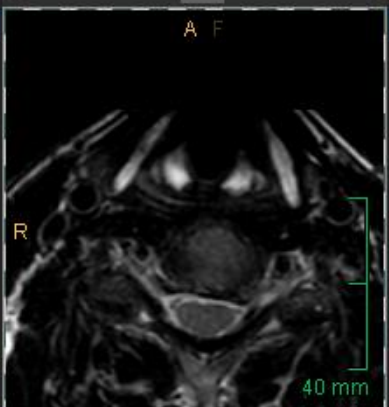
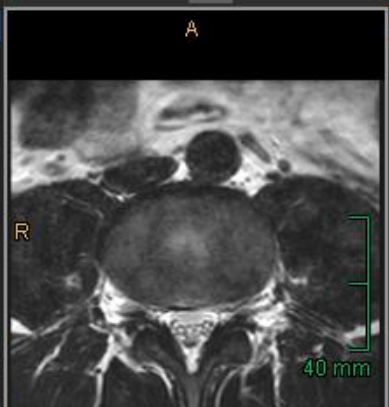
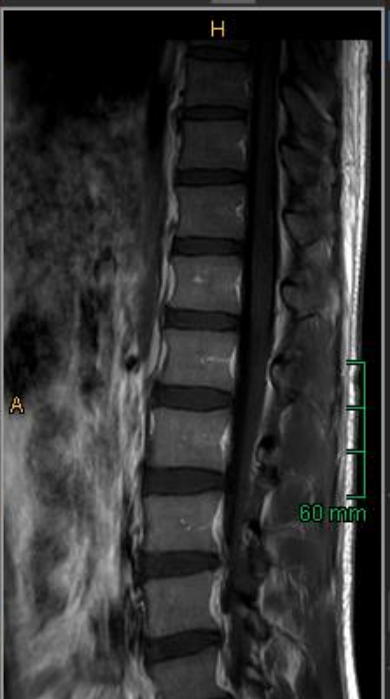
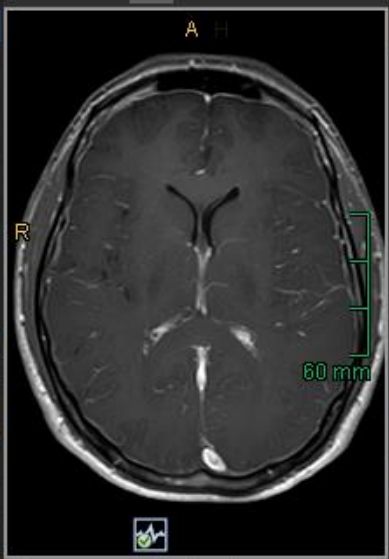
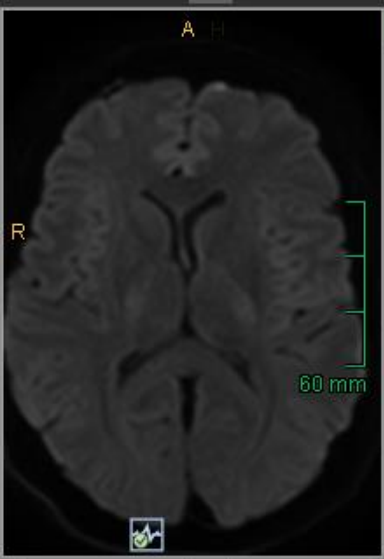
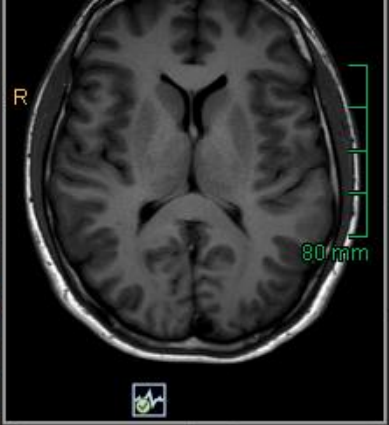
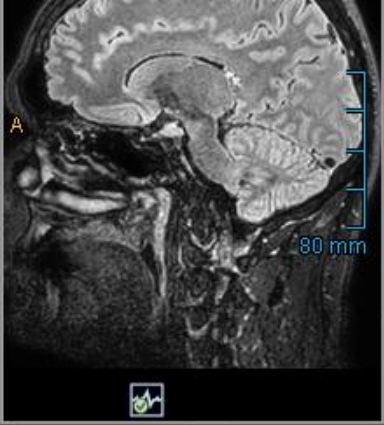


Refining MR protocols and why they are used

Dr. med. Niklas Lützen
Department of Neuroradiology
CSF Center Freiburg, Germany
Chairman: Prof. Dr. med. H. Urbach

No disclosures



Why refine MRI protocols?



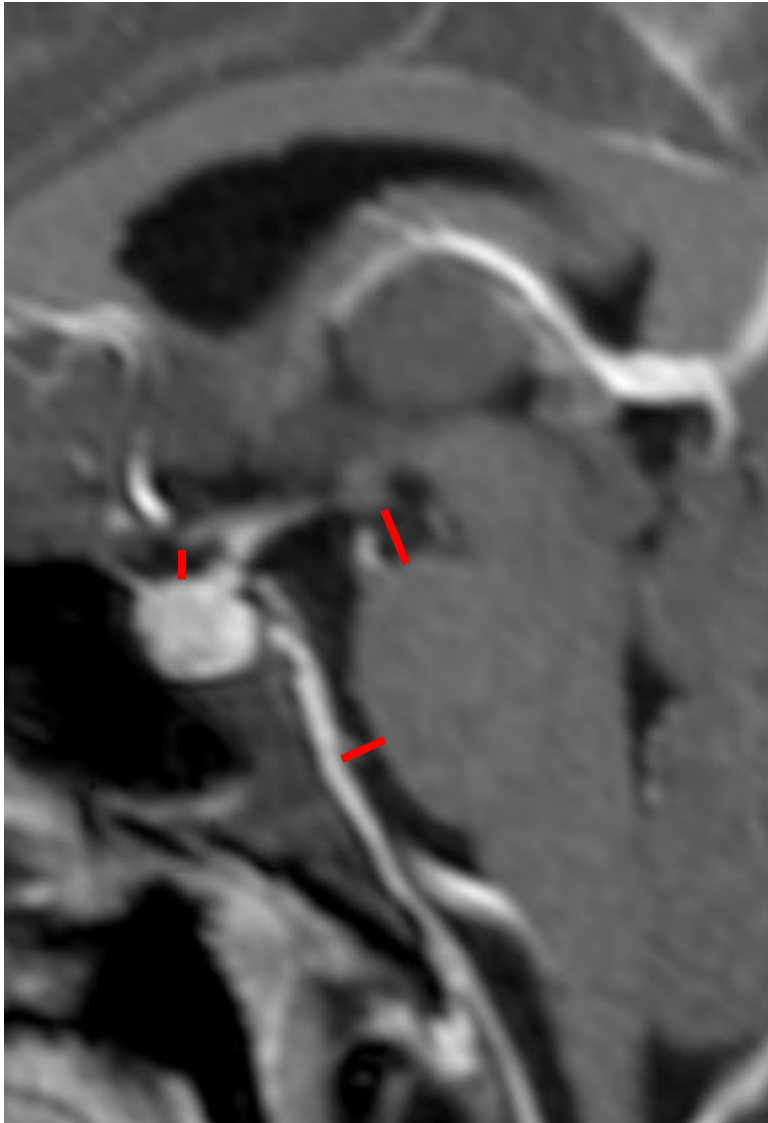
Relevance of MRI protocols

- MRI is **always the first step** in SIH workup!
- Influence on everything that follows (myelography)
- Impact on the time to diagnosis
- MRI sequences are complex (terminology, manufacturer dependent)
- MRI acronyms: <https://www.dkfz.de/en/radiologie/images/MR-Akronymliste.pdf>

Contents

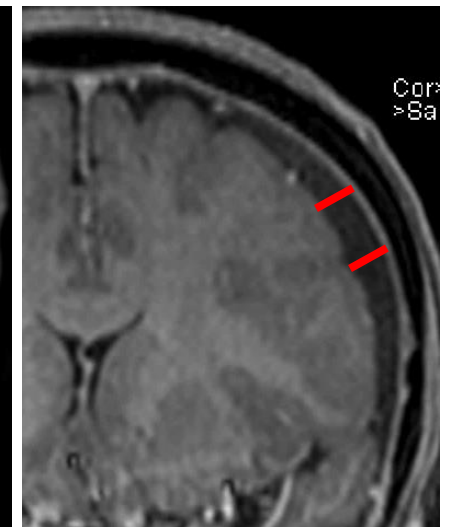
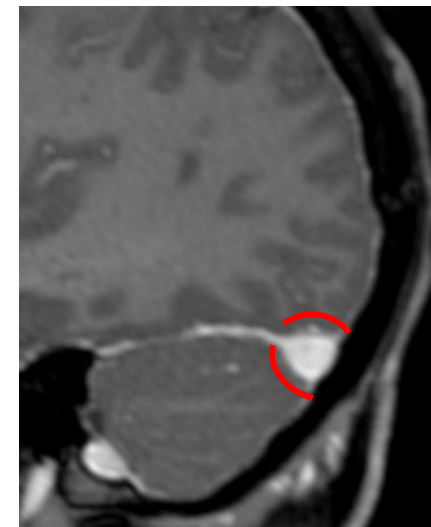
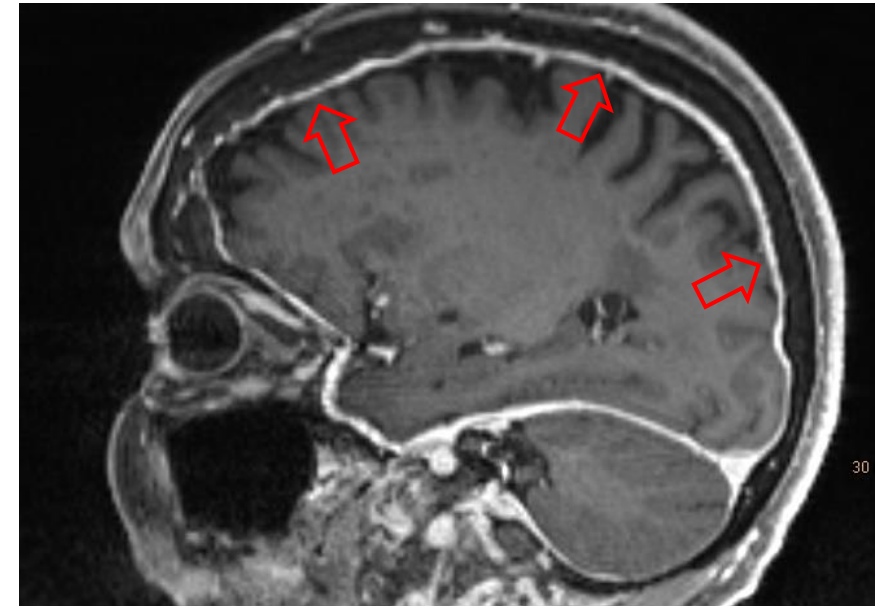
- MRI sequences of the head
- MRI sequences of the spine
- MRI protocols: first-line investigation and follow-up

T1w gadolinium (Gd⁺)

