

# SIH Cranial Imaging - qualitative and quantitative

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2023 Intracranial Hypotension Conference

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## Definition

INTRACRANIAL HYPOTENSION, ALSO KNOWN AS CRANIOSPINAL HYPOTENSION IS DEFINED AS CEREBROSPINAL FLUID (CSF) PRESSURE <6 CM H<sub>2</sub>O IN PATIENTS WITH CLINICAL PRESENTATION COMPATIBLE WITH INTRACRANIAL HYPOTENSION, NAMELY, POSTURAL HEADACHE, NAUSEA, VOMITING, NECK PAIN, VISUAL AND HEARING DISTURBANCES, AND VERTIGO. IT MOST COMMONLY RESULTS FROM A CSF LEAK SOMEWHERE ALONG THE NEURAXIS.

Headache Classification Committee of the International Headache Society (IHS)

The International Classification of Headache Disorders, 3rd edition: (2018)

Cephalalgia. 38 (1): 1-211. [doi:10.1177/0333102417738202](https://doi.org/10.1177/0333102417738202) - [Pubmed](#)

## Diagnostic criteria for headache due to spontaneous intracranial hypotension: a perspective

THE CLINICAL AND RADIOGRAPHIC MANIFESTATIONS OF SPONTANEOUS INTRACRANIAL HYPOTENSION ARE HIGHLY VARIABLE AND MANY PATIENTS DO NOT SATISFY THE 2004 (2018) INTERNATIONAL CLASSIFICATION OF HEADACHE DISORDERS CRITERIA. WE DEVELOPED NEW DIAGNOSTIC CRITERIA FOR SPONTANEOUS INTRACRANIAL HYPOTENSION BASED ON CASES WE HAVE SEEN REFLECTING THE VARIABLE MANIFESTATIONS OF THE DISORDER. THESE CRITERIA PROVIDE A BASIS FOR CHANGE WHEN THE CLASSIFICATION CRITERIA ARE NEXT REVISED. DIAGNOSTIC CRITERIA CONSIST OF

- ORTHOSTATIC HEADACHE
- THE PRESENCE OF AT LEAST ONE OF THE FOLLOWING:
  1. low opening pressure ( $\leq 60$  mm H<sub>2</sub>O)
  2. sustained improvement of symptoms after epidural blood patching, \*\*\*demonstration of an active spinal cerebrospinal fluid leak,
  3. cranial magnetic resonance imaging changes of intracranial hypotension (eg, brain sagging or pachymeningeal enhancement);
- NO RECENT HISTORY OF DURAL PUNCTURE
- NOT ATTRIBUTABLE TO ANOTHER DISORDER

# SIH Cranial Imaging features

## CT

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Described features of intracranial hypotension include:

- subdural collection
- acquired tonsillar ectopia
- dural venous sinus distention
- “layer-cake” skull: diffuse calvarial hyperostosis seen in up to 14% of patients

# SIH Cranial Imaging features

## MRI

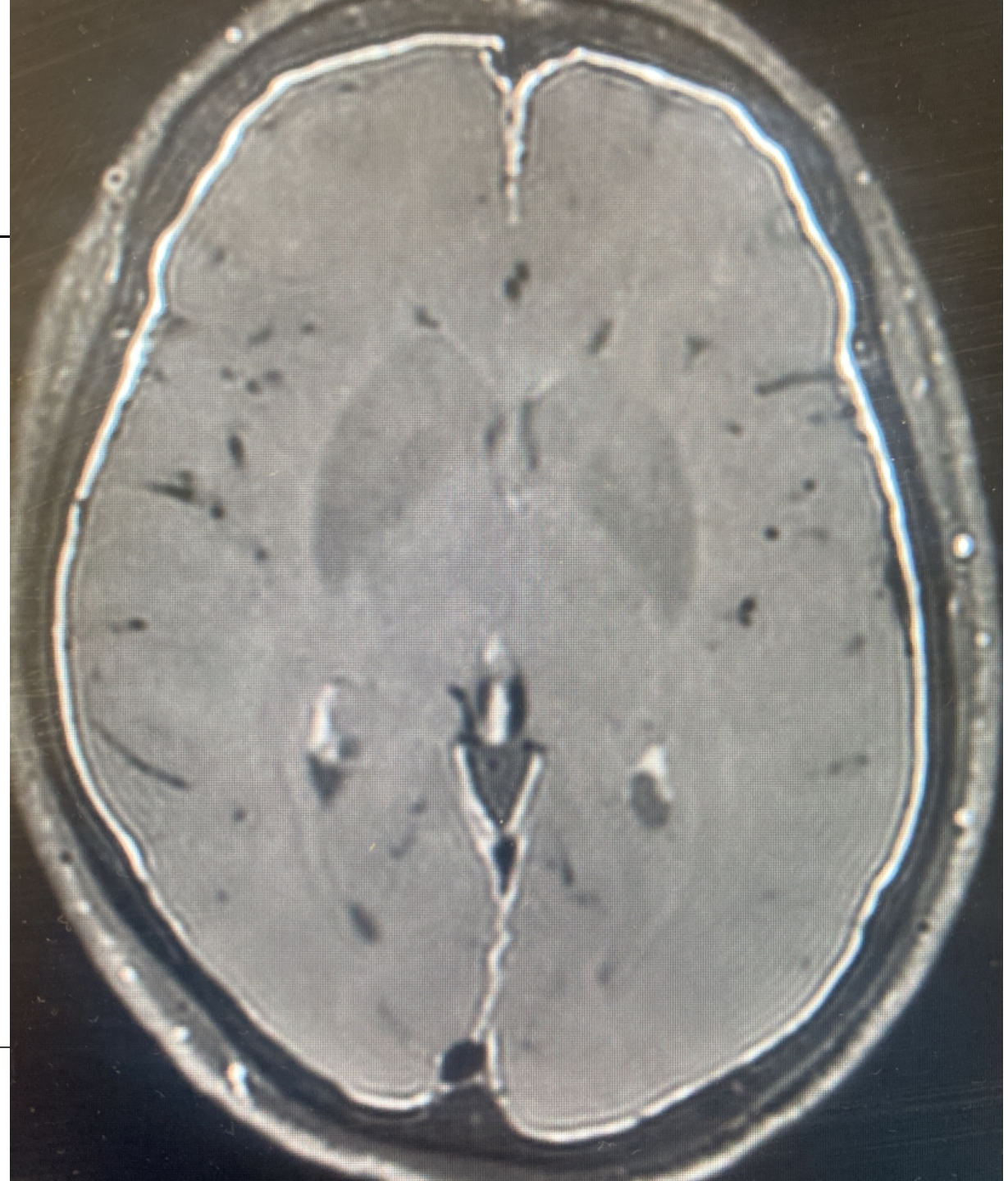
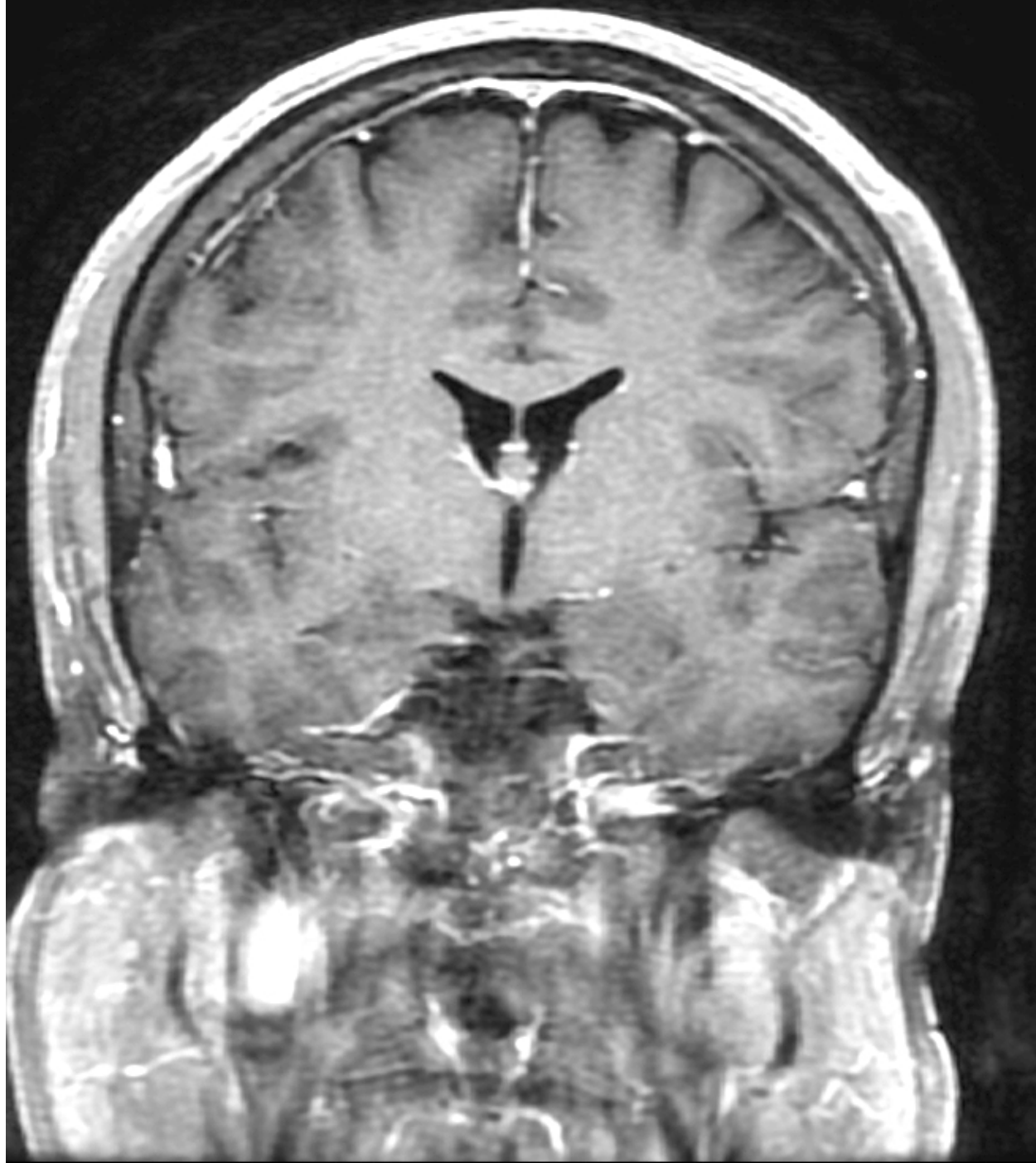
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The most common qualitative finding is

