

Current SIH Diagnostic Imaging

Marcel Maya, MD

Cedars Sinai

CEDARS TEAM

Wouter I. Schievink, MD
Rachelle B. Tache, NP

Marcel M. Maya, MD
Franklin G. Moser, MD
Ravi S. Prasad, MD
Vikram Wadhwa, MD

Neurosurgery

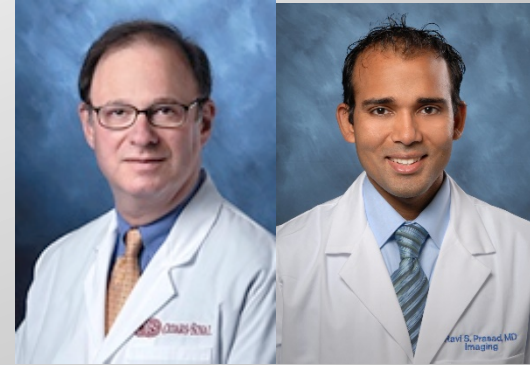
Neuroradiology

Ronald Andiman, MD

Headache
Medicine

Charles Louy, MD
Howard Rosner, MD
Mary A. Vijjeswarapu, MD

Anesthesiology



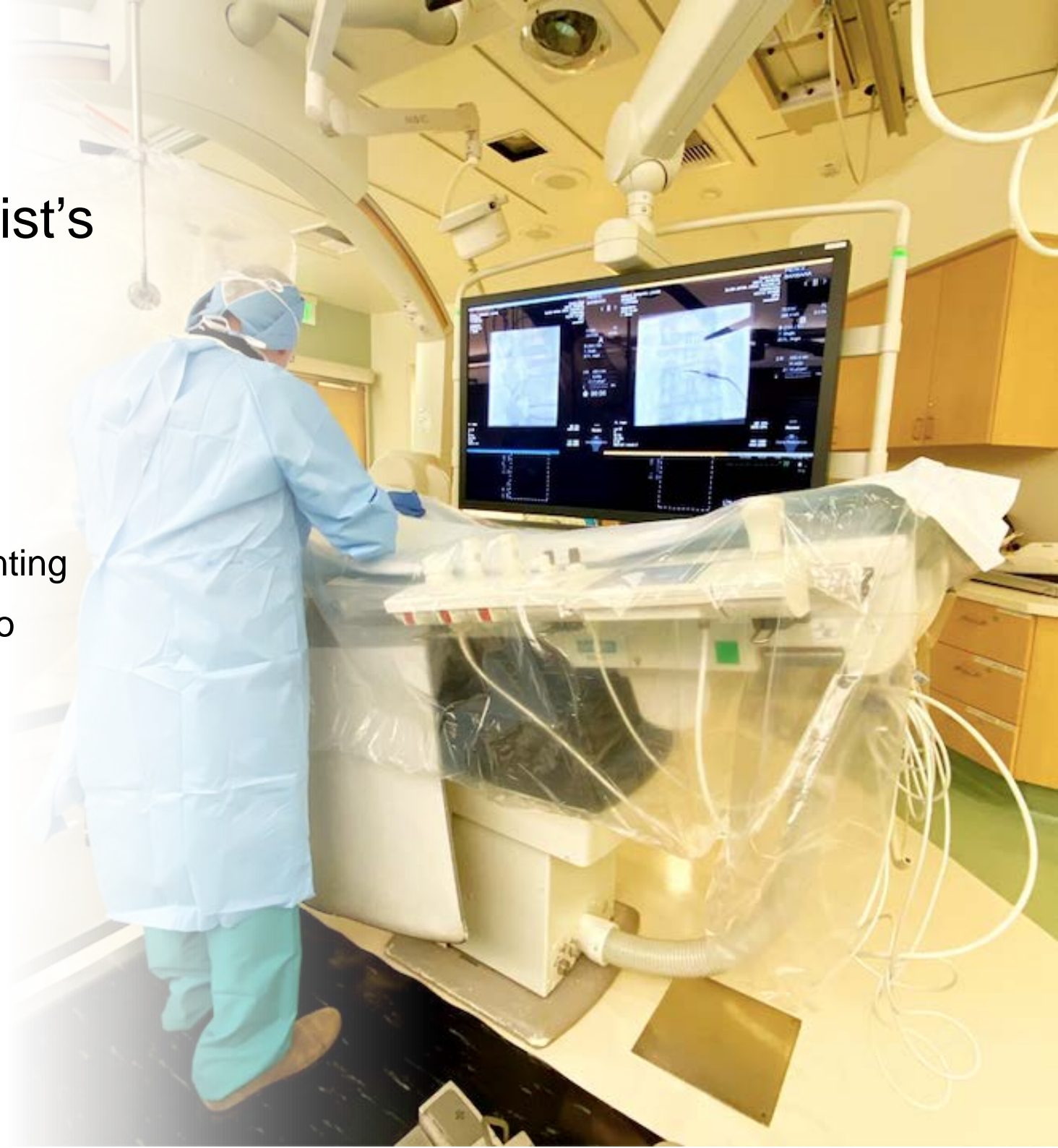


SIH: A Neuroradiologist's Disease

- Craniospinal neuroanatomy
- Old and new diagnostic techniques/tools
 - LP
 - myelogram
 - CT
 - MR

SIH: A Neuroradiologist's Disease

- Interventional skills
 - EBP, Fibrin glue
 - Venous Sinus stenting
 - Spinal fistula embo



