A Care Model for CSF Leaks

Andrew L. Callen MD
Assistant Professor of Neuroradiology
Director, CU CSF Leak Program

University of Colorado
Anschutz Medical Campus

spinal csf leak
FOUNDATION
because your dura maters®

DISCLOSURES

Medical Advisory Board:

Spinal CSF Leak Foundation

Consultant:

Eli Lilly

Back pain

Diplopia

Ataxia

Personality changes

Parkinsonism, torticollis, tremor, chorea

Nausea/Vomiting

Amyotrophic symptoms mimicking ALS

Tinnitus

Dizziness

ORTHOSTATIC HEADACHE

Blurry vision

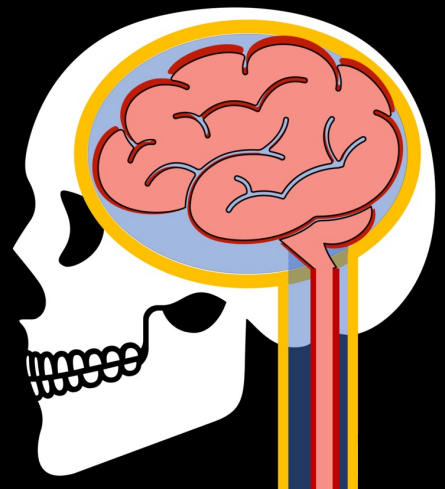
Memory decline

Hearing loss

FTD-like symptoms

Coma

Fatigue

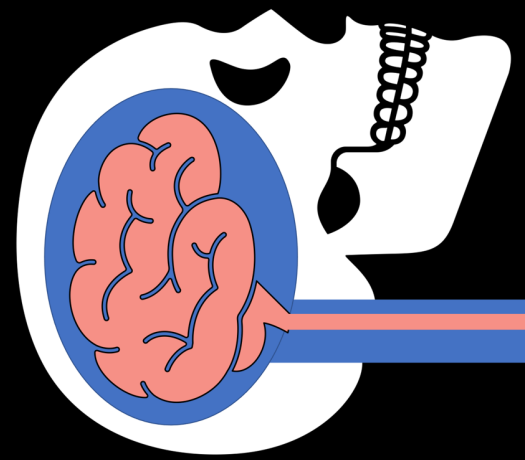


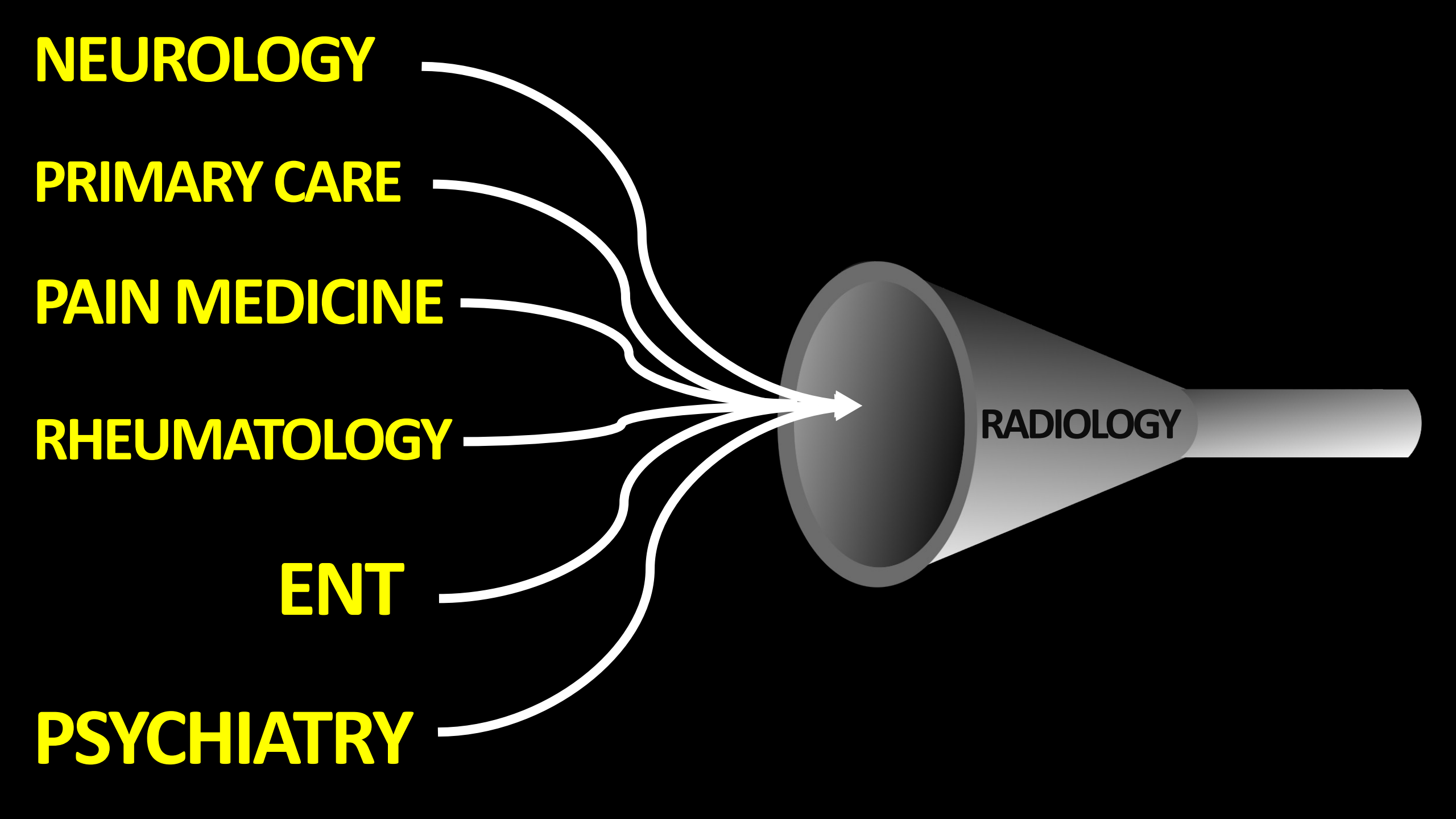
Photophobia

Encephalopathy

Facial numbness or paresthesia

Upper extremity radicular symptoms




NEUROLOGY
PRIMARY CARE
PAIN MEDICINE
RHEUMATOLOGY
ENT
PSYCHIATRY
RADIOLOGY

Why radiologists?

AS RADIOLOGISTS, WE:

May be the first to suggest SIH

Have the procedural skills to localize the leak

Have the procedural skills to treat the leak!

The Traditional Radiology Proceduralist Model Does Not Work for CSF Leaks

By the time the patient arrives for procedure:

- Trust in healthcare ↓
- Understanding of diagnostic/treatment options ↓
- Fear/skepticism ↑

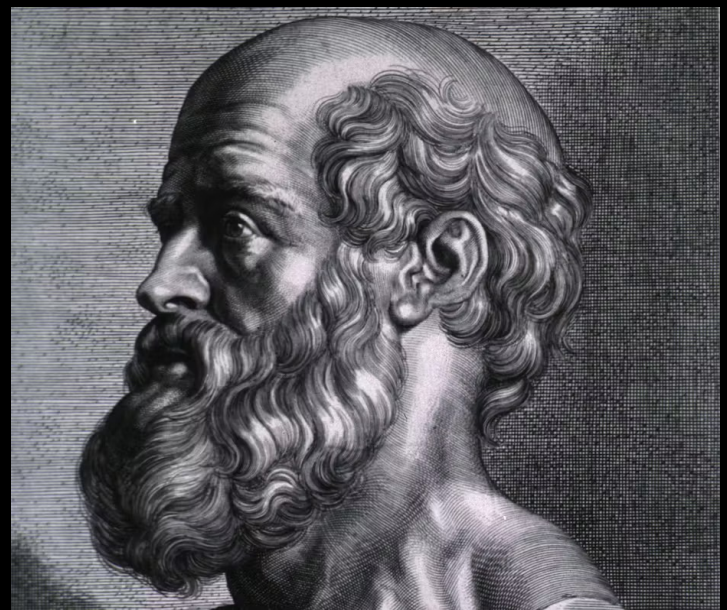
The Traditional Radiology Proceduralist Model Does Not Work for CSF Leaks

By the time the provider arrives for procedure:

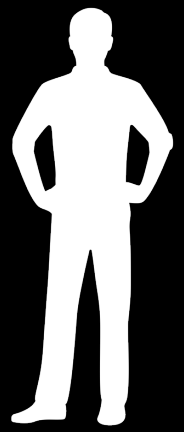
- Understanding of patient's symptoms ↓
- Access to all possible 1st line neuroimaging (and optimal procedure planning) ↓
- Appropriate infrastructure for followup ↓

“it is far more important to know what person the disease has, than what disease the person has”

-Hippocrates



CLINIC VISIT:



Referral to CSF Program

ALL prior imaging, tests, procedures

MRI Brain and Total Spine (CSF Leak Protocol)

- Obtain complete medical history
  - START FROM THE BEGINNING
- Go over imaging together
- Explain diagnostic tests and risks/benefits
- Explain treatment options and risks/benefits
- Obtain Validated Health Metrics

CSF LEAK MULTIDISCIPLINARY CONFERENCE:

Neurology, Neuroradiology, Neurosurgery

Patients without straightforward clinical or imaging presentation

Recommendations documented in patient chart

What if my imaging is “normal”?

