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Post Dural Puncture Headache: 8:15 AM - 8:45 AM

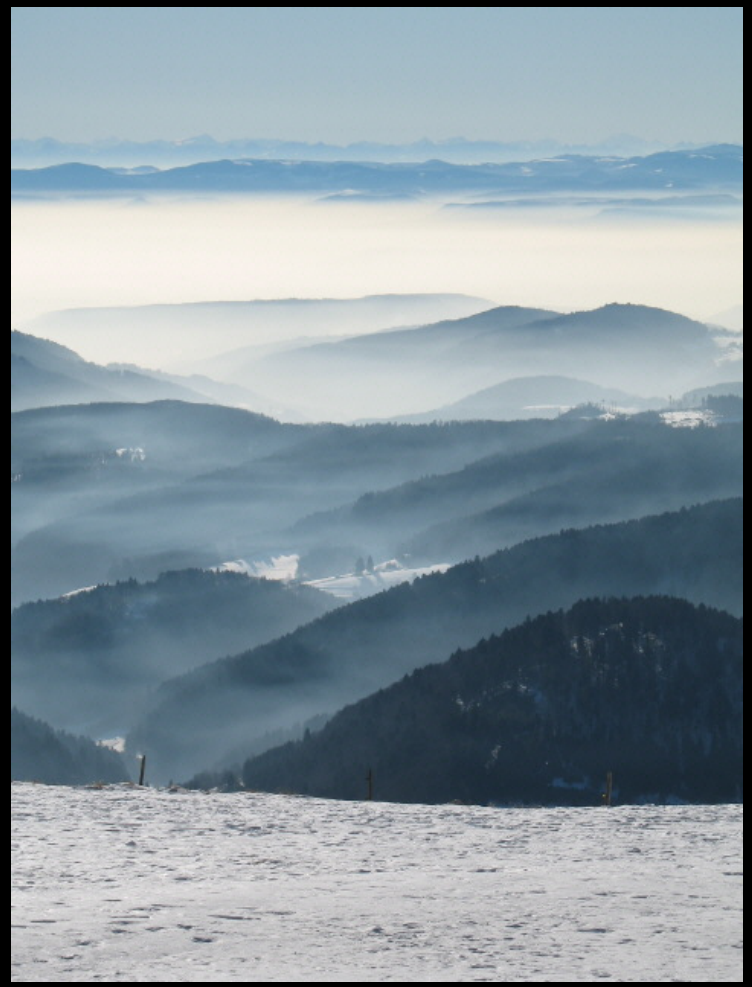
Emerging Concepts in Post-Dural Puncture Headache (PDPH)

Jürgen Beck

Director Dept. of Neurosurgery

Medical Center – University of Freiburg, Germany

Chair CSF-Section - European Association of Neurosurgical Societies




Britt Schilling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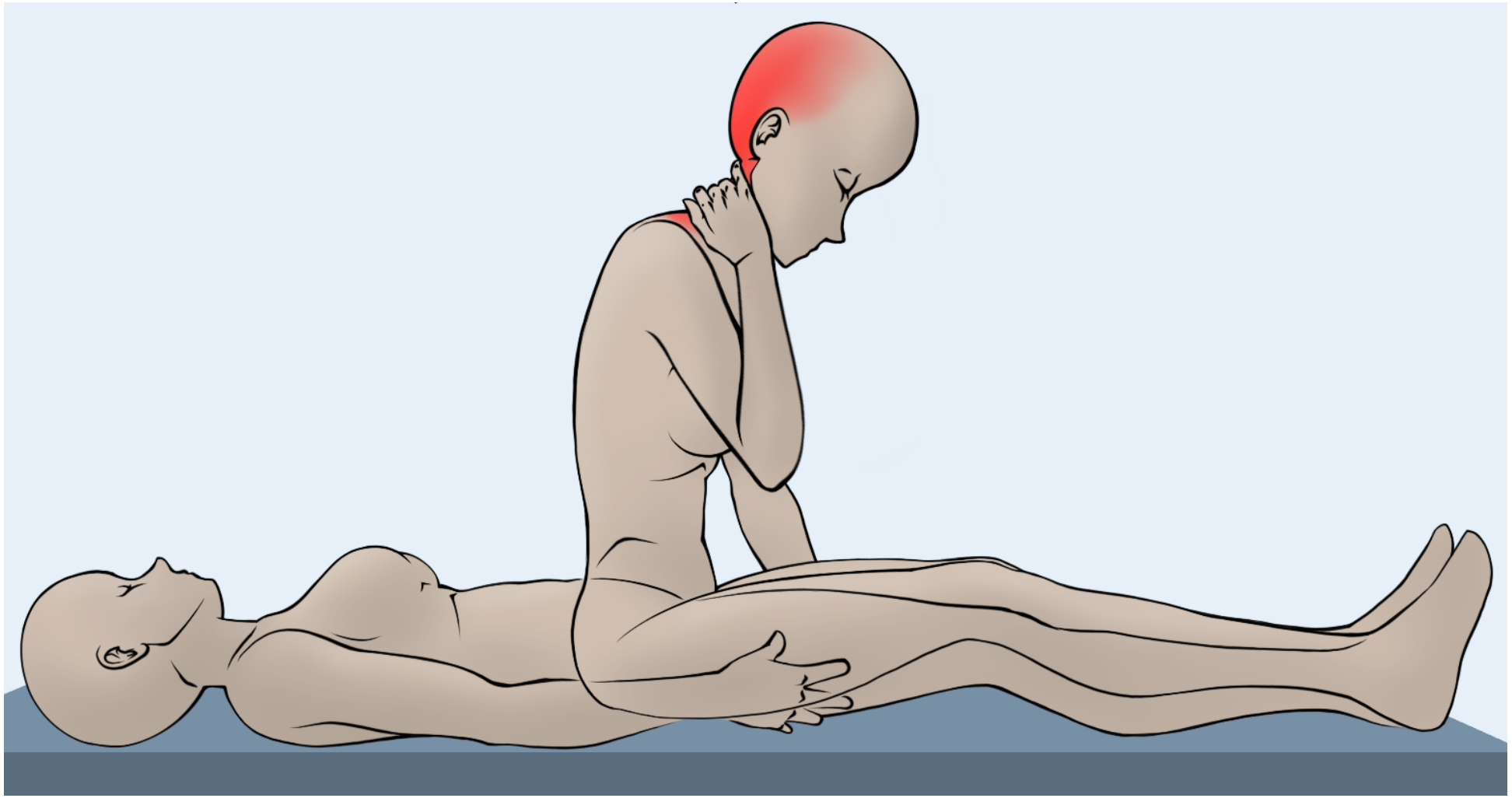
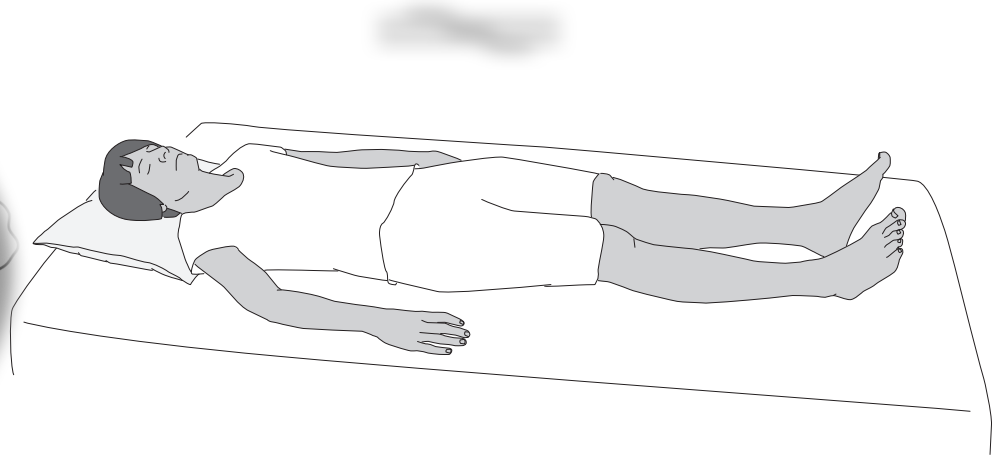


Post
Dural
Puncture
Headache

≠

Spontaneous
Intracranial
Hypotension



Postdural puncture headache - PDPH

Description

Headache occurring **within 5 days** of a **lumbar puncture**, caused by **cerebrospinal fluid (CSF) leakage** through the dural puncture.

It remits spontaneously within 2 weeks, or after sealing of the leak with autologous epidural lumbar patch.

ICHD-3: The International Classification of Headache Disorders 3rd edition. Cephalalgia 2023

Postdural puncture headache - PDPH

Onset after more than 5 days

Lybecker et al. Anesthesiol Scand 1995
Vilminger et al. Cephalalgia 1998
Hayes et al. Int J Obstet Anesth 2010
Moore et al. JAMA Neurol 2020

Symptoms for more than 14 days

Mac Arthur et al. BMK 1993
Ranganathan et al. J Clin anesth 2015
Niraj et al. Anaesthesia 2021
Ansari J. et al. British Journal of Anaesthesia, 2021

Chronic postdural puncture headache (cPDPH)

Chronic PDPH – Serious and underrated![1]

"My condition has completely changed my life"

"I lost 2 years of my life in social isolation"

"I lost my partner"

"I lost my joie-de-vivre"

"No restaurant, no cinema, no reading"

- Orthostatic headache
- Neck pain
- Tinnitus
- Visual disturbance

- Fatigue
- Reduced QOL
- Depression
- Subdural hematomas **6%**

acute | **chronic** | **Long Term**

Dural puncture

>14 days

[1]Kraus et al., Frontiers of Neurology 2024

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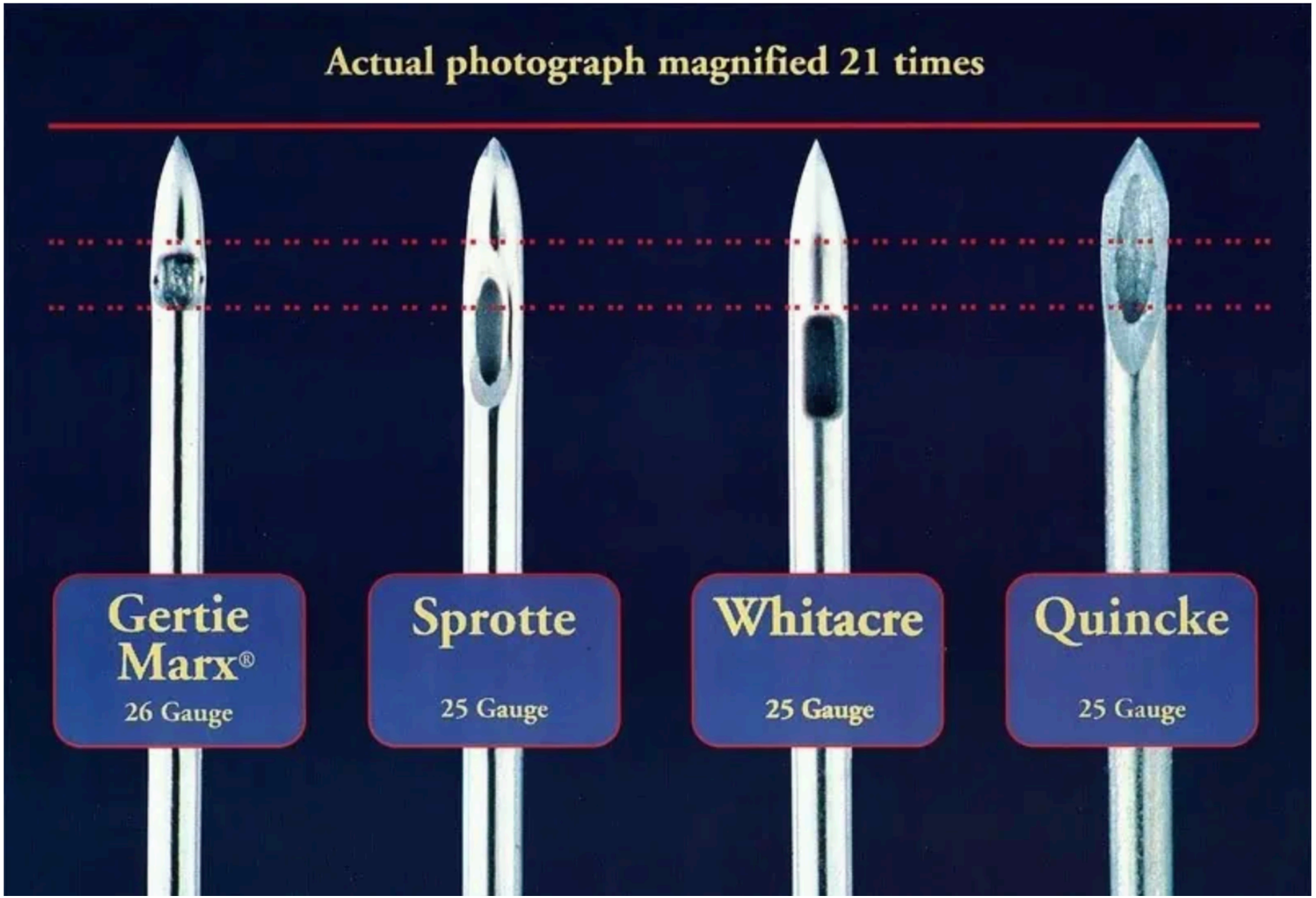


Modifiable Risk Factors

11.0% → 4.2%

Strupp & Katsavara, Nervenarzt, 2009, Uppal et al., Reg Anesth Pain Med. 2024

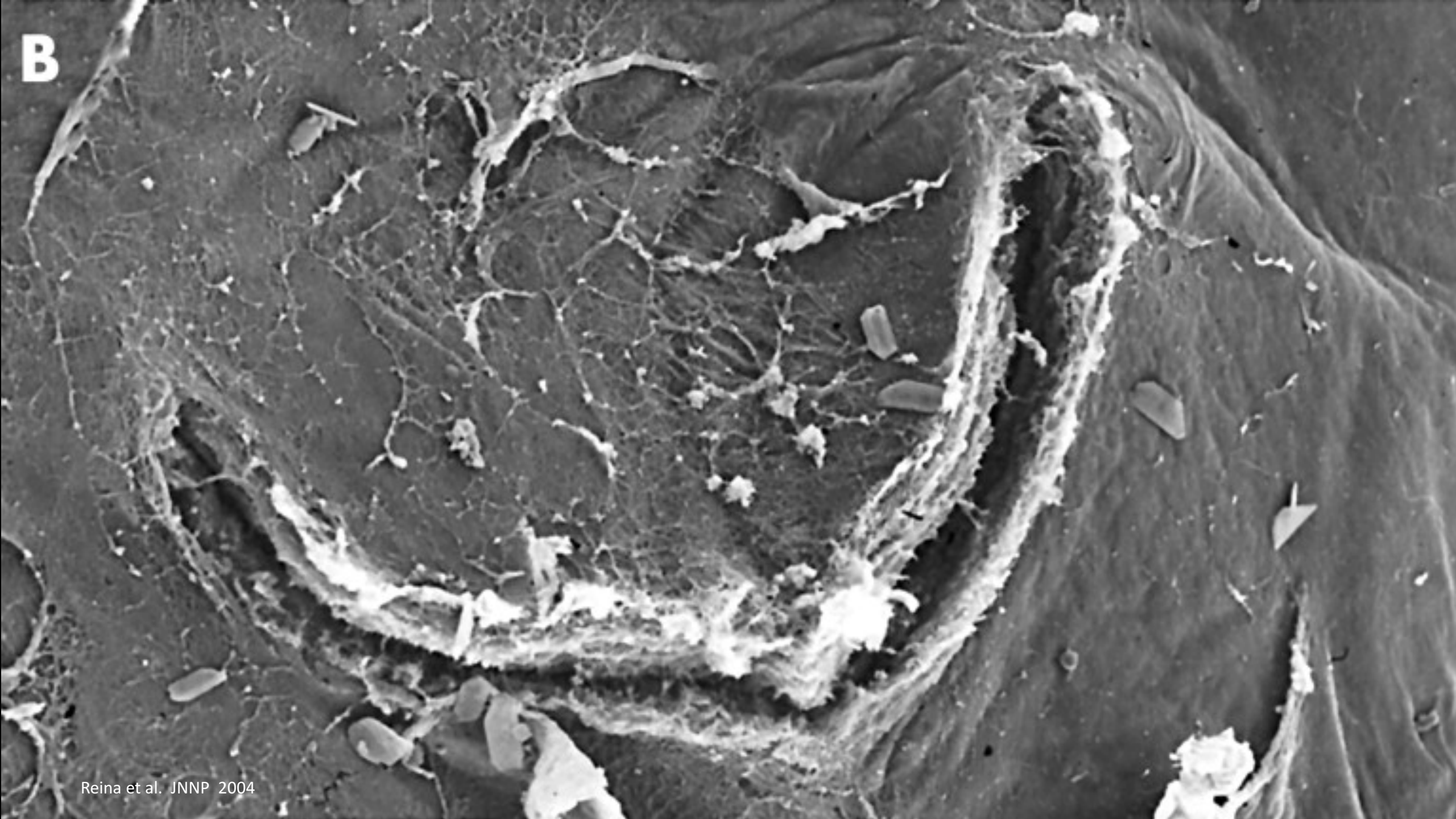
Nath et al., Lancet 2018

Risk factors

Table 4. Procedural Characteristics Associated With PDPH

Factor	Statement	Level of certainty
Needle type	Compared with cutting needles, noncutting spinal needles are associated with decreased PDPH risk.	High
	There is limited evidence regarding a particular design of noncutting spinal needle and the risk of PDPH.	Low
Needle size	When using cutting needles, narrower-gauge needles reduce the risk of PDPH.	High
	For noncutting needles, limited evidence suggests narrower-gauge needles reduce the risk of PDPH.	Moderate
Needle advancement	Evidence is insufficient to confirm benefit of any technique used to identify the epidural space on reduction of the incidence of PDPH.	Low
No. of attempts	Evidence suggests an association between the number of attempts and the risk of PDPH.	Moderate
Operator experience	Evidence suggests that a higher level of operator experience level reduces the incidence of PDPH, but the net benefit may be small.	Moderate
Level of neuraxial block	Evidence does not suggest an association of PDPH with the level of epidural insertion.	Moderate
Patient position	Evidence suggests a lower risk of PDPH with techniques performed with the patient in the lateral decubitus position.	Moderate
Traumatic vs atraumatic tap	Evidence suggests that the choice of needle for LP does not alter the risk of traumatic tap and the risk of PDPH.	Moderate

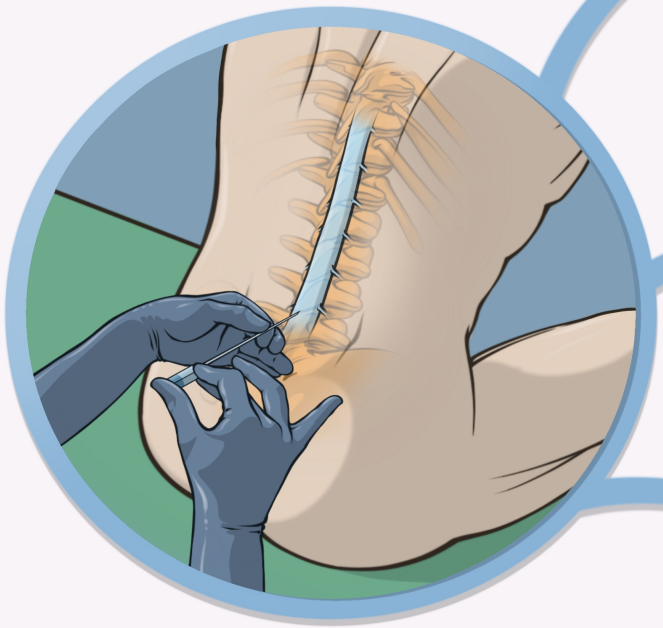
Uppal et al., Reg Anesth Pain Med. 2024, Weji et al. Perioperative Medicine 2020



Reina et al. JNNP 2004

Chronic PDPH

- n = 61 patients
- Neurosurgery Freiburg



381 days on sick leave

5 doctors/institutions

31 days in acute hospital care

Kraus et al. Frontiers Neurol 2024

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RESEARCH Open Access

Health-related quality of life, work ability and disability among individuals with persistent post-dural puncture headache

Ali Kapan[1*], Thomas Waldhör[2], Tobias Schiffler[1], Jürgen Beck[3] and Christian Wöber[4,5]

Sick leave due to pPDPH

3–6 Months	14 (7.8)
6–12 Months	43 (24.0)
Over 1 year	64 (35.8)
Over 2 years	6 (3.4)

Ability to be in an Upright Position

Not at all	29 (16.2)
Less than 1 h	50 (27.9)
2–4 h	29 (16.2)
Most of the day	16 (8.9)
Whole day	55 (30.7)

Ability to take care of children

Not at all	20 (23.3)
Under 1 h	23 (26.7)
2–4 h	17 (19.8)
4–6 h	15 (17.4)
Whole day	11 (12.8)

