


CT myelography for spinal CSF leak: What, why, when and how?

Dr Lalani Carlton Jones

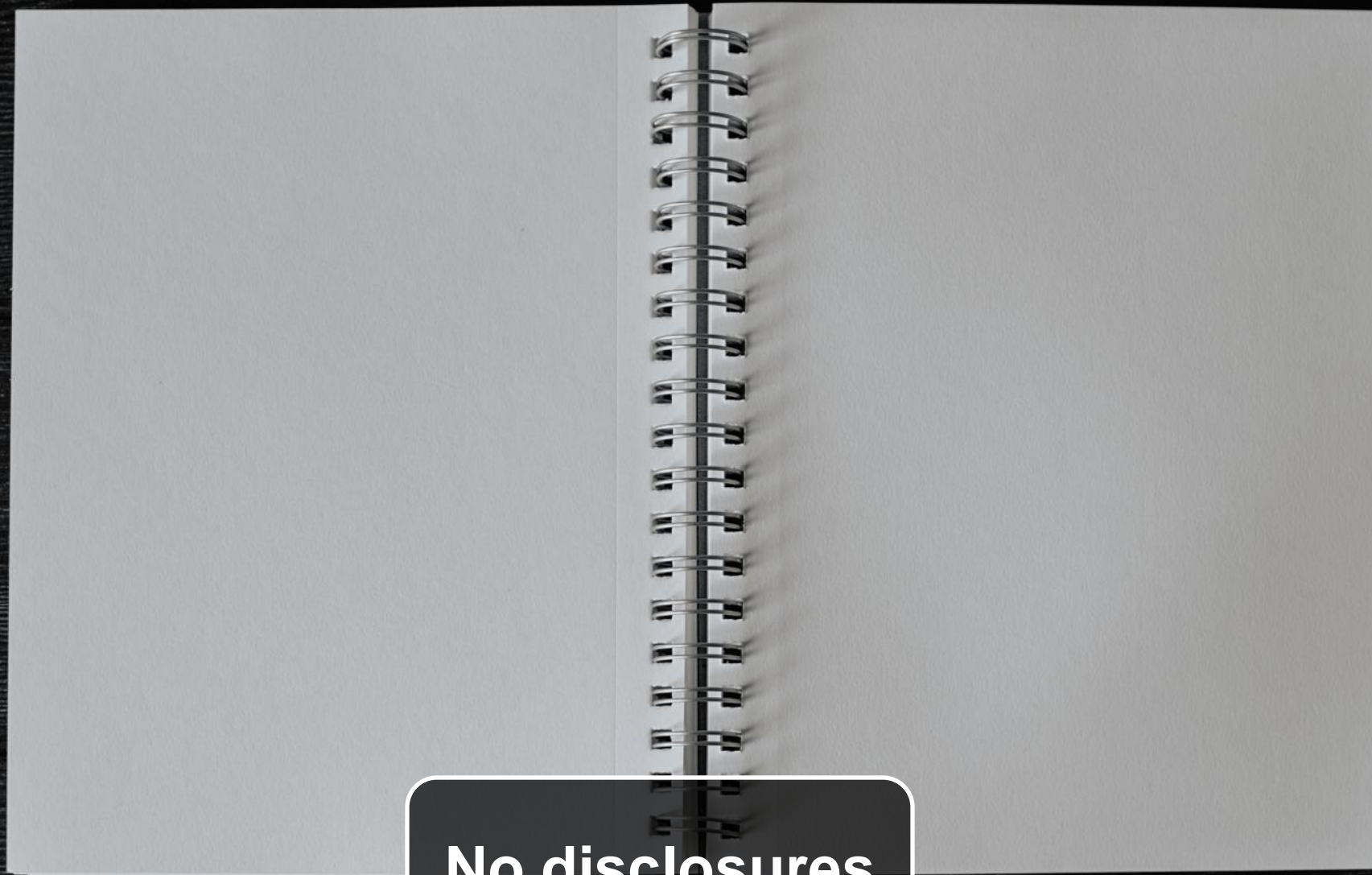
Consultant Neuroradiologist

Guy's & St Thomas' and King's College Hospitals, London, U.K

 @NeuroradLal

Bridging the Gap conference, Colorado, 2 November 2024

Disclosures



No disclosures

Why CTM?



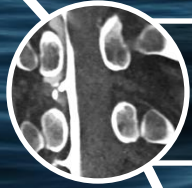
Progress in CTM

2019

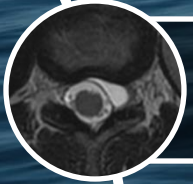


2024





What is CTM?



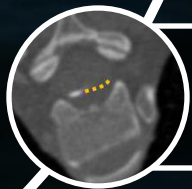
Pre-procedure



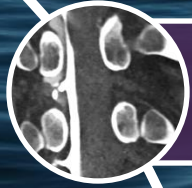
How I do it



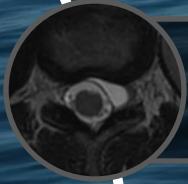
Post procedure



Pearls and pitfalls



What is CTM?



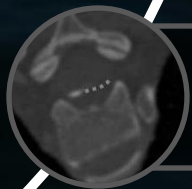
Pre-procedure



How I do it



Post procedure



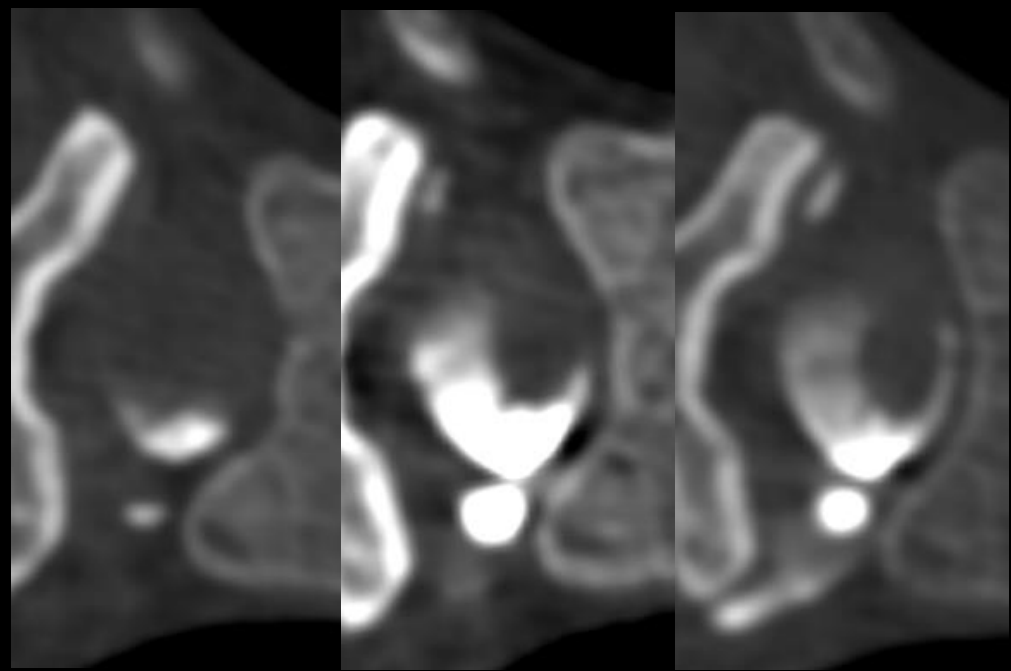
Pearls and pitfalls

What is CT myelography?

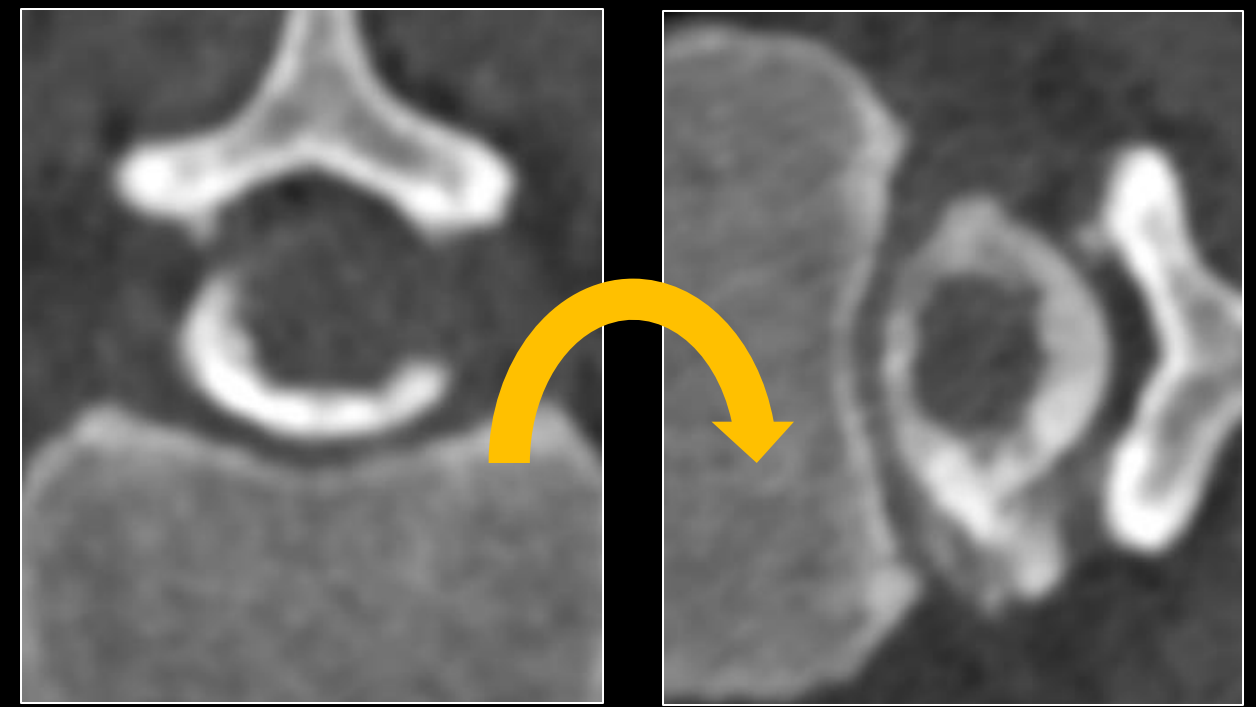


What does dynamic CT myelography mean?

Detecting change over time



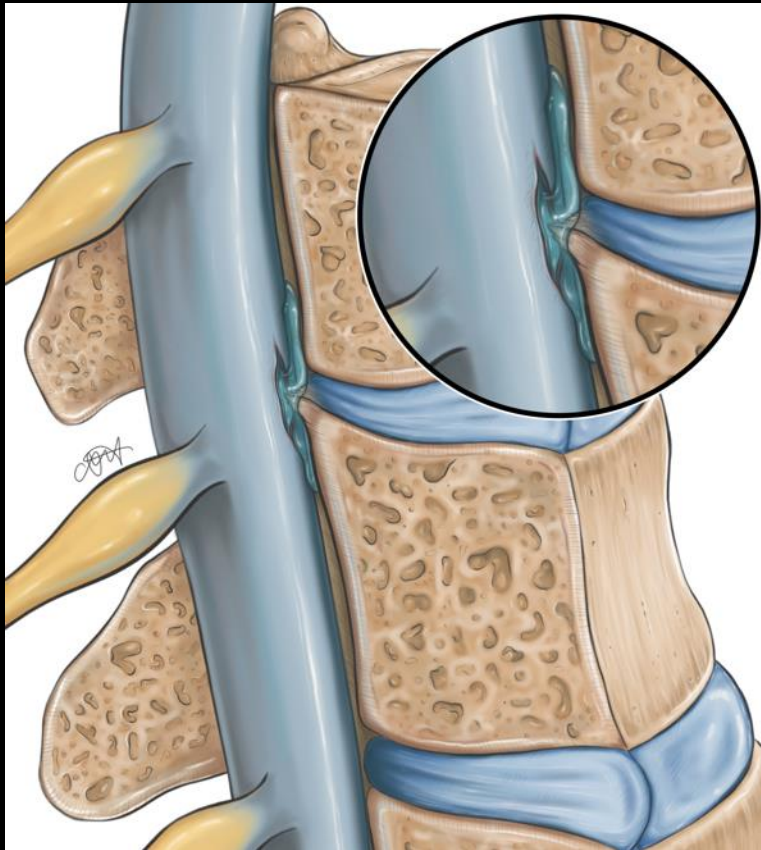
Review in real time & adapt



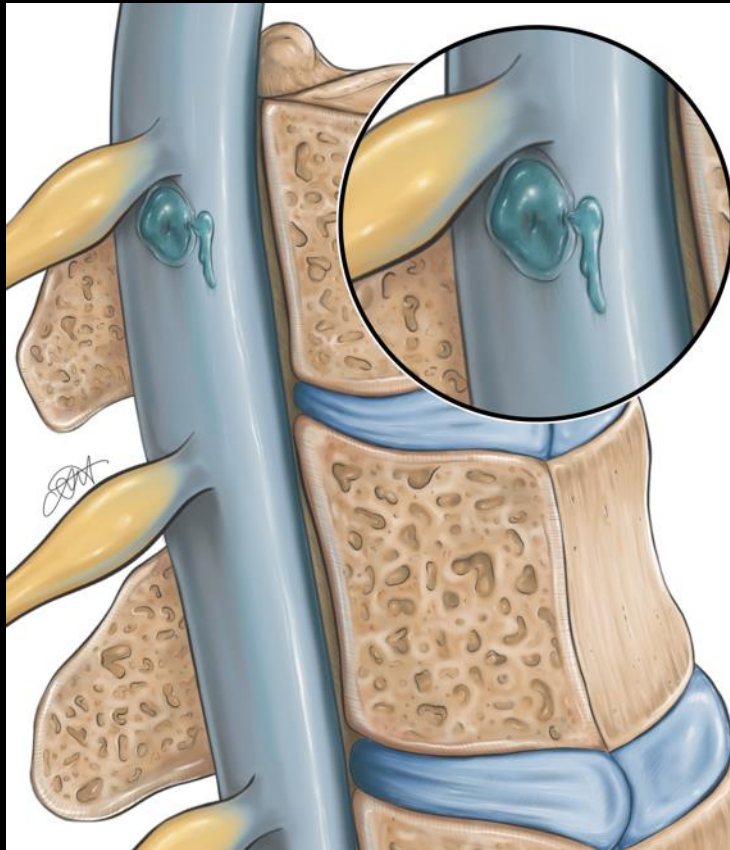
Operator dependent technique

3 main types of leak: 3 main types of CTM

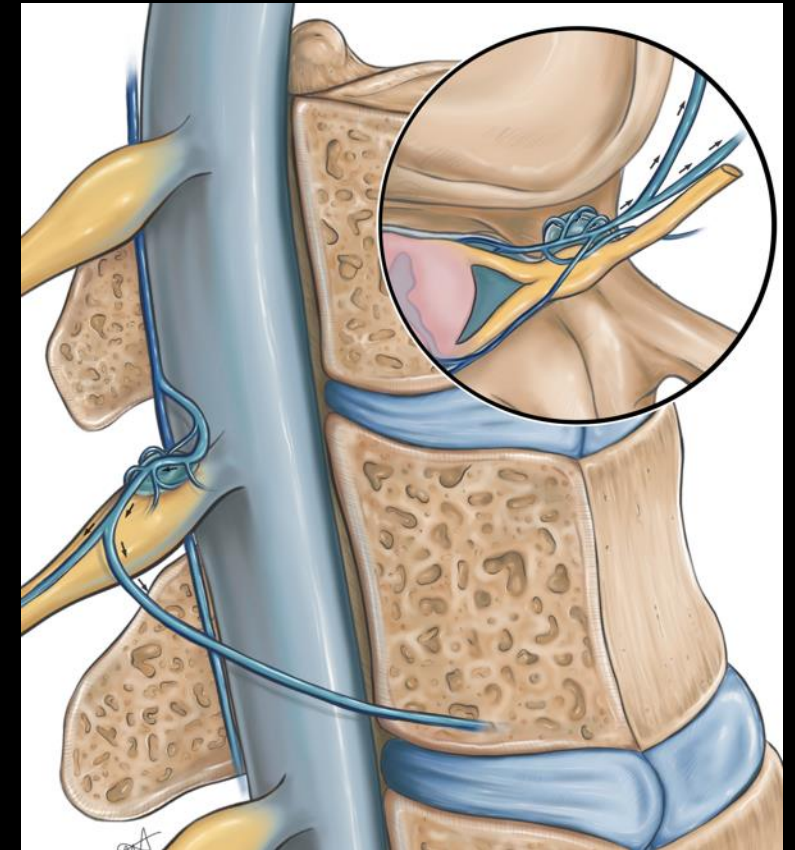
Type 1: Dural tear



Type 2: Lateral leak



Type 3: CSF-venous fistula



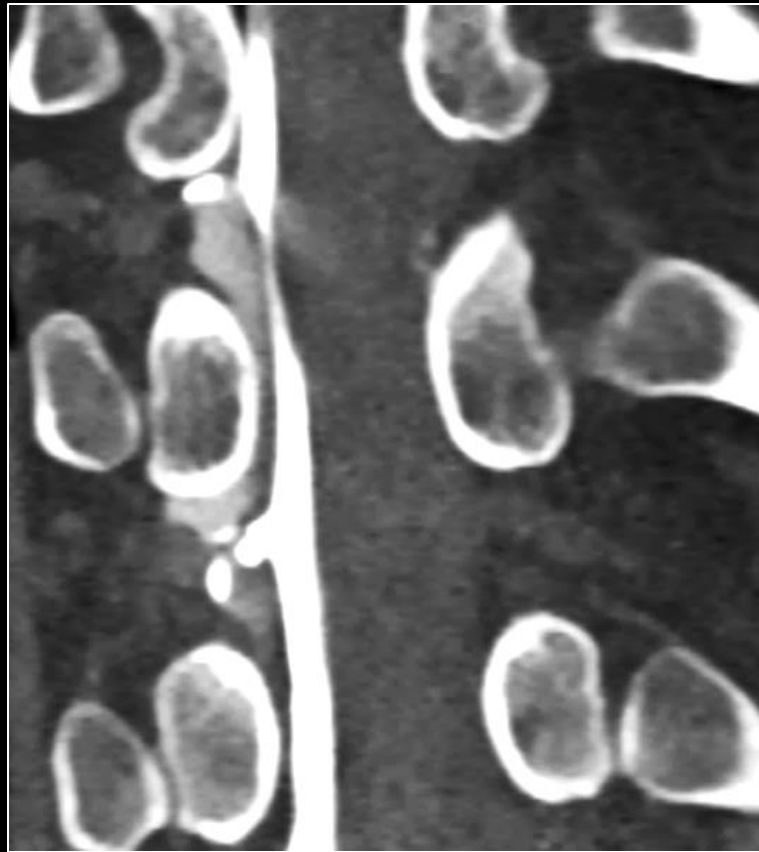
3 main types of leak: 3 main types of CTM

Ventral dural tear



Prone dynamic

Lateral leak



Decubitus dynamic

CSF venous fistula



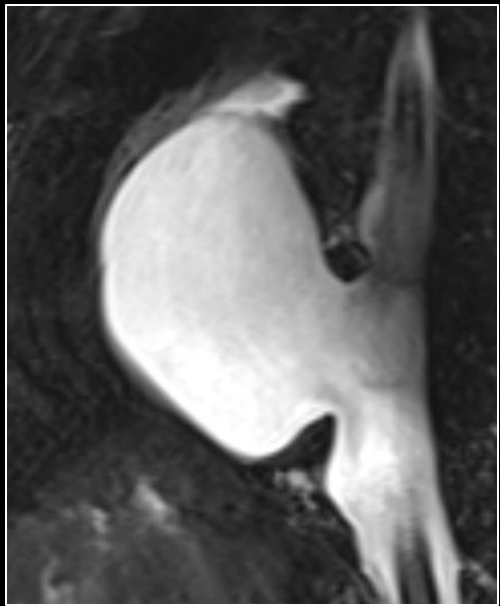
**Bilateral decubitus
Also 'dynamic'**

But there are other types of leak – modify approach to CTM

Sacral dural tear



Dural ectasia



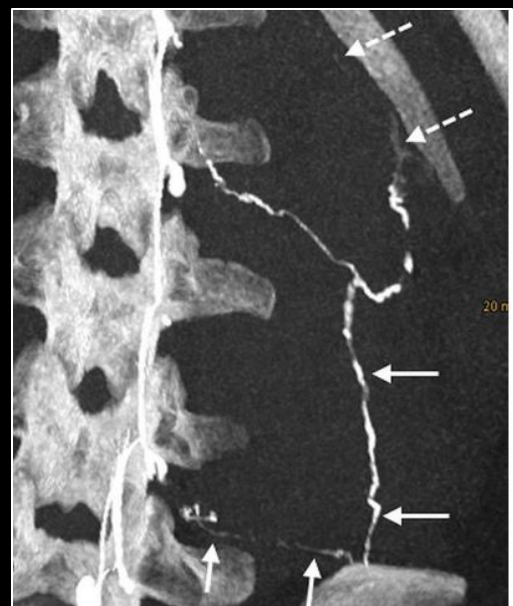
Arachnoid 'bleb'



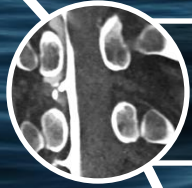
CSF to vascular malformation



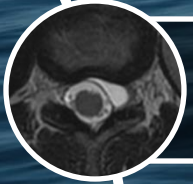
CSF-lymphatic fistula



Primary CSF-lymphatic fistula: a previously unknown cause of spontaneous intracranial hypotension
Niklas Lützen¹ · Katharina Wolf² · Amir El Rahal² · Florian Volz² · Theo Demerath¹ · Charlotte Zander¹ · Claus Christian Pieper³ · Marius Schwabenland⁴ · Horst Urbach¹ · Jürgen Beck²



What is CTM?