JAMA Neurology | Original Investigation

Clinical Presentation, Investigation Findings, and Treatment Outcomes of Spontaneous Intracranial Hypotension Syndrome

A Systematic Review and Meta-analysis

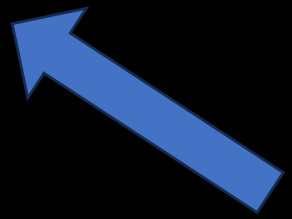
Brain magnetic resonance imaging findings were normal in 19% (95% CI, 13%-24%) of patients.

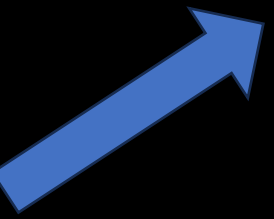
“radiology is not a CBC”

-Soonmee Cha, MD

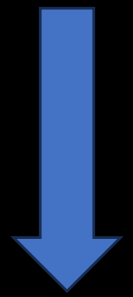
True Negatives

False Negatives





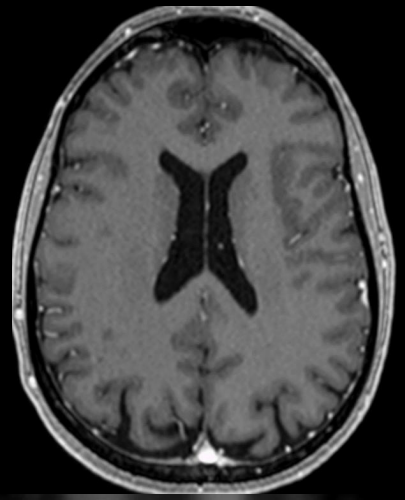
The 'Normal' SIH Brain



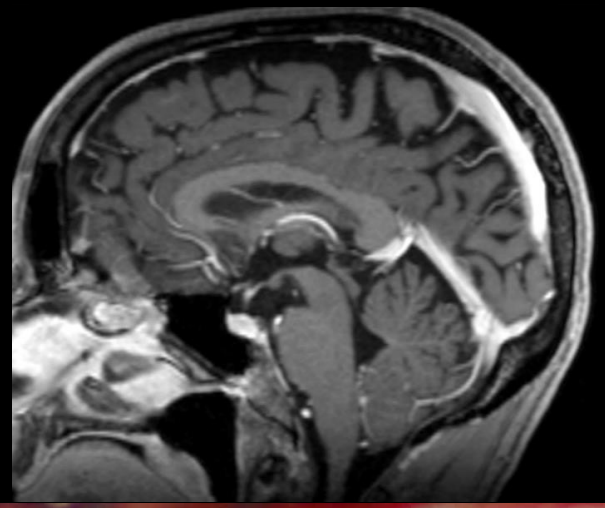
'Normalization' Over Time

1. True Negative

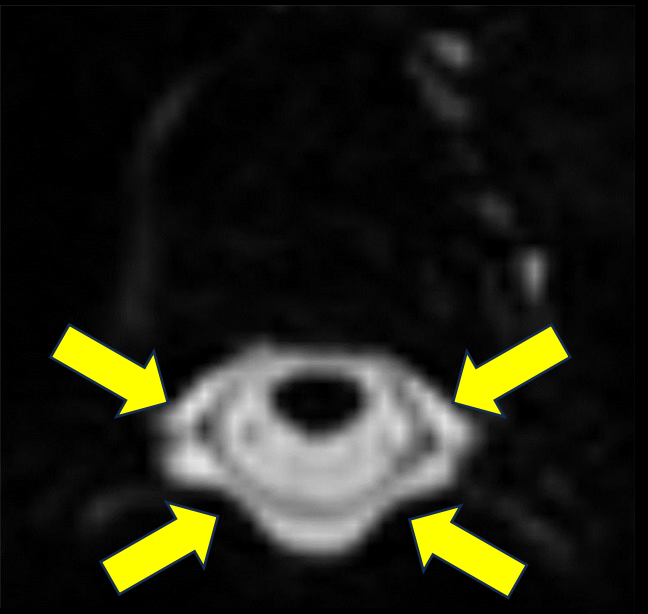
Preop Ax T1+C



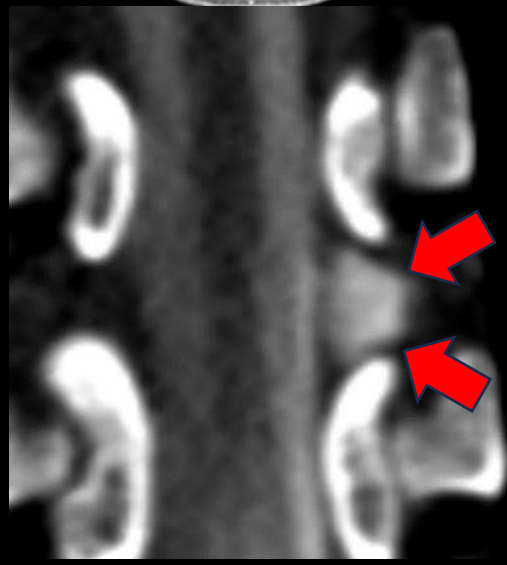
Preop Sag T1+C



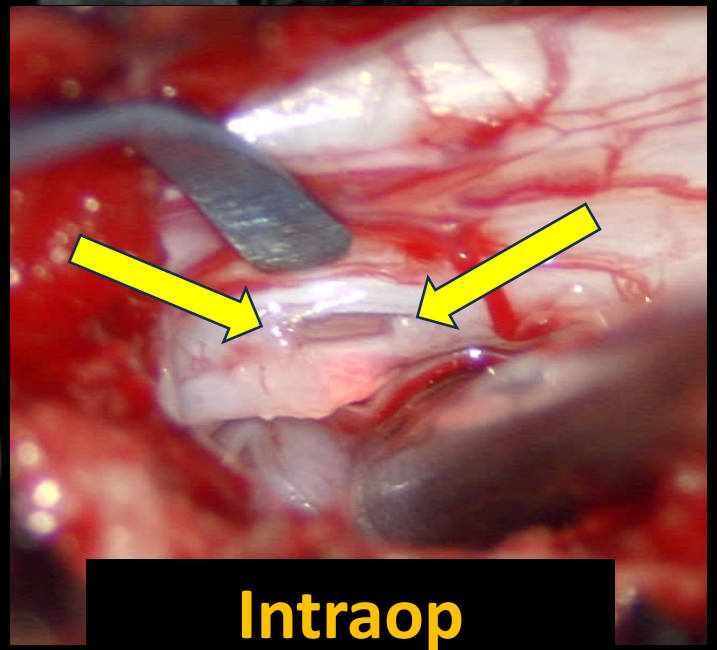
Preop Sag STIR



Preop Ax 3DT2FS



Dynamic CTM



Intraop

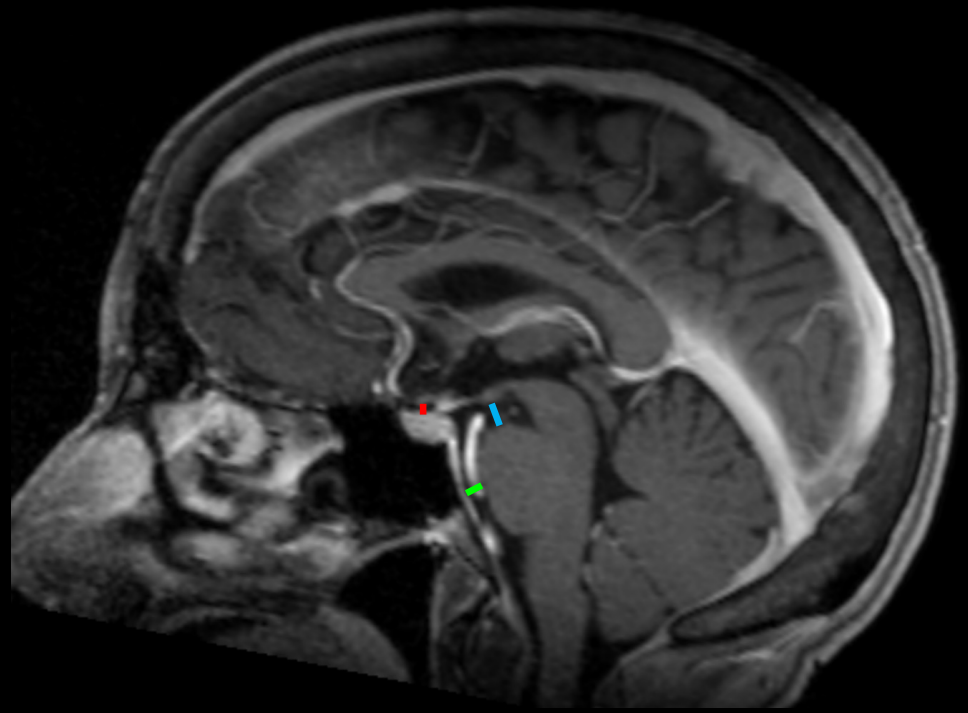
Postop Sag STIR

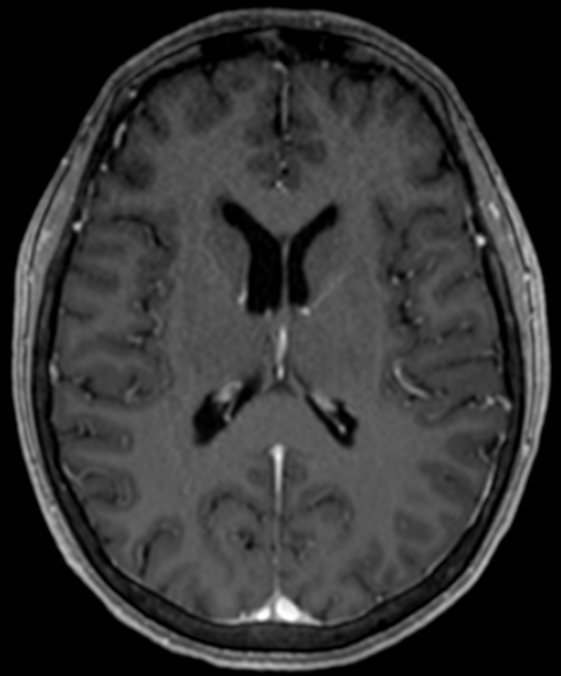
Postop Ax 3DT2FS

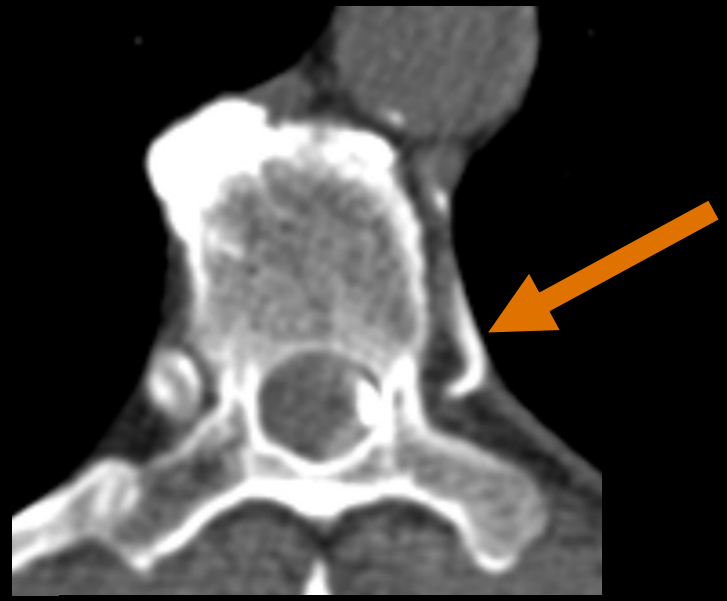
2. False Negative

IMPRESSION: ~~"No evidence of SIH."~~

Bern = 4 (intermediate probability)







