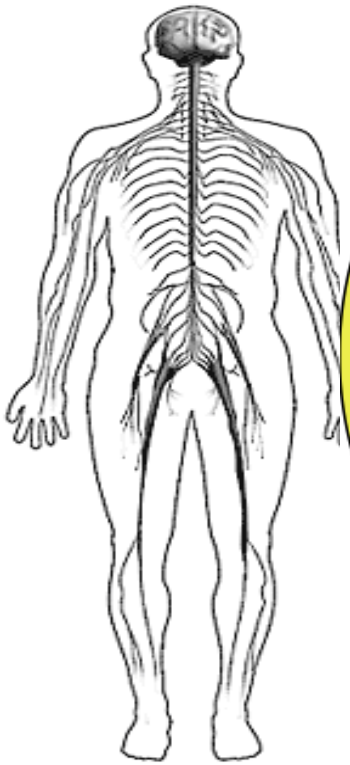


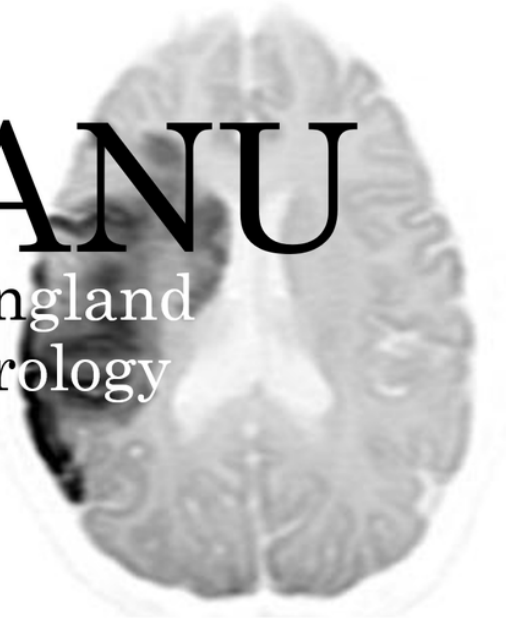


Right Person

Right Place

Right Time

And Right Modality…



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Thanks and Questions?

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