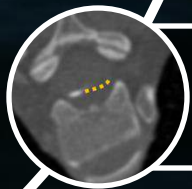
Pre-procedure



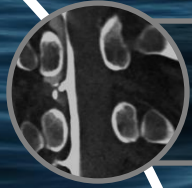
How I do it



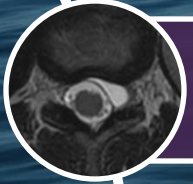
Post procedure



Pearls and pitfalls



What is CTM?



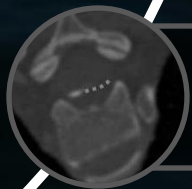
Pre-procedure



How I do it



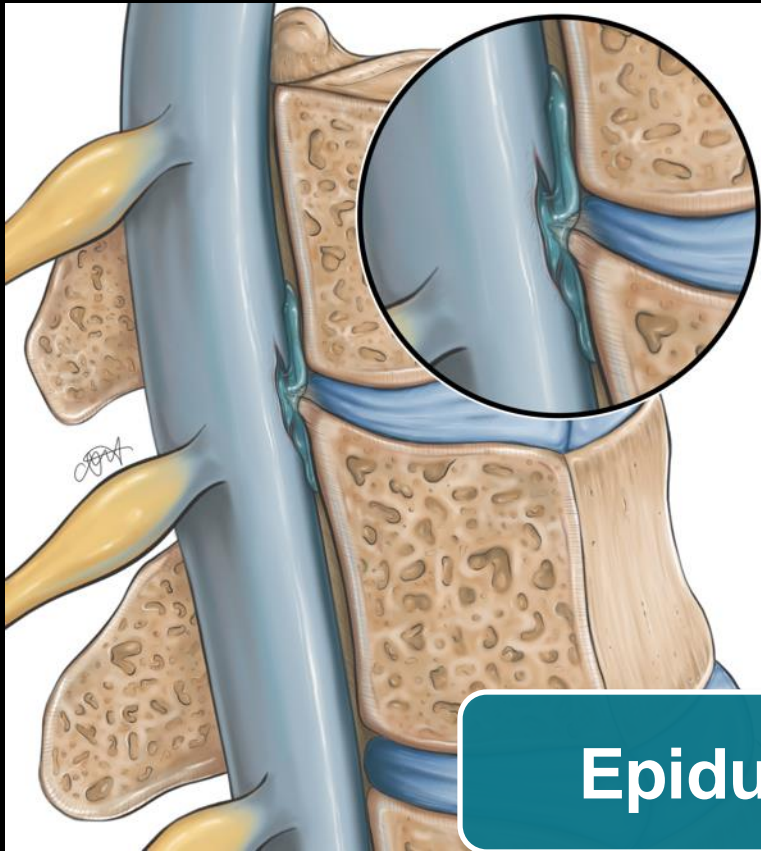
Post procedure



Pearls and pitfalls

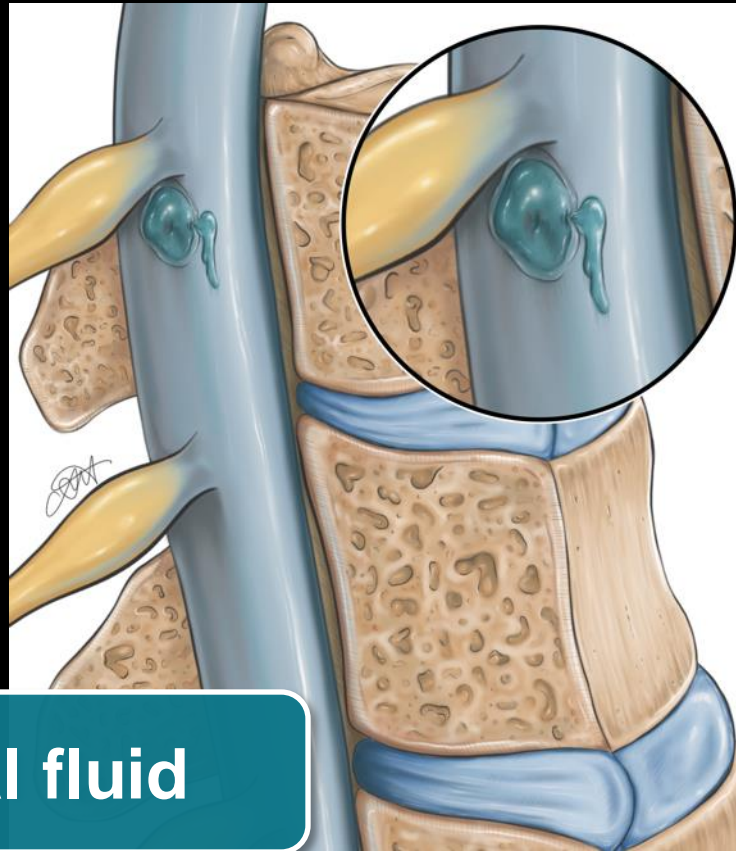
3 main types of leak

Type 1: Dural tear

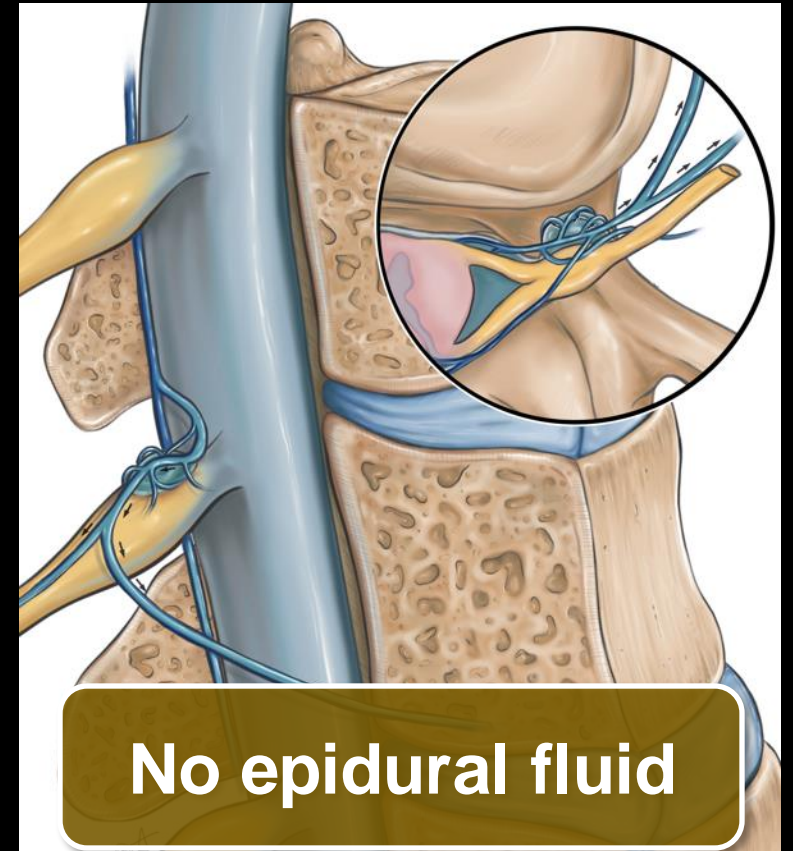


Epidural fluid

Type 2: Lateral leak

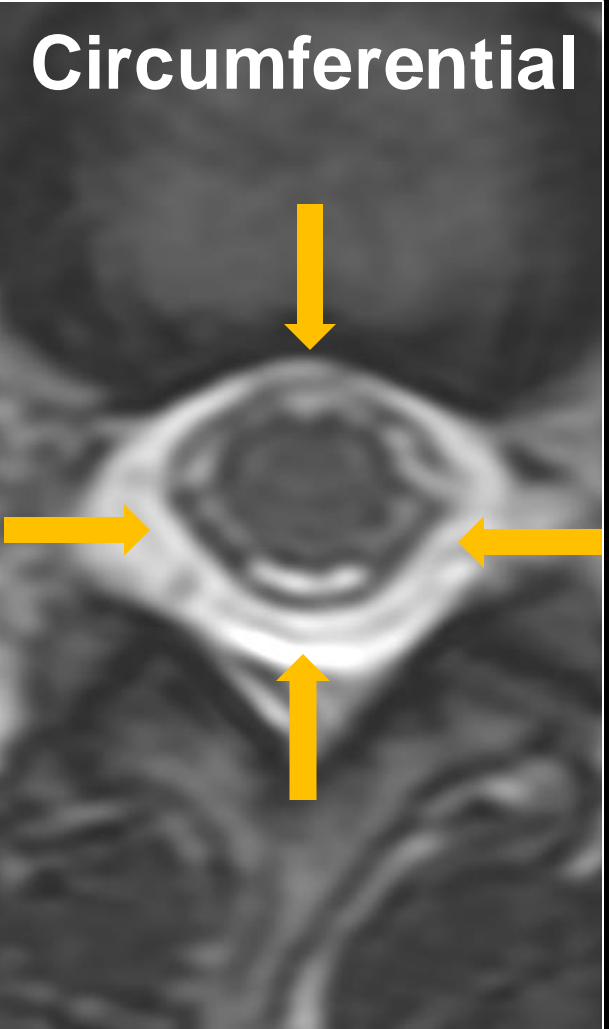
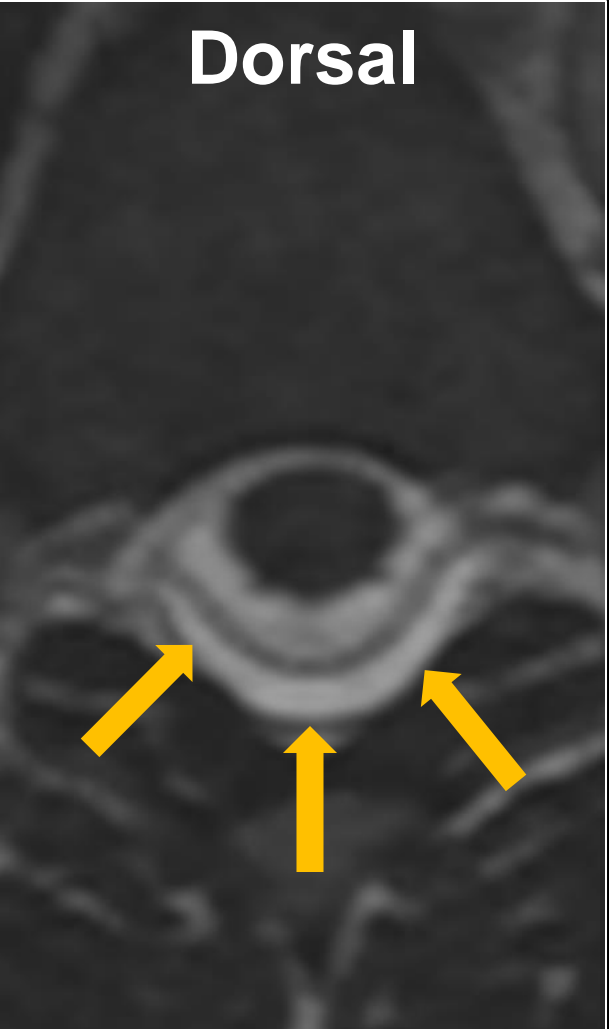
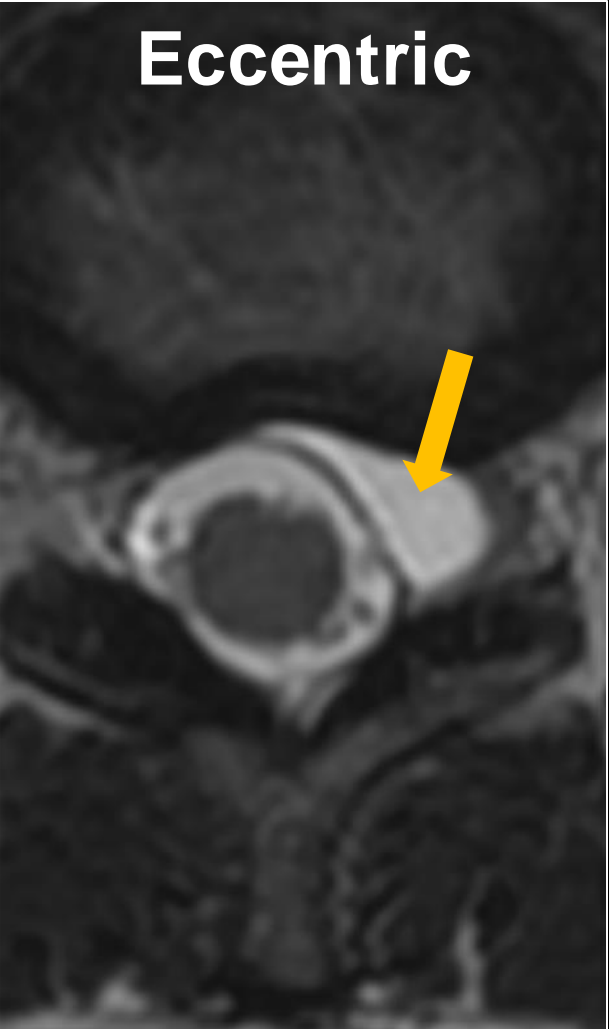
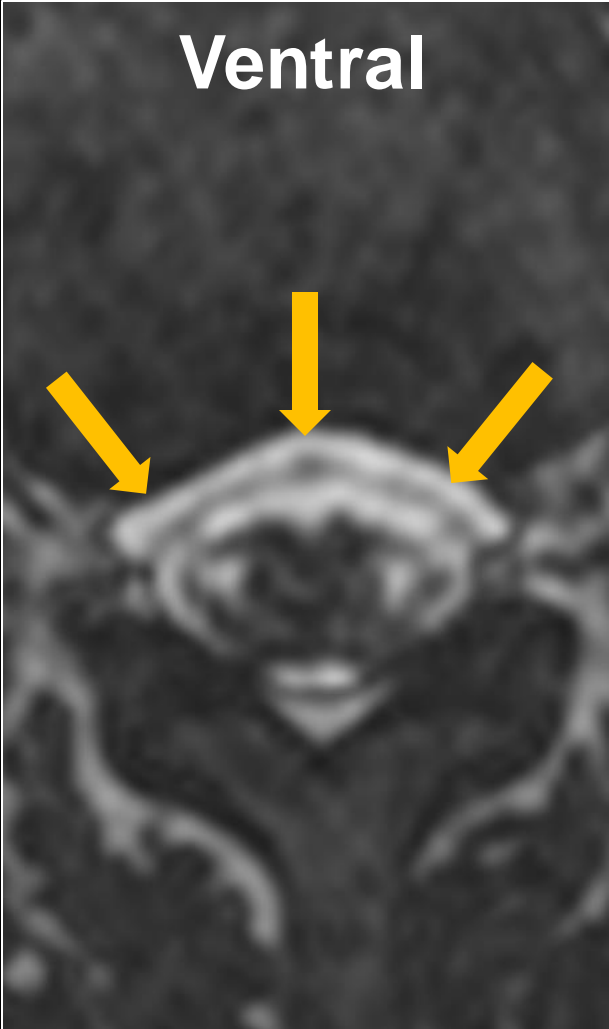


Type 3: CSF-venous fistula



No epidural fluid

Start with the spine MRI: Is there epidural fluid? Where?



Other clues: the “flow void sign”

“Flow void sign”: flow artefact on T2-weighted MRI can be an indicator of dural defect location in ventral type 1 spinal CSF leaks

Lalani Carlton Jones, Diogo G.L. Edelmuth, David Butteriss, Daniel J. Scoffings



Pre-procedure consultation

Rationale for CTM

What happens during CTM

'Instructions'

What happens afterwards



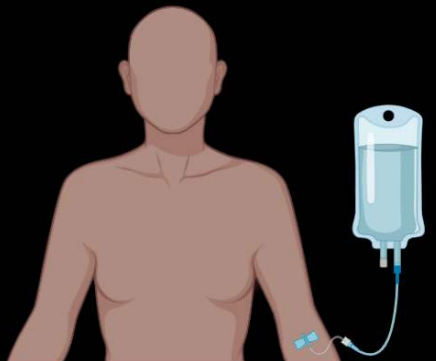
Pre-procedure consultation



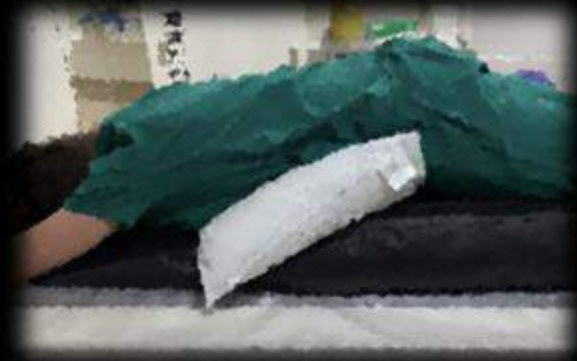
30 mins-1h



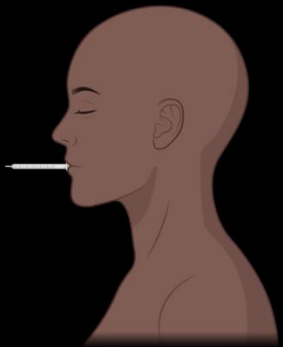
Local



Light sedation



Position



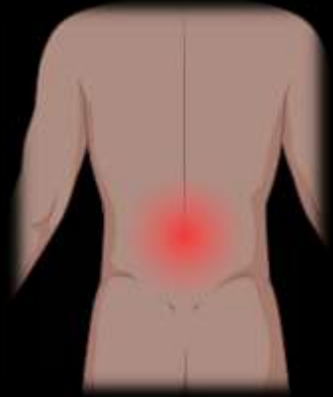
Maneuvres



Injection headache



“Keep still!”



Backache afterwards



I'll tell you what I find

Informed consent: complications

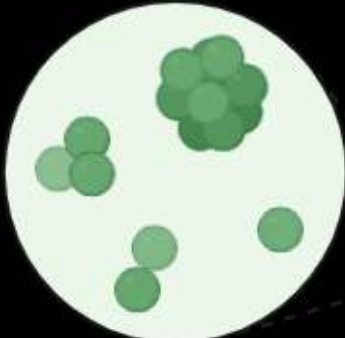
Related to Lumbar puncture



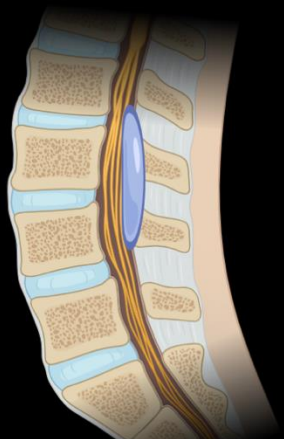
Headache



Bleeding



Infection



CSF leak

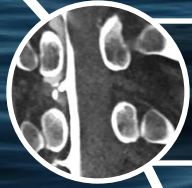
Related to contrast



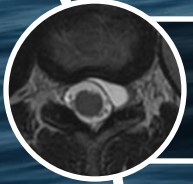
Allergic rxn



Seizures



What is CTM?



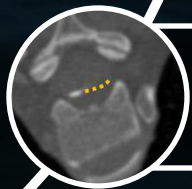
Pre-procedure



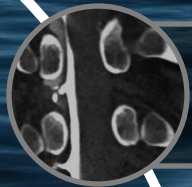
How I do it



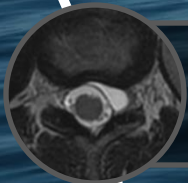
Post procedure



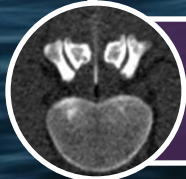
Pearls and pitfalls



What is CTM?