Full time work in same job = 12 %

According to Kapan et al. Headache 2024

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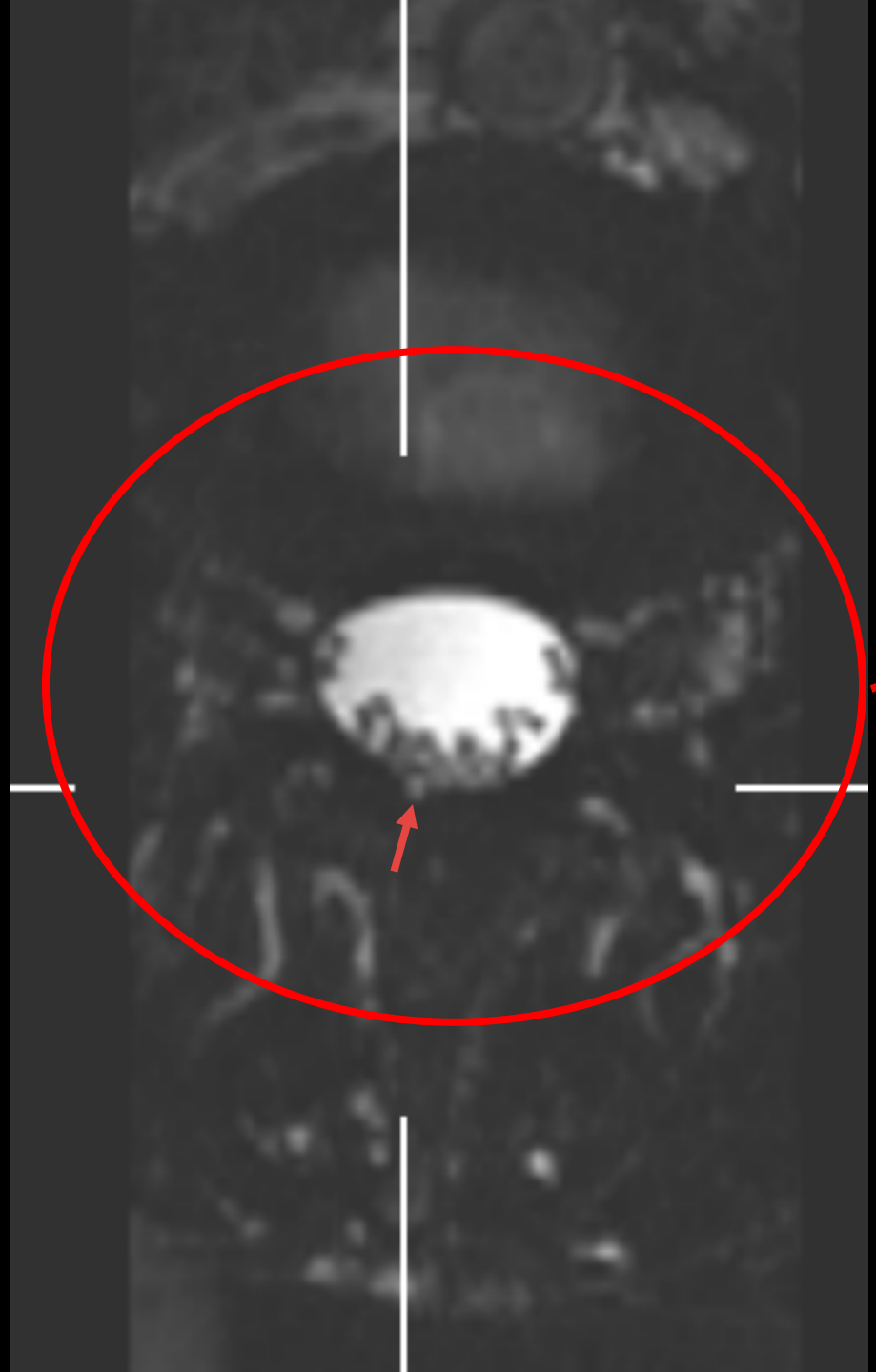
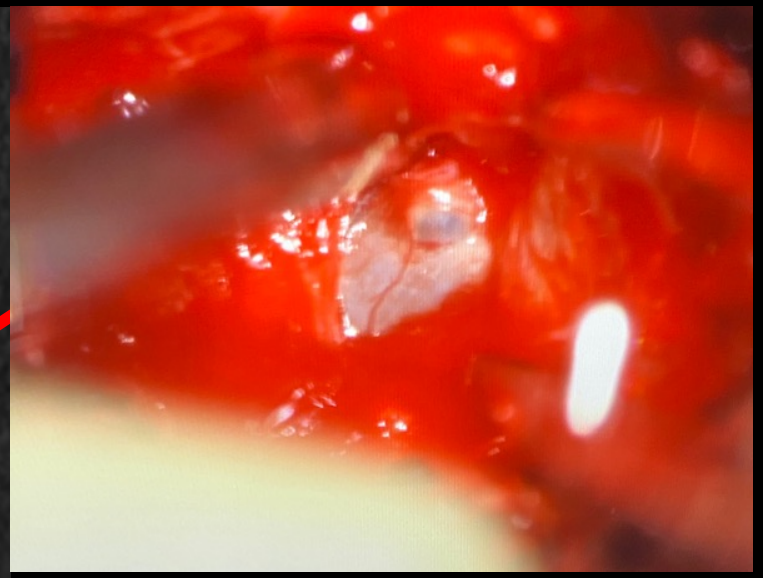
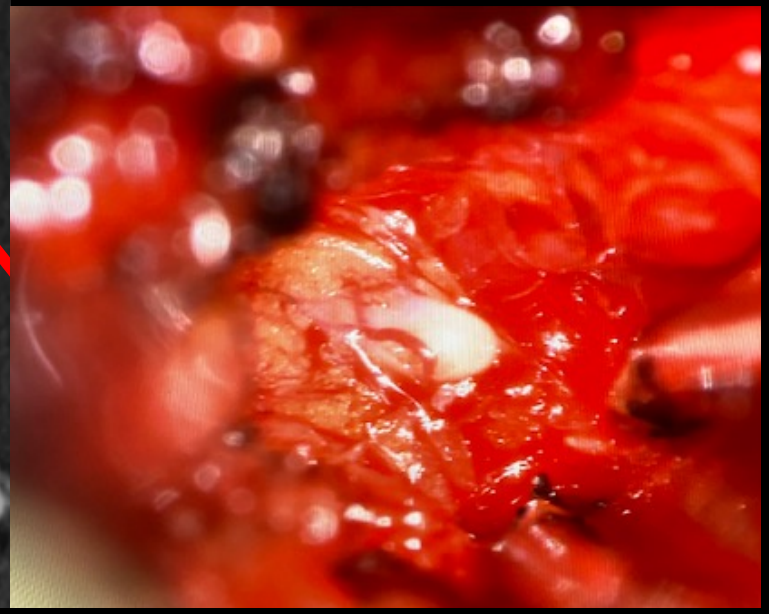
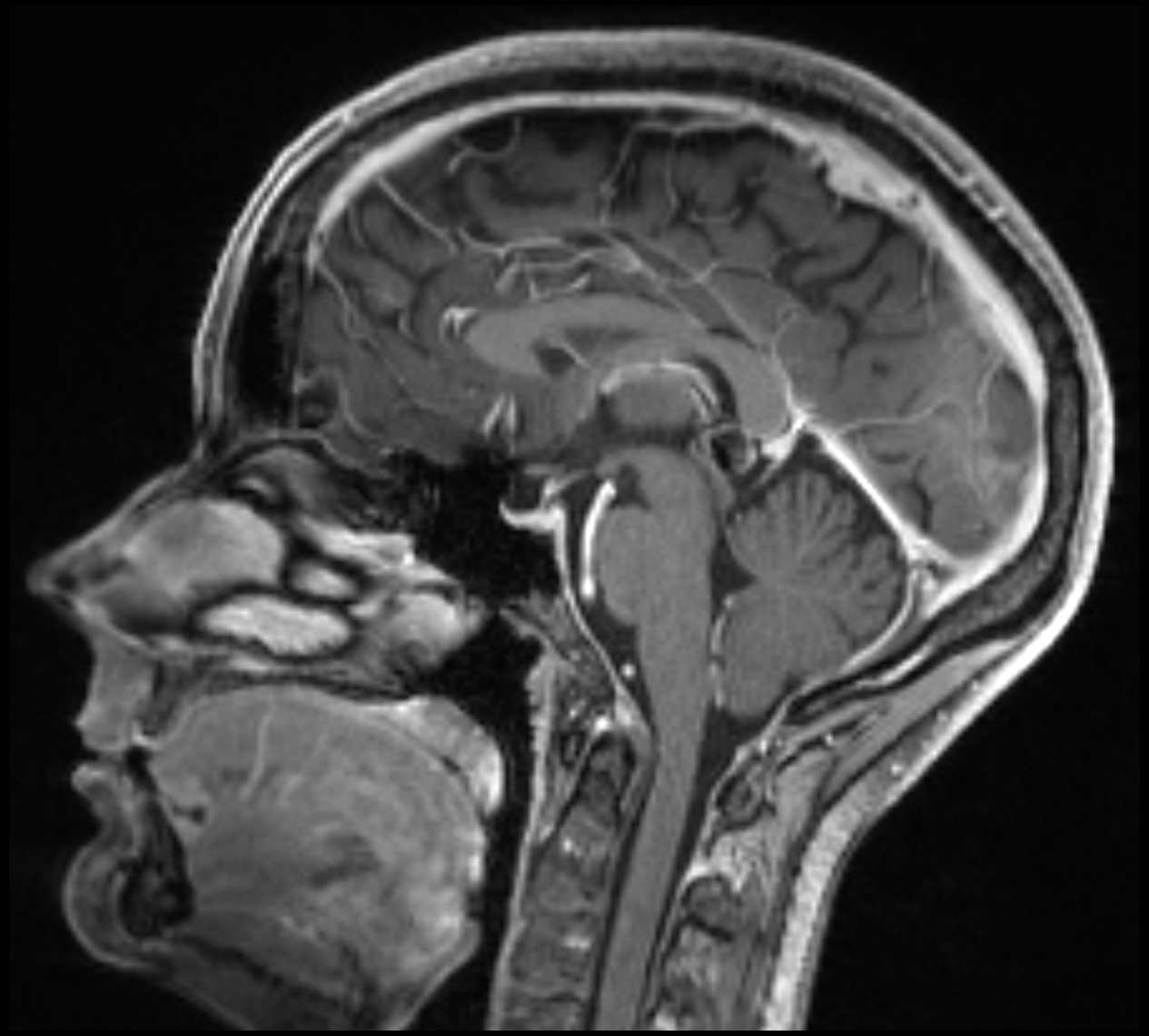
„Arachnoid Bleb“

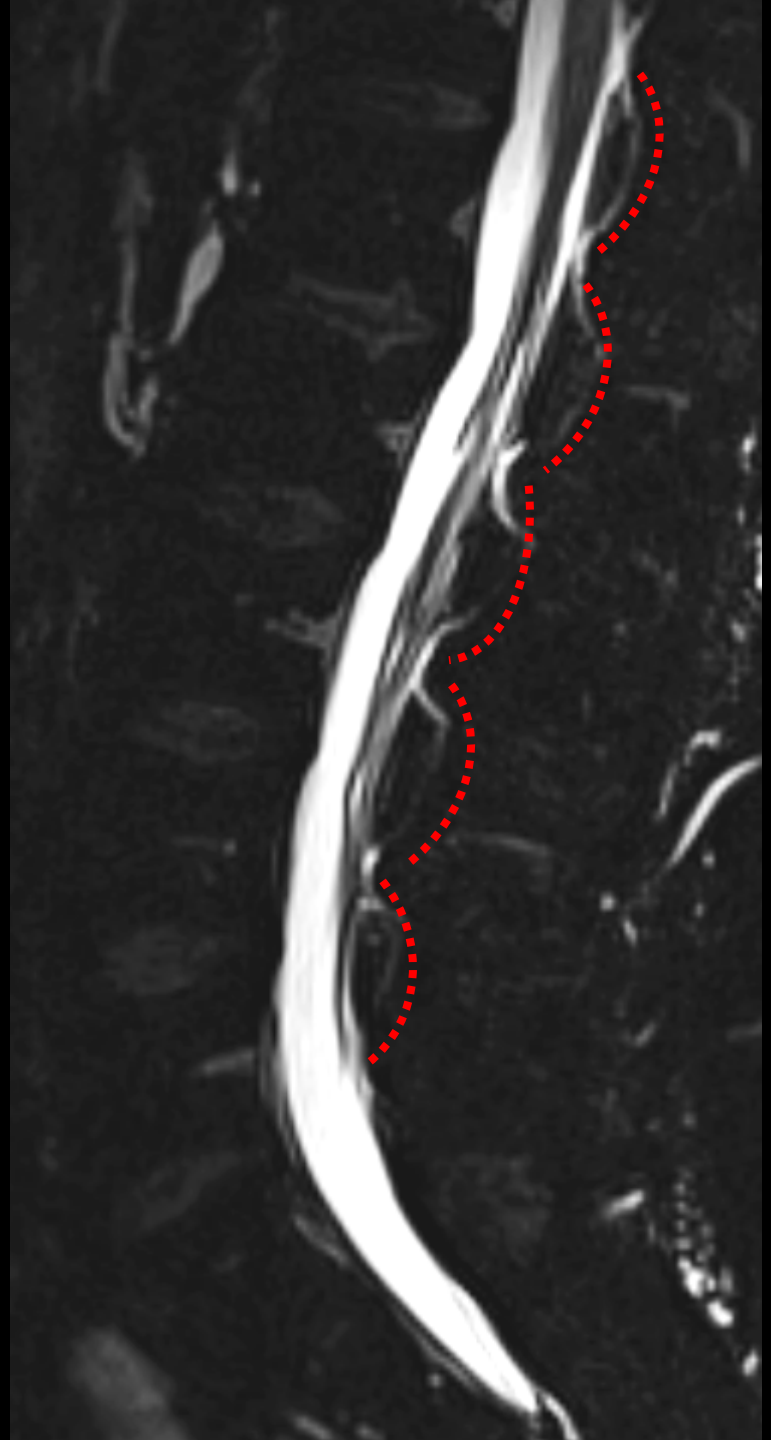
~ 9 %





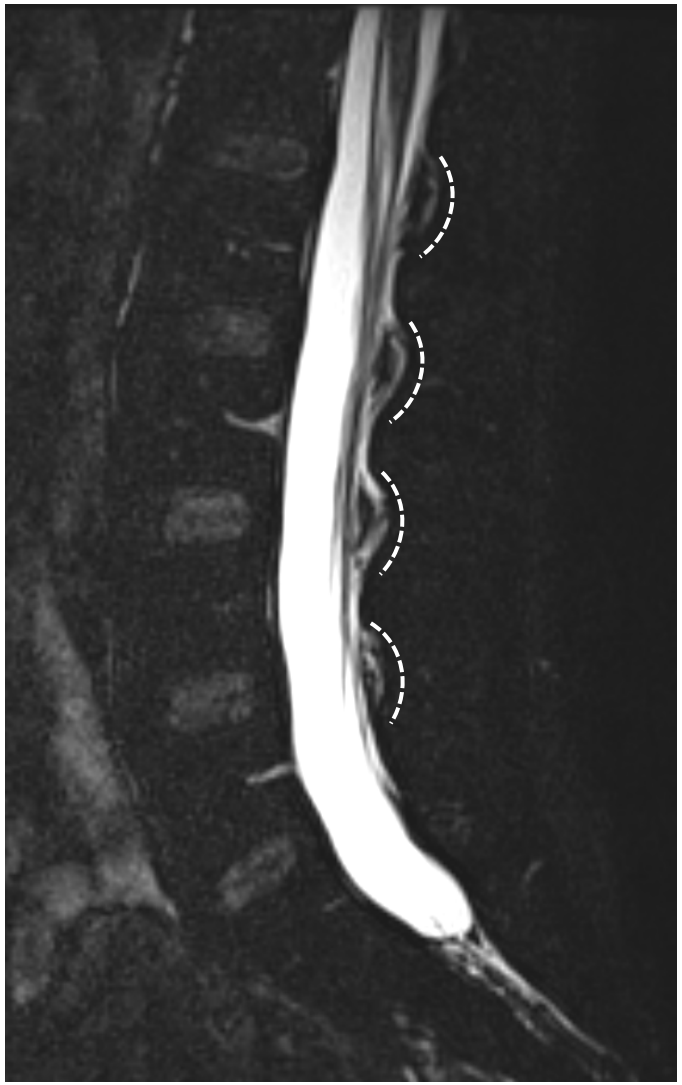


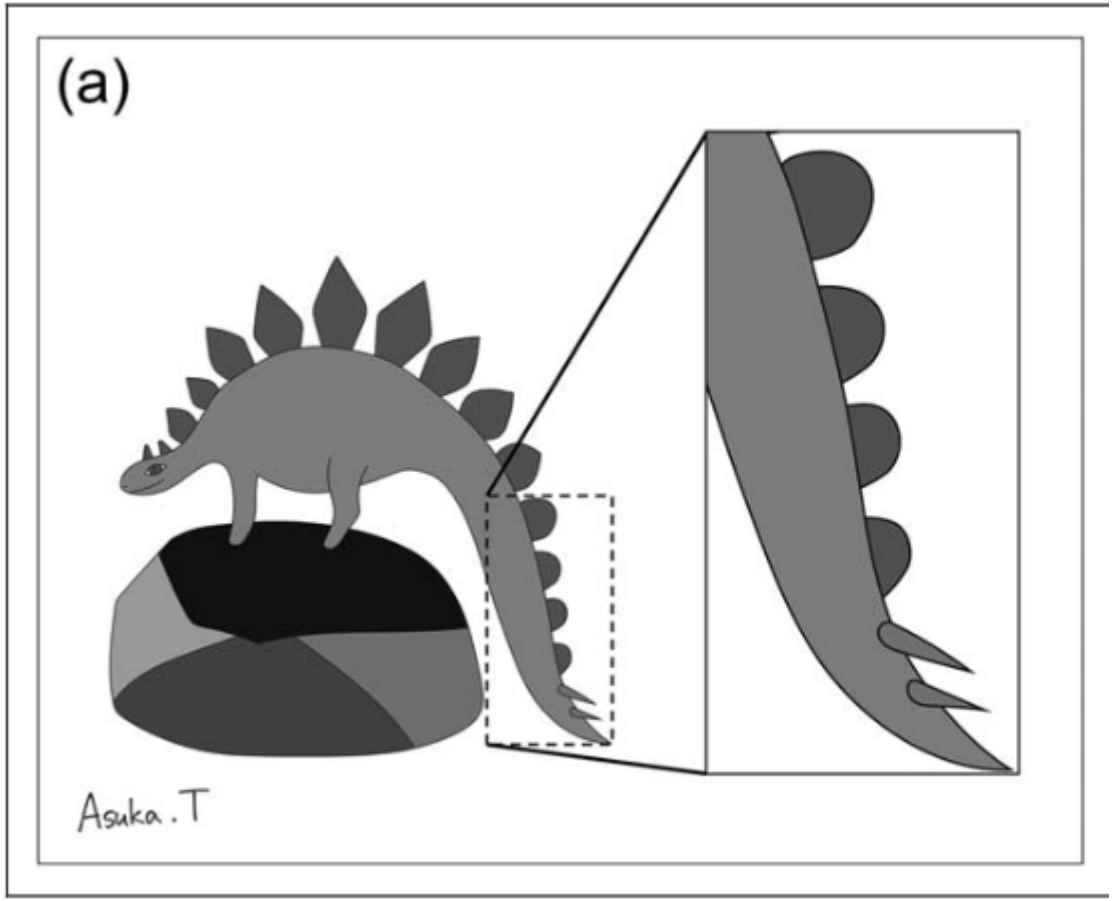




Post-dural puncture headache (PDPH)

Dinosaur tail sign

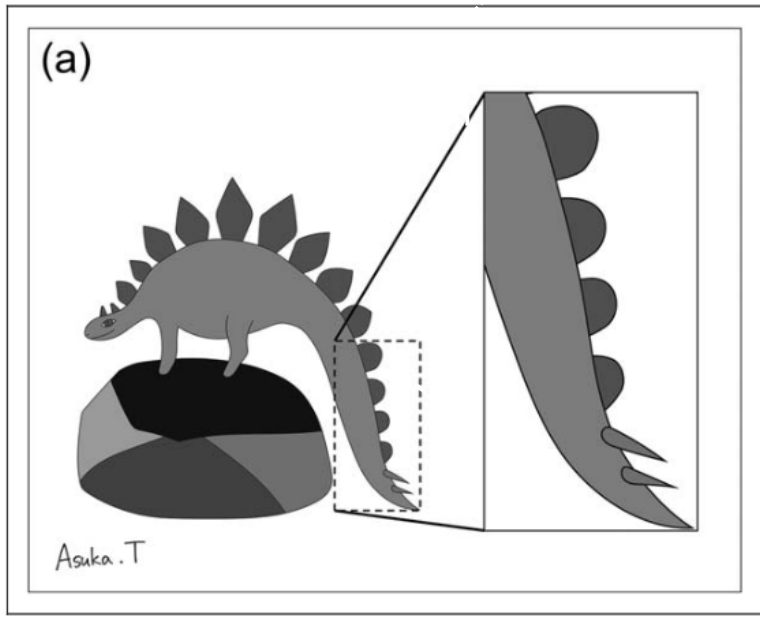




* Sakurai et al., Headache 2017

Post-dural puncture headache (PDPH)

Dinosaur tail sign



Dinosaur tail sign is

very often present in healthy patients

even without any dural puncture

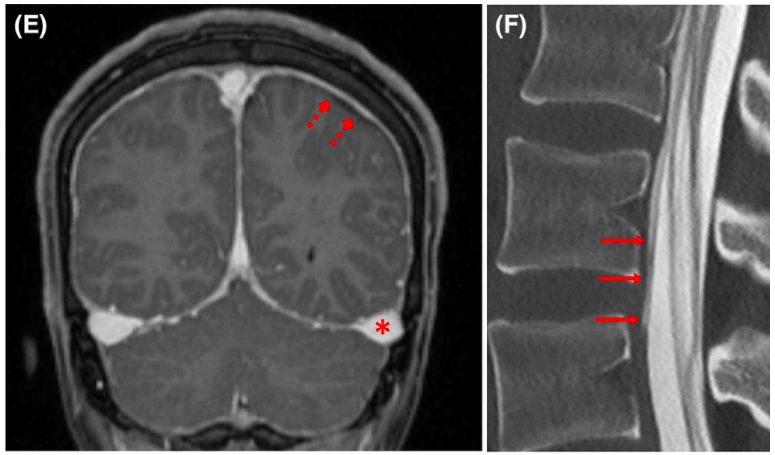
experience based

chronic Post Dural Puncture Headache - cPDPH

Patients with chronic post-dural puncture headache do not have typical imaging features of intracranial hypotension: An MRI study using the Bern score

Charlotte Zander MD[1] | Christian Fung MD[2] | Amir El Rahal MD[3] | Florian Volz MD[3] | Katharina Wolf MD[3] | Alexander Rau MD[1] | Hansjörg Mast[1] | Jürgen Beck MD[3] | Horst Urbach MD[1] | Niklas Lützen MD[1]

Headache. 2025;00:1–9.



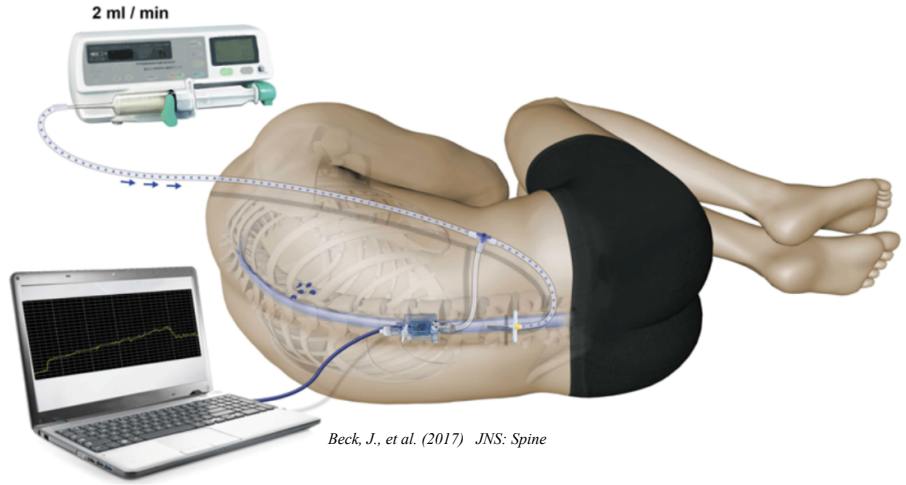
RESEARCH ARTICLE

CSF Pressure and Dynamics in Patients With Chronic Postdural Puncture Headache

A Single-Center Cohort Study

Christian Fung,[1,1]* Luisa Mona Kraus,[1,2,2]* Amir El Rahal,[1] Levin Haeni,[1] Florian Volz,[1] Katharina Wolf,[1] Mukesch Johannes Shah,[1] Horst Urbach,[3] Niklas Lützen,[3] and Jürgen Beck[1]

Neurology® 2025;105:e213998.



FREIBURG CSF CENTER

UNIVERSITÄTS KLINIKUM FREIBURG

CSF-Center Freiburg

EANS CerebroSpinal Fluid Section

International Collaborations

Inselspital Bern, Switzerland

Lindenhofspital Bern, Switzerland

UZH Zuerich, Switzerland

AKH, Vienna, Austria

University College London, UK

King's College, UK

Danish Headache Center, Denmark

Cedars Sinai, CA, USA

Stanford, CA. USA

Nagoya University, Japan

Aurora, CU Anschutz, USA

Neurosurgery & Neurology
J. Beck, K. Wolf, F. Volz, A. El Rahal, V. Vieira da Silva
L. Krismer, M. Overstijns, M. Shah

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

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

Freiburg CSF Center
Prof. Dr. Jürgen Beck

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Received: 4 May 2025 | Accepted: 20 August 2025

