How I do it: Surgical repair

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CSF leak program, Cedars-Sinai Medical Center, Los Angeles, CA, USA

- Neurosurgery

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  Rachelle B. Tache, M.S.N., A.P.R.N., N.P.-C.


- Neuroradiology

  Marcel Maya, M.D.

  Franklin G. Moser, M.D., M.M.M.

  Ravi S. Prasad, M.D.

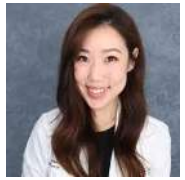
  Vikram Wadhwa, M.D.




- Neurology

  Jessica Choi, M.D.

  Diana (Nasima) Shadbehr, M.D



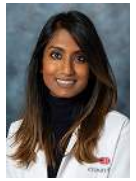

- Anesthesiology

  Charles Louy, M.D., Ph.D.

  Howard Rosner, M.D.

  Mary Alice Vijjeswarapu, M.D.





The key to surgical success is imaging

The key to surgical success is imaging

J Neurosurg 88:243–246, 1998

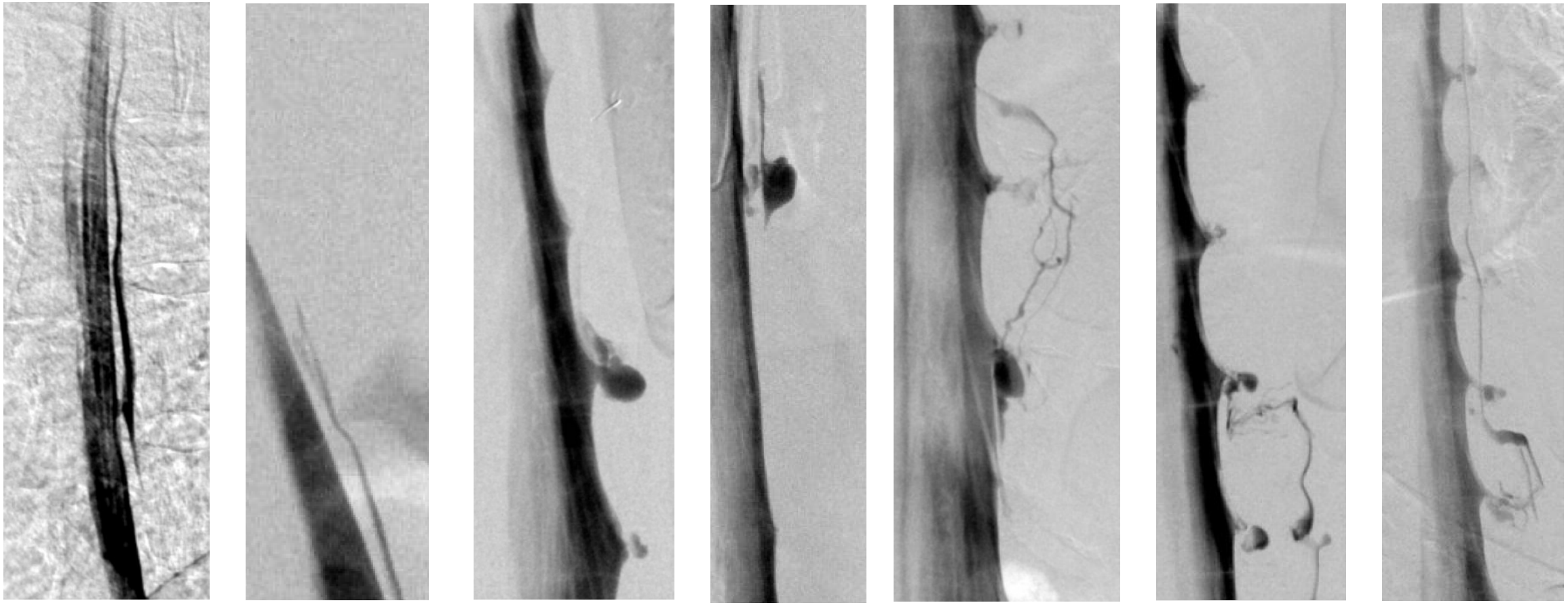
Surgical treatment of spontaneous spinal cerebrospinal fluid leaks

WOUTER I. SCHIEVINK, M.D., VITTORIO M. MORREALE, M.D., JOHN L. D. ATKINSON, M.D., FREDRIC B. MEYER, M.D., DAVID G. PIEPGRAS, M.D., AND MICHAEL J. EBERSOLD, M.D.

Department of Neurologic Surgery, Mayo Clinic, Rochester, Minnesota

Surgical
ligation of diverticulum ligation of diverticula
ligation of diverticulum
packing of epidural space
packing of epidural space
packing of epidural space & nerve root intradurally, fibrin glue
packing of epidural space & nerve root intradurally, fibrin glue
packing of epidural space
packing of epidural space
packing of epidural space

Key to success = digital subtraction myelography (DSM)



Key to success = dynamic CT-myelography

Courtesy of: Dr Lalani Carlton-Jones

Types of **spontaneous spinal** CSF leaks as a cause of SIH

A classification system of spontaneous spinal CSF leaks

Wouter I. Schievink, MD
M. Marcel Maya, MD
Stacey Jean-Pierre, PA-C
Miriam Nuño, PhD
Ravi S. Prasad, MD
Franklin G. Moser, MD, MMM

Correspondence to Dr. Schievink: schievinkw@cshs.org

ABSTRACT

Objective: Spontaneous spinal CSF leaks cause spontaneous intracranial hypotension but no systematic study of the different types of these CSF leaks has been reported. Based on our experience with spontaneous intracranial hypotension, we propose a classification system of spontaneous spinal CSF leaks.

Methods: We reviewed the medical records, radiographic studies, operative notes, and any intraoperative photographs of a group of consecutive patients with spontaneous intracranial hypotension.

Results: The mean age of the 568 patients (373 [65.7%] women) was 45.7 years. Three types of CSF leak could be identified. Type 1 CSF leaks consisted of a dural tear (151 patients [26.6%]) and these were almost exclusively associated with an extradural CSF collection. Type 1a represented ventral CSF leaks (96%) and type 1b posterolateral CSF leaks (4%). Type 2 CSF leaks consisted of meningeal diverticula (240 patients [42.3%]) and were the source of an extradural CSF collection in 53 of these patients (22.1%). Type 2a represented simple diverticula (90.8%) and type 2b complex meningeal diverticula/dural ectasia (9.2%). Type 3 CSF leaks consisted of direct CSF-venous fistulas (14 patients [2.5%]) and these were not associated with extradural CSF collections. A total of 163 patients (28.7%) had an indeterminate type and extradural CSF collections were noted in 84 (51.5%) of these patients.

Conclusions: We identified 3 types of spontaneous spinal CSF leak in this observational study: the dural tear, the meningeal diverticulum, and the CSF-venous fistula. These 3 types and the presence or absence of extradural CSF form the basis of a comprehensive classification system.

Neurology® 2016;87:673–679

Spontaneous Intracranial Hypotension: A Systematic Imaging Approach for CSF Leak Localization and Management Based on MRI and Digital Subtraction Myelography

R.I. Farb, P.J. Nicholson, P.W. Peng, E.M. Massicotte, C. Lay, T. Krings and K.G. terBrugge

AJNR Am J Neuroradiol 2019, 40 (4) 745-753

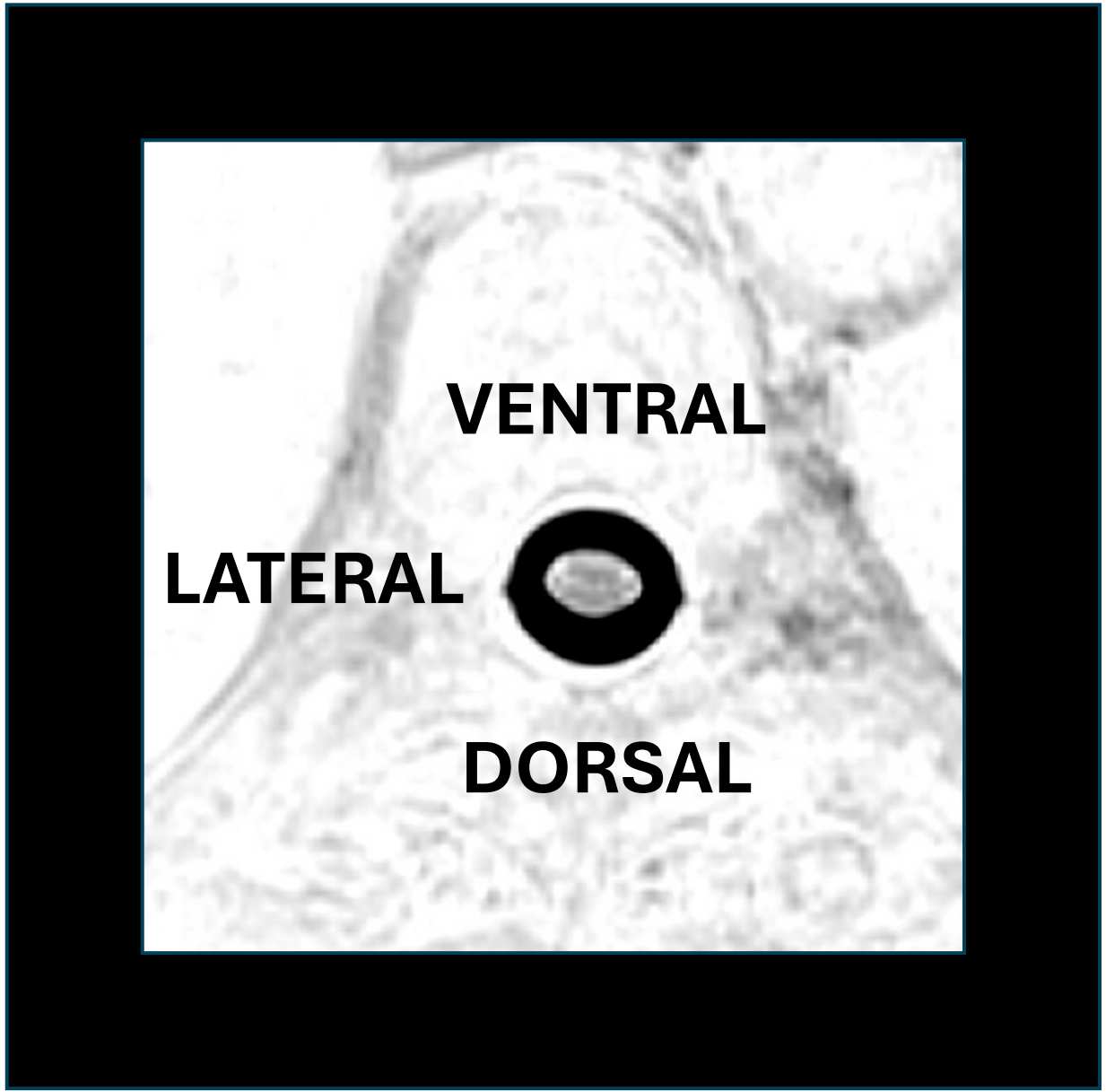
Journal of Neurology (2024) 271:7016–7020
https://doi.org/10.1007/s00415-024-12598-5

LETTER TO THE EDITORS

Primary CSF-lymphatic fistula: a previously unknown cause of spontaneous intracranial hypotension