Pre-procedure



How I do it



Post procedure



Pearls and pitfalls

There's no one 'best way' to do a CTM



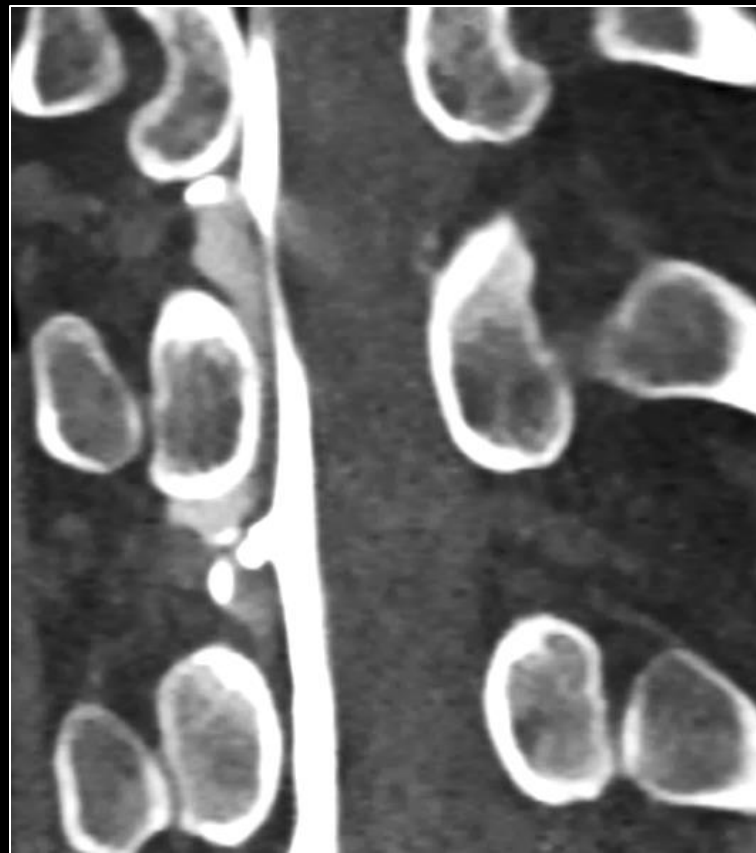
3 main types of leak: 3 main types of CTM

Ventral dural tear



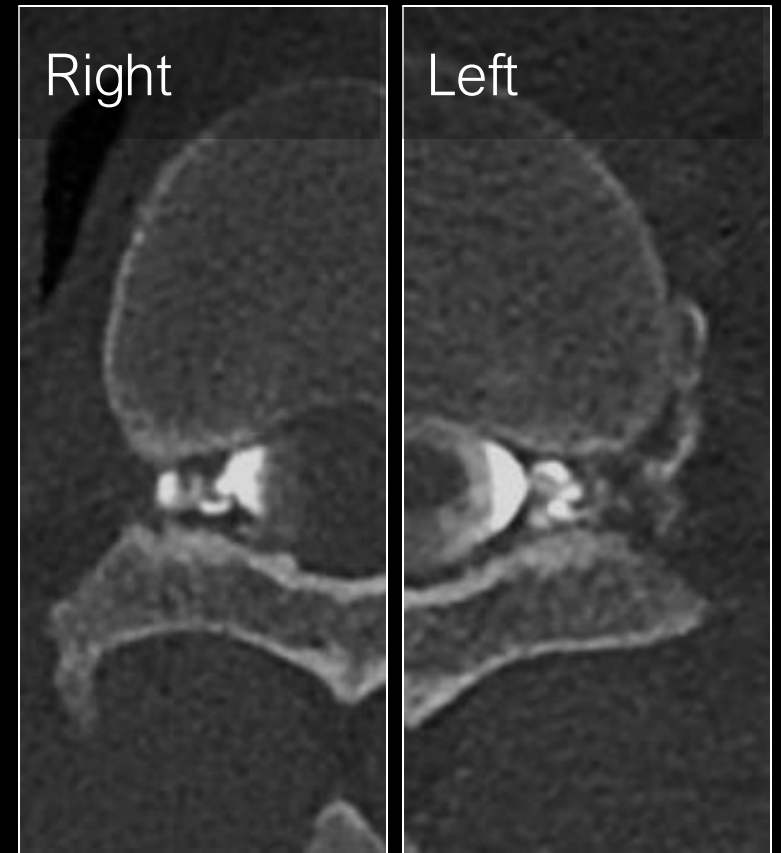
Prone Dynamic

Lateral Leak



Decubitus dynamic

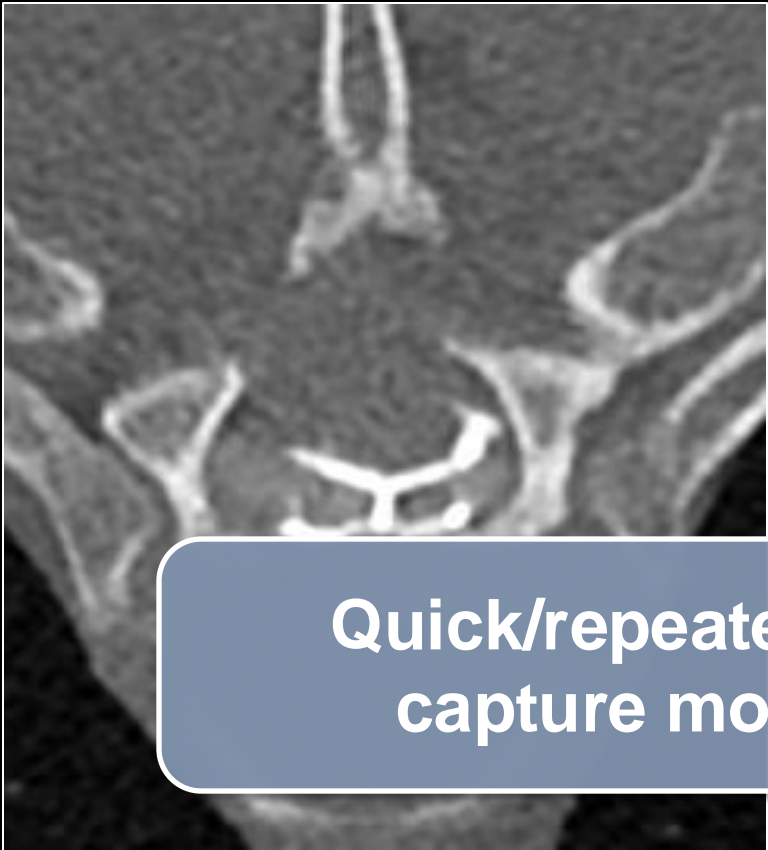
CSF venous fistula



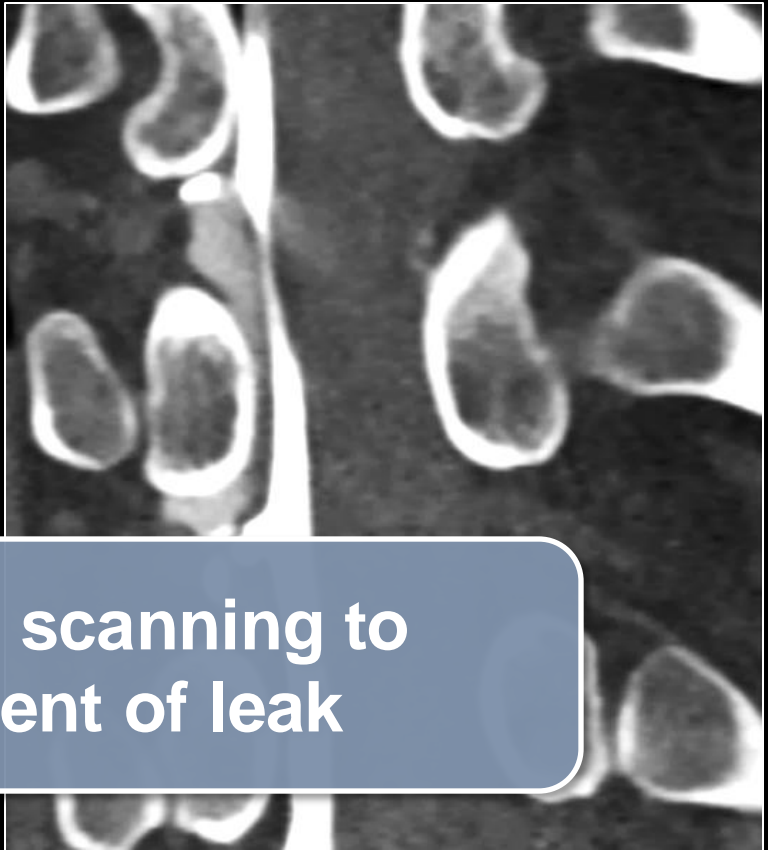
**Bilateral decubitus
Also dynamic**

3 main types of leak: 3 main types of CTM

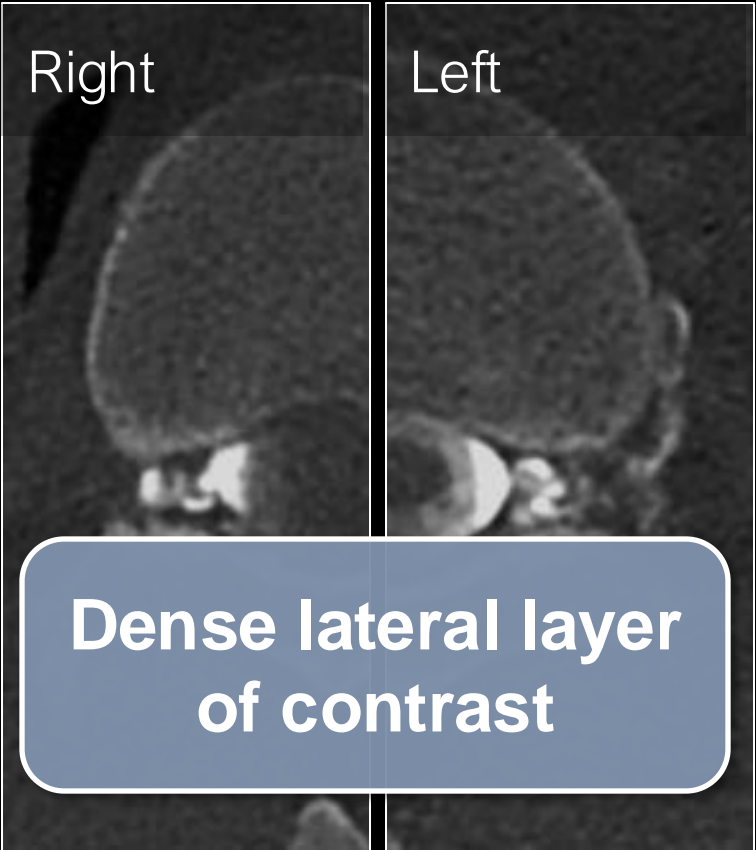
Ventral dural tear



Lateral Leak



CSF venous fistula



Quick/repeated scanning to capture moment of leak

Dense lateral layer of contrast

Prone Dynamic

Decubitus dynamic

**Bilateral decubitus
Also dynamic**

3 main types of CTM

Prone dynamic

Decubitus dynamic

Bilateral decubitus

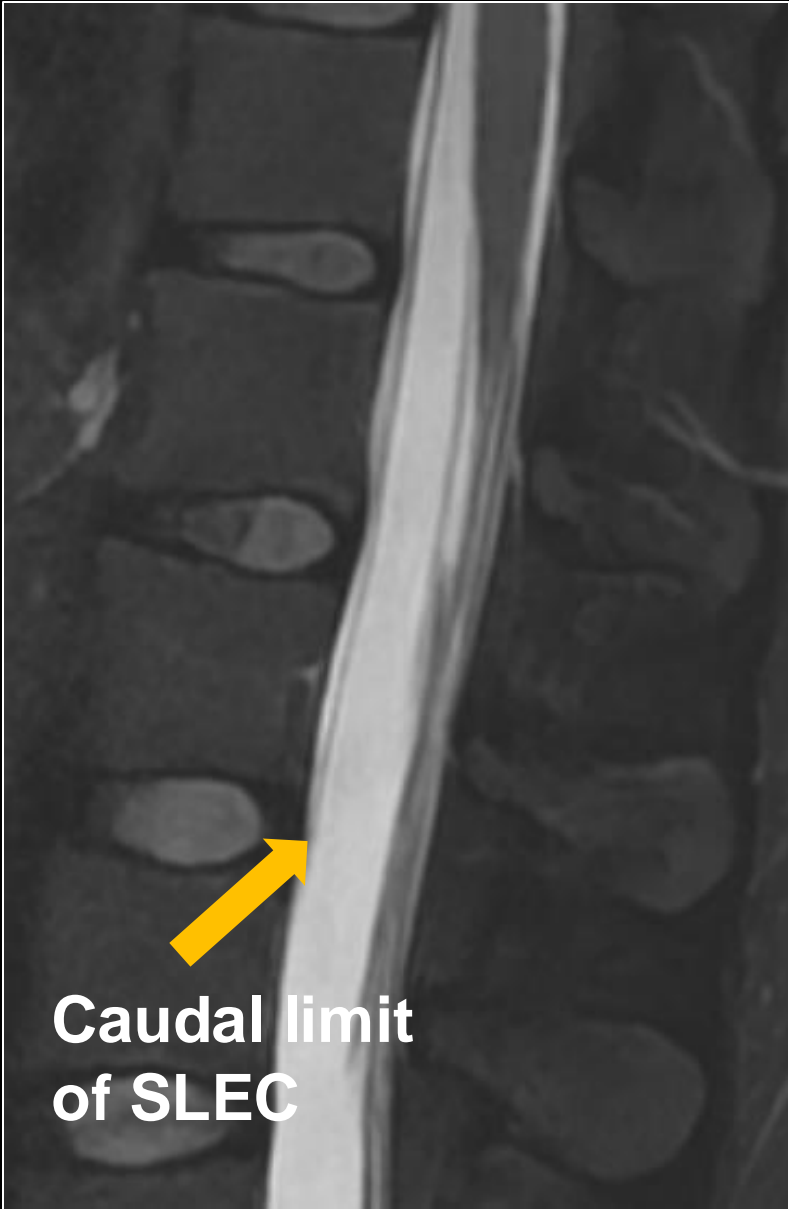
Common features

Specifics

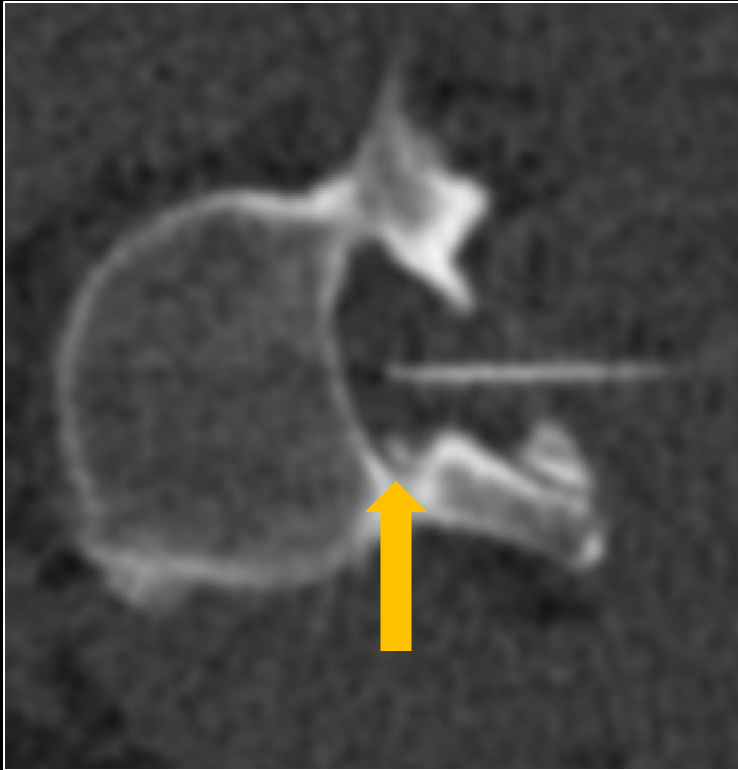
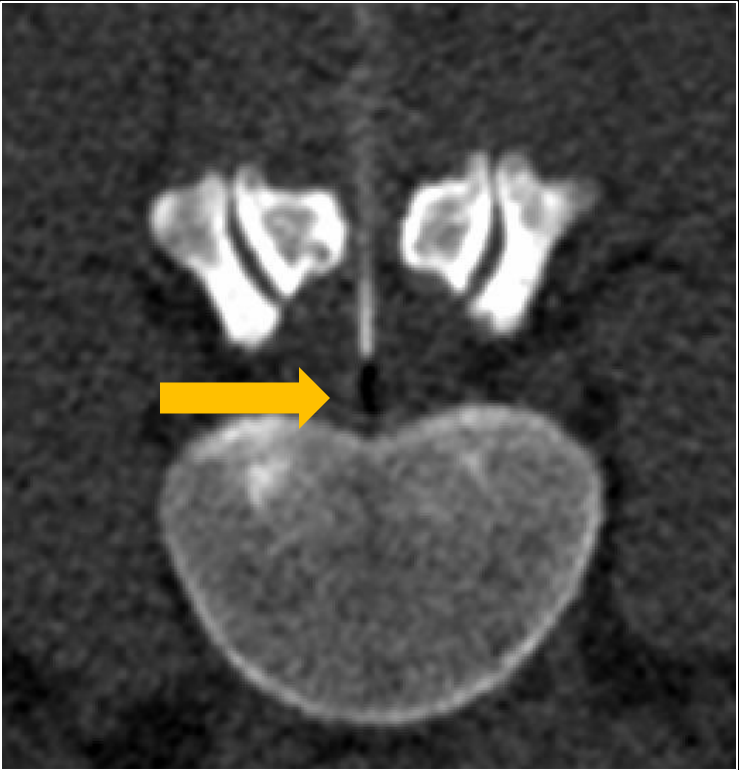
Specifics