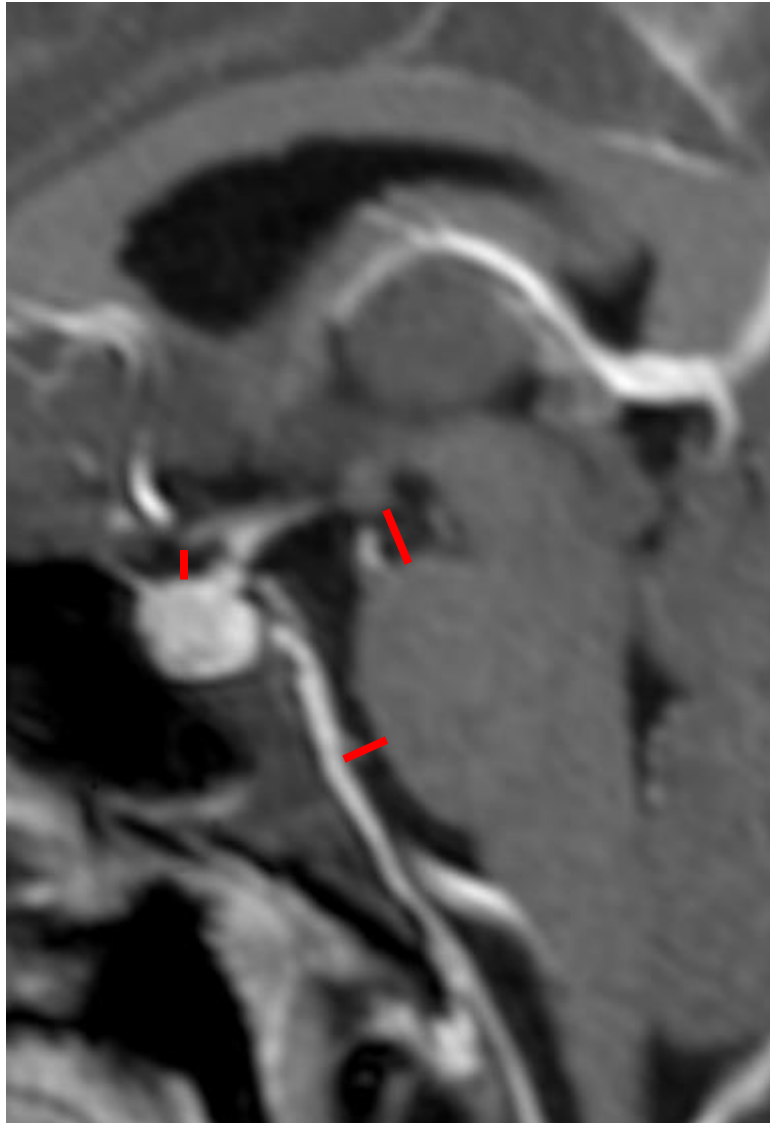


Bern SIH-Score⁽¹⁾

1. Suprasellar <4mm
(**2 points**)
2. Prepontine < 5mm
(**1 point**)
3. Mamillopontine <6.5mm
(**1 point**)
4. Dural enhancement
(**2 points**)
5. Engorgement of sinus
(**2 points**)
6. Hygroma/Subdurals
(**1 point**)



T1w gadolinium (Gd⁺)

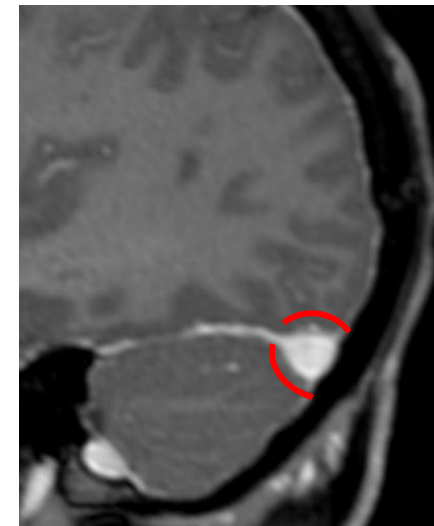
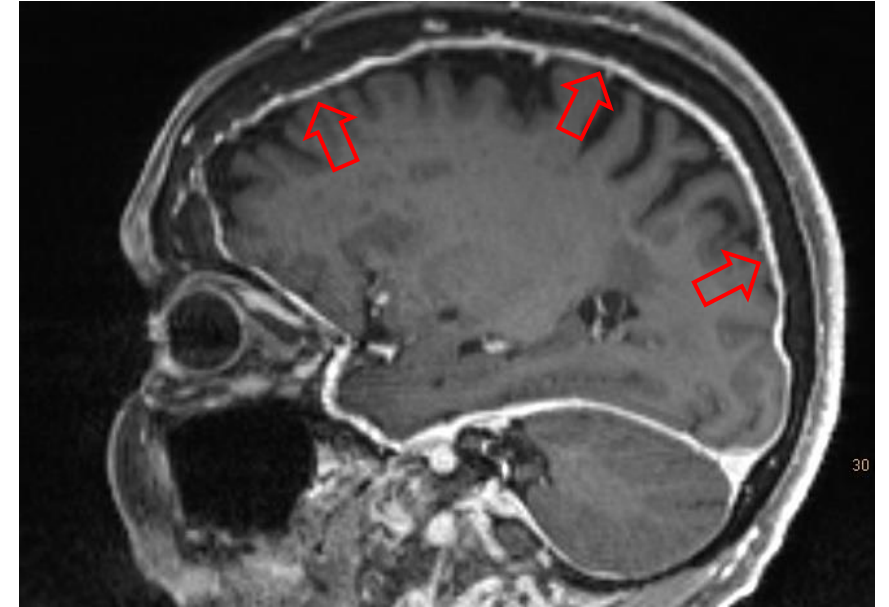


Probability for SIH:⁽¹⁾

Score 0-2 → low

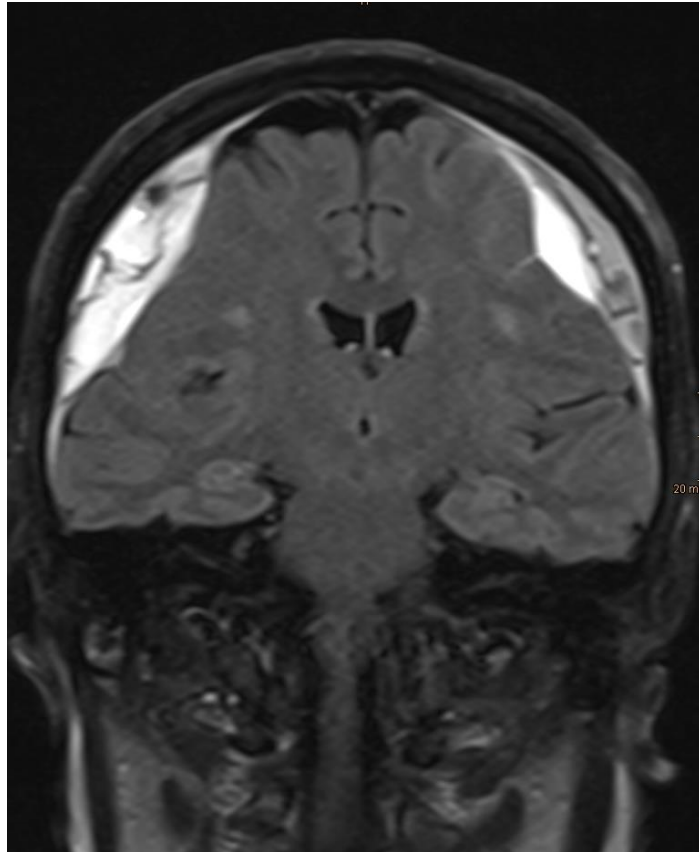
Score 3-4 → intermediate

Score 5-9 → high



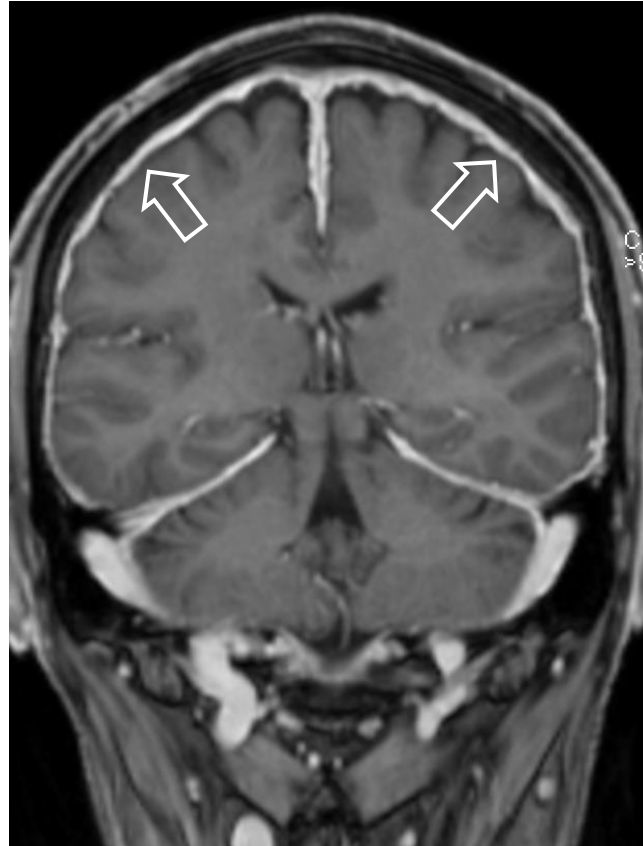
T2w FLAIR

Visibility of subdurals

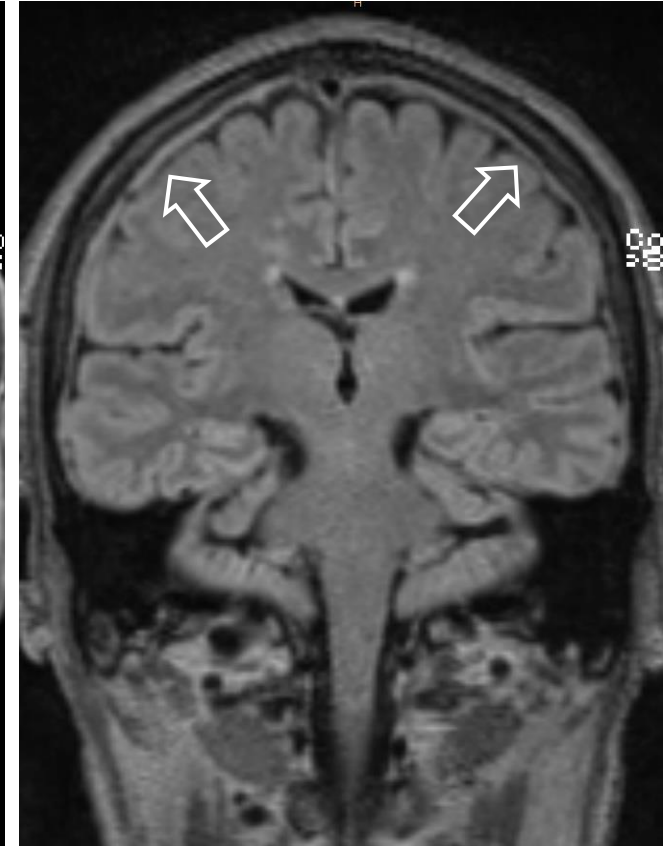


FLAIR

Alternative for T1 post Gd⁺(1,2)

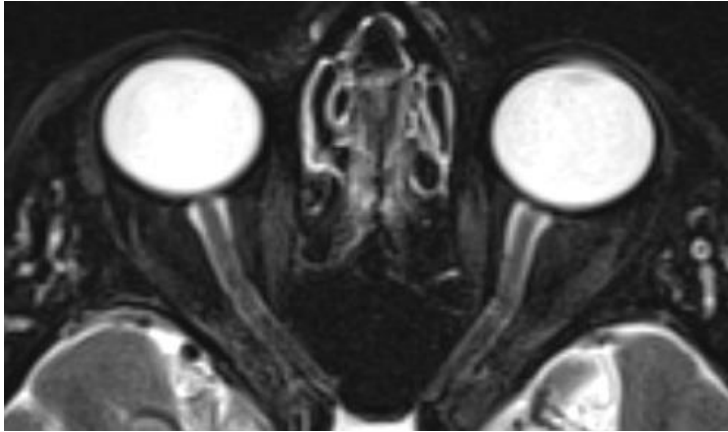


T1 Gd⁺



FLAIR

T2w of the orbit

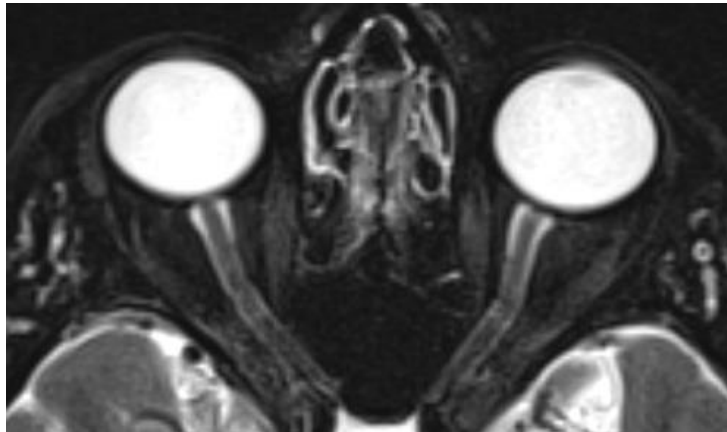


Regular perioptic space

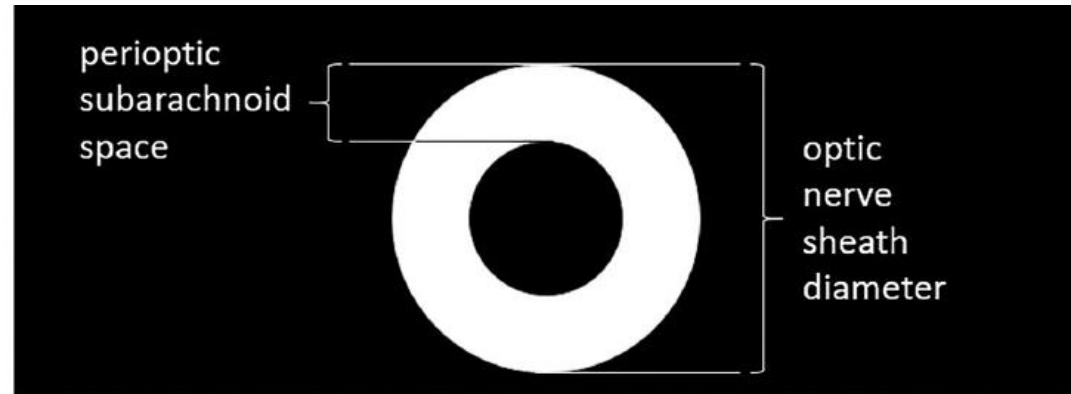
T2 fs, T2 SPAIR, T2 STIR
Best: Axial or coronal