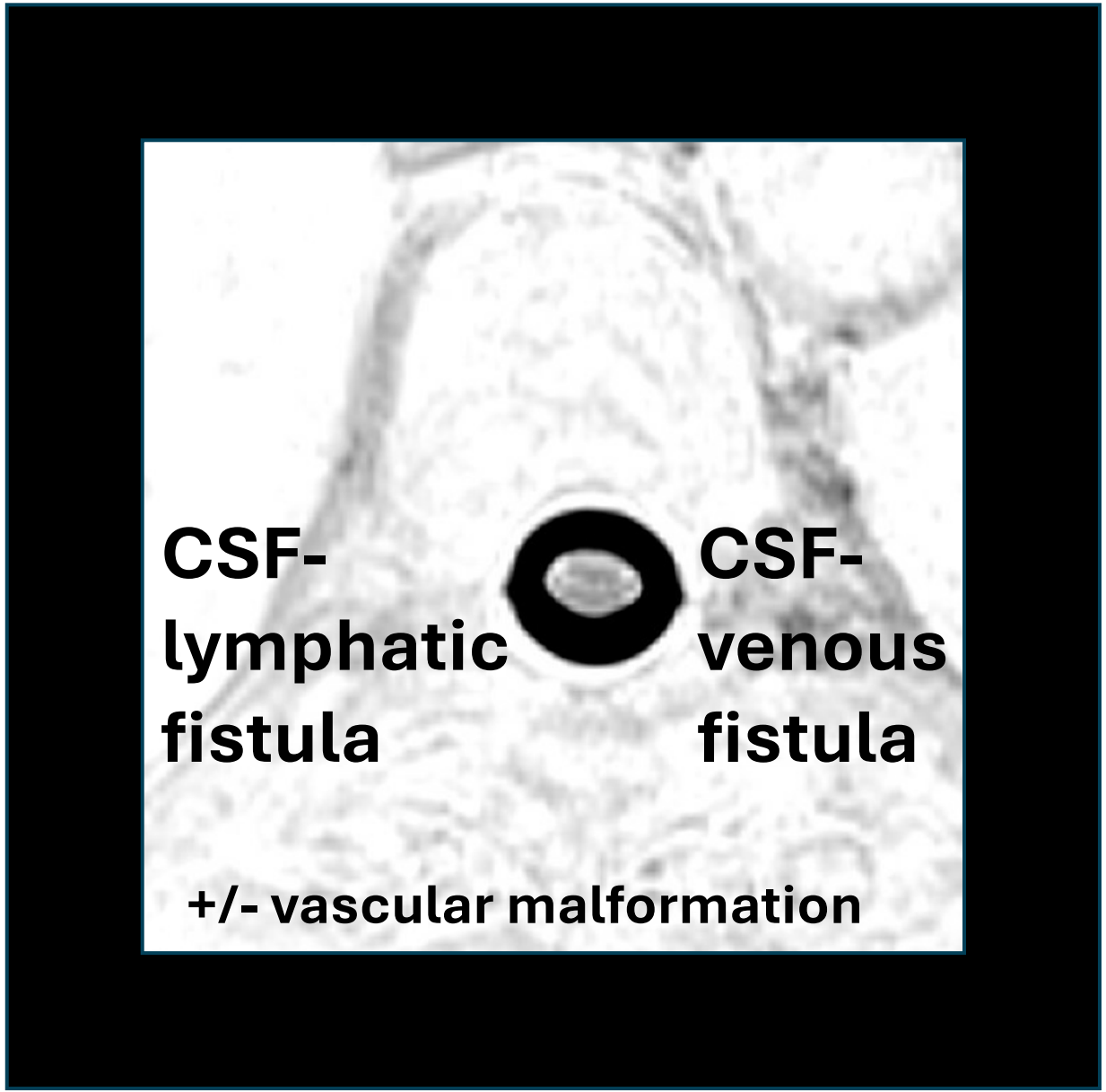
Niklas Lützen[1] · Katharina Wolf[2] · Amir El Rahal[2] · Florian Volz[2] · Theo Demerath[1] · Charlotte Zander[1] · Claus Christian Pieper[3] · Marius Schwabenland[4] · Horst Urbach[1] · Jürgen Beck[2]