Specifics

CT-guided lumbar puncture

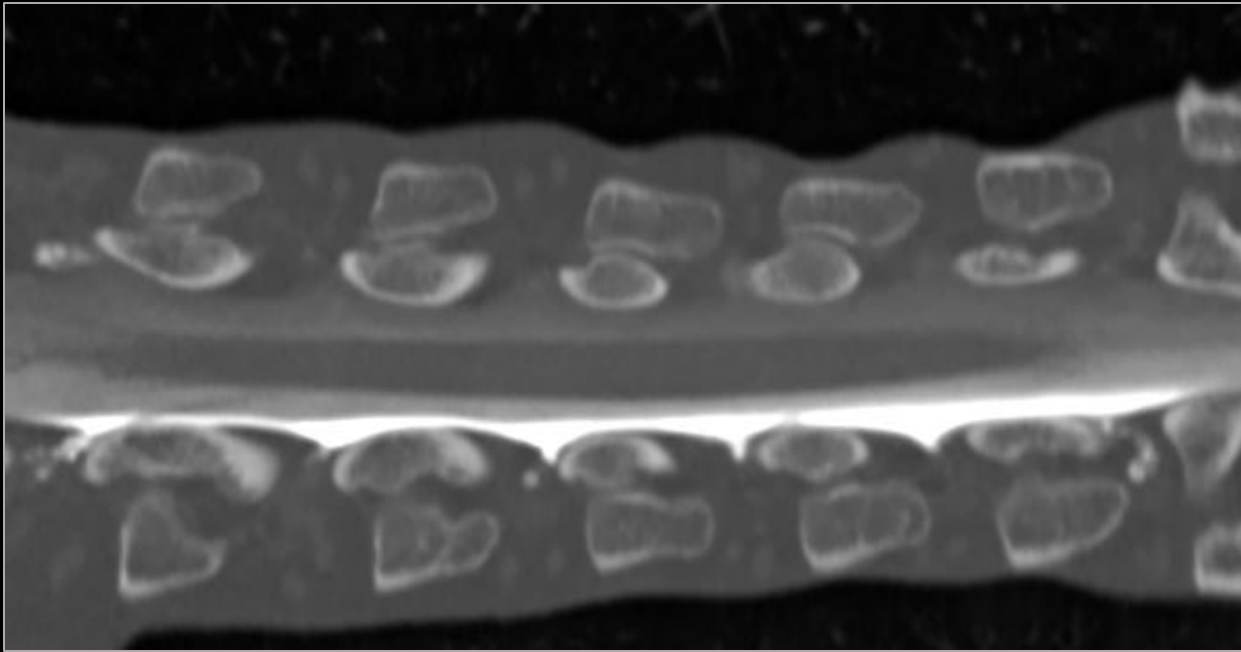


Test injection of contrast

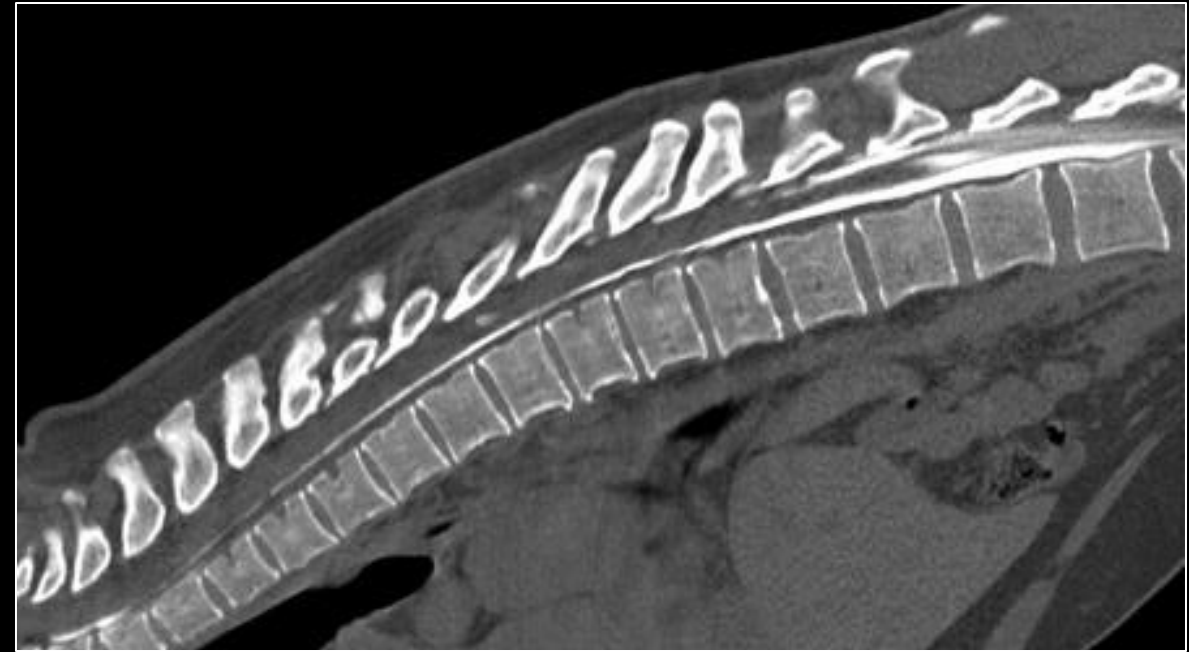


Principles of patient positioning: behaviour of contrast

Contrast is denser than CSF



Contrast flows under gravity



The two most common positions

Prone



Lateral decubitus



The two most common positions

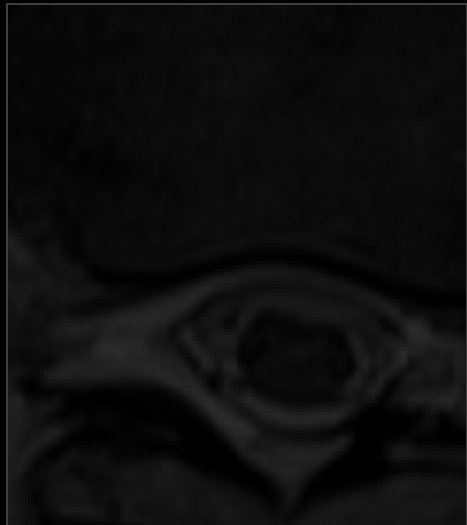
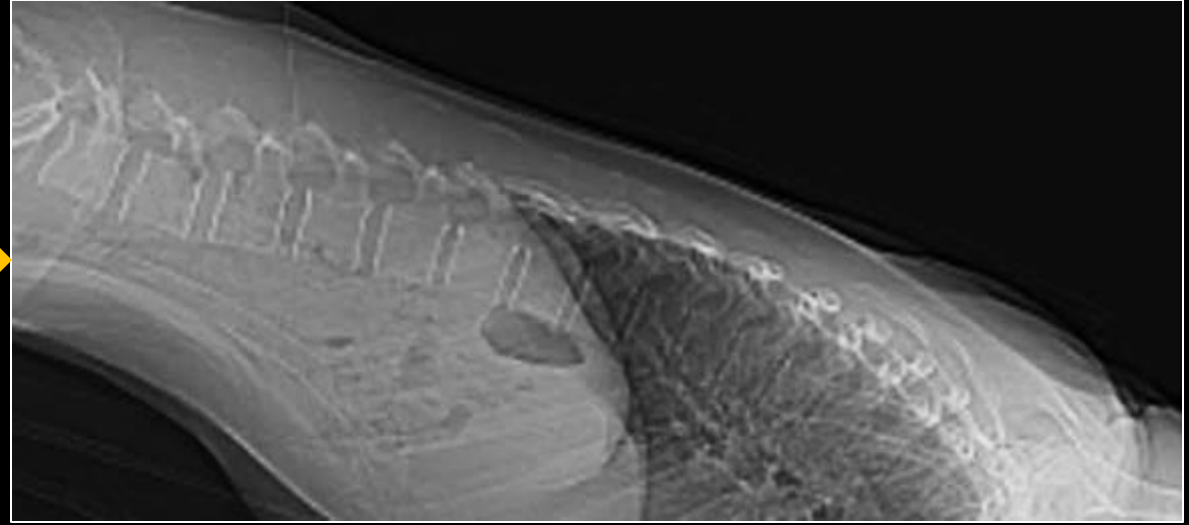
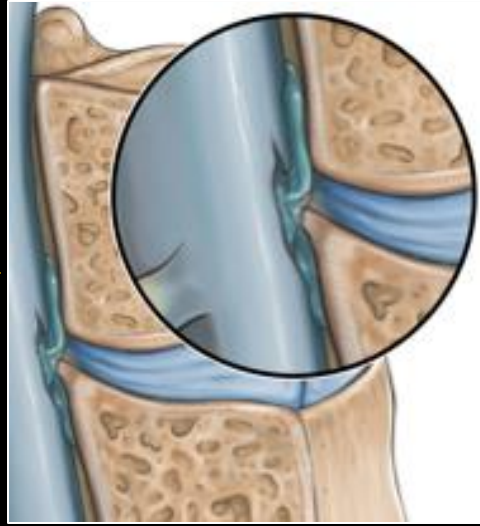
Prone



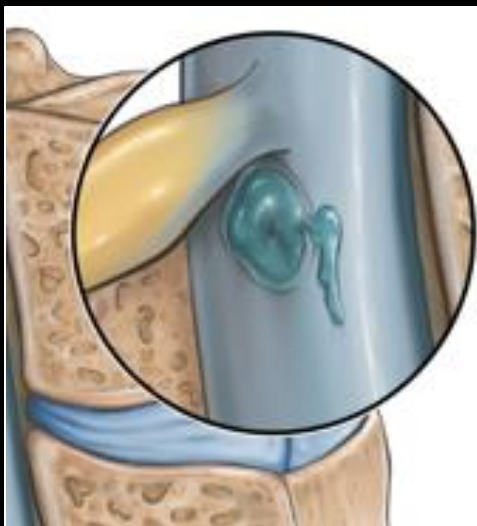
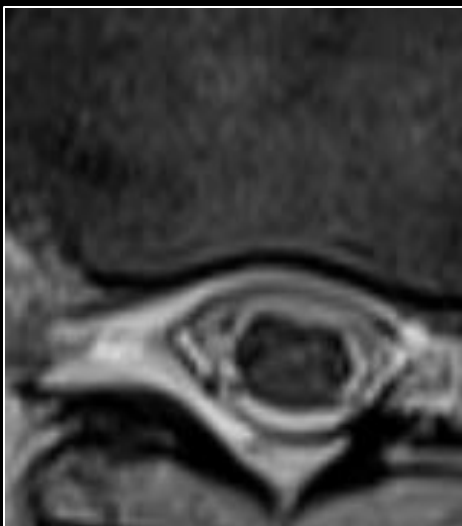
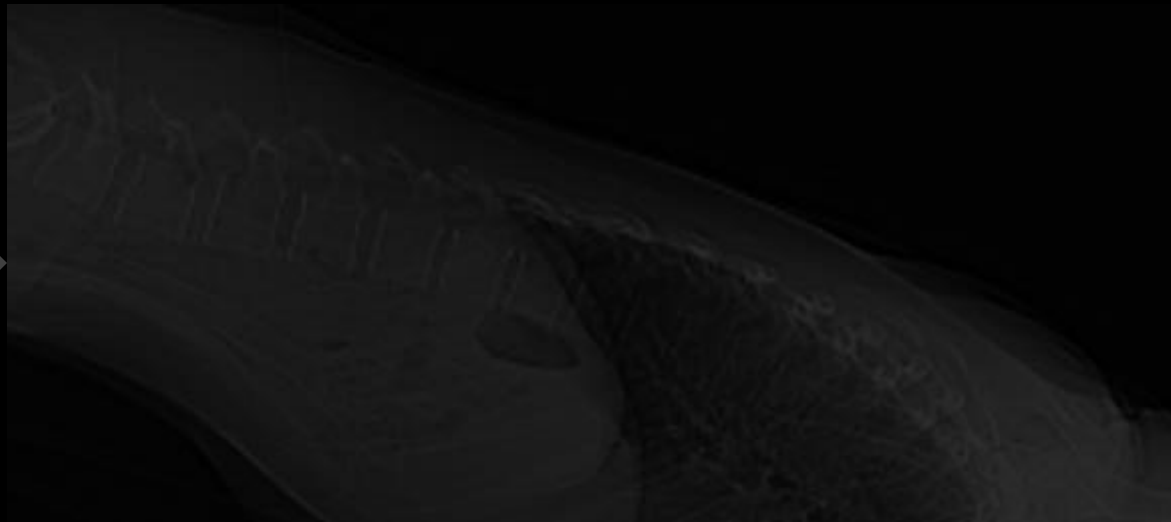
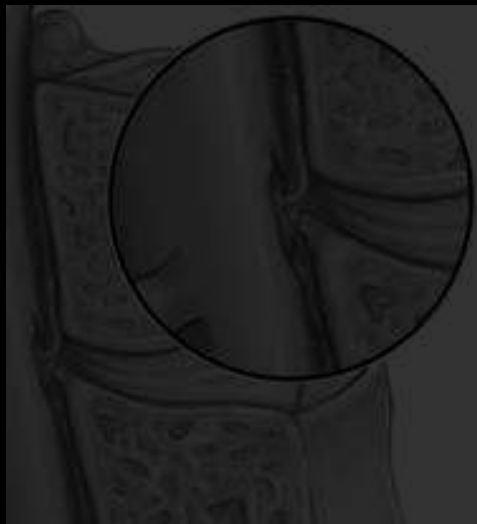
Lateral decubitus



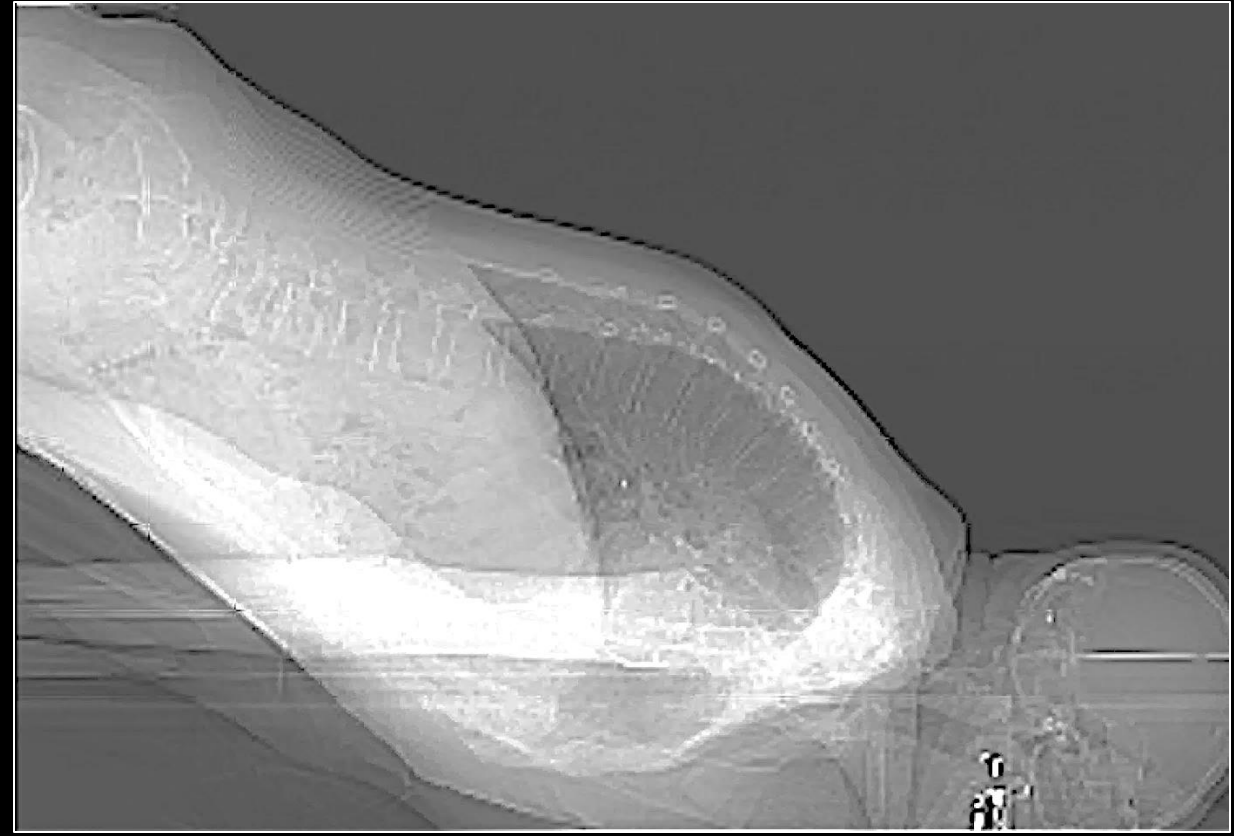
Ventral fluid – prone dynamic myelogram



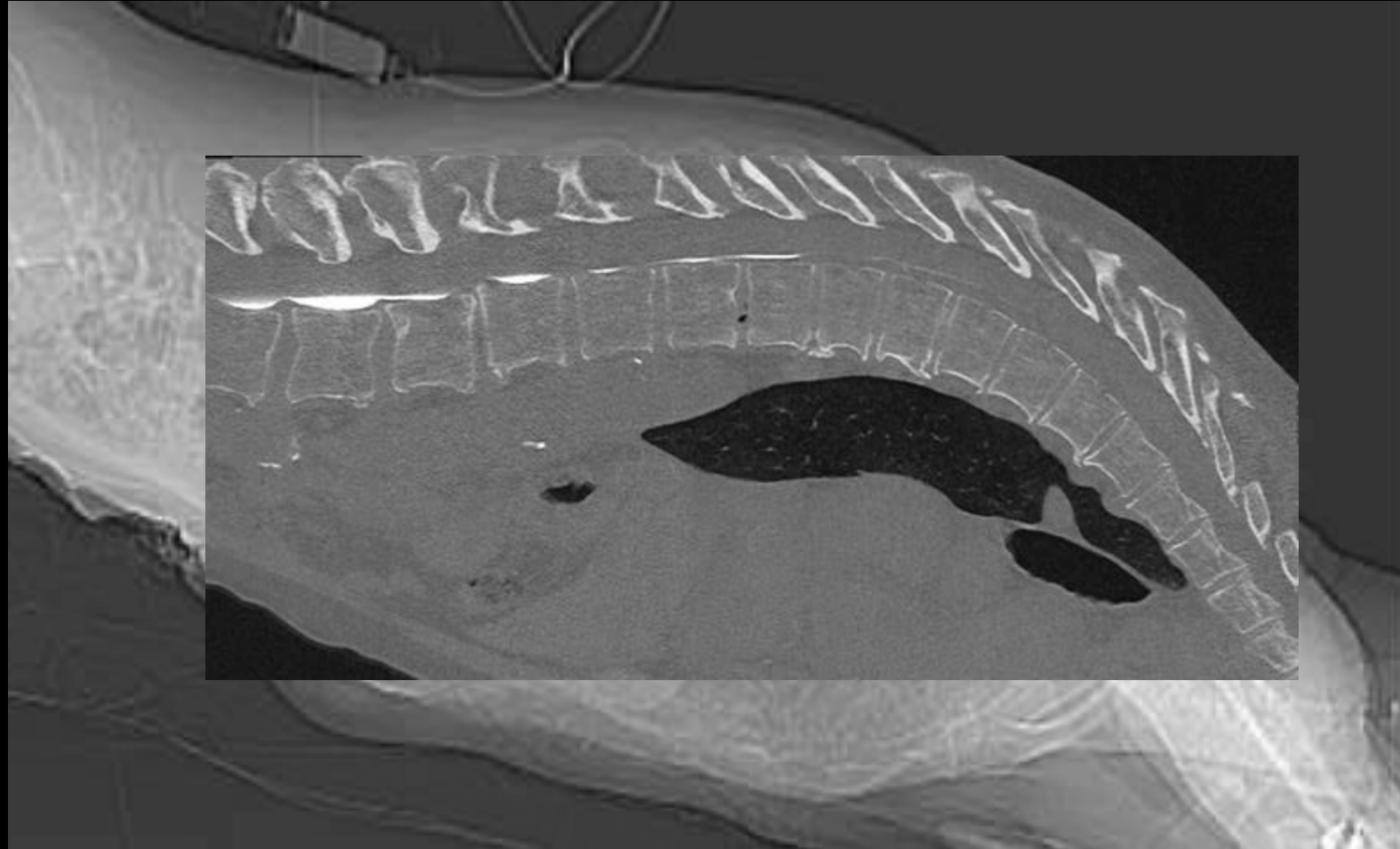
Asymmetric fluid – decubitus dynamic myelogram



Time spent positioning is time well spent



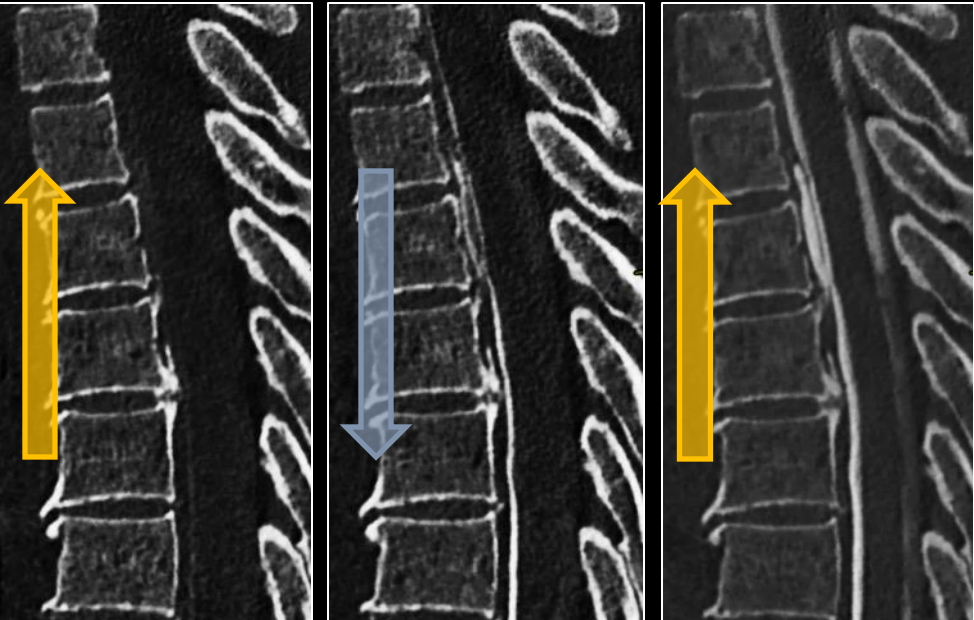
Poor positioning prevents perfect progression



