Imaging the Leak: Craniospinal Features and Myelographic Strategies in Spontaneous Intracranial Hypotension

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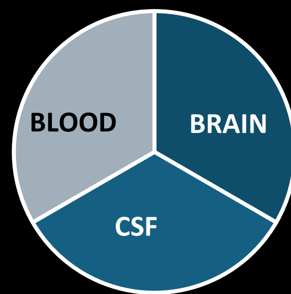
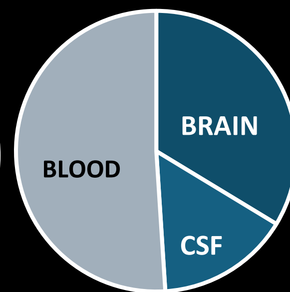
Definition:
A clinical condition caused by **reduced intracranial pressure** due to a **spinal CSF leak**.

Mechanism:
CSF leak leads to an **imbalance** between:

- **Blood**
- **Cerebrospinal fluid (CSF)**
- **Brain parenchyma**



MONRO-KELLIE DOCTRINE



SIH

CLINICAL MANIFESTATIONS

Orthostatic Headache

Characteristics:

- **Aggravated** when **sitting or standing**.
- **Relieved** when **lying down**.

Mechanism:

- **Upright posture** leads to a **drop in intracranial pressure** relative to the spine.
- **Equilibrium is restored** upon lying down.

Other clinical manifestations include, but not limited to, back/neck pain, vomiting/nausea, hearing loss, tinnitus/ vertigo, photophobia, diplopia, dementia, encephalopathy etc.

Low CSF pressure is not always demonstrated on lumbar puncture.

Unlike spinal leaks, skull base leaks rarely cause SIH

BERN SCORING SYSTEM

To evaluate the probability of a CSF leak

Major criteria (2 points each)

Venous sinus engorgement
Pachymeningeal enhancement
Suprasellar cistern of 4 mm or less

Minor criteria (1 point each)

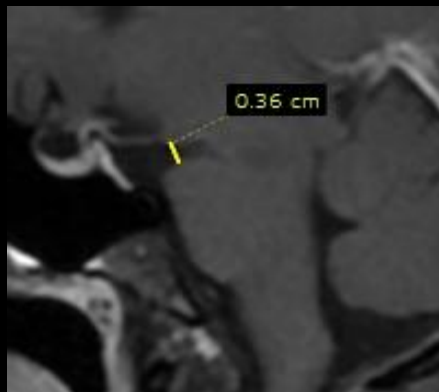
Subdural collection
Prepontine cistern of 5 mm or less
Mamillopontine distance of 6.5 mm or less

Interpretation of scores

- Low probability – 0 to 2
- Intermediate probability – 3 to 4
- High probability – 5 to 9

BRAIN IMAGING – ACUTE STAGE

QUANTITATIVE SIGNS



PONTOMESENCEPHALIC ANGLE

Angle between two lines along

- Anterior margin of the midbrain
- Anterosuperior margin of the pons

CUTOFF ANGLE: <50˚

MAMILLOPONTINE DISTANCE

Distance between the mamillary bodies and the superior aspect of the pons.

CUTOFF VALUE: <6.5 mm

INTERPEDUNCULAR ANGLE

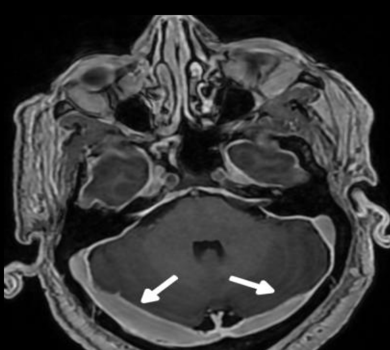
Angle formed by the posterior half of the cerebral peduncles

CUTOFF ANGLE: <40.5°

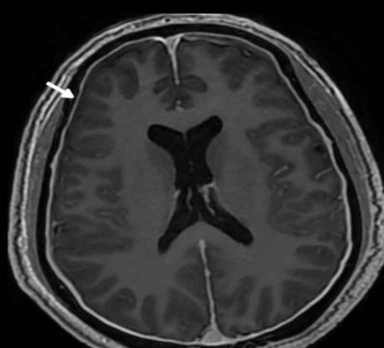
Interpeduncular angle is increased in PSP and MSA-P (> 57°)