T2w of the orbit

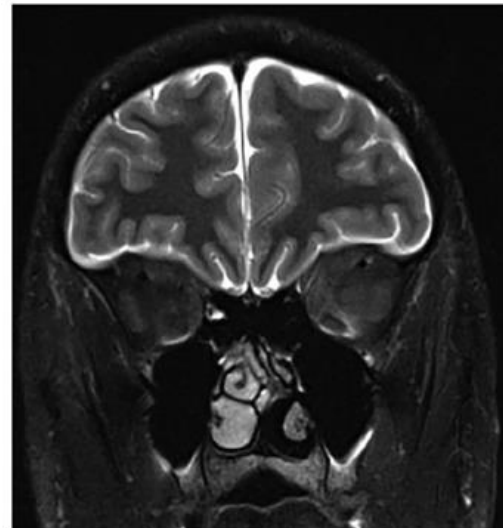
Useful in unclear cases of SIH ⁽¹⁾



Regular perioptic space



A



B

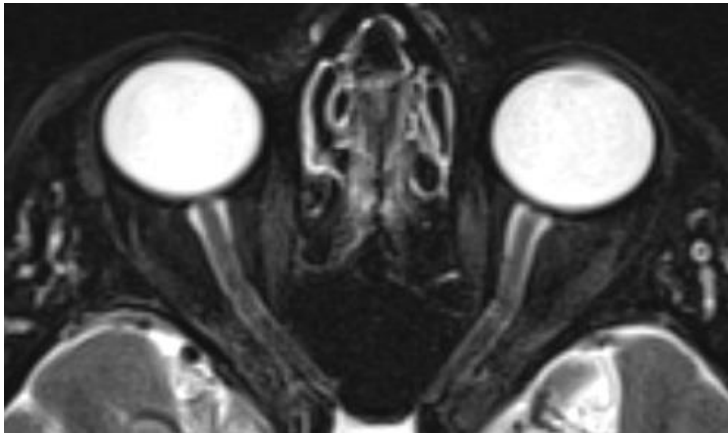


C

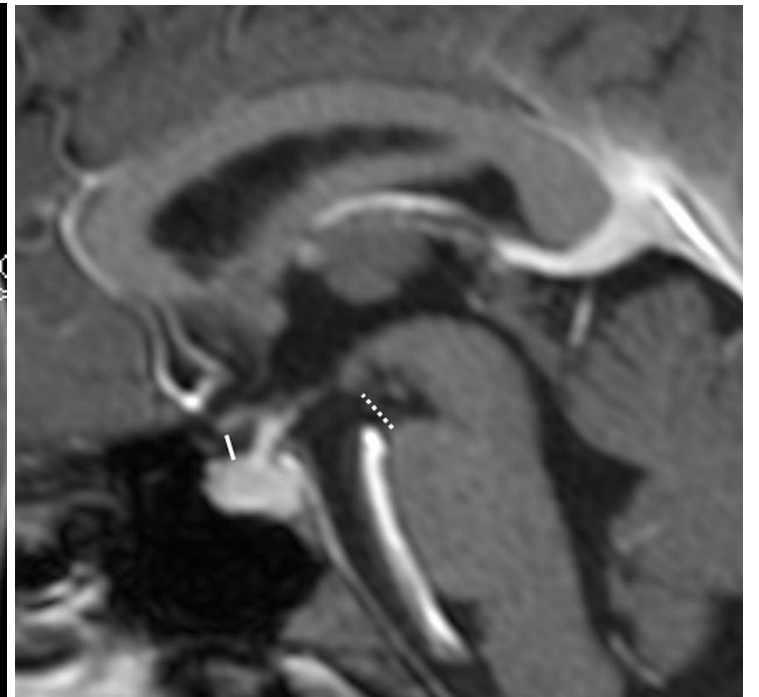
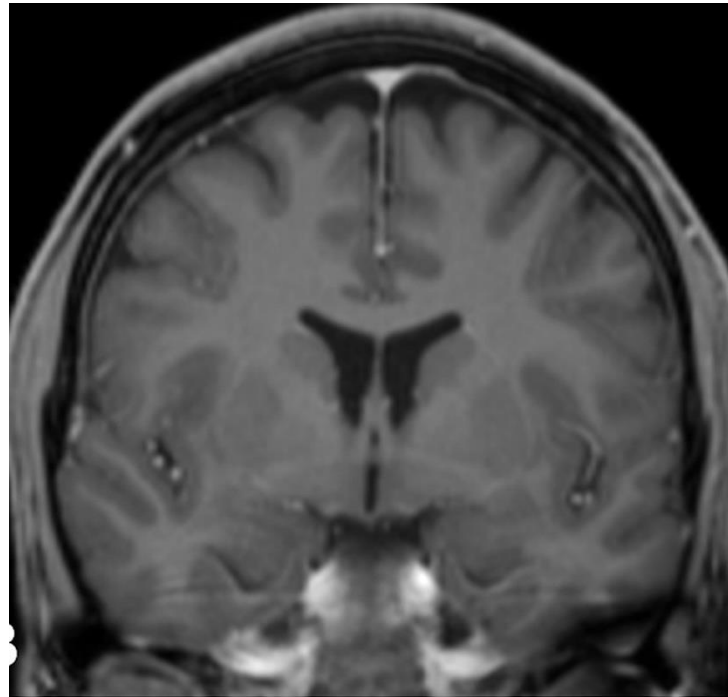
Cutoff-values:
4.4mm optic diameter
1.0mm perioptic space

T2w of the orbit

Useful in unclear cases of SIH



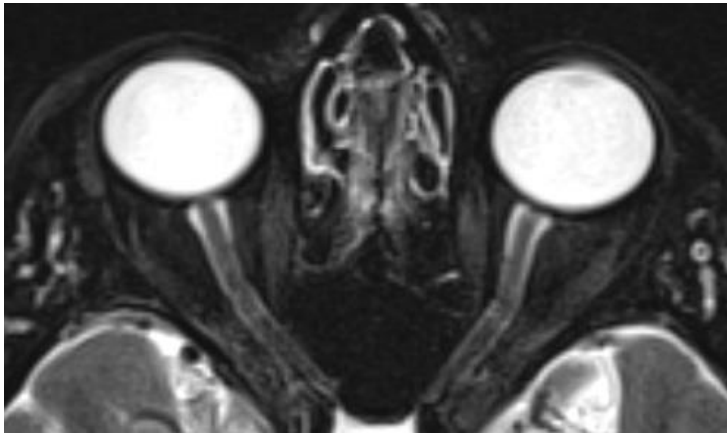
Regular perioptic space



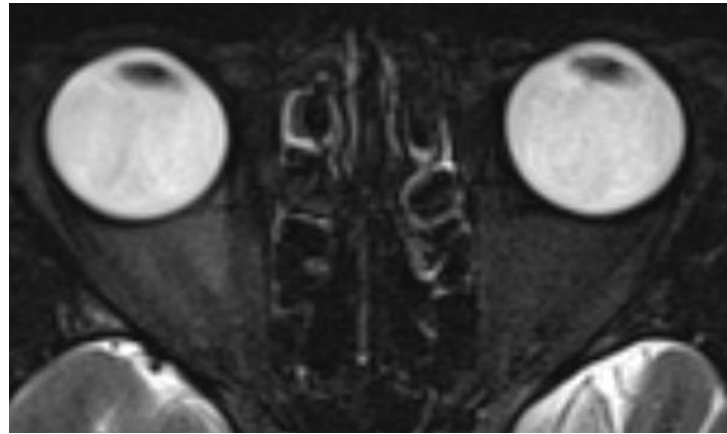
SIH score of 3 (intermediate probability)