Dynamic CT myelography: 2 approaches

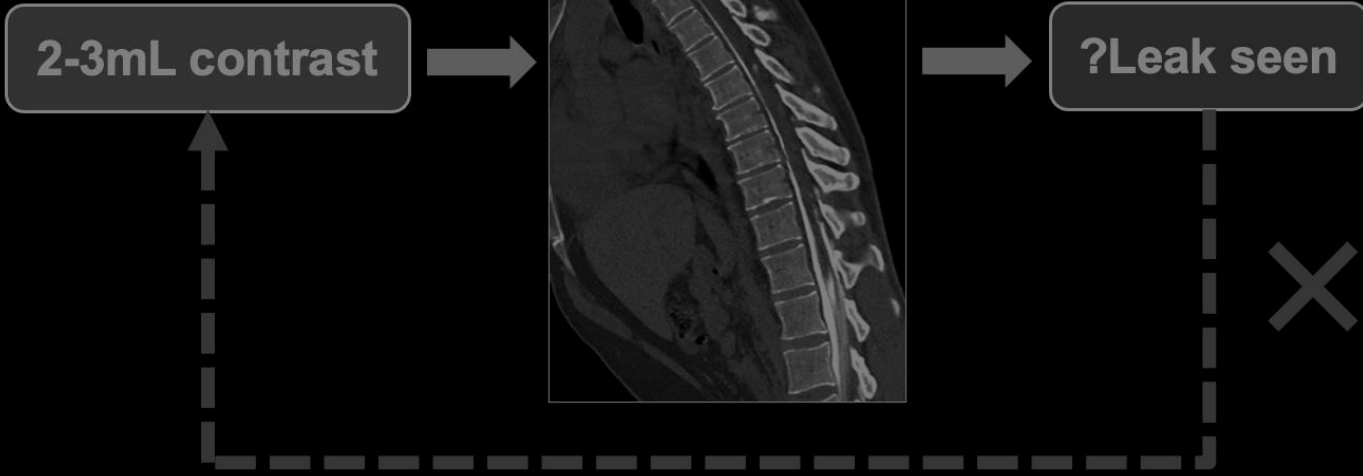
'Ultrafast' dCTM

Inject while scanning



3 passes usually enough

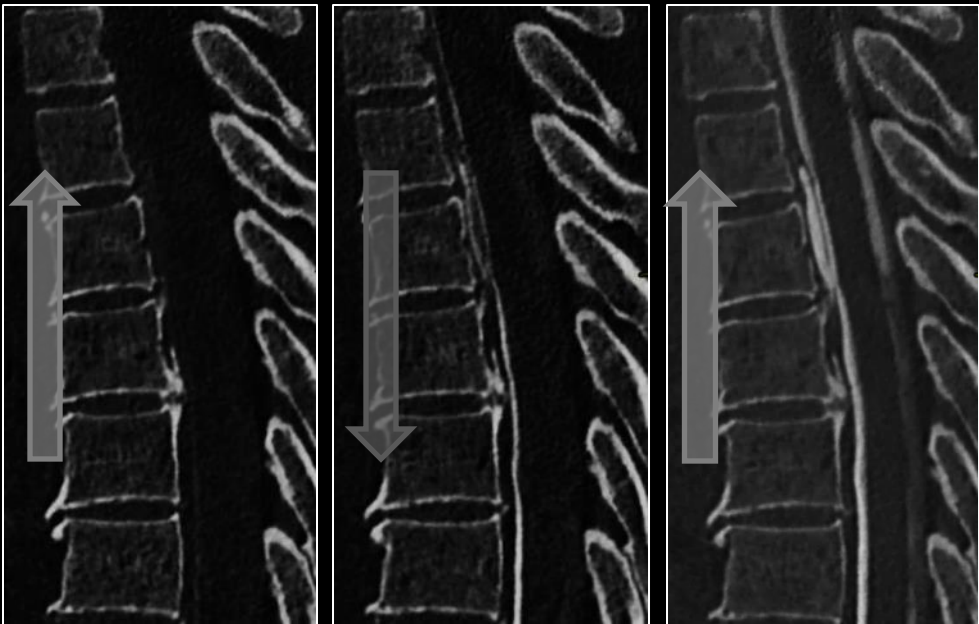
'Incremental' dCTM



Dynamic CT myelography: 2 approaches

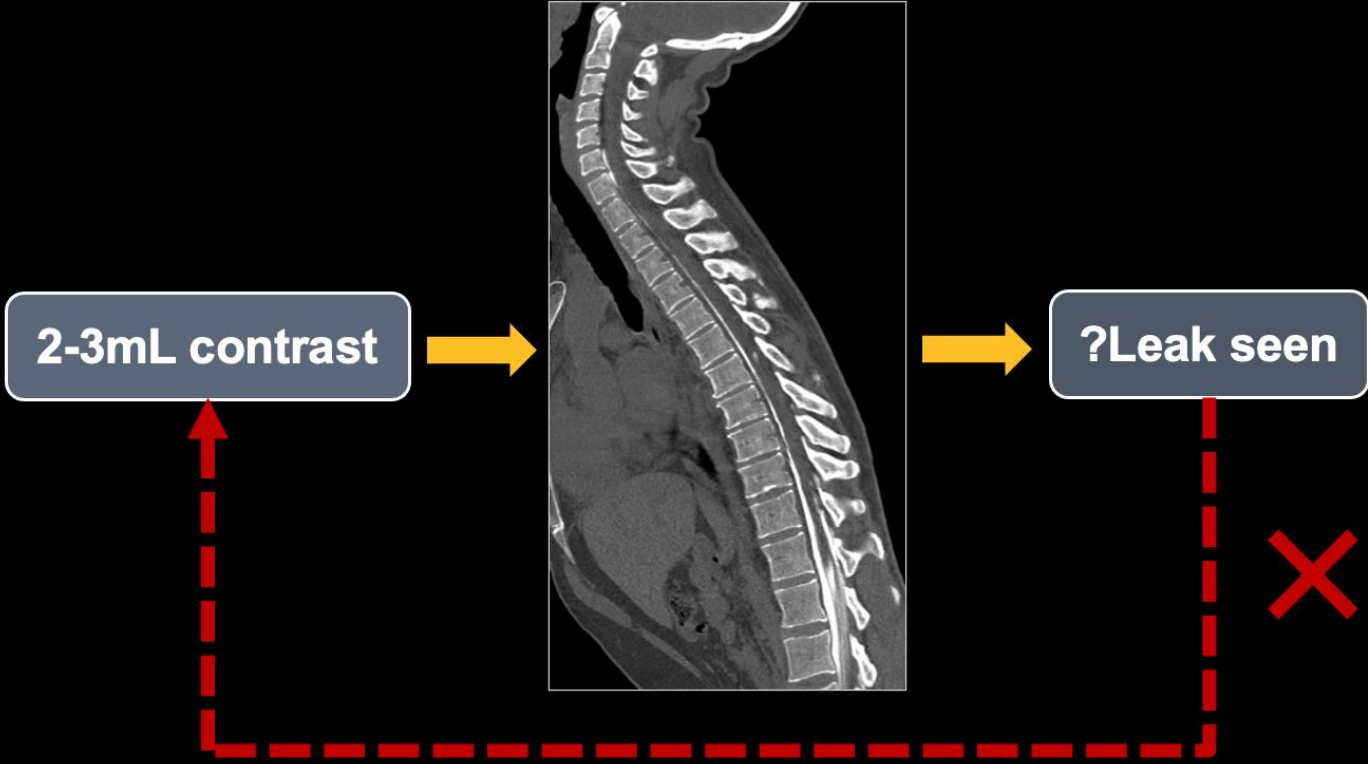
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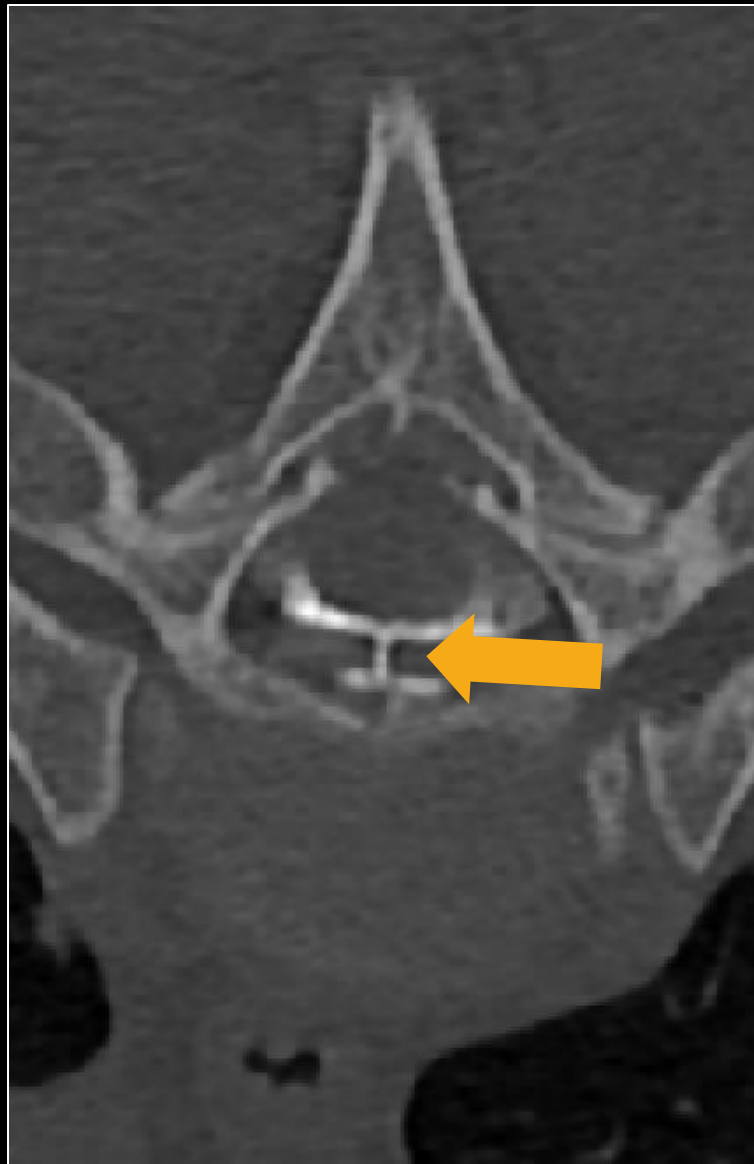
'Incremental' dCTM



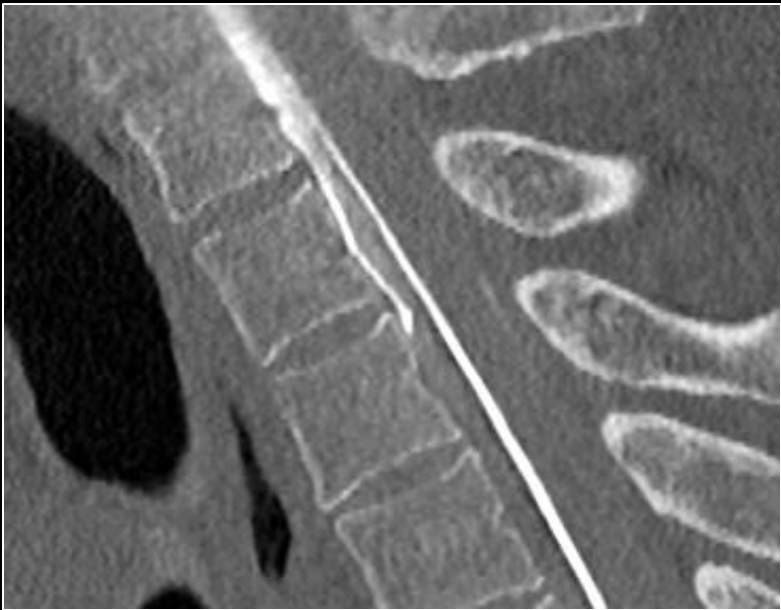
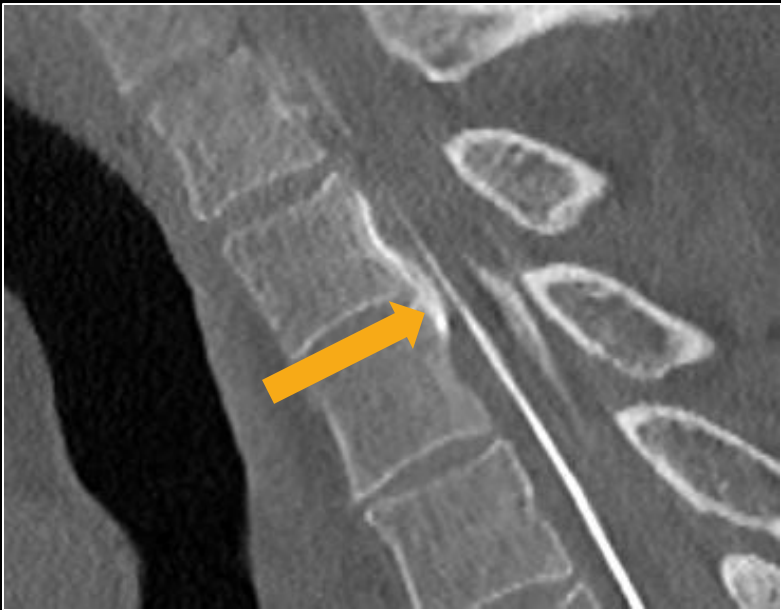
Modified Dynamic CT Myelography for Type 1 and 2 CSF Leaks: A Procedural Approach

M.D. Mamlouk, P.Y. Shen, and B.C. Dahlin

Prone ultrafast dynamic CTM: ventral dural tear at T1-T2



Prone incremental dynamic CTM: ventral dural tear at T2-T3

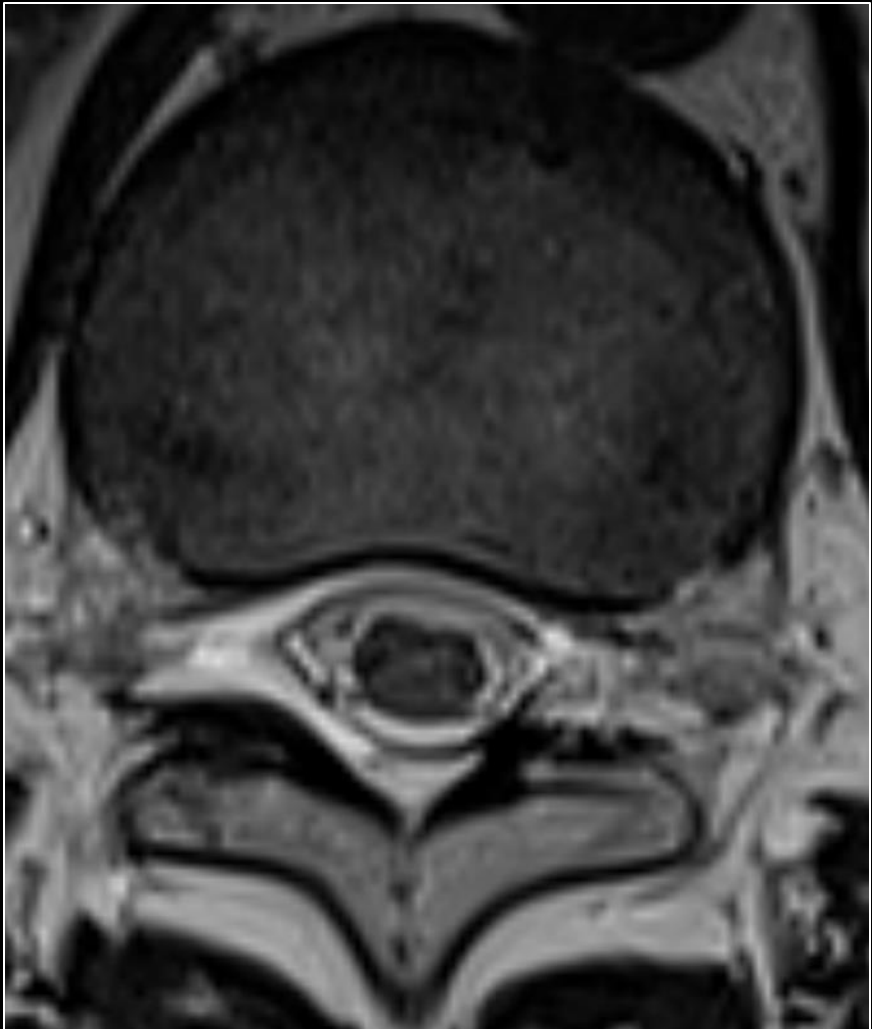


Chronic SLECs can be difficult

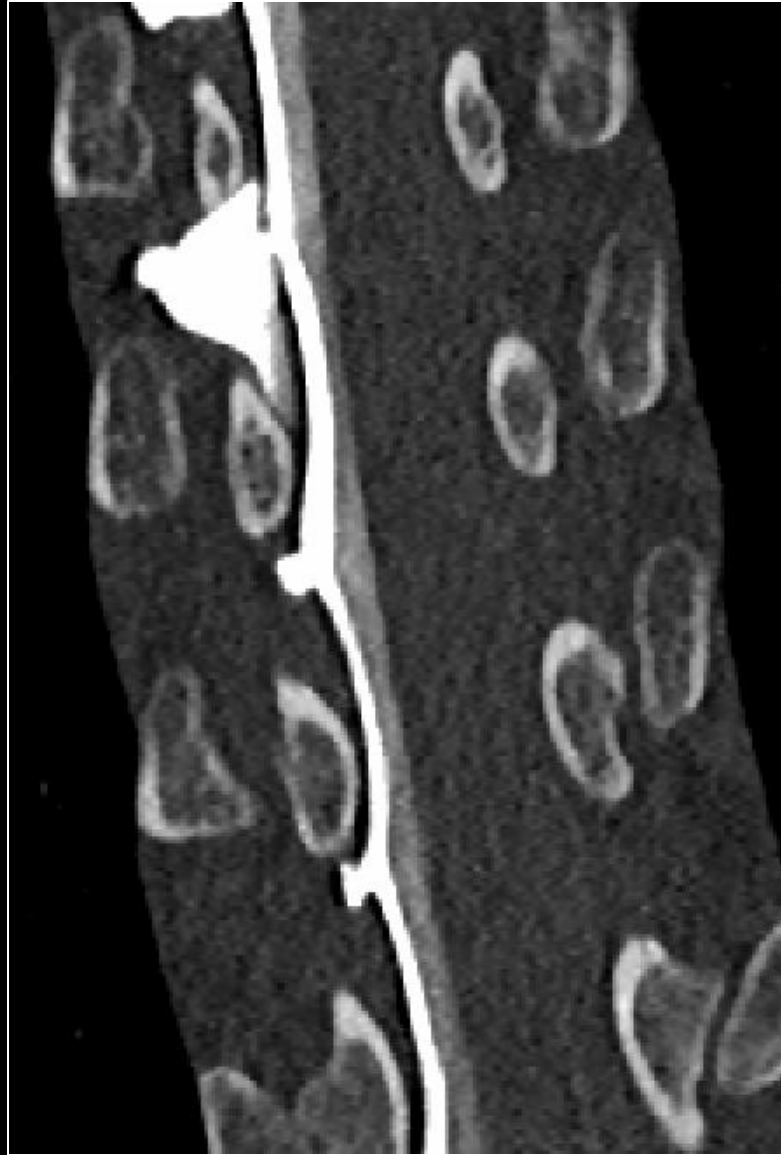
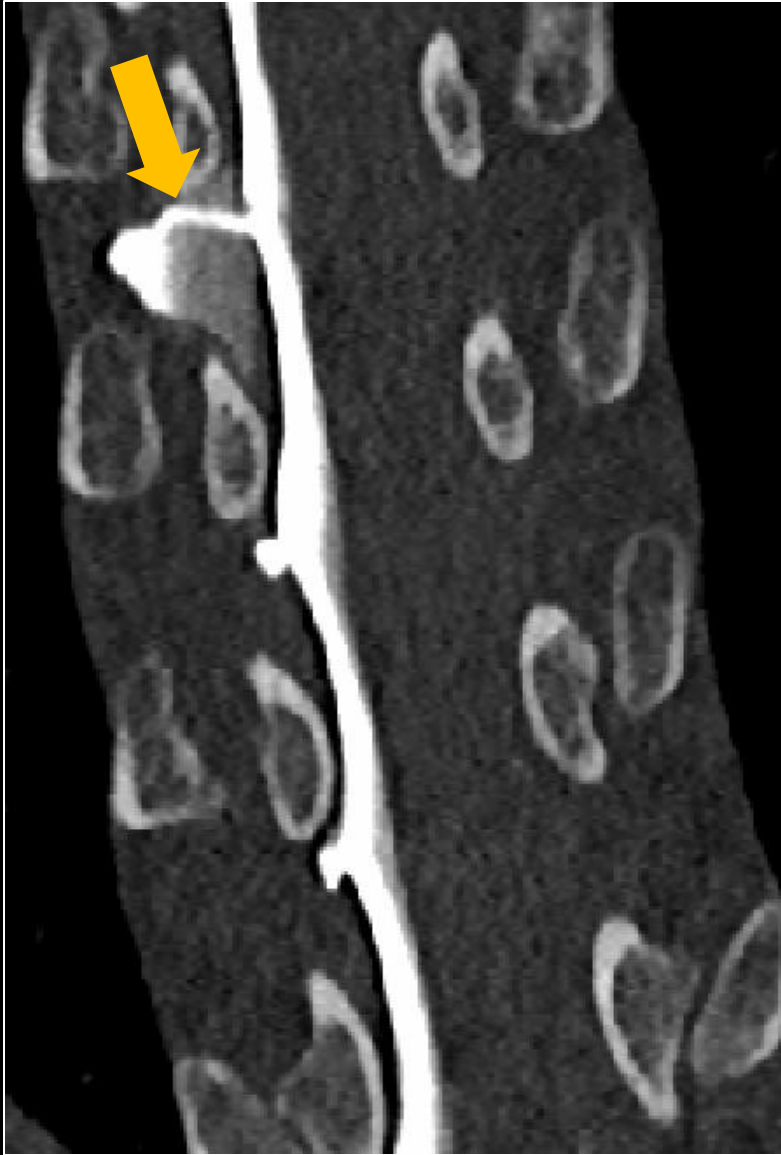
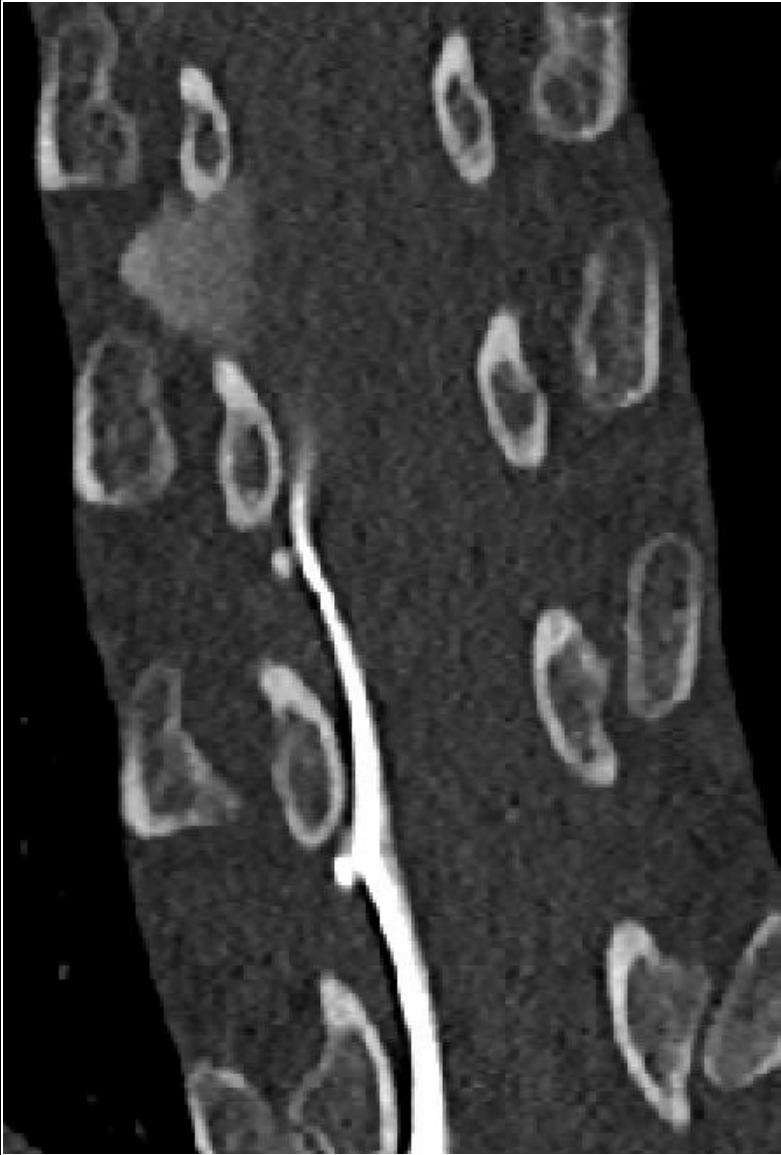
Valsalva manoeuvre