DURAL TEARS OF THE COMMON THECAL SAC

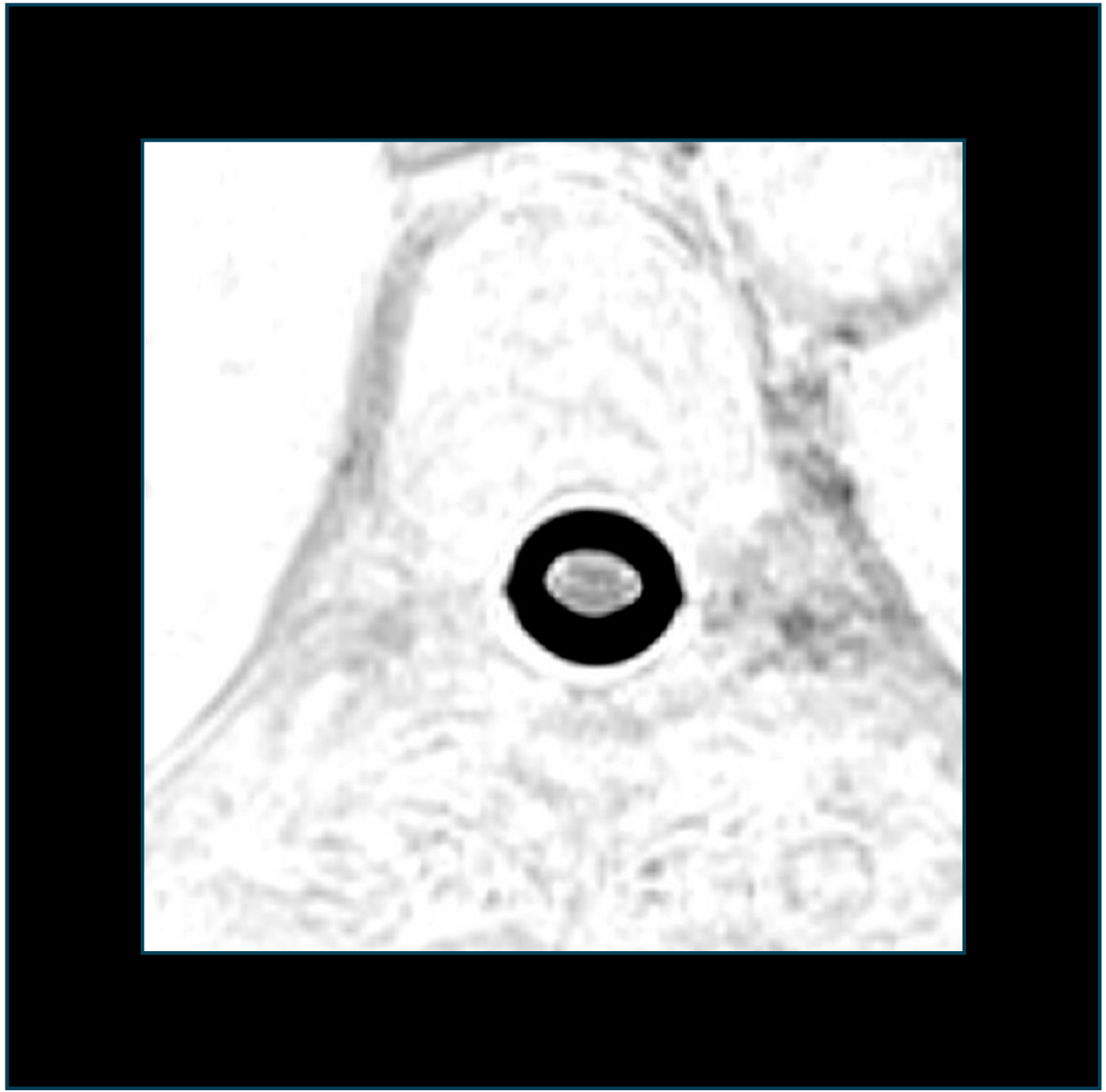


DURAL DIVERTICULA

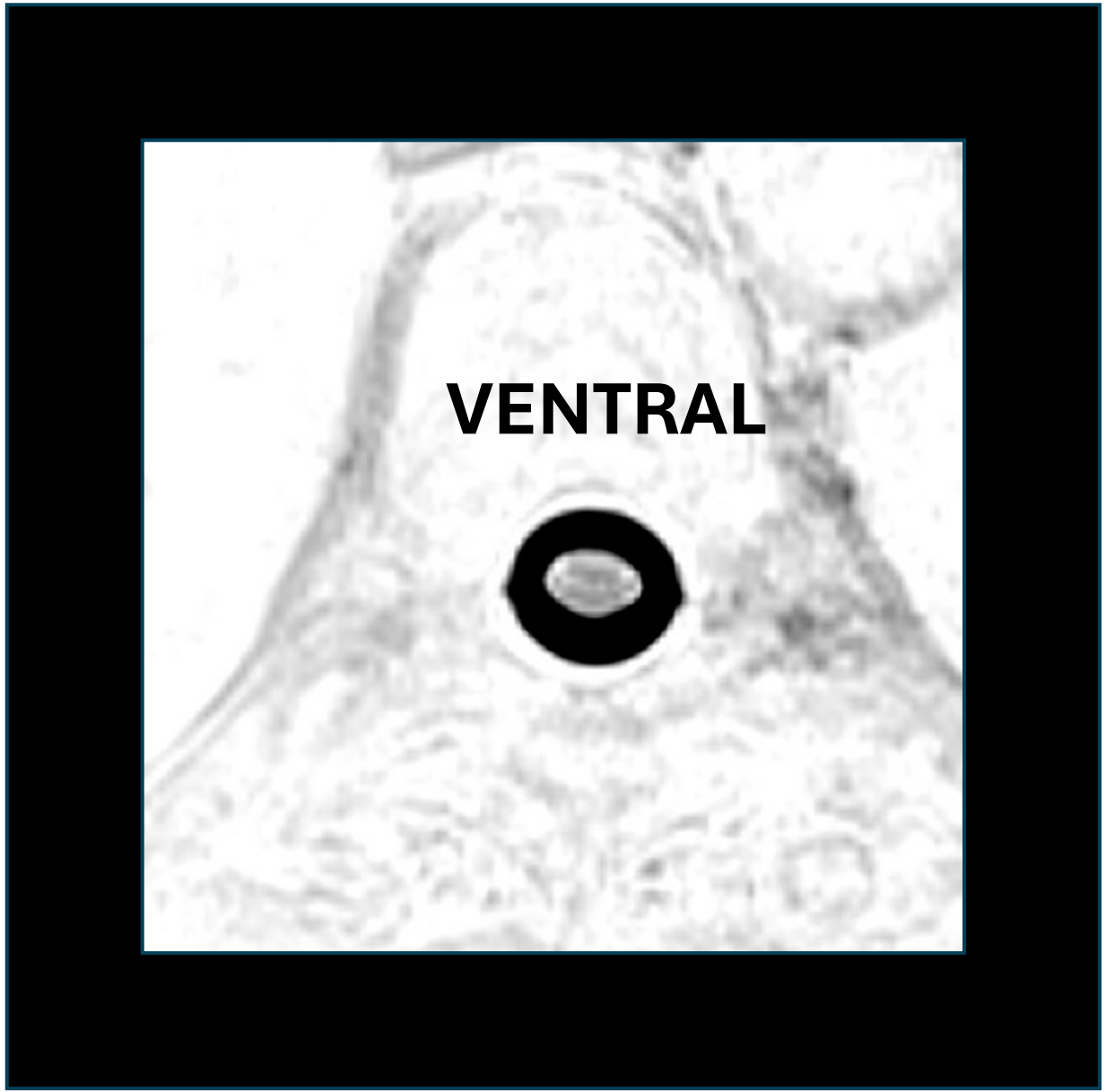
FISTULAS

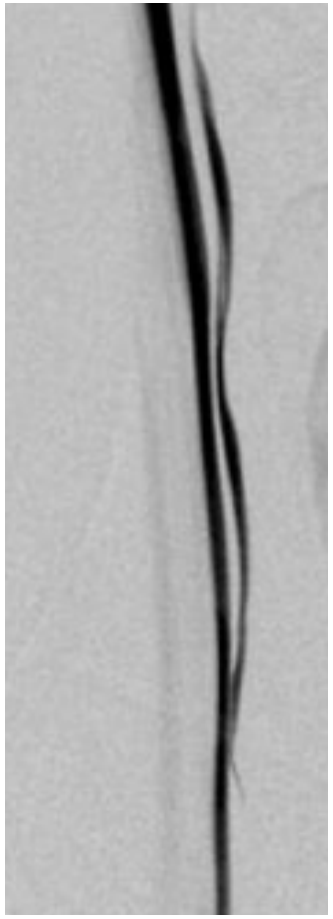

CSF-
lymphatic
fistula
CSF-
venous
fistula
+/- vascular malformation

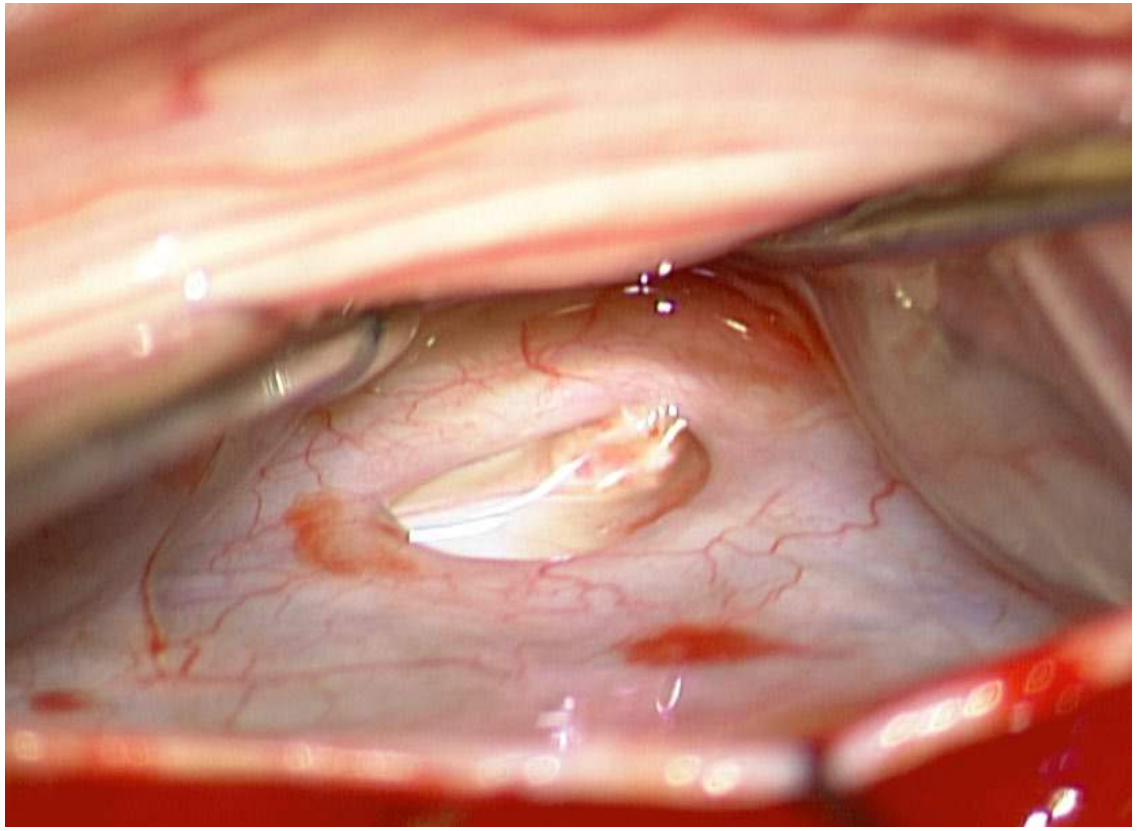
DISTAL NERVE ROOT TEARS



DURAL TEARS OF THE COMMON THECAL SAC

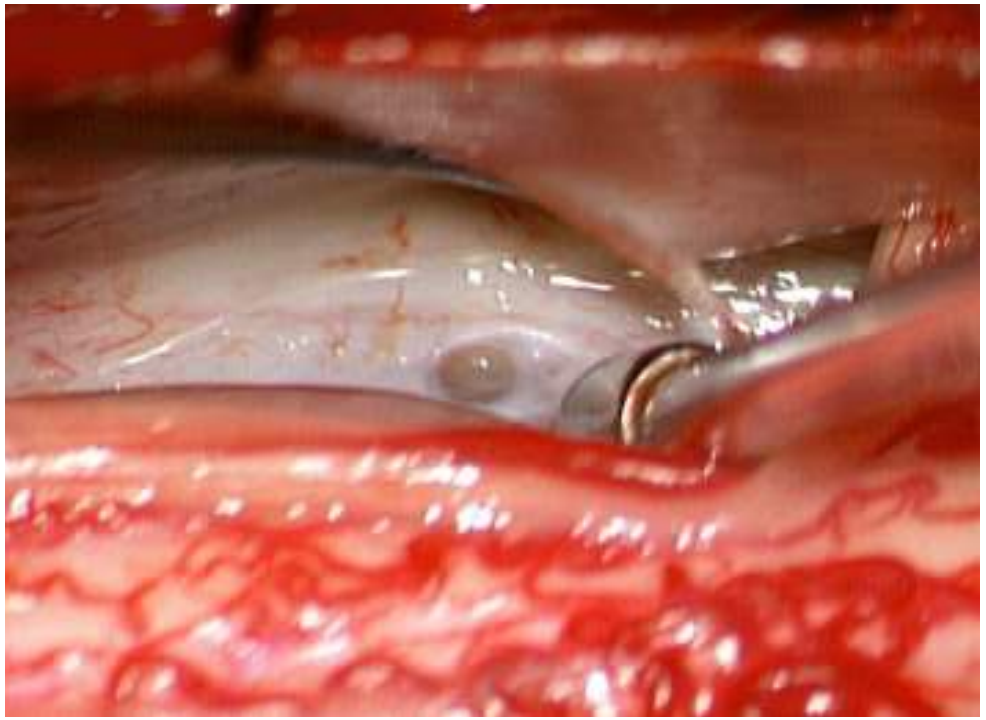




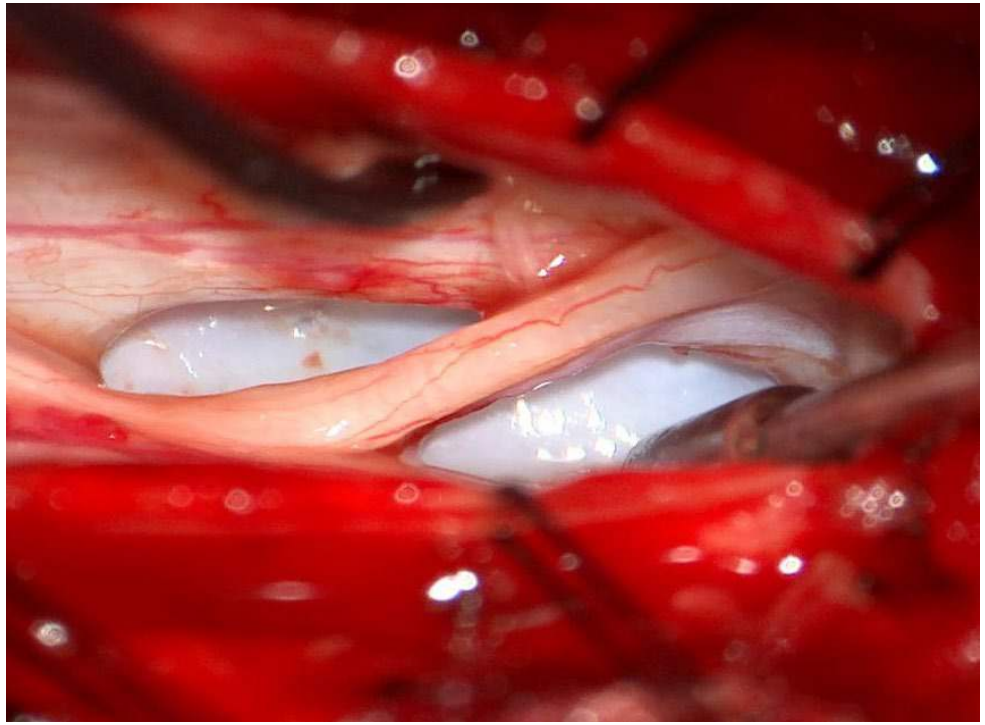


Ventral leak

Size of ventral dural tears

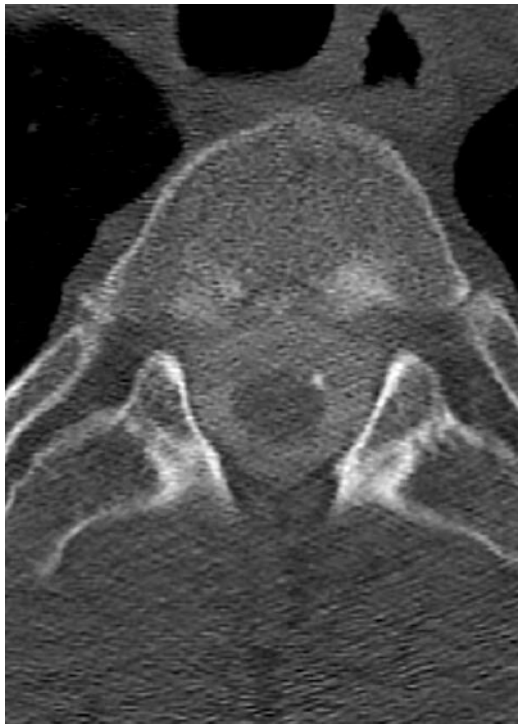


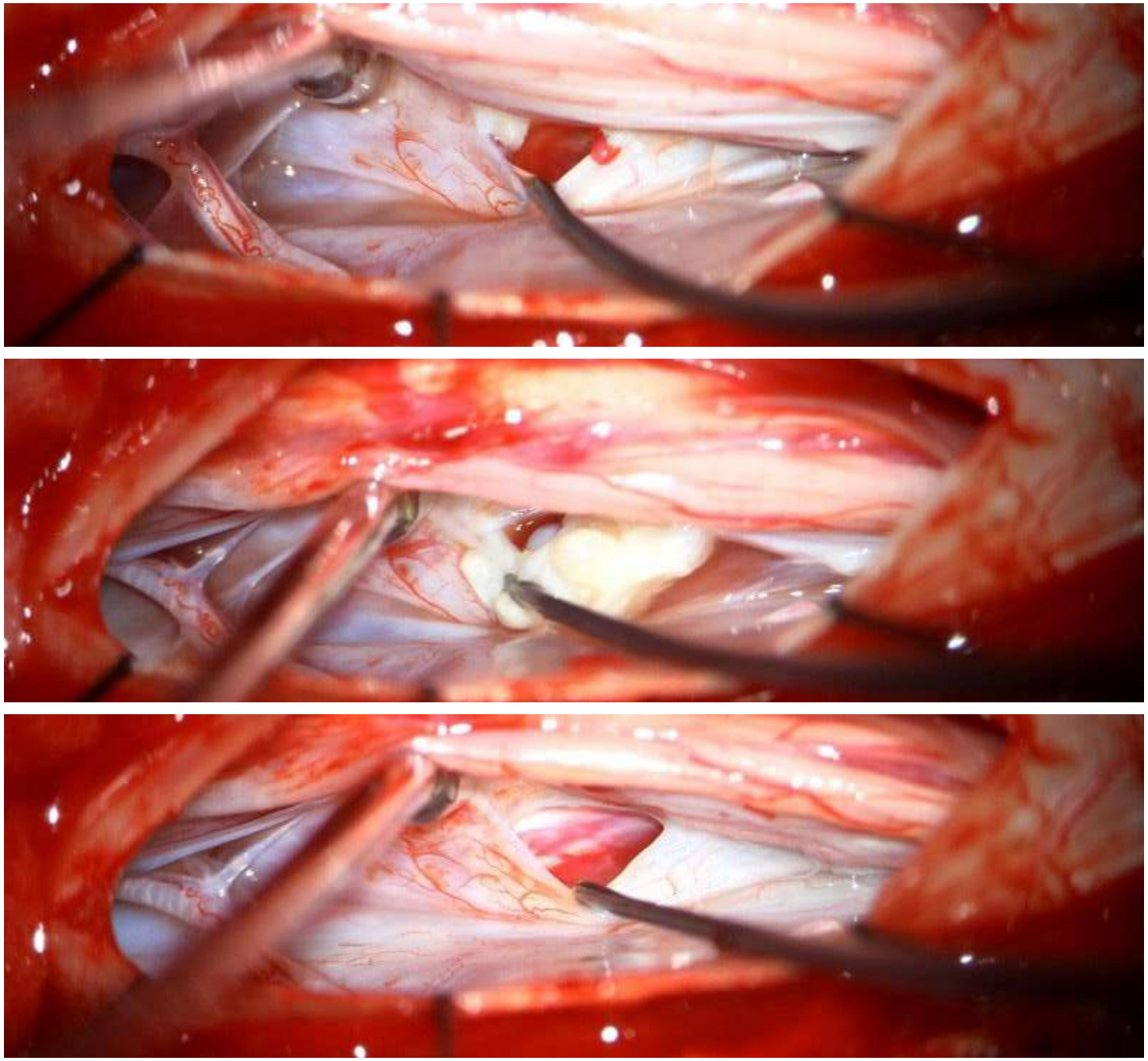
1.5 mm



15 mm

Bony spicules in SIH due to ventral dural tear – calcified disc, calcified ligament, osteophytes, microspurs



Surgical repair of ventral CSF leaks: in order of decreasing invasiveness

- Extradural repair with facetectomies and multi-level fusion

---

- Intradural repair with laminectomy with/without laminoplasty
- Intradural repair with hemilaminectomy
- Intradural repair with hemilaminectomy through tubular retractor