QUALITATIVE SIGNS - EVOLUTION

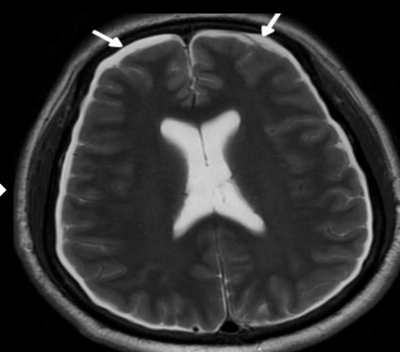
VENOUS ENGORGEMENT



PACHYMENINGEAL ENHANCEMENT



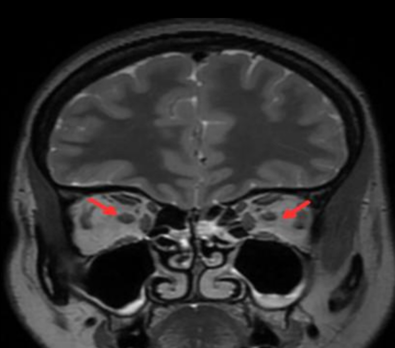
SUBDURAL COLLECTION



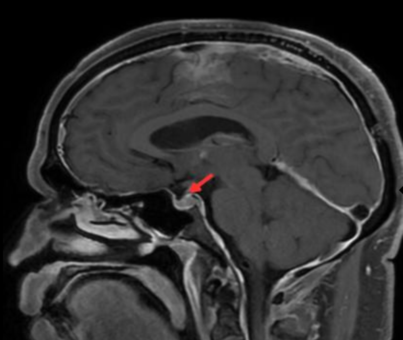
SAGGING OF BRAIN

Mimic: Chiari Malformation

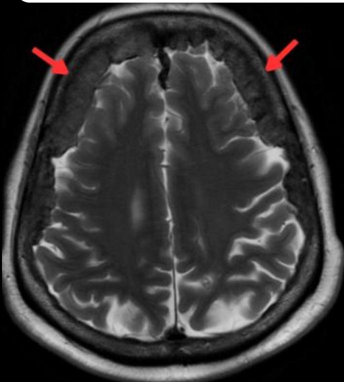
COLLAPSED PERIOPTIC CSF SHEATH



PITUITARY ENGORGEMENT



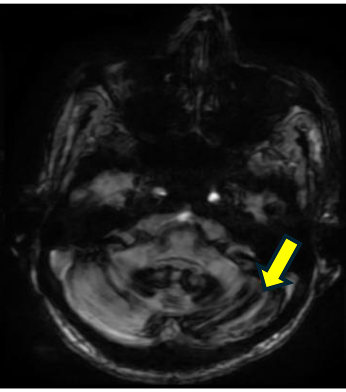
BRAIN IMAGING – CHRONIC STAGE



CALVARIAL THICKENING *(LAYER CAKE SKULL)*

Compensatory mechanism for depleted CSF volume, predominantly involving the skull's **inner table.**

DD:
Hyperostosis Frontalis Interna



SUPERFICIAL SIDEROSIS

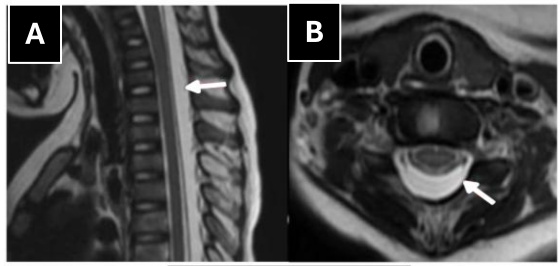
Results from bleeding due to **friable epidural veins.**

Commonly seen in the **posterior fossa**

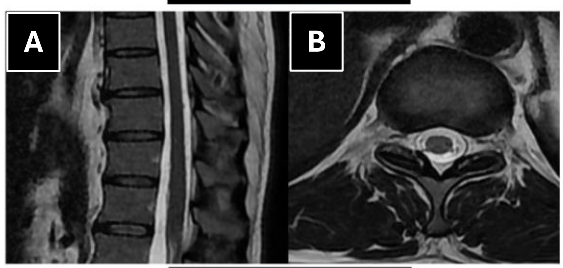
SPINAL IMAGING

TYPES OF CSF LEAK		
Type 1	Dural tear: SLEC* positive 1A - Ventral tear (fast leaks) 1B - Lateral tear	
Type 2	Type 2A: SLEC positive - Proximal nerve root sleeve tear/meningeal diverticular/dural ectasia	
	Type 2B: SLEC negative- Distal root sleeve tear	
Type 3	CSF venous fistula (CVF)	
Type 4	No identifiable cause	

*SLEC: Spinal longitudinal extradural collection.