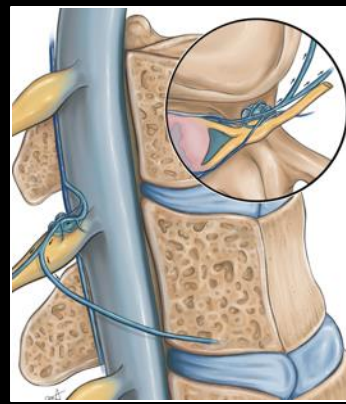
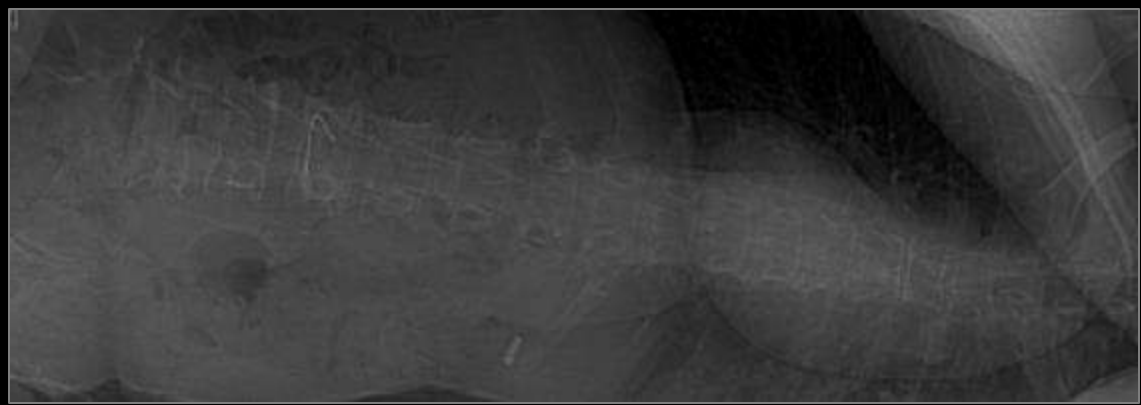
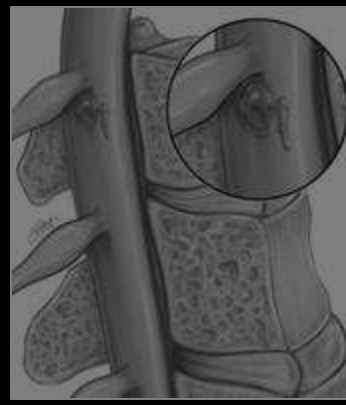
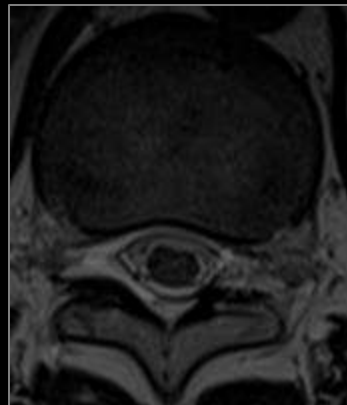
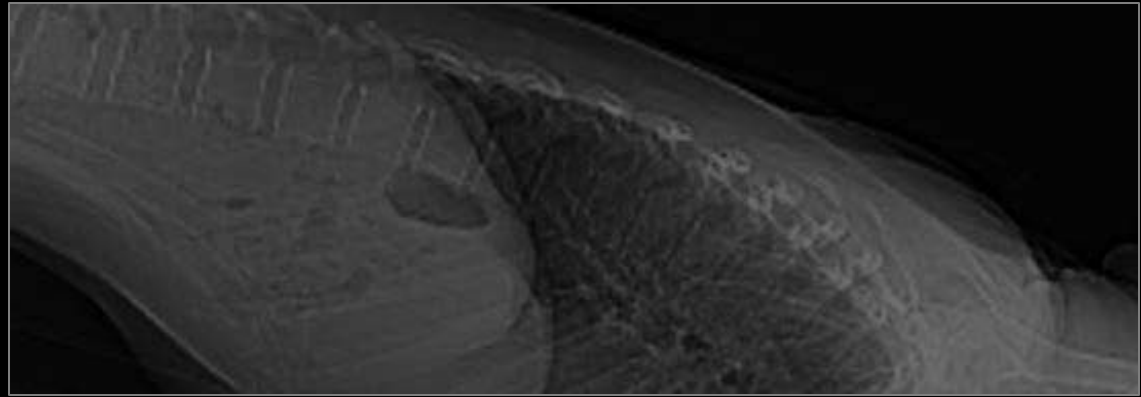
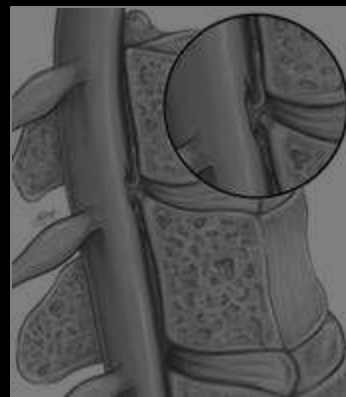
Lateral decubitus UFDCTM: Right T10 nerve root sleeve tear



Lat decub UFDCCTM: Right T8 nerve root sleeve tear



No epidural fluid – look for CVF → decubitus CTM



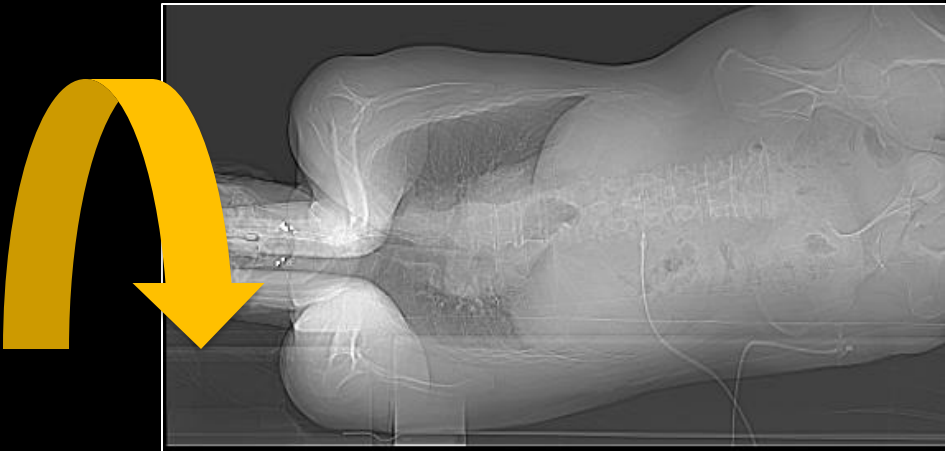
Bilateral decubitus CTM

Same-Day Bilateral Decubitus CT Myelography for Detecting CSF-Venous Fistulas in Spontaneous Intracranial Hypotension

L. Carlton Jones and P.J. Goadsby



Contrast

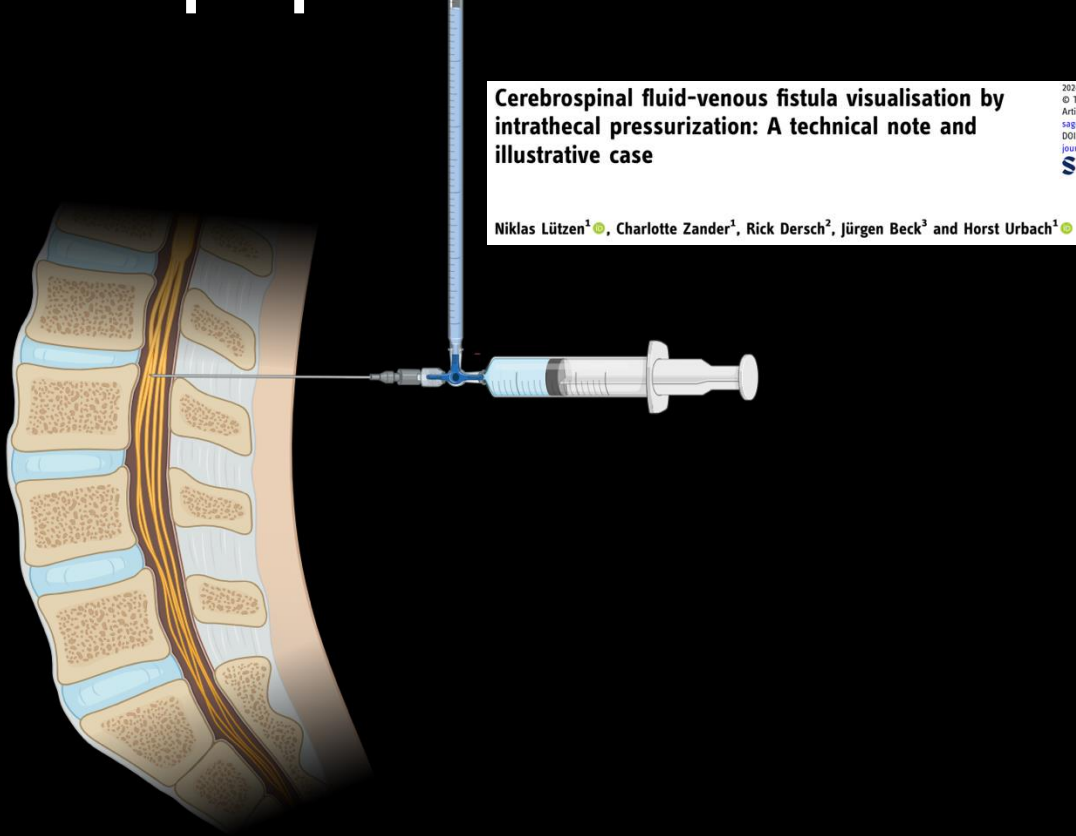


Repeat bolus



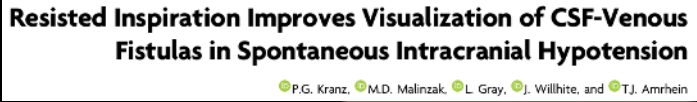
Provocative manoeuvres for CVFs

Saline prepressurization



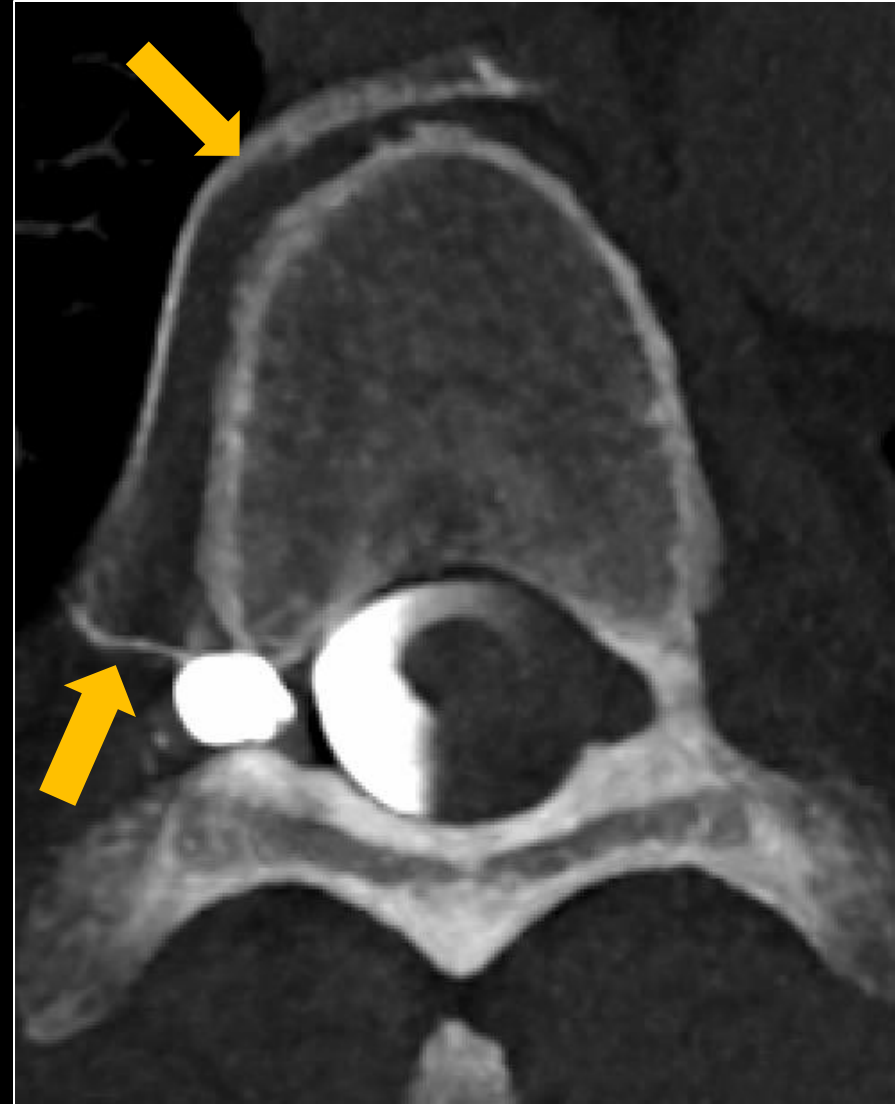
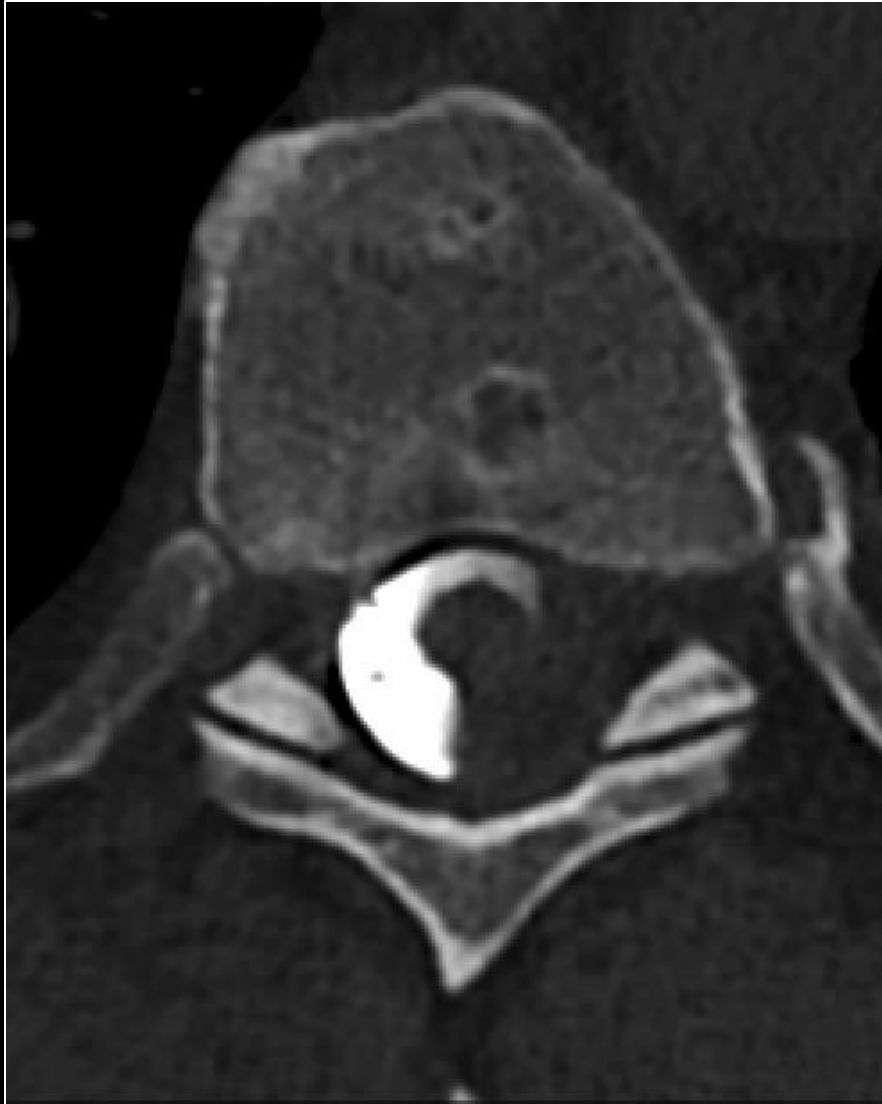
Increases CSF pressure

Resisted inspiration



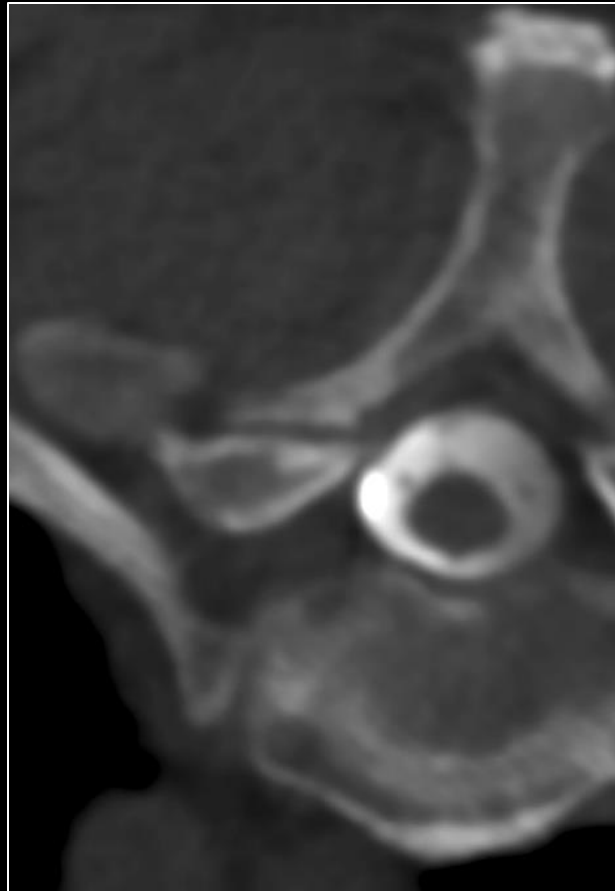
Increases CSF pressure
Decreases venous pressure