Normal Brain

Monro-Kellie hypothesis

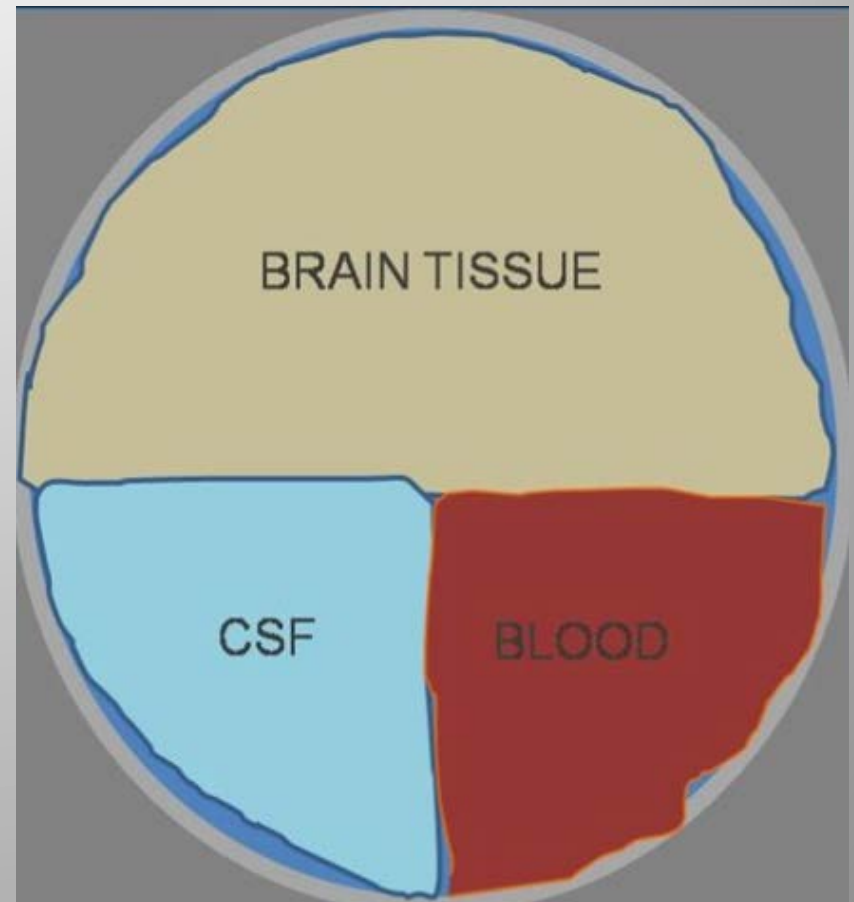
Blood

Brain

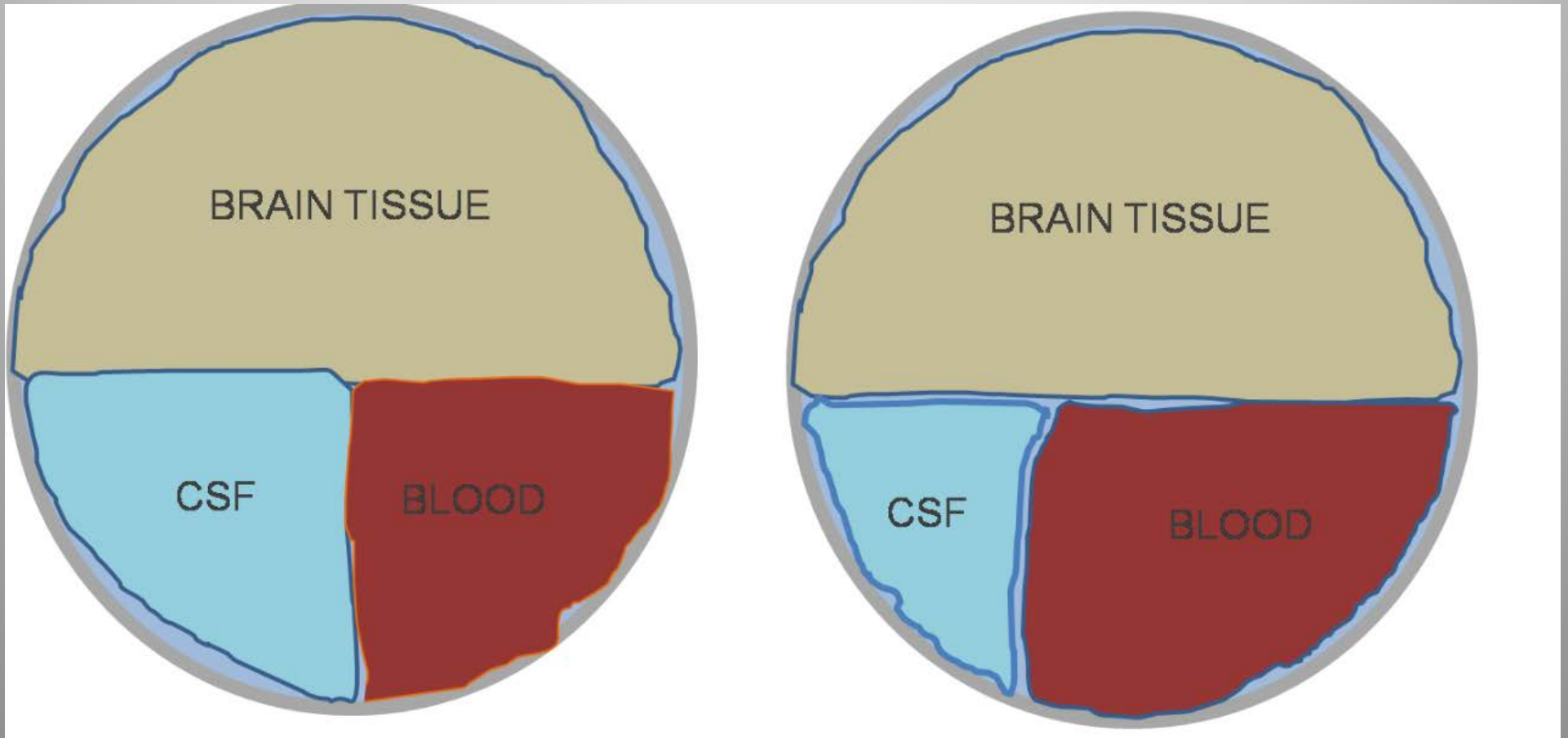
CSF

Skull volume fixed

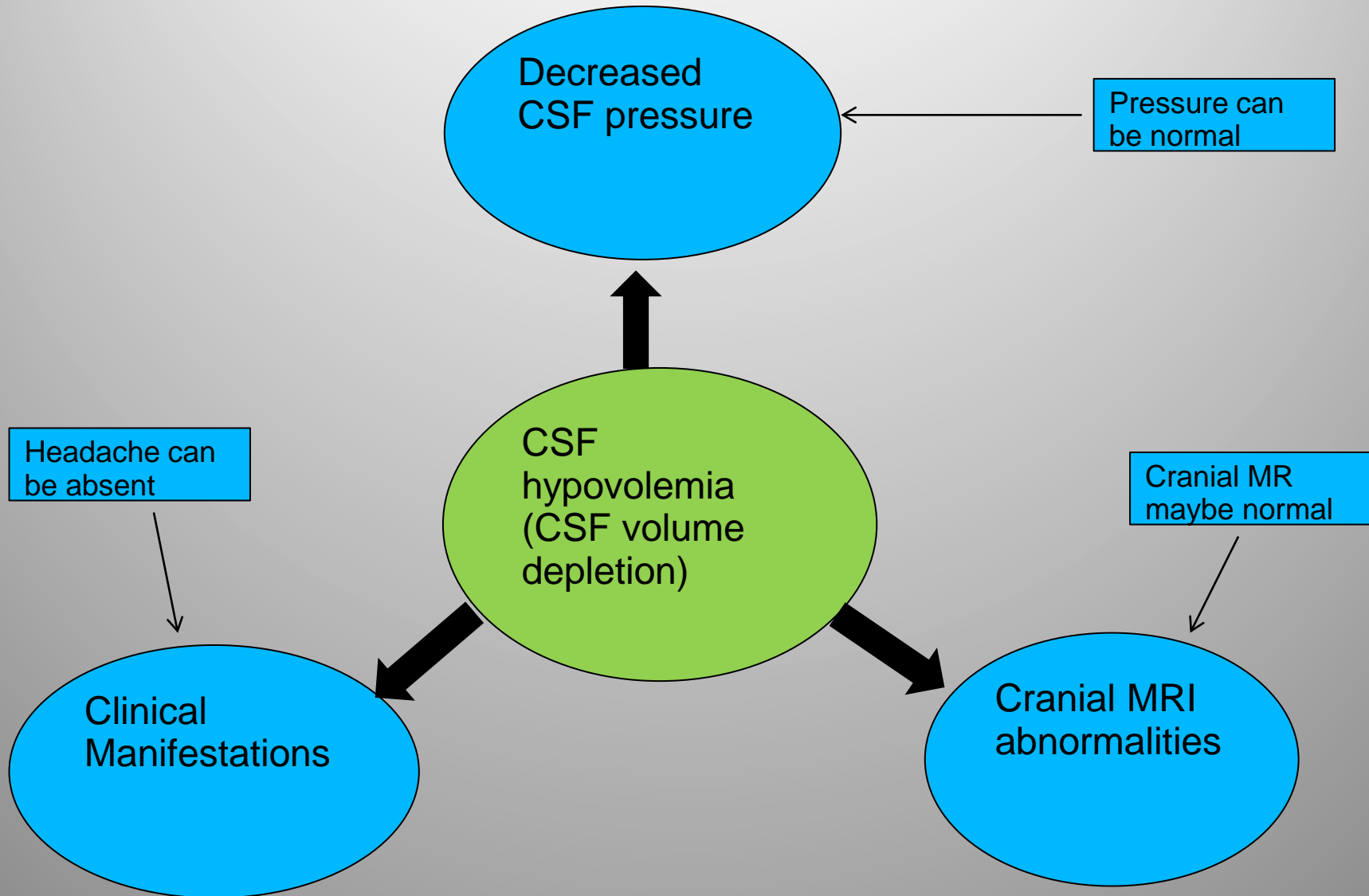
1400-1700 ml



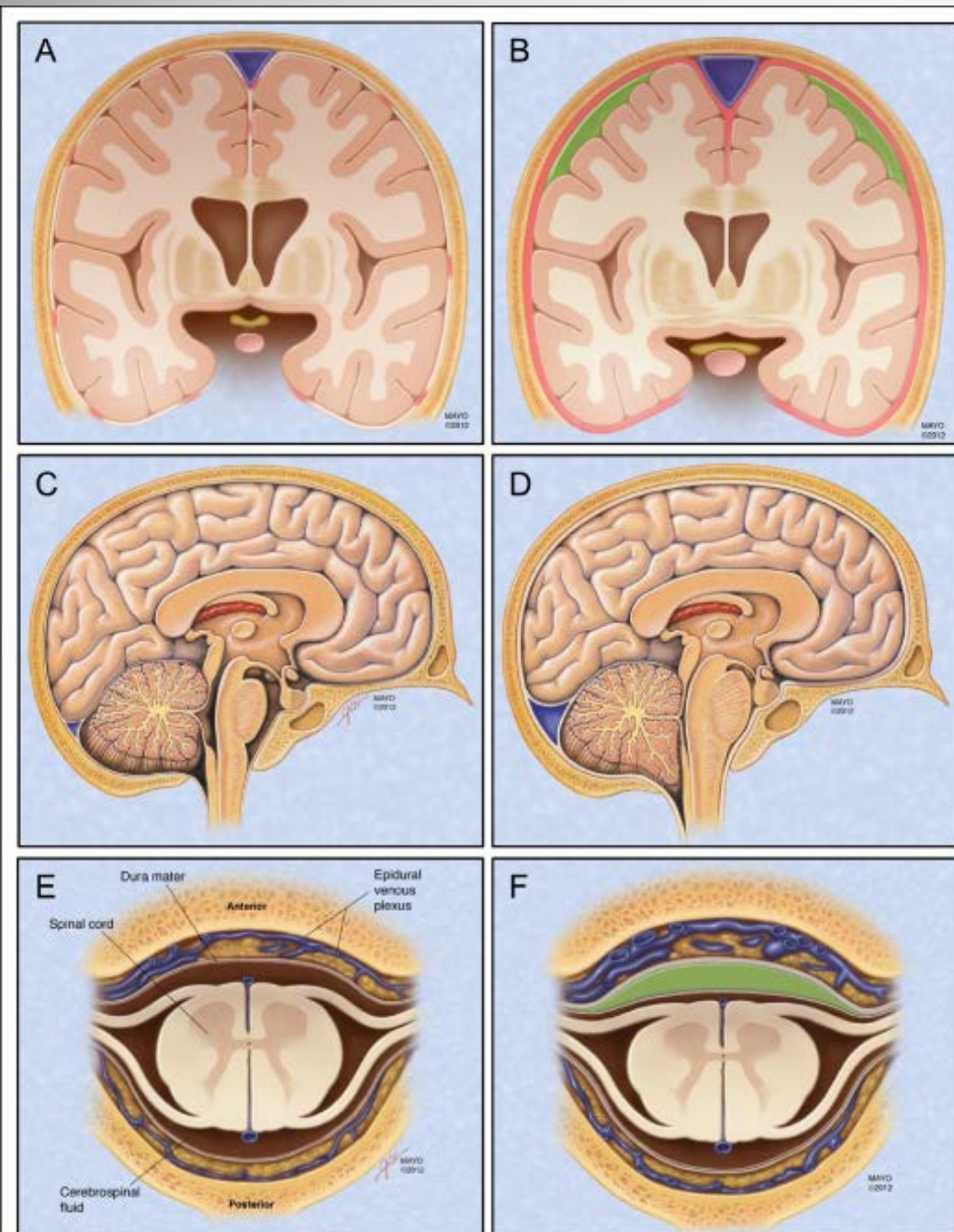
Monro-Kellie Hypothesis



Hypotension or Hypovolemia?



Intracranial Hypotension/Hypovolemia



Pachymeningeal enhancement

Brain “sagging” or “sinking”

- cerebellar tonsils low
- brainstem distortion
- Pontine enlargement
- crowding of the posterior fossa
- flattening of the optic chiasm

Subdural hygromas/hematomas

Engorged venous sinuses

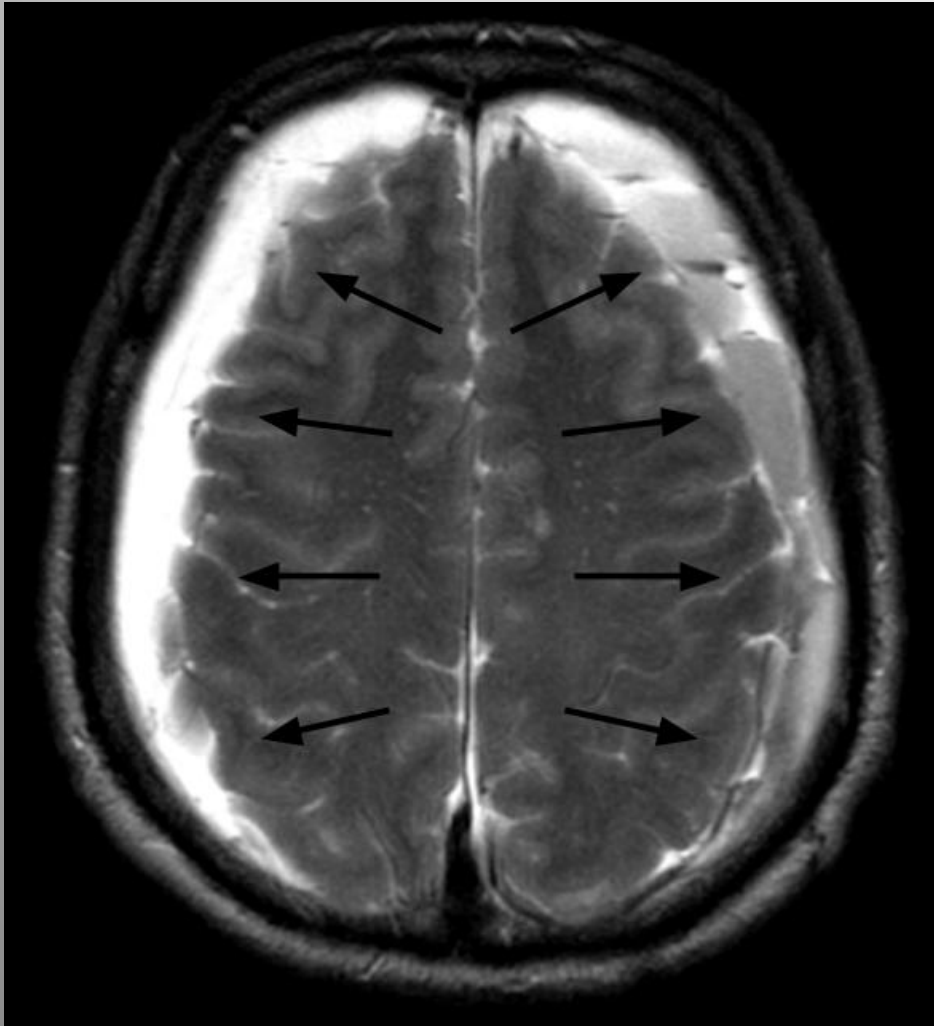
Pituitary hyperemia

Cranial MRI

- S Subdural hygroma/hematoma
- E Enhancement of pachymeninges
- E Enlargement of veins
- P Pituitary hyperemia
- S Sagging of brain

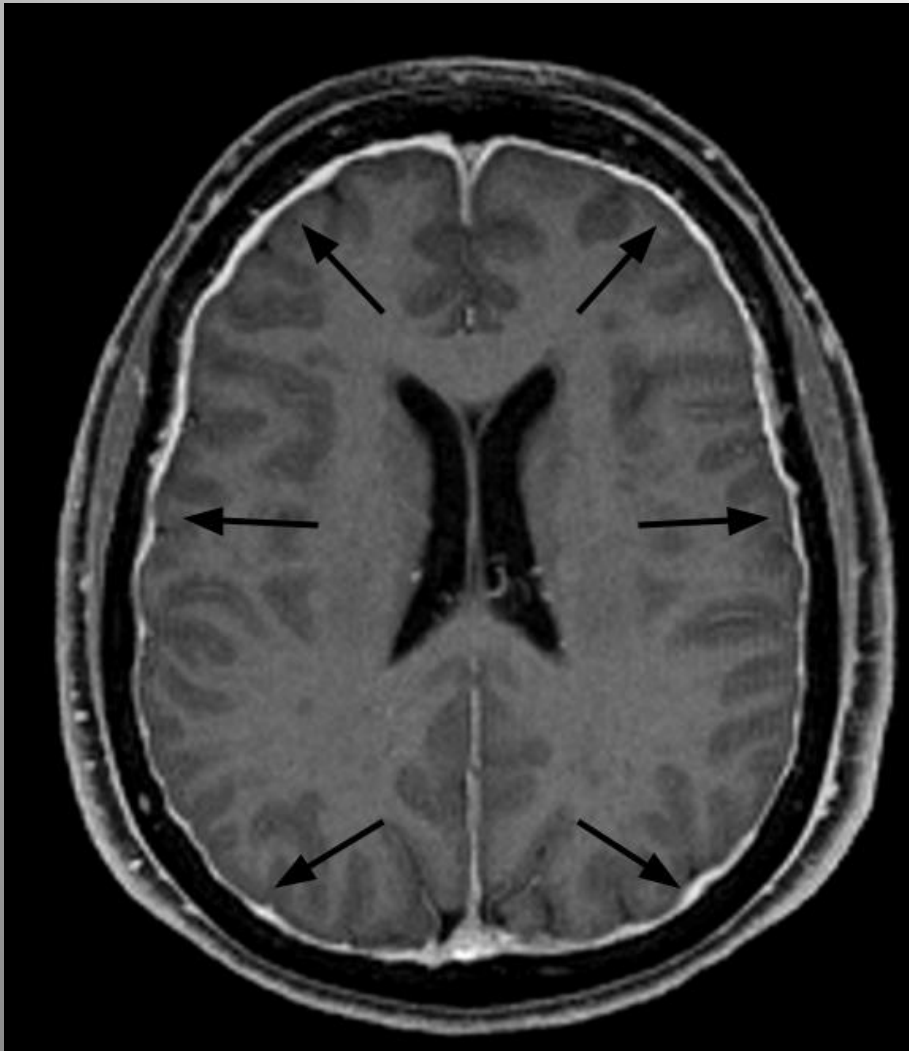


Cranial MRI



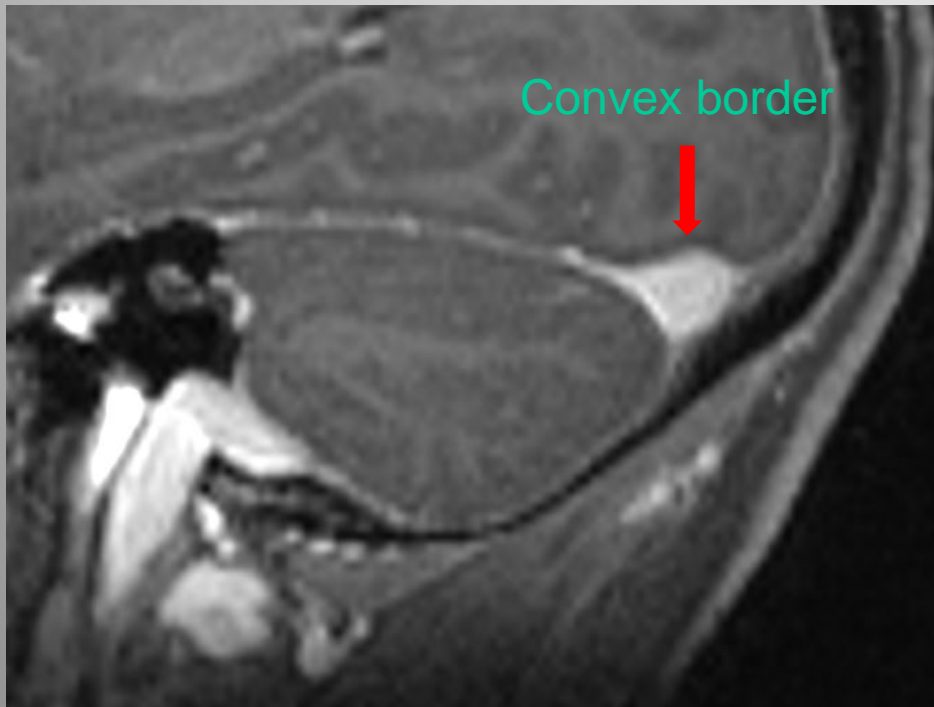
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Cranial MRI



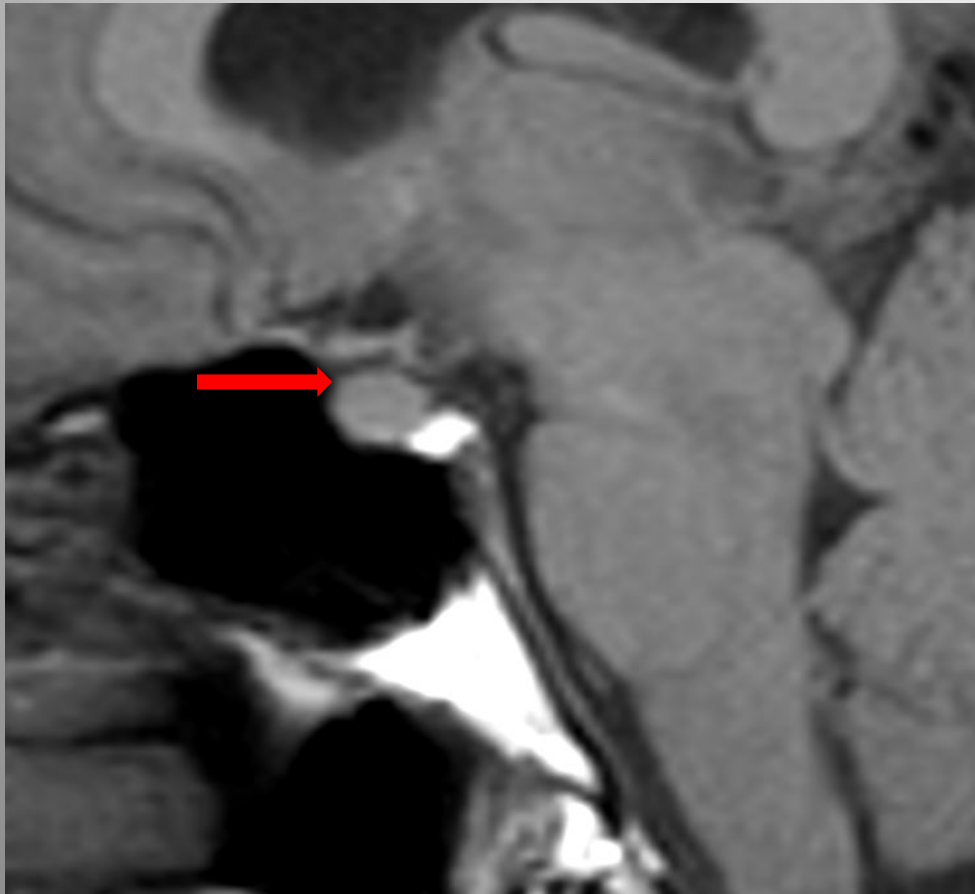
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Cranial MRI