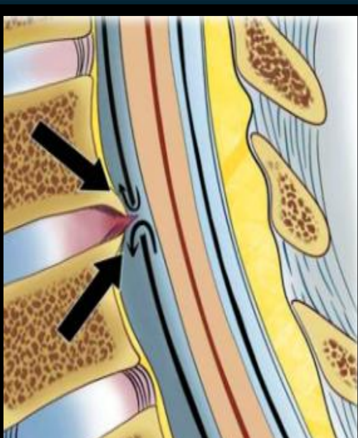


SLEC+ LEAK



SLEC- LEAK

TYPE I LEAK – DURAL TEAR



Spinal ventral dural tear from **calcified disc spur** (thick black arrows) with CSF leak into epidural space (curved arrows).

Most commonly occur in the **thoracic spine.**
Typically **fast-leaks, SLEC +.**

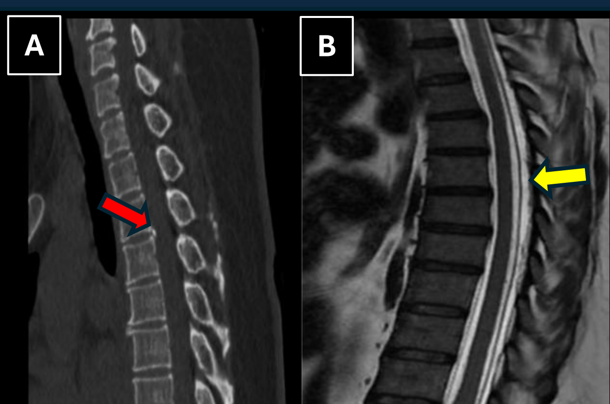
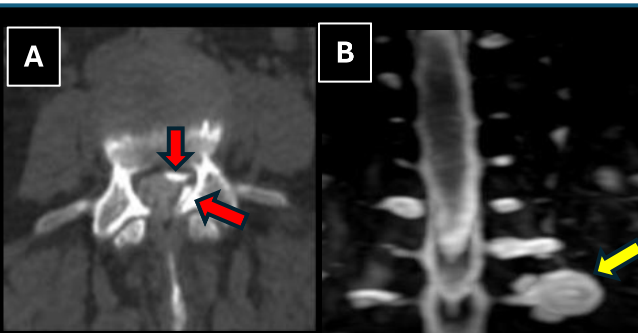


Fig A: Sagittal bone window CT image of the thoracic spine shows a **discogenic spur**.
Fig B: Sagittal T2 W images of the thoracic spine show **spinal epidural collection**.

TYPE IIA LEAK

Proximal nerve root sleeve tear



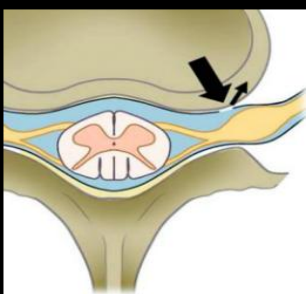
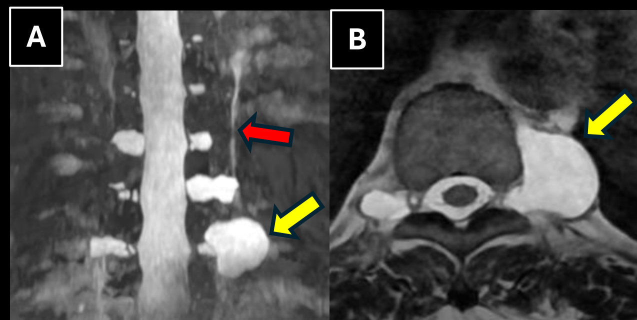


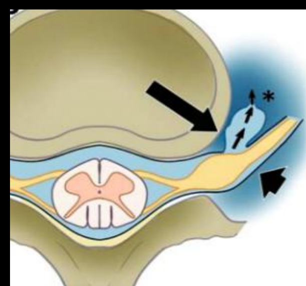
Fig A: CT myelogram shows **lateral epidural collection**
Fig B: Coronal STIR shows multiple **meningeal diverticulae**, largest on the left, presumed leak site.

Typically **slow-leaks, SLEC +**

TYPE IIB LEAK

Distal nerve root sleeve tear

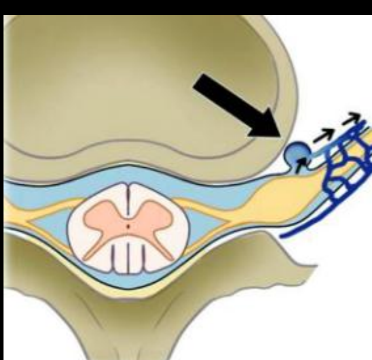


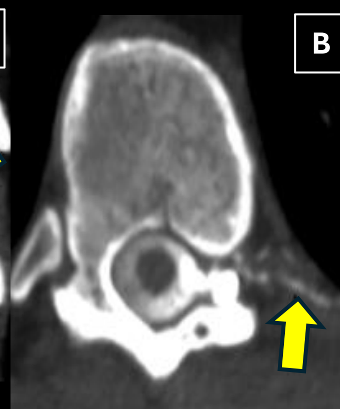


Figs A & B: Coronal and axial STIR show multiple **thoracic diverticulae** with a linear T2 hyperintense track from the left diverticulum suggesting **CSF leak** . No epidural collection seen.