T2w of the orbit

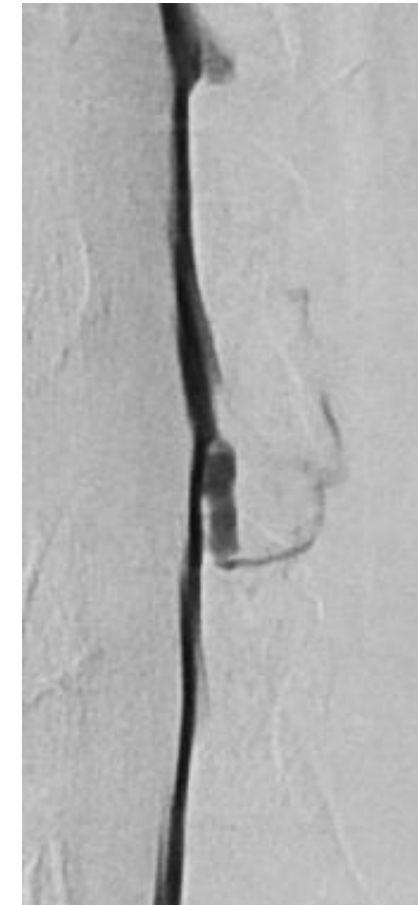
Useful in unclear cases of SIH



Regular perioptic space



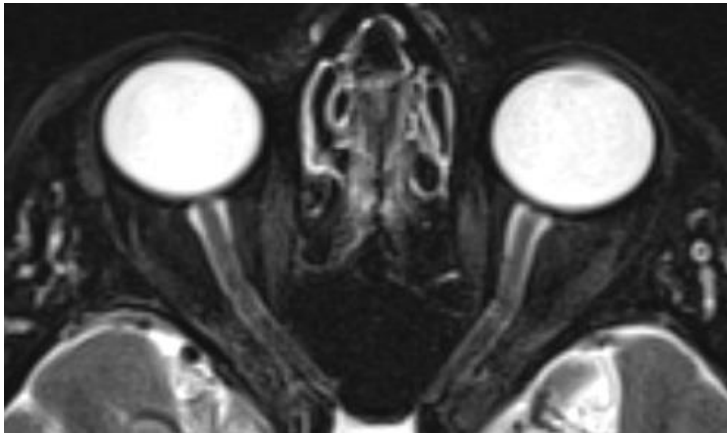
Empty perioptic spaces



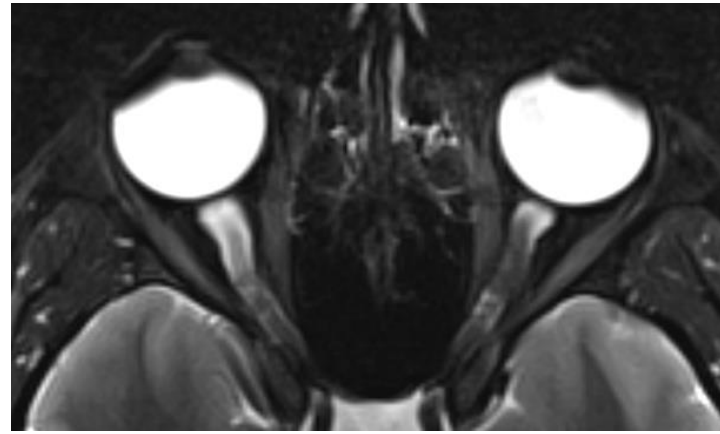
CSF-venous fistula, Th11/12 left

T2w of the orbit

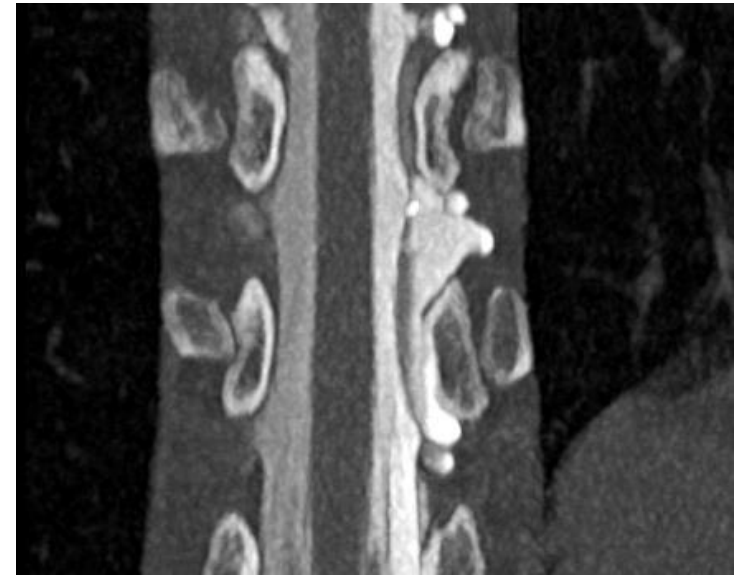
Monitoring tool



Regular perioptic space

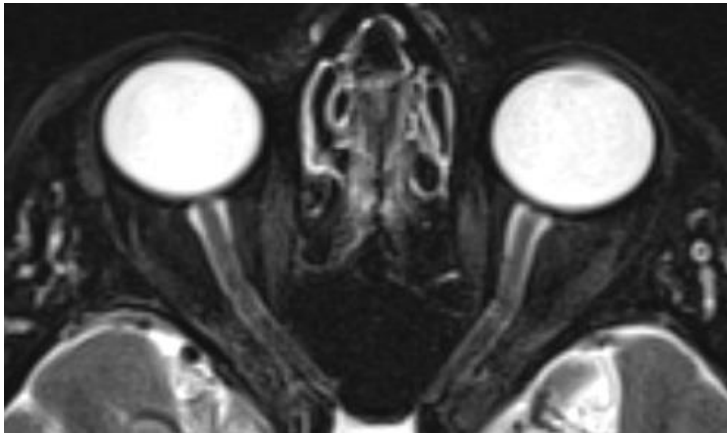


Type 2 leak patient

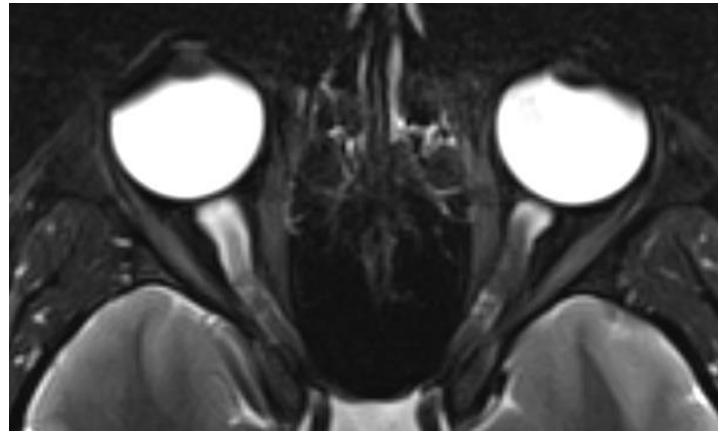


T2w of the orbit

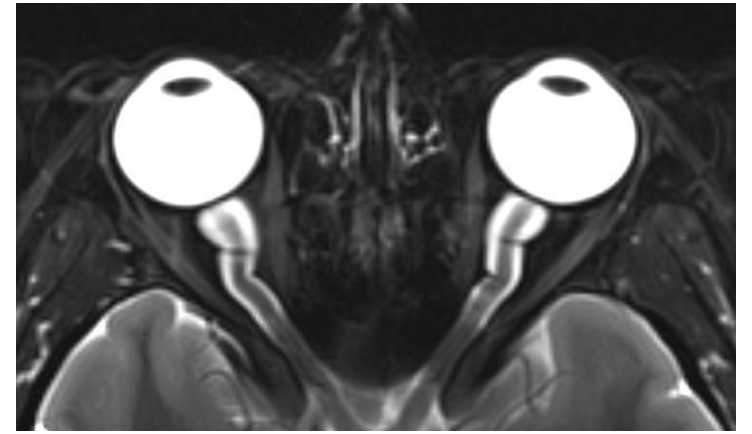
Monitoring tool



Regular perioptic space



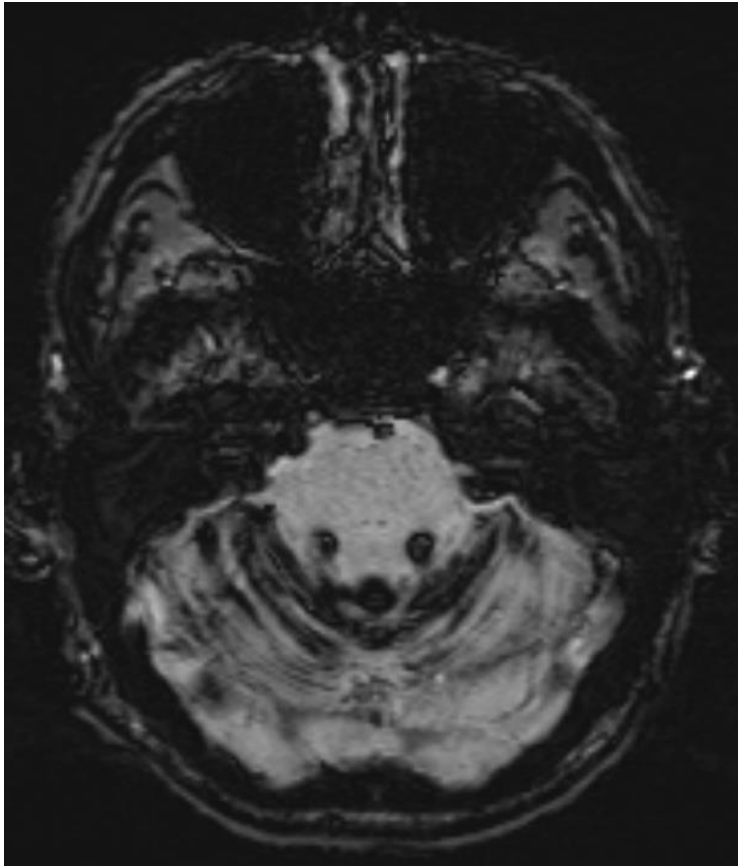
Type 2 leak patient



Rebound intracranial hypertension
after treatment

SWI/T2*

Infratentorial siderosis (deposition of blood)



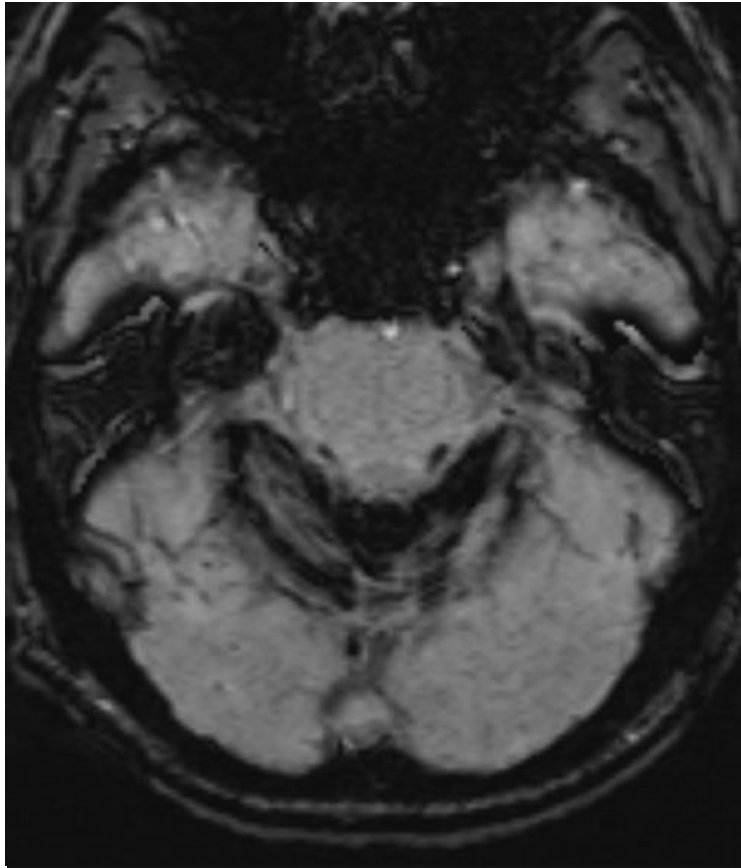
SWI

Complication of long-term disease
(in particular type 1 leaks)

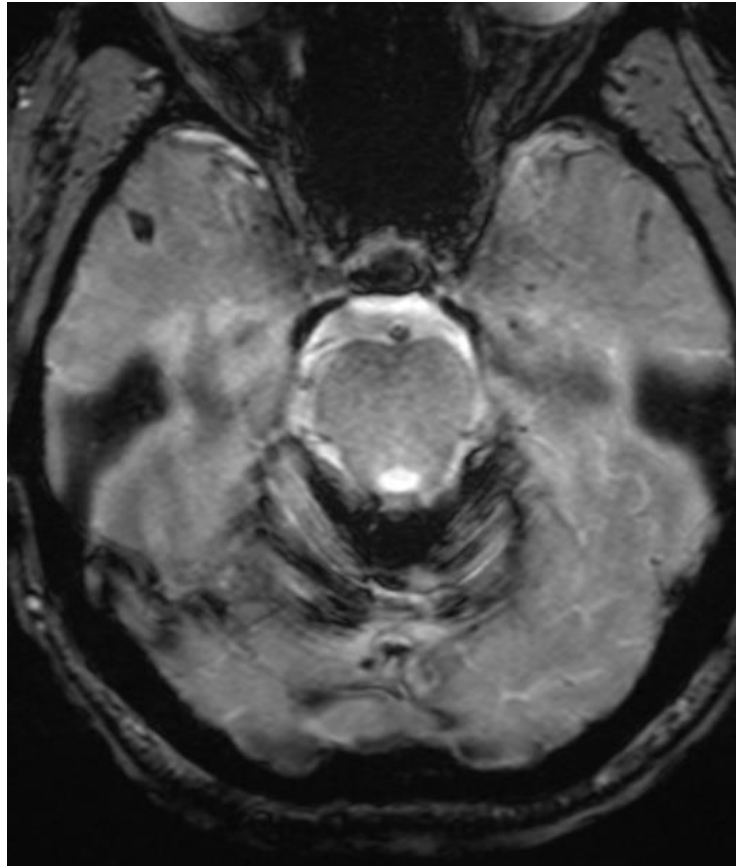
- Ataxia
- Hearing disturbances
- Dementia

→ Treatment stops progression¹

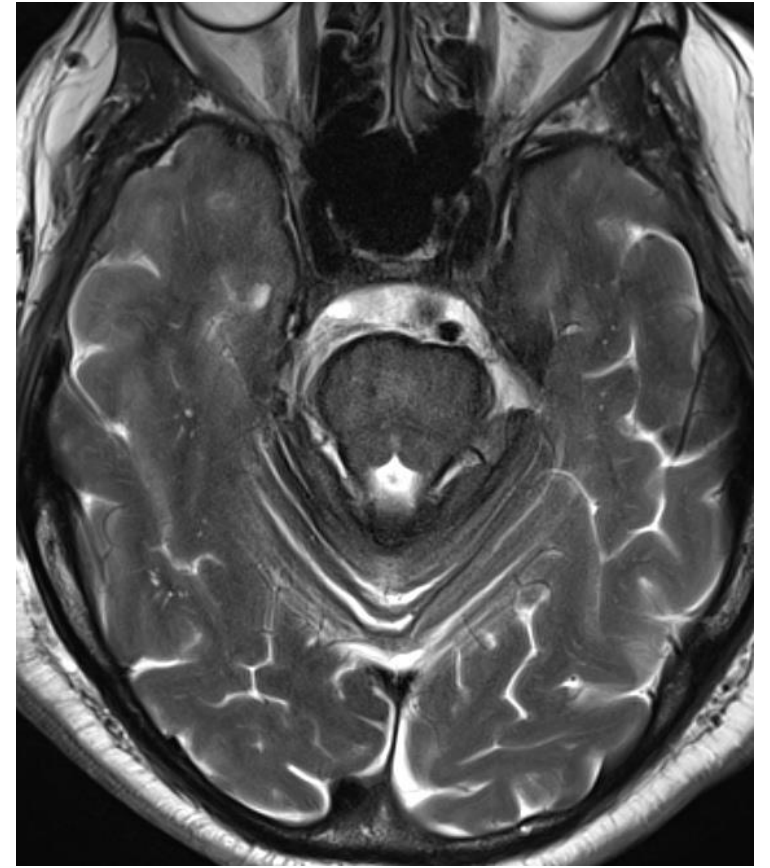
SWI/T2*



SWI (high sensitive)



T2* (less sensitive)



T2 (low sensitive)