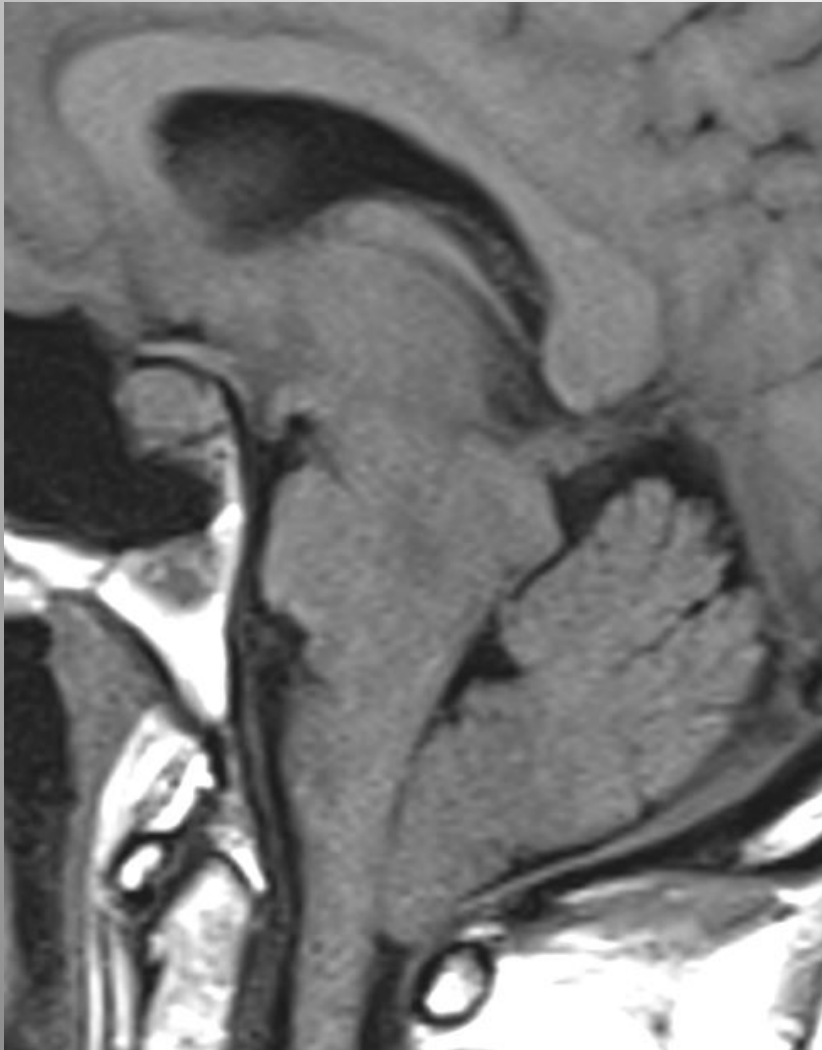
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- E Enhancement of pachymeninges
- E **Enlargement of veins**
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- S Sagging of brain

Cranial MRI

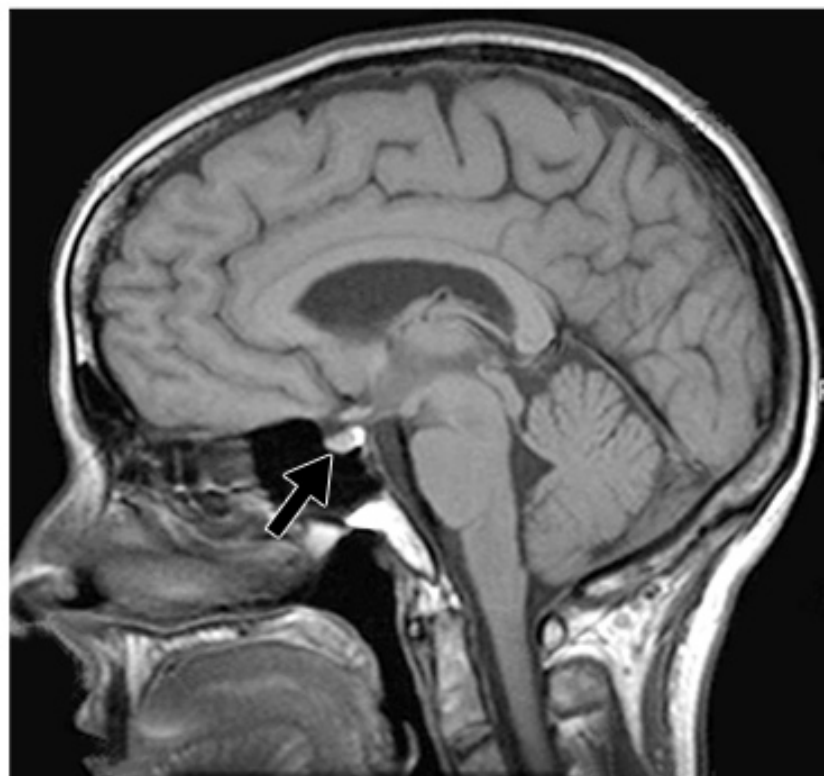
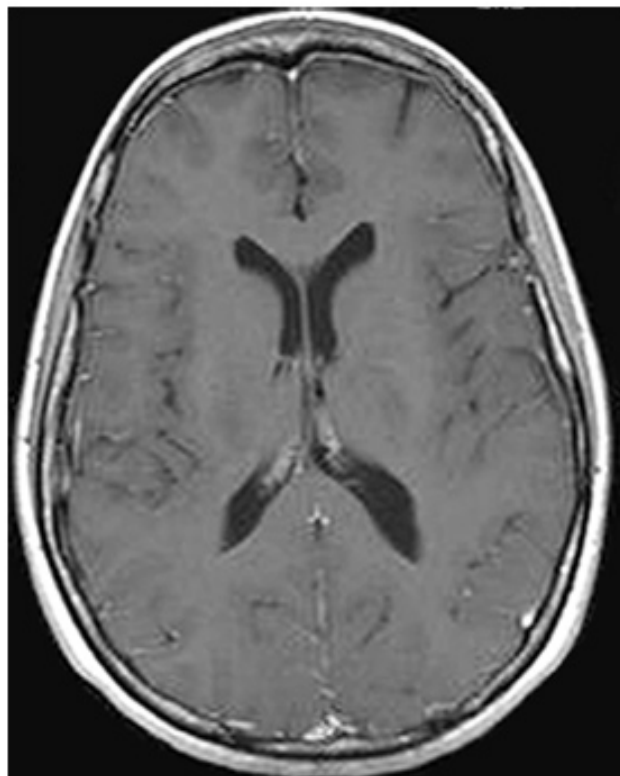
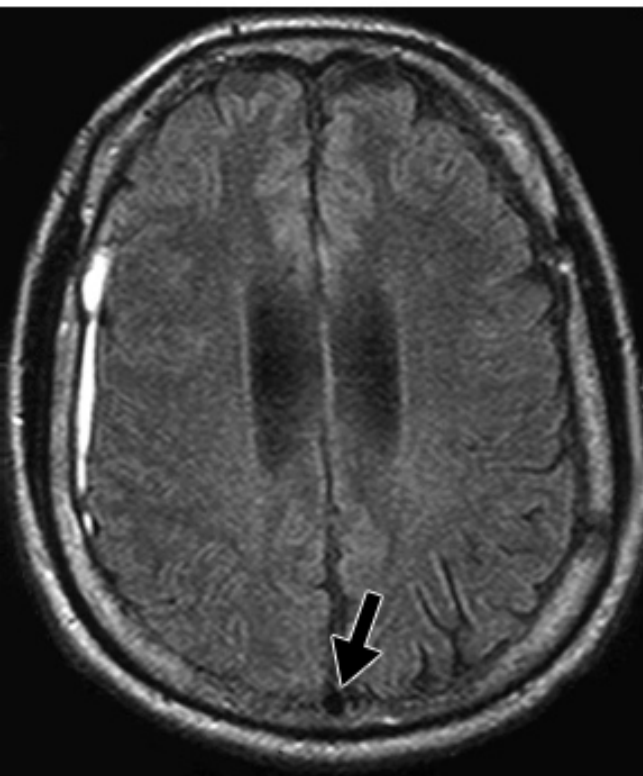
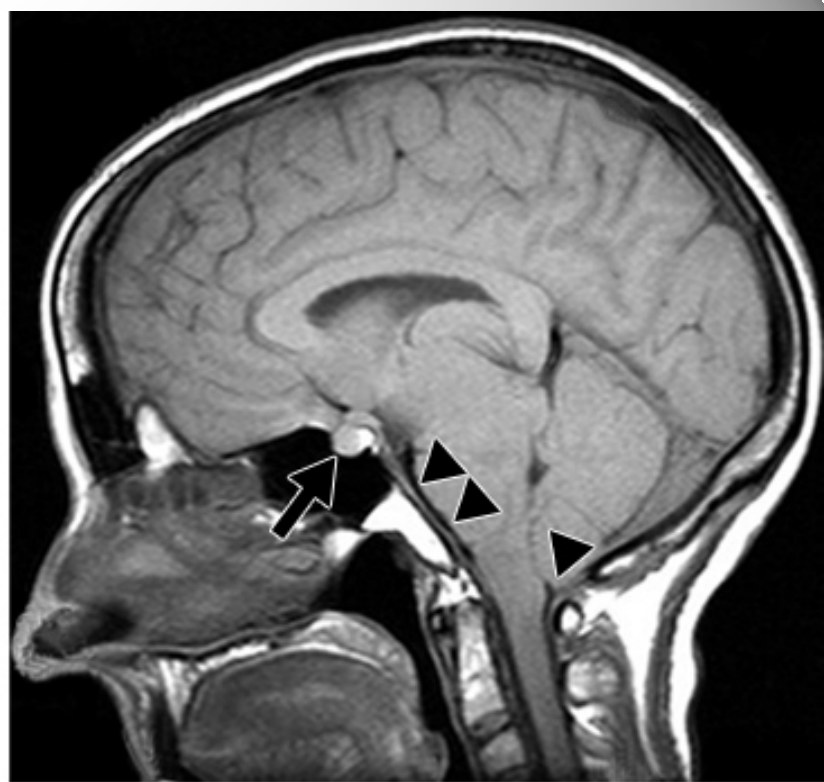
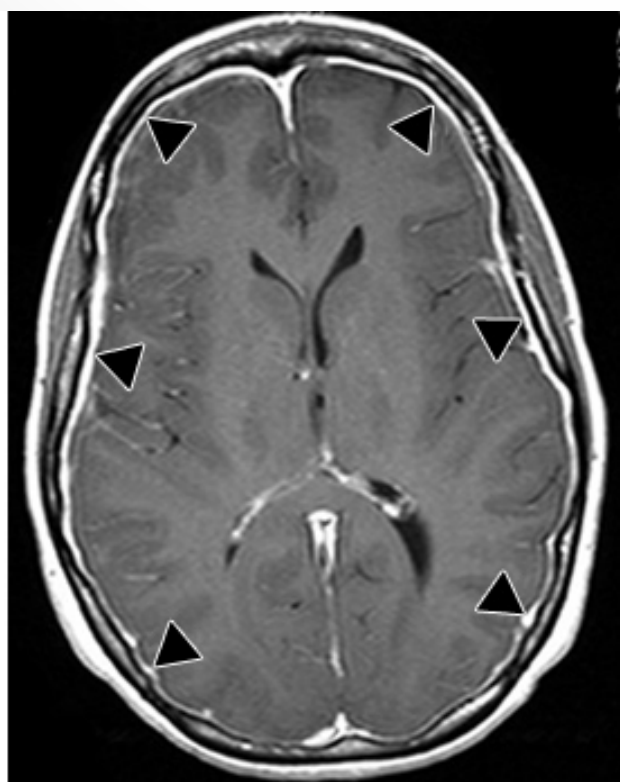
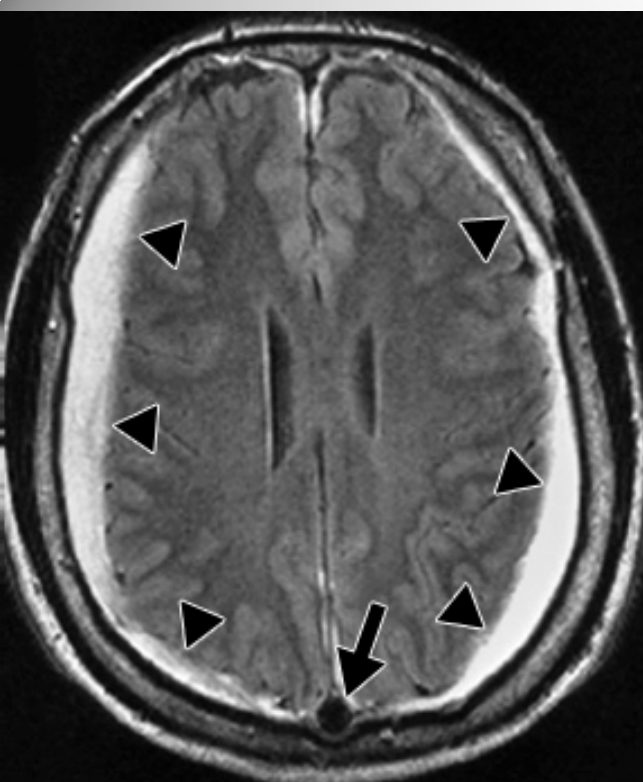


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Cranial MRI



- S Subdural hygroma/hematoma
- E Enhancement of pachymeninges
- E Enlargement of veins
- P Pituitary hyperemia
- S **Sagging of brain**



Goals of SIH Imaging

Initial workup and dx

ICHHD-3 imaging criteria

cranial MR brain sagging

cranial MR dural enhancement

spinal MR extrathecal CSF

Treatment decisions



Non invasive

Minimize radiation

More invasive

Ionizing radiation based

Dynamic CTM

DSM

Goals of SIH Imaging

Problem Solving

Not responsive to conservative

Chronic duration

Severe or disabling symptoms

Aggressive precipitating injury

Connective tissue disease



Non invasive

Minimize radiation

More invasive

Ionizing radiation based

Dynamic CTM

DSM

So many options...

- Radionuclide Cisternography
- MRI Brain
- MRI Spine
- MR Myelogram (T2-weighted)
- MR Spine Intrathecal Gadolinium
- Conventional CT Myelogram
- Dynamic CT guided Myelogram
- Digital Subtraction Myelogram



So many options...

- Radionuclide Cisternography
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Classification of CSF Leaks before 2018

		Incidence
Type 1	Dural Tear	26.6%
Type 2	Meningeal Diverticulum	42.3%
Type 3	CSF Venous Fistula	2.5%
Type 4	Indeterminate	28%

Classification of CSF Leaks since April 2018

		Incidence
Type 1	Dural Tear	40%
Type 2	Meningeal Diverticulum	17%
Type 3	CSF Venous Fistula	23%
Type 4	Indeterminate	19%

MR Spine with contrast

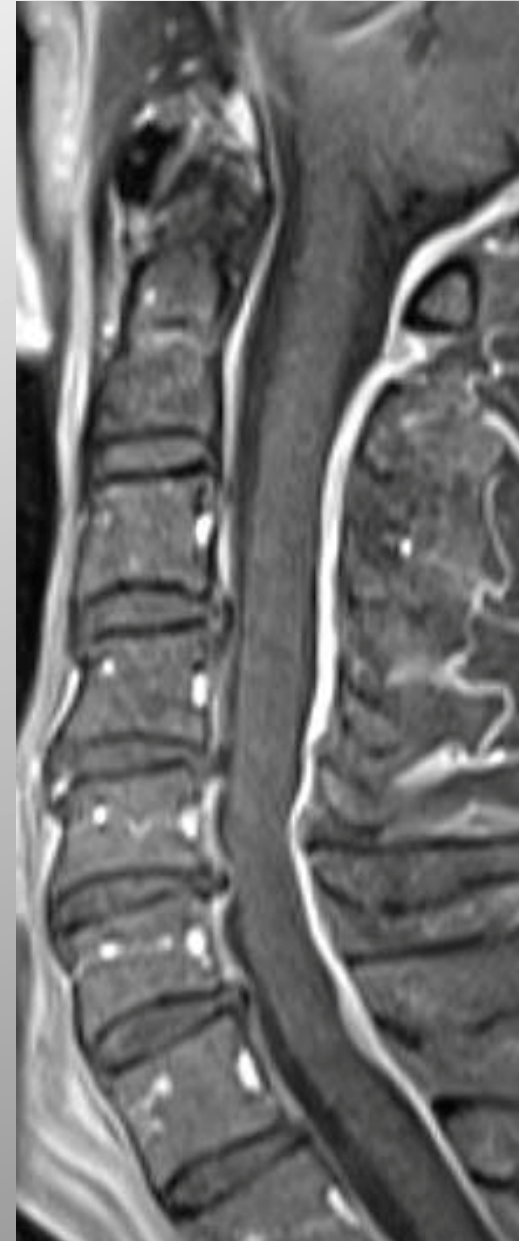
Excellent detection

dural enhancement

diffuse leakage
(false localizing sign)