- pachymeningeal thickening and enhancement, followed by
- dural venous engorgement,
- tonsillar herniation,
- subdural collection;

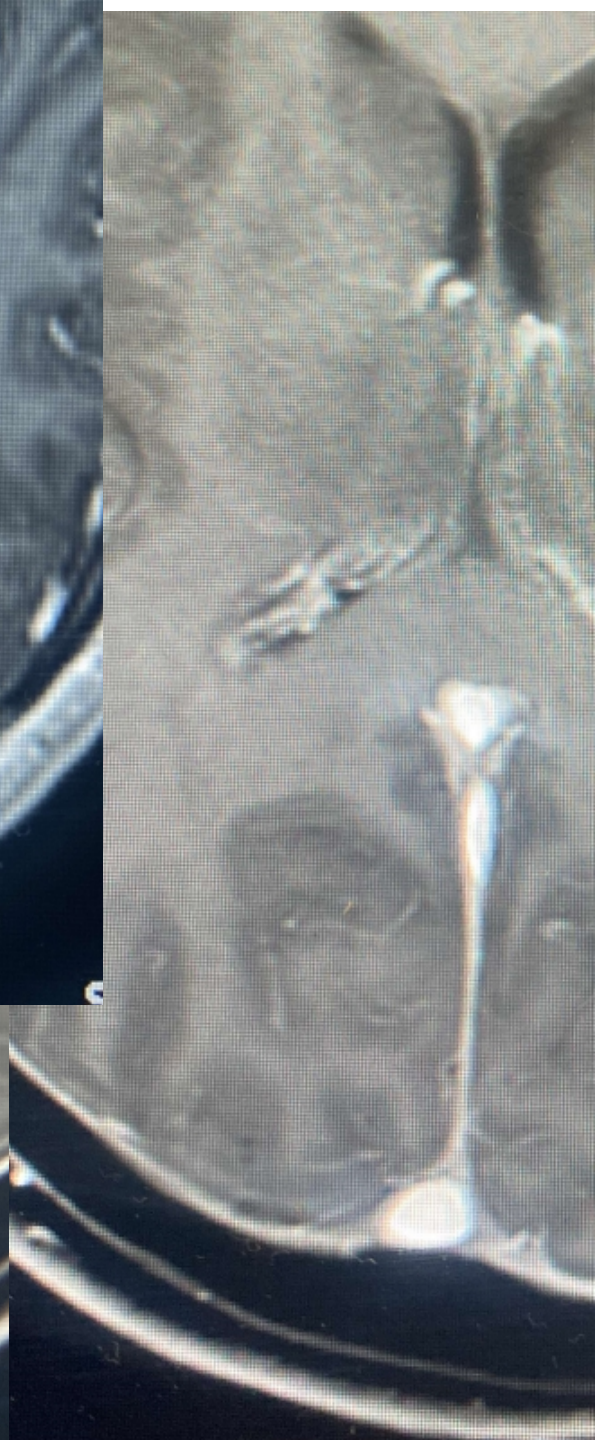
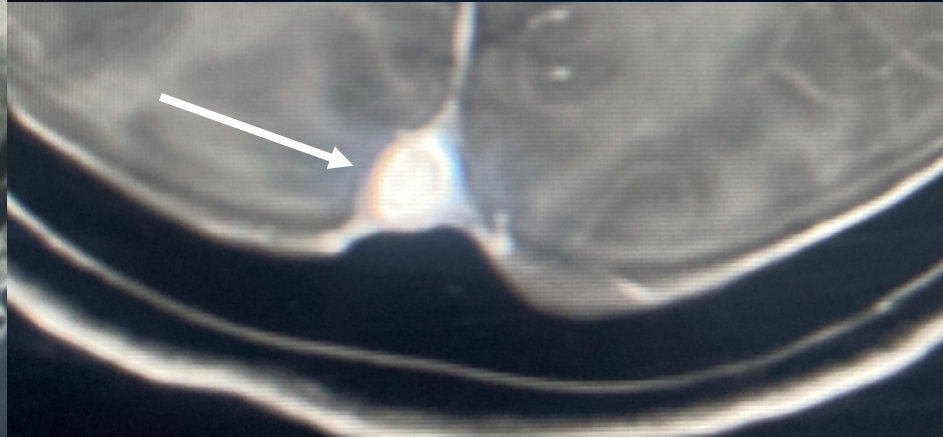
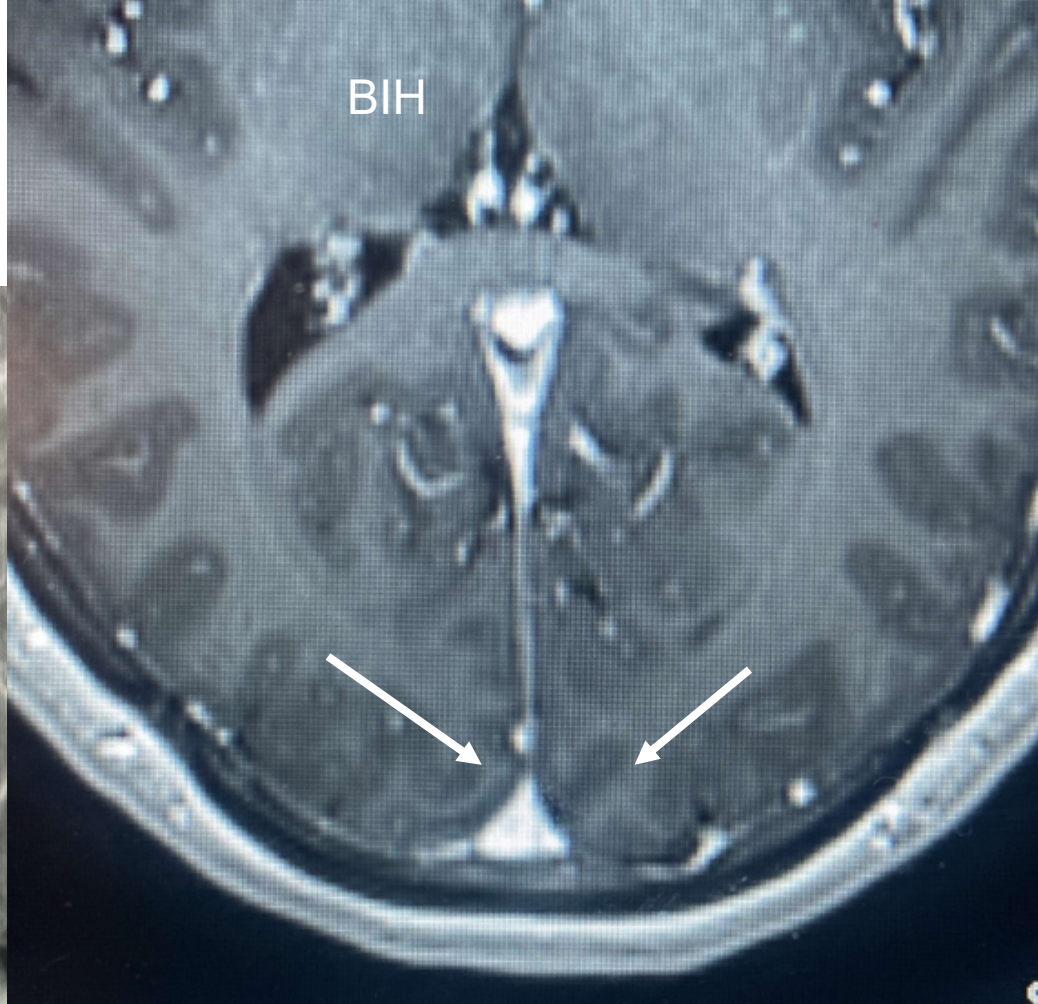
however, these features **are not always present**, which is why quantitative findings are helpful in making a more accurate diagnosis on MRI.