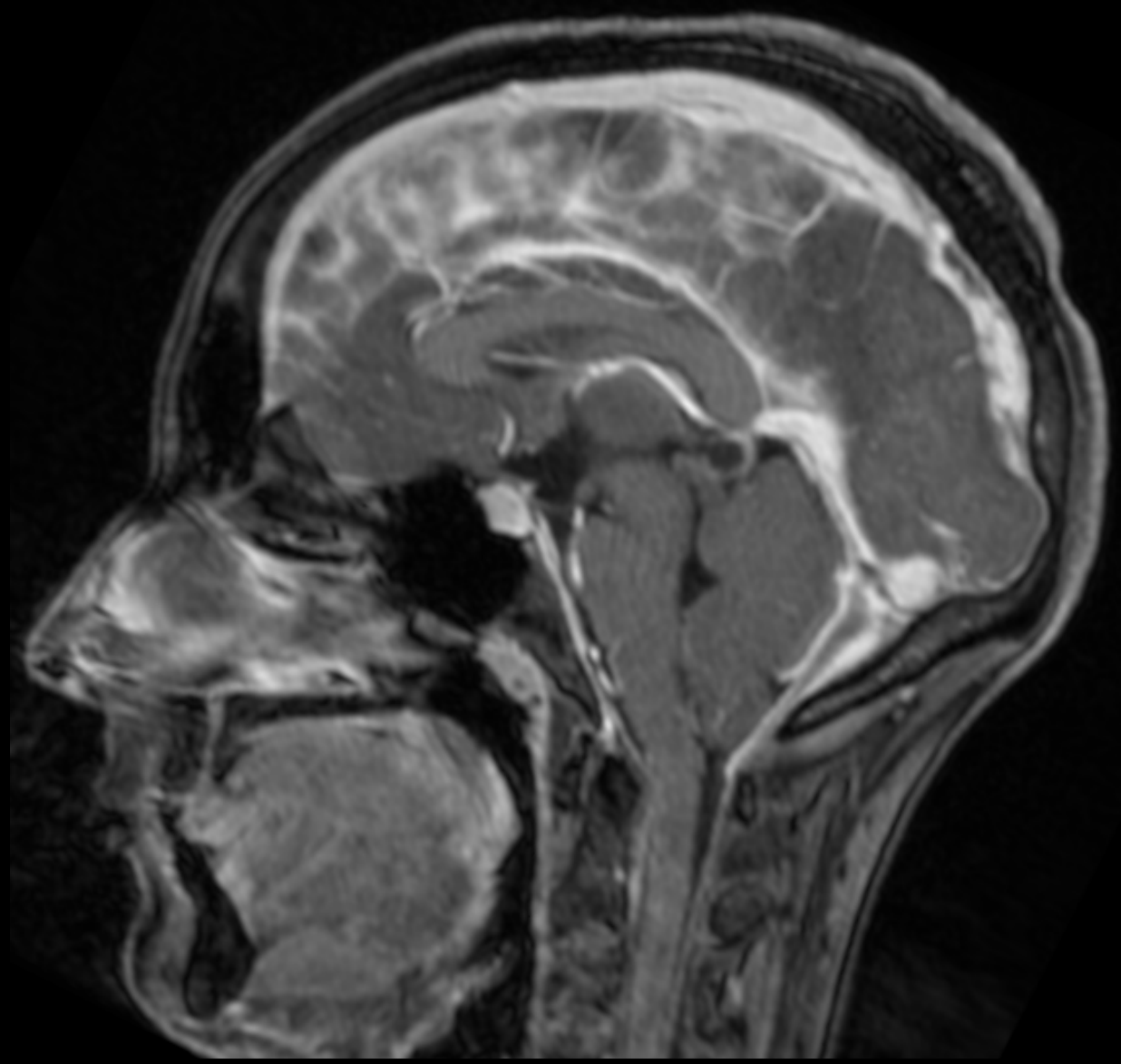
DOI: 10.1111/head.15057

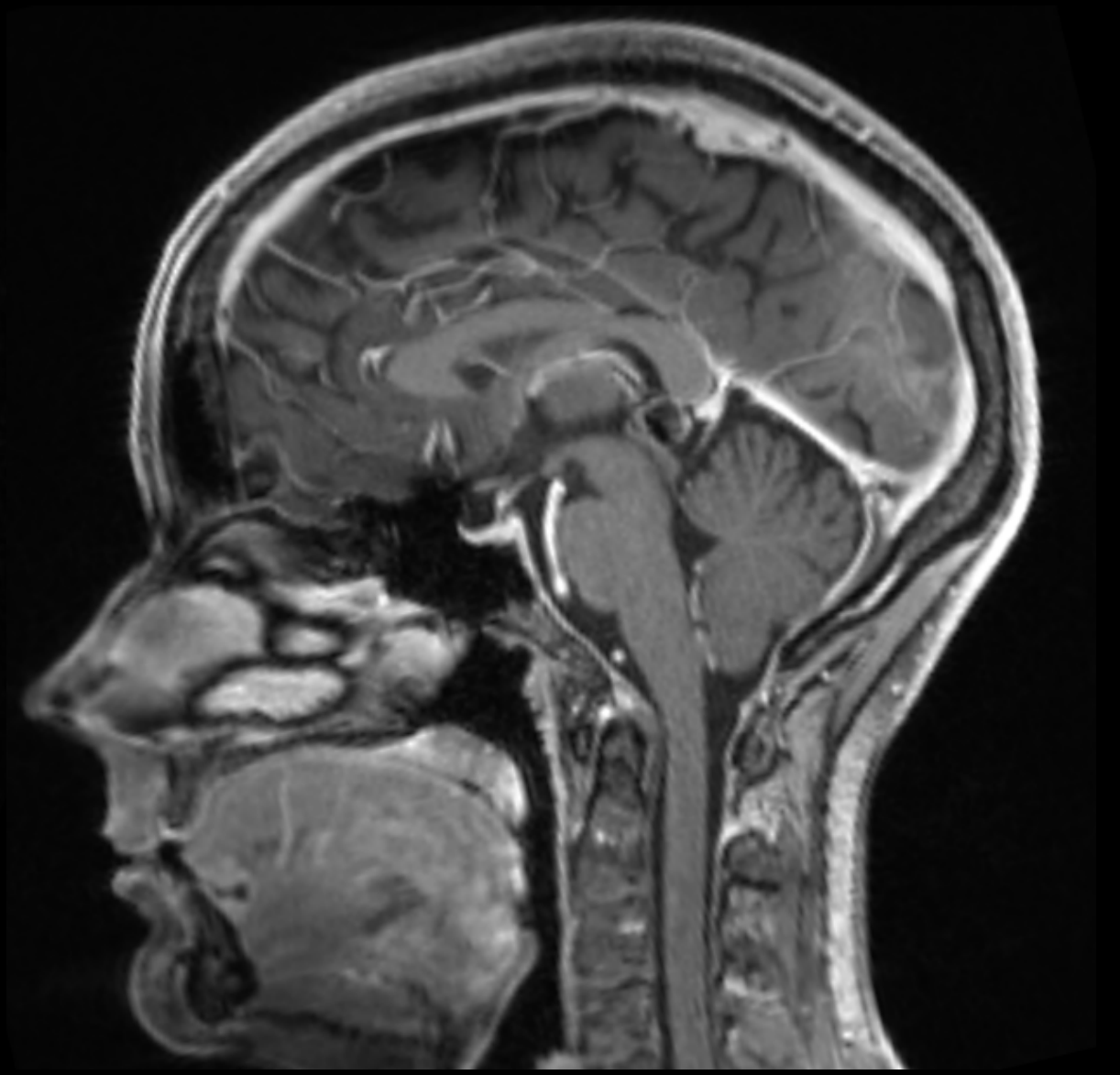
HEADACHE

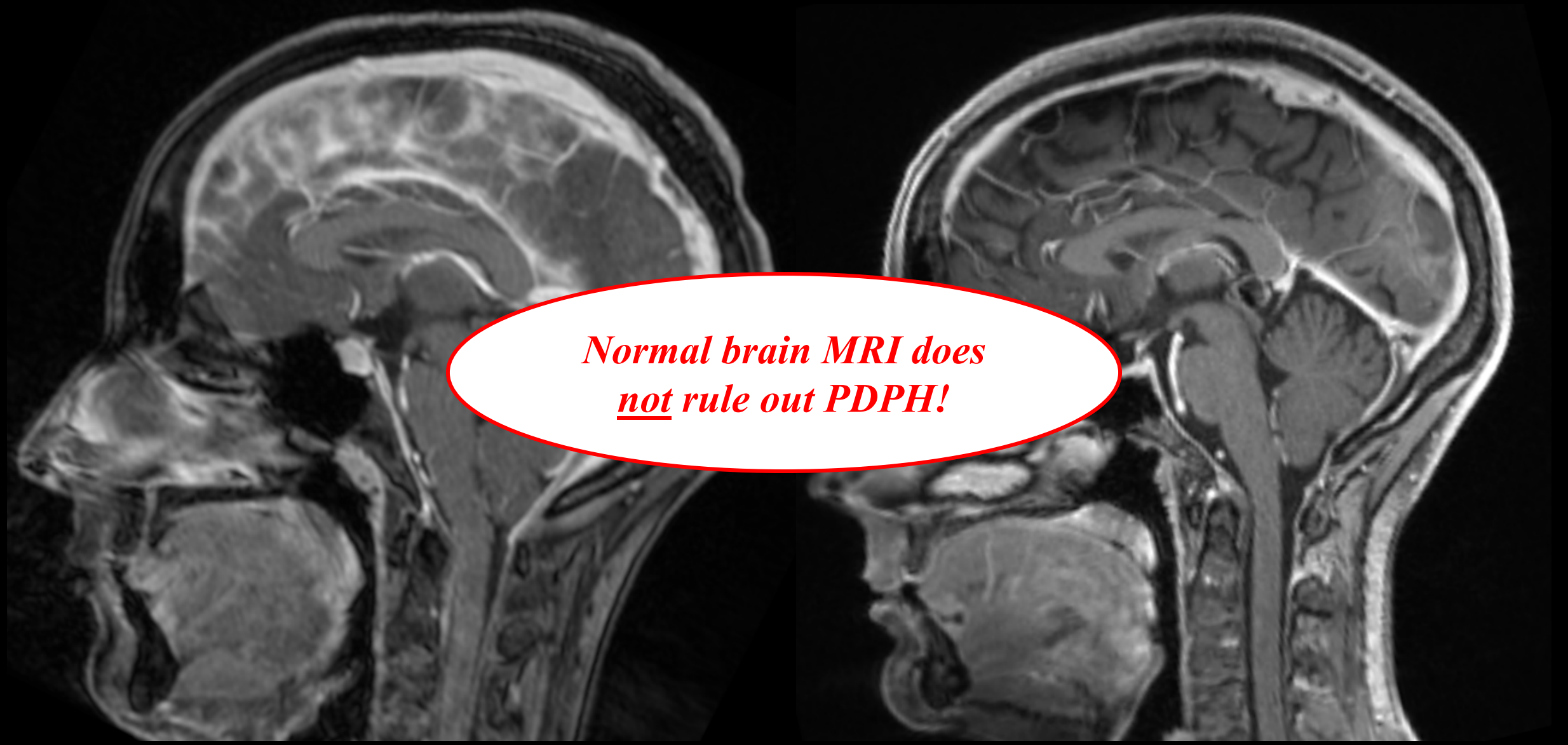
RESEARCH SUBMISSION

Patients with chronic post-dural puncture headache do not have typical imaging features of intracranial hypotension: An MRI study using the Bern score

Charlotte Zander MD[1] | Christian Fung MD[2] | Amir El Rahal MD[3] | Florian Volz MD[3] | Katharina Wolf MD[3] | Alexander Rau MD[1] | Hansjörg Mast[1] | Jürgen Beck MD[3] | Horst Urbach MD[1] | Niklas Lützen MD[1]



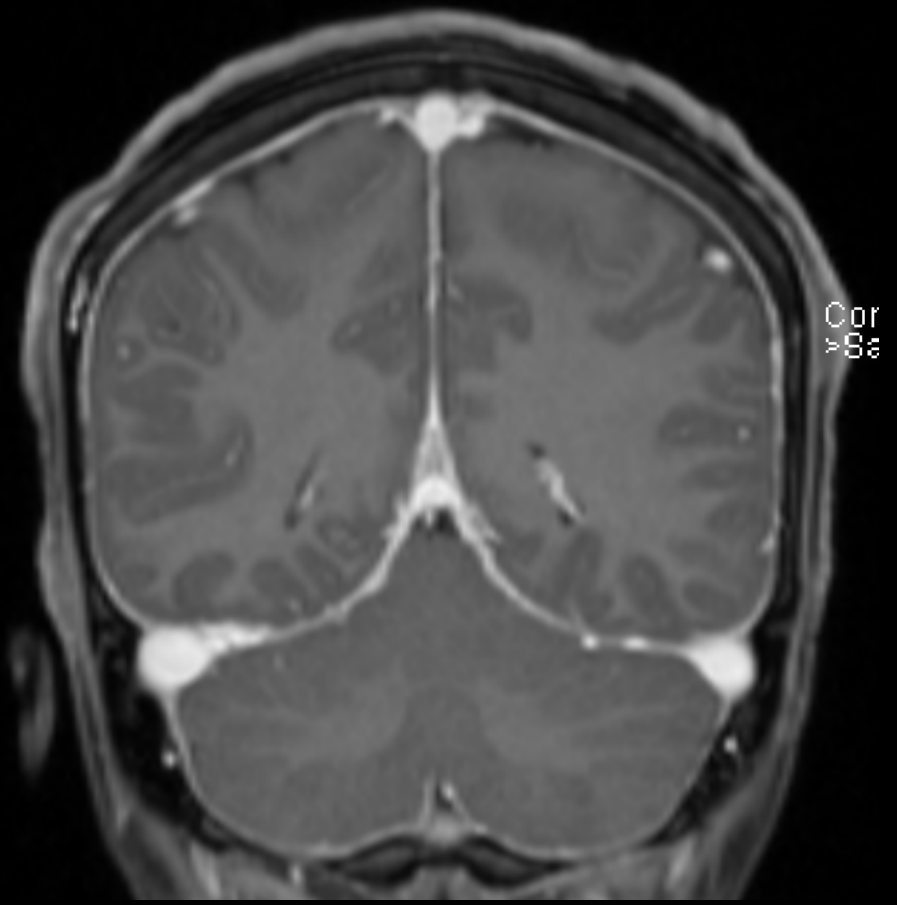




Normal brain MRI does not rule out PDPH!

28 years, UDP while PDA

30 years, UDP while PDA


Cor
>Sa

12 %

Patients with chronic post-dural puncture headache do not have typical imaging features of intracranial hypotension: An MRI study using the Bern score

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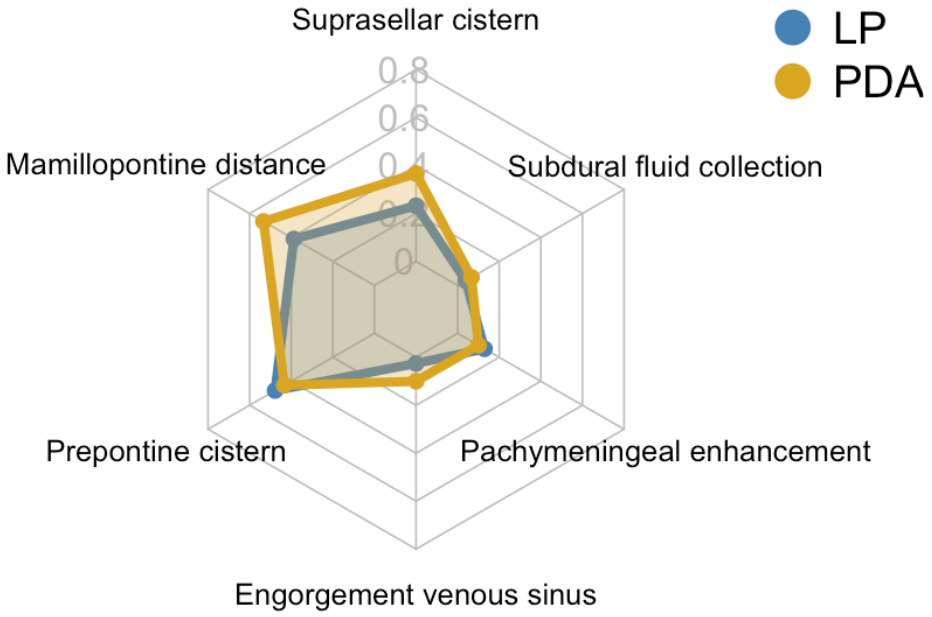
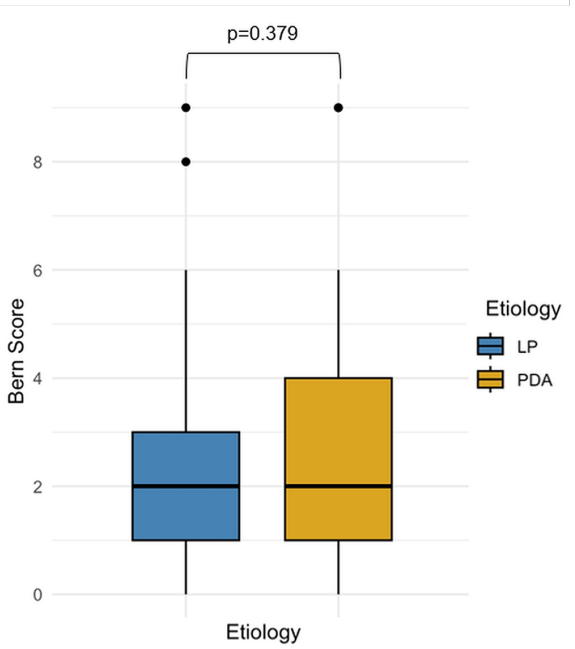
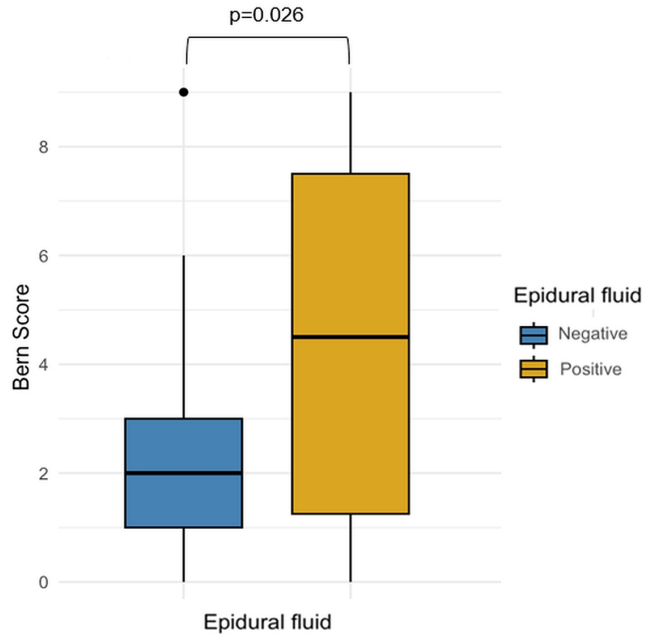
Epidural fluid in only 12.0%







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Is PDPH an MR-imaging Diagnosis ?

Does negative imaging rule out PDPH ?

PDPH = MRI-Diagnosis?

NO!

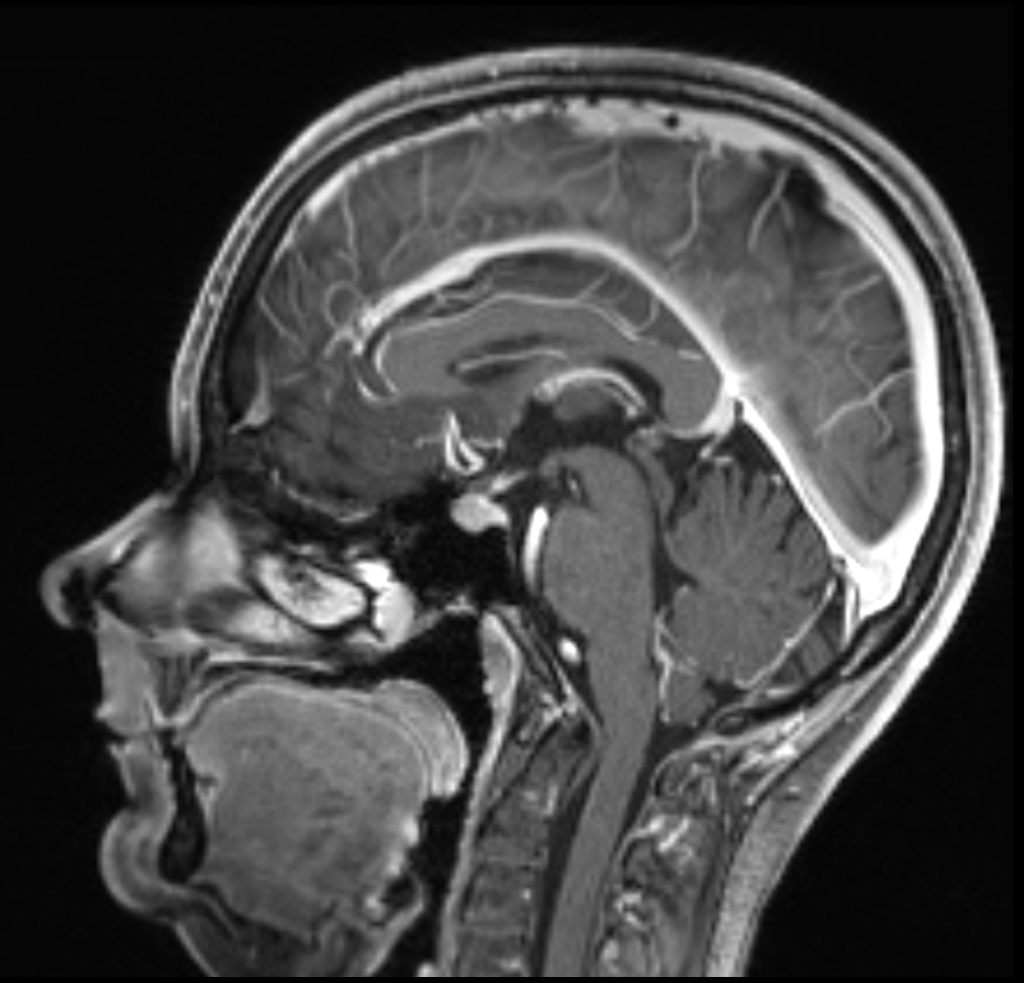
Statement on Post-Dural Puncture Headache Management, American Society of Anesthesiologists, 2023:

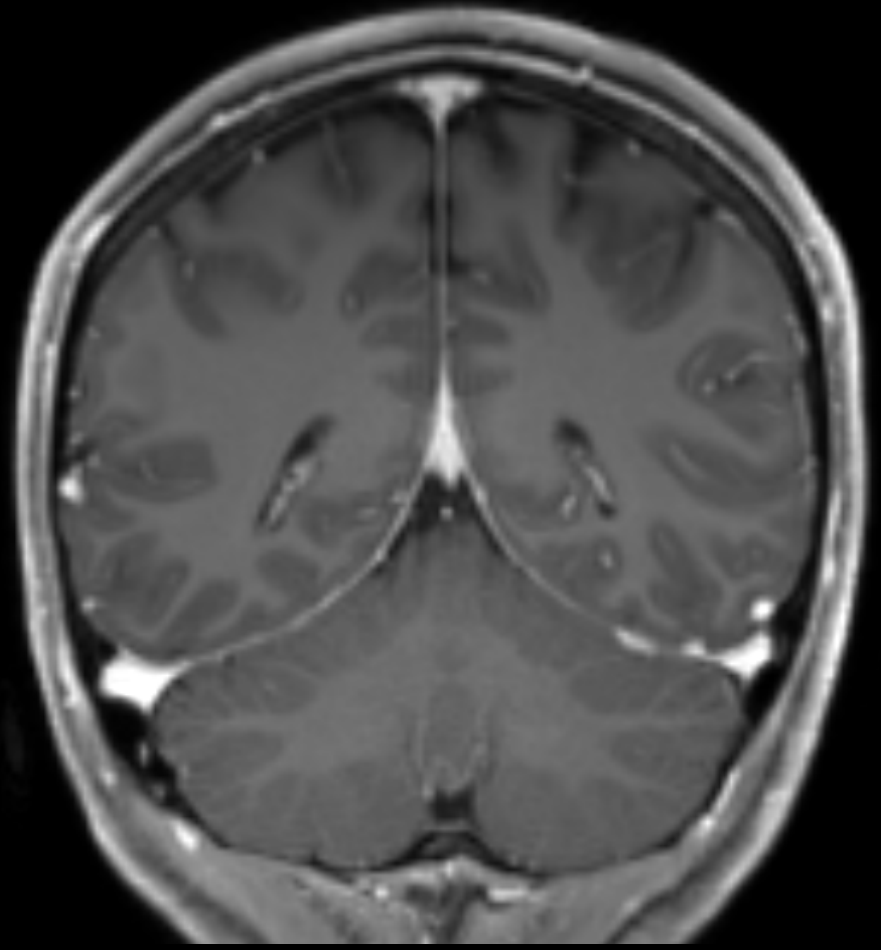
- **Clinical diagnosis:** Typical symptoms after dural puncture

1. **Imaging in context of atypical symptoms and to rule out complications**
2. **Imaging if chronic PDPH develops**
3. **Imaging in CSF centers – extended (presurgical) evaluation**