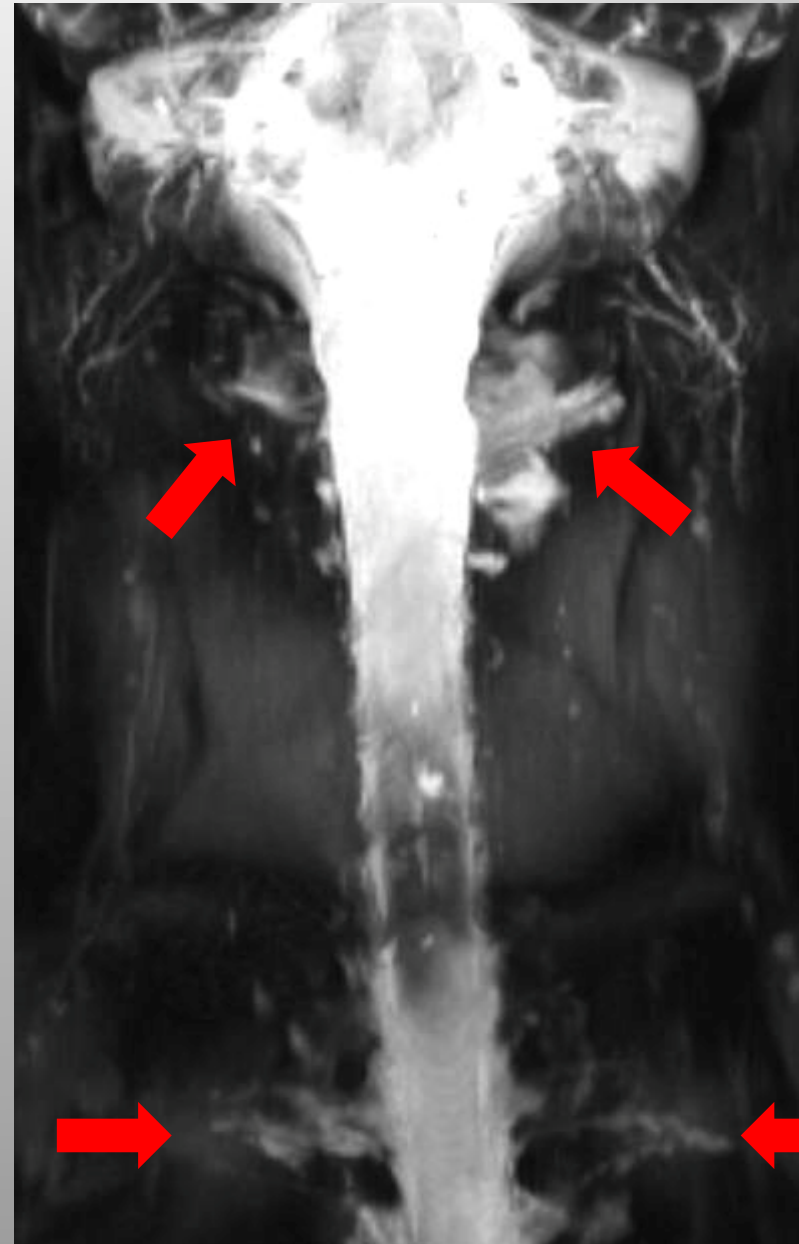
extrathecal collections (type 1)

meningeal diverticula (type 2)

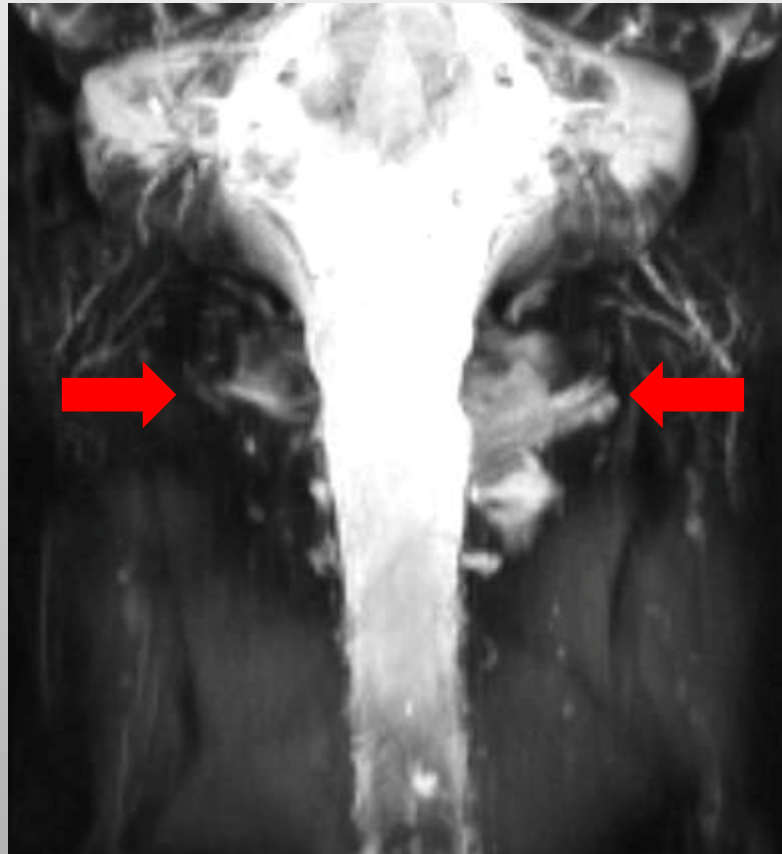


MR Spine with Myelo T2-weighted

diffuse leakage
(false localizing sign)



MR Spine with Myelo T2-weighted



False localizing sign of C1–2 cerebrospinal fluid leak in spontaneous intracranial hypotension

WOUTER I. SCHIEVINK, M.D., M. MARCEL MAYA, M.D., AND JAMES TOURJE, M.D.

Maxine Dunitz Neurosurgical Institute and Imaging Medical Group, Cedars-Sinai Medical Center, Los Angeles, California

MR Spine with Myelo T2-weighted

False localizing sign of cervico-thoracic CSF leak in spontaneous intracranial hypotension

Wouter I. Schievink, MD
M. Marcel Maya, MD
Ray M. Chu, MD
Franklin G. Moser, MD,
MMM

ABSTRACT

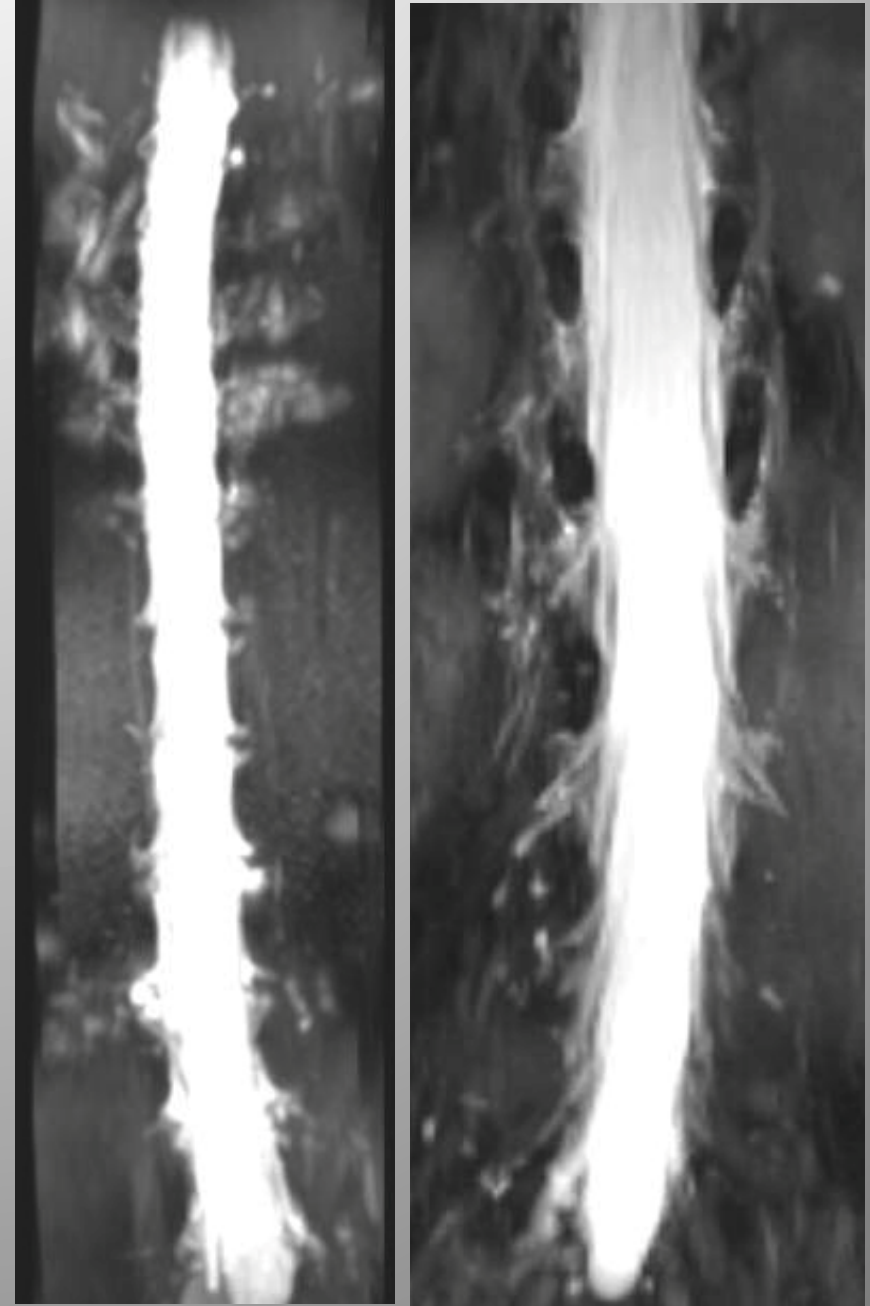
Objective: Spontaneous spinal CSF leaks are an important cause of new-onset headache. Spontaneous spinal CSF leaks are reported to be particularly common at the cervico-thoracic junction. The author took a study to determine the significance of these cervico-thoracic CSF leaks.

Methods: The patient population consisted of a consecutive group of 13 patients who

Can be seen anywhere

Thoracic

lumbosacral



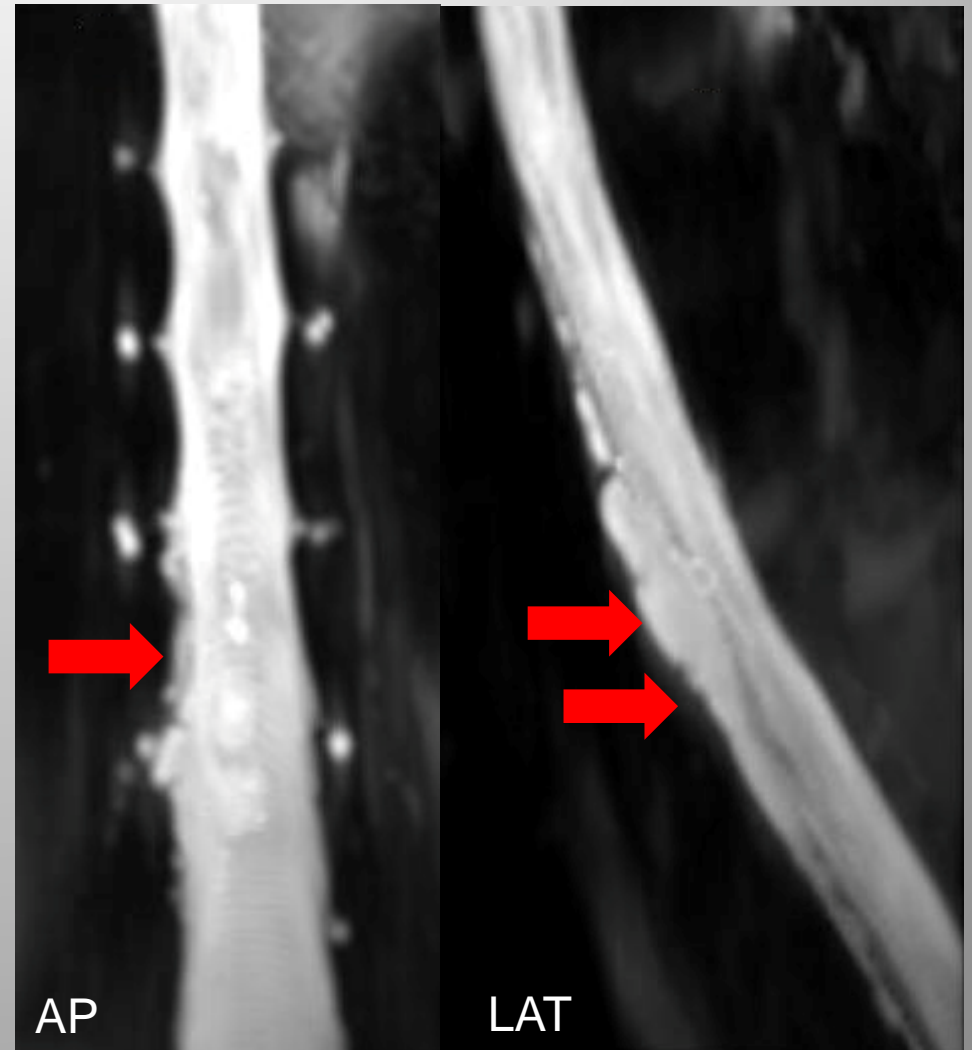
MR Spine with Myelo T2-weighted

extrathecal collections (type 1)



MR Spine with Myelo

extrathecal collections (type 1)