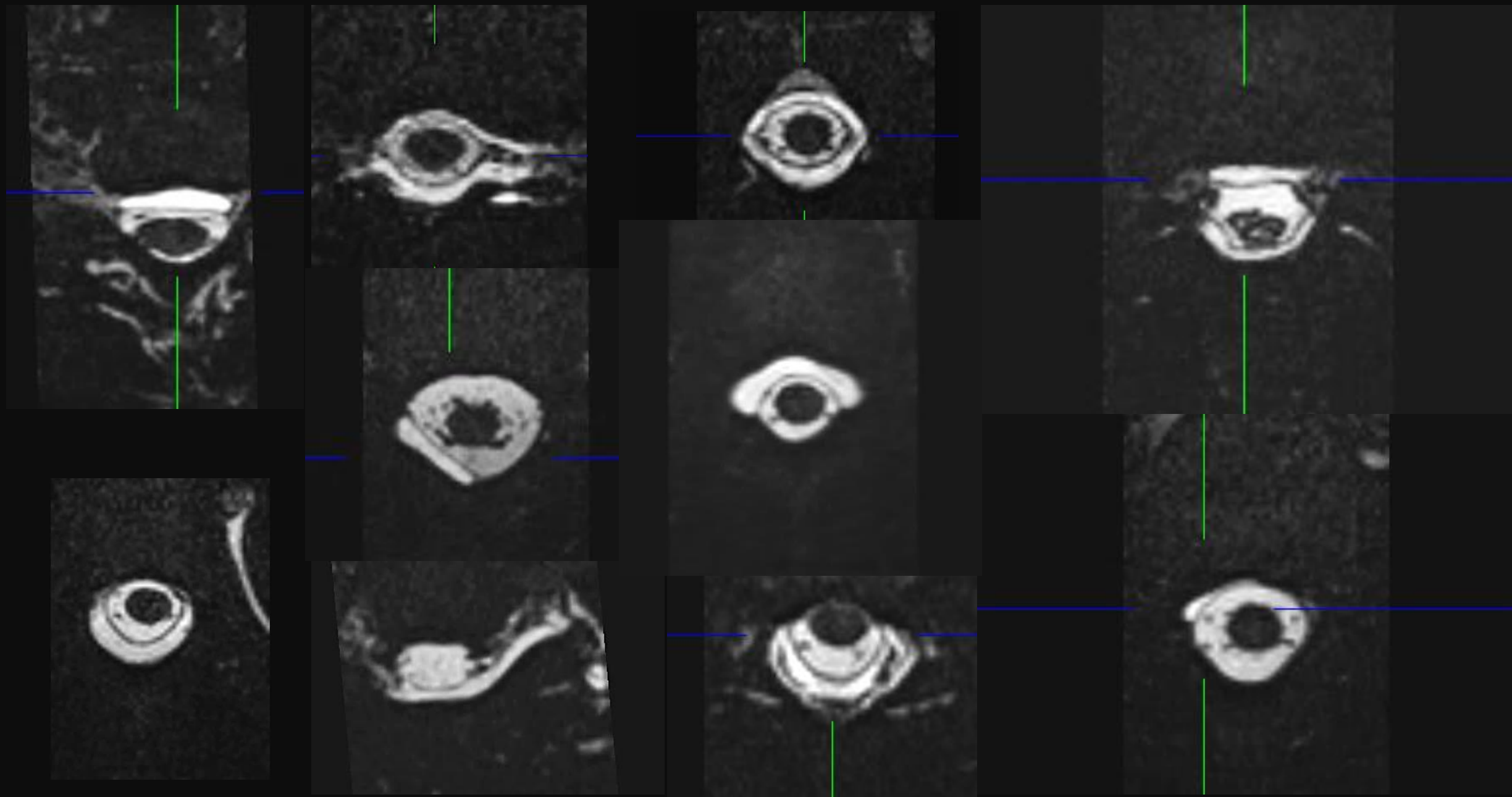
Heavily T2w of the spine (3D)



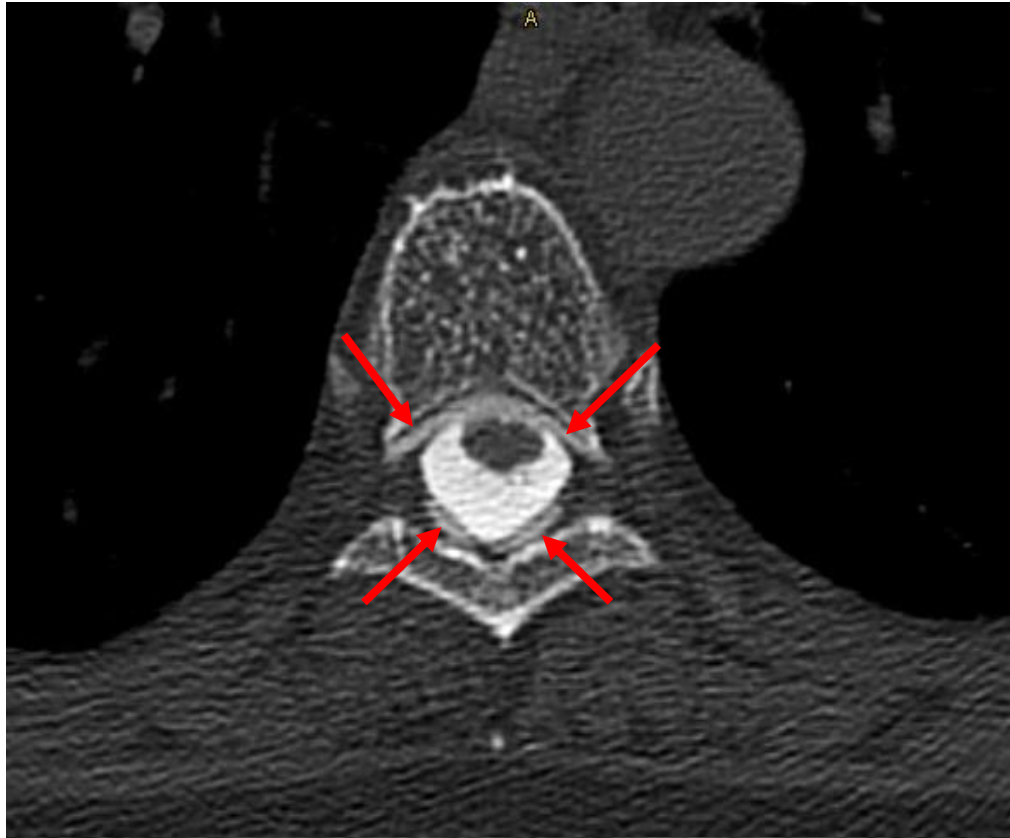
SPACE fs or T2w fs
≤ 1mm sagittal

What are we looking for?

→ ***Epidural fluid***
(=*dural tear*)

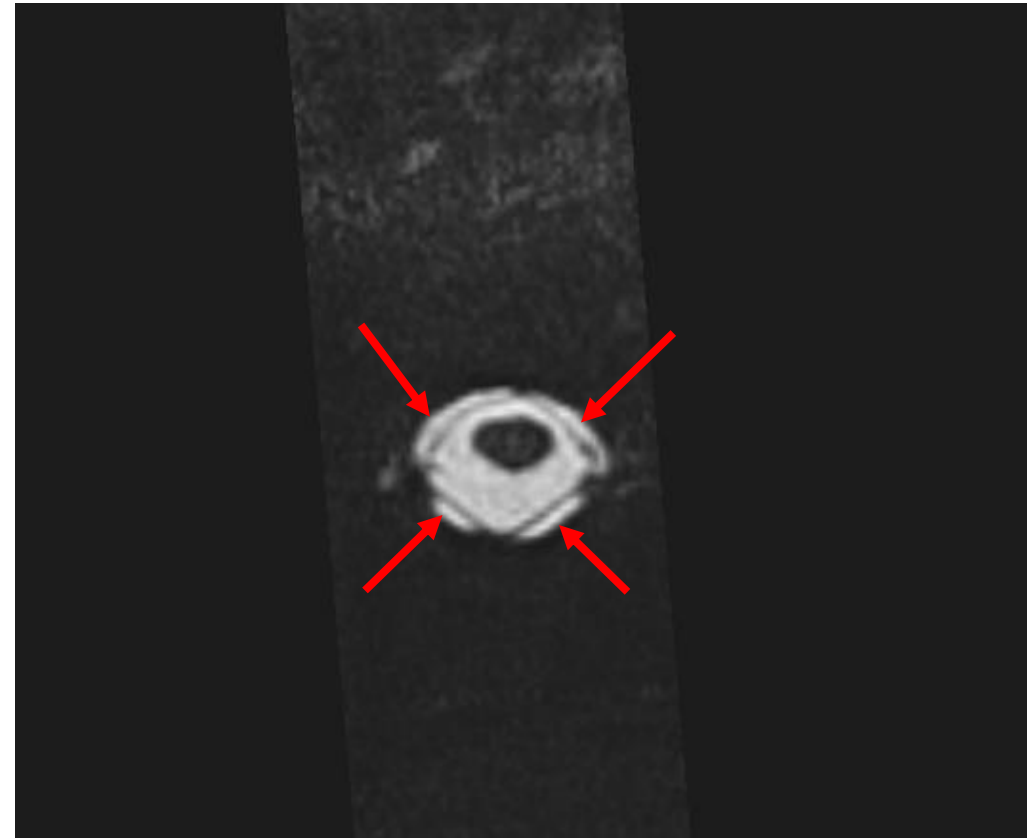


Comparable sensitivity for epidural fluid⁽¹⁾



Conventional CT myelography

(→ lumbar puncture, delayed scan
In supine position)



Heavily T2w (SPACE fs)

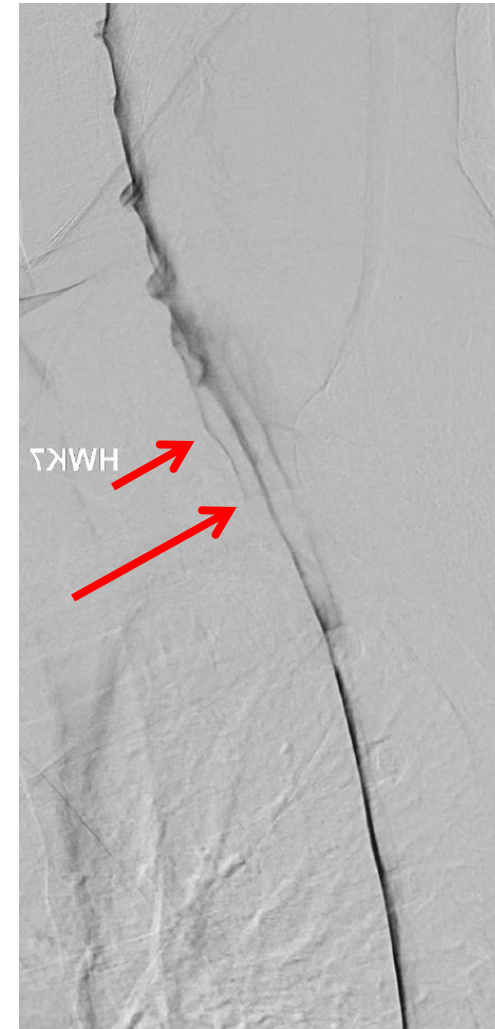
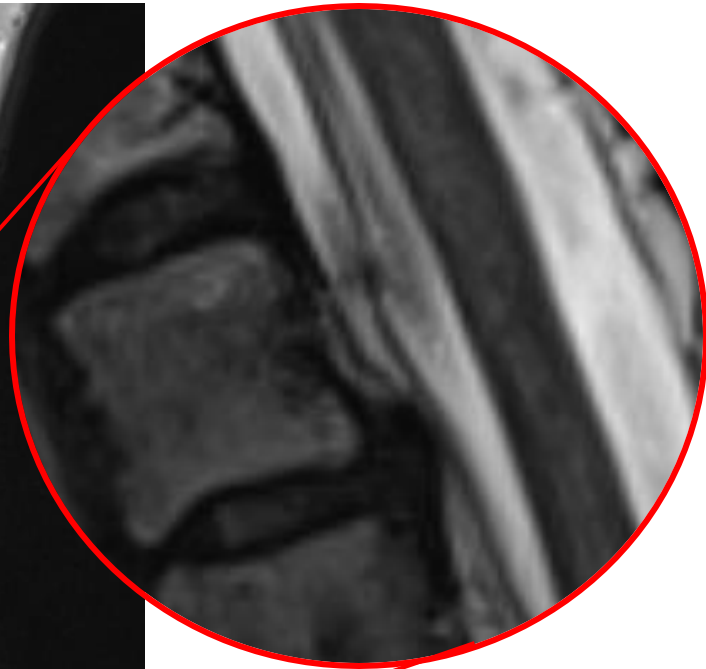
Conventional CT myelography