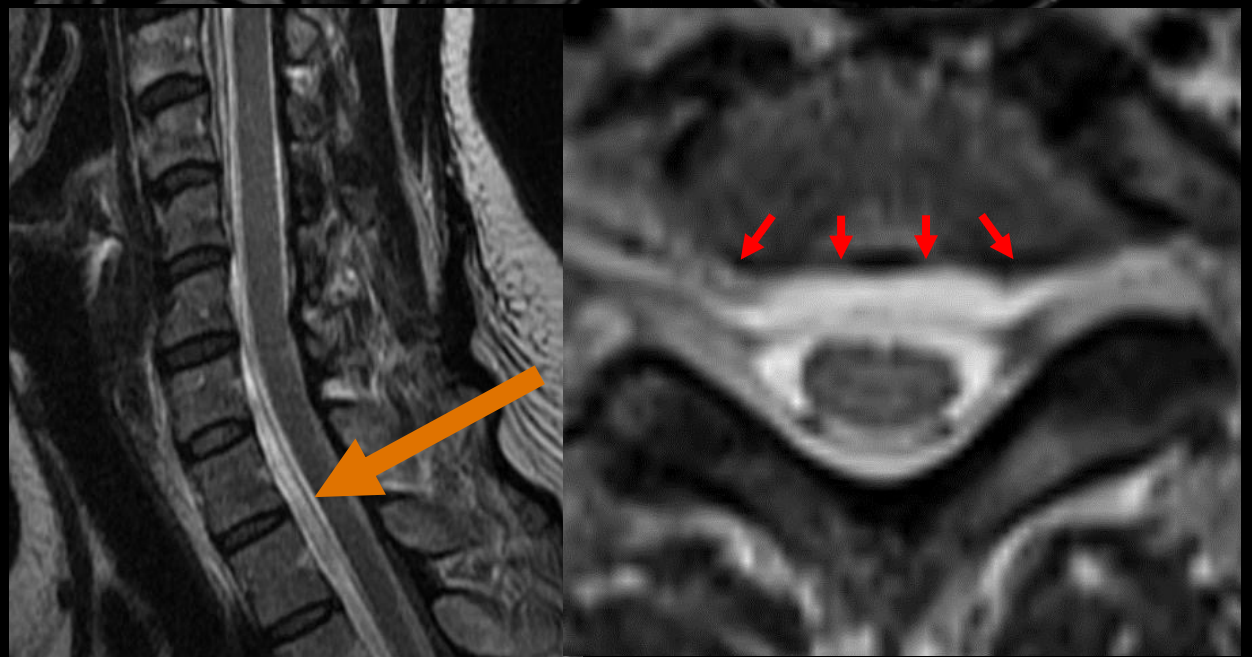
Left T7-8 CVF

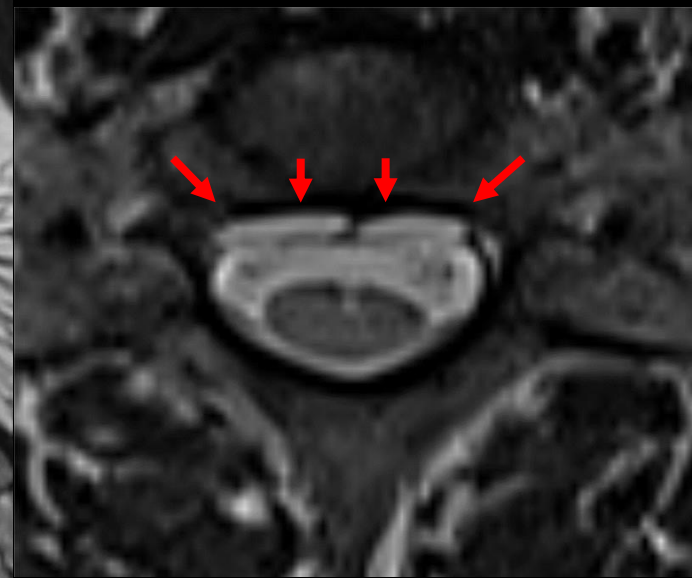
SSD 1 mm
MPD 4.8 mm
PPD 3 mm

- No dural thickening
- No subdural collection
- No venous engorgement

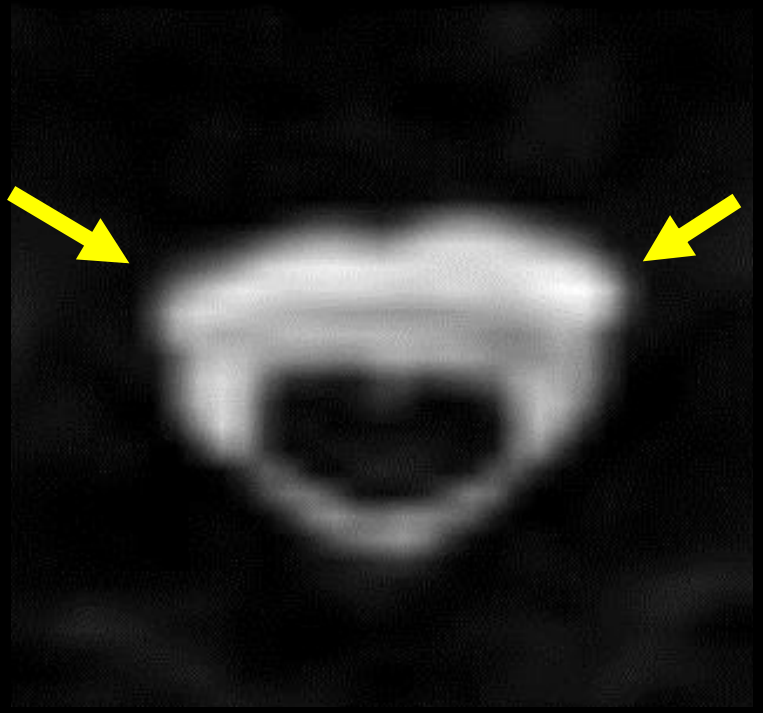
3. ‘Normalization’ Over Time

2018 → Nontargeted EBP → 2023



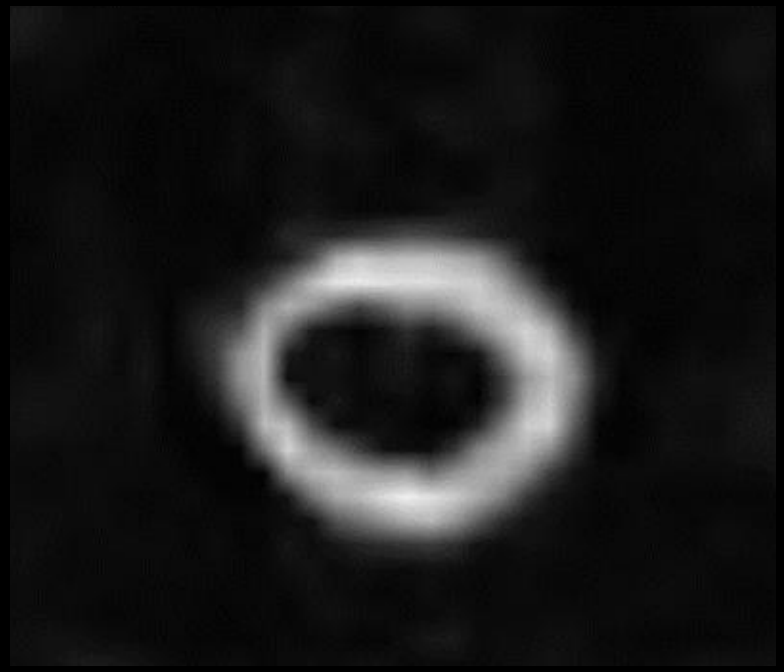


PREOPERATIVE



PREOP HIT6 = 68

POSTOPERATIVE



POSTOP HIT6 = 48

(HIT6 range: 36-78)

BERN SCORE:

The Likelihood of *Finding* a Leak on a CTM

NOT: The likelihood that patient HAS a leak

NOT: A reflection of clinical severity

NOT: Likelihood of response to patching

STANDARDIZED REPORTING

↓ discordance vs expert blinded reader

(44% vs 17%, p = 0.05)

Less false “negatives”

No false positives

Most missed :

PPD > SSD > MPD > Venous

SIH Bern Score:
-Subdural collections: [ ] [1 point if present]
-Mamillopontine distance: [ ] mm (normal > 6.5 mm) [1 point if narrowed]