Surgical repair of ventral CSF leaks: in order of decreasing invasiveness

- ~~Extradural repair with facetectomies and multi-level fusion~~

- Intradural repair with laminectomy with/without laminoplasty =

  safest and most effective
- Intradural repair with hemilaminectomy =

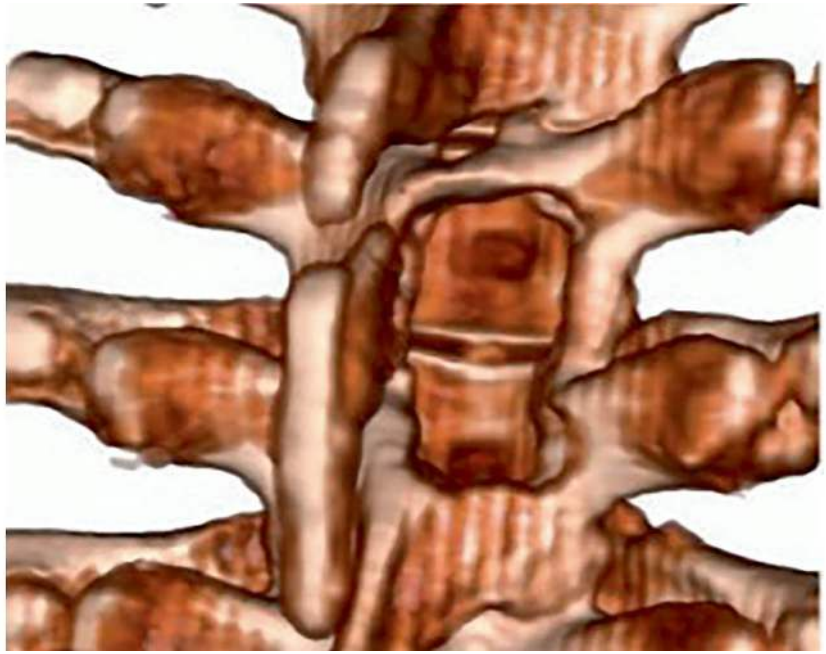
  faster recovery and almost as safe and effective
- Intradural repair with hemilaminectomy through tubular retractor =

  even faster recovery and almost as safe and effective but trans-tubular suturing is challenging

Posterior Approach and Spinal Cord Release for 360° Repair of Dural Defects in Spontaneous Intracranial Hypotension

Jürgen Beck, MD*
Andreas Raabe, MD*
Wouter I. Schievink, MD‡
Christian Fung, MD*
Jan Gralla, MD§
Eike Piechowiak, MD§
Kathleen Seidel, MD*
Christian T. Ulrich, MD*

BACKGROUND: Spinal cerebrospinal fluid (CSF) leaks are the cause of spontaneous intracranial hypotension (SIH).
OBJECTIVE: To propose a surgical strategy, stratified according to anatomic location of the leak, for sealing all CSF leaks around the 360° circumference of the dura through a single tailored posterior approach.
METHODS: All consecutive SIH patients undergoing spinal surgery were included. The anatomic site of the leak was exactly localized. We used a tailored hemilaminotomy and intraoperative neurophysiological monitoring (IOM) for all cases. Neurological status was assessed before and up to 90 d after surgery.



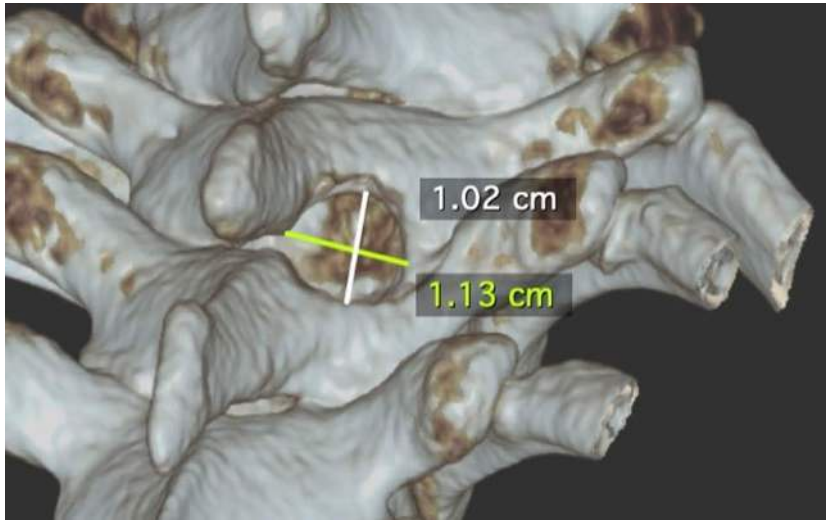
Acta Neurochirurgica
https://doi.org/10.1007/s00701-021-04987-w

HOW I DO IT - SPINE - OTHER

How I do it: the trans-laminar, facet-joint sparing minimal invasive approach for ventral dural repair in spontaneous intracranial hypotension—a 2-dimensional operative video

Marco V. Corniola[1,2,3] · Torstein R. Meling[1,2]

Received: 5 August 2021 / Accepted: 20 August 2021

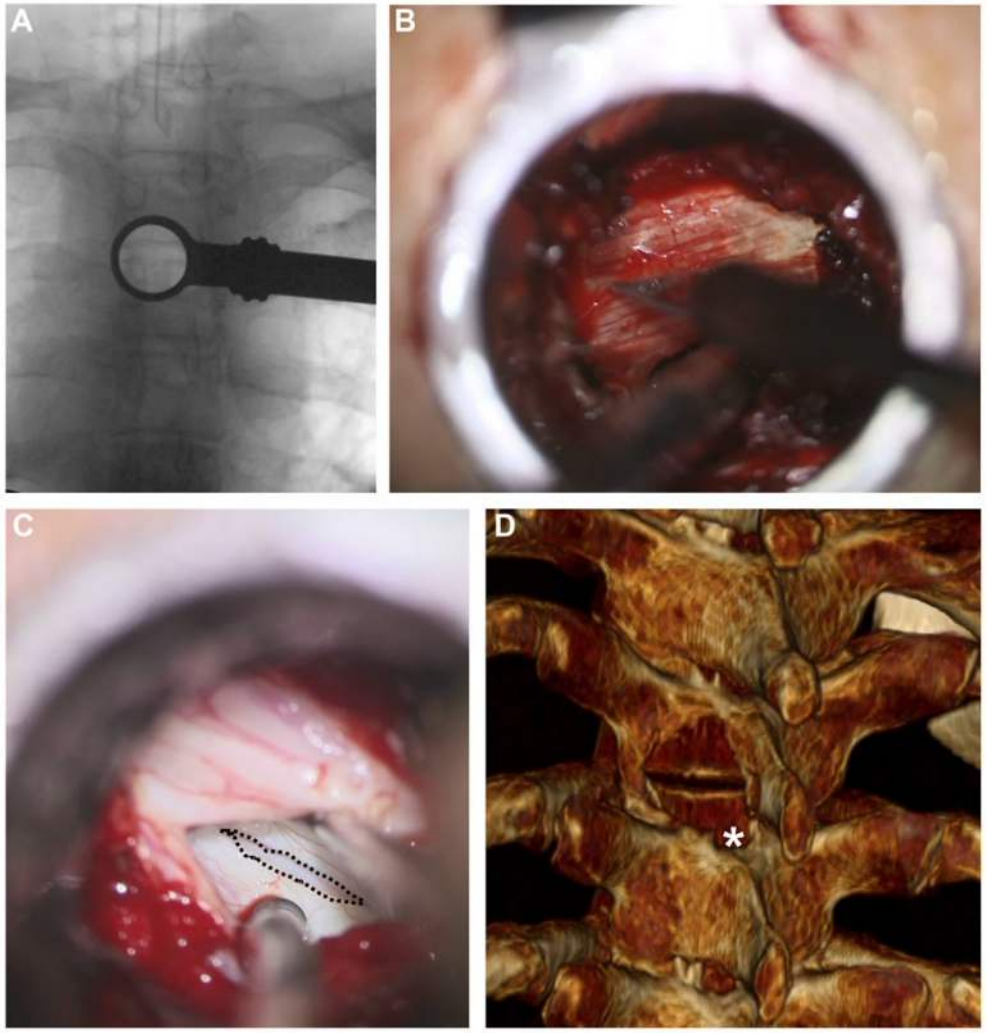


OPEN

Keyhole Fenestration for Cerebrospinal Fluid Leaks in the Thoracic Spine: Quantification of Bone Removal and Microsurgical Anatomy

Florian Volz, MD *, Roberto Doria-Medina, MD*, Christian Fung, MD*, Katharina Wolf, MD*, Amir El Rahal, MD*‡, Niklas Lützen, MD§, Horst Urbach, MD§, Theresa Bettina Loidl, MD*, Ulrich Hubbe, MD*, Jan-Helge Klingler, MD*, Jürgen Beck, MD*

*Department of Neurosurgery, Medical Center - University of Freiburg, Freiburg, Germany; ‡Faculty of Medicine, University of Geneva, Geneva, Switzerland; §Department of Neuroradiology, Medical Center - University of Freiburg, Freiburg, Germany



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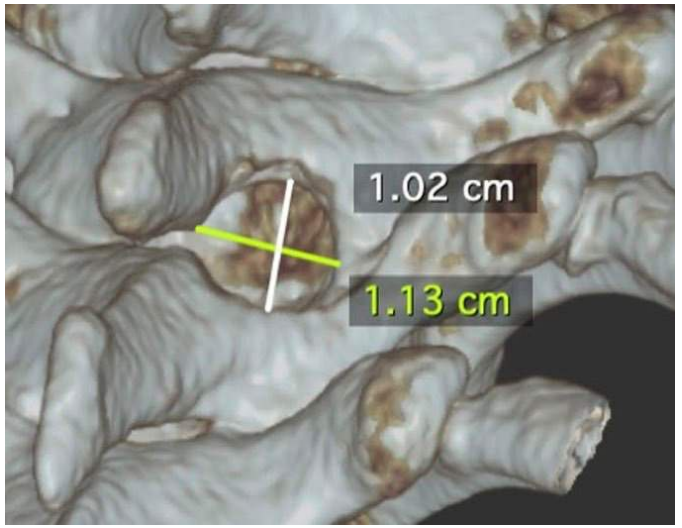

F

2009-2011

Extradural repair with multi-level fusion

Since 2011

Posterior intradural repair

Since 2023

MISS - retractor 2.5 cm incision

Surgical repair of ventral CSF leaks: in order of decreasing invasiveness

- ~~Extradural repair with facetectomies and multi-level fusion~~

- Intradural repair with laminectomy with/without laminoplasty =

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- Intradural repair with hemilaminectomy through tubular retractor =

  even faster recovery and almost as safe and effective but trans-tubular suturing is challenging

---

- Extradural endoscopic repair

2009-2011

Extradural repair with multi-level fusion

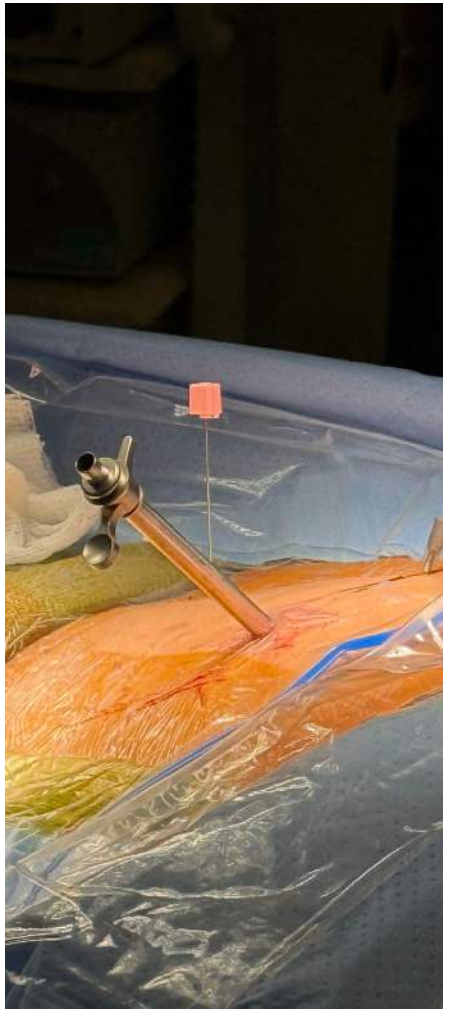
Since 2011

Posterior intradural repair

Since 2023

MISS - retractor
2.5 cm incision

Since 2025



Endoscopy
8 mm tube (o.d.)