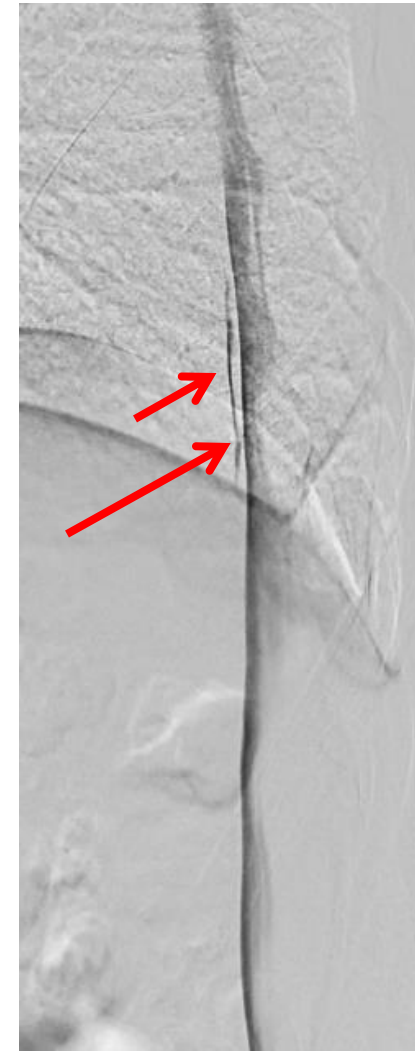
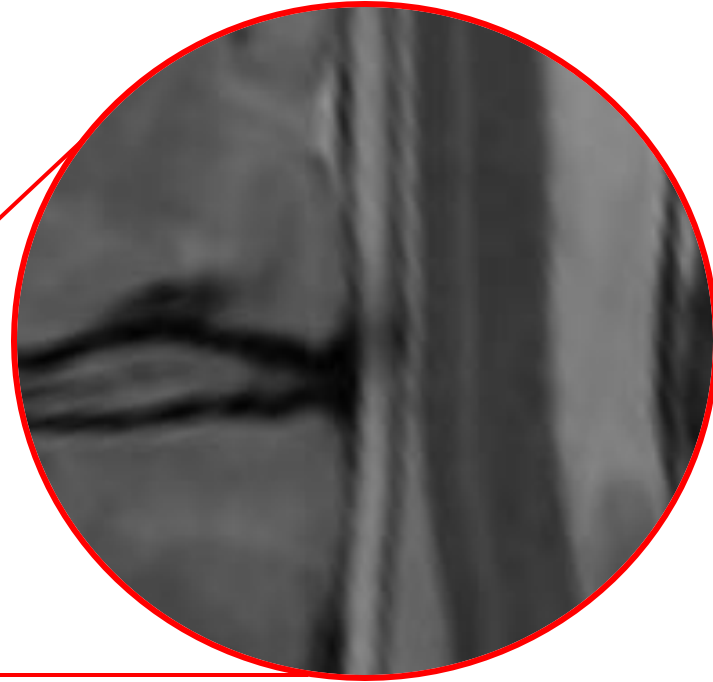
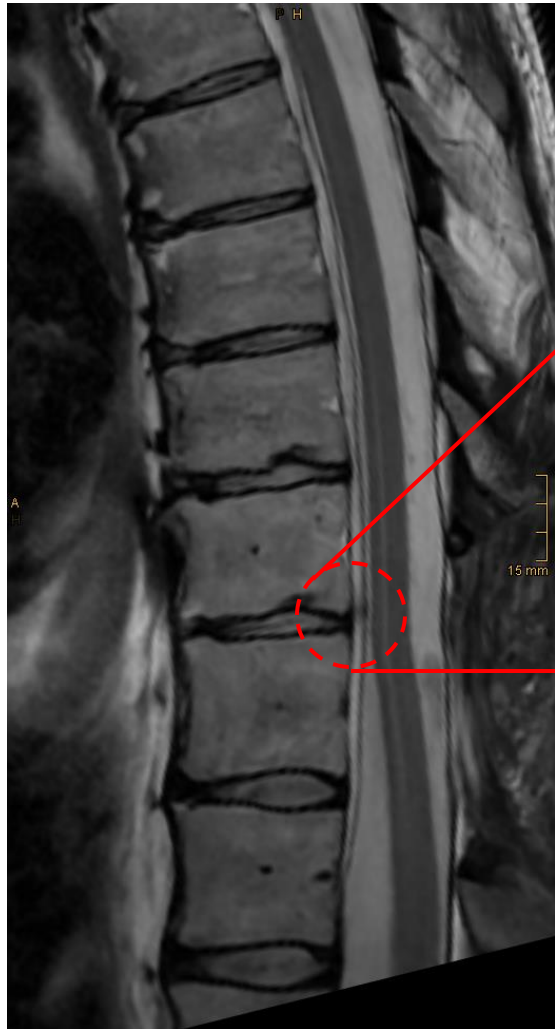
Not necessary anymore!

Conventional CT myelography

T2w of spine: Flow-void sign⁽¹⁾



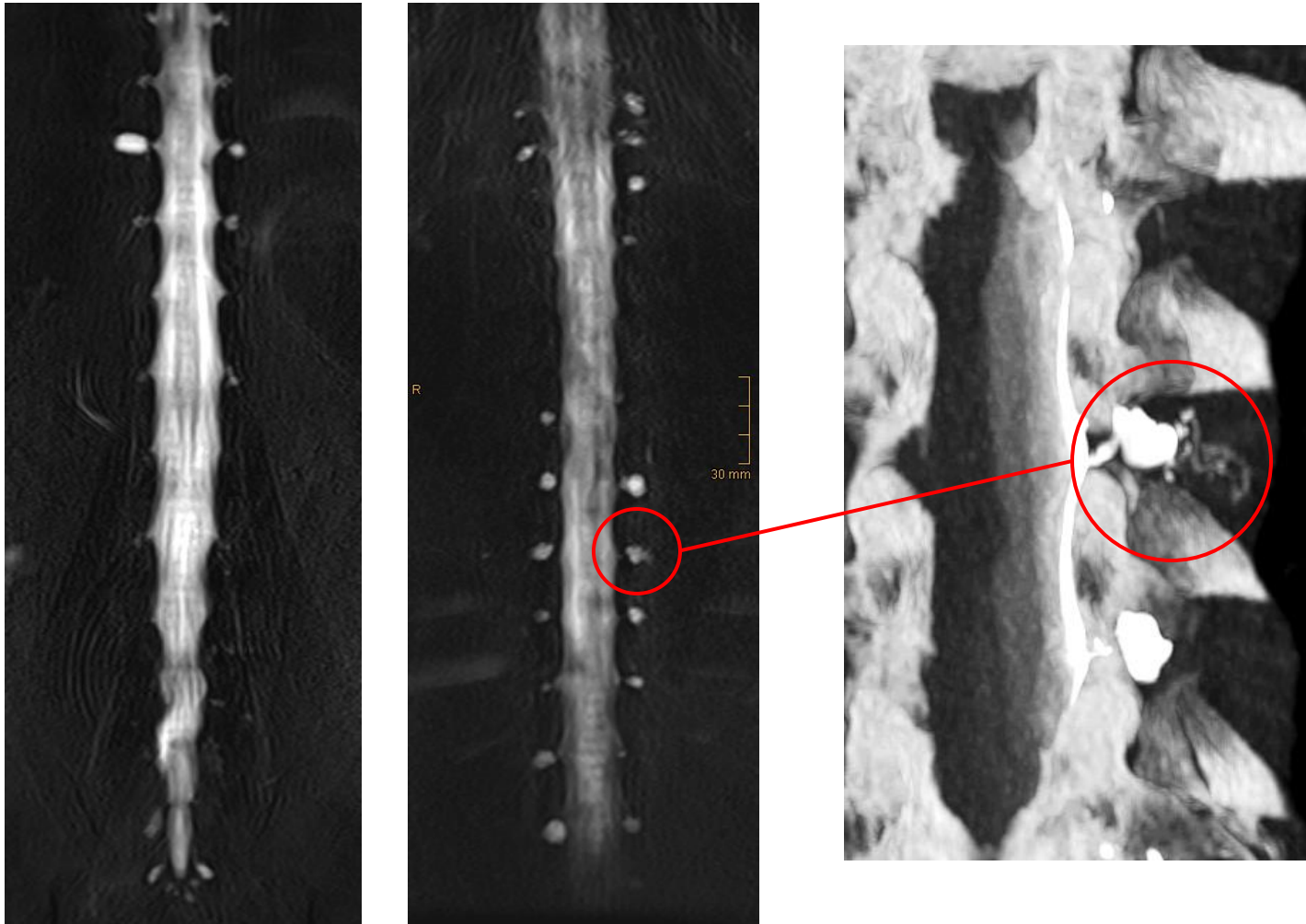
T2w of spine: Flow-void sign⁽¹⁾



Coronal T2w myelogram



Coronal T2w myelogram (HASTE)