YES! We need MRI

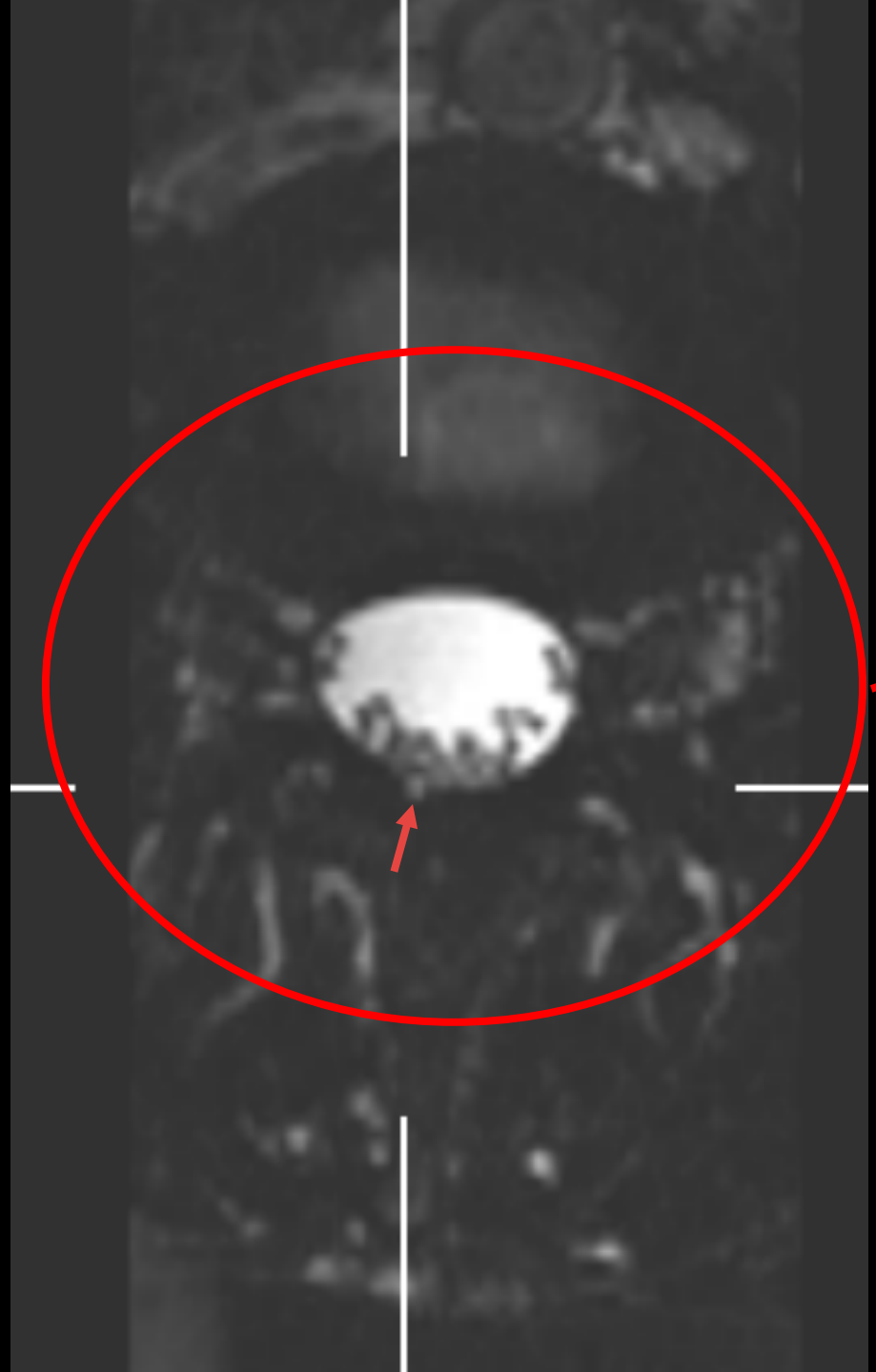
CSF-center





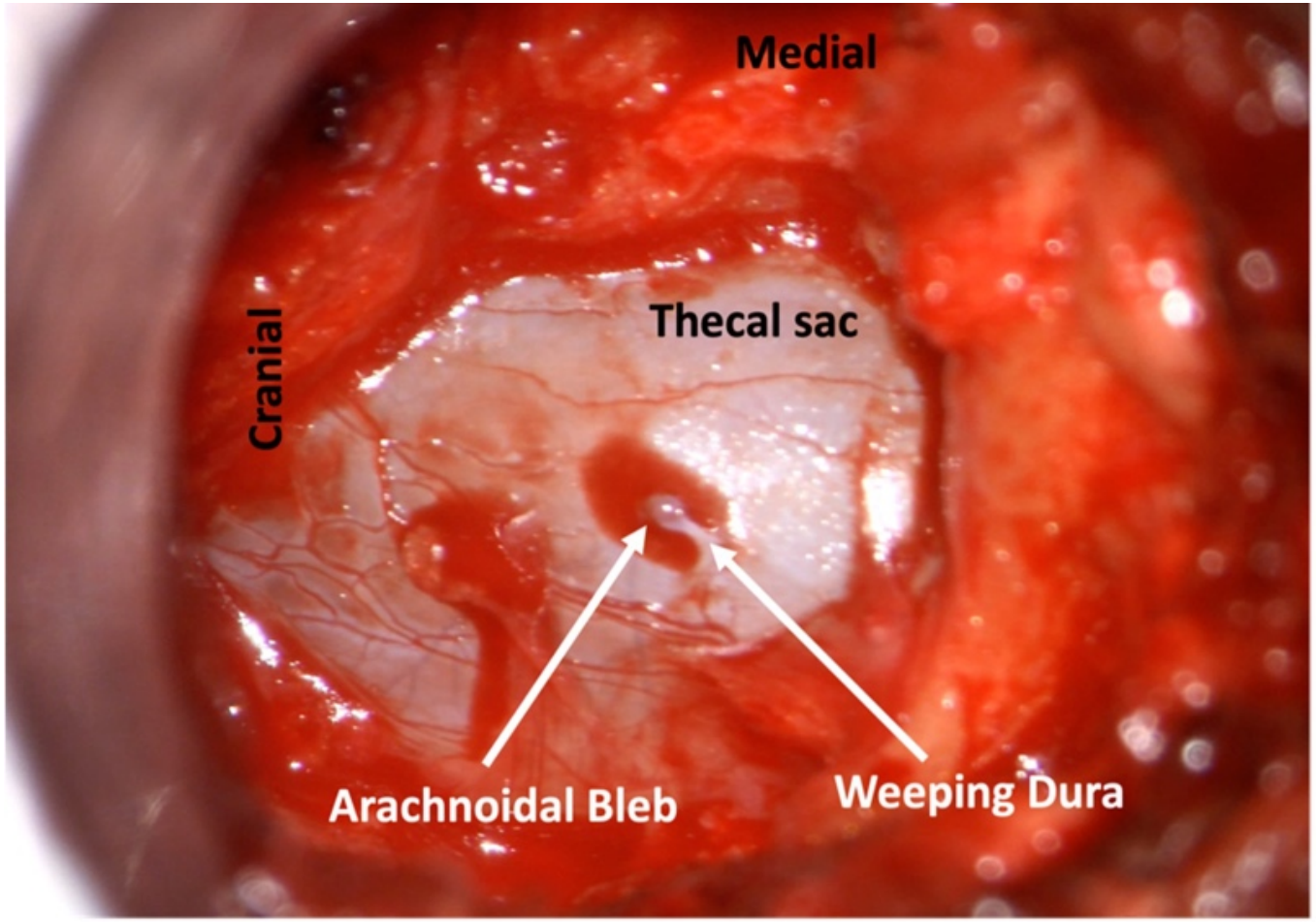
„Arachnoid Bleb“

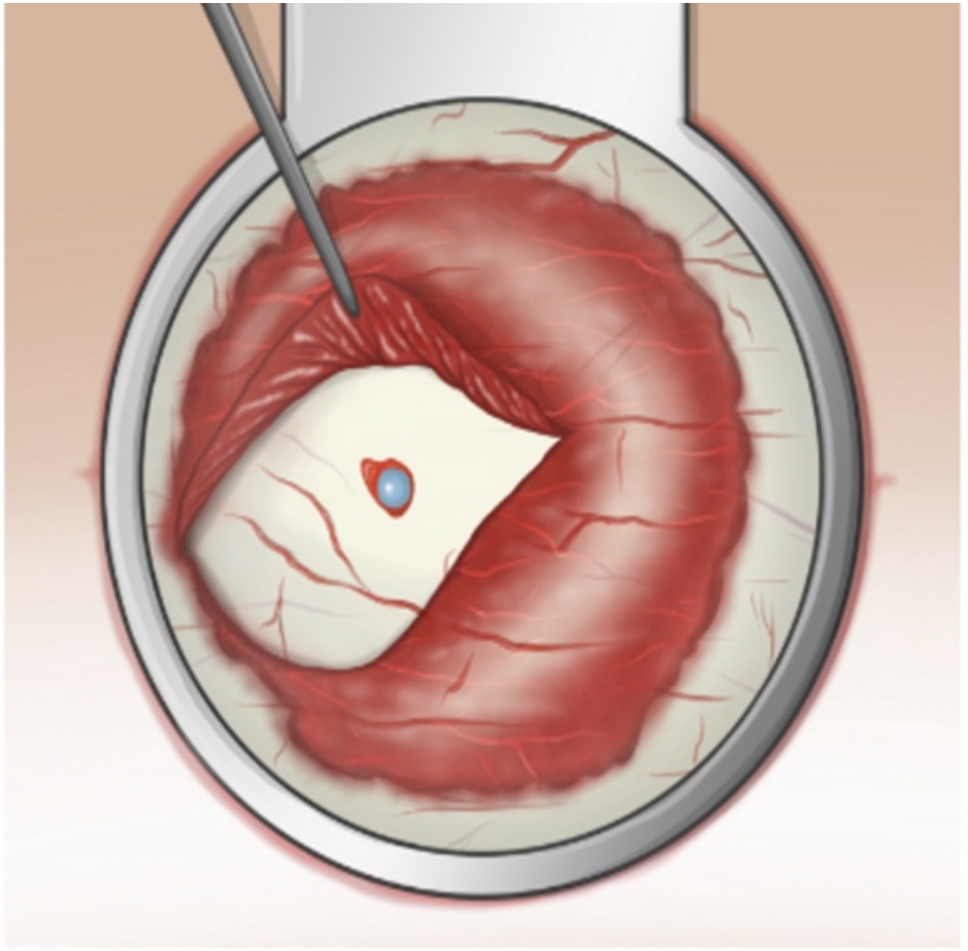
~ 9 %



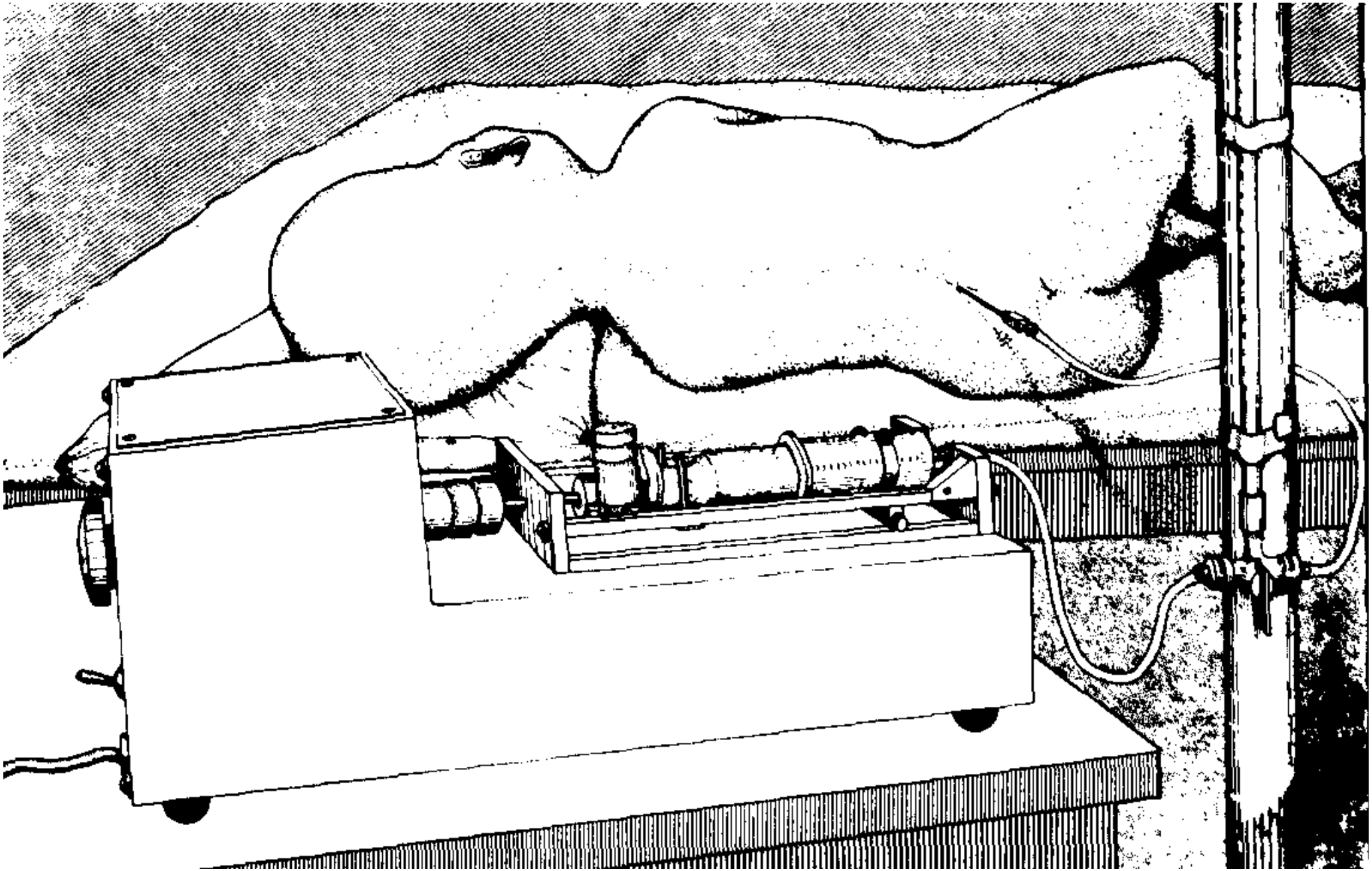
El Rahal et al, Oxford medical 2025

Neo-membranes and blebs

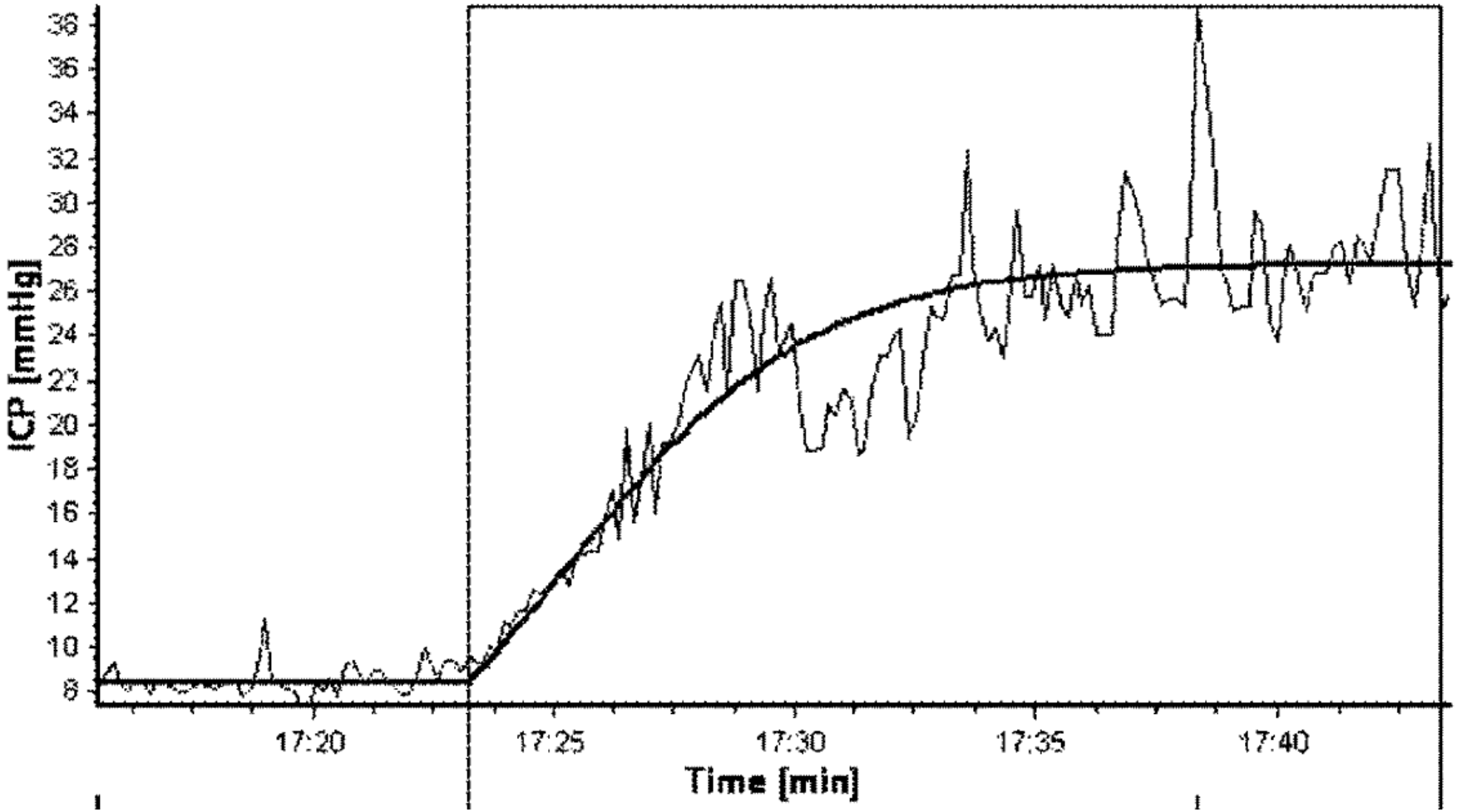




El Rahal et al. Oxford Medical Case Reports 2025



Katzmann and Hussey Neurology 1970



Assessment of cerebrospinal fluid outflow resistance

Anders Eklund · Peter Smielewski · Iain Chambers · Noam Alperin · Jan Malm · Marek Czosnyka · Anthony Marmarou

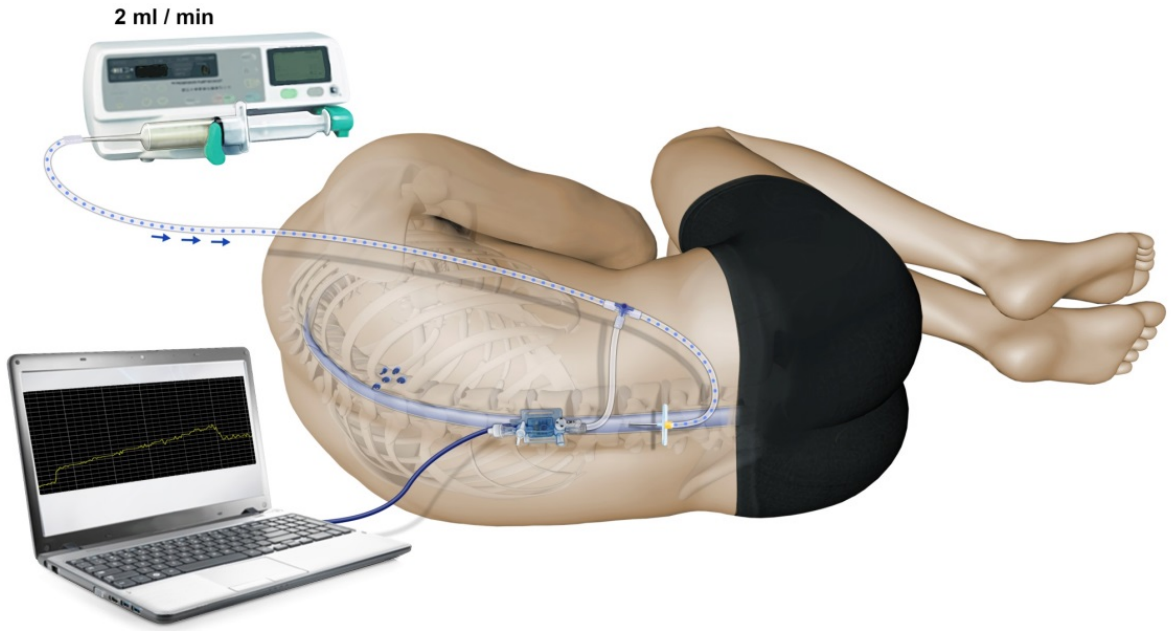
JNS SPINE

CLINICAL ARTICLE

J Neurosurg Spine 27:227–234, 2017

Cerebrospinal fluid outflow resistance as a diagnostic marker of spontaneous cerebrospinal fluid leakage

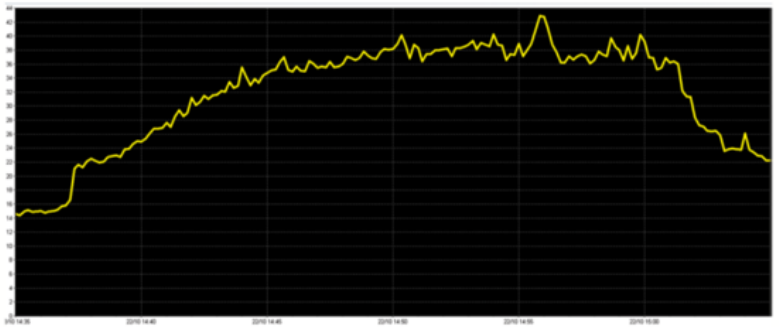
*Jürgen Beck, MD,[1] Christian Fung, MD,[1] Christian T. Ulrich, MD,[1] Michael Fiechter, MD,[1] Jens Fichtner, MD,[1] Heinrich P. Mattle, MD,[2] Marie-Luise Mono, MD,[2] Niklaus Meier, MD,[2] Pasquale Mordasini, MD,[3] Werner J. Z'Graggen, MD,[1] Jan Gralla, MD,[3] and Andreas Raabe, MD[1]



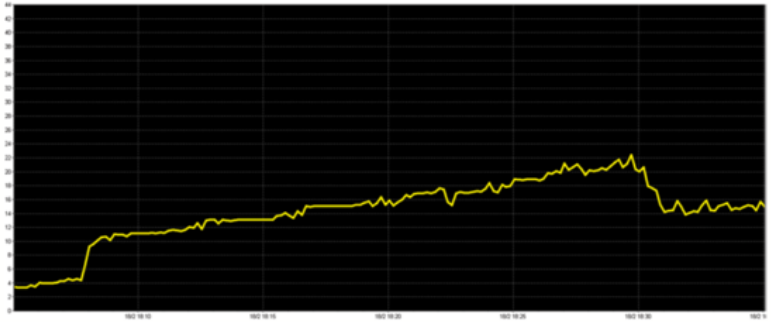
2017

Lumbar infusion test

normal



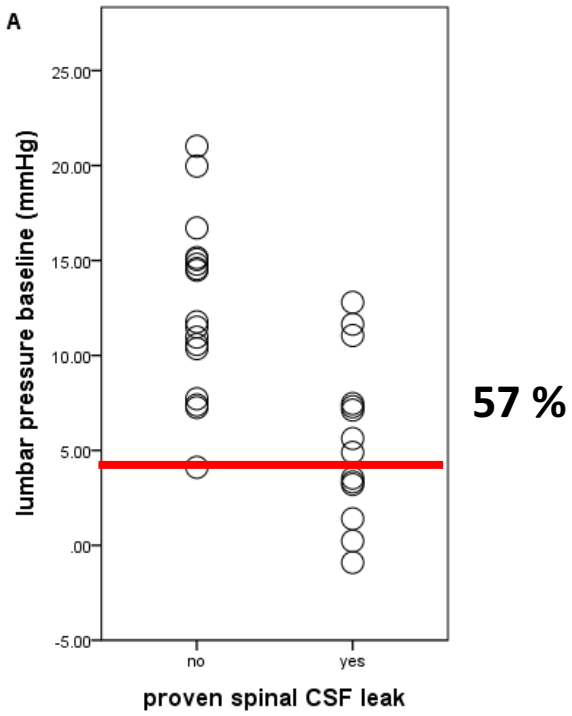
open leak



SIH

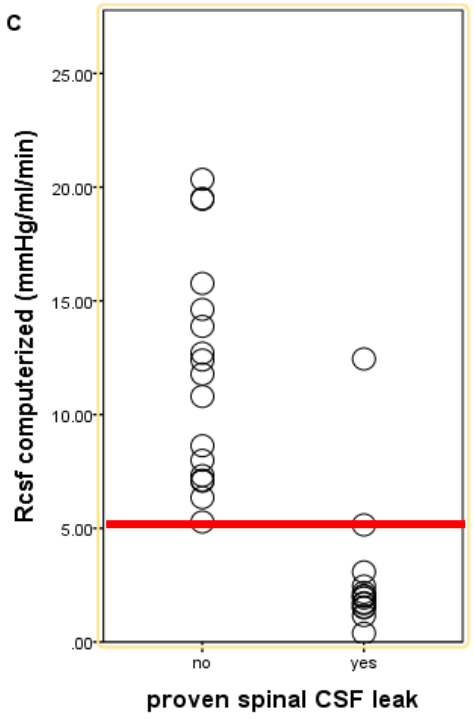
Lumbar infusion test – acute phase

Opening pressure

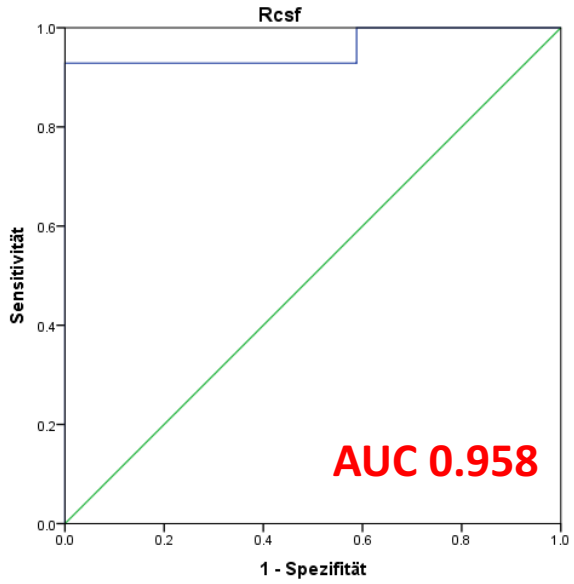


57 %

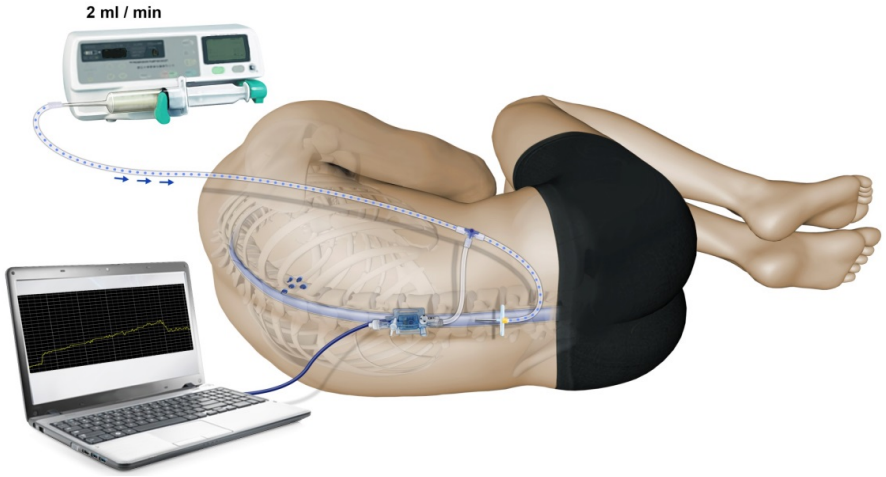
Resistance to CSF outflow (R_{CSF})



14 %



Lumbar infusion test – for acute SIH



- Specific pattern of CSF dynamics
- Investigator independent
- **Rcsf out** may be the best CSF-leak specific diagnostic parameter

Beck et al. J Neurosurg Spine 2017

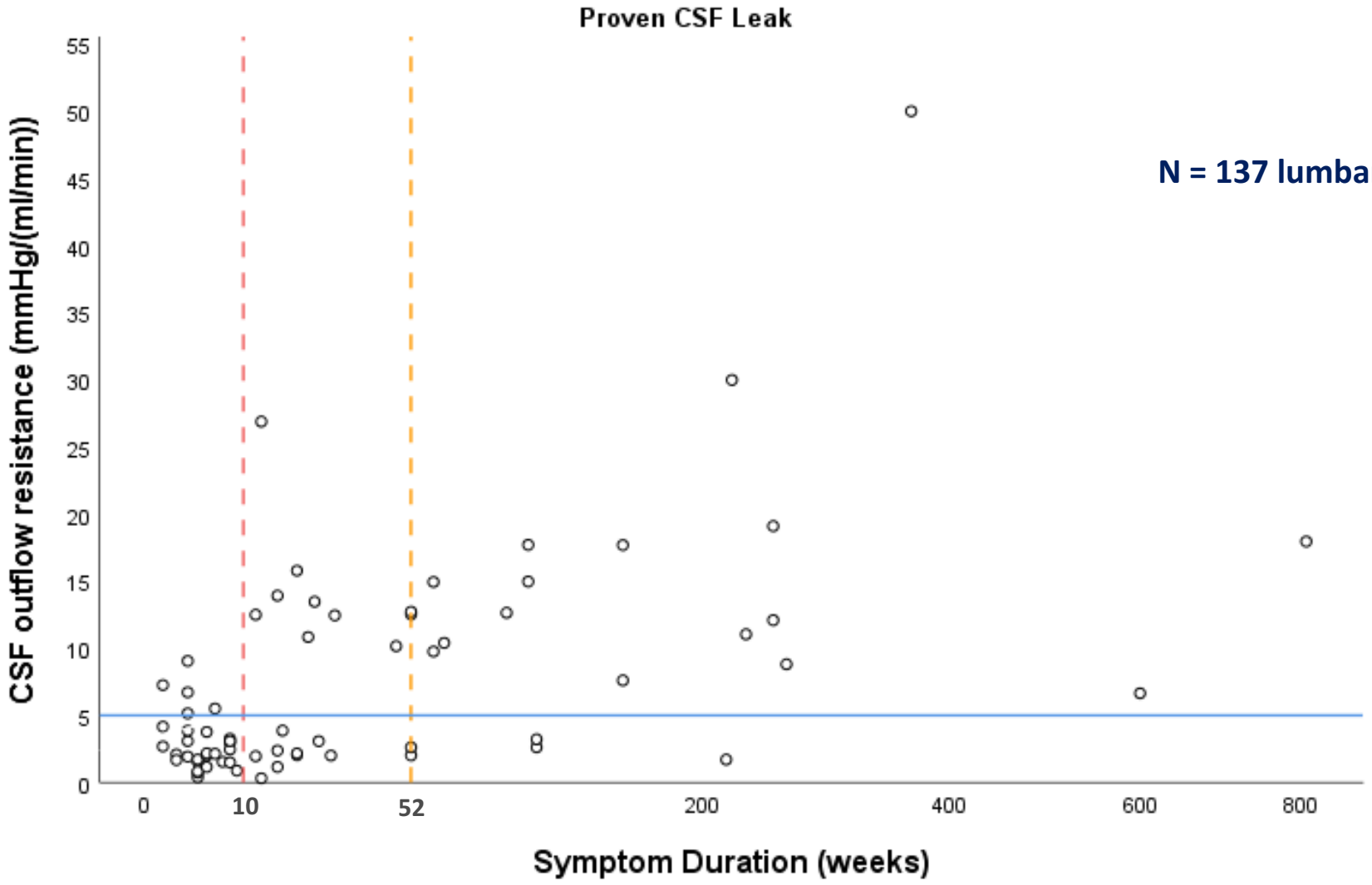
Natural history of SIH

Acute
≤10 weeks

Subacute
11-52 weeks

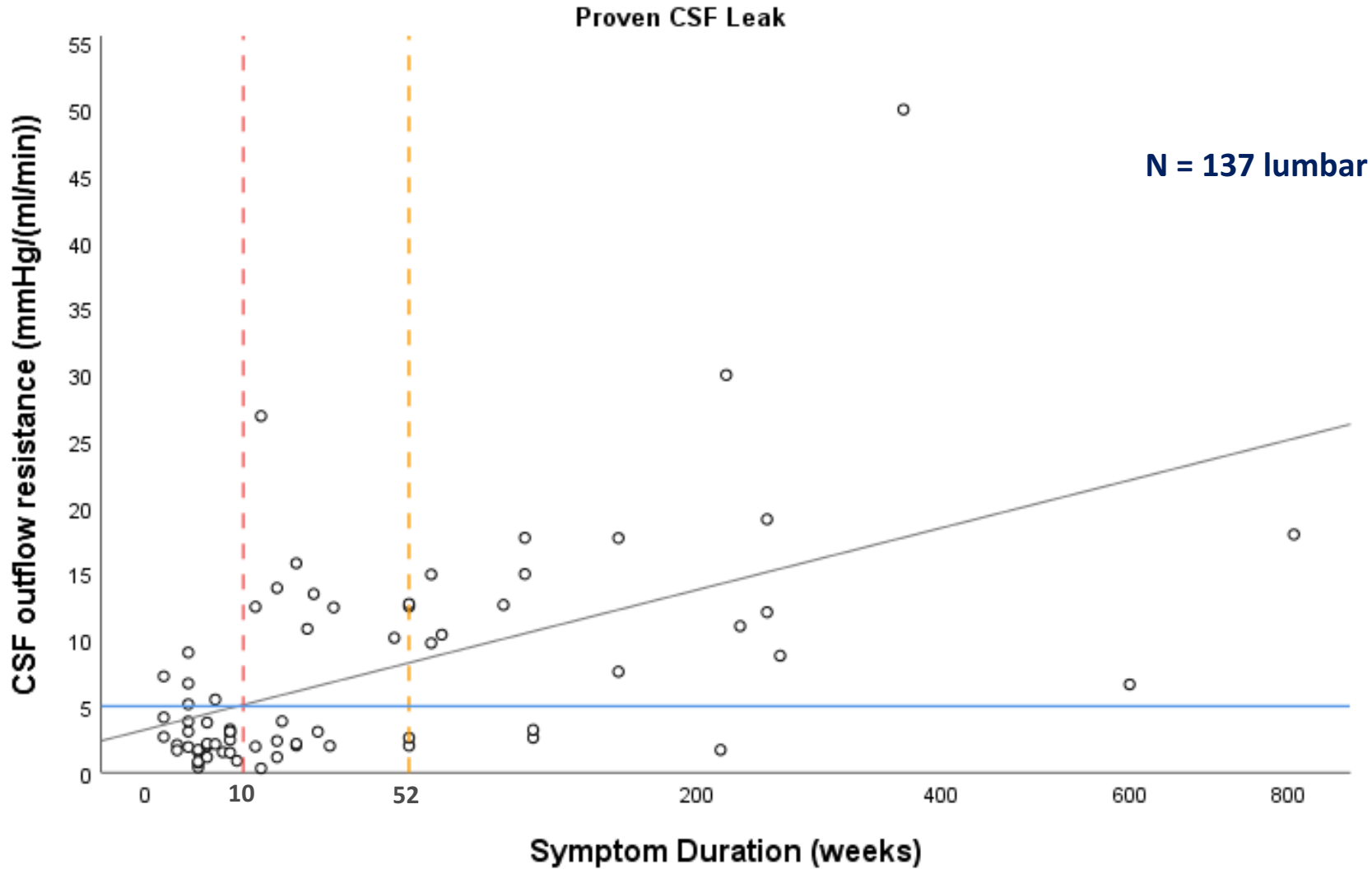
Chronic
>52 weeks

Natural history – resistance to CSF outflow (R_{CSF})