Typically **slow-leaks, SLEC -**

TYPE III LEAK – CSF VENOUS FISTULA

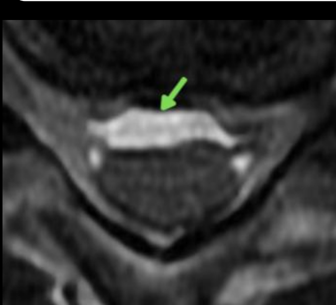




Figs A and B: Coronal and axial decubitus CT myelogram shows a **CSF venous fistula** draining into the **lateral branches of external vertebral venous plexus**

Typically **slow-leaks, SLEC -**

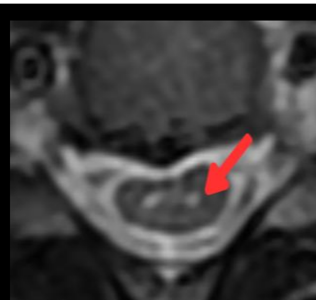
SPINAL IMAGING - CHRONIC STAGE



SPINAL COLLECTION

Axial T2W image shows epidural collection with **rounded margins**

Often **loculated**



BIBRACHIAL AMYOTROPHY

Axial T2W image shows hyperintensity in the region of the anterior horn cells (**Owl's eye appearance**)

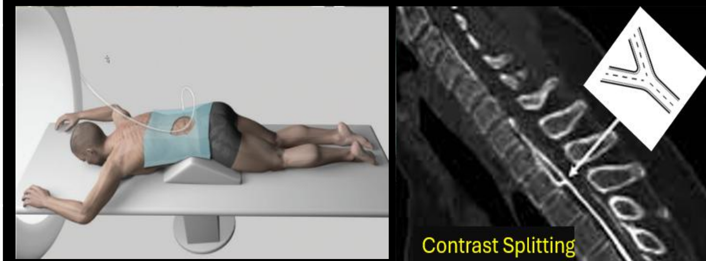
DD – **Anterior spinal artery infarct**

MYELOGRAPHIC TECHNIQUES

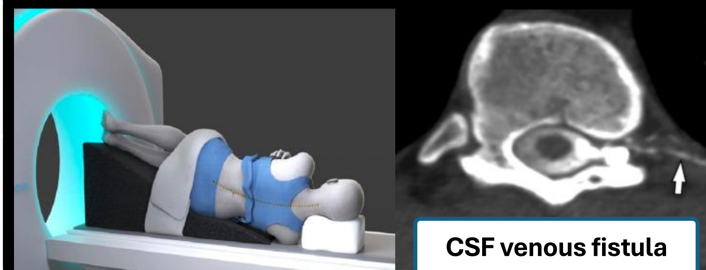
TECHNIQUE	ADVANTAGES
CT Myelography (CTM)	Best for **slow-flow leaks**
Digital Subtraction Myelogram (DSM)	Highest sensitivity for **slow leaks** and **CSF venous fistulas**
Dynamic Fluoroscopic Myelography (DFM)	Real-time leak detection Useful for **high-flow leaks**
MR Myelography	Non-invasive, for **CSF venous fistulas and slow leaks**
Photon Counting CT Myelography	**Best spatial resolution**, higher contrast, less image noise

CT MYELOGRAPHY - CTM

SLEC + : PRONE CTM



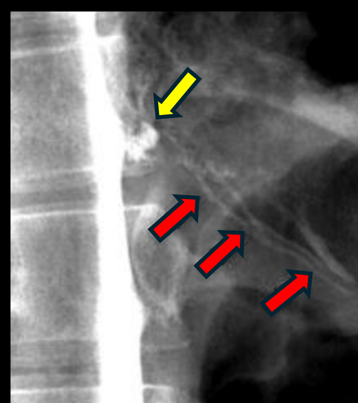
SLEC – : LATERAL CTM



DIGITAL SUBTRACTION MYELOGRAPHY - DSM

Left-sided DSM shows a right D12 **diverticulum** with a CSF venous fistula draining into the **paraspinal venous plexus**

DYNAMIC FLUOROSCOPIC MYELOGRAPHY-DFM



DFM shows a **diverticulum** with a CSF venous fistula draining into the **external vertebral venous plexus.**

DIAGNOSTIC APPROACH AND MANAGEMENT