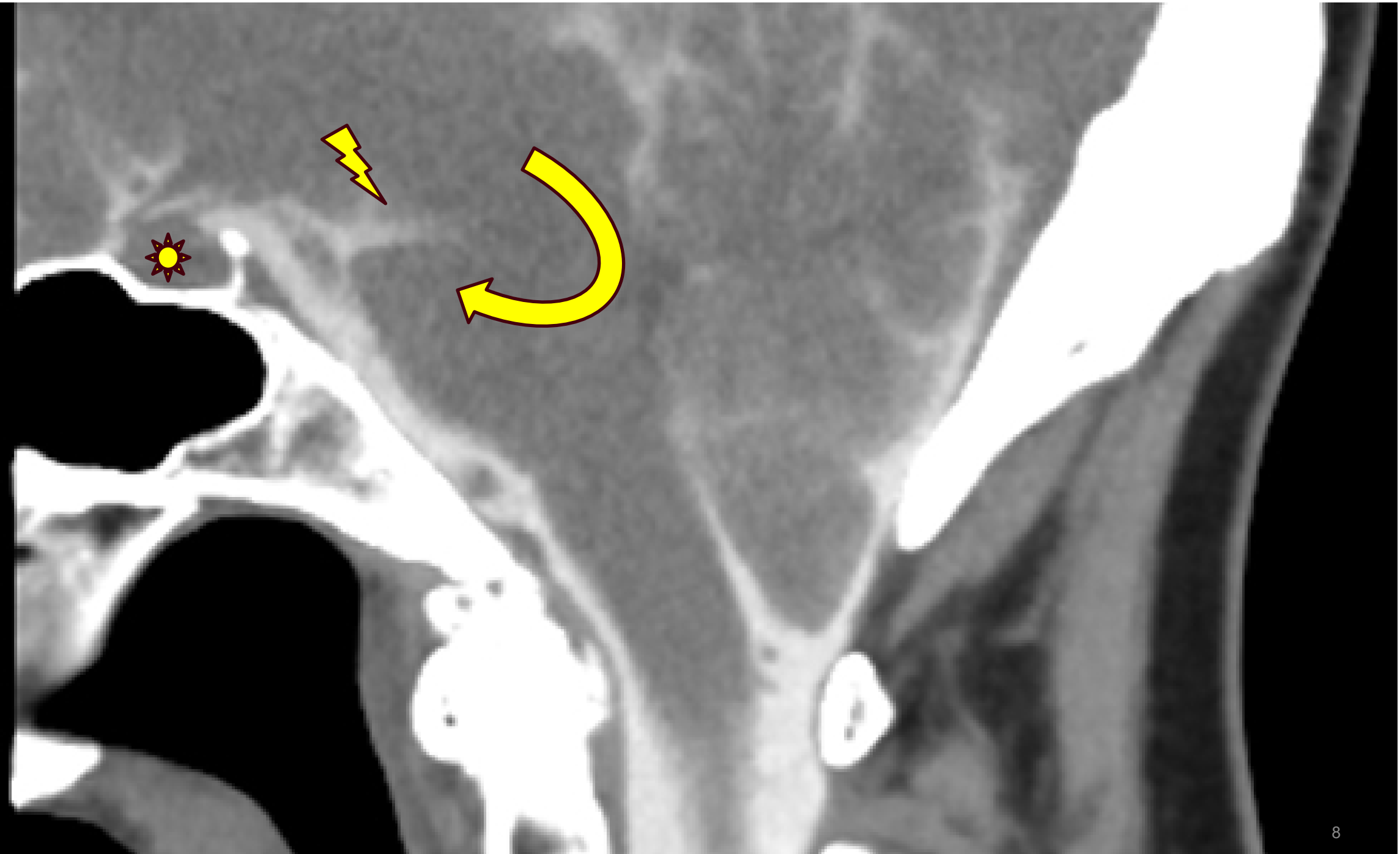
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# MRI Findings