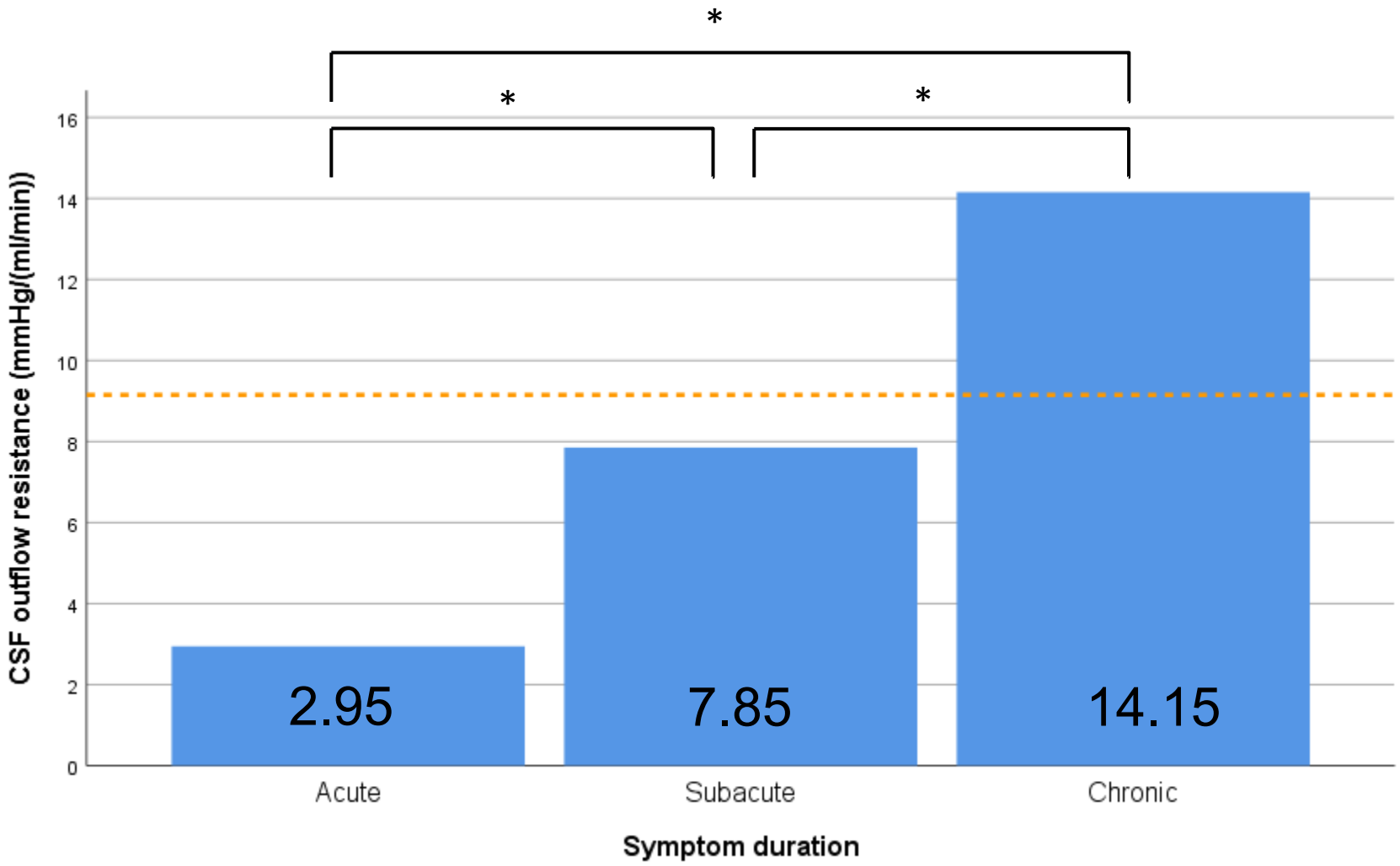
N = 137 lumbar infusion tests

Natural history – resistance to CSF outflow (R_{CSF})



N = 137 lumbar infusion tests

Natural history – resistance to CSF outflow (R_{CSF})

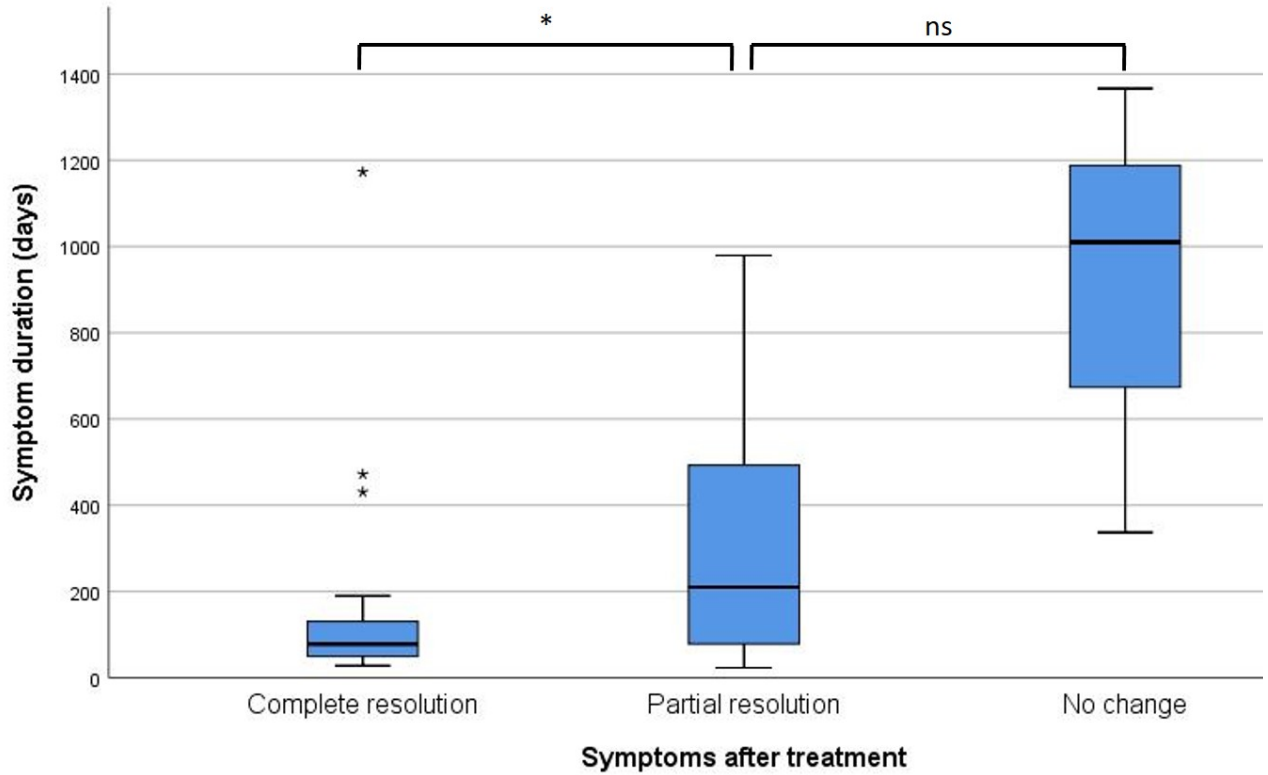


Time matters

... for spinal leaks

Outcome after surgical treatment of cerebrospinal fluid leaks in spontaneous intracranial hypotension—a matter of time

Levin Häni[1] · Christian Fung[2] · Christopher Marvin Jesse[1] · Christian Thomas Ulrich[3] · Eike Immo Piechowiak[4] · Jan Gralla[4] · Andreas Raabe[1] · Tomas Dobrocky[4] · Jürgen Beck[2]



- Duration most powerful predictor for good outcome
- **12 weeks** as a cutoff

Häni et al. J Neurol 2021

RESEARCH ARTICLE

CSF Pressure and Dynamics in Patients With Chronic Postdural Puncture Headache

A Single-Center Cohort Study

Christian Fung,[1,1]* Luisa Mona Kraus,[1,2,2]* Amir El Rahal,[1] Levin Haeni,[1] Florian Volz,[1] Katharina Wolf,[1] Mukesch Johannes Shah,[1] Horst Urbach,[3] Niklas Lützen,[3] and Jürgen Beck[1]

Neurology® 2025;105:e213998.

FREIBURG CSF CENTER

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Patients with a history of intentional or accidental dural puncture (N = 76)

Excluded (n = 53):
- Patient had prior lumbar surgery for disk herniation (1)
- Patients refused LIT because of fear of additional LP (19)
- LIT was not performed (n = 33):
  - Admitted for EBP only (27)
  - No staff was available (6)

R_{CSF}
ICP_{base}
ICP_{plat}
AMP_{base}
AMP_{plat}
Elastance
PVI

Patients with CSF study (n = 23)

Excluded (n = 2):
- Data set not available because of technical error (1)
- Study terminated due to paresthesia (1)

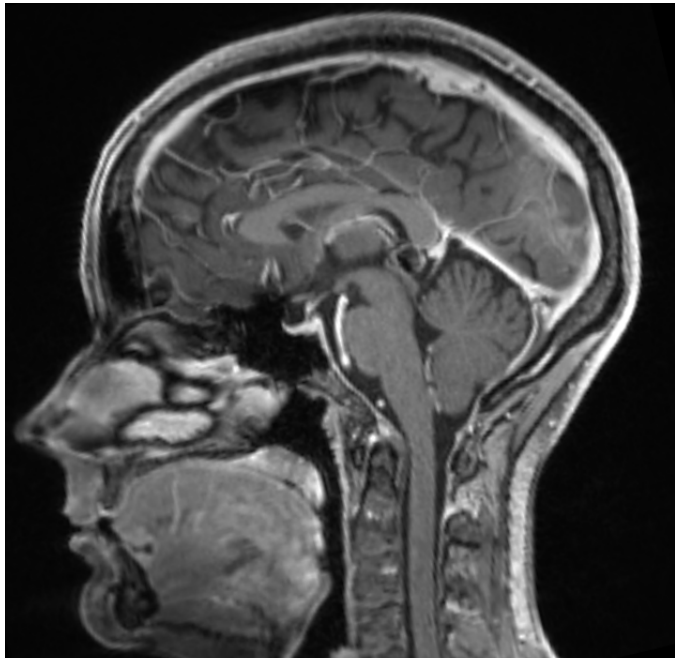
Data sets available (n = 21)

Table 1 Epidemiologic Data

	N = 21	%
Sex		
Female	19	90
Male	2	10
Age, y, median (IQR)	39 (30–49)	
Reason for dural puncture		
Diagnostic lumbar puncture	15	71
Peridural anesthesia	4	19
Other epidural puncture	2	10
Symptom duration, mo, median (IQR)	21 (9–34)	
No. of EBPs, median (IQR)	3 (1–4)	

Abbreviations: EBP = epidural blood patch; IQR = interquartile range.

Median Bern Score = 1



Normal brain MRI

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Table 2 LIT Data

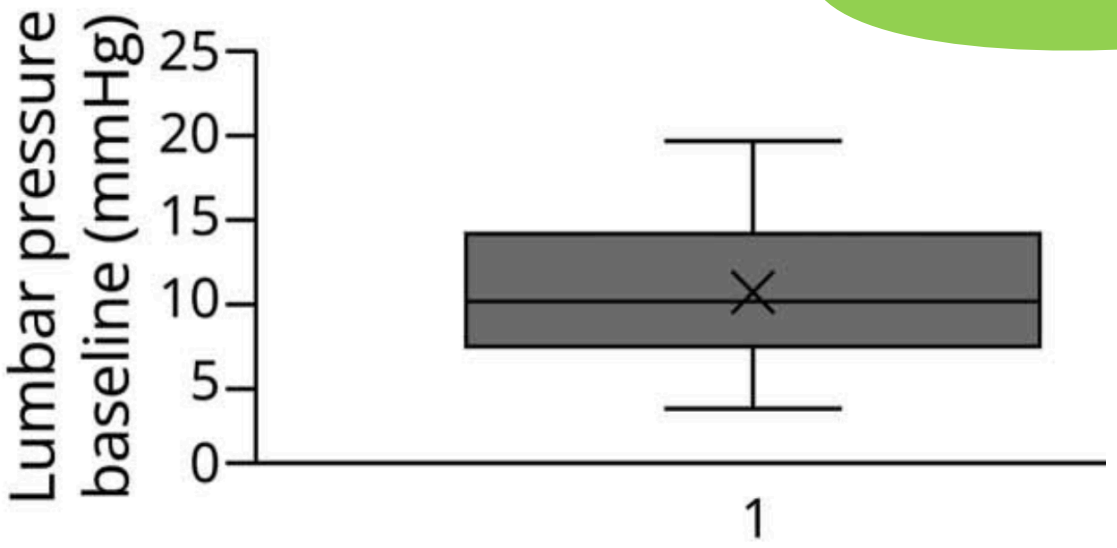
	N	Min	Max	Mean	SE	SD	Variance	Median	25	50	75
R_{CSF} (mm Hg/[mL/min])	21	5.48	22.99	11.00	0.97	4.45	19.51	10.77	6.79	10.77	13.78
Lumbar pressure baseline (mm Hg)	21	3.33	19.70	10.51	1.03	4.70	20.54	9.84	7.24	9.84	14.05
Lumbar pressure plateau (mm Hg)	21	17.70	47.06	30.06	1.80	8.27	65.64	30.73	22.34	30.73	37.21
$AMP_{baseline}$ (mm Hg)	21	0.01	1.37	0.33	0.08	0.37	0.14	0.21	0.04	0.21	0.41
$AMP_{plateau}$ (mm Hg)	21	0.24	26.77	3.14	1.22	5.61	31.47	1.48	0.93	1.48	2.74
Elastance coefficient (mL^{-1})	20	0.01	0.92	0.22	0.04	0.19	0.04	0.17	0.13	0.17	0.23
PVI (mL)	21	2.50	230.41	23.63	10.43	47.79	2,283.91	13.47	9.62	13.47	18.47

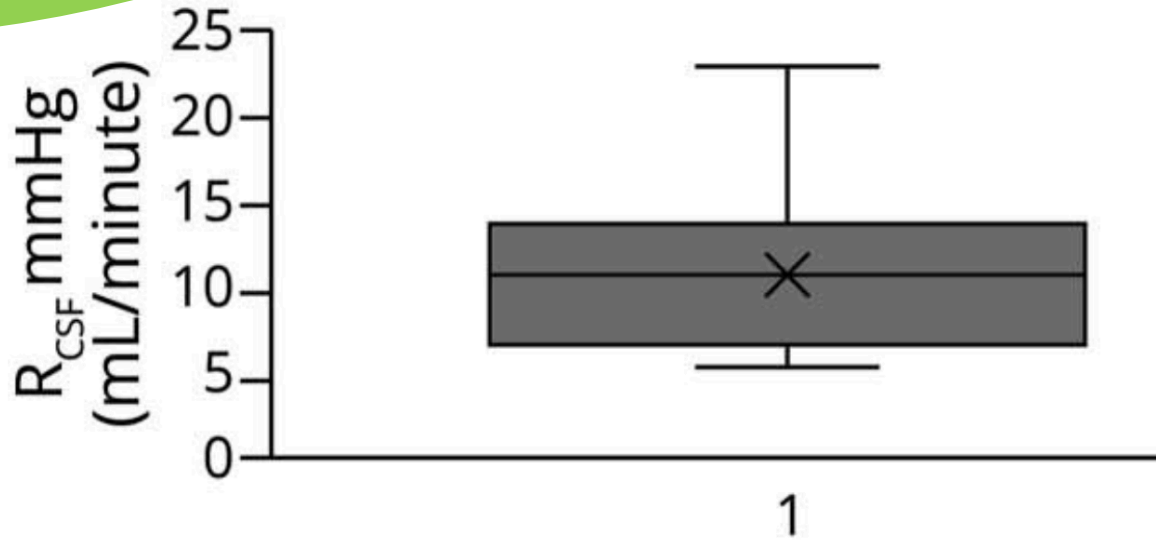
Abbreviations: $AMP_{baseline}$ = amplitude at baseline; $AMP_{plateau}$ = amplitude at plateau; LIT = lumbar infusion test; PVI = pressure-volume index; R_{CSF} = resistance to CSF outflow.

RESEARCH ARTICLE

CSF Pressure and Dynamics in Patients With Chronic Postdural Puncture Headache

normal !





Lumbar pressure

R_{CSF}out

Fung et al. Neurology 2025

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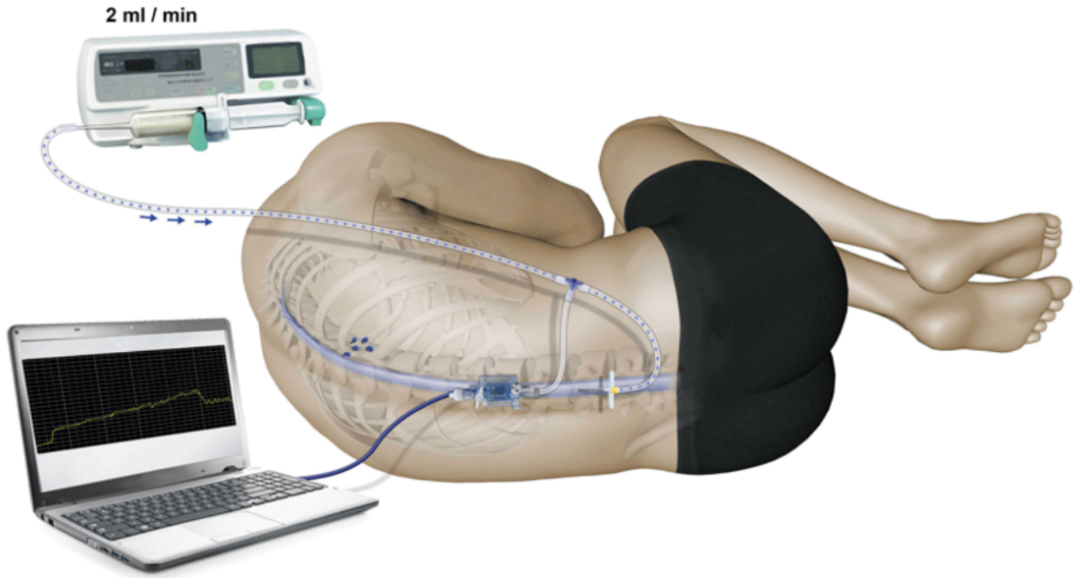
Diagnostics ? CSF dynamics?



R_{CSF} out is not related to cPDPH

Fung et al. Neurology 2025

RESEARCH ARTICLE

CSF Pressure and Dynamics in Patients With Chronic Postdural Puncture Headache

cPDPH does not seem to be related to

- **a measurable CSF leak**
- **low CSF pressure**
- **CSF depletion**
- **a reduced outflow resistance**

Dynamic myelography / CT-myelography

- **there was no leak on imaging**

Fung et al. Neurology 2025

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PDPH as a CSF hypotension state ?

TABLE IV

SUMMARY OF DIFFERENCE BETWEEN CEREBROSPINAL FLUID PRESSURE AT FIRST AND SECOND LUMBAR PUNCTURE IN RELATION TO HEADACHE

Headache	Pressure Decreased	Pressure Unchanged or Increased	Total
Present ..	4	1	5
Absent ..	20	17	37
Total ..	24	18	42

Marshall J. Lumbar-puncture headache.
J Neurol Neurosurg Psychiatry. 1950; 13: 71-74

*Smith et al 2019: „Risk of PDPH does not appear to be influenced by **opening pressure**, CSF pressure, volume or **pressure-volume-index**"*

EDITORIAL

Acute and Chronic CSF Dynamics Disorders Are Not the Same: Mechanistic Insights From Postdural Puncture Headache

Jeremy K. Cutsforth-Gregory

Neurology® 2025;105:e214152.

Correspondence
Dr. Cutsforth-Gregory
jeremycg@mayo.edu

... should not be that PDPH is not due to active CSF leakage

... patients can still have symptoms even when all the signs we ***currently*** know to identify a leak are normal.

EDITORIAL

Acute and Chronic CSF Dynamics Disorders Are Not the Same: Mechanistic Insights From Postdural Puncture Headache

Jeremy K. Cutsforth-Gregory

Neurology® 2025;105:e214152.