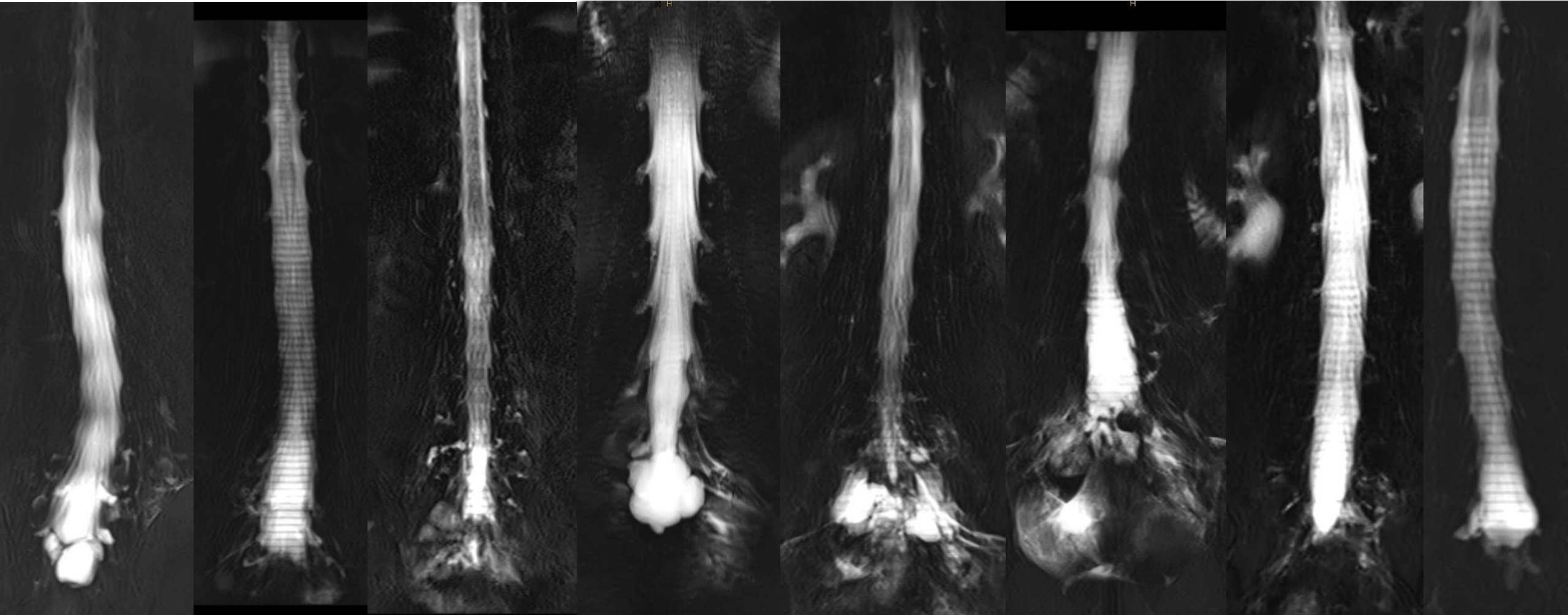


SIH score 1

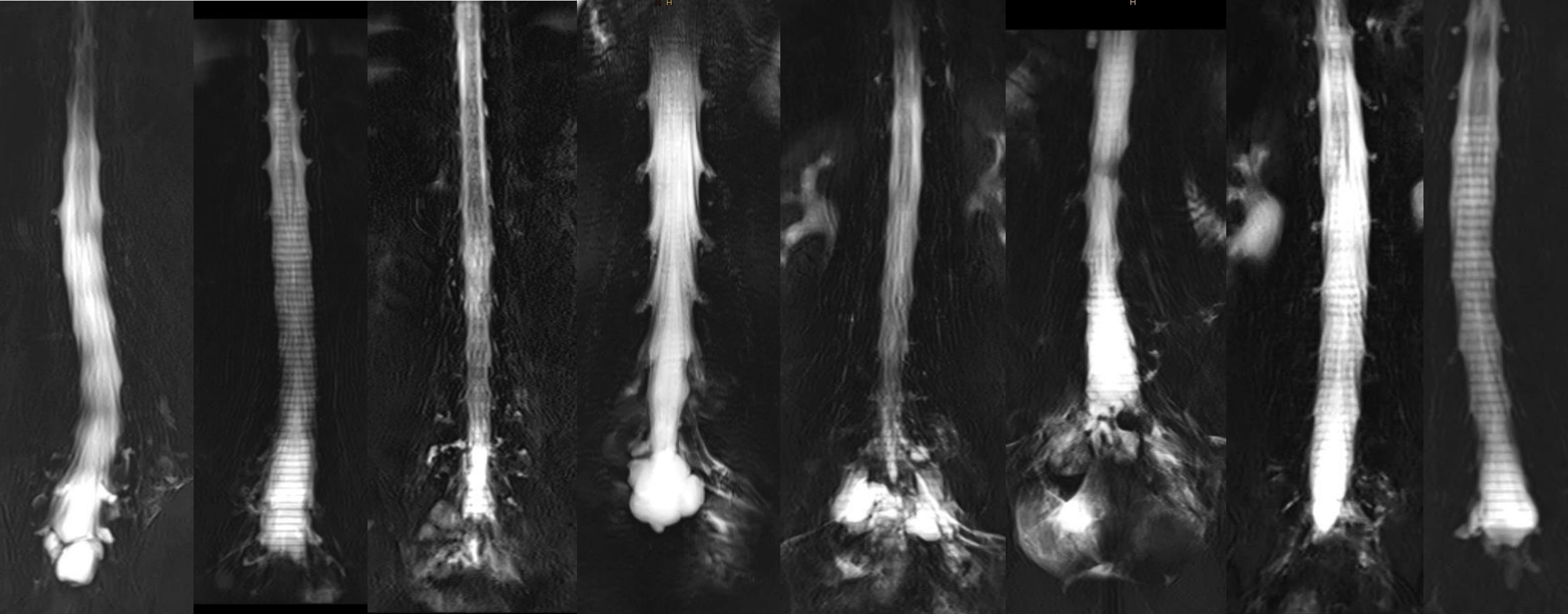
Imaging negative patients:

Meningeal diverticula
increase likelihood for CVF¹

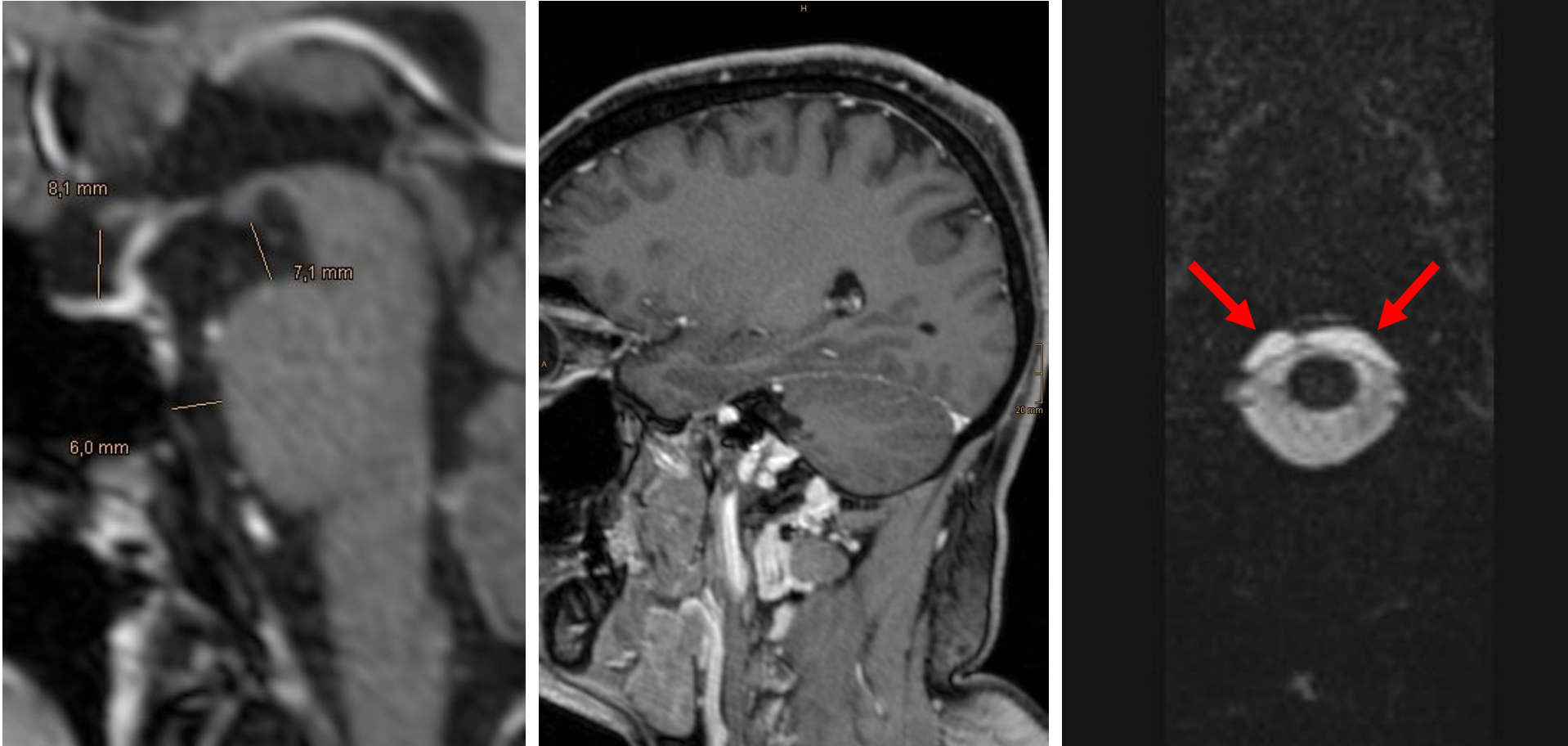
Coronal T2w myelogram (HASTE)



Sacral dural leaks



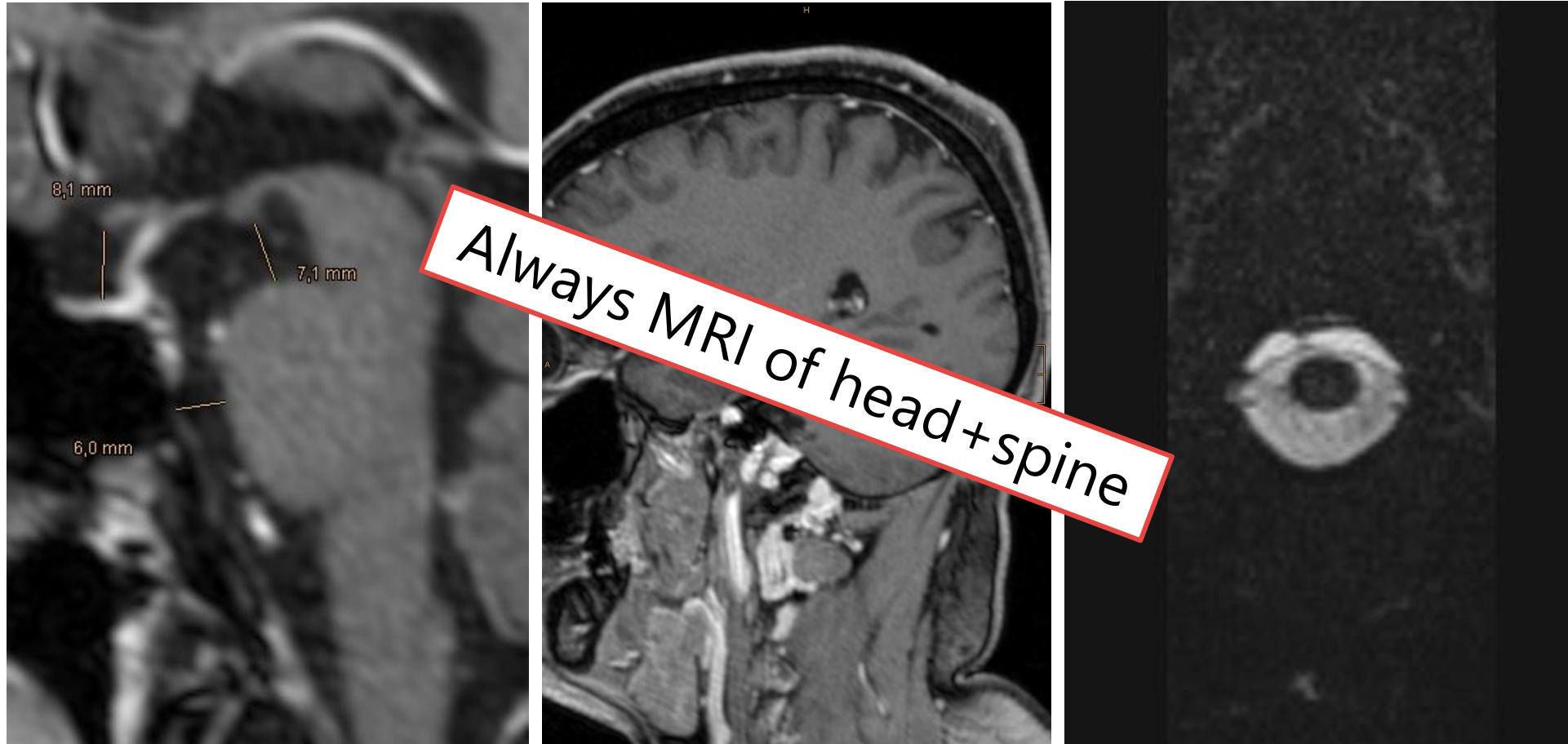
Pitfall



SIH Score 0

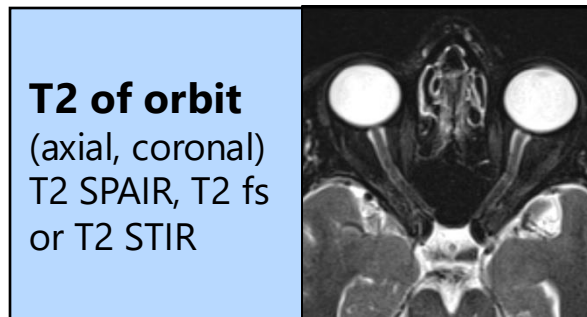
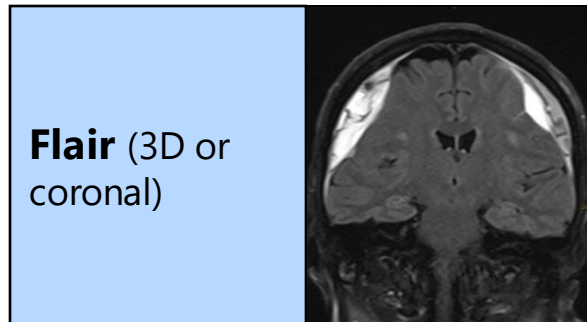
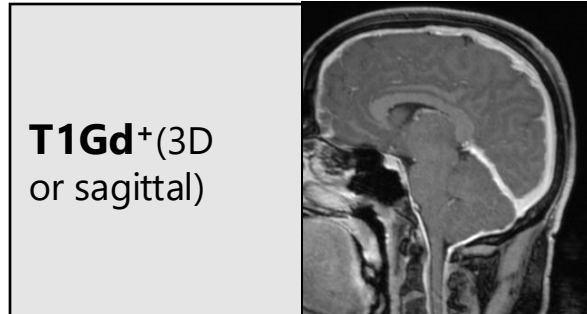
Fluid +

Decrease of MRI signs over time ⁽¹⁾



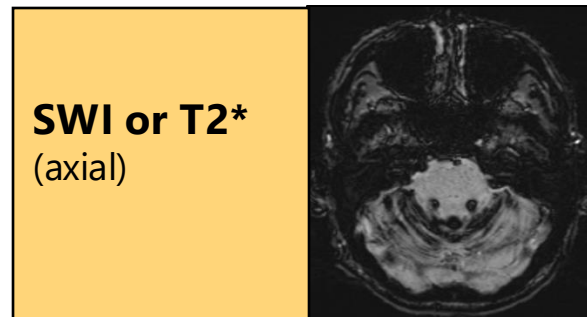
MRI protocol

Head

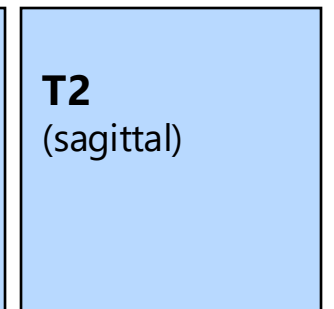
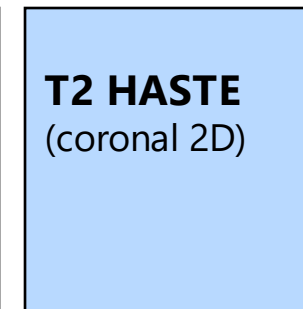
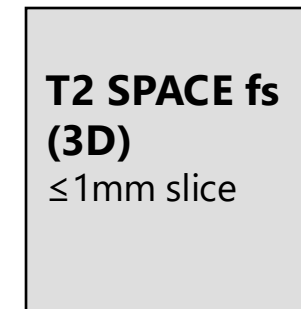