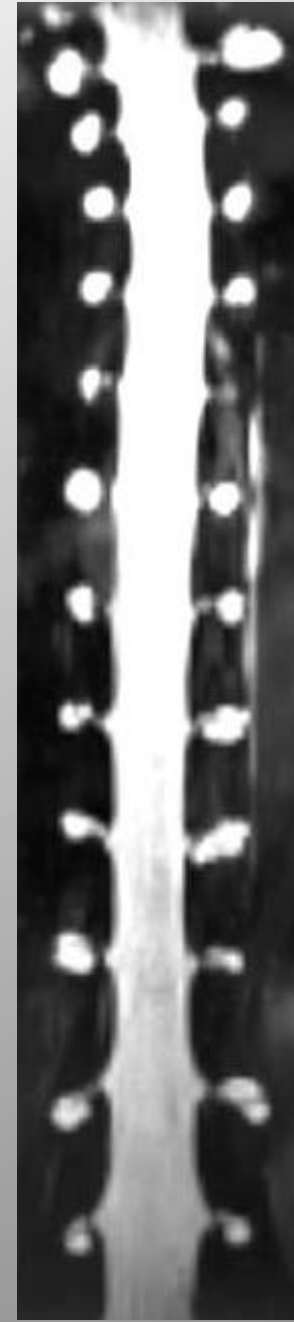
Type 2 leak Meningeal Diverticula

Excellent detection

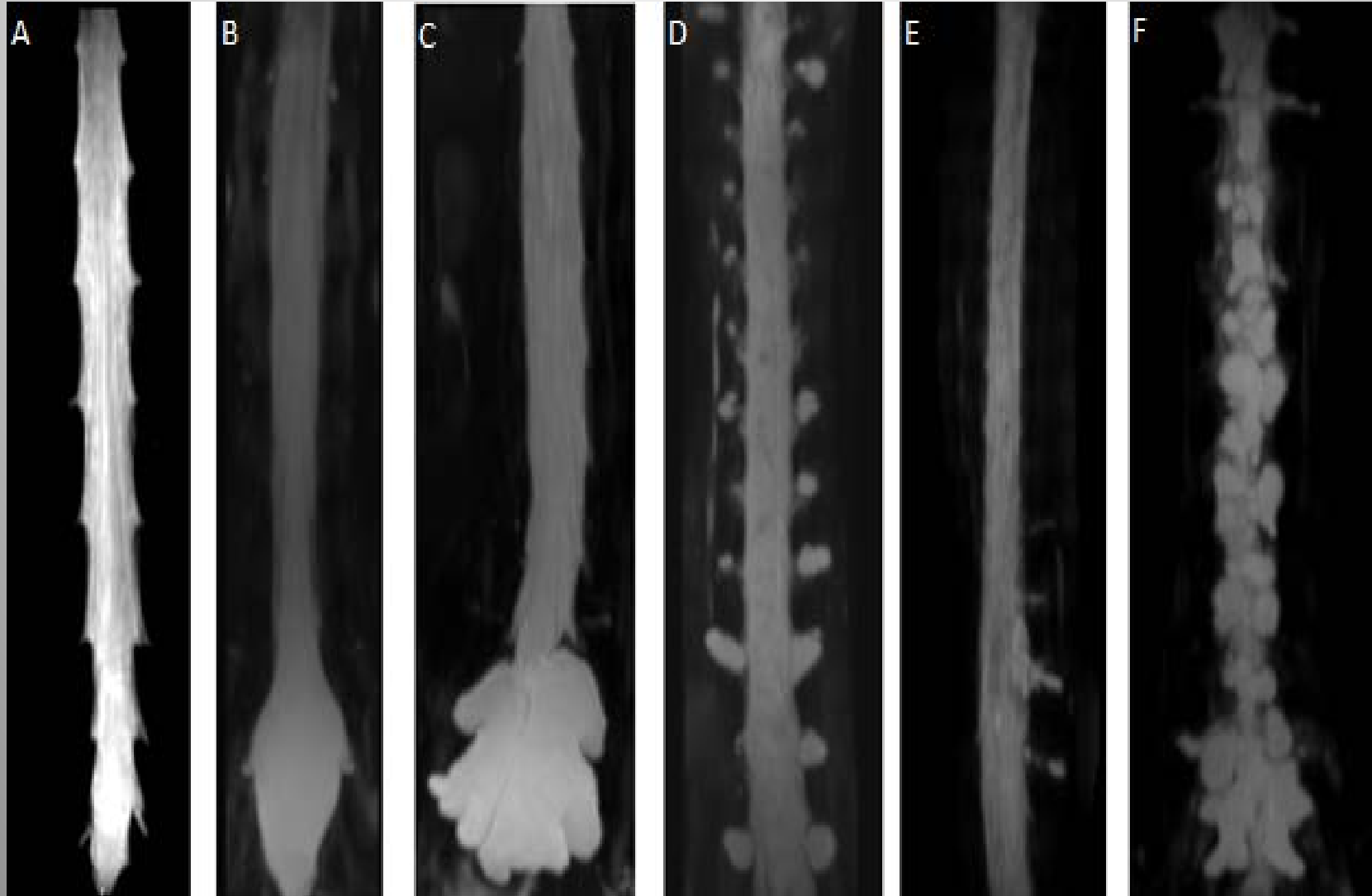
MR Myelo ✓ ✓ ✓ ✓

CT Myelo ✓ ✓ ✓ ✓

MR Intrathecal myelo ✓ ✓



Type 2 leak Meningeal Diverticula

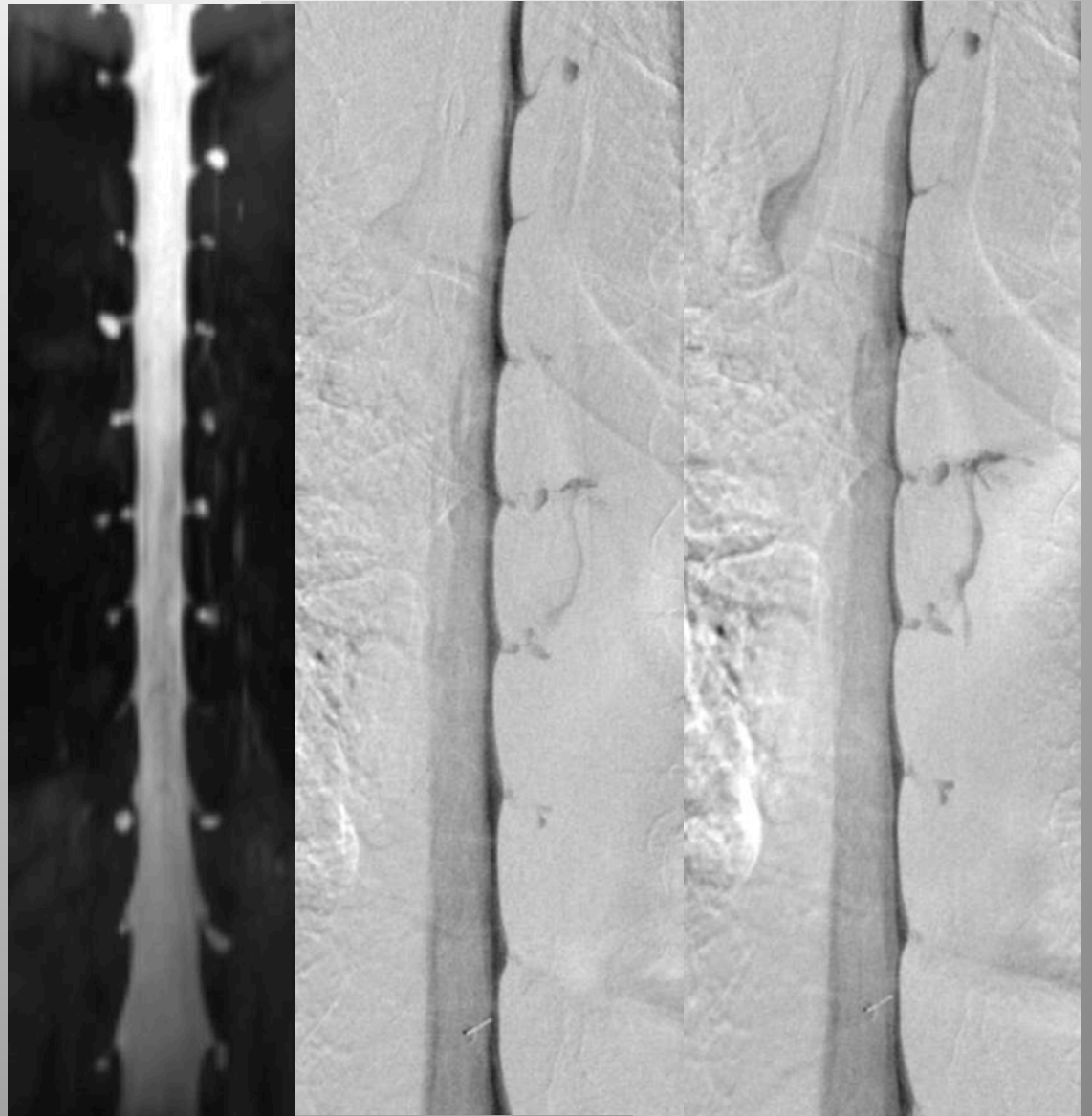


Type 3 Leak CSF venous fistula

MR Myelo not sensitive

Dynamic CTM ✓ ✓

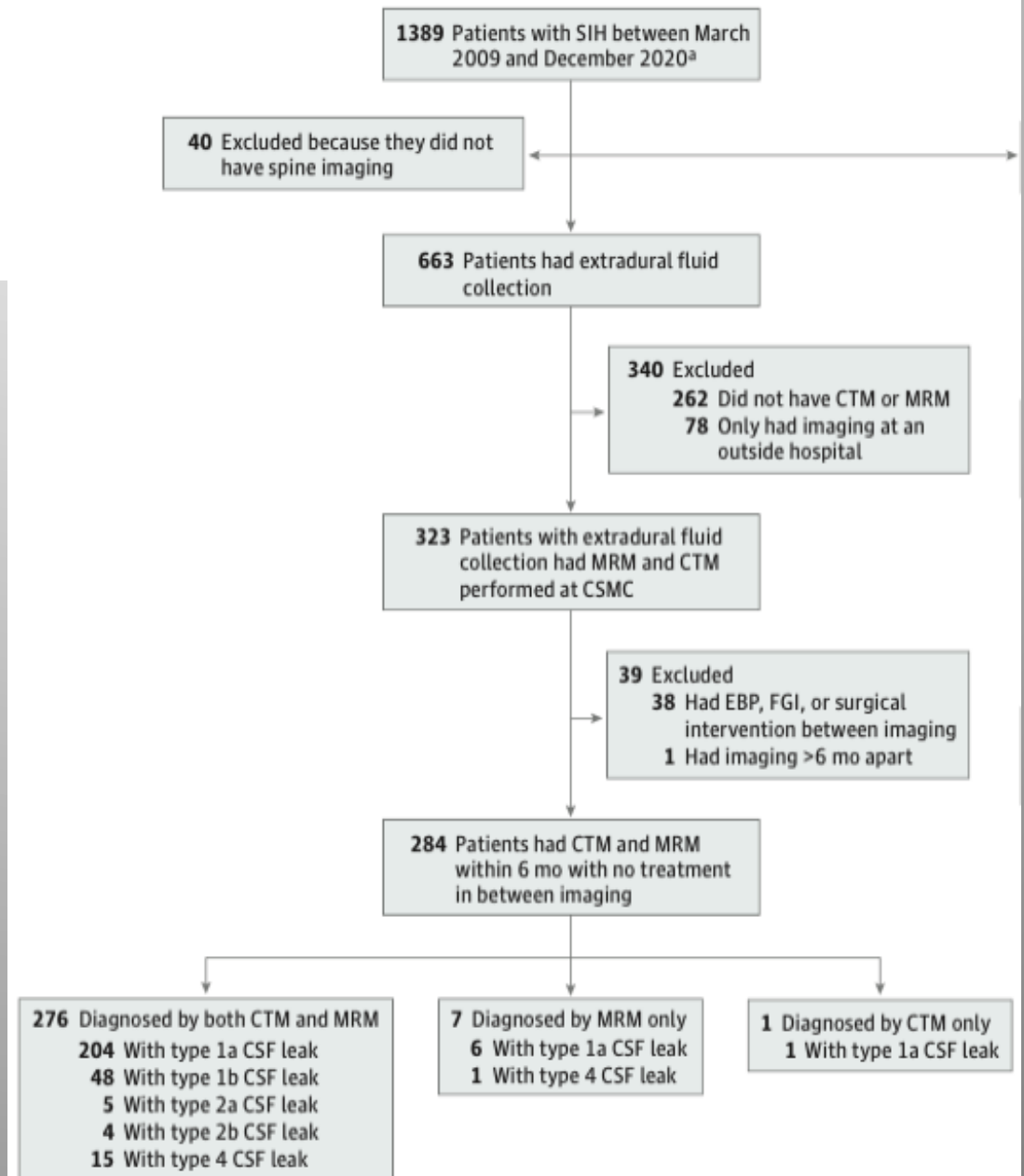
DSM ✓ ✓ ✓



CT Myelo vs MR Myelo

RESEARCH LETTER

Computed Tomography vs Heavily T2-Weighted Magnetic Resonance Myelography for the Initial Evaluation of Patients With Spontaneous Intracranial Hypotension



CT Myelo vs MR Myelo

- 284 patients with extradural fluid collections
- CTM/MRM concordant in 276/284
- 8/284 (1.4%) mismatch
 - Seven patients (1.2%) MRM alone
 - 1 patient (0.2%) CTM alone
- Overall agreement 98.6%

MR Myelo vs CT Myelo

RESEARCH LETTER

Computed Tomography vs Heavily T2-Weighted Magnetic Resonance Myelography for the Initial Evaluation of Patients With Spontaneous Intracranial Hypotension

- MRM is non inferior to CTM for detection of extradural CSF
- MRM and CTM were discordant in less than 2% of patients
- with most of those favoring MRM over CTM

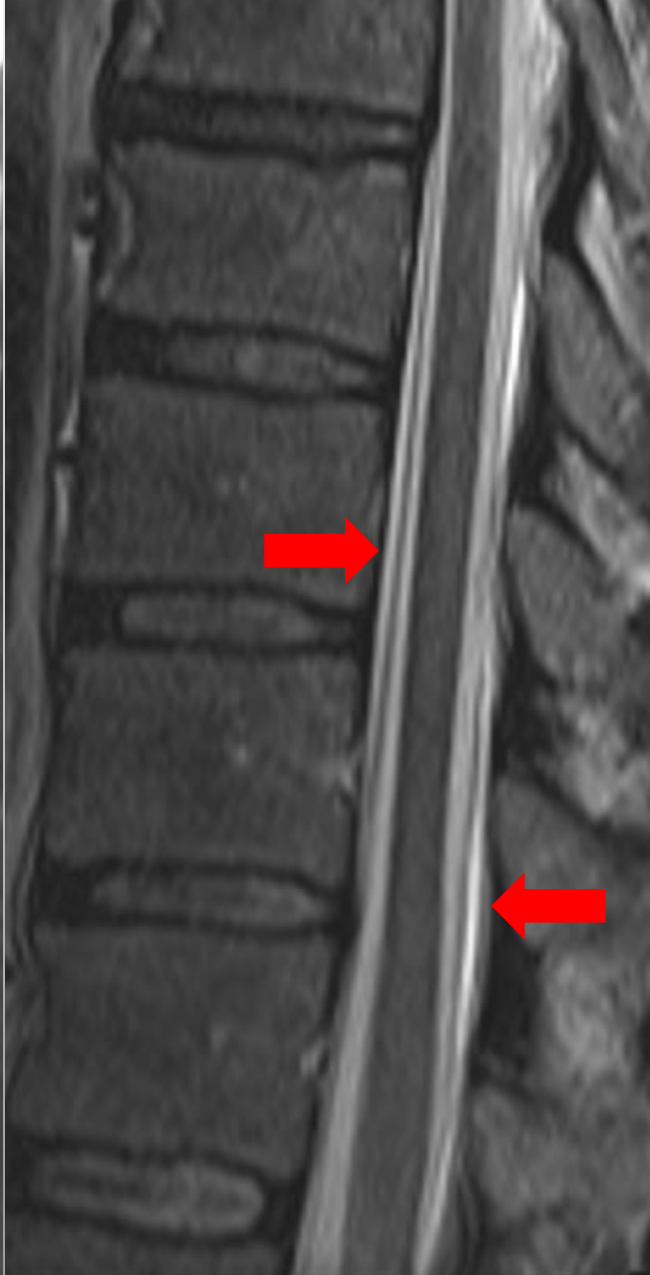
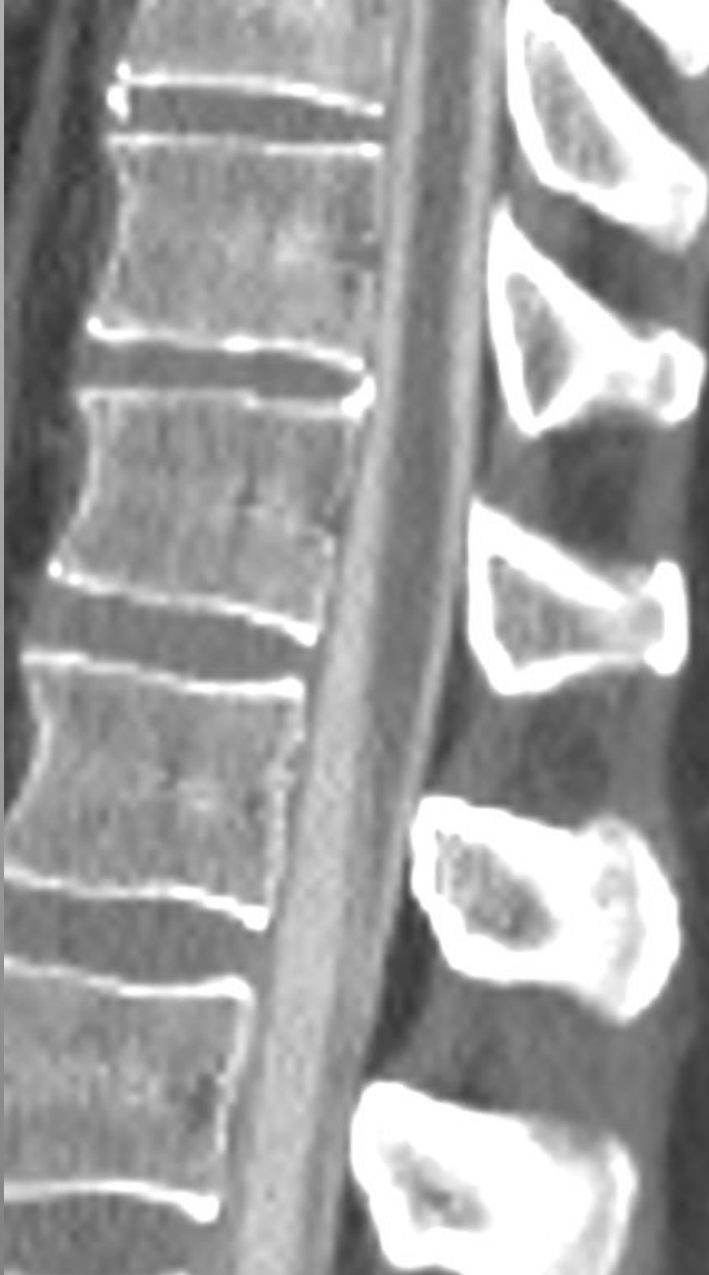
MR Myelo vs CT Myelo