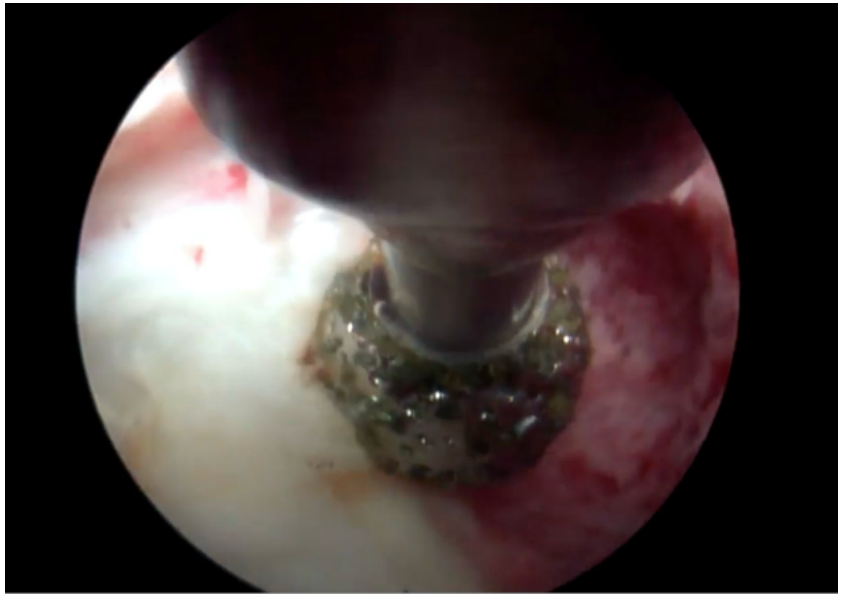
NEUROSURGICAL FOCUS VIDEO

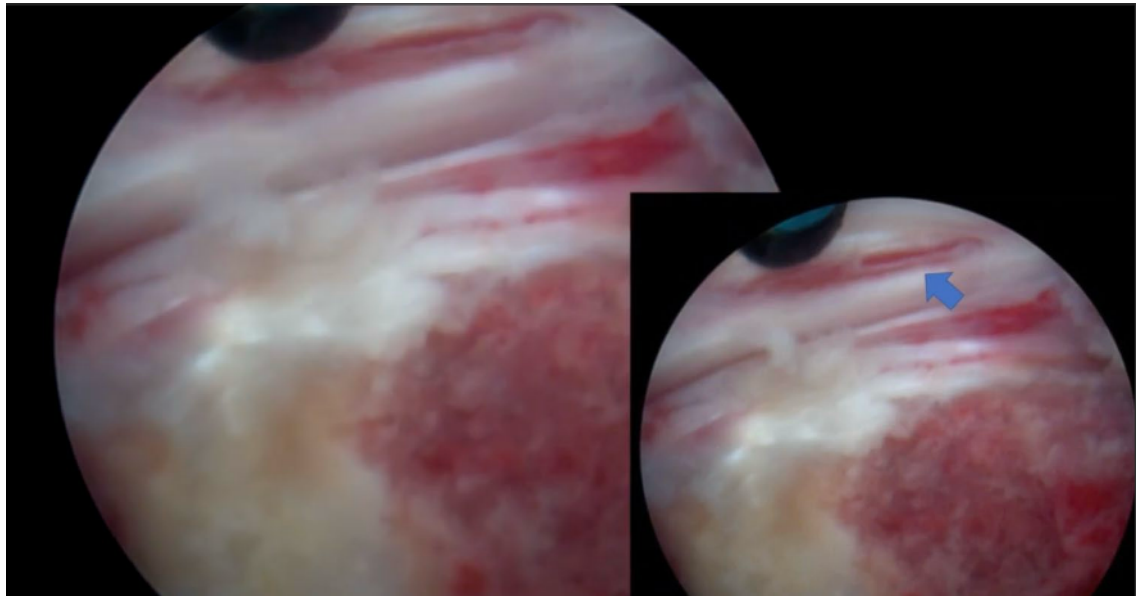
Neurosurg Focus Video 10(2):V17, 2024

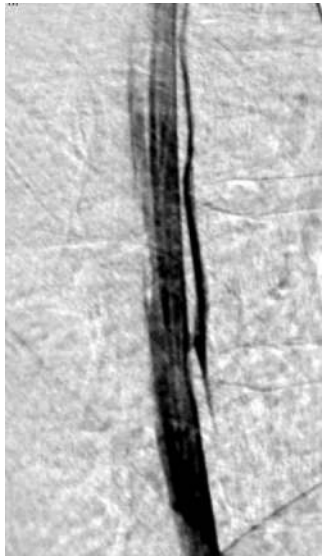
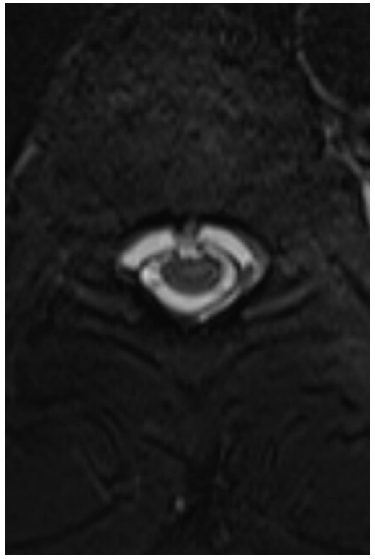
Full endoscopic resection of ventral thoracic osteophyte and repair of spontaneous CSF leak

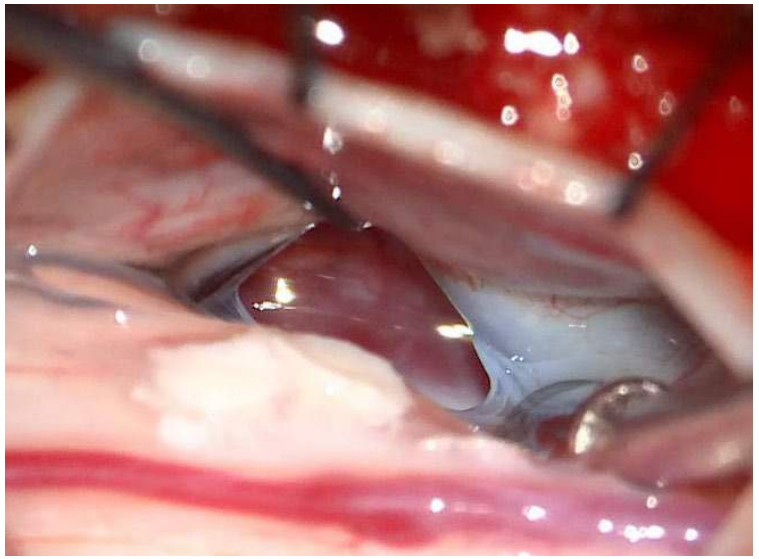
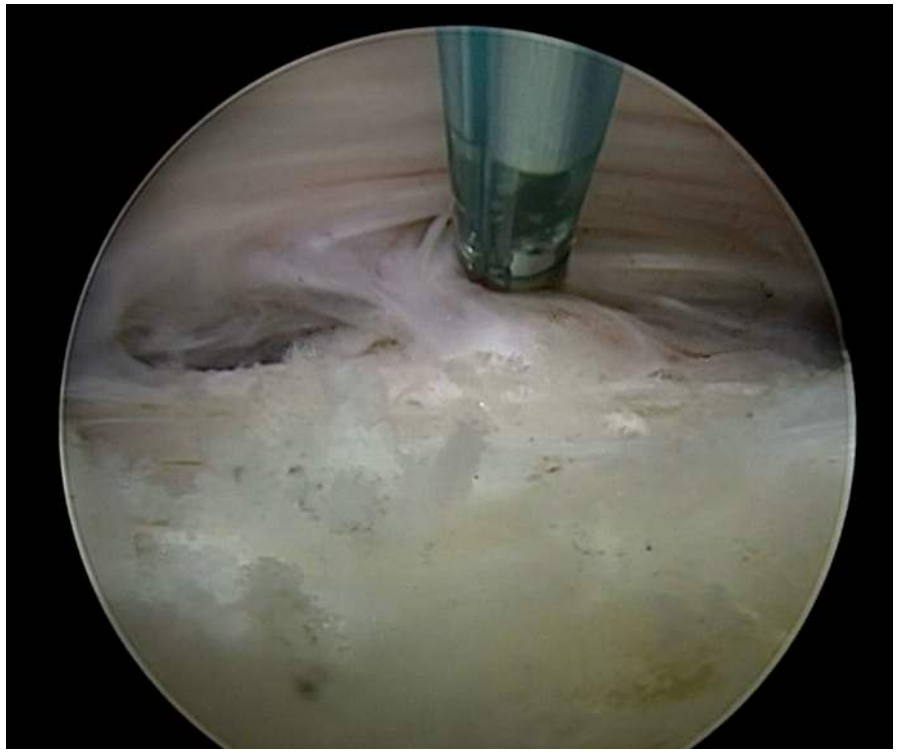
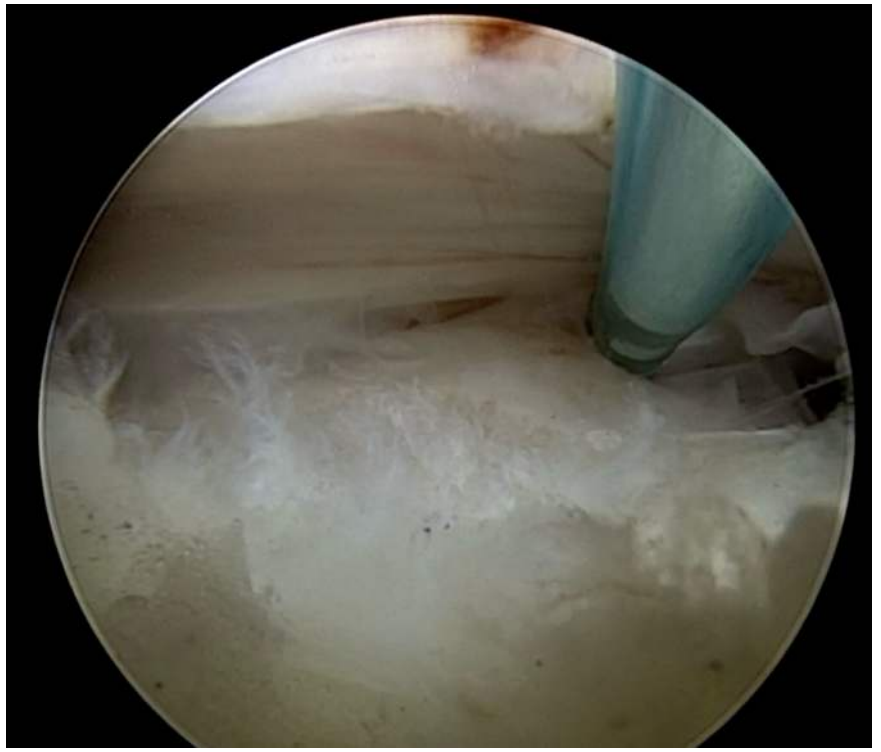
Nelson Sofoluke, MD,[1] Jannik Leyendecker, MD,[2,3] Christoph P. Hofstetter, MD, PhD,[2] and Sanjay Konakondla, MD[1]

[1]Department of Neurosurgery, Geisinger Neuroscience Institute, Danville, Pennsylvania; [2]Department of Neurological Surgery, University of Washington, Seattle, Washington; and [3]Department of Orthopedics and Trauma Surgery, University of Cologne, Faculty of Medicine, Cologne, Germany

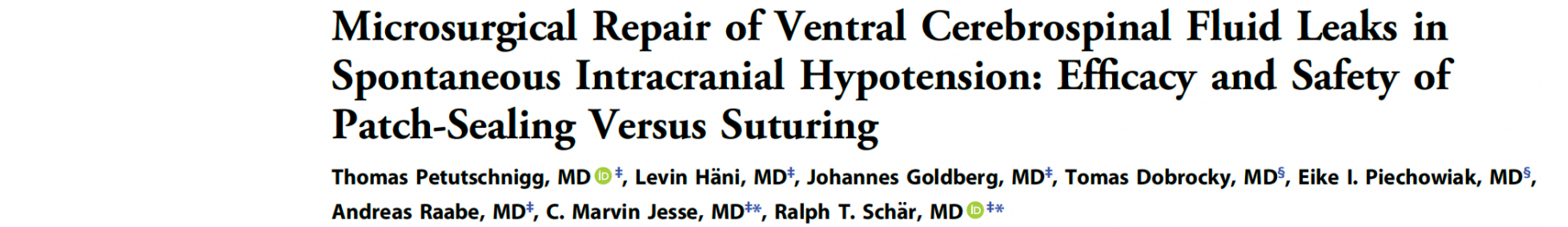





Dr Corey Walker



Microsurgical Repair of Ventral Cerebrospinal Fluid Leaks in Spontaneous Intracranial Hypotension: Efficacy and Safety of Patch-Sealing Versus Suturing