Correspondence
Dr. Cutsforth-Gregory
jeremycg@mayo.edu

(1) Normal CSF opening pressure does not rule out PDPH or SIH

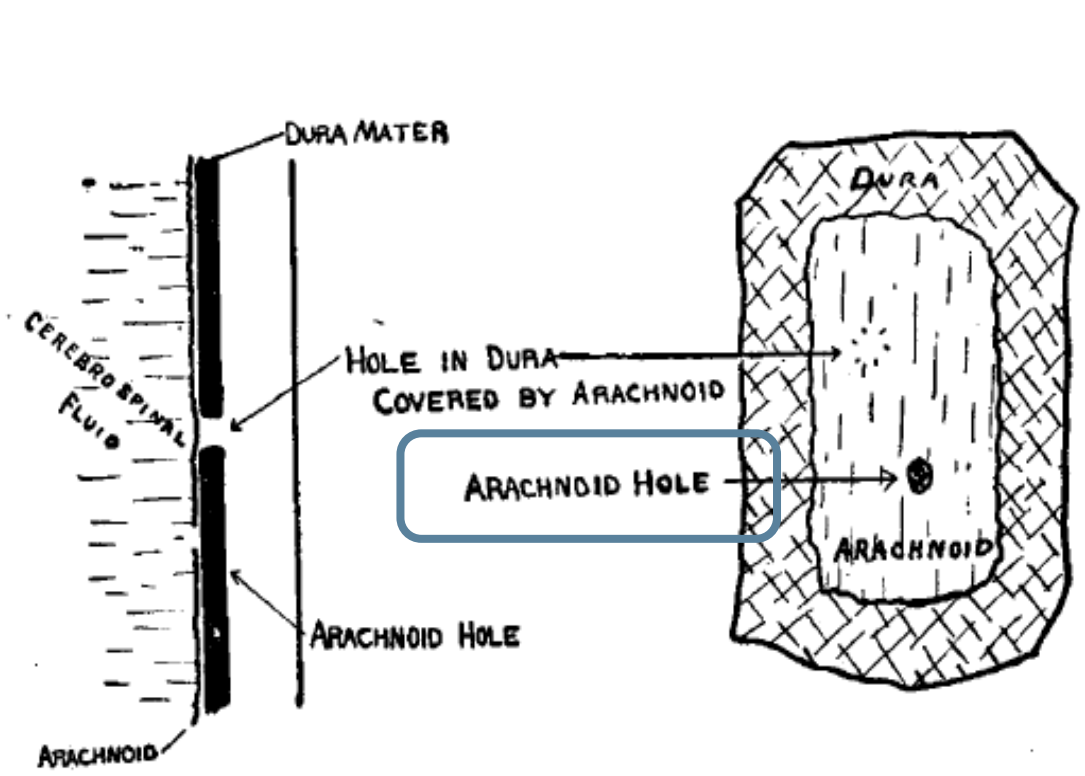
(2) A low Bern score (nearly normal brain MRI) does not rule out PDPH or SIH

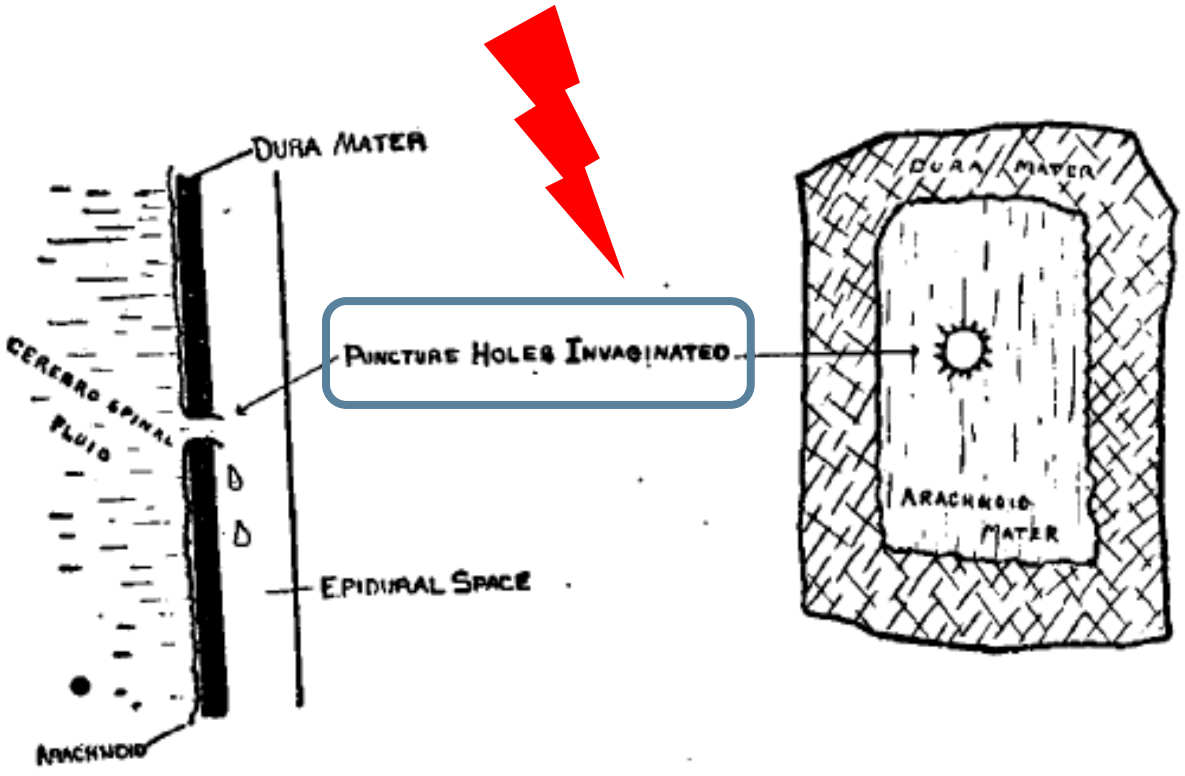
(3) Epidural blood patching may help patients with suspected spinal CSF leak even if they do not meet ICHD-3 criteria for SIH

THE CAUSE OF LUMBAR PUNCTURE HEADACHE

RUSSELL G. MACROBERT, M.B. (TOR.)
Associate Physician, Neurological Institute
NEW YORK

JOUR. A. M. A.
MAY 11, 1918





EDITORIAL

Acute and Chronic CSF Dynamics Disorders Are Not the Same: Mechanistic Insights From Postdural Puncture Headache

Jeremy K. Cutsforth-Gregory

Neurology® 2025;105:e214152.

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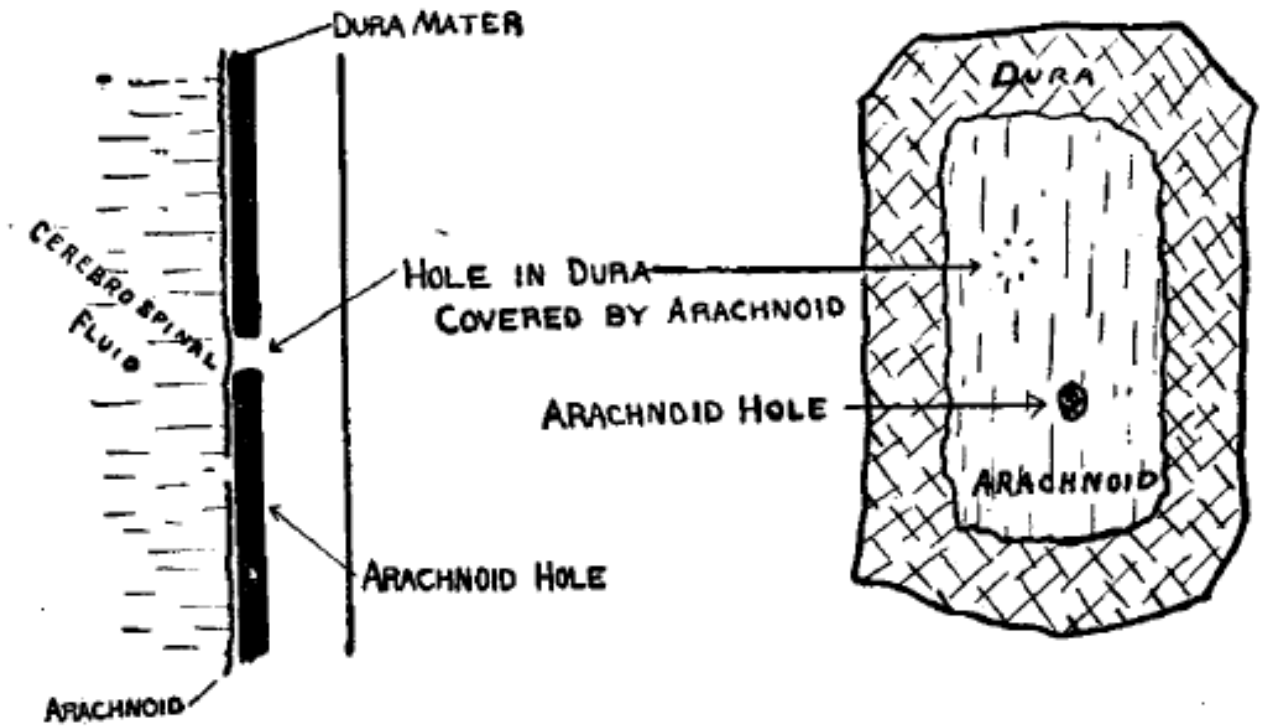
jeremycg@mayo.edu

... Perhaps future work will demonstrate **structural or functional remodeling of the dura** that **occurs over time** and perpetuates orthostatic headache even as certain measures of fluid dynamics normalize ...

RUSSELL G. MACROBERT, M.B. (TOR.)
Associate Physician, Neurological Institute
NEW YORK



JOUR. A. M. A.
MAY 11, 1918

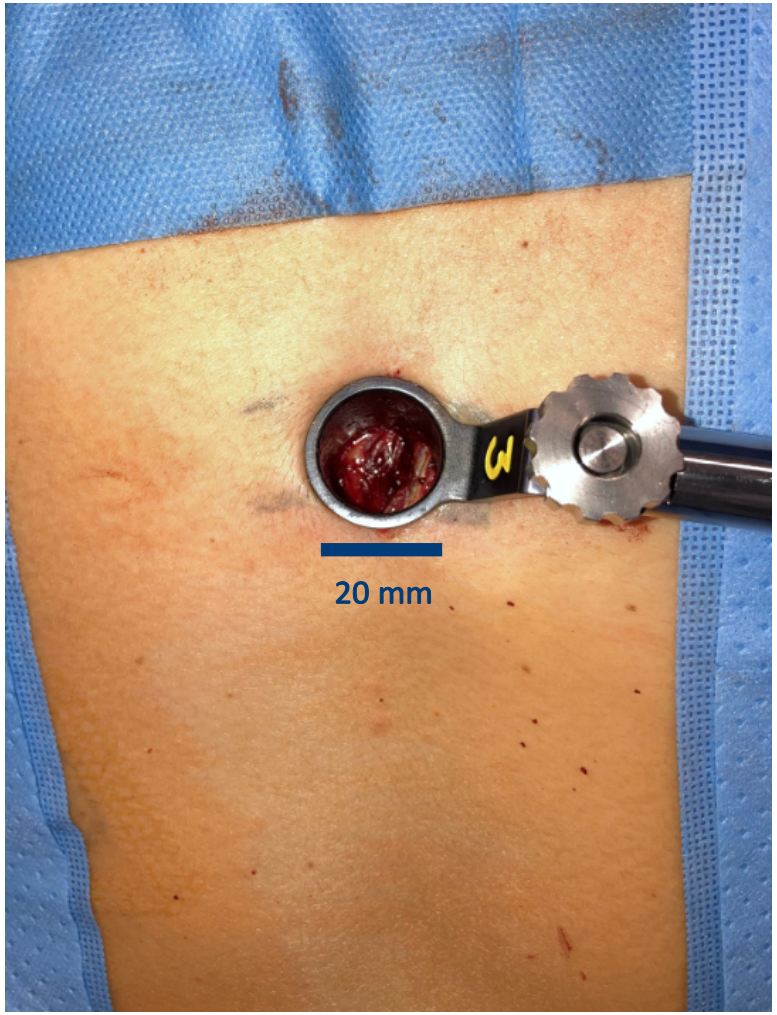
over time ...

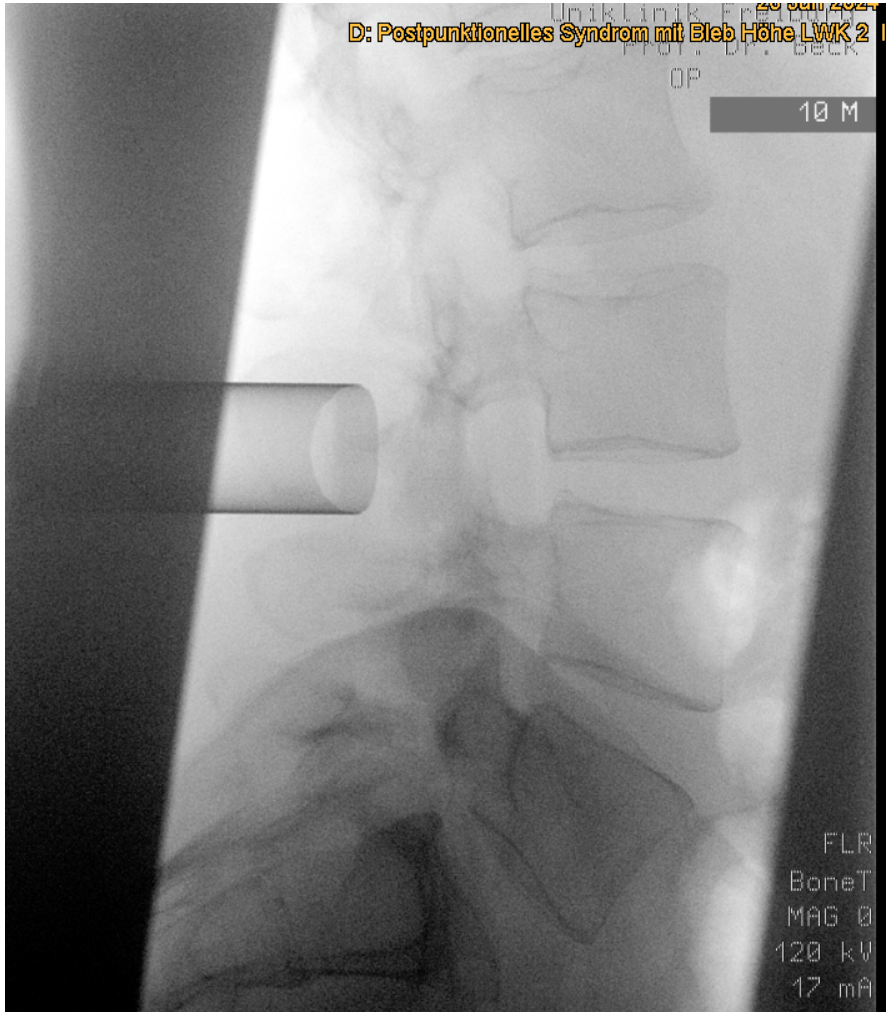
Arachnopathy
Duropathy

What else do we have ?

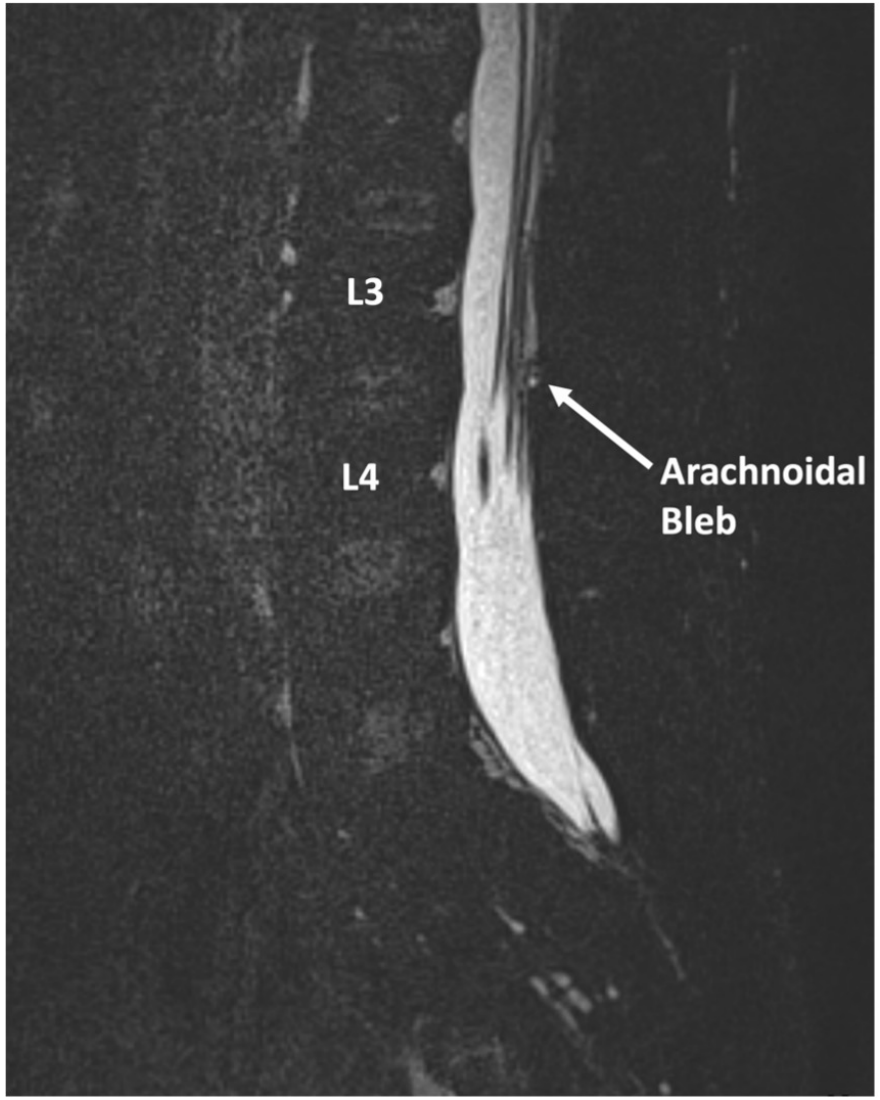
Surgical findings

Surgical findings - Minimal invasive approach





Arachnoid Bleb - Weeping Dura



El Rahal et al. Ox Med Case Rep 2025

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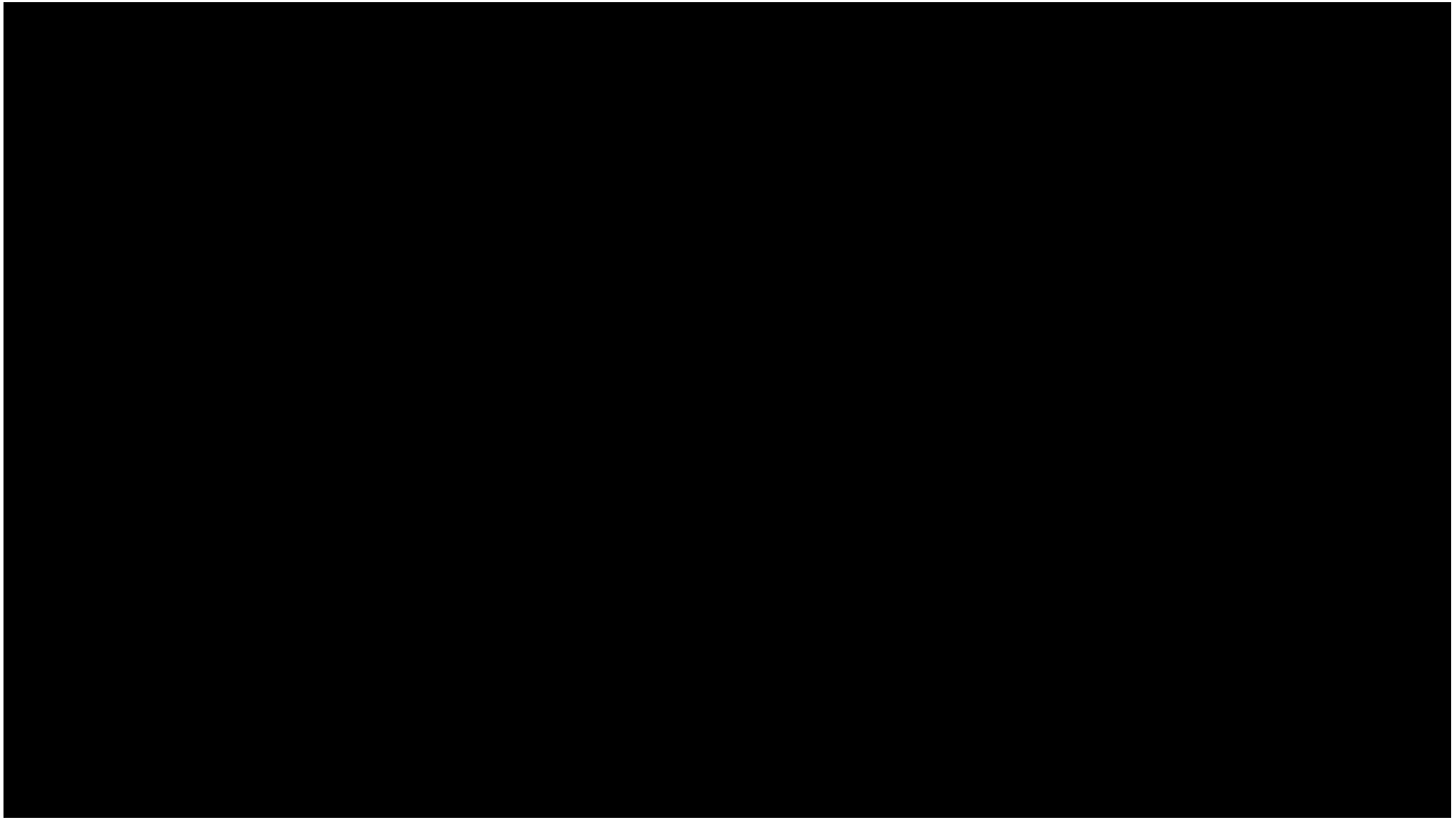
Weeping dura



El Rahal et al. Ox Med Case Rep 2025

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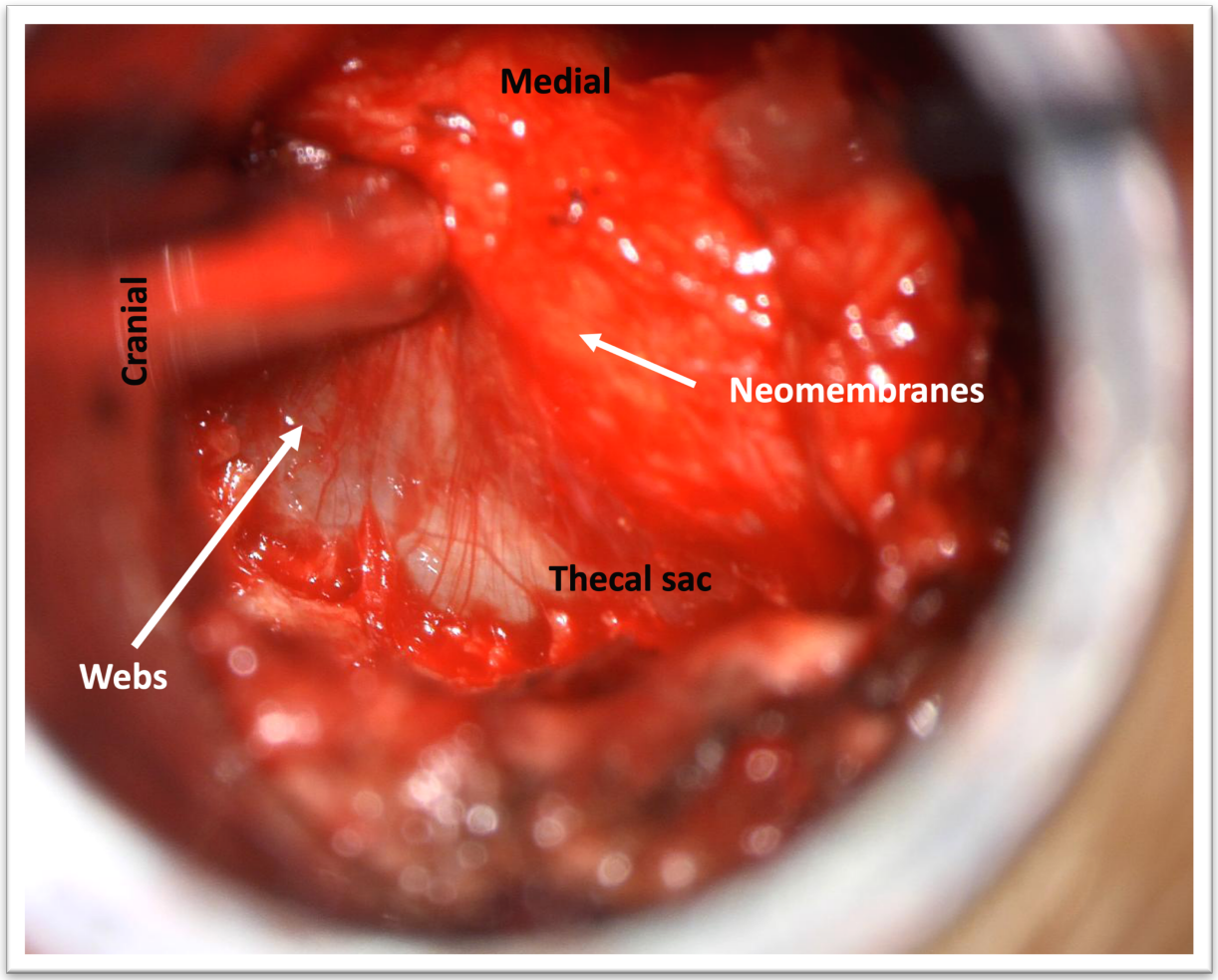
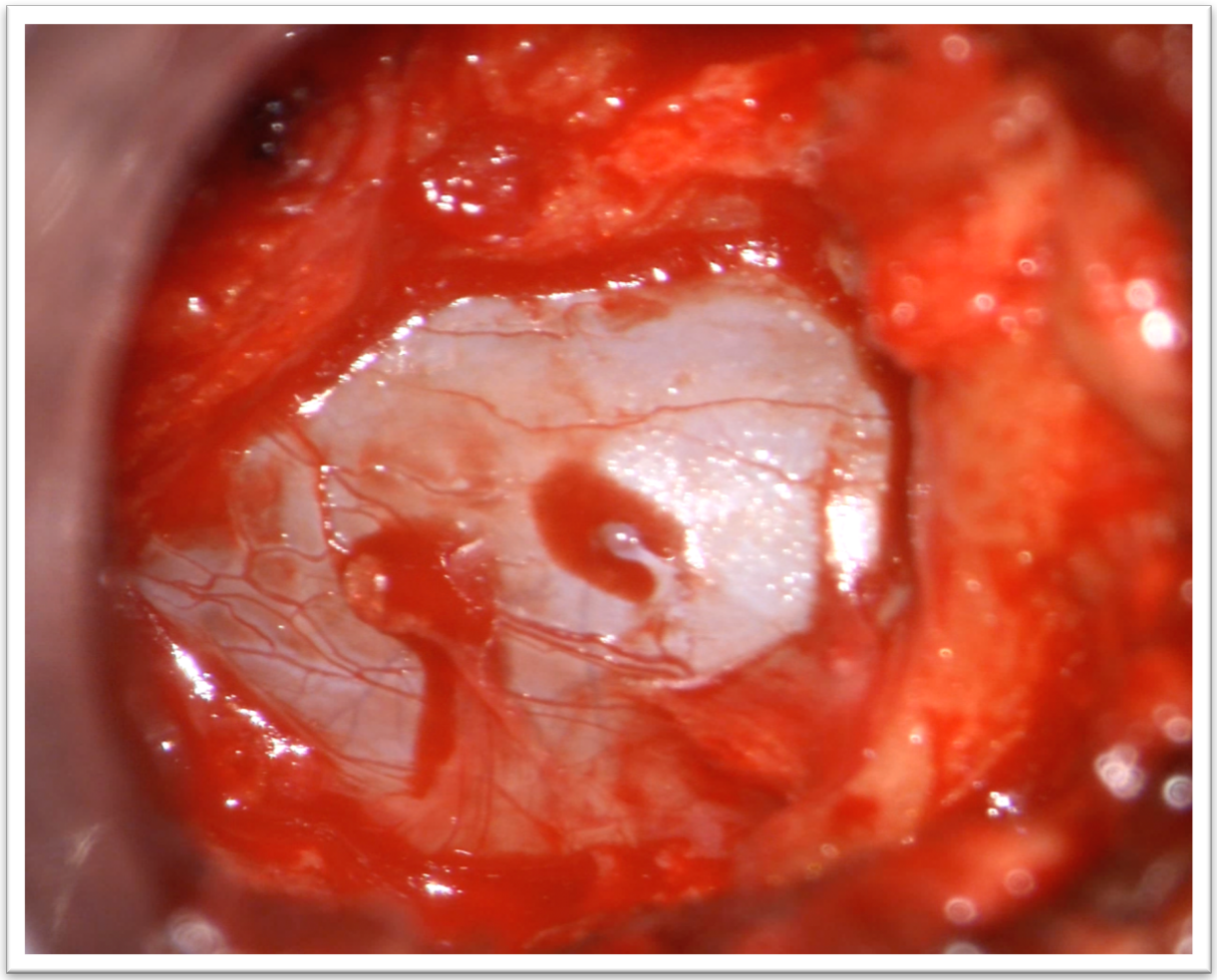
Arachnoid Bleb - Weeping Dura