RESEARCH LETTER

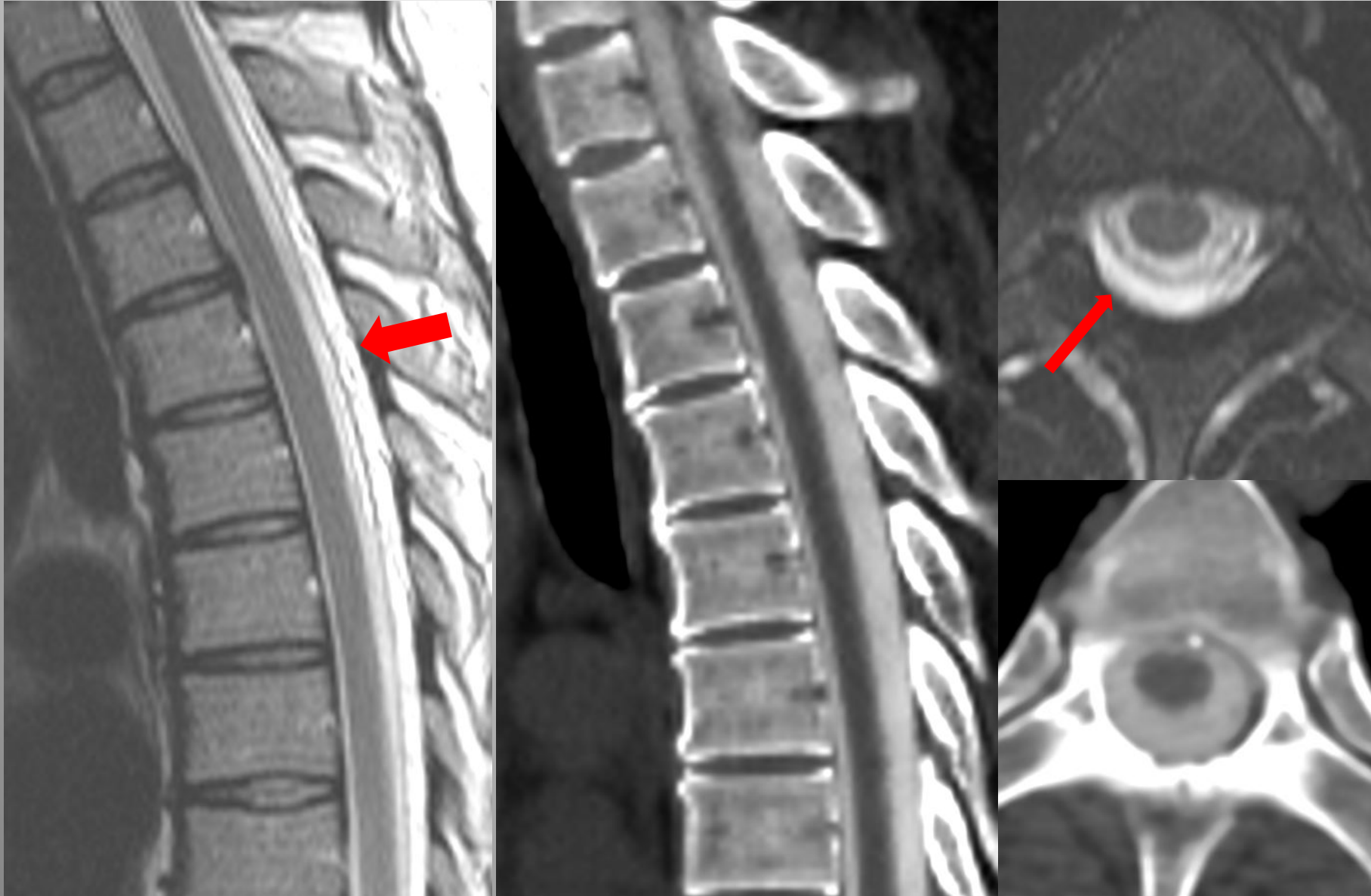
Computed Tomography vs Heavily T2-Weighted Magnetic Resonance Myelography for the Initial Evaluation of Patients With Spontaneous Intracranial Hypotension

- MRM advantages
 - no radiation exposure
 - no LP
 - lower resource utilization/cost
- CTM advantages
 - CSF pressure measurements
 - exquisite bony detail

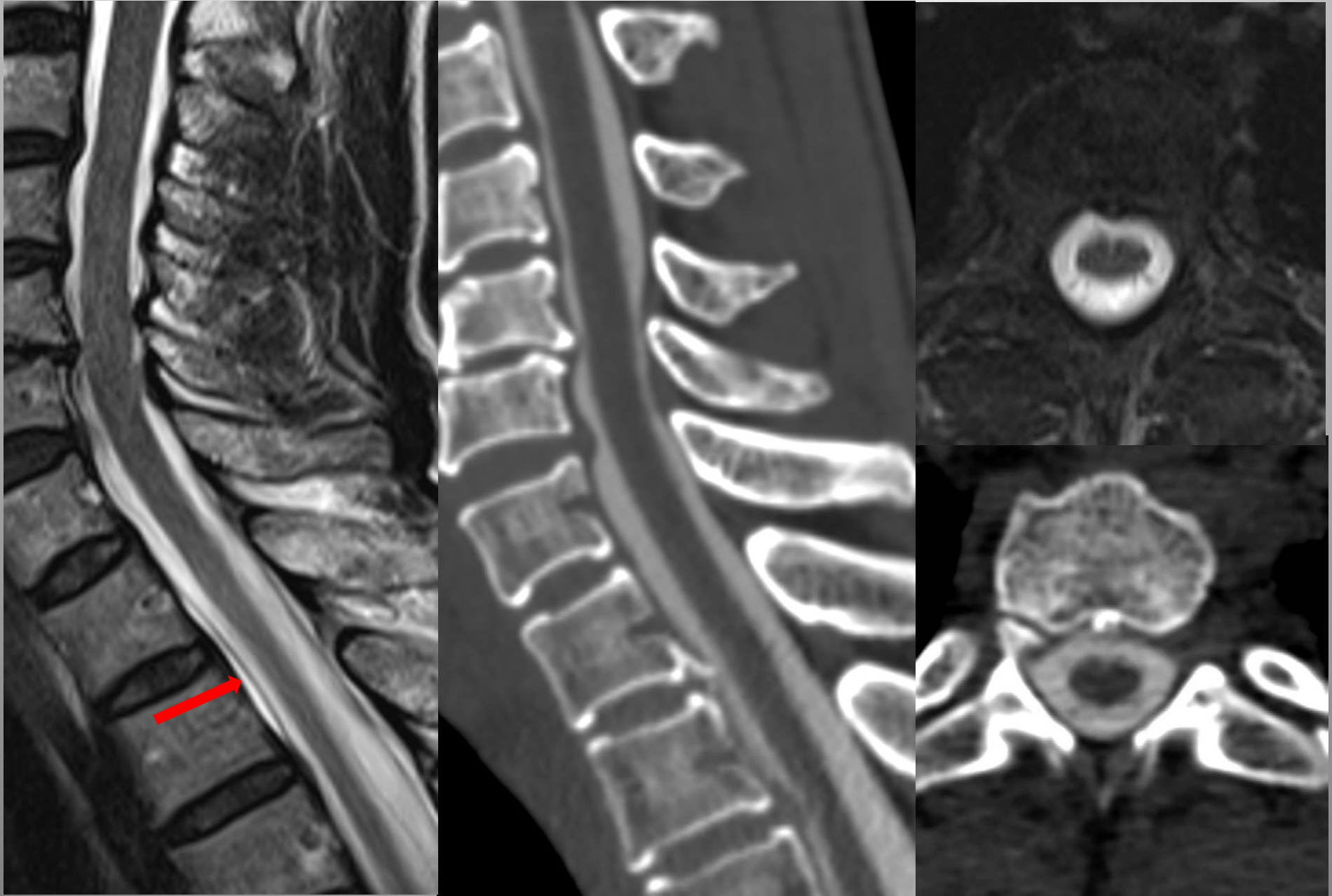
MRM > CTM



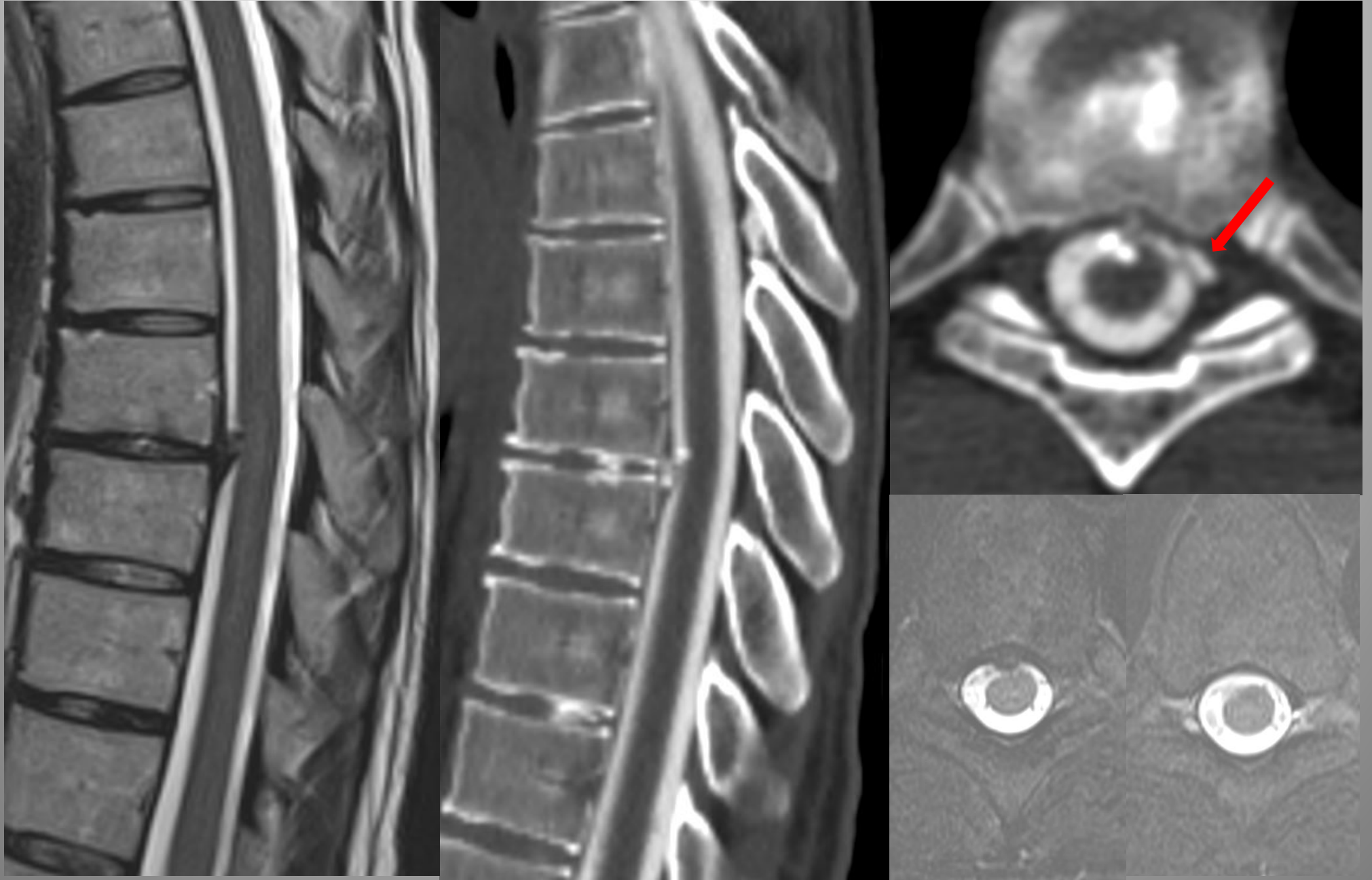
MRM > CTM



MRM > CTM



CTM > MRM



More invasive... DSM

Initially prone and only for type 1 leaks

Now decubitus/prone for all types of leaks

- precise localization of Type 1 leak site/dural tear

- increased sensitivity and accurate localization of Type 3 (CSF venous fistula)

DSM Technique

Biplane angio equipment
General Anesthesia
Fully paralysed
90-sec breath hold, 2 fr/sec
Puncture @ L2-3
22 G Gertie Marx



DSM Technique

Positioning and tilt tailored

patient anatomy

leak type (ventral/lateral/fistula)