-Prepontine cistern distance: [ ] mm (normal > 5 mm): [1 point if narrowed]
-Dural venous engorgement: [ ] [2 points if present]
-Suprasellar cistern distance: : [ ] mm (normal > 4 mm) [2 points if narrowed]
-Dural thickening: [ ] [2 points if present]

Total Score: [ ]
IMPRESSION:
1. [Normal MRI of the brain - no findings to suggest intracranial hypotension.]
2. Total SIH Score: [ ]

Low Probability: 2 points or fewer
Intermediate Probability: 3 to 4 points
High Probability: 5 points or more

Reference: Dobrocky et al. Assessing Spinal CSF Leaks in SIH With a Scoring System Based on Brain MRI Findings. JAMA Neurology 2019.

Turner, Zander, Thaker, Timpone, Callen. AJR 2023

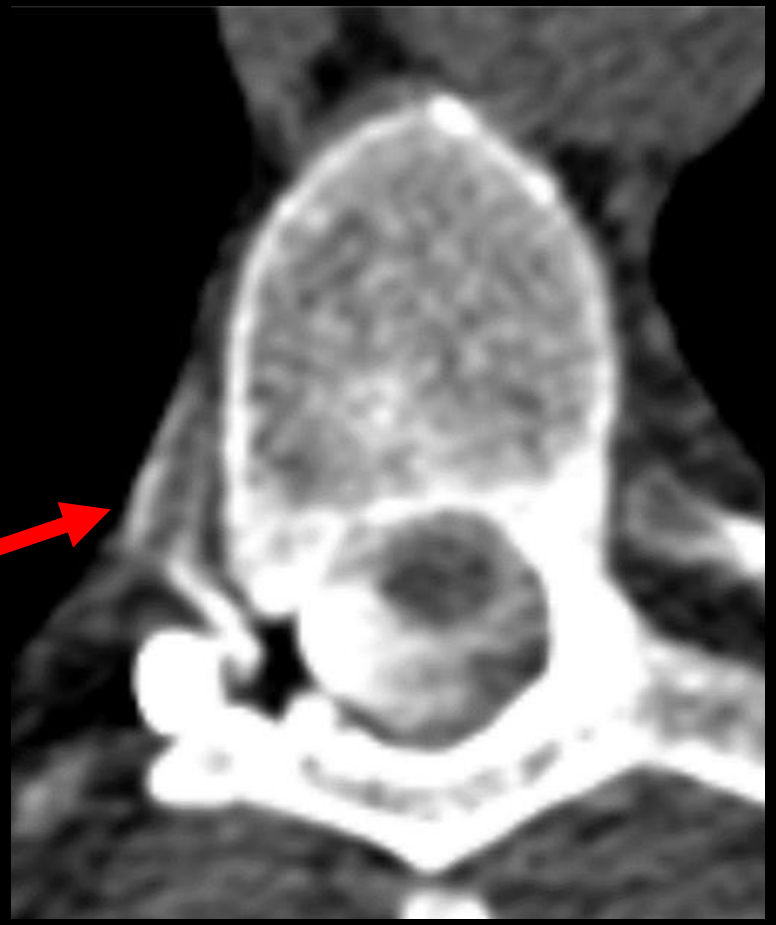
NOT ALL MYELOGRAMS ARE CREATED EQUAL

61M, YEARS OF ORTHOSTATIC HEADACHE

2016: CTM
"No leak"

2021 Diagnosis:

SIH due to CVF



2021: DYNAMIC CTM

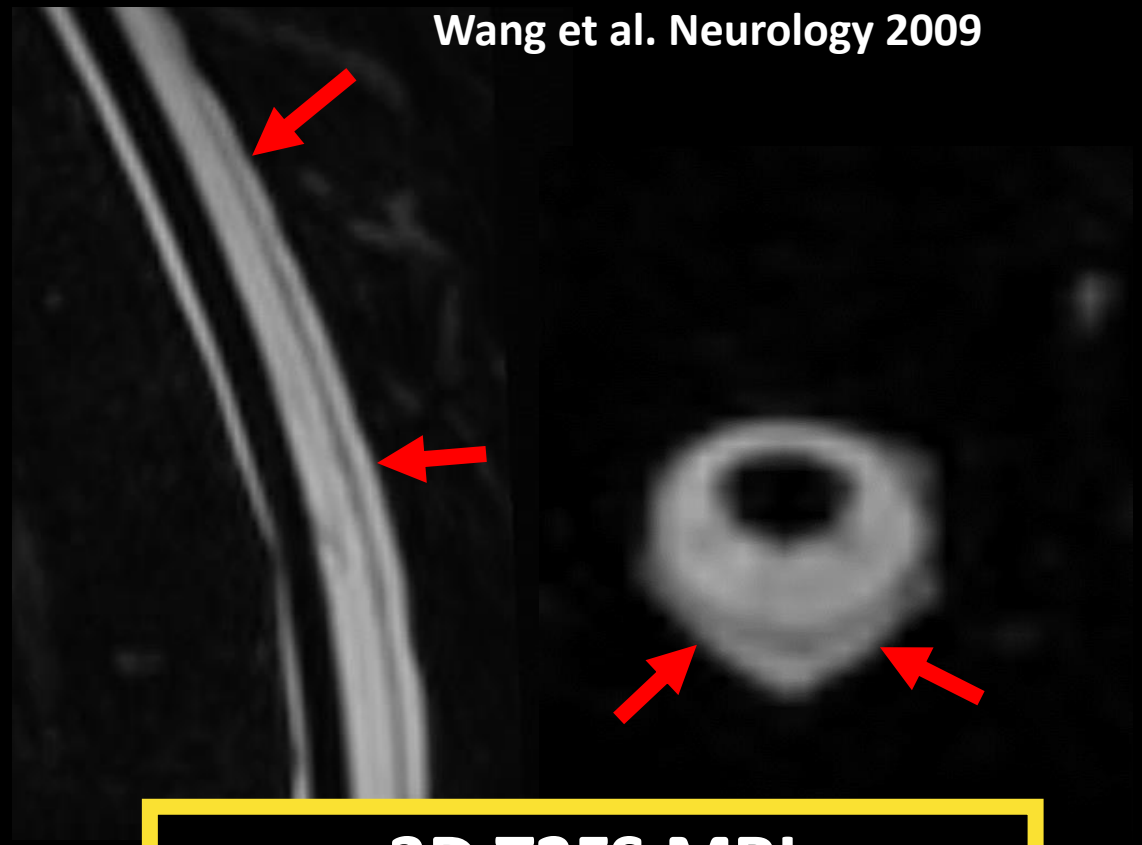
‘CONVENTIONAL’ CTM IN SIH:

Is there a role?