DURAL VENOUS ENGORGEMENT





TONSILLAR HERNIATION



# SIH Cranial Imaging features

## MRI

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- qualitative signs
  - **pachymeningeal enhancement** (most common finding): becomes less prevalent over time after the onset of symptoms; hence, in patients with a chronic duration of symptoms in whom clinically the headache pattern also changes from orthostatic to atypical constant headache, the absence of dural enhancement may hinder the diagnosis of intracranial hypotension
  - increased venous blood volume - **venous distension sign** - rounding of the cross-section of the dural venous sinuses
  - **enlargement of the pituitary gland**
  - **subdural effusions and eventual subdural haematomas**
  - **diffuse cerebral oedema**
  - **sagging brainstem and acquired tonsillar ectopia**
  - **drooping splenium of the corpus callosum**
  - **decreased fluid within the optic nerve sheath**

# SIH Cranial Imaging features

## MRI

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- quantitative signs
  - mammillopontine distance  $< 5.5$  mm
  - pontomesencephalic angle  $< 50^\circ$
  - interpeduncular angle  $< 40.5^\circ$  measured in the axial plane at or immediately below the level of the mammillary bodies
  - upslope of floor of 3<sup>rd</sup> ventricle  $< 20^\circ$
  - Suprasellar cistern  $\leq 4$  mm
  - Prepontine cistern  $\leq 5$  mm

# SEEPS

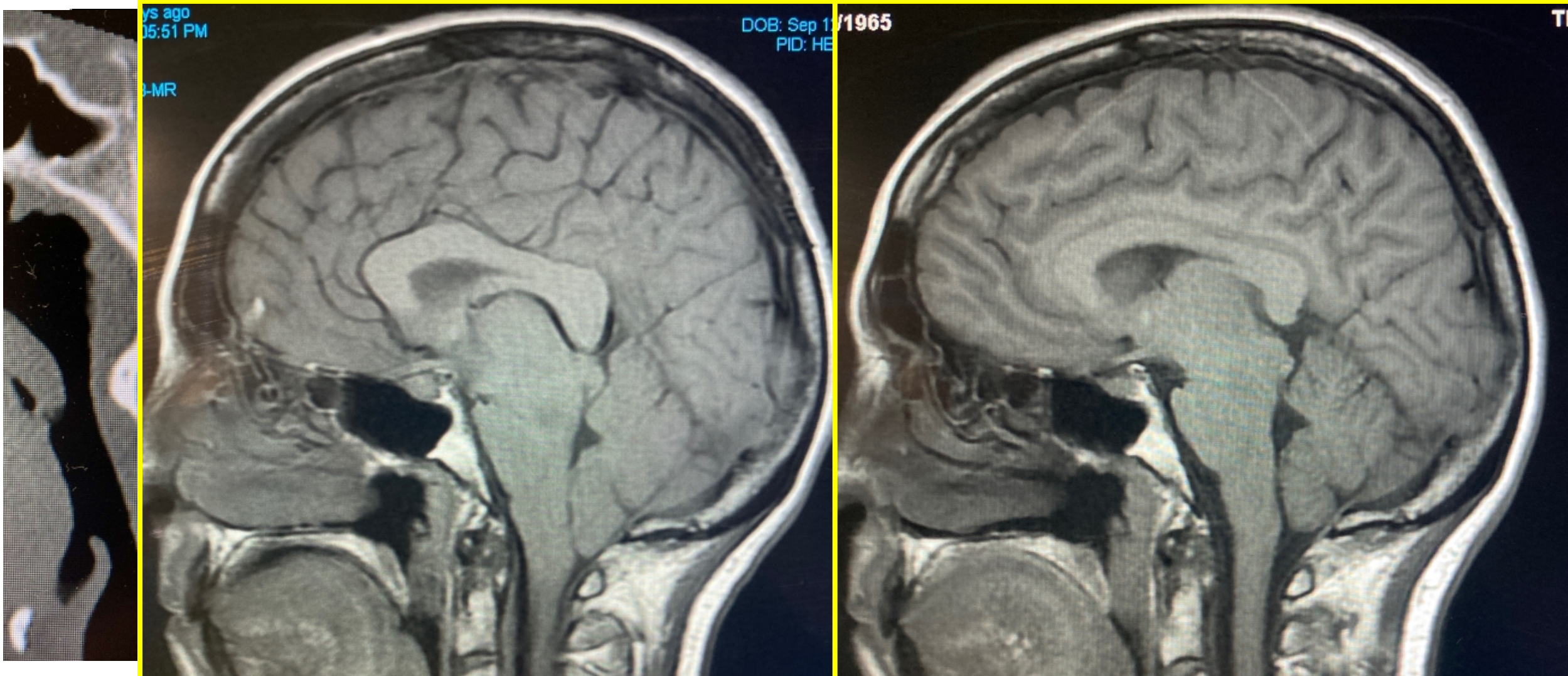
## MNEMONIC

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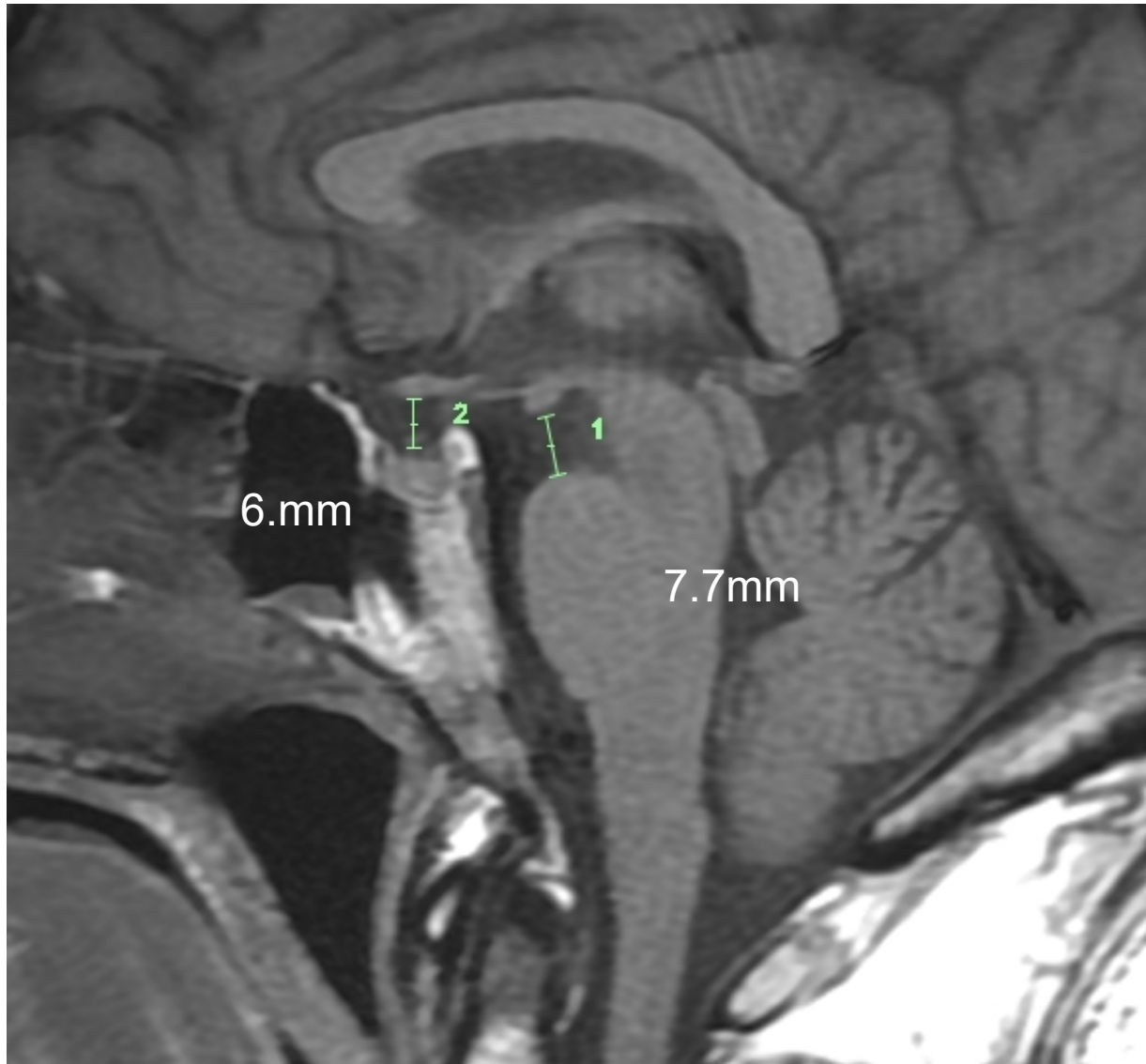
- **S**: subdural fluid collections
- **E**: enhancement of the pachymeninges
- **E**: engorgement of the venous sinuses
- **P**: pituitary hyperaemia
- **S**: sagging brain