El Rahal et al. Ox Med Case Rep 2025

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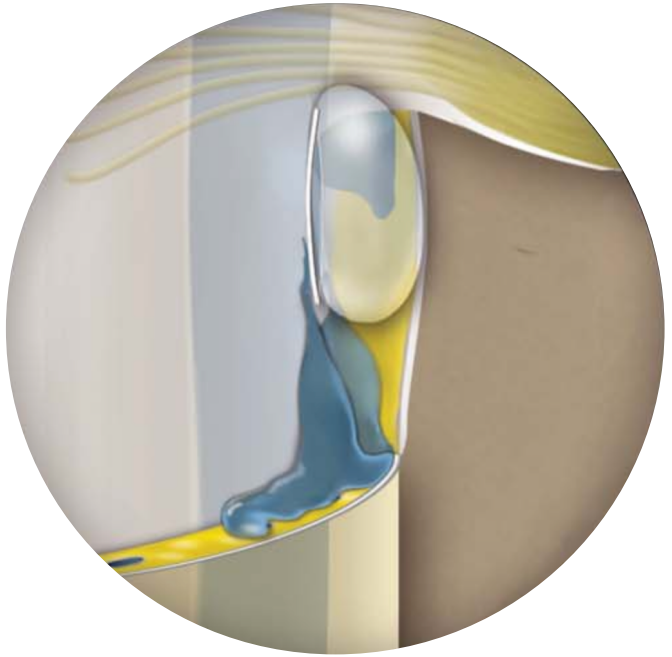
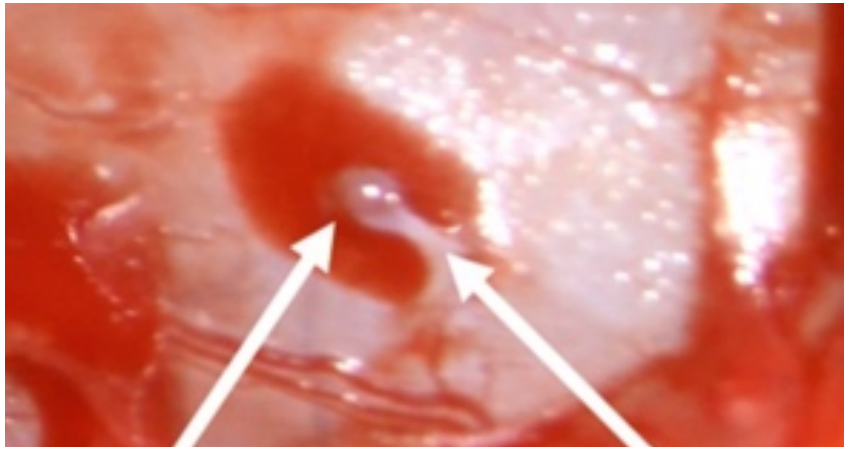
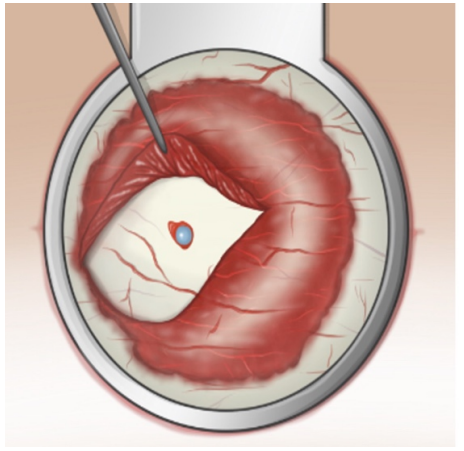


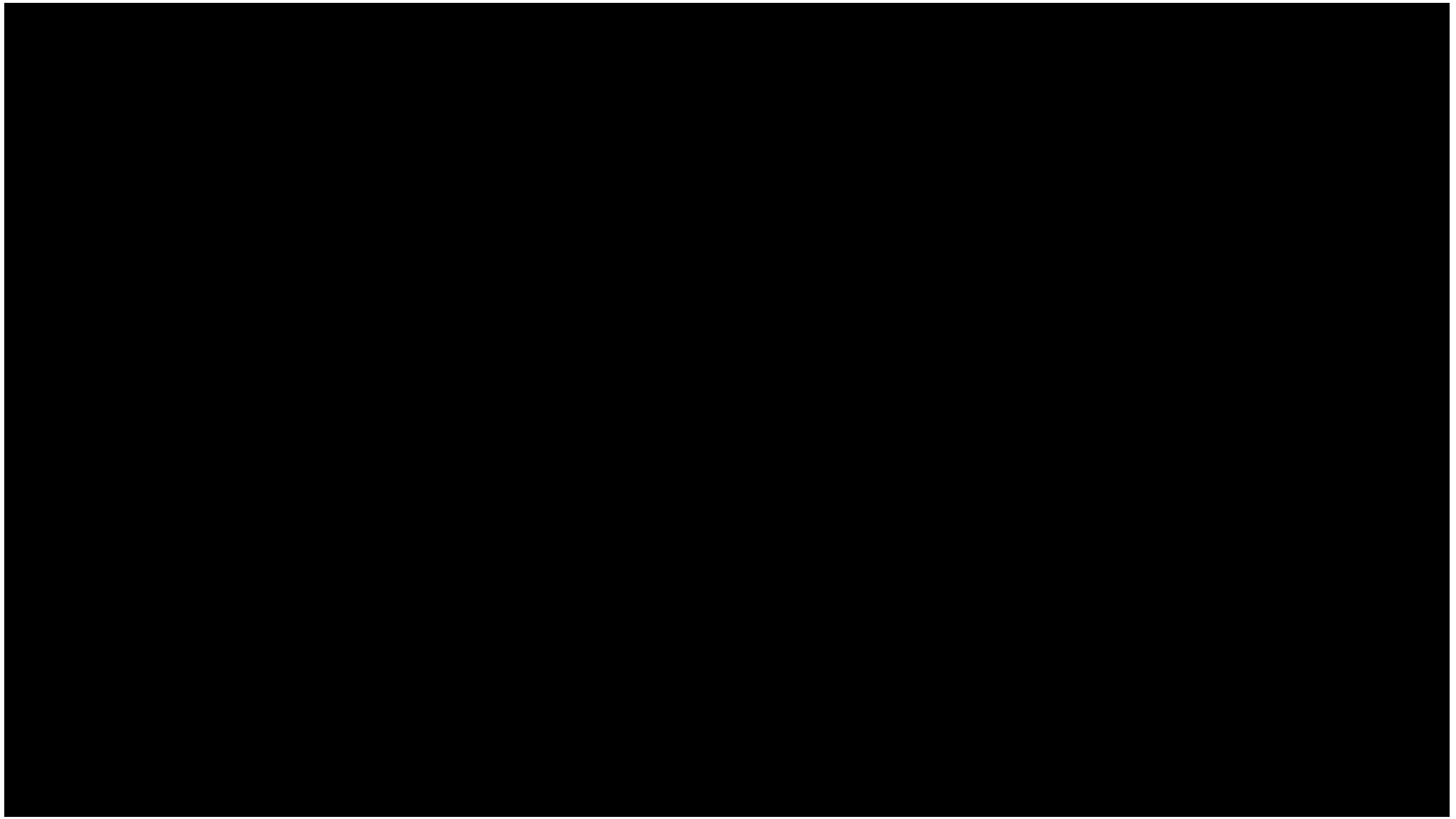
Beck et al. Neurology 2016



El Rahal et al. Ox Med Case Rep 2025



Bleb reduction and Sandwich-Suture



El Rahal, Volz, Beck et al. 2024

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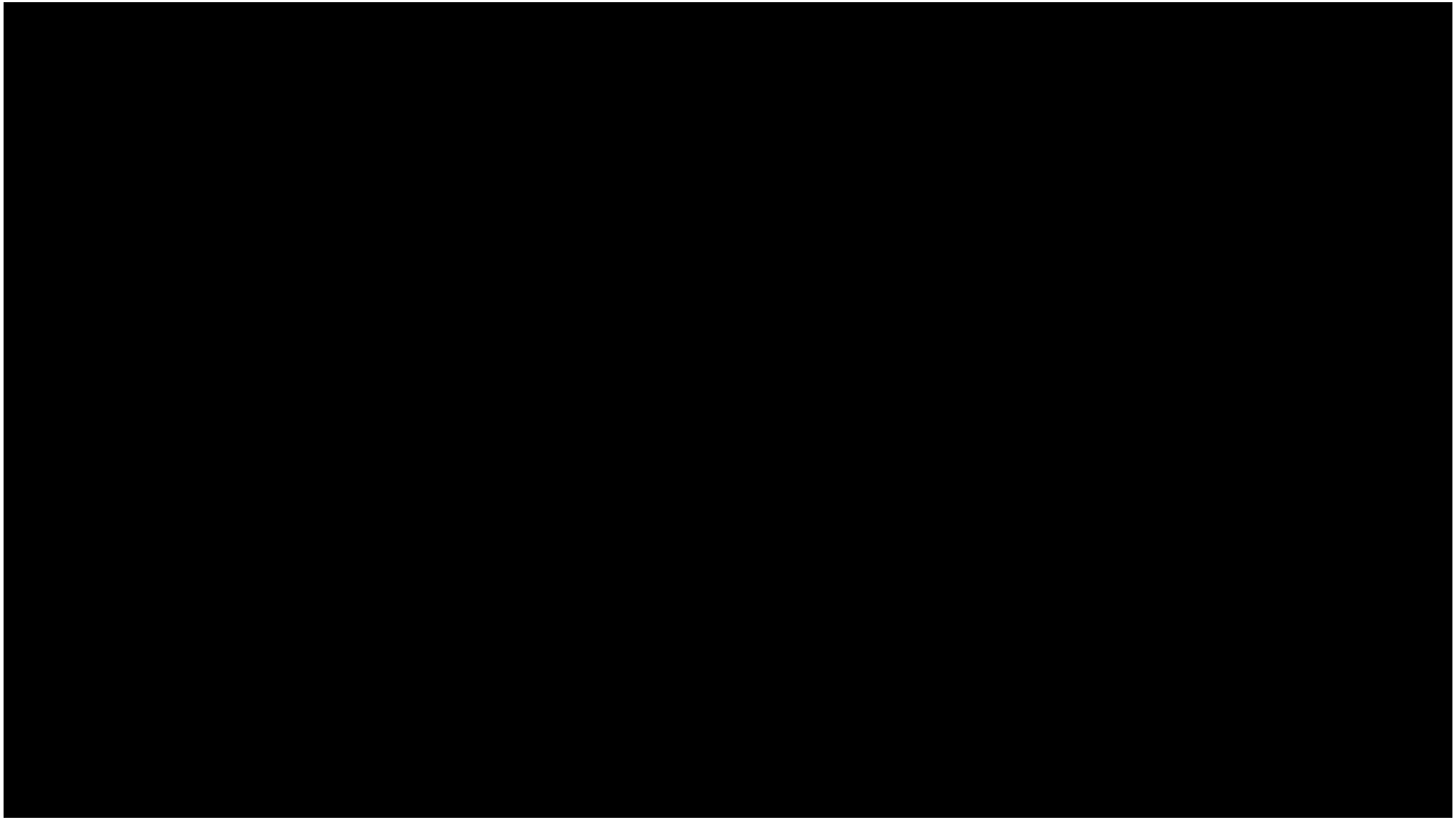
cPDPH – multiple leak – clipping and 360° Patch



El Rahal , Volz, Beck et al. 2024

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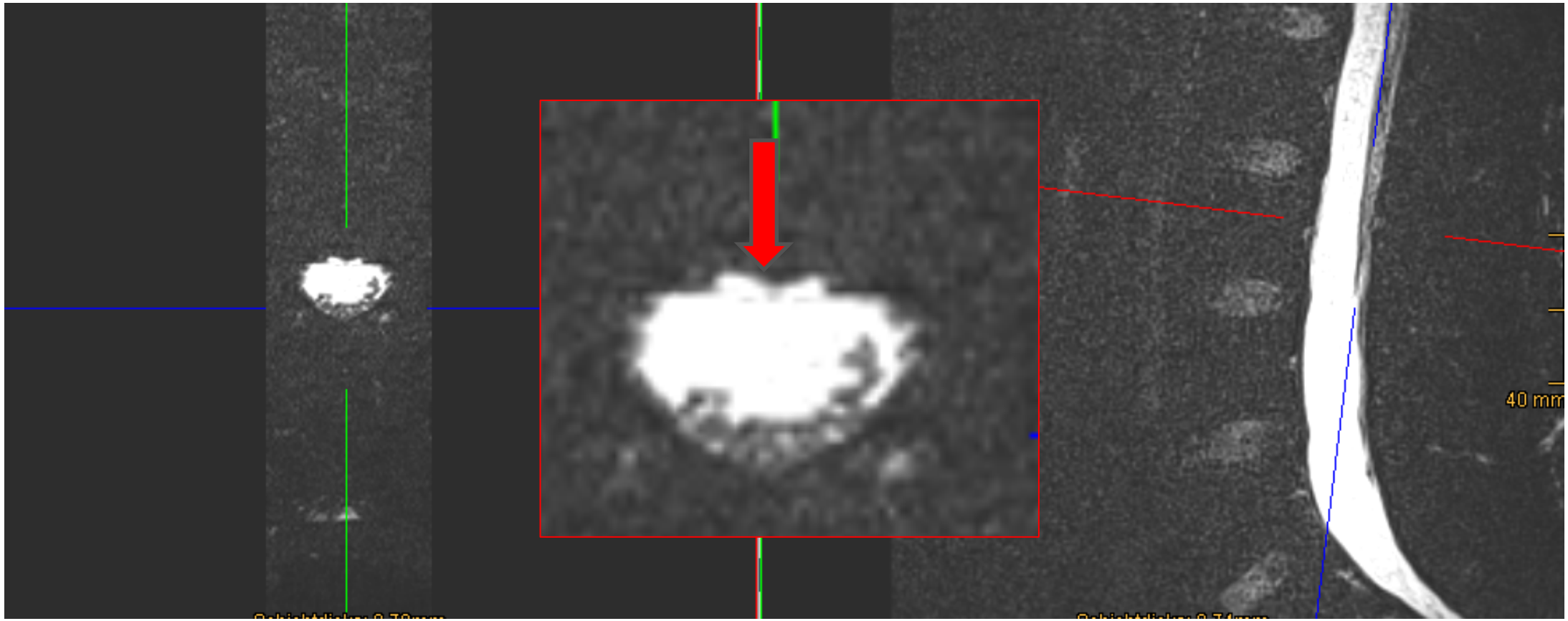
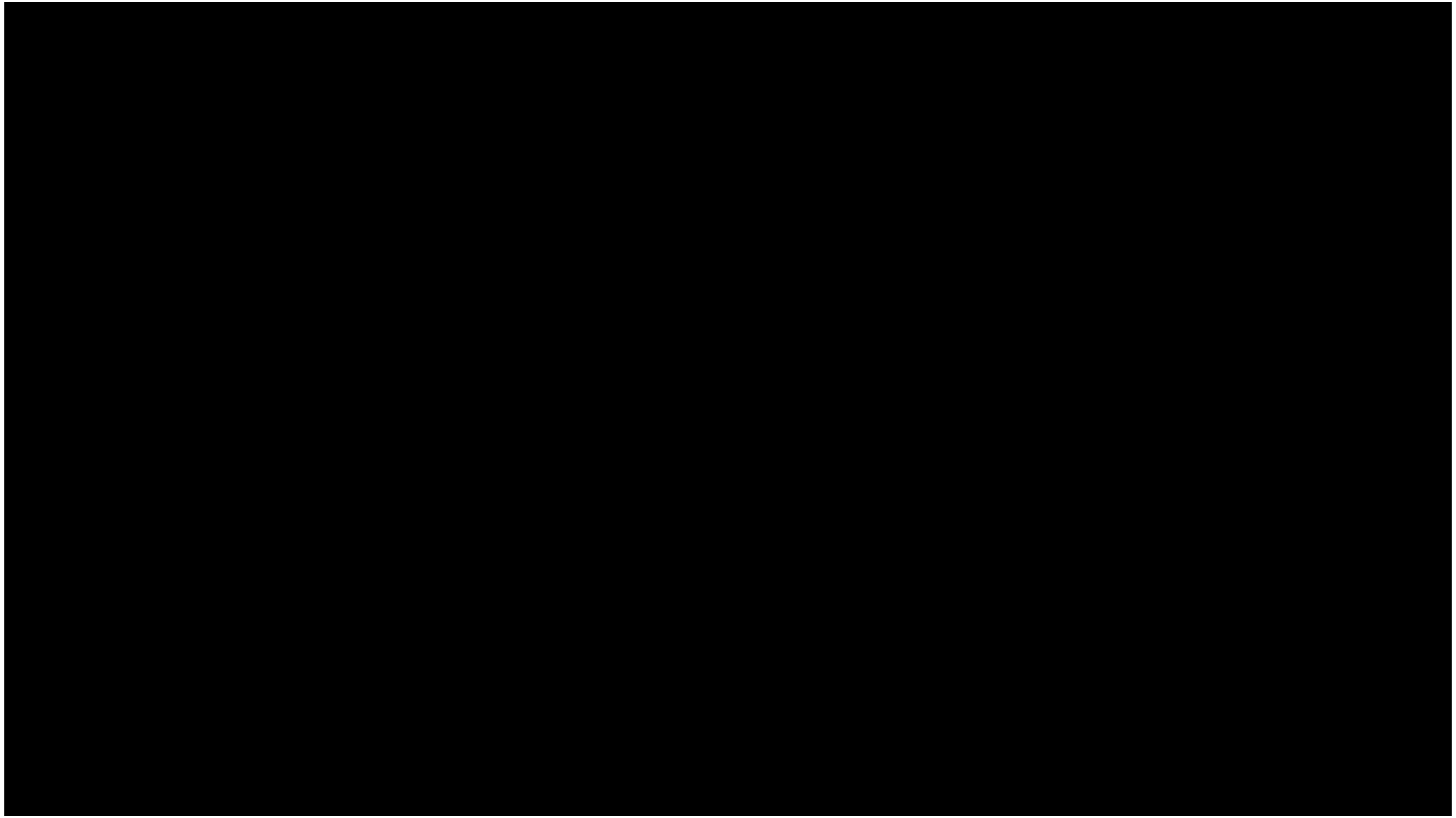
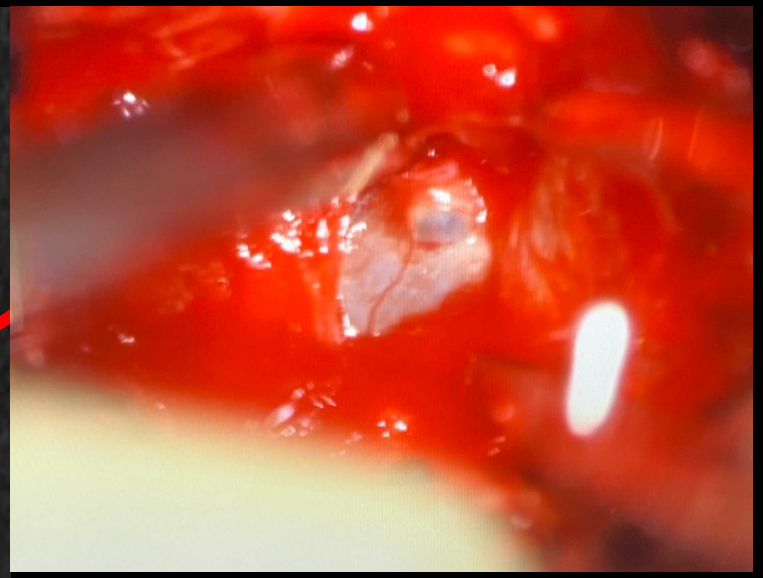
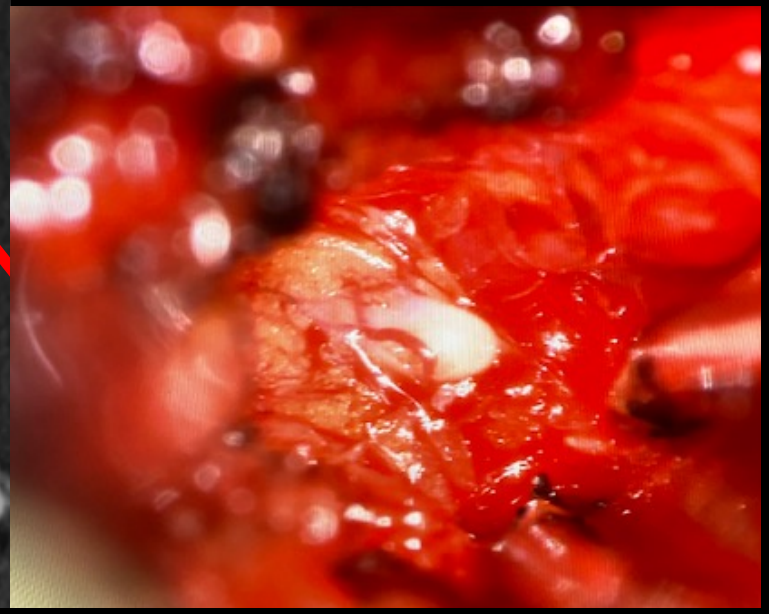