Probably not.

Tay et al. JAMA Neurology 2021
Wang et al. Neurology 2009

Conventional CTM



3D T2FS MRI

Myelography: Definitions

Conventional CT Myelogram

Digital Subtraction Myelogram

Myelography: Definitions

Conventional Myelogram	CT Myelogram	Dynamic CT Myelogram	Digital Subtraction Myelogram
Poor temporal resolution			Excellent temporal resolution
Good spatial resolution			Excellent spatial resolution
Large (entire) FOV			Limited FOV
Assess contributory surrounding anatomy			Superimposition artifacts
			Anesthesia support

Myelography: Definitions

Spine

Original research

Direct comparison of digital subtraction myelography versus CT myelography in lateral decubitus position: evaluation of diagnostic yield for cerebrospinal fluid-venous fistulas

Niklas Lützen, [1] Theo Demerath, [1] Urs Würtemberger, [1] Nebiyat Filate Belachew, [1] Enrique Barvulsky Aleman, [1] Katharina Wolf, [2] Amir El Rahal, [2] Florian Volz, [2] Christian Fung, [2] Jürgen Beck, [2] Horst Urbach [1]

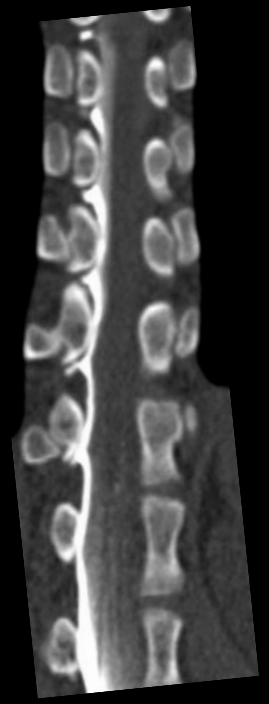
Dynamic CT Myelogram

Inject on CT table: scan immediately + multiple phases

Poor temporal resolution

Very good temporal resolution

Excellent temporal resolution



Sub mm slices

Good spatial resolution

Excellent spatial resolution

Large (entire) FOV

Limited FOV

Assess contributory surrounding anatomy

Superimposition artifacts

Anesthesia support

Treat in same setting

CSF AND VENOUS PRESSURES

Inspiration: ↑ **conspicuity of CVF**

Amrhein et al AJNR. 2020

'Resisted' Inspiration:

↓ P_{venous} **and** ↑ P_{CSF}

Mark et al AJNR. 2022

GOAL:

CSF Pressure >> Venous Pressure

WHAT IS IT LIKE TO GET A DYNAMIC CT MYELOGRAM?

FREQUENTLY ASKED QUESTIONS

Will I be put to sleep?

No, we do most of these exams with local anesthetic, but can use moderate sedation if needed.

FREQUENTLY ASKED QUESTIONS

What about PDPH?

We perform all dCTM with a noncutting spinal needle. If you develop a new/worse headache afterwards, we will patch you.

FREQUENTLY ASKED QUESTIONS

Does it hurt?

<u>Two parts of the exam can be uncomfortable:</u>

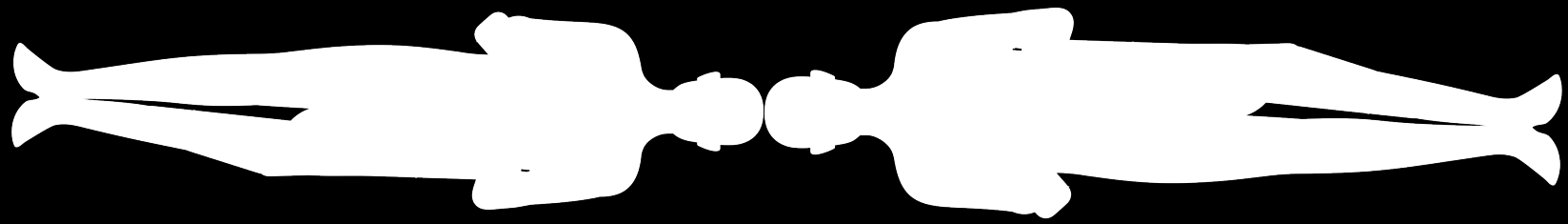
- ***Numbing of the skin/needle entry***
- ***During contrast dye injection, its possible you can develop a headache during the exam. This usually goes away in ~30 min***

FREQUENTLY ASKED QUESTIONS

Does it require two days?

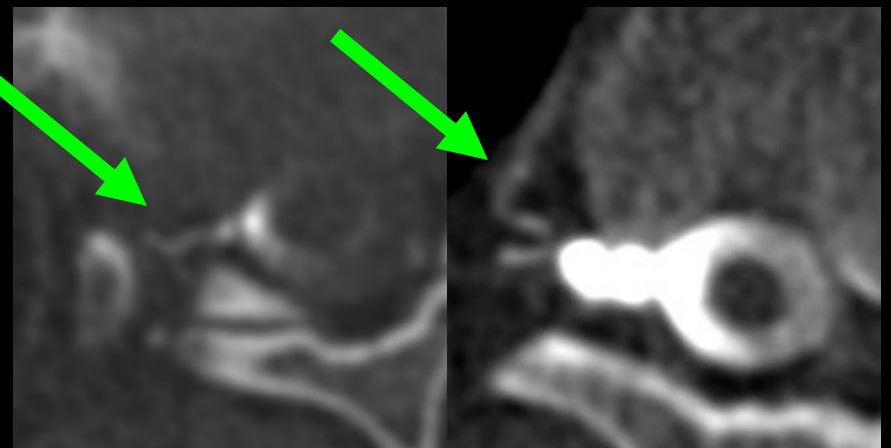
DSM requires two days. We can often get a bilateral exam on dCTM in one day. We can usually tell based on the quality of the exam if a second day is needed.

DO YOU NEED A SECOND DAY?

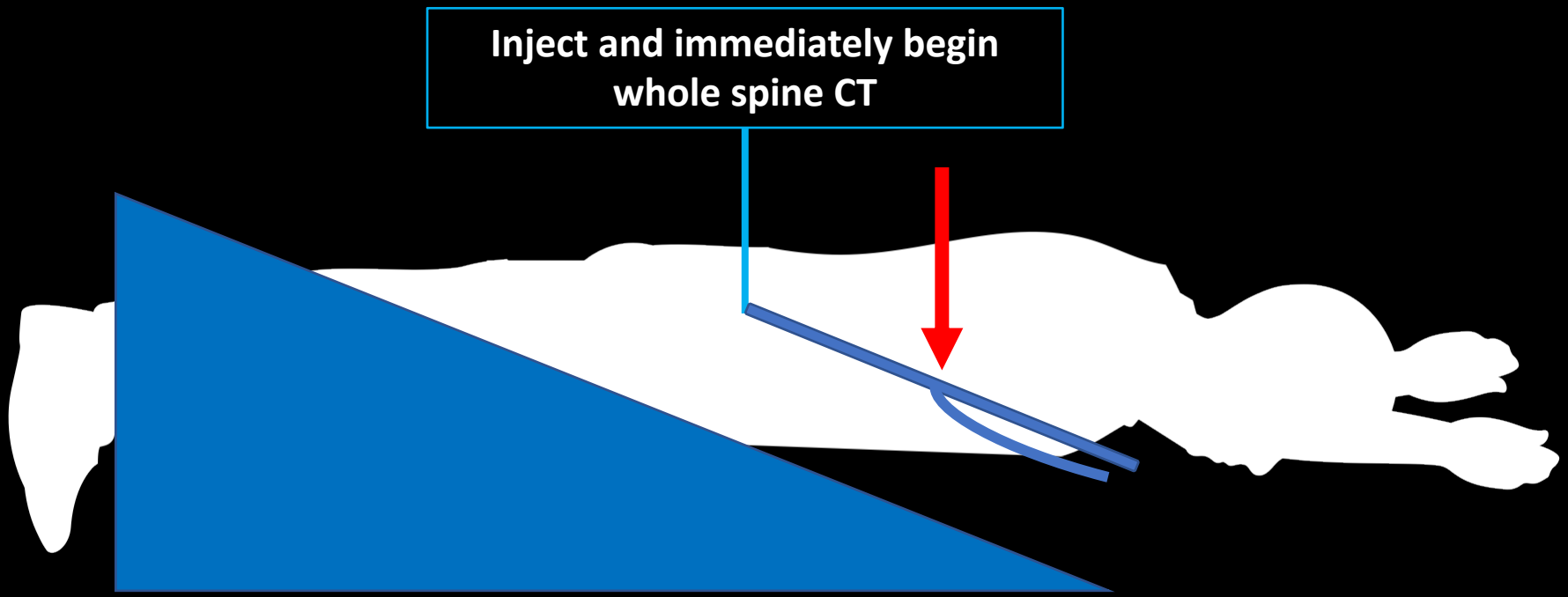


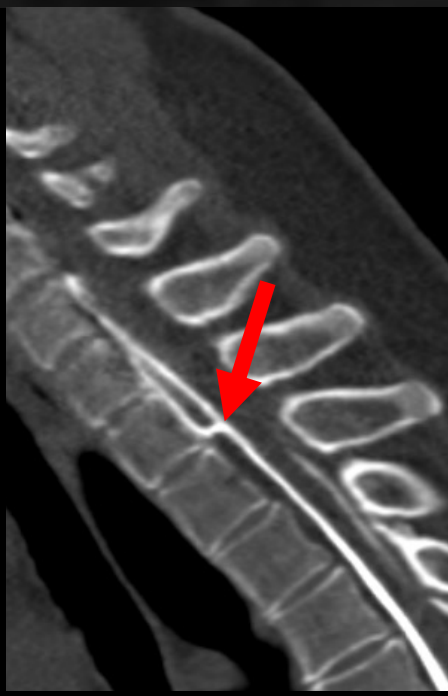
- DSM requires two days (1 for each side)
- Flip and rebolus works on dCTM