Thomas Petutschnigg, MD ‡, Levin Häni, MD‡, Johannes Goldberg, MD‡, Tomas Dobrocky, MD§, Eike I. Piechowiak, MD§, Andreas Raabe, MD‡, C. Marvin Jesse, MD‡*, Ralph T. Schär, MD ‡*

Surgical closure of spinal cerebrospinal fluid leaks improves symptoms in patients with superficial siderosis

Amir El Rahal | Benedikt Haupt | Christian Fung | Debora Cipriani | Levin Häni | Niklas Lützen | Tomas Dobrocky | Eike Piechowiak | Oliver Schnell | Andreas Raabe | Katharina Wolf | Horst Urbach | Luisa Mona Kraus | Florian Volz | Jürgen Beck

Minimally invasive surgery for spinal cerebrospinal fluid leaks in spontaneous intracranial hypotension

Jürgen Beck, MD,[1] Ulrich Hubbe, MD,[1] Jan-Helge Klingler, MD,[1] Roland Roelz, MD,[1] Luisa Mona Kraus, MD,[1] Florian Volz, MD,[1] Niklas Lützen, MD,[2] Horst Urbach, MD,[2] Kristin Kieselbach, MD,[3] and Christian Fung, MD[1]

Calcified Hofmann's ligaments as the cause of spinal cerebrospinal fluid leaks associated with spinal ventral dural tears

Keisuke Takai, MD, PhD,[1] Takeaki Endo, MD,[1] and Takashi Komori, MD, PhD[2]

Infratentorial Superficial Siderosis and Spontaneous Intracranial Hypotension

Wouter I. Schievink, MD,[1] M. Marcel Maya, MD,[2] Jennifer Harris, MD,[3] vier Galvan, MD,[2] Rachelle B. Taché, NP-C, MSN,[1] and Miriam Nuño, PhD[4]

Dorsolateral Transdural Surgical Management of Spontaneous Intracranial Hypotension From Ventral Dural Cerebrospinal Fluid Leaks: Case Series and Technical Report

Adela Wu, MD*†, Mark D. Mamlouk, MD‡§, Mark F. Sedrak, MD*†

Results of posterior intradural repair of ventral CSF leak = (the "gold standard")

No of patients (range): 12 - 79
Successful repair (range): 83.5 – 100%
Successful repair (combined): 87.5%

Posterior intradural ventral spinal CSF leak repair–
With identification and repair of dural tear

Cedars-Sinai: first 400 patients (Since Summer 2011)

- Successful repair (radiographic): 96%

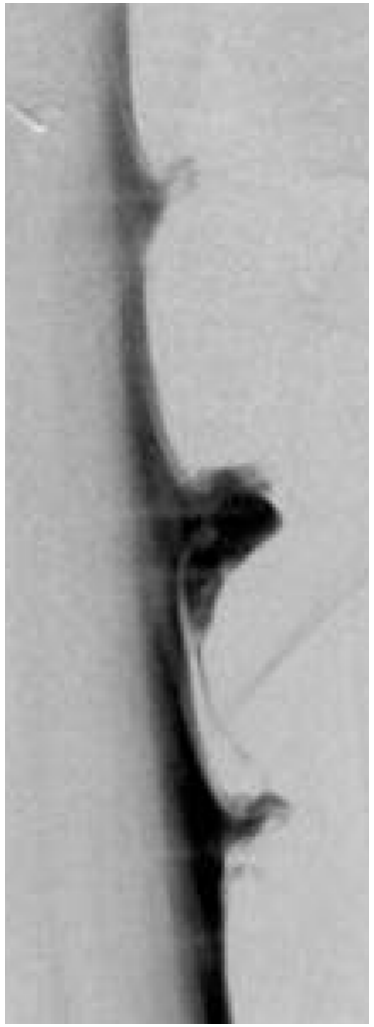
- Complications
  - permanent neurologic deficit: <1%
  - infection: 1%
  - iatrogenic CSF leak: 4%
  - post-op epidural hematoma: 0%
  - peri-op mortality: 0%

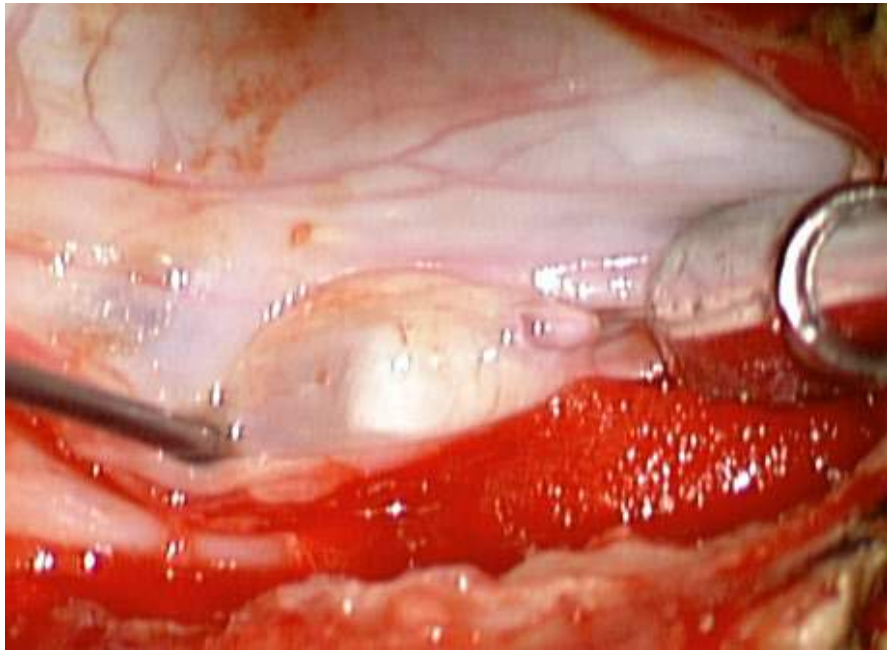
Durability of intradural ventral CSF leak repair

- 37 patients > 10 years post-op
- 2 lost to follow-up
- 407.5 person-years of follow-up
- Successful repair (97%)