# Examples

## SAGGING BRAINSTEM AND ACQUIRED TONSILLAR HERNIATION

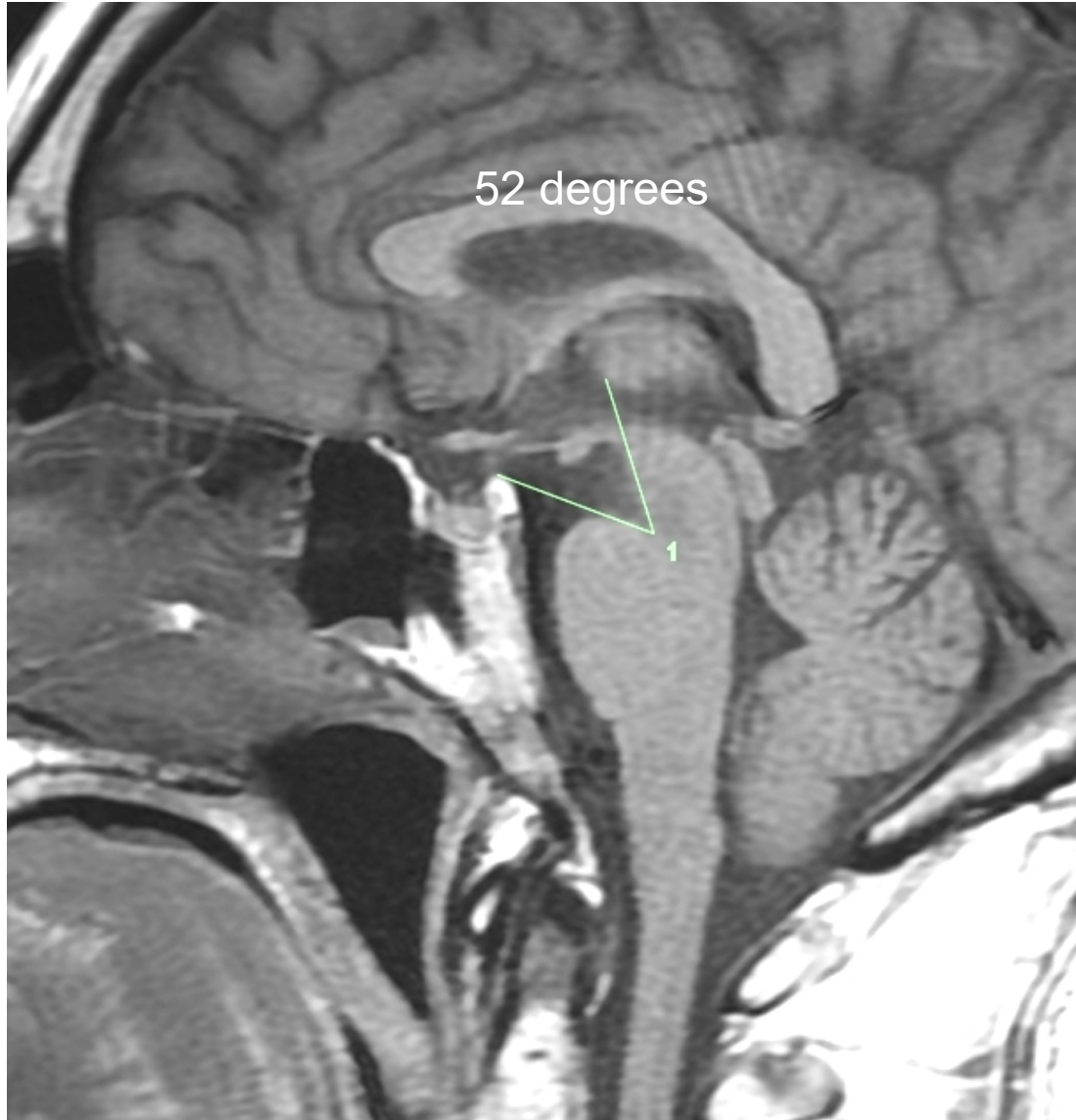


MAMILLOPONTINE DISTANCE  
SUPRA PITUITARY DISTANCE



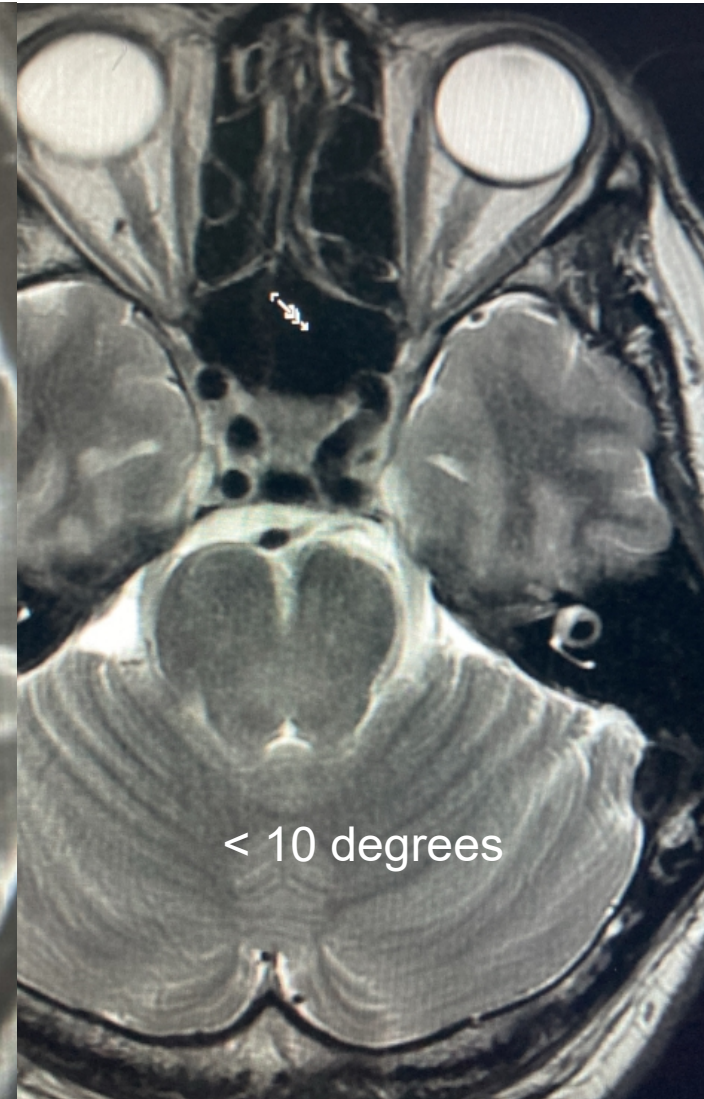
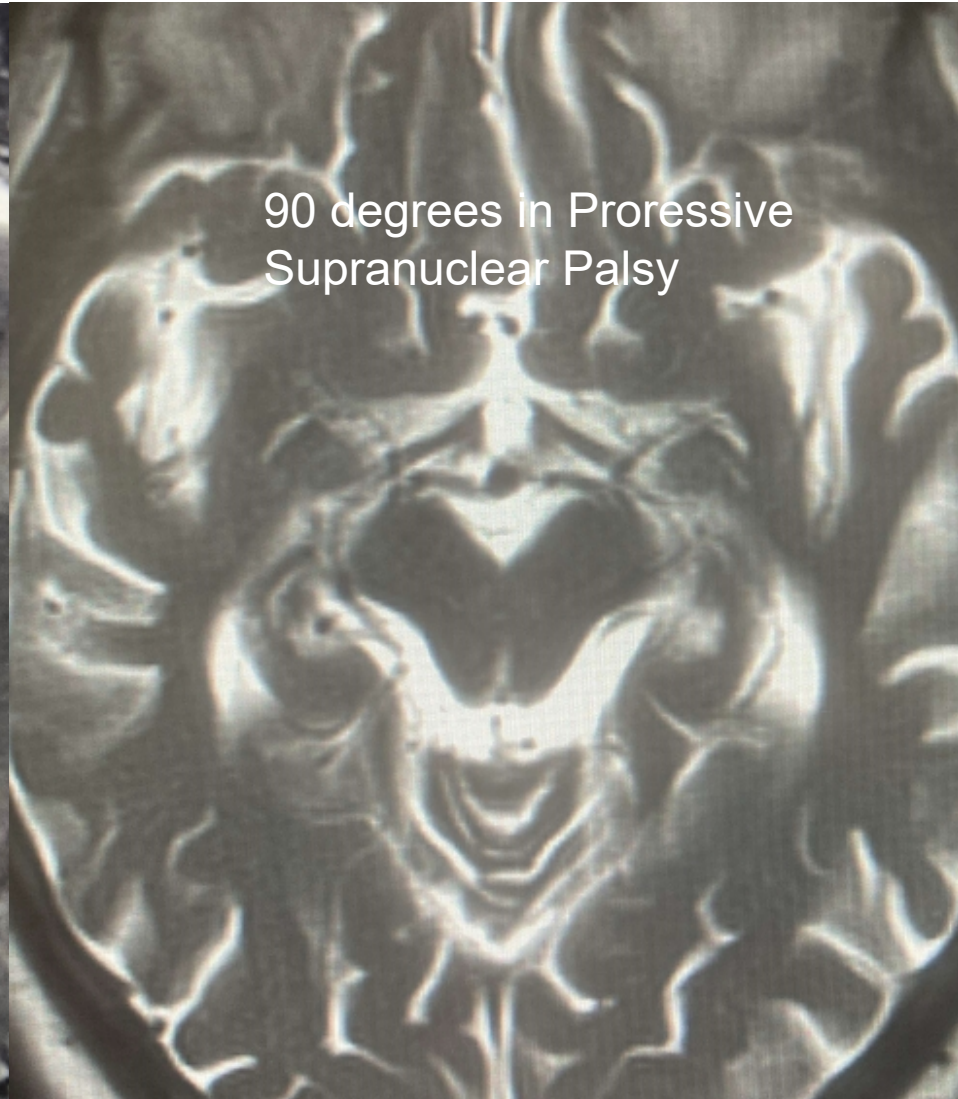
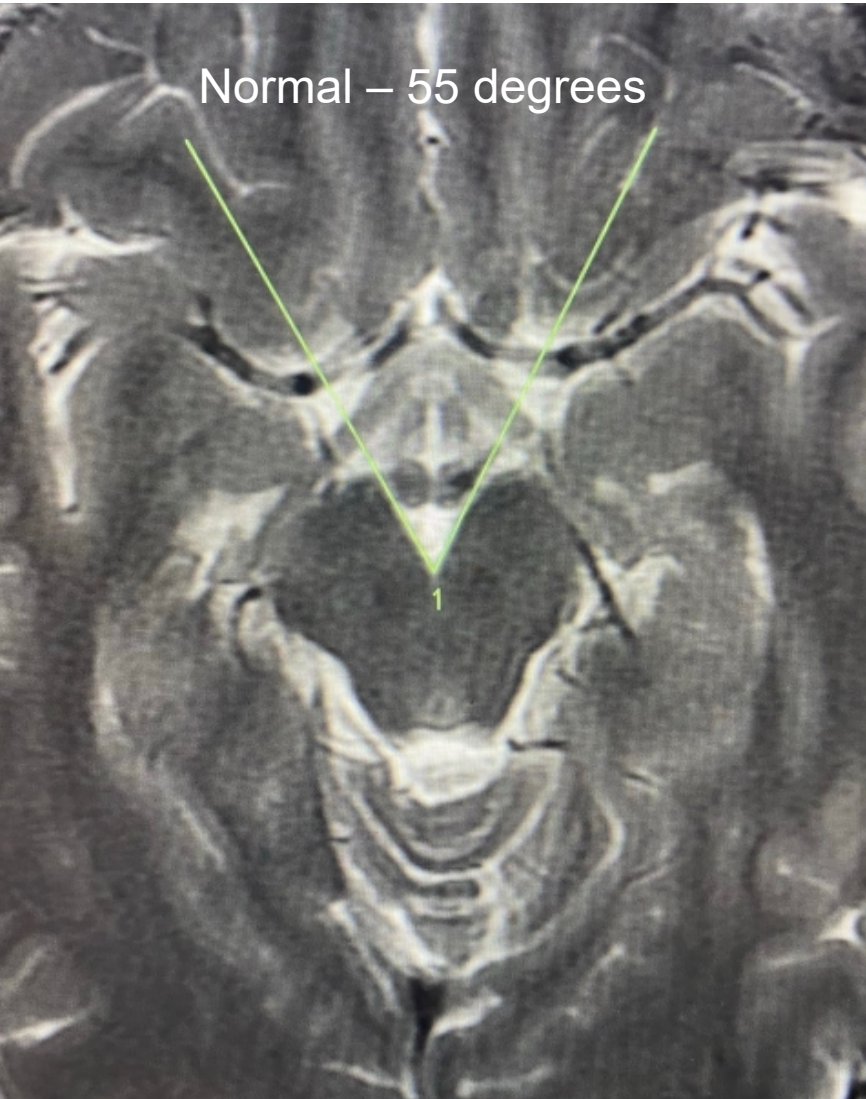
# Examples

## PONTO-MESENCEPHALIC ANGLE



# Quantitative parameters

## INTER-PEDUNCULAR ANGLE



**Even  
measurements  
are not enough**





# How to formalize assessment

## BERN SIH SCORE

Assessing Spinal Cerebrospinal Fluid Leaks in Spontaneous Intracranial Hypotension With a Scoring System Based on Brain Magnetic Resonance Imaging Findings.

Dobrocky T, Grunder L, Breiding PS, Branca M, Limacher A, Mosimann PJ, Mordasini P, Zibold F, Haeni L, Jesse CM, Fung C, Raabe A, Ulrich CT, Gralla J, Beck J, Piechowiak EI.