  Carlton Jones AJNR 2022
- **Flip without rebolus also works!**



SUSPECT FAST LEAK:
(spinal epidural fluid present)

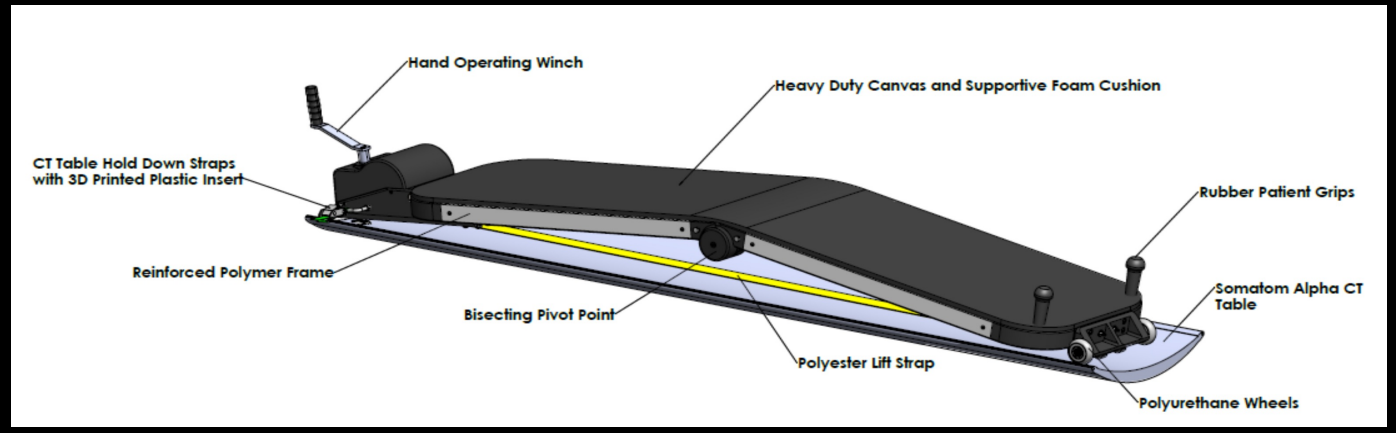


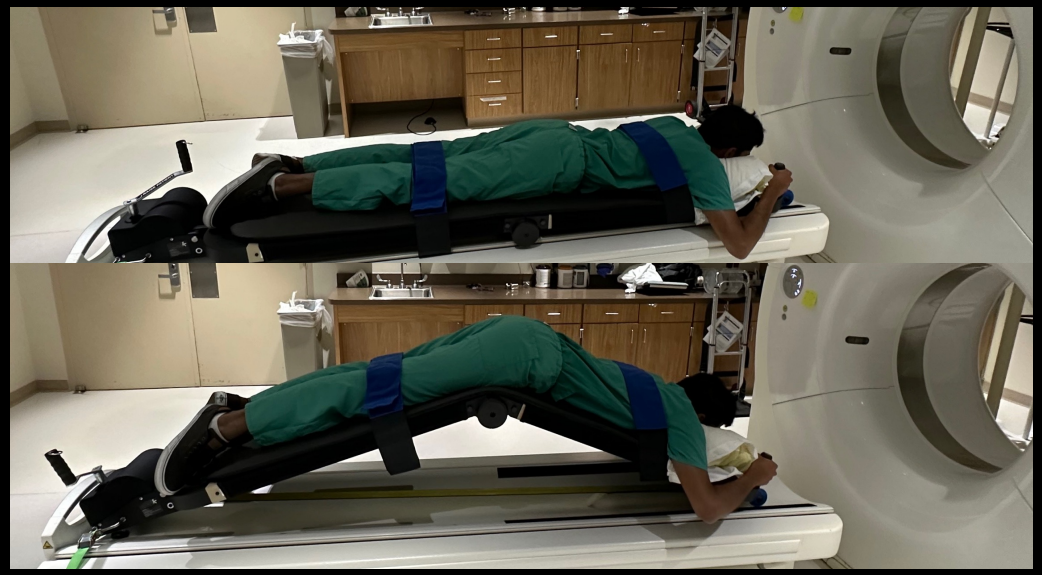


AJNR
AMERICAN JOURNAL OF NEURORADIOLOGY

A Novel Patient-Positioning Device for Dynamic CT Myelography

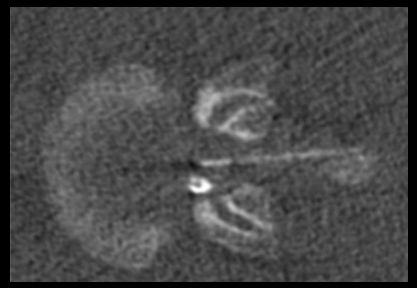
Andrew L. Callen, Rich Wojcik, and Michael Bojanowski





DYNAMIC CTM for CVF: TECHNIQUE

1. Access

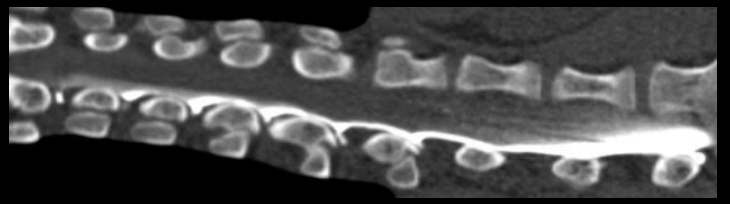


2. Measure OP

3. ⬆ pressure with saline to ~25-30 cm H2O

4. Elevate Hips

5. Infuse 5-10 cc 300m contrast

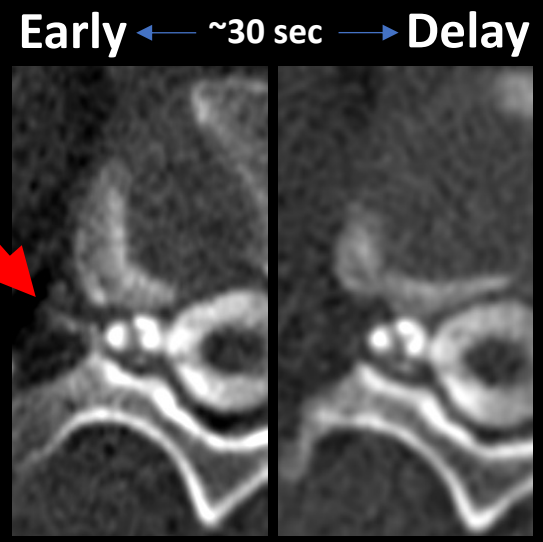


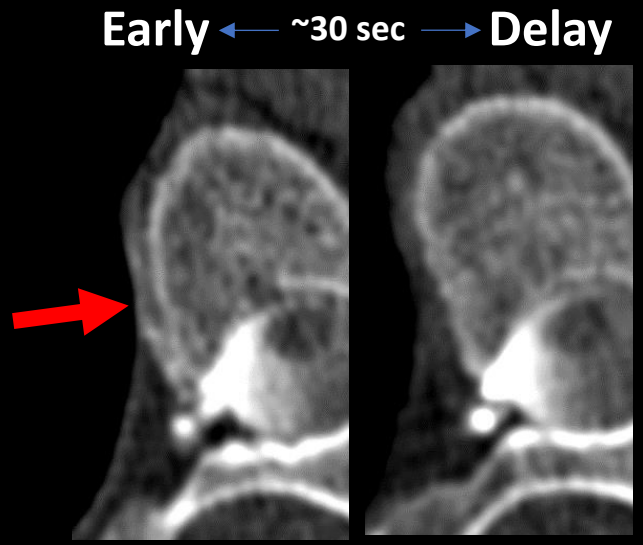
6. 2 full length scans in succession

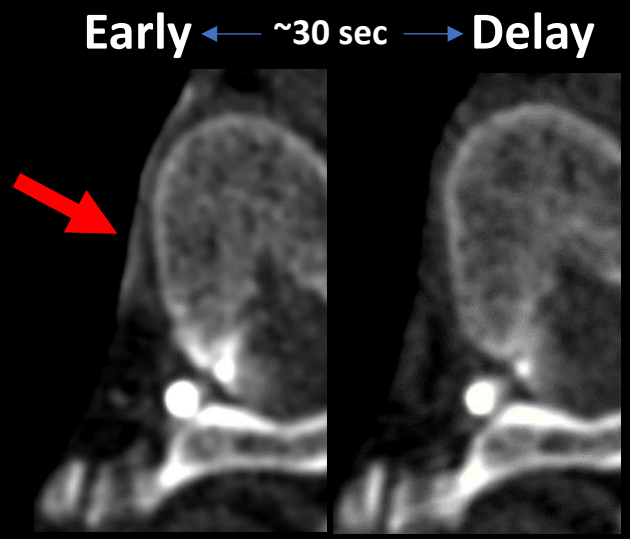
(Resisted inspiration through 1 cc syringe)