- Recurrent CSF leak: 0

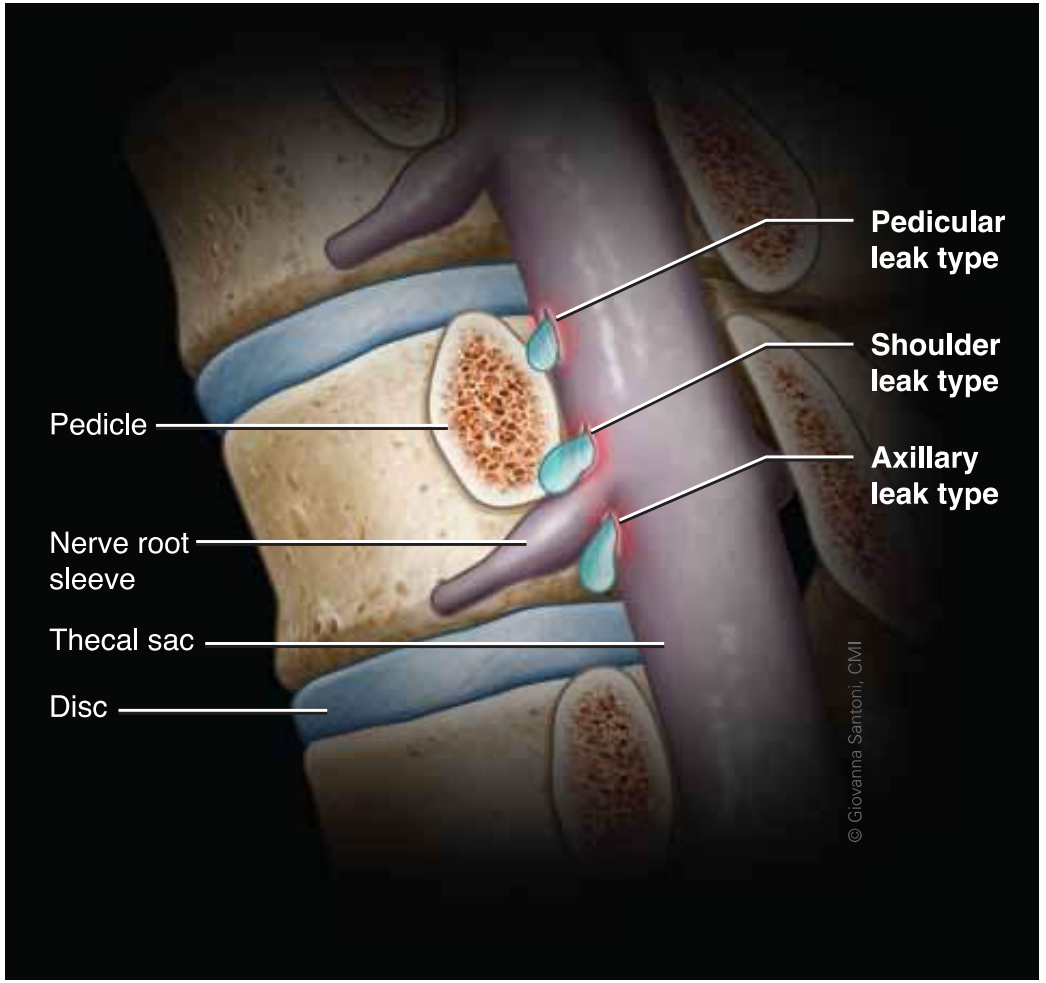
DURAL TEARS OF THE COMMON THECAL SAC





Lateral leak

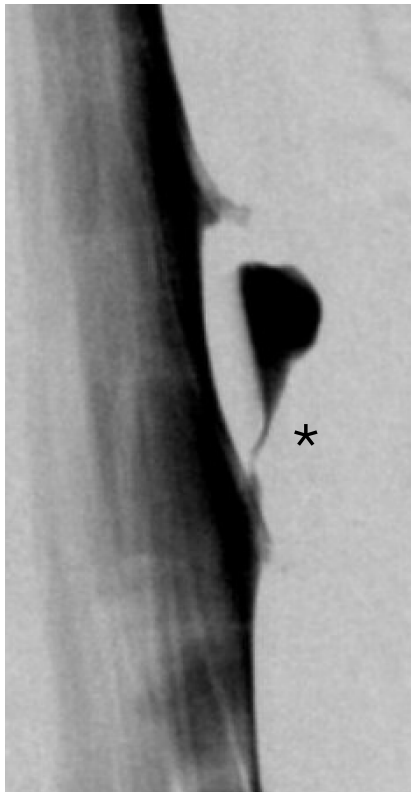
Types of lateral CSF leaks

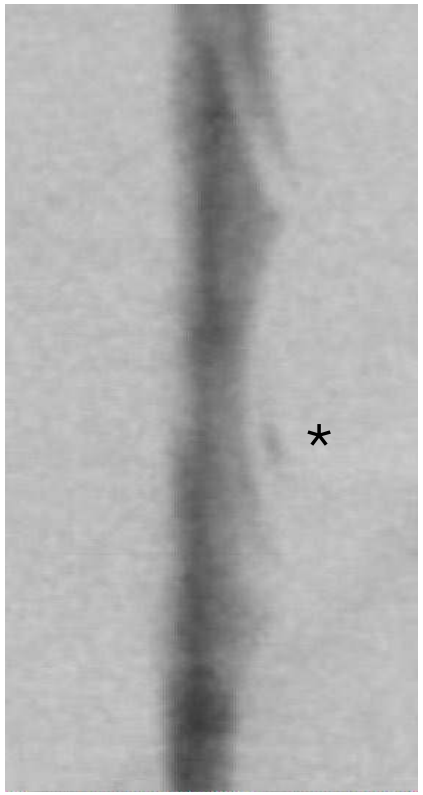


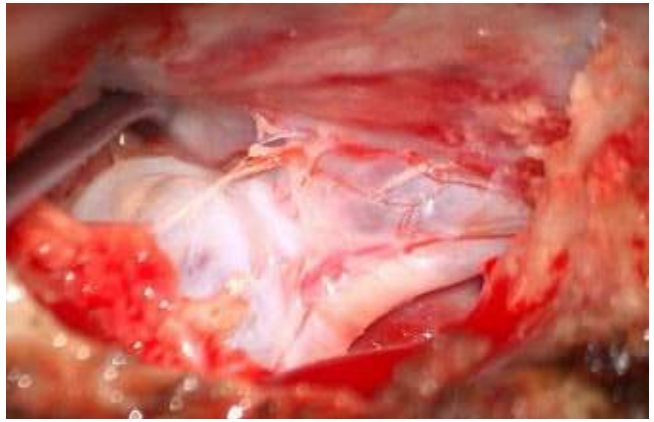
5-10%

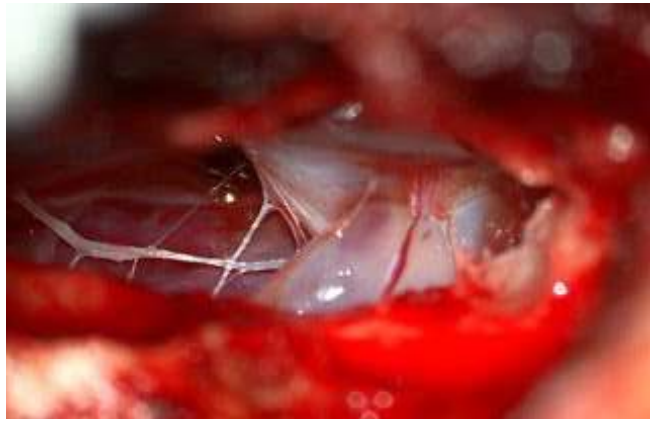
20-30%

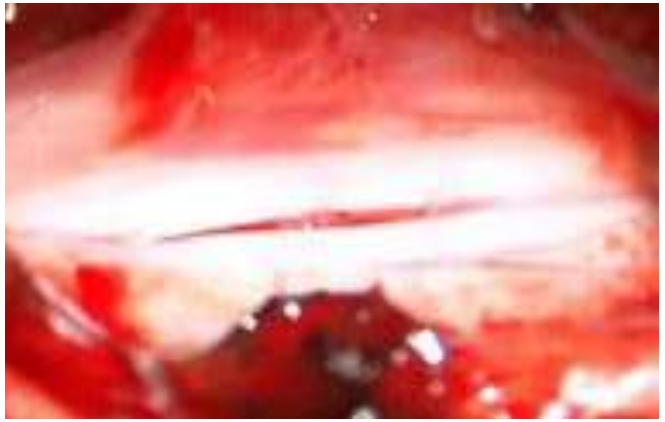
60-80%











AXILLA

SHOULDER

PEDICULAR

HOT TOPICS IN HEADACHE | April 7, 2025 |

Pathogenic Variation in Fibrillin-2 Confers Susceptibility to Spontaneous Cerebrospinal Fluid Leaks Through Impairment of Cellular Adhesion (S35.005)

Cassie Parks, Mukti Singh, Elizabeth Wohler, Renan Martin, Emily Juzwiak, Xinyi Sun, Silke Peeters, Bart Loeys, Nara Sobreira, Clair Baldock, Wouter Schievink, and Hal Dietz | AUTHORS INFO & AFFILIATIONS

April 8, 2025 issue • 104 (7_Supplement_1) • https://doi.org/10.1212/WNL.0000000000211344

SPINE

CLINICAL ARTICLE

J Neurosurg Spine 38:147–152, 2023

Minimally invasive surgery for spinal cerebrospinal fluid leaks in spontaneous intracranial hypotension

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Successful repair: 17/17 = 100%

ORIGINAL RESEARCH

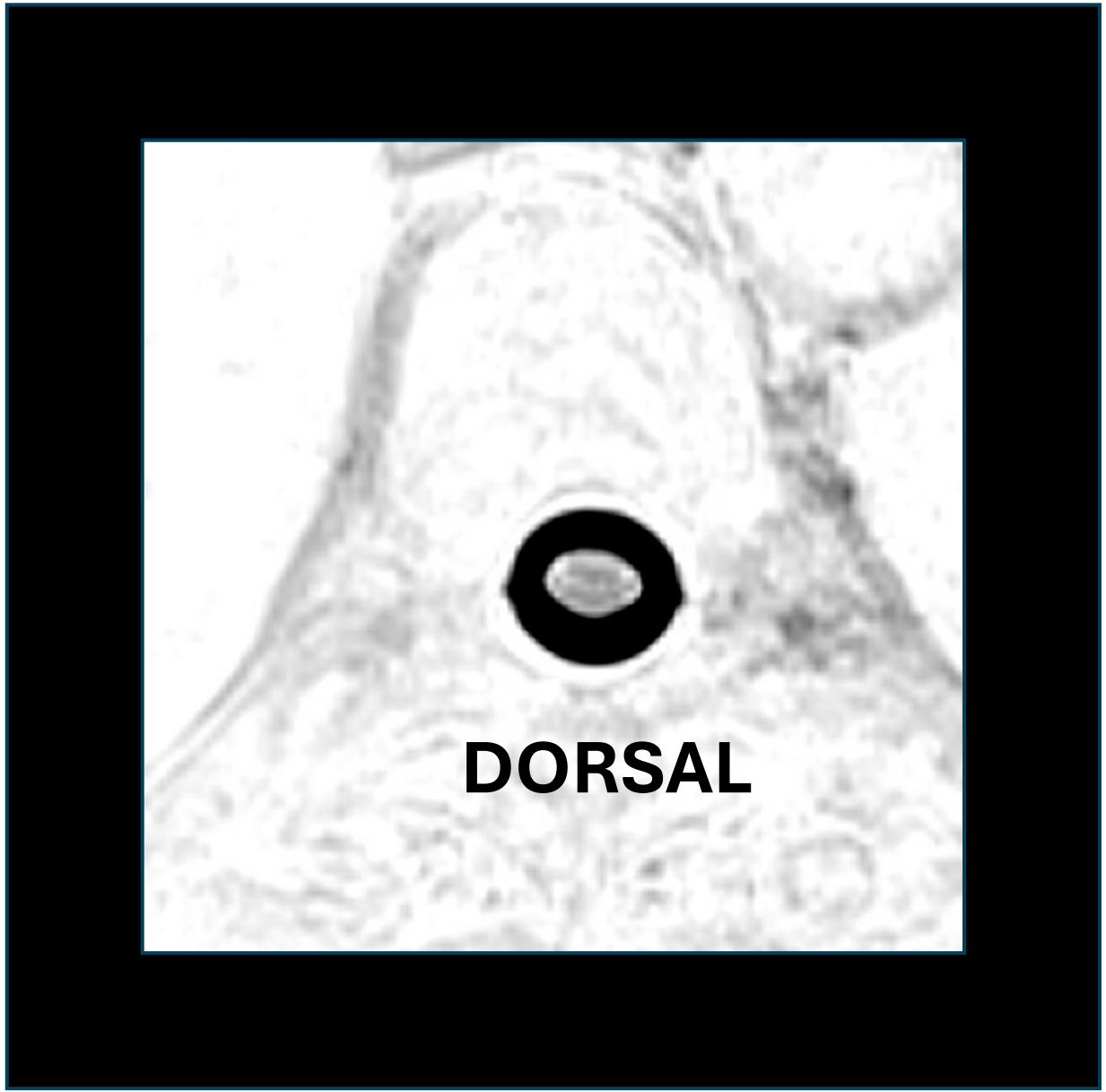
SPINE IMAGING AND SPINE IMAGE-GUIDED INTERVENTION

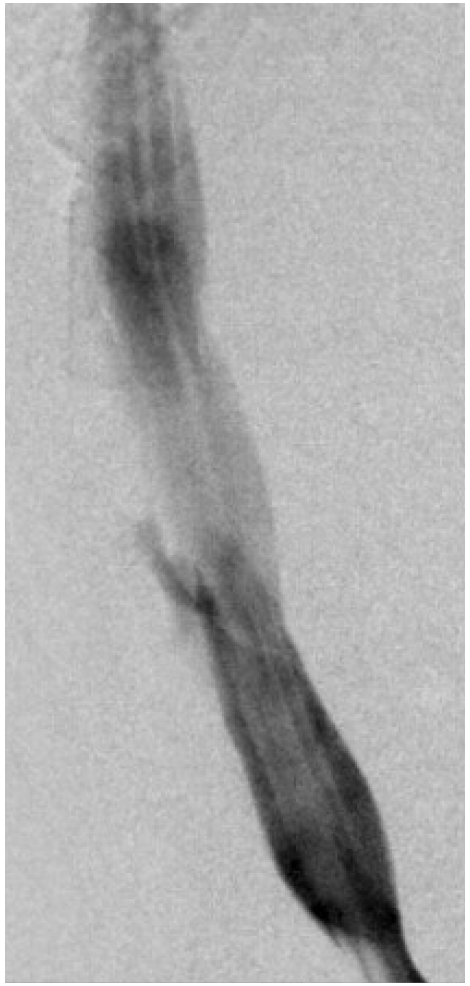
Lateral Spinal CSF Leaks in Patients with Spontaneous Intracranial Hypotension: Radiologic-Anatomic Study of Different Variants

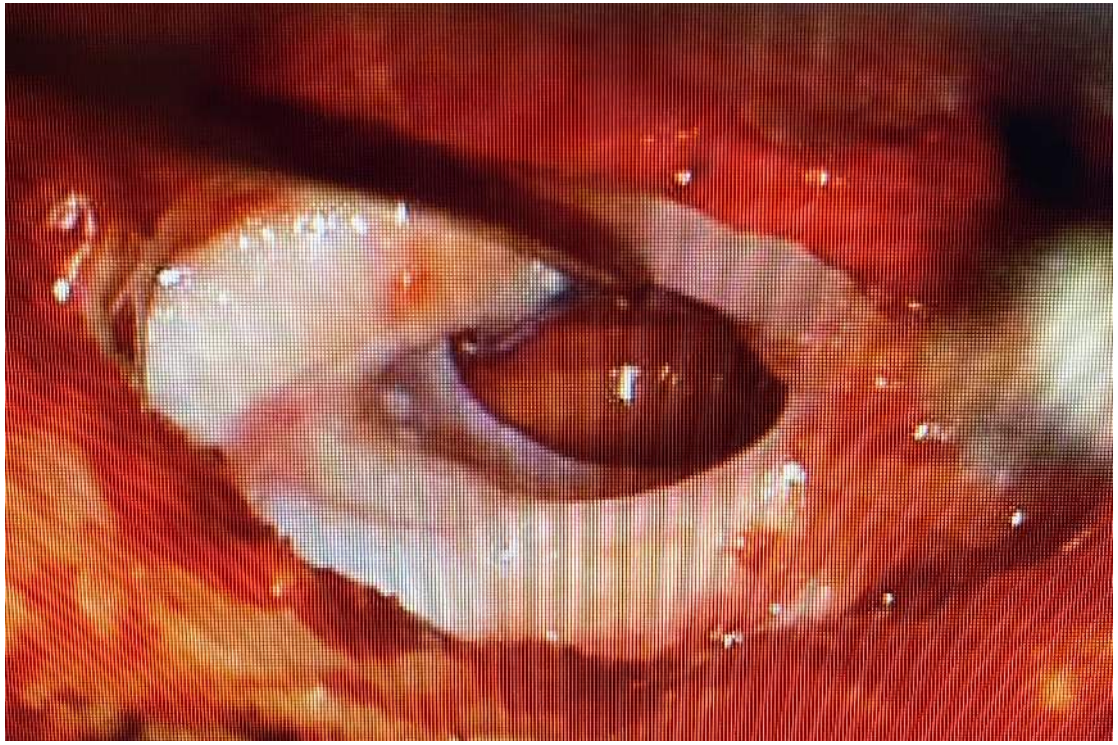
Wouter I. Schievink, Marcel M. Maya, Angelique Sao-Mai S. Tay, Rachelle B. Taché, Ravi S. Prasad, Vikram Wadhwa, and Miriam Nuño