Typical appearance of CSF-venous fistula on CTM



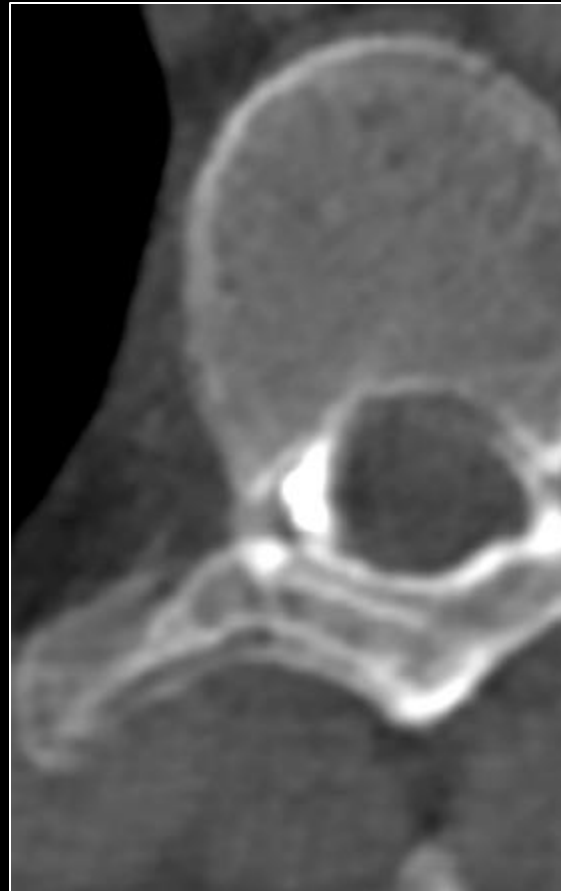
Variable appearances of CVFs

Right T1-T2



Intercostal vein

Right T7-T8



To level below

Left T10-T11



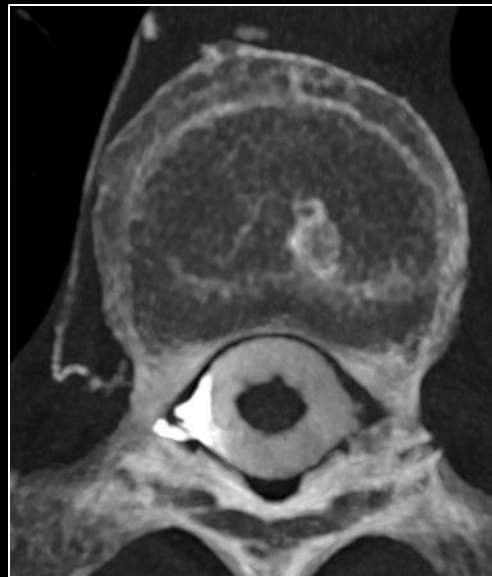
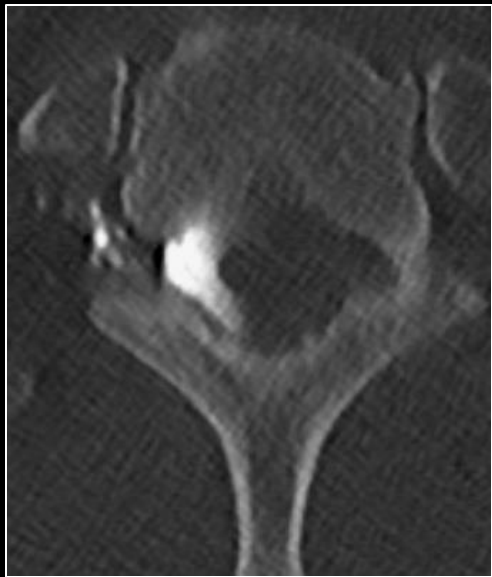
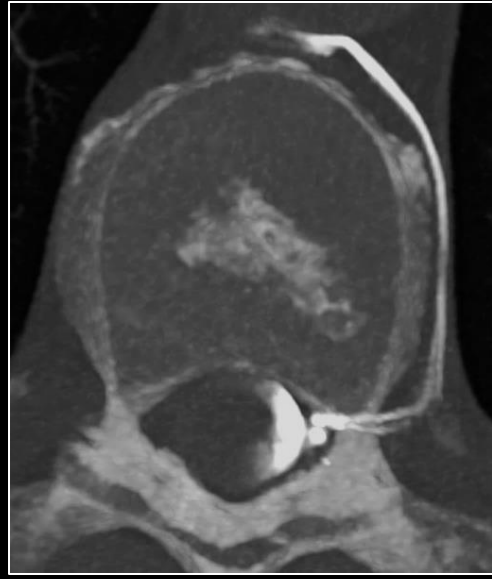
**Internal epidural
plexus**

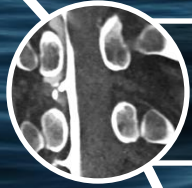
Left T4-T5



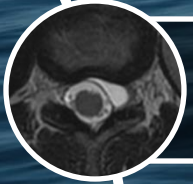
Transosseous

Variable appearances of CVFs





What is CTM?



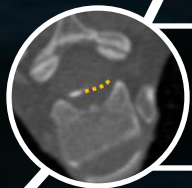
Pre-procedure



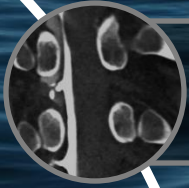
How I do it



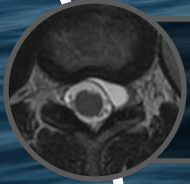
Post procedure



Pearls and pitfalls



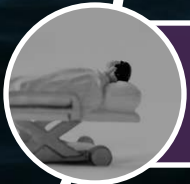
What is CTM?



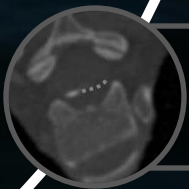
Pre-procedure



How I do it



Post procedure



Pearls and pitfalls

Post CTM recovery

2-4 hour bed rest

Head elevated

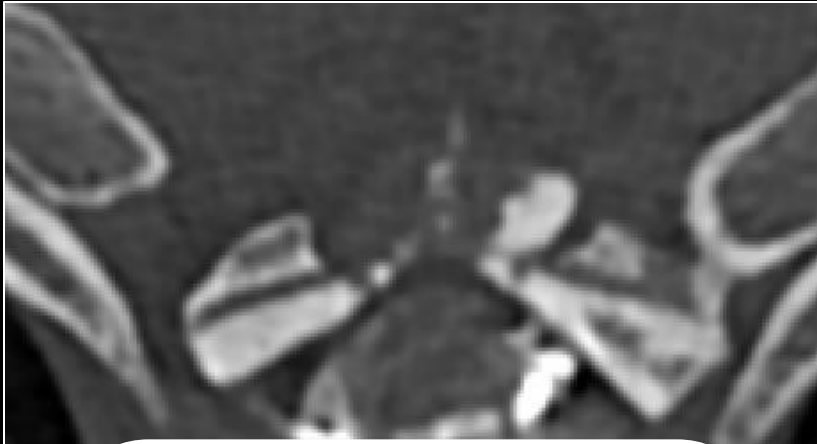
Bathroom privileges

Analgesics, antiemetics as needed



Results of CTM: ventral dural tears and lateral leaks

Localising



“The good news is, I’ve found your leak and this is how we can treat it...”

Non-localising



“I’ve shown your leak is active, but we need to do more work to pin it down”

No leak occurs



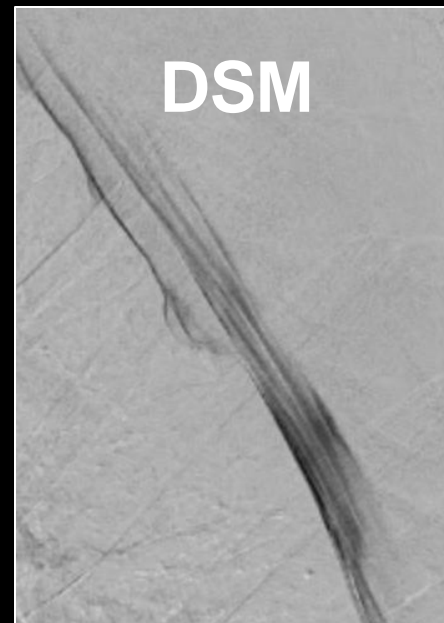
“I haven’t been able to show a leak today, but we can try again see if it opens”

Non-localizing dynamic CTM



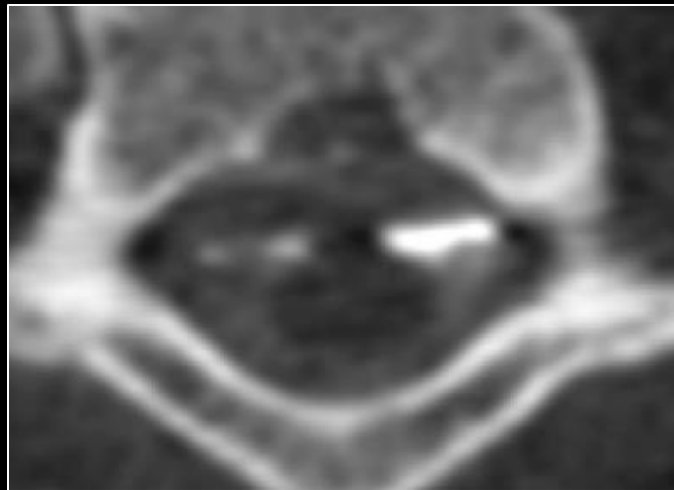
Repeat dCTM, scan sooner

Try a different modality



No leak occurs: what to do next?

?Membranes/cord



Pre-pressurise



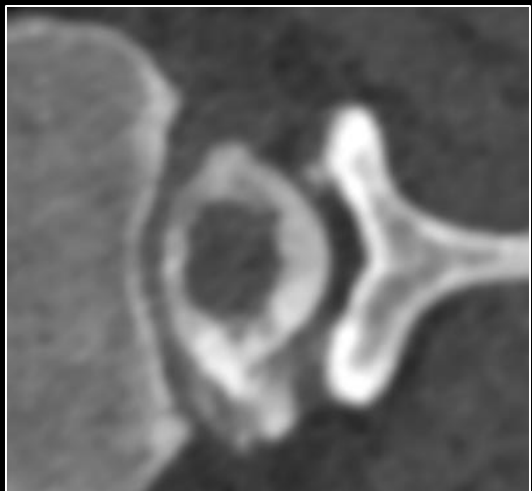
Valsalva / 'Strain'



Wrong position



Change & repeat

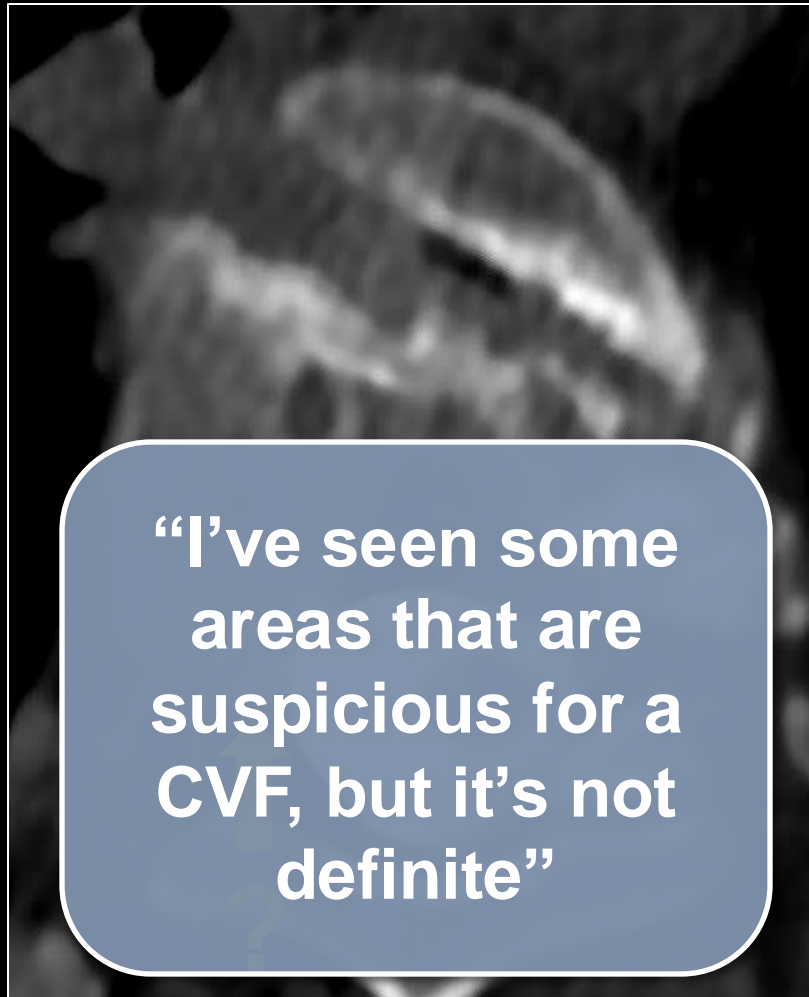


Results of CTM: CSF-venous fistulas

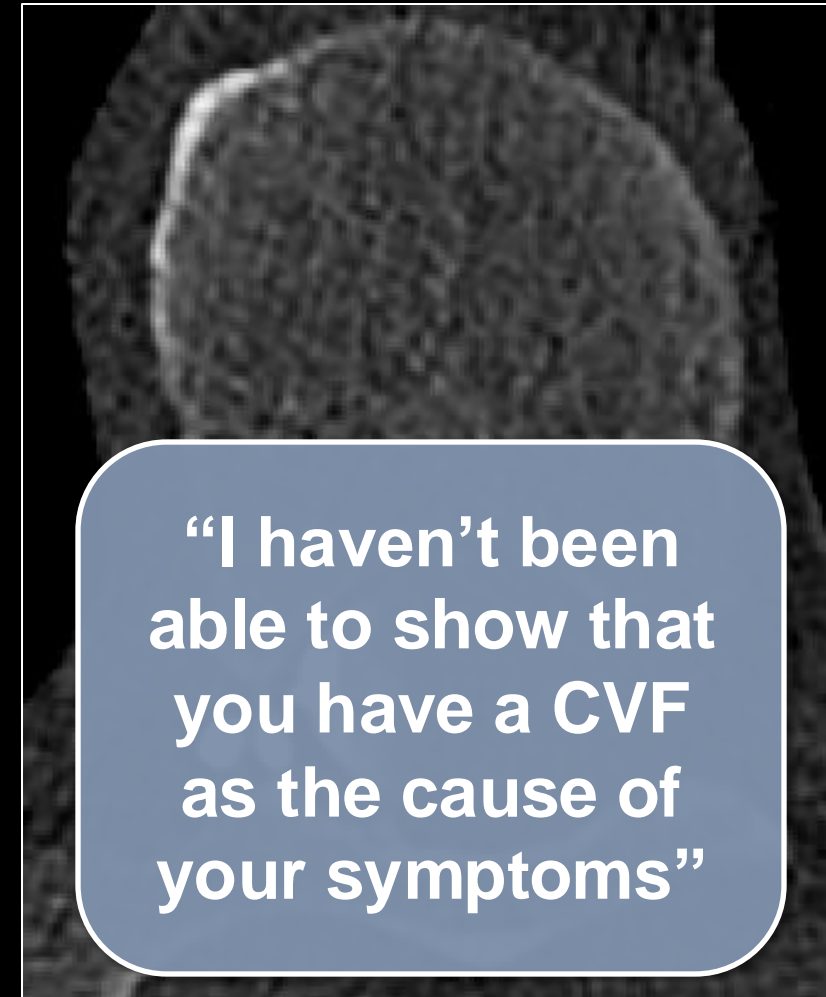
CVF localised

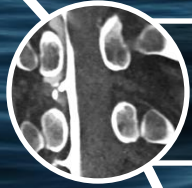


Equivocal ?veins

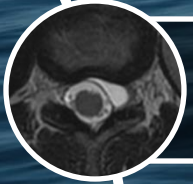


Negative





What is CTM?



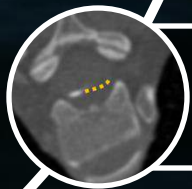
Pre-procedure



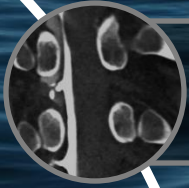
How I do it



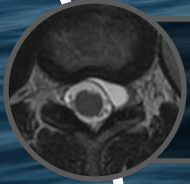
Post procedure



Pearls and pitfalls



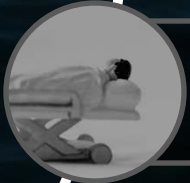
What is CTM?