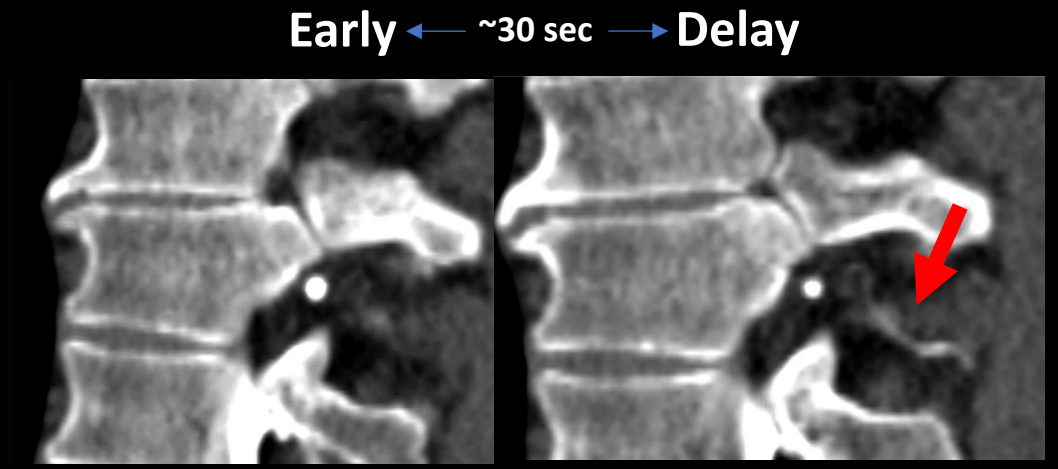
7. Infuse remainder of contrast, flip and rescan

Multiple Phases = ⬆ Temporal Resolution



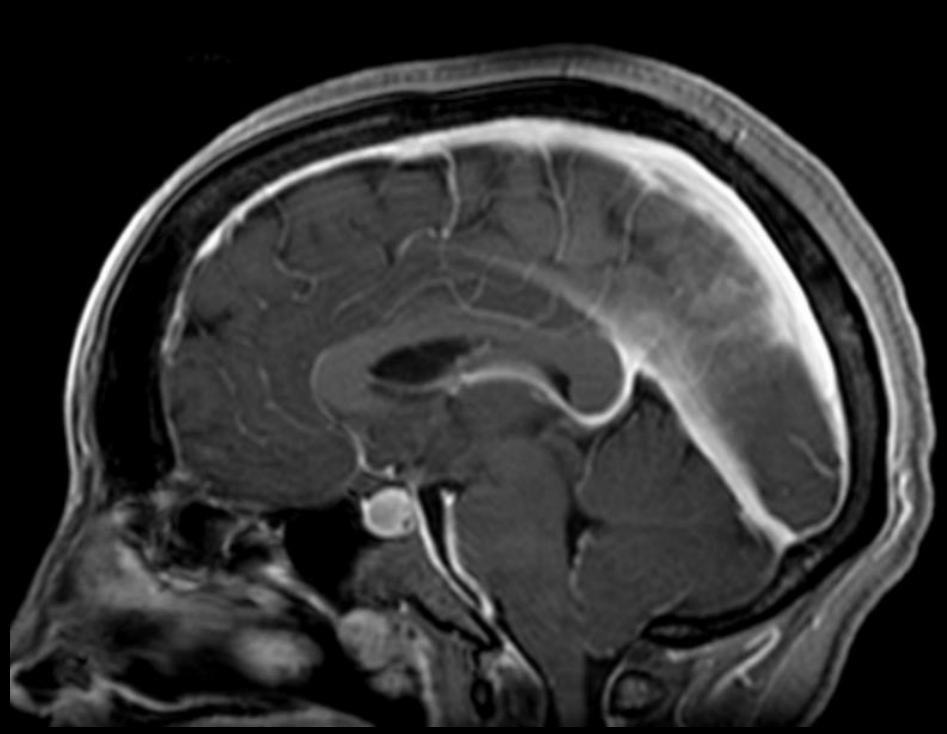






Callen et al AJNR 2023 (In Press)

May have to repeat if high suspicion…



R T8-T9

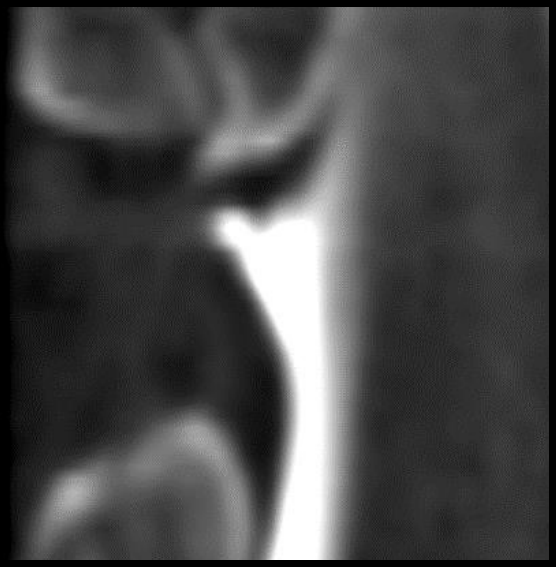
R T8-T9, one week later

MAY HAVE TO REPEAT AFTER TREATMENT

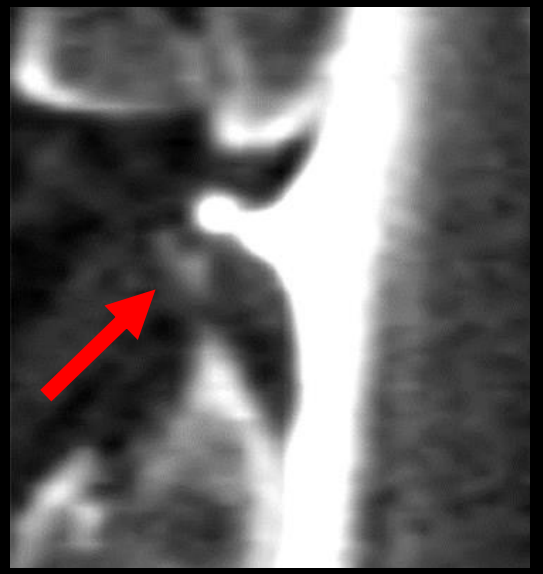
persistent symptoms post embolization

L decub T10-11

Onyx Embolization



R decub T11-12
pre embo



R decub T11-T12
post embo

CVF TREATMENT OPTIONS

Efficacy

Invasiveness

FIBRIN OCCLUSION

- perform same day as dCTM
- multi-site data: ~59% cure rate*
- needle placement matters!*

ONYX EMBOLIZATION

- high cure rate
-less multi-site data

SURGICAL LIGATION

- 95%-100% cure rate
-may require root ligation

*

Factors Predictive of Treatment Success in CT-Guided Fibrin Occlusion of CSF-Venous Fistulas: A Multicenter Retrospective Cross-Sectional Study

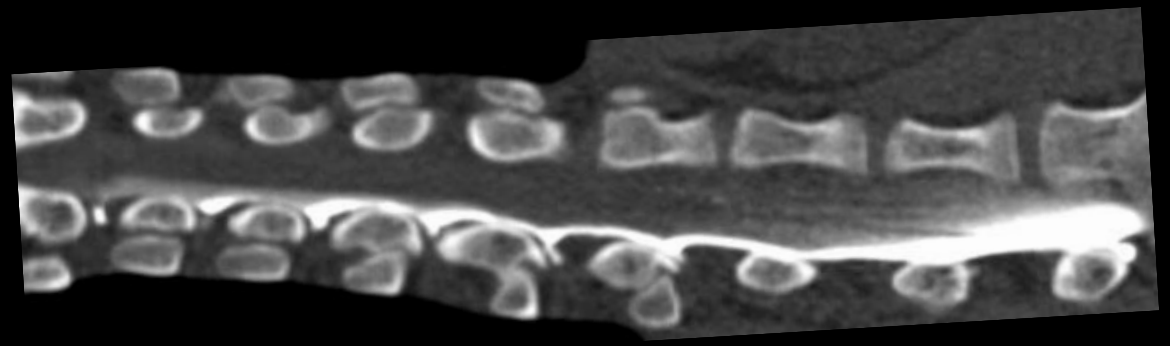
Andrew L. Callen, Lalani Carlton Jones, Vincent M. Timpone, Jack Pattee, Daniel J. Scoffings, David Butteriss, Thien Huynh, Peter Y. Shen, and Mark D. Mamlouk