Scan times

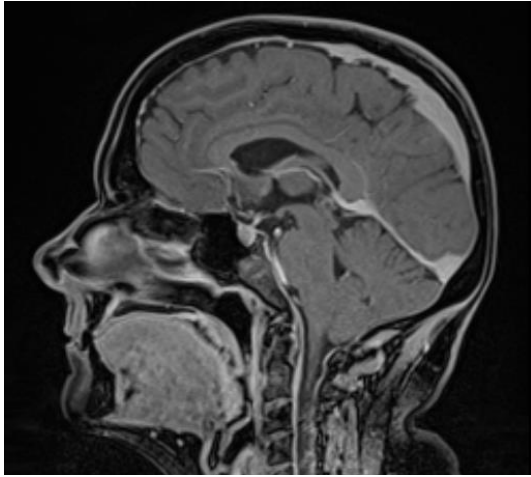
- 22:30 min
- 37:00 min
- 40:30 min



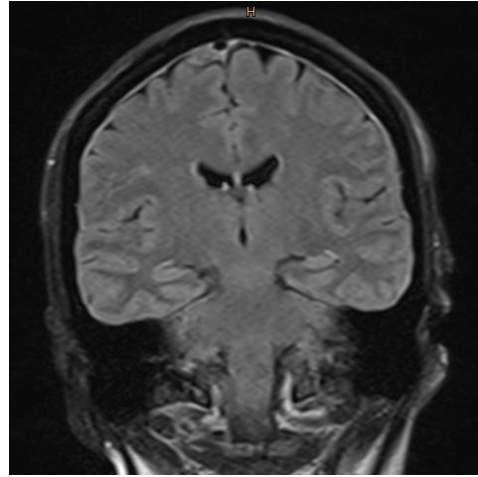
Spine (incl. sacrum)



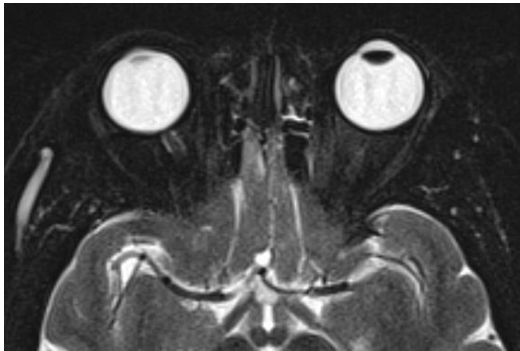
SIH screening protocol (17min)



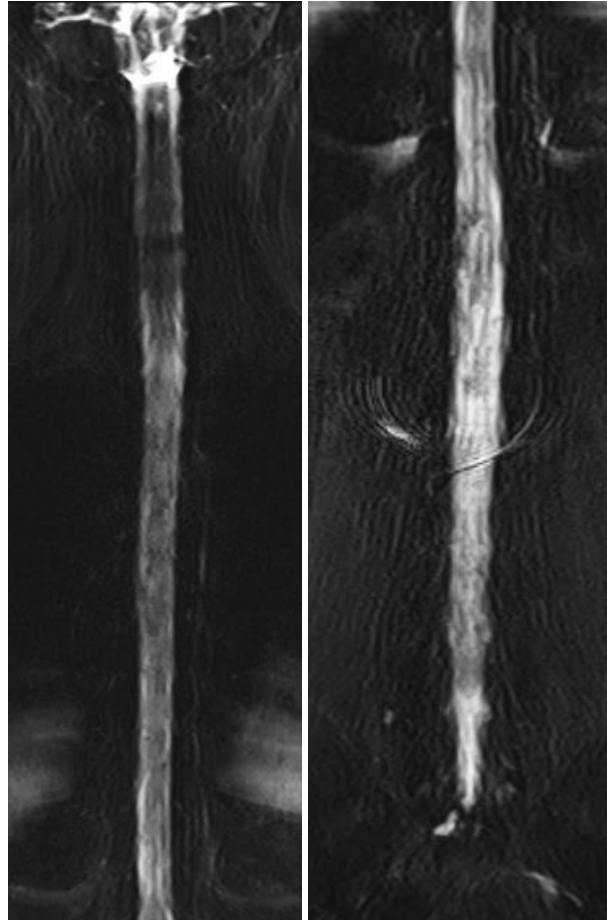
3D VIBE fs (2:16)



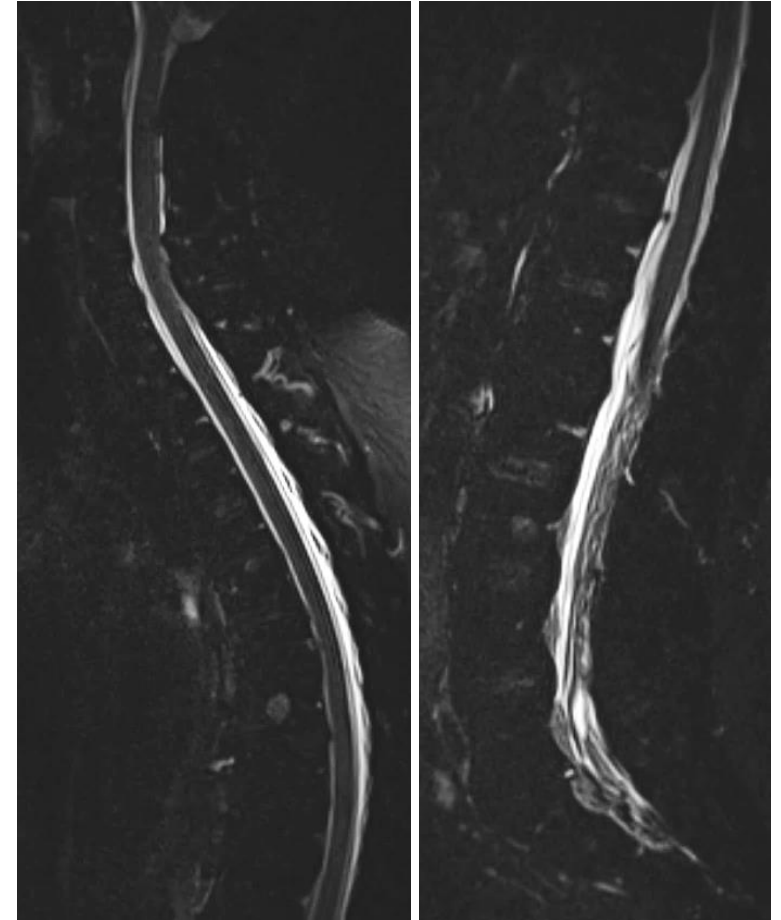
Coronal 2D TIRM (2:08)



Axial T2 SPAIR (1:34)



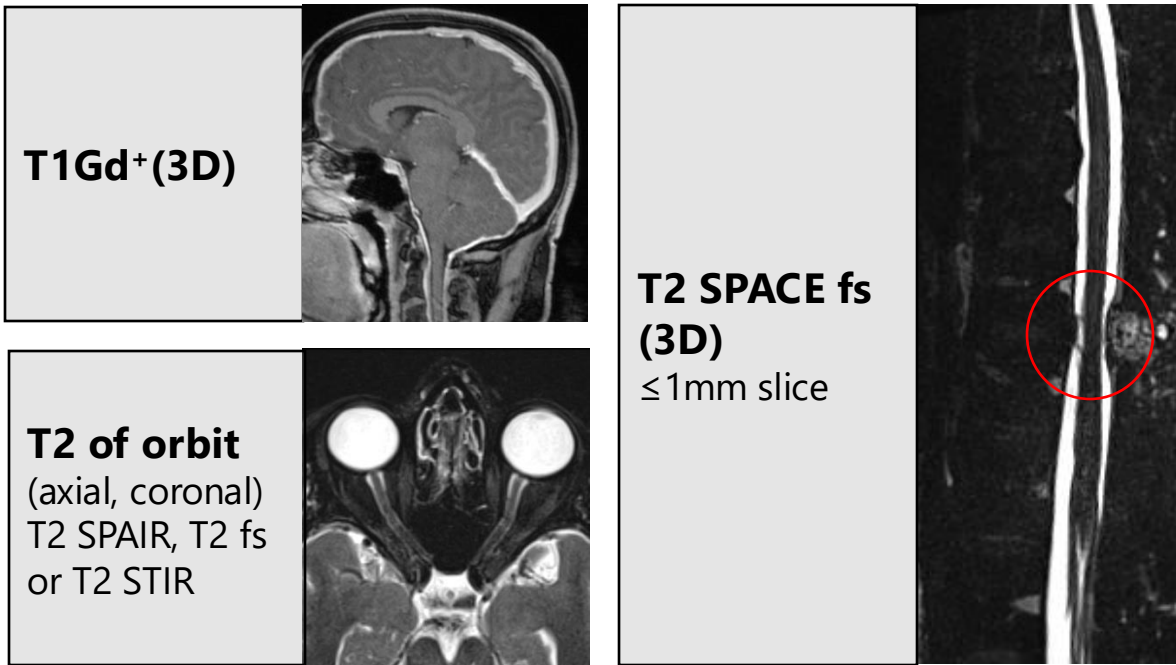
Coronal T2 HASTE (2x 0:20)



3D SPACE fs 1mm (2x 5:25)

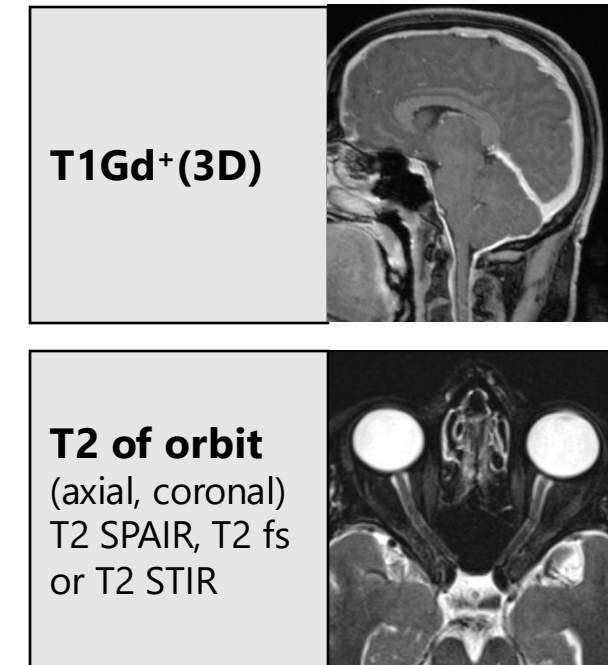
MRI follow-up (after treatment)

For **dural leaks** (type 1, 2 or sacral)



Scan time: 13:00 min

For **CSF-venous fistula** (type 3)



Scan time: 8:00 min

Take-away message

- Focus on important MRI sequences
- Always MRI of head + spine
- **3D HEAVILY T2 of the spine (3D)**
- Waive „conventional CT myelography“ !!
- Cover the entire spine incl. sacrum
- Future directions: MRI predictors for leak localization



EANS CEREBROSPINAL FLUID
SECTION

International Collaborations

Inselspital Bern, Switzerland
(Dorbocky, Piechowiak, Schankin, Raabe)

Lindenhofspital Bern, Switzerland
(Fung, Ulrich)

ETH Zuerich, Switzerland
(The Interface Group)

AKH, Vienna, Austria
(Kapan)

King's College, UK
(Carlton-Jones)

Cedars Sinai, CA, USA
(Schievink)

Stanford, CA, USA
(Carroll)

CSF-Center Freiburg



Neurosurgery & Neurology
J. Beck, K. Wolf, F. Volz,
L. Krismer, A. El Rahal, M. Shah

Neuroradiology
H. Urbach, N. Lützen,
C. Zander, T. Demerath, H. Mast



Nuclear Medicine
P.T. Meyer & Team

Anesthesiology
H. Bürkle & Team

Neuroophthalmology
W. Lagrèze & Team

Neuromedical AI Lab
T. Ball & Team

Medical Physics
M. Reisert & Team



CSF-Center
Freiburg



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Baden-Württemberg