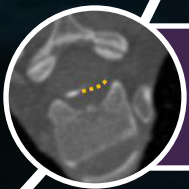
Pre-procedure



How I do it



Post procedure



Pearls and pitfalls

Advantages of CTM

Coverage



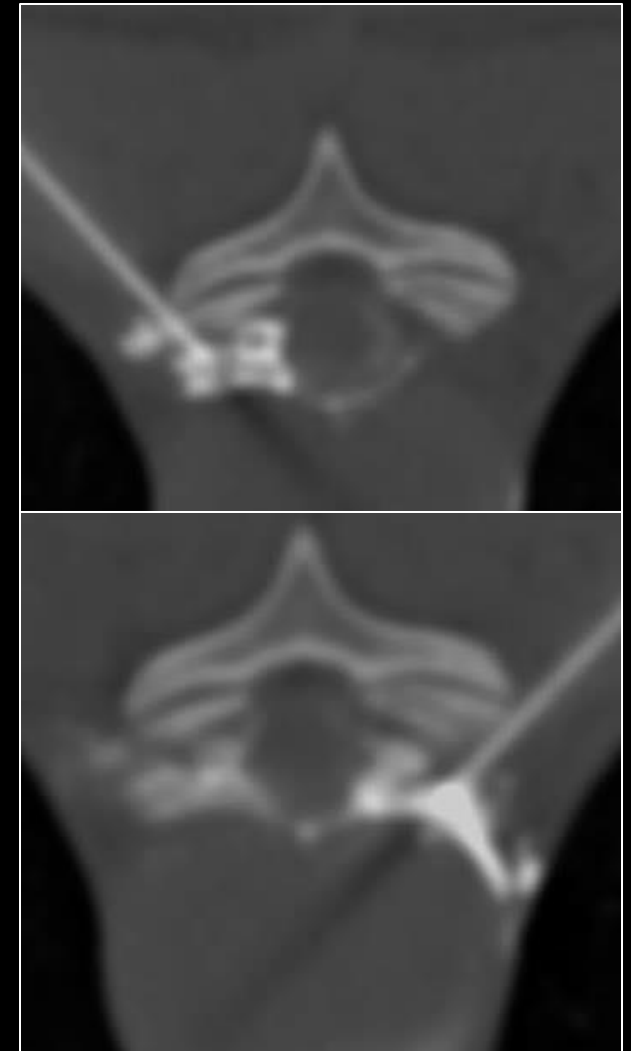
Fewer artefacts



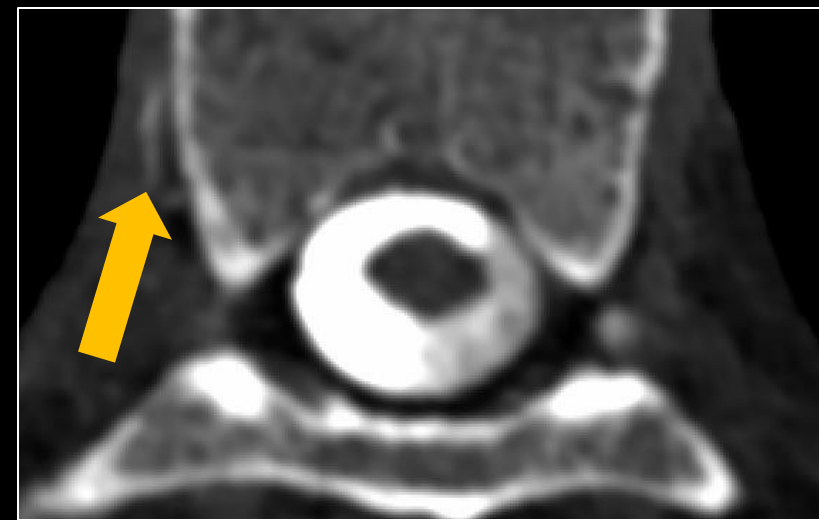
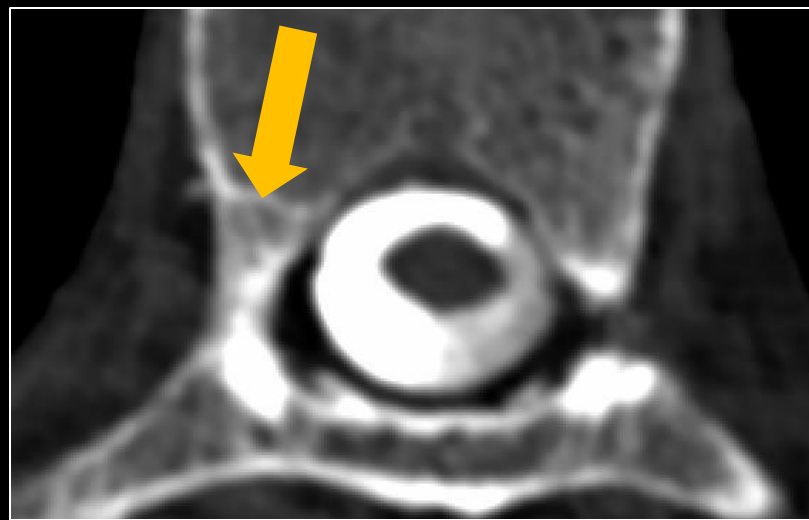
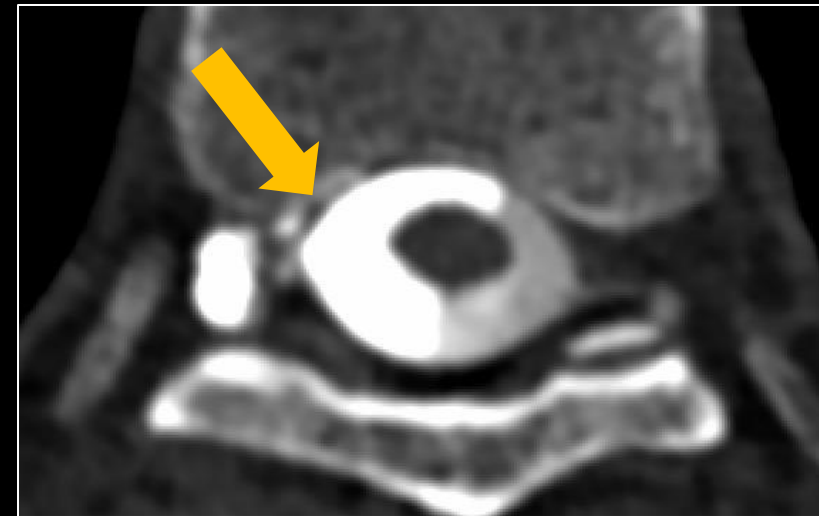
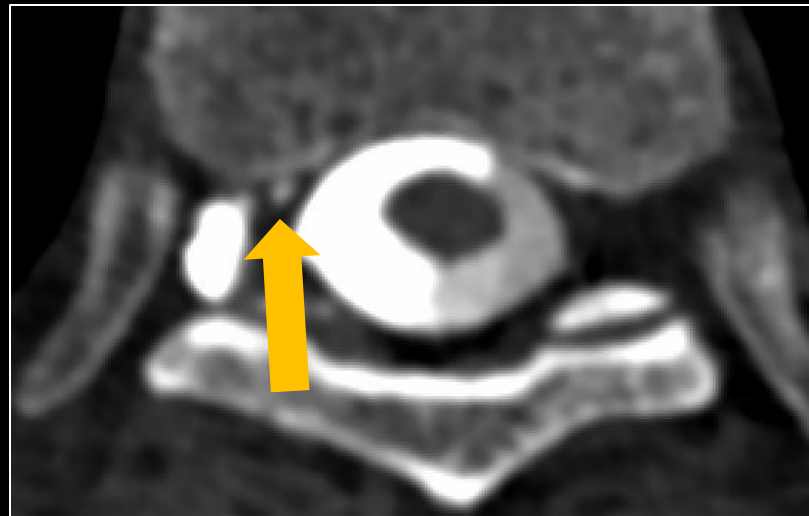
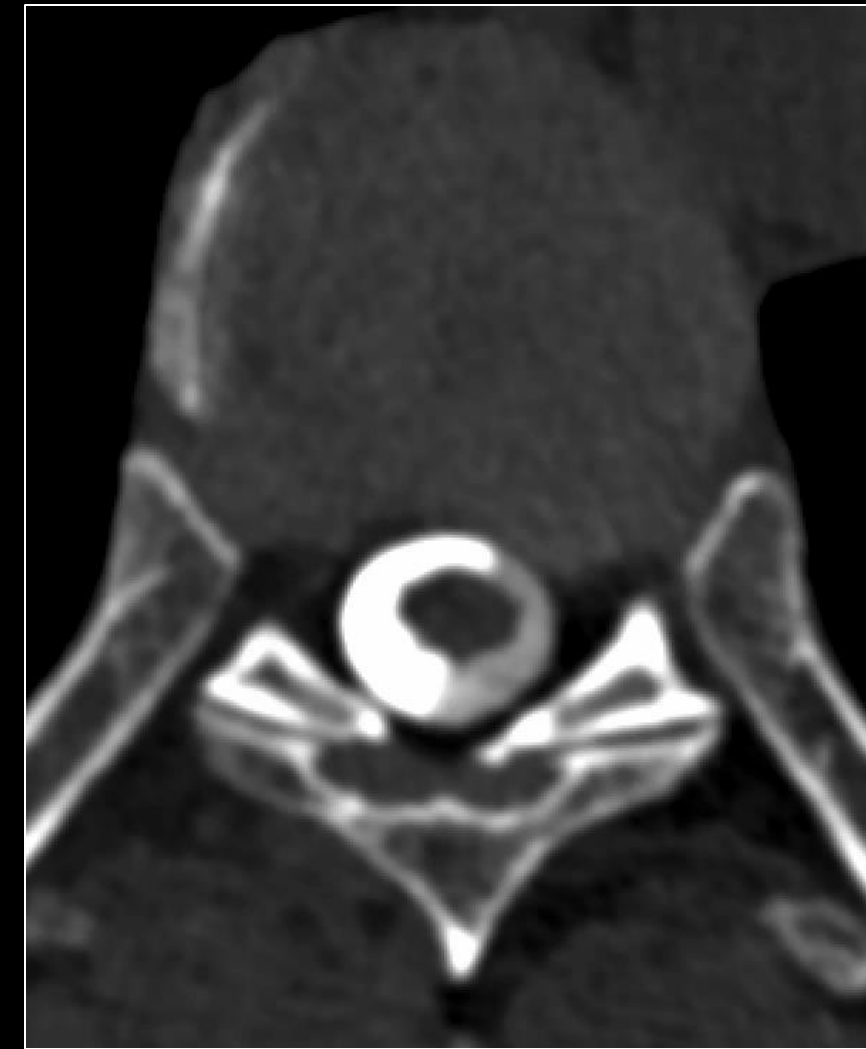
Upper thoracic leaks



Treatment planning

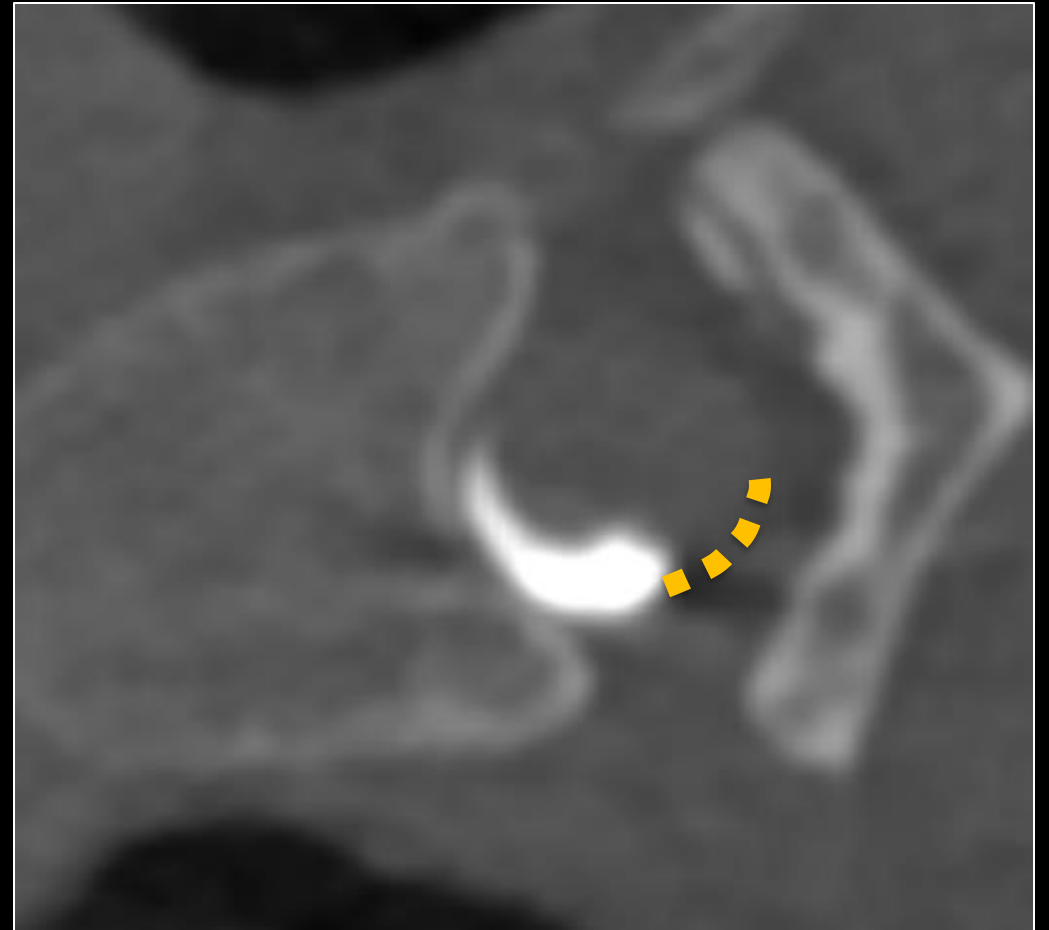


Advantage of CTM: small and transosseous veins

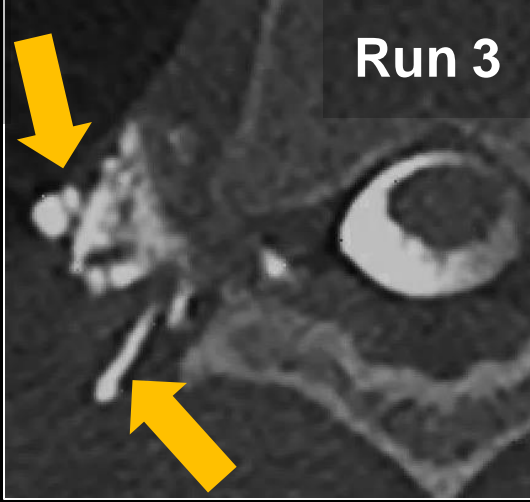
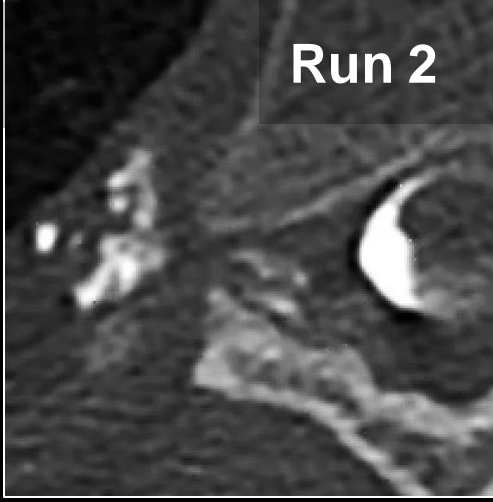
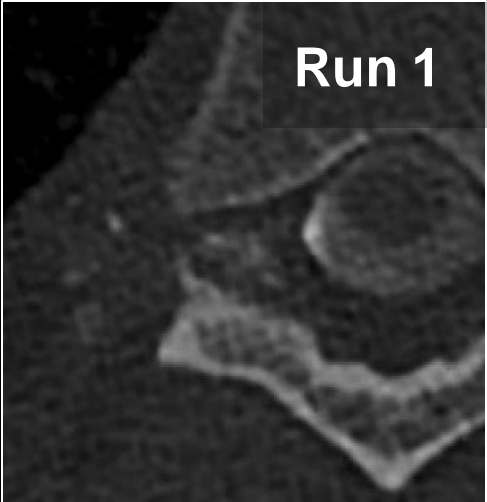
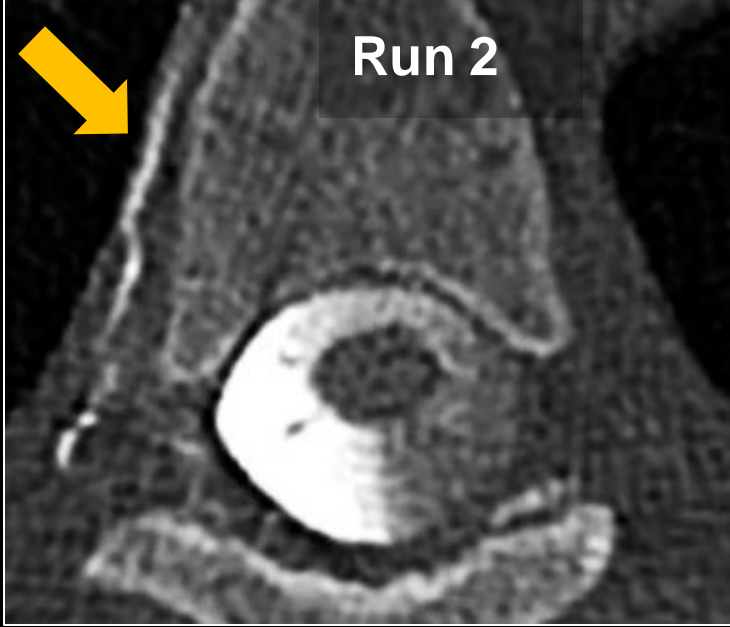


Assessing quality - can be done dynamically

Avoid rotation



CVFs: several phases may be useful



Temporal Characteristics of CSF-Venous Fistulas on Dynamic Decubitus CT Myelography: A Retrospective Multi-Institution Cohort Study

Andrew L. Callen, Mo Fakhri, Vincent M. Timpone, Ashesh A. Thaker, William P. Dillon, and Vinil N. Shah

Timing matters

Density and Time Characteristics of CSF-venous fistulas on CT myelography in Patients with Spontaneous Intracranial Hypotension

Diogo G.L. Edelmuth, Timothy J. Amrhein, and Peter G. Kranz

Density matters

2 phases better than 1

CTM: decreasing radiation dose

Reduce exposure

A screenshot of a CT scanner's control panel. The interface is grey with white text and various input fields. A vertical blue bar is visible in the background. The parameters shown are:

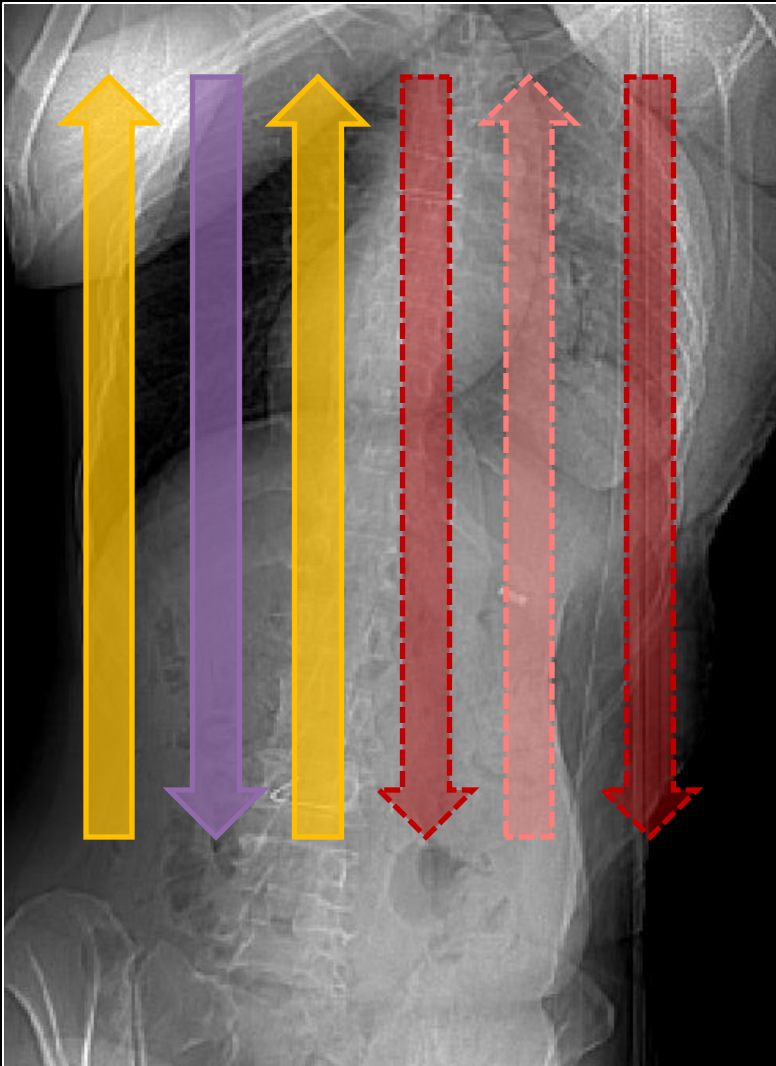
- Eff. mAs: []
- kV: 140
- Scan time: 4.06 s
- Delay: 2 s
- Slice: 0.6 mm Acq.
- No. of images: 401
- Comments: 1st Pass
- Range: Begin 834.0 End 994.0

At the bottom, there are two buttons: "Routine" and "Scan".

Limit coverage



Fewer passes



A low-angle shot of a roller coaster track curving upwards against a clear blue sky. The track is made of reddish-brown metal. A blue vertical pipe is visible in the lower-left foreground.

Dynamic CTM great for capturing leaks

Operator experience is important

Meticulous technique matters

An aerial photograph of a beach with waves crashing on the shore. The water is a deep blue-green, and the sand is a light brown. The image is darkened to serve as a background for text.

Be patient with patient positioning

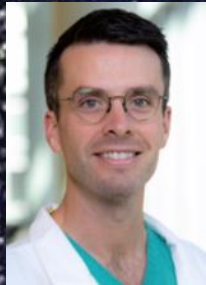
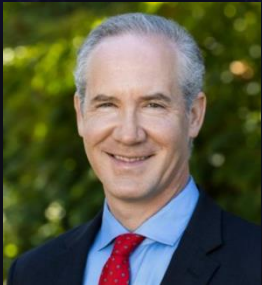
Radiation dose can be reduced

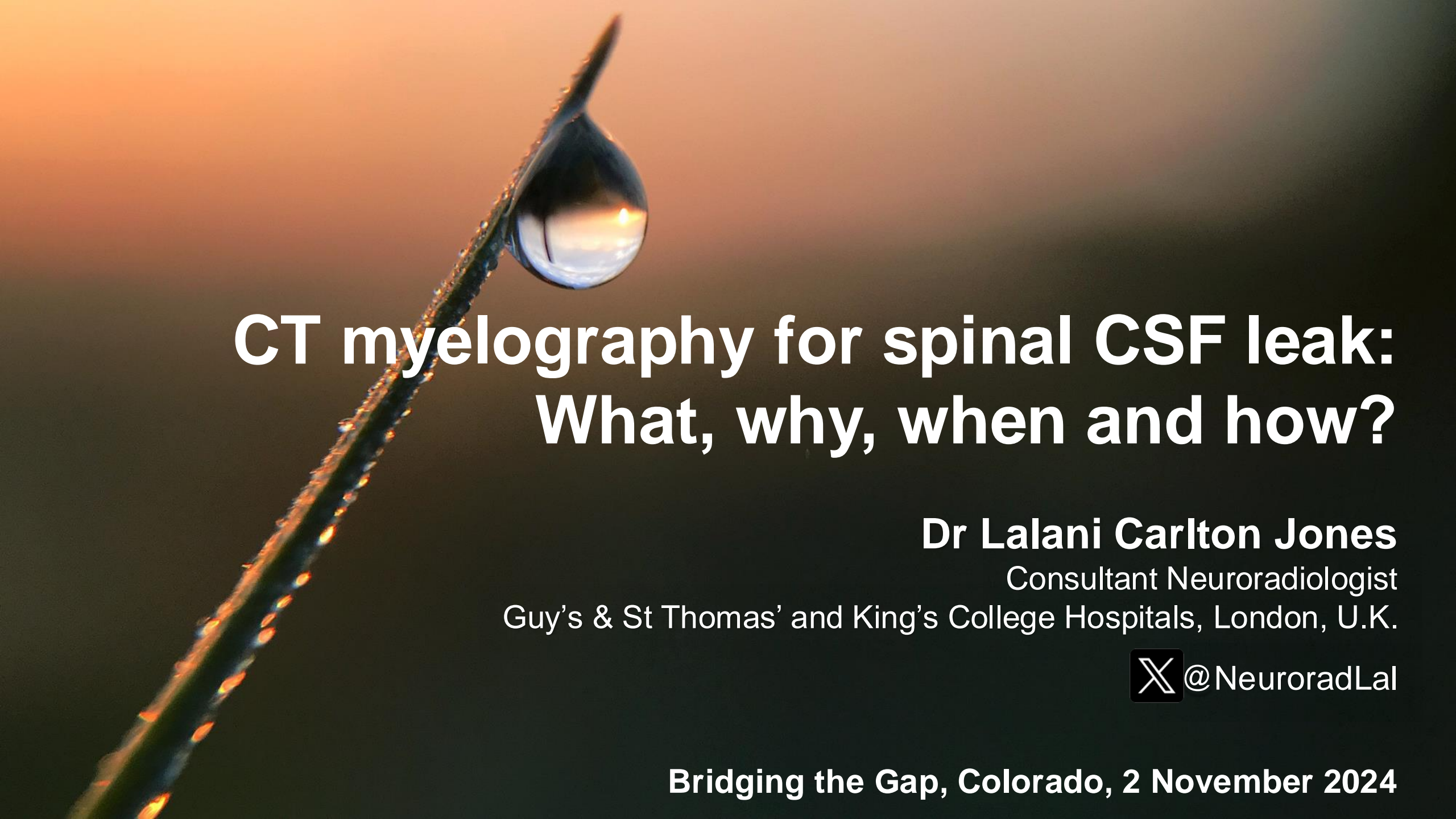
It may take more than one attempt



Guy's & St Thomas' and King's College Hospitals team

Thank you..





CT myelography for spinal CSF leak: What, why, when and how?

Dr Lalani Carlton Jones

Consultant Neuroradiologist

Guy's & St Thomas' and King's College Hospitals, London, U.K.

 @NeuroradLal

Bridging the Gap, Colorado, 2 November 2024