40 mm

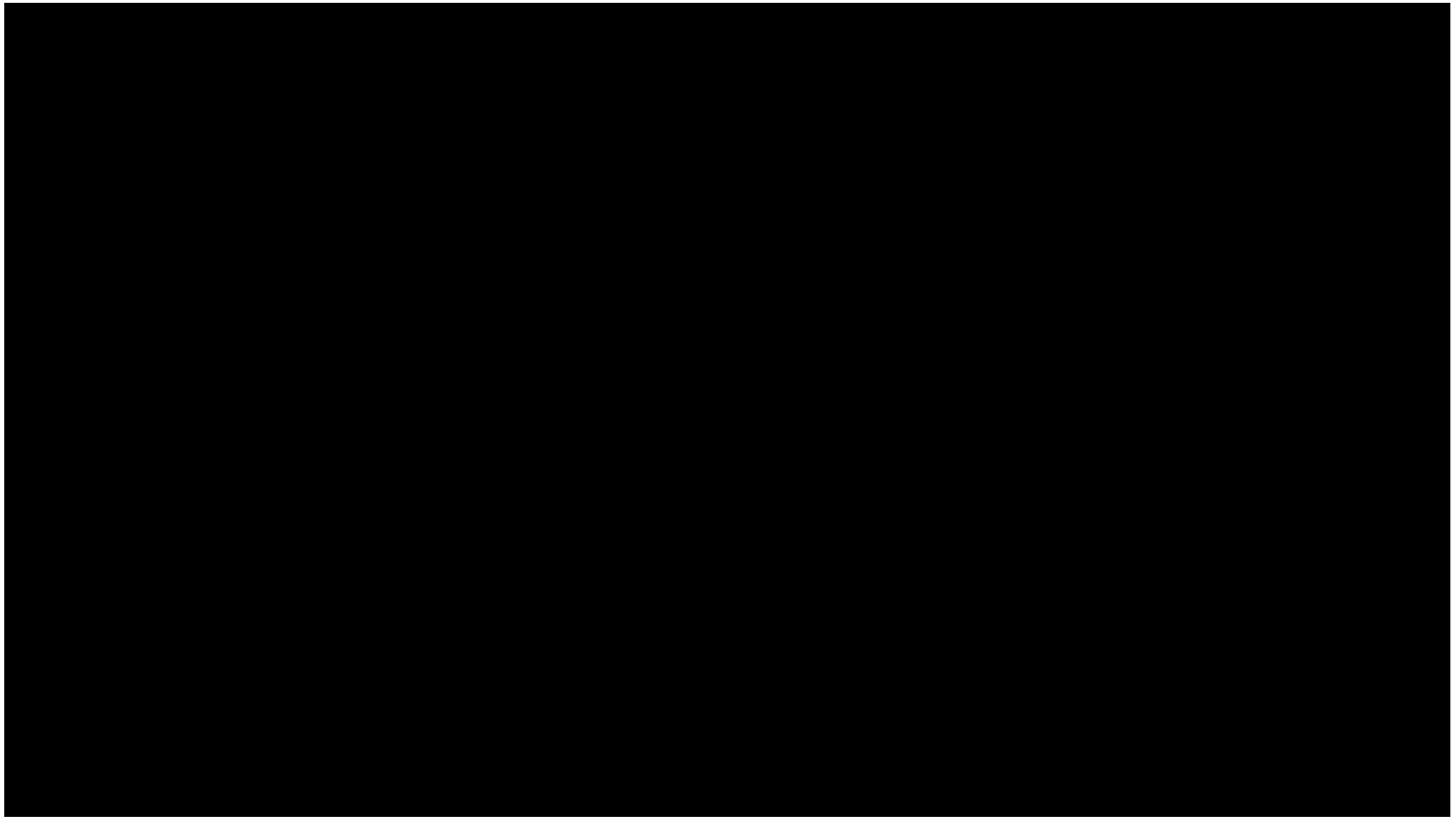
cPDPH – transdural ventral leak



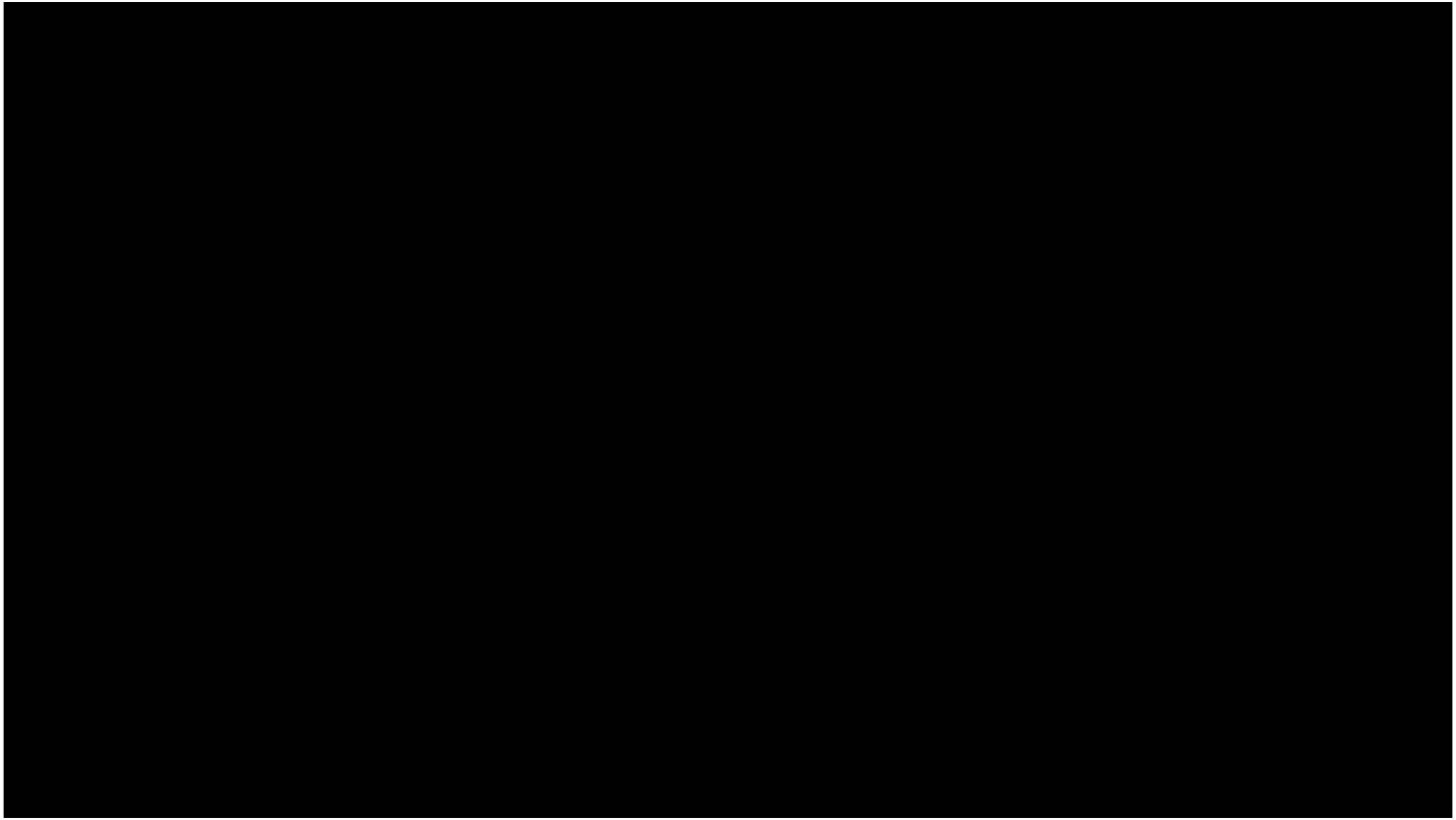




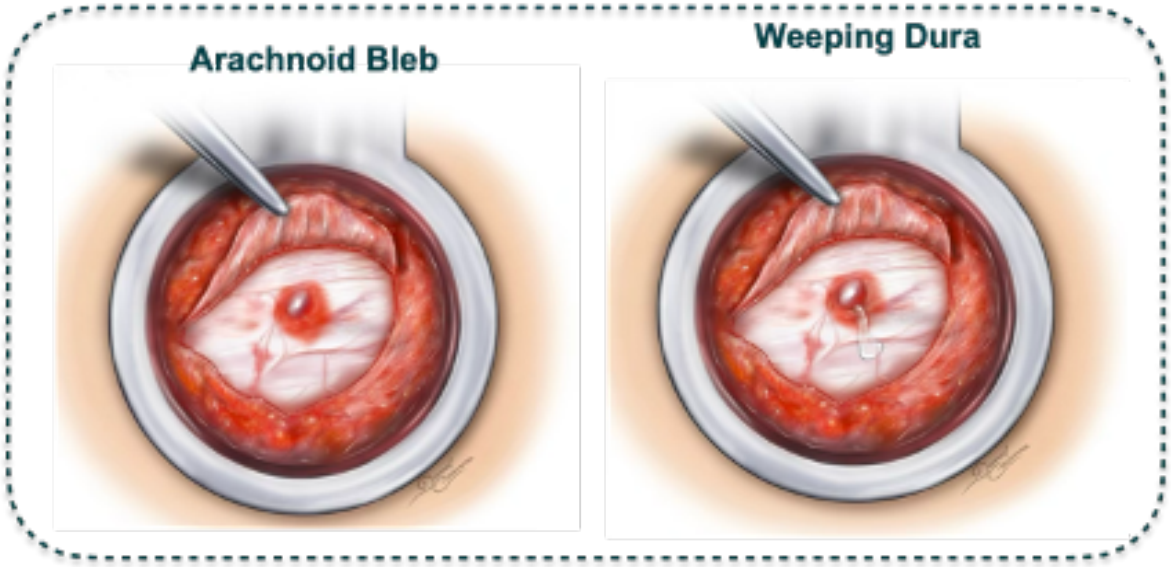
cPDPH – vein on a bleb

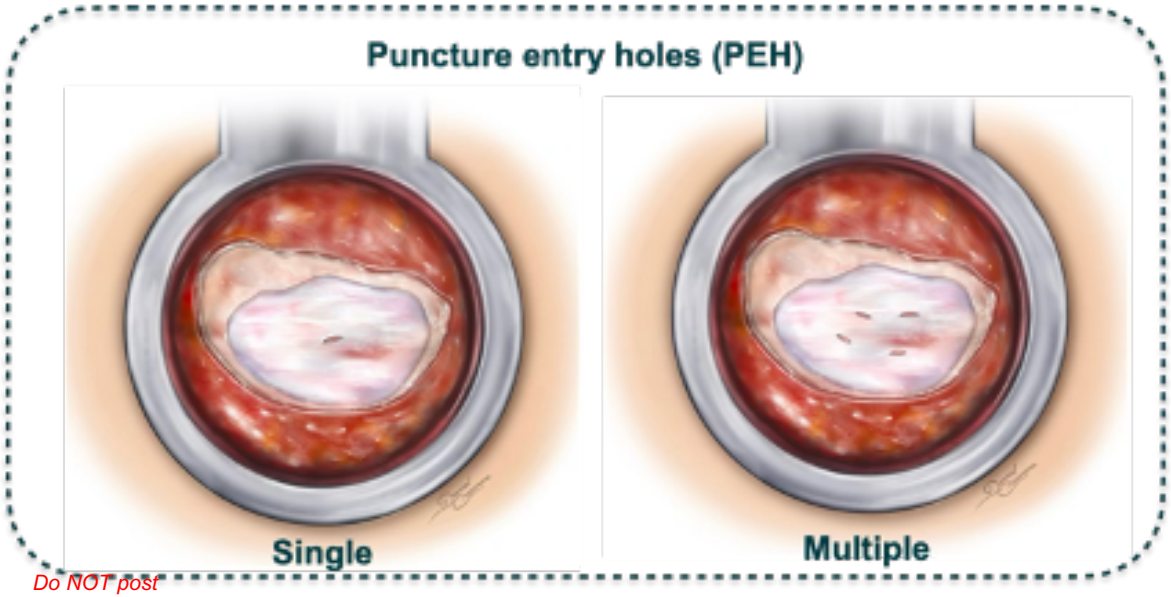


Chronic L4-L5 leak – extensive neo-membranes



PDPH - Surgical anatomy and findings





El Rahal, Volz, Overstijns, Beck et al. unpublished

Do NOT post

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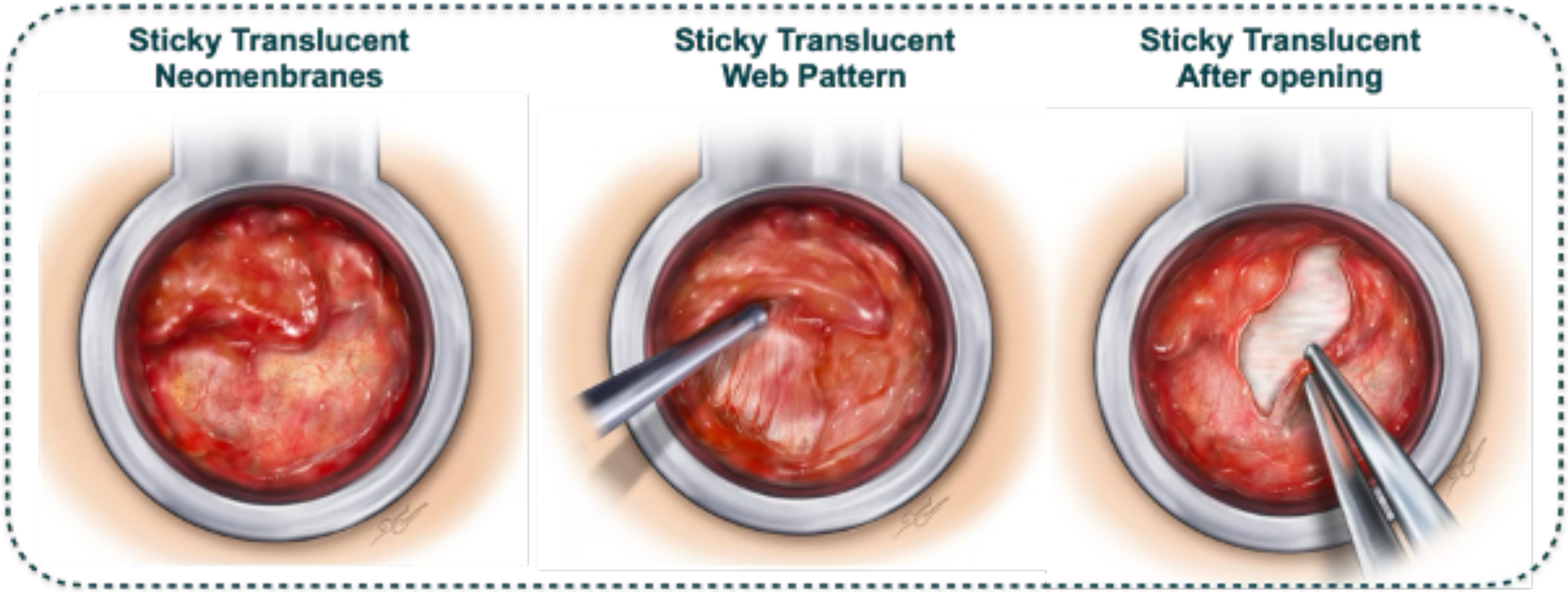
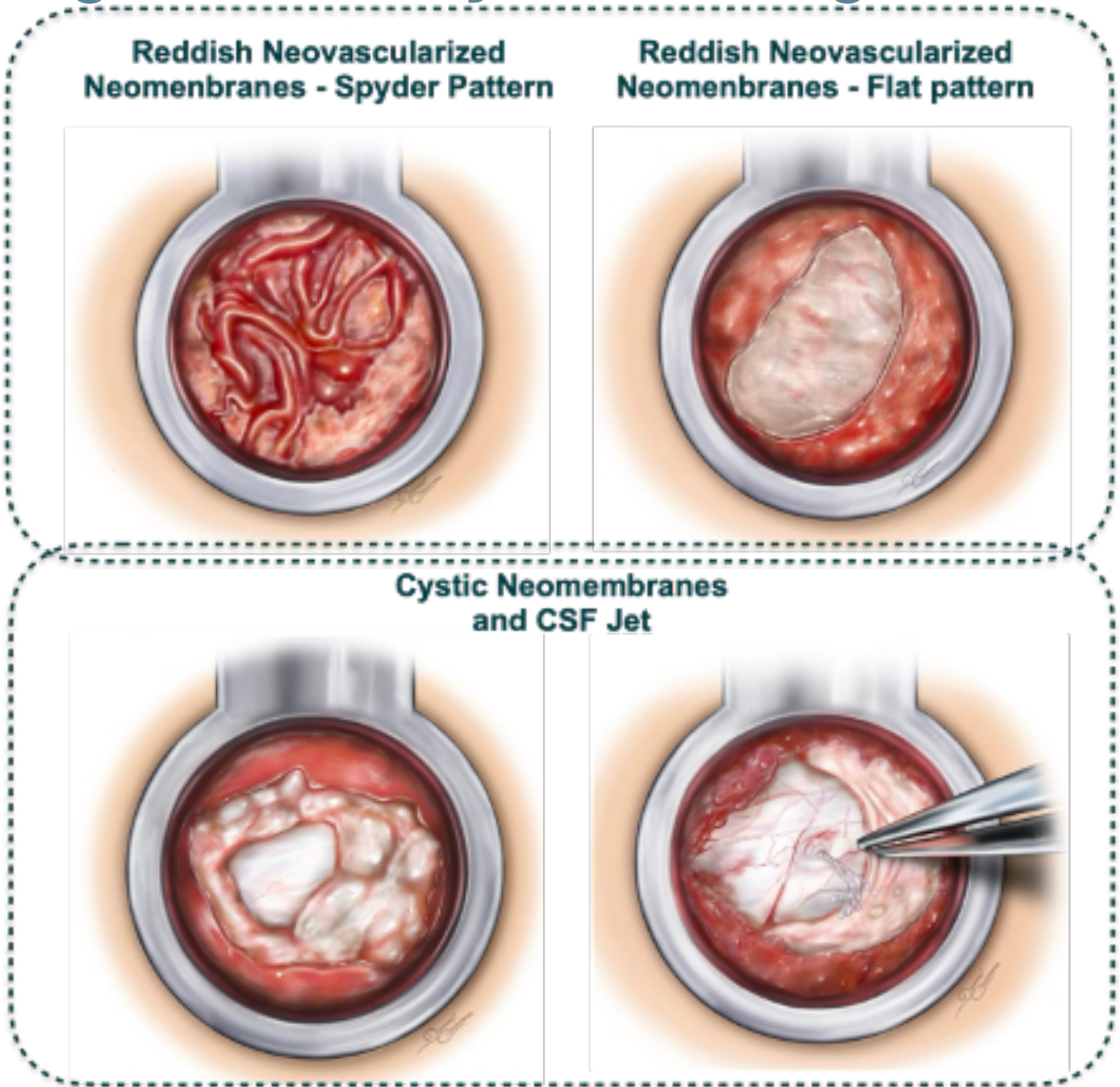
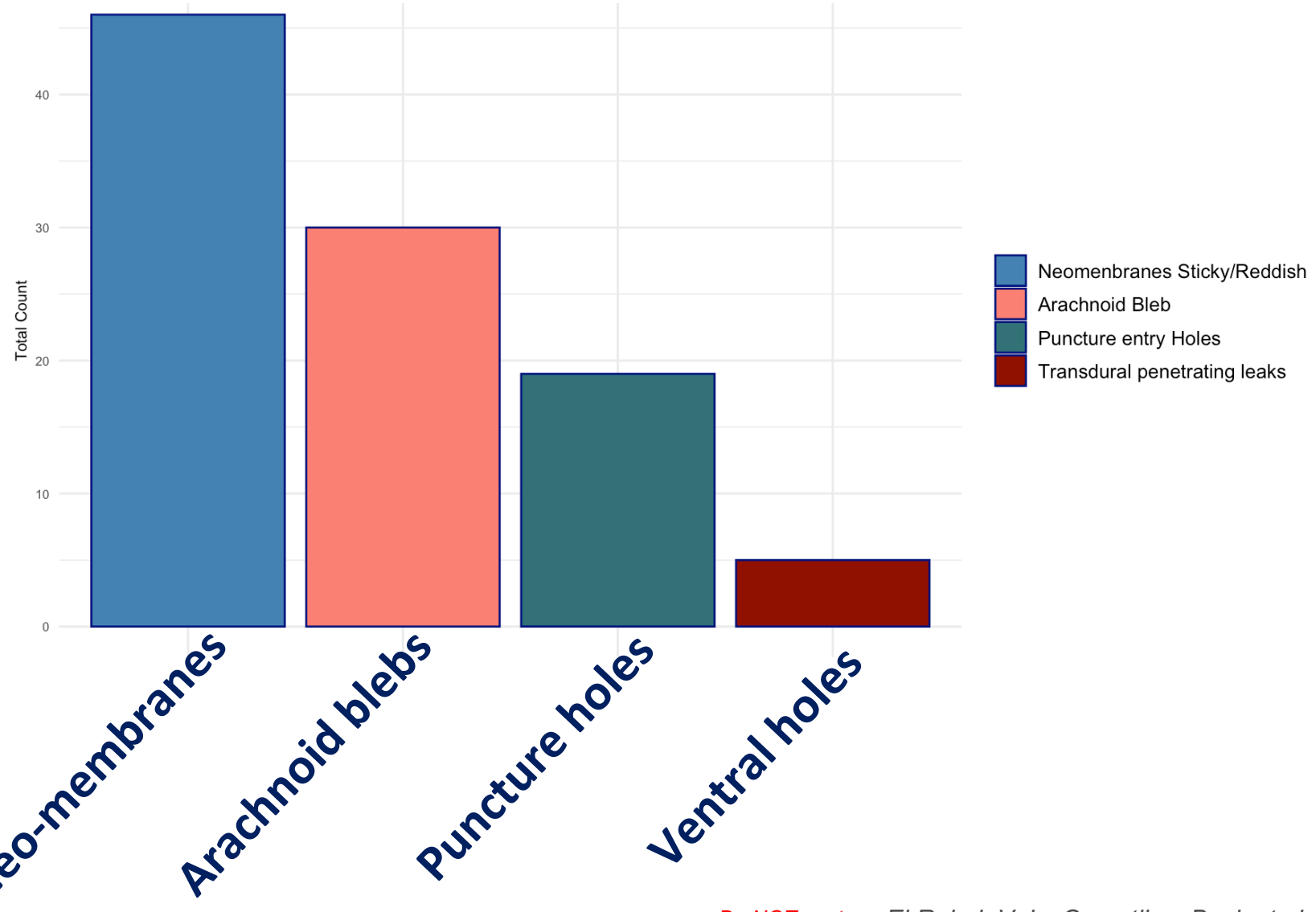
PDPH - Surgical anatomy and findings



PDPH - Surgical anatomy and findings



PDPH – **micro-surgical anatomy** and findings



El Rahal, Volz, Overstijns, Beck et al. unpublished

cPDPH – pathophysiology

leaking – oozing/weeping – ↑absorbtion

arachnopathy - duropathy

metabolic syndrom

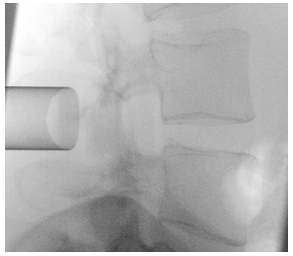
central syndrom

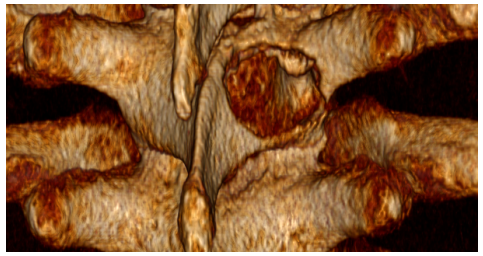
cPDPH

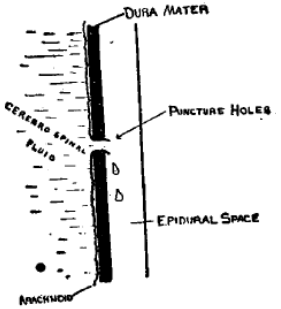
1. Not a benign disease
2. Best managed in specialized centers
3. International collaborations

cPDPH Program – Surgery for PDPH – Freiburg CSF-Center

1. **Resect pathology** – neo membranes and pathological vessels
2. **Respect arachnoid** – key element to prevent CSF leaking / oozing
3. **Restore anatomy** – rebuild layers and augment dura







cPDPH Program – Freiburg CSF-Center

IMAGING

MRI:
- Whole brain
- Heavily T2 spine MRI
- Arachnoidal blep
- Epidural fluid
- Cine motion MR

Optional
- Dynamic myelogram
- Dynamic CT-myelo
- Ga-CSF PET and Infusion testing

CLINCAL SPECTRUM

The Freiburg SIH/pPDPH Inventory

Neuro-psychological evaluation

PROMs

Smart device - health profile

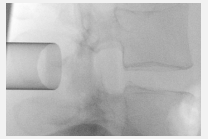
Sleep monitoring

TARGETED TREATMENT

Epidural blood patches

Multi-disciplinary Team
CSF-Board decision

Multilevel - **MIS minimal invasive surgical exploration**



SUPPORTIVE TREATMENT

Interdisciplinary multimodal pain treatment

PROMS
Outpatient visists

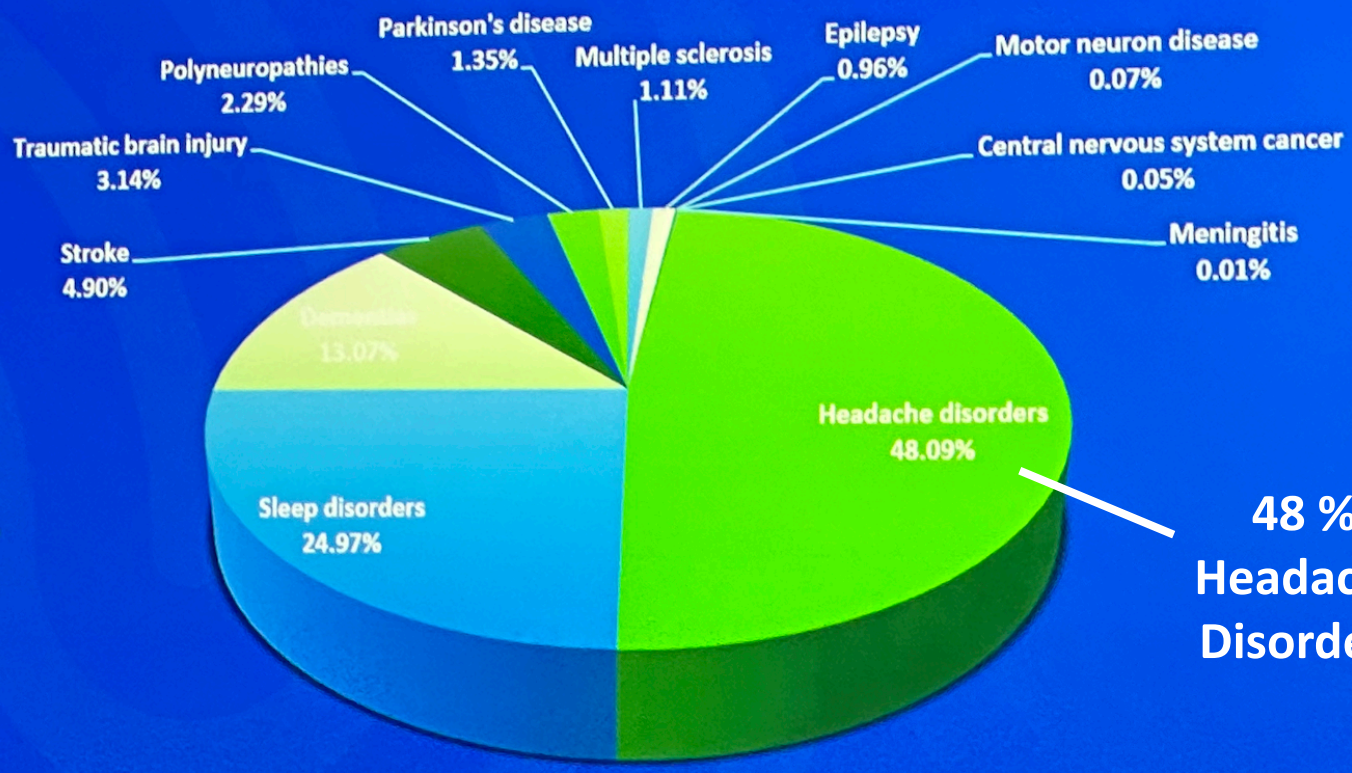
LONG-TERM FOLLOW-UP & OUTCOME EVALUATION

COIN-EU (Cost of Illness in Neurology in Europe) Project

Annual Total Costs per Disease (Purchase Power Parity)

Cost data and Estimations

Direct costs:	€ 678,000,000,000
Indirect costs:	€ 264,000,000,000
Informal care costs:	€ 726,000,000,000
	€ 1,668,000,000,000



48 % Headache Disorders

Source: Dodel R, Boon P, et al. Cost of Neurological Disorders in Europe - COIN-EU. Unpublished study; 2024 https://www.ean.org/research/projects/economic-burden-of-neurological-diseases-in-europe

CSF-Center Freiburg

EANS CerebroSpinal Fluid Section

International Collaborations

Inselspital Bern, Switzerland

Lindenhofspital Bern, Switzerland

UZH Zuerich, Switzerland

AKH, Vienna, Austria

University College London, UK

King's College, UK

Danish Headache Center, Denmark

Cedars Sinai, CA, USA

Stanford, CA. USA

Nagoya University, Japan

Aurora, CU Anschutz, USA

Neurosurgery & Neurology
J. Beck, K. Wolf, F. Volz, A. El Rahal, V. Vieira da Silva
L. Krismer, M. Overstijns, M. Shah

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

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

Freiburg CSF Center
Prof. Dr. Jürgen Beck

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CSF CENTER FREIBURG

Baden-Württemberg
Ministerium für Wissenschaft, Forschung und Kunst

@JrgenBeck
@Niklas_Luetzen
@KathaDCwolf
@ZanderCharlotte

Thank you

Freiburg im Breisgau, Germany

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