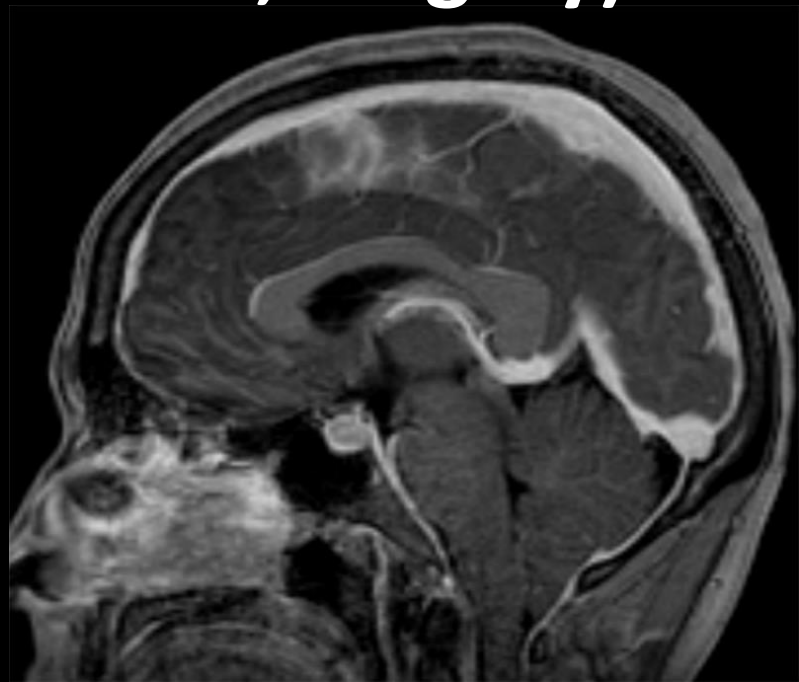
MYELO OR PATCH FIRST?

High Probability MRI Brain (Bern ≥ 5):

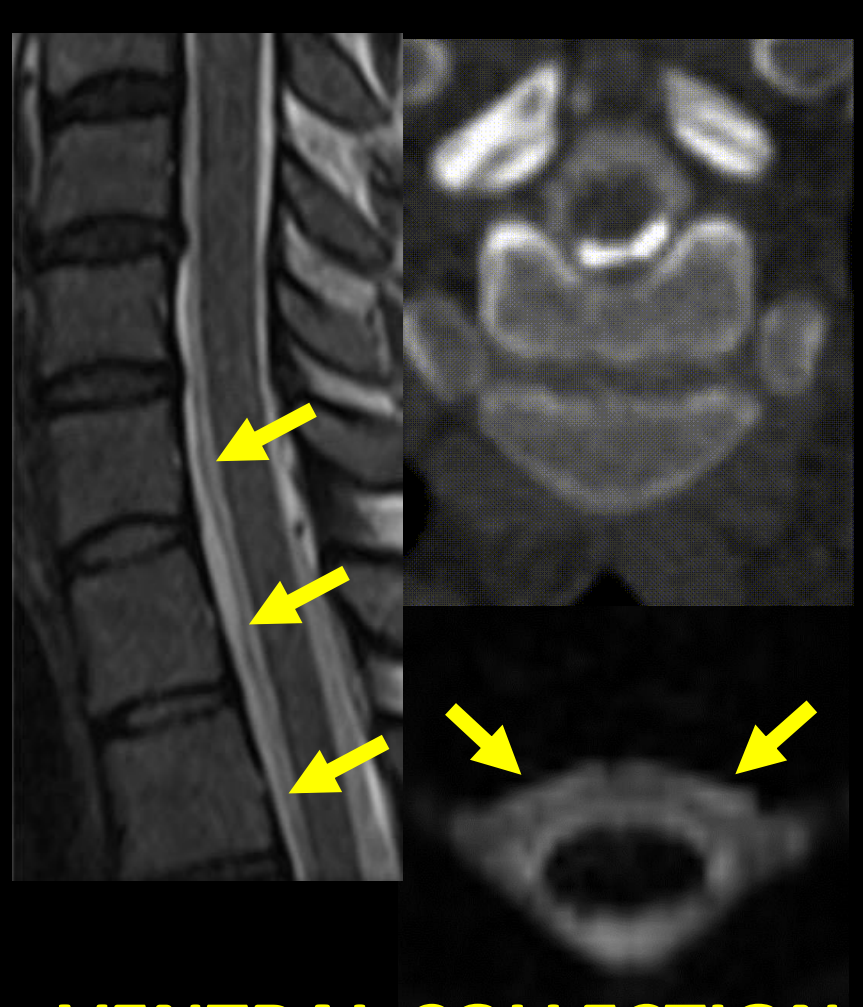
- **Myelography**: tailored to leak type (SPINE MRI!)

- **Treatment**: Shared decision making
  - Risks/benefits of all options (patching, embo, surgery)
  - Concurrent referral to Neurosurgery (Even if not surgery first line!)

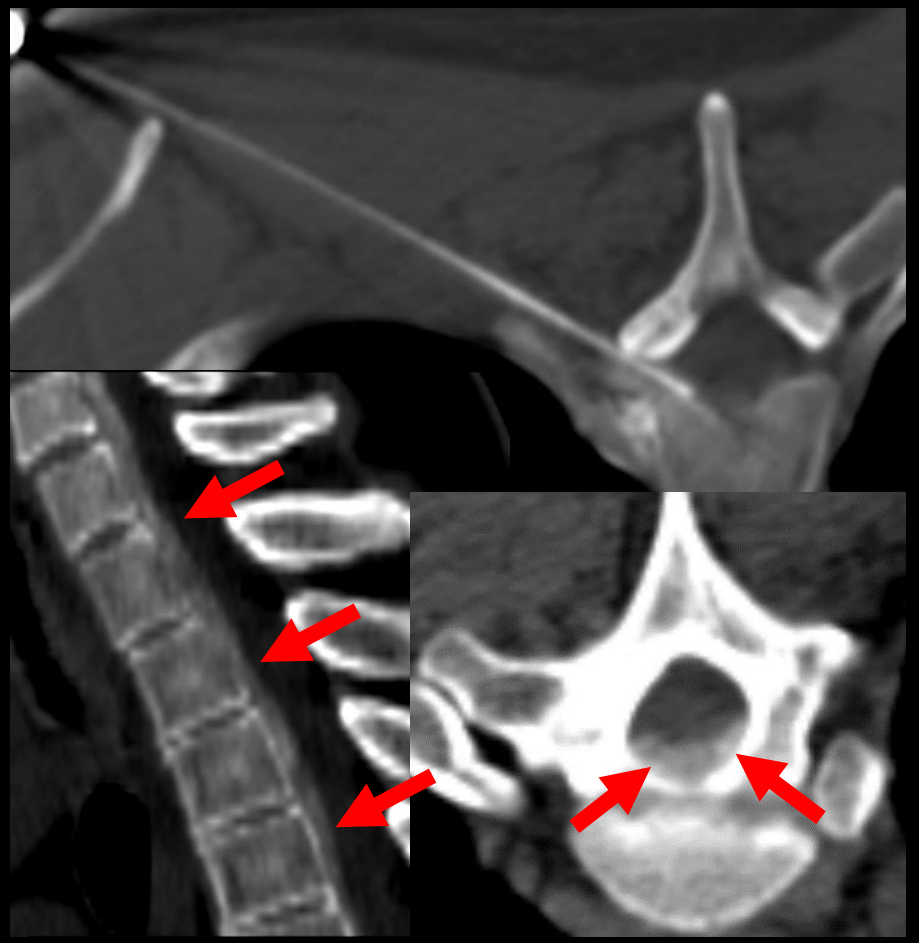




35M SIH Prior Nontargeted EBP x 2



VENTRAL COLLECTION
T1-2 DEFECT



TARGETED PATCH

RESOLUTION

Intermediate probability brain (Bern 3-4), no fluid on spine:

- Myelography: suspect CVF, possibly slow leaking cyst

- Patching: “nontargeted” vs “targeted”
  - ‘Soft’ targets: Cysts, osteophytes, ??? veins

Bern Score 0-2, no fluid on spine:

Myelography versus empiric patching

Weighing yield of the myelo vs potential PDPH

Considering

- Age of Patient
- Radiation Exposure
- Connective Tissue Disease?

FOLLOWUP:

1 week and 1 month post intervention (minimum)

Repeat imaging if pre was abnormal

Next steps? Repeat patch? New diagnostic study? Referral?

CONCLUSION:

Radiologists are central to the care of patients with CSF Leaks

Traditional proceduralist models do not work for CSF Leak Care. Establishing a patient relationship is critical.

Multidisciplinary collaboration and longitudinal follow-up are keys for success

THANK YOU!

Samantha Petrucci, MD PhD

Nadya Andonov, NP

Andrew.Callen@cuanschutz.edu

@AndrewCallenMD

University of Colorado
Anschutz Medical Campus

spinal csf leak
FOUNDATION
because your dura maters®