JAMA Neurol. 2019 May 1;76(5):580-587. doi:  
10.1001/jamaneurol.2018.4921. PMID: 30776059; PMCID:  
PMC6515981.

# Assessing Spinal Cerebrospinal Fluid Leaks in Spontaneous Intracranial Hypotension with a Scoring System Based on Brain Magnetic Resonance Imaging Findings

Three blinded readers retrospectively reviewed the brain MRI scans of 152 participants patients with SIH and a spinal CSF leak, patients with orthostatic headache without a CSF leak, and healthy control participants, evaluating 9 quantitative and 7 qualitative signs.

- 56 with SIH and a spinal CSF leak,
- 16 with orthostatic headache without a CSF leak,
- 60 control participants
- 20 patients in the validation cohort.

A predictive diagnostic score based on multivariable backward logistic regression analysis was then derived. Its performance was validated internally in a prospective cohort of patients who had clinical suspicion for SIH.

# Final scoring system

- Six imaging findings were included in the final scoring system.
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## Major (2 points each):

- pachymeningeal enhancement,
- engorgement of venous sinus, and
- effacement of the suprasellar cistern of 4.0 mm or less.

## Minor (1 point each):

- subdural fluid collection,
  - effacement of the prepontine cistern of 5.0 mm or less,
  - mammillopontine distance of 6.5 mm or less.
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# BERN SIH Score

- Probability of having a spinal CSF leak
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**Low** - 2 points or fewer

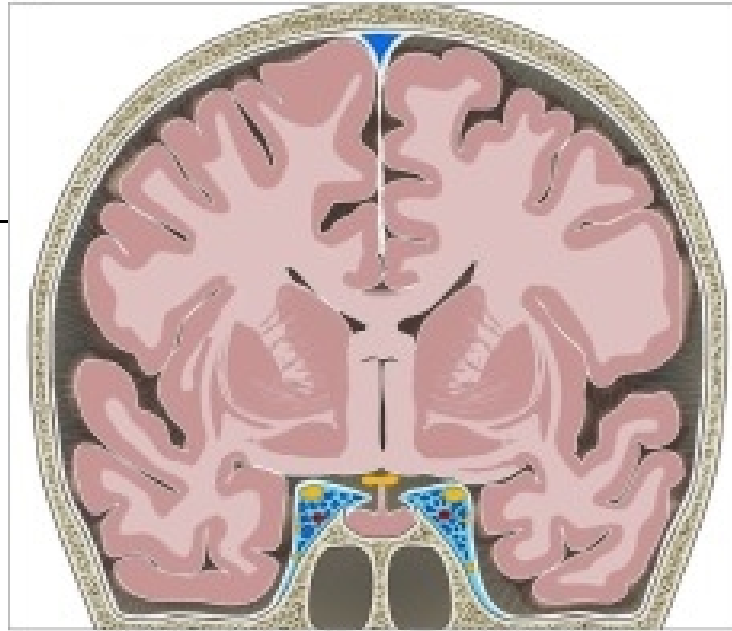
**Intermediate** - 3 to 4 points,

**High** - 5 points or more on a scale of 9 points.

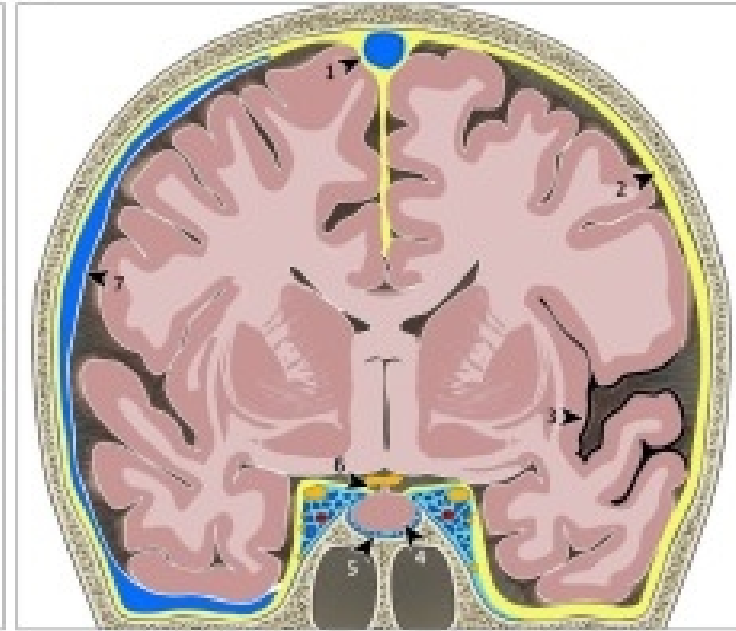
The discriminatory ability of the proposed score could be demonstrated in the validation cohort.

• BERN SCORE

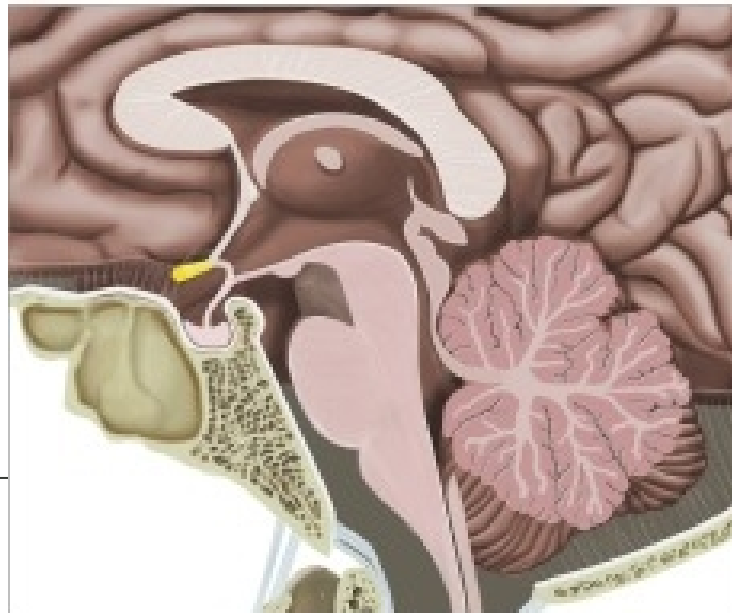
A Coronal illustration showing normal findings



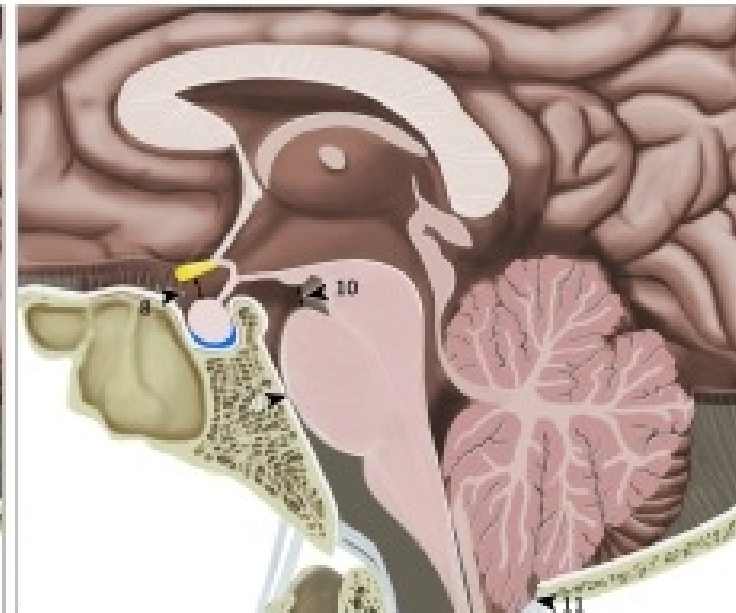
B Coronal illustration showing typical signs of intracranial hypotension