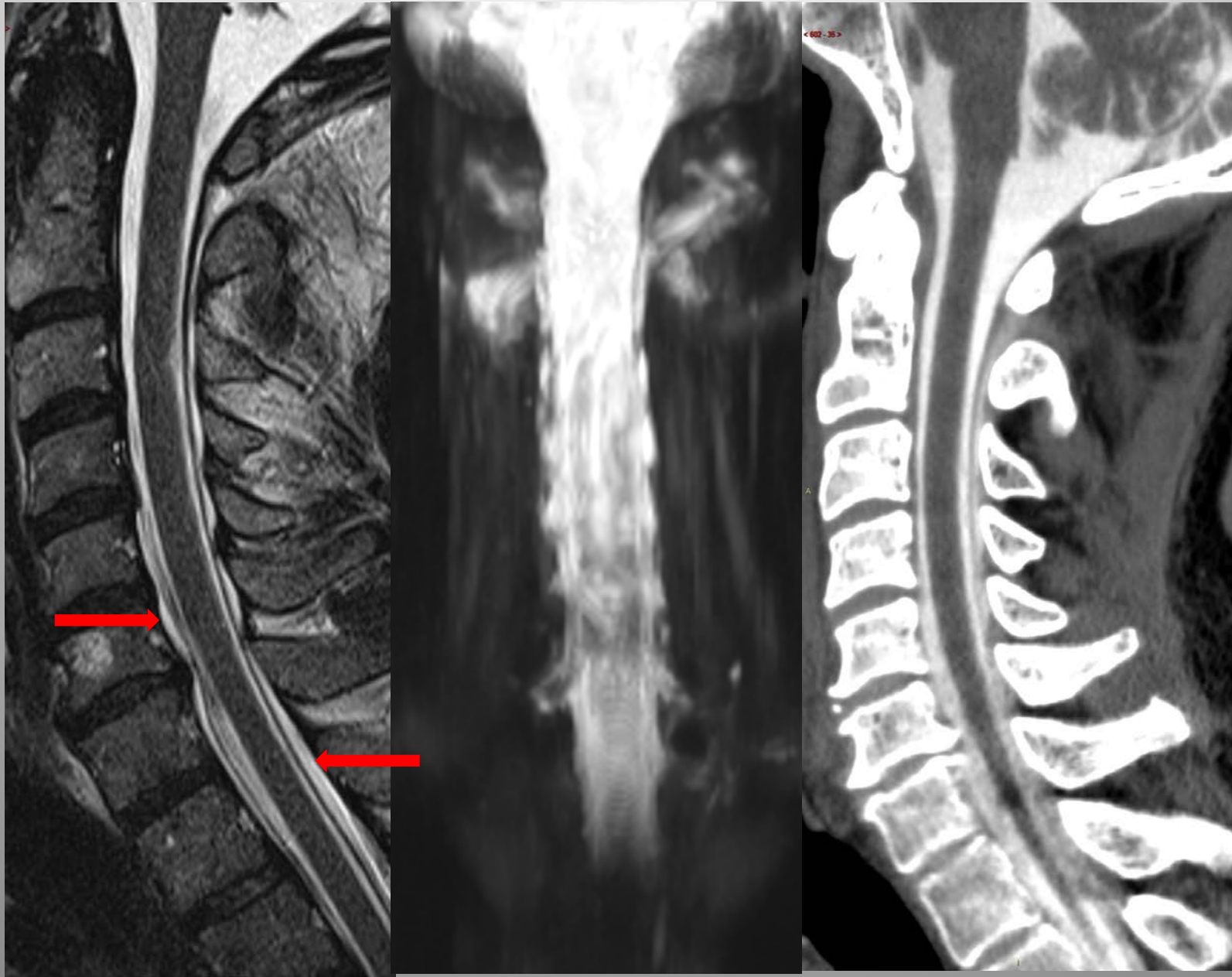
IV glucagon

Spot myelography after DSM

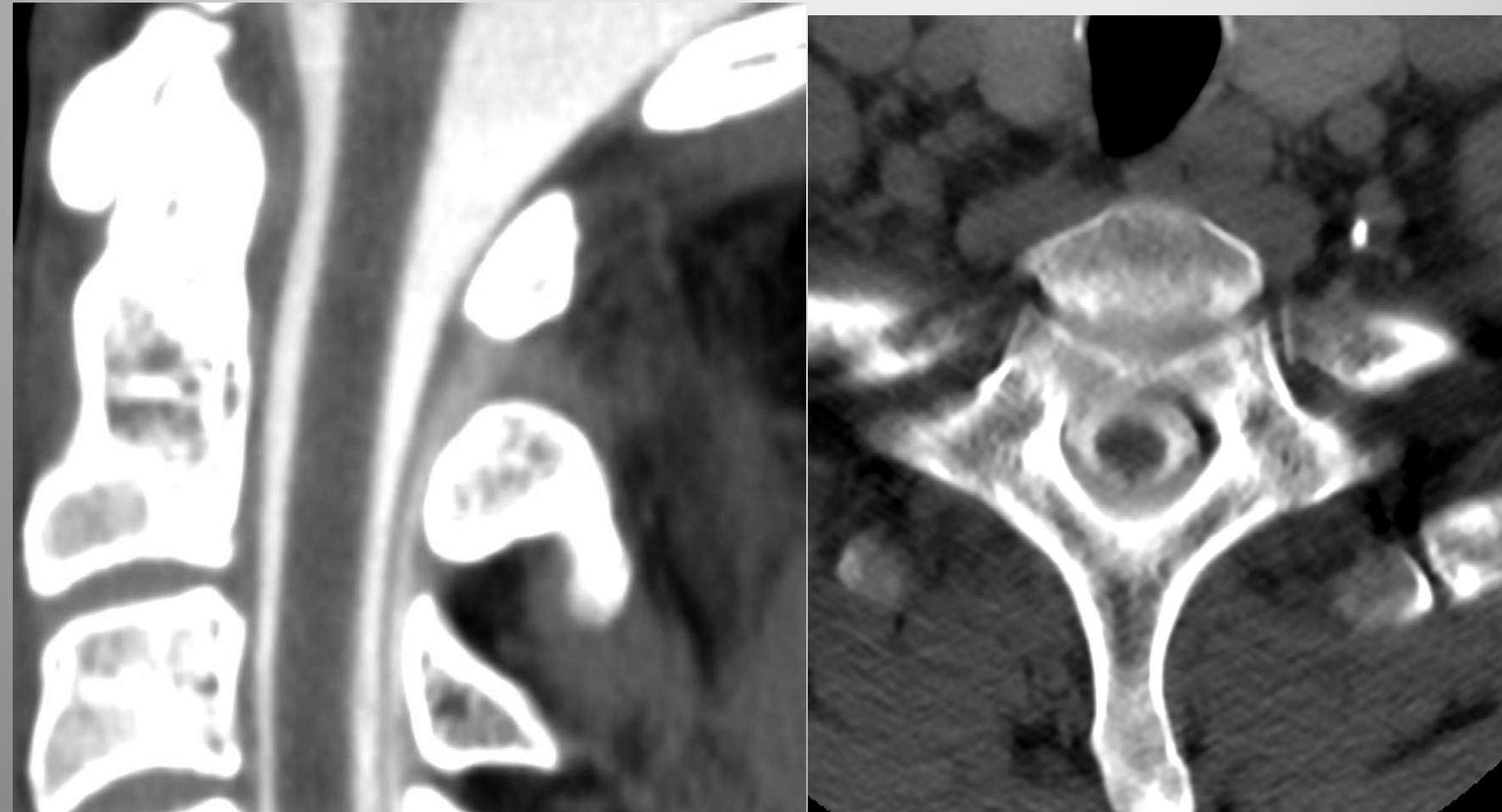
CT myelogram after recovery
(one hour)



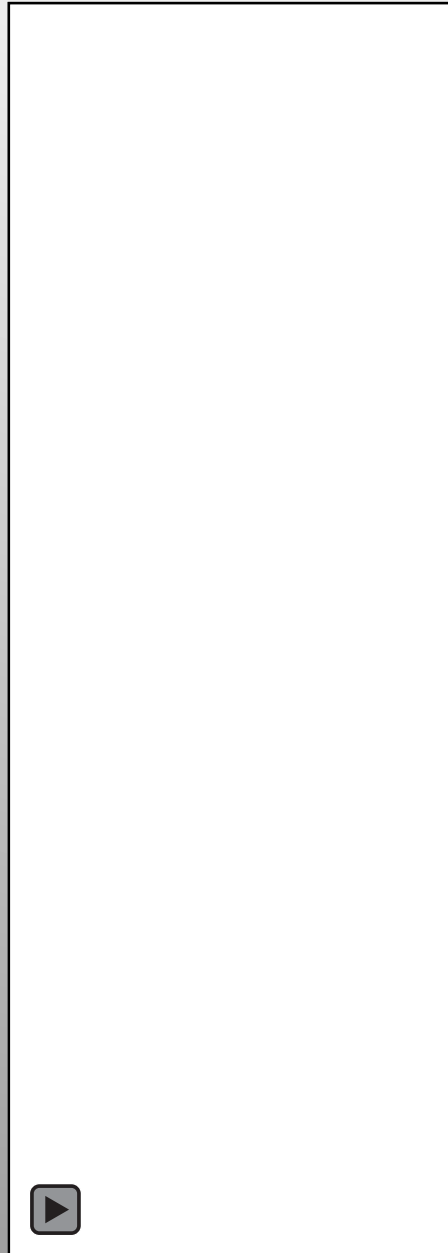
Type 1 (Dural tear)



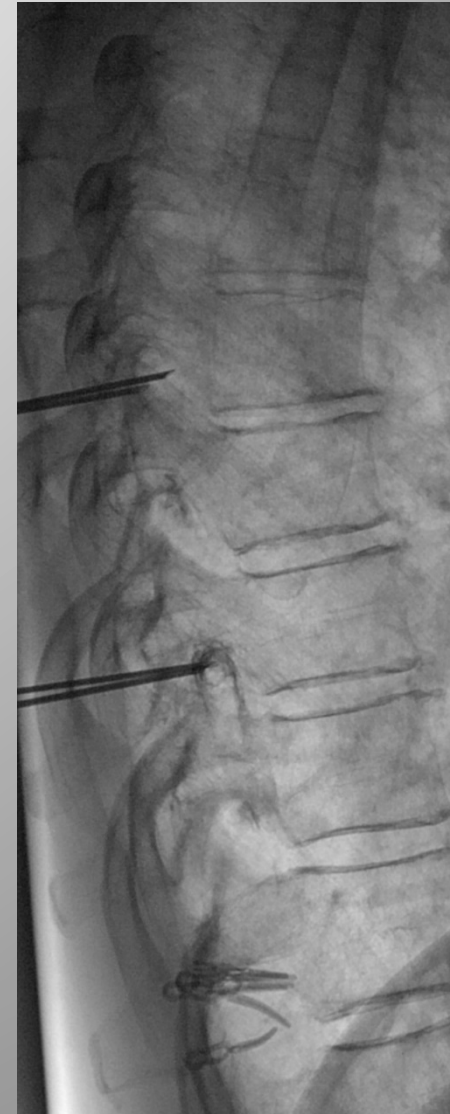
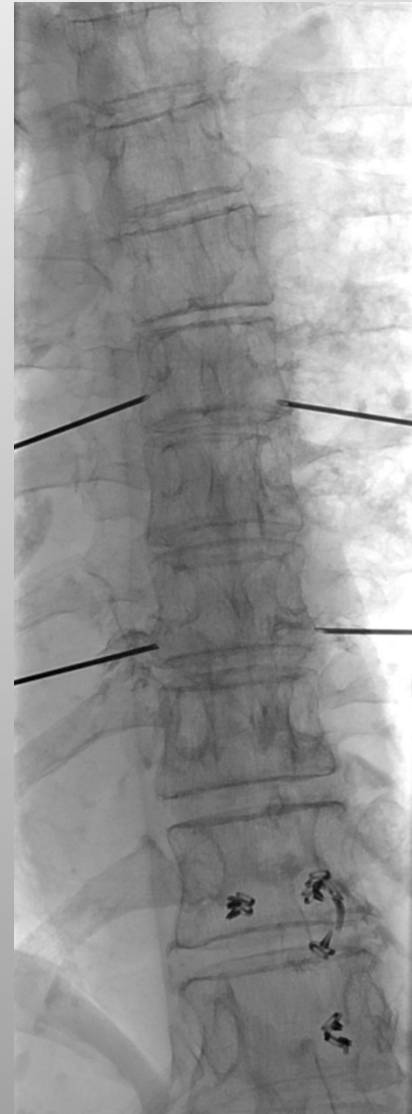
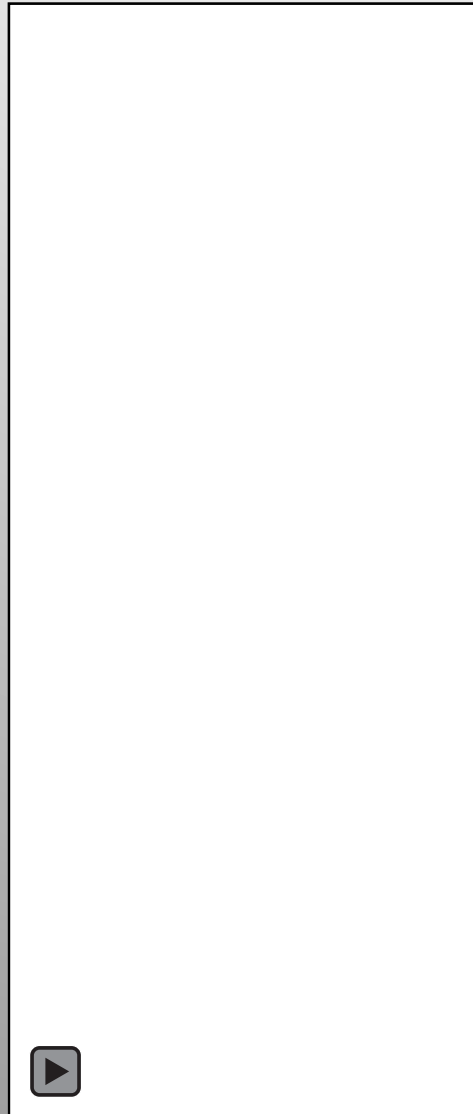
False localizing C1-2



Type 1 (Ventral) Leak DSM



Type 2 (Meningeal diverticulum)



Type 3 (CSF Venous Fistula)



Type 3 (CSF Venous Fistula)



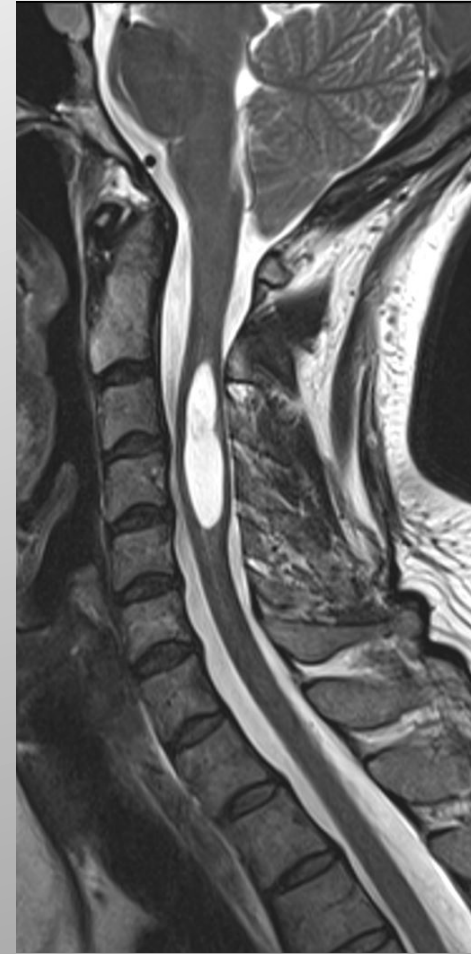
Type 3 (CSF Venous Fistula)



Type 3 (CSF Venous Fistula)