C Sagittal illustration of posterior fossa showing normal findings

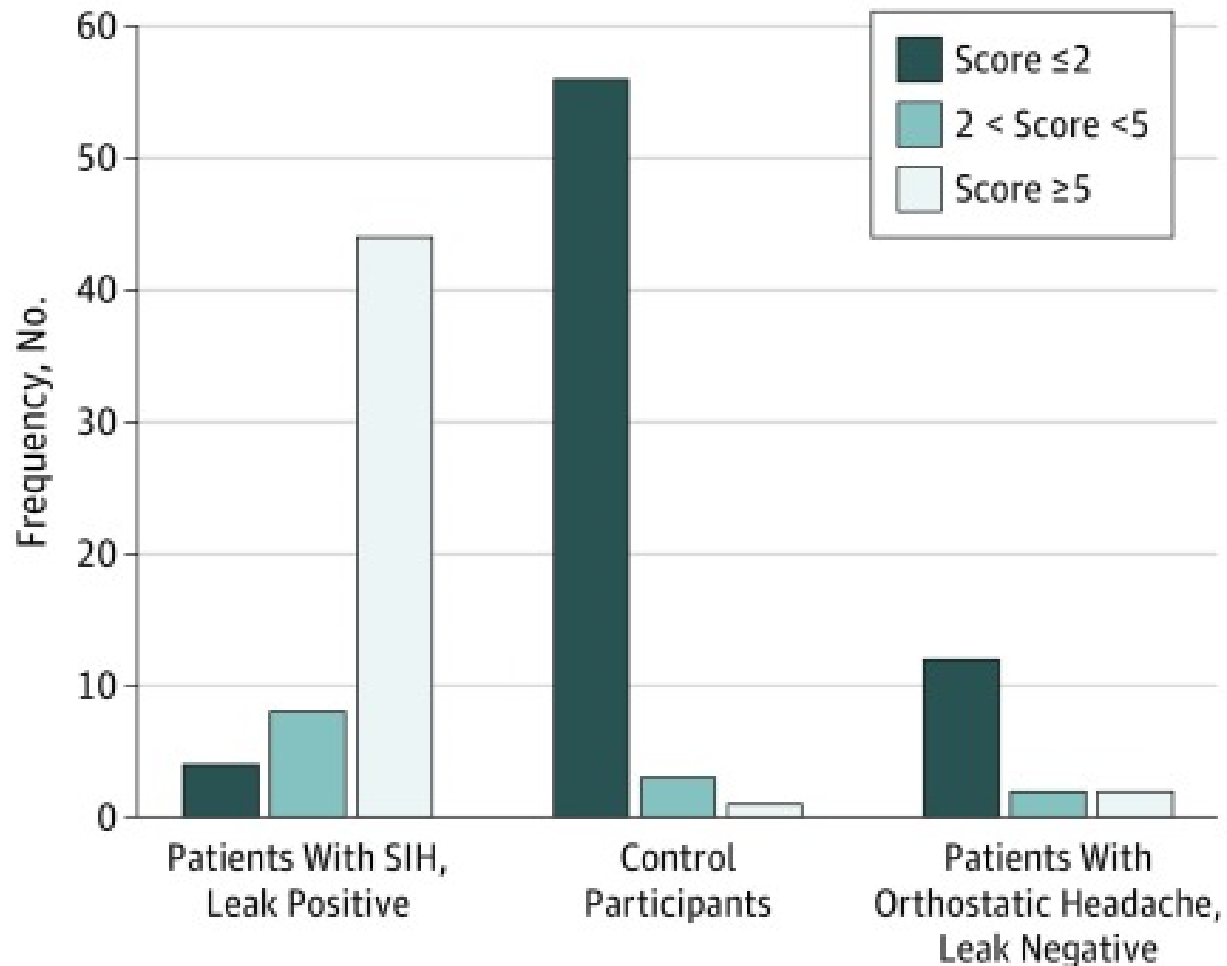


D Sagittal illustration of posterior fossa showing typical signs of intracranial hypotension

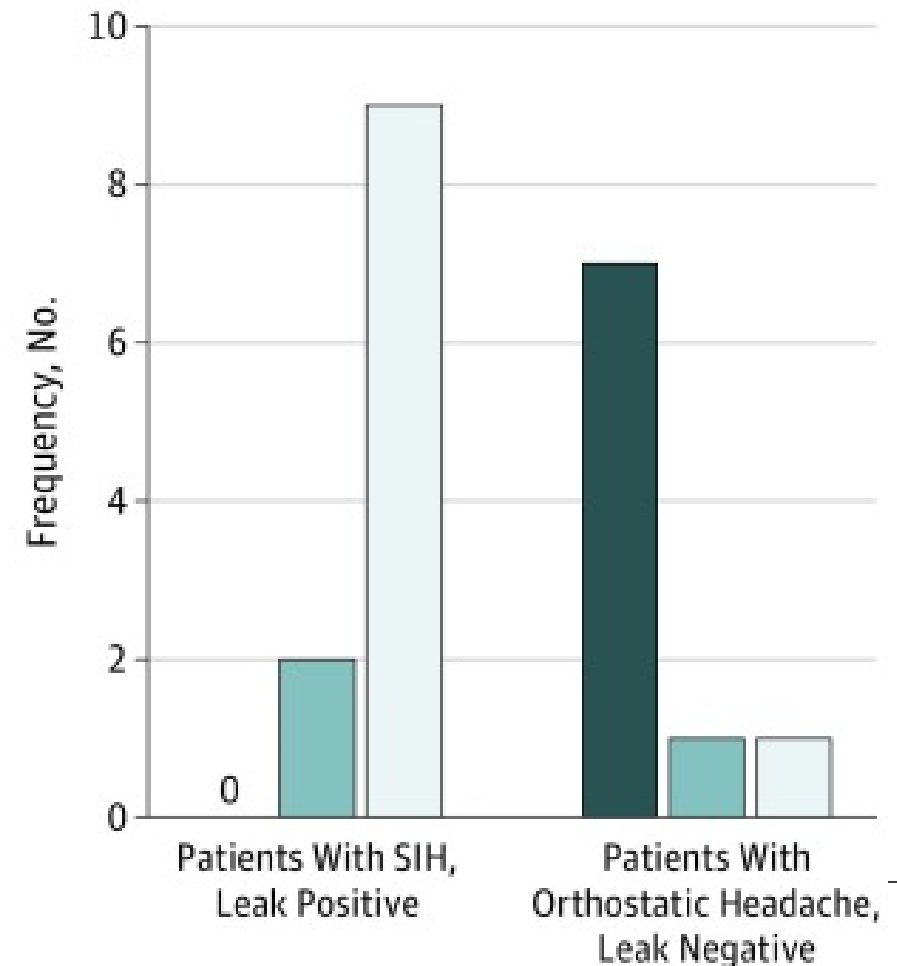


# BERN SIH Predictive Model Score

**A** Derivation cohort



**B** Validation cohort



# Our experience

## BERN SIH SCORE

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- This is a very valuable initiative
- further refinements or changes in thresholds or weightings may be required to increase discriminatory ability
- eg Pachymeningeal enhancement 2 points - when we know this becomes less prevalent over time after the onset of symptoms
- larger multicentre patient cohort

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- Questions?