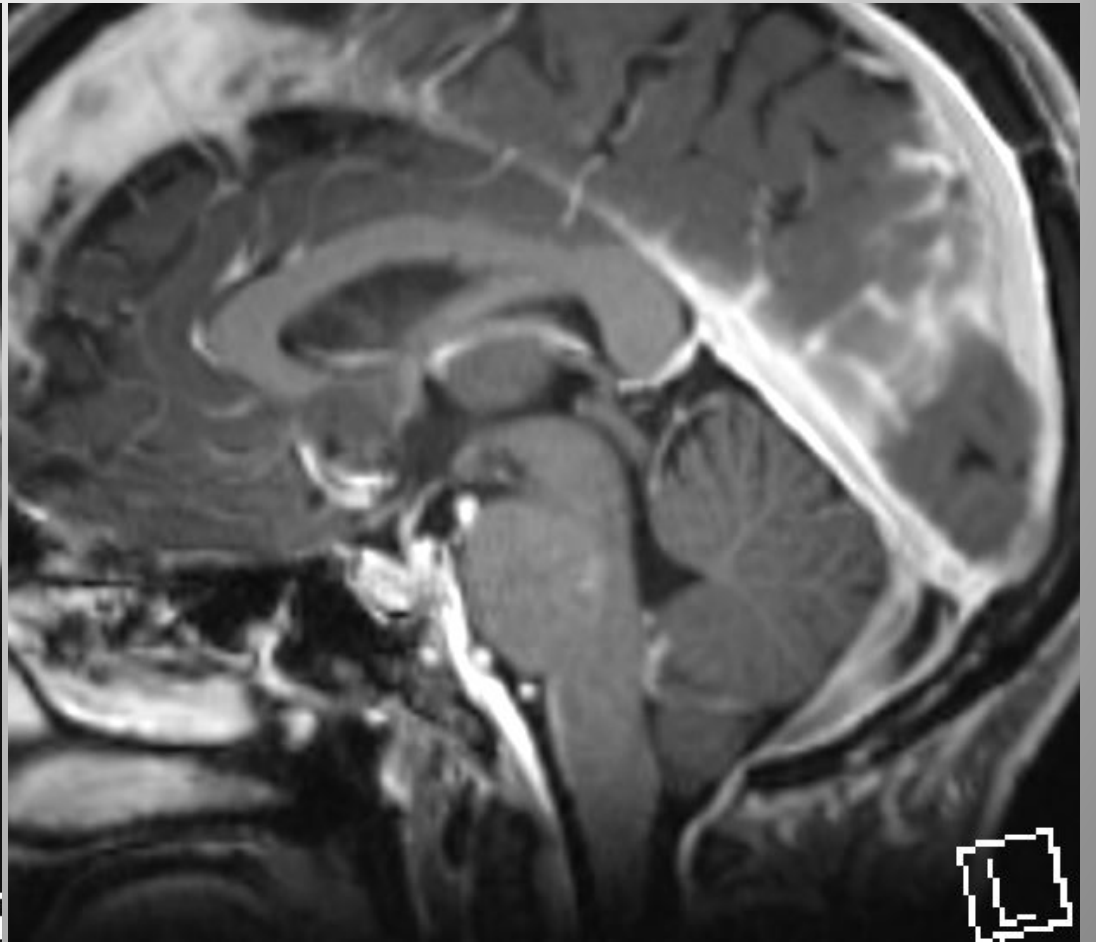
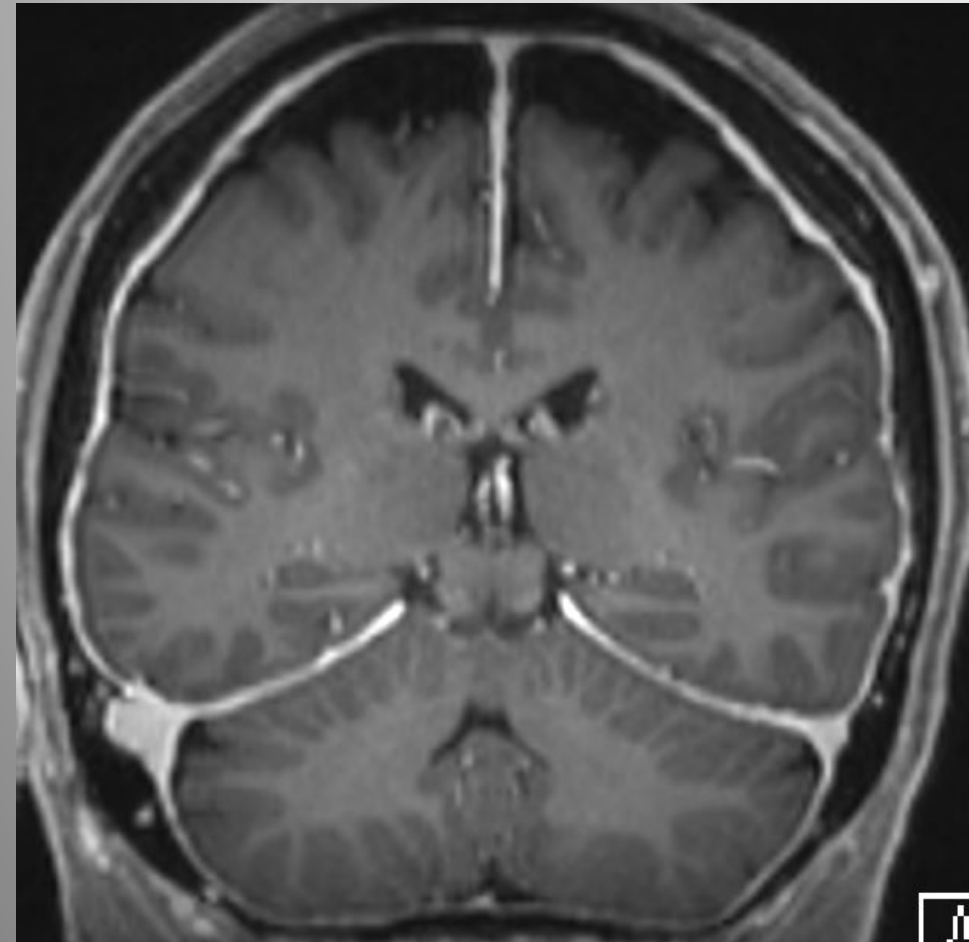


Preop

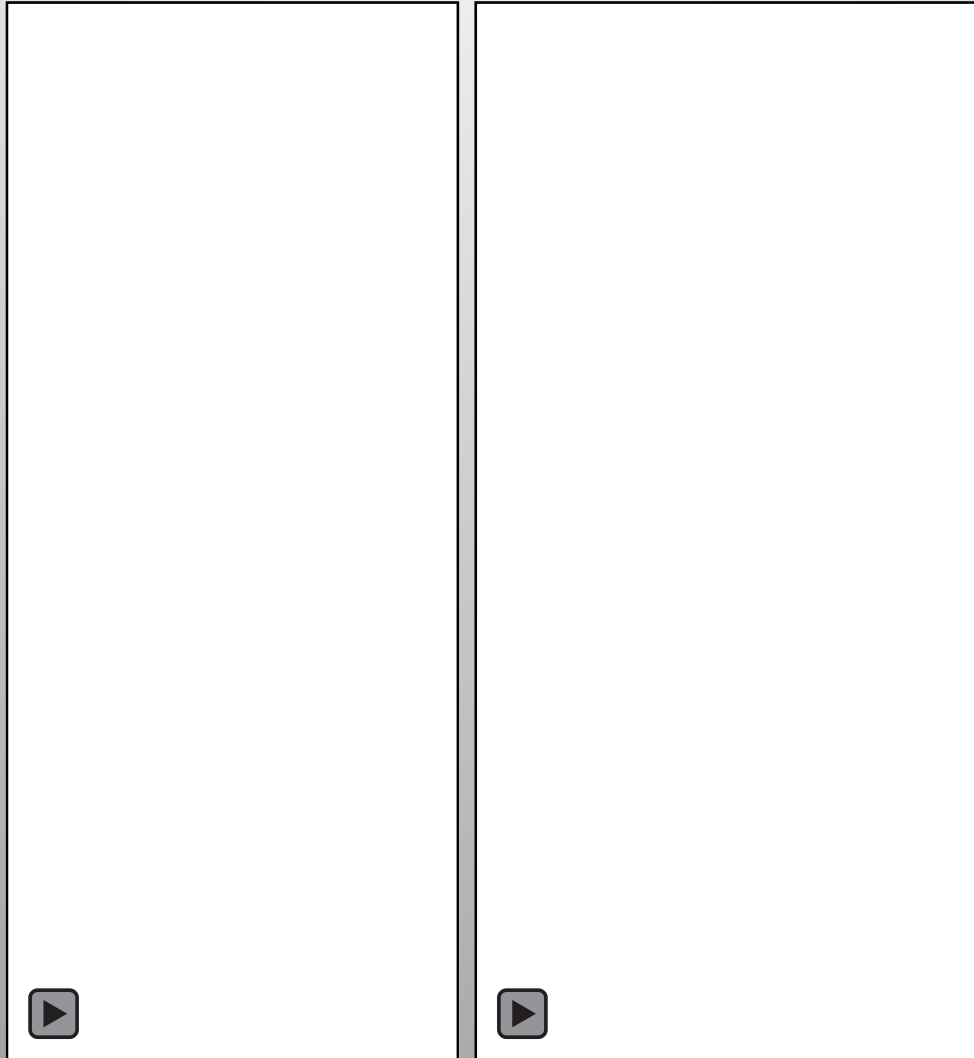


Postop and Fibrin Glue

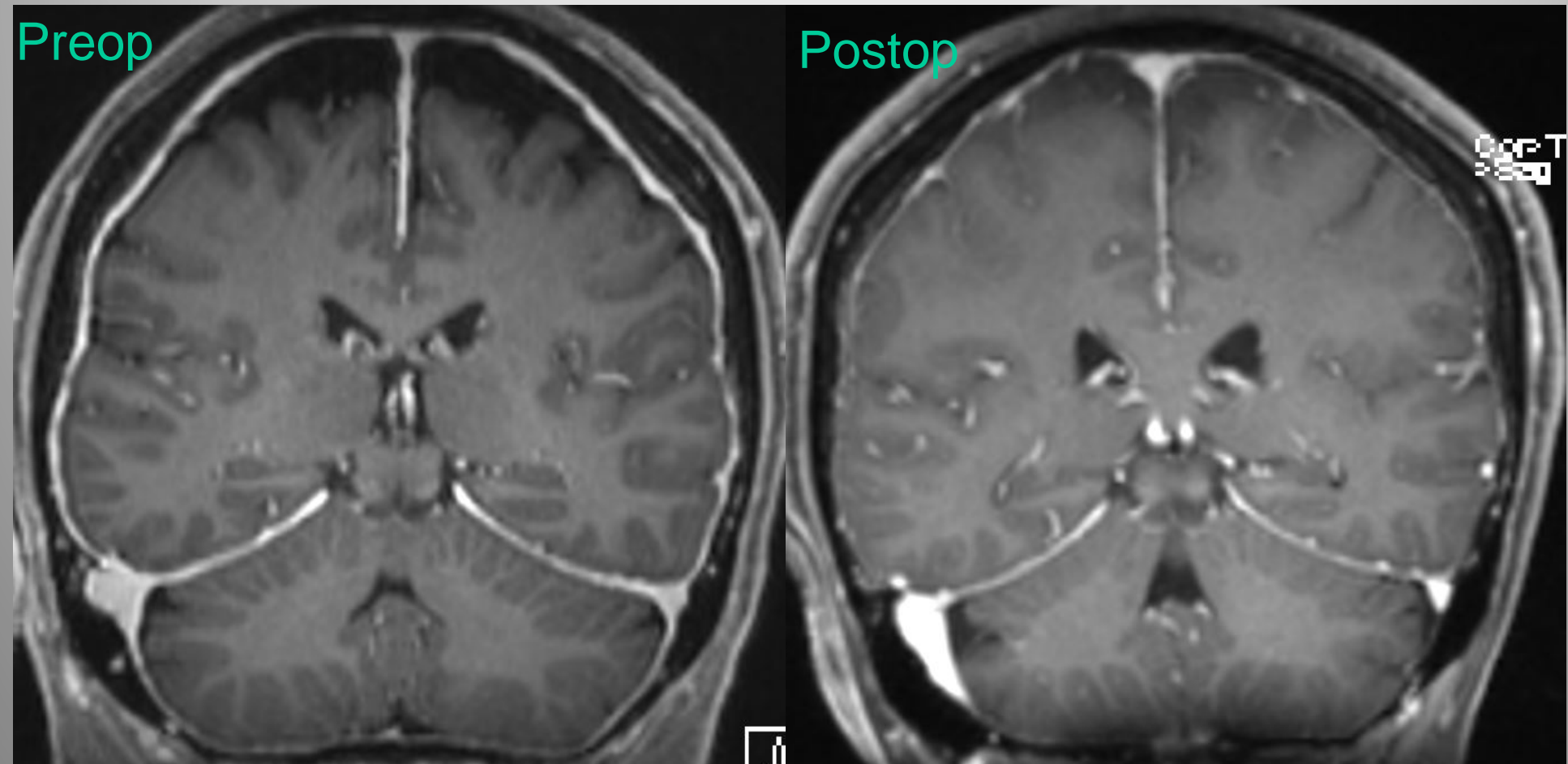
Type 3 (CSF Venous Fistula)



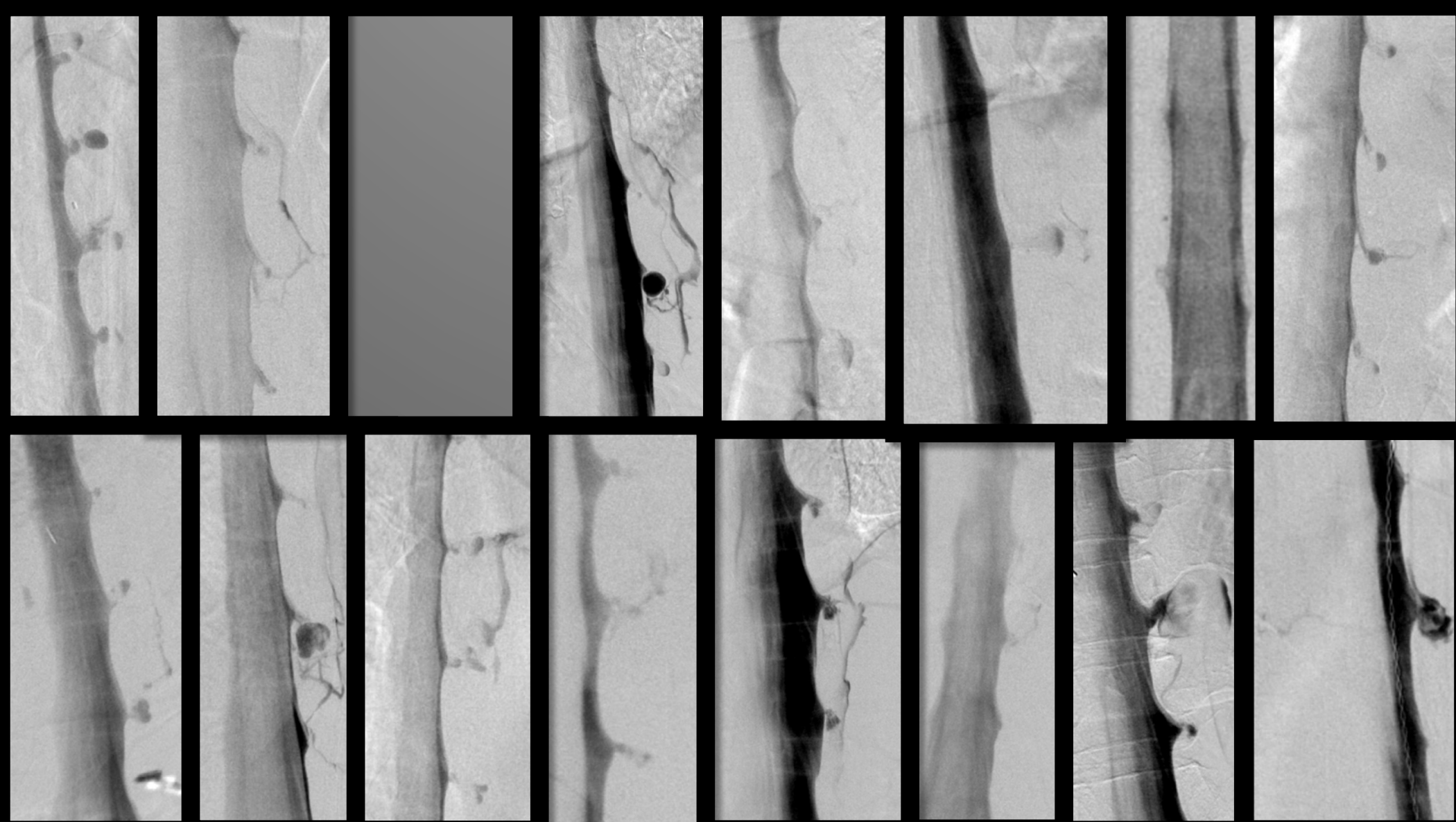
Type 3 (CSF Venous Fistula)



Type 3 (CSF Venous Fistula)



DSM LATERAL DECUBITUS



SIH Imaging



- Crucial in diagnosis/treatment
- Advanced understanding SIH

BUT...



Unresolved Imaging Questions

Discordance between Clinical and Imaging?
What are we missing in 20% of cases (no leak site)
How do we wean off radiation based imaging?



🙏 🙏 🙏 **THANK YOU** 🙏 🙏 🙏