Successful repair: 55/56 = 98.2%

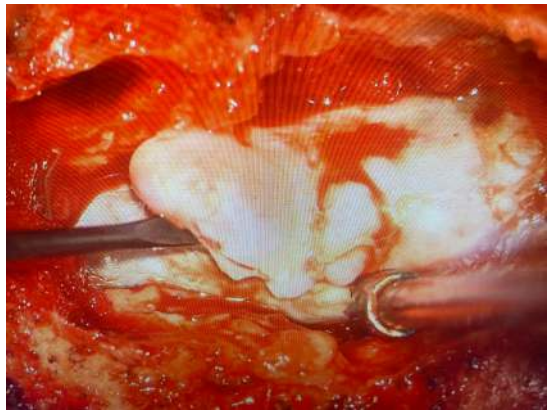
DURAL TEARS OF THE COMMON THECAL SAC

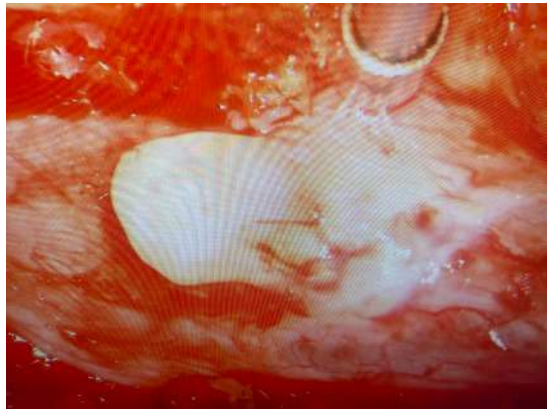


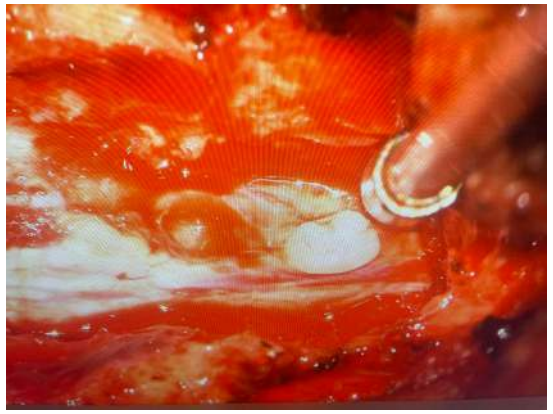




Dorsal leak





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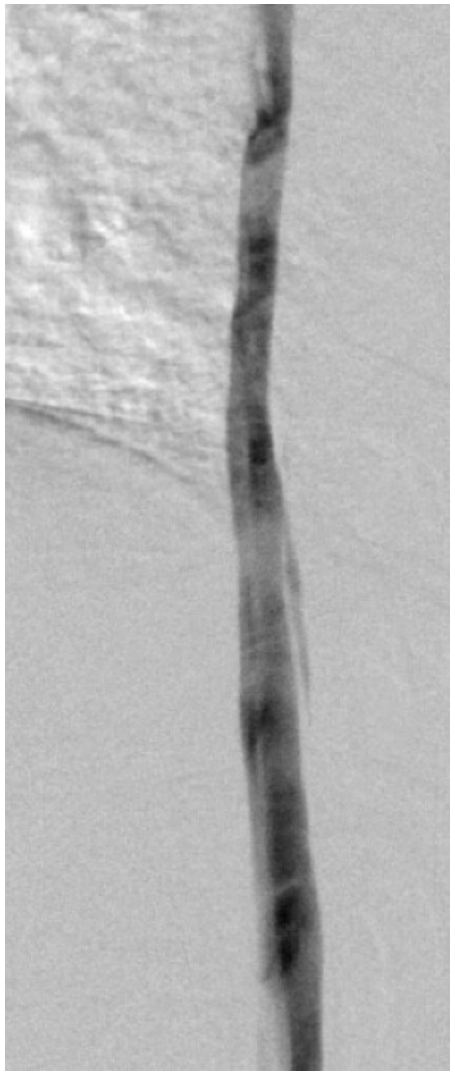
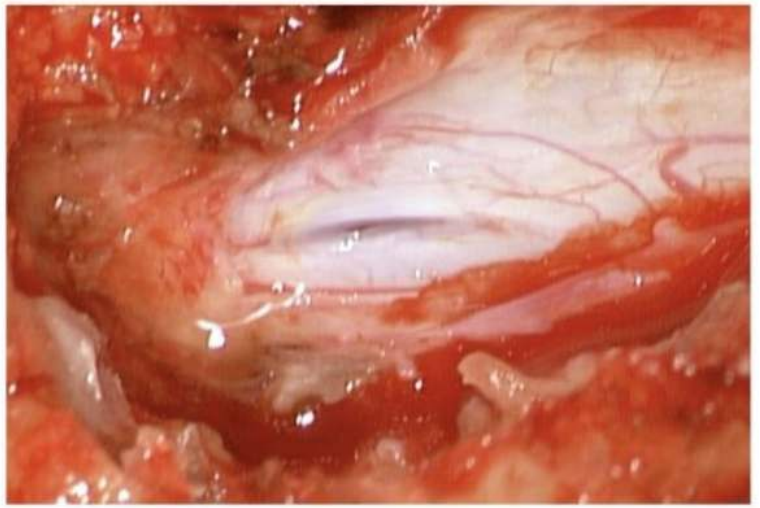
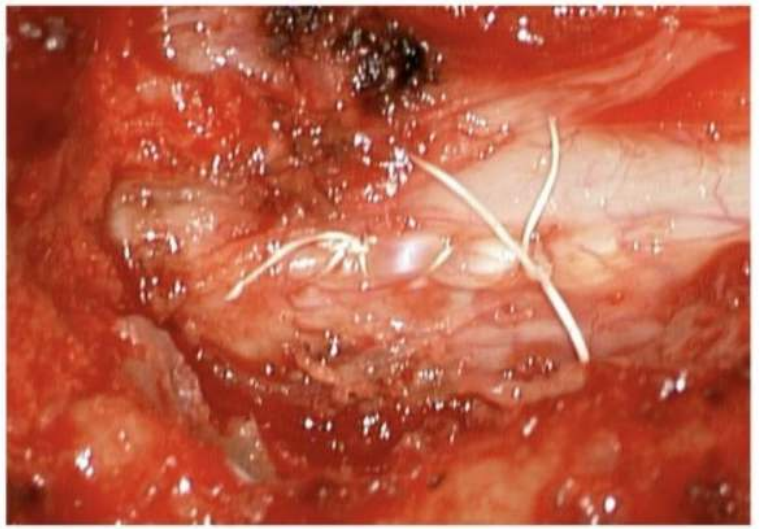
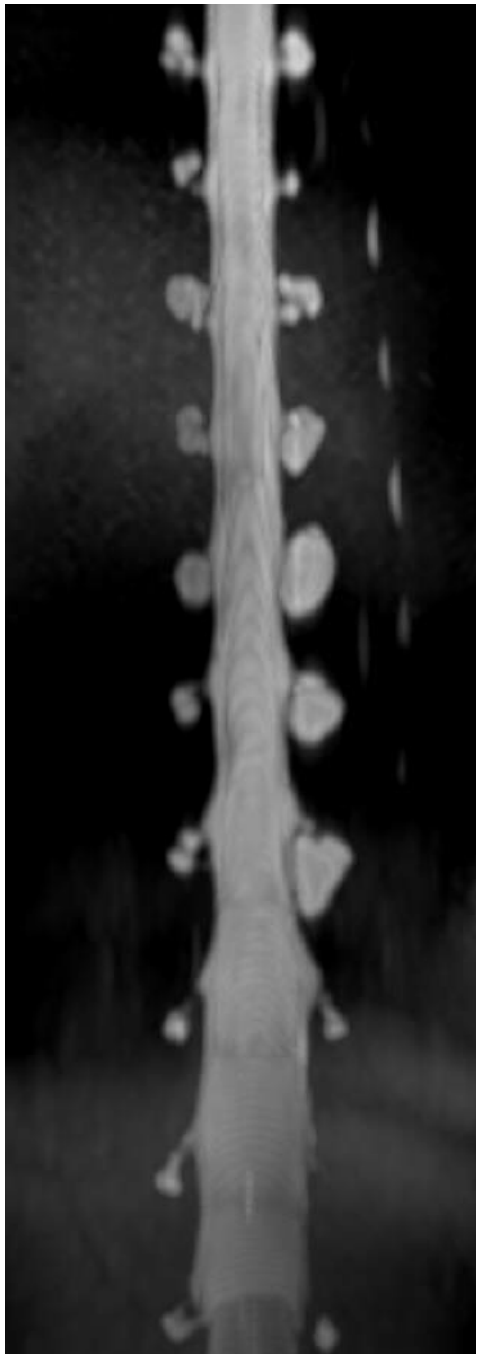
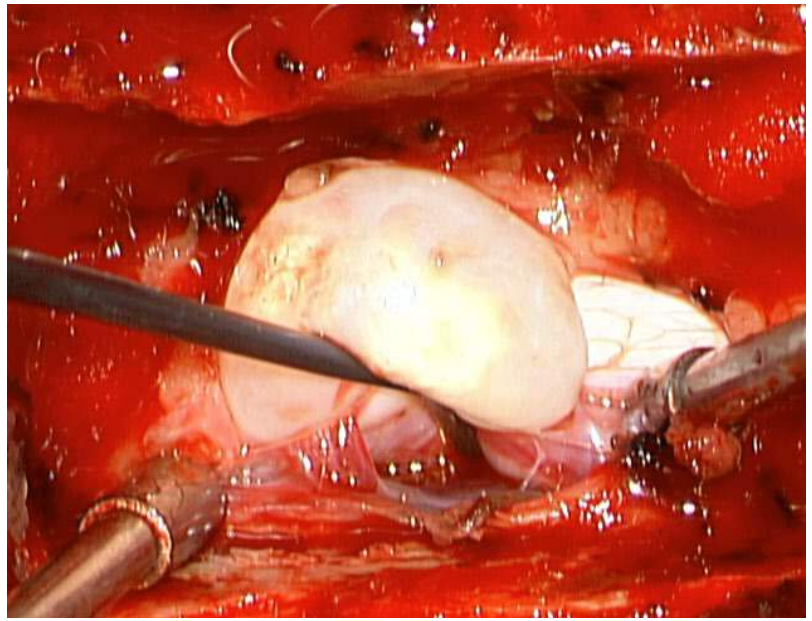




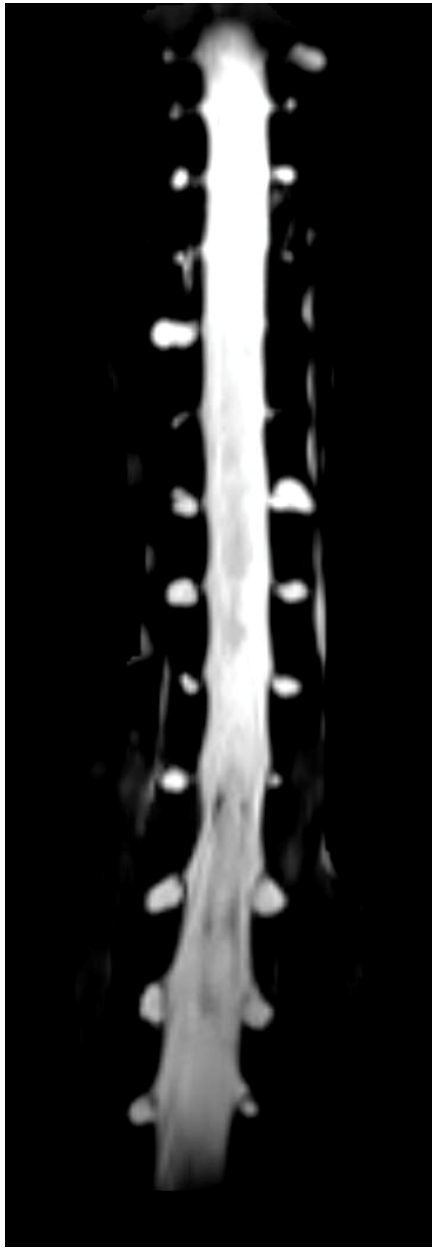


DURAL DIVERTICULA





Simple meningeal diverticula



Spinal Meningeal Diverticula in Spontaneous Intracranial Hypotension: Analysis of Prevalence and Myelographic Appearance

P.G. Kranz, S.S. Stinnett, K.T. Huang, and L. Gray

Table 1: Demographic data

	Control	SIH	*P* Value
Age (mean) (SD) (yr)	55.56 (13.85)	50.37 (13.27)	
Min/median/max	35/58/77	30/52/81	.186[a]
Sex			
Male (No.) (%)	12 (67)	5 (26)	
Female (No.) (%)	6 (33)	14 (74)	.014[b]

Note:—Min indicates minimum; max, maximum.
[a] *P* value based on the Wilcoxon rank sum test of the difference between medians.
[b] *P* value based on a χ^2 test of the difference in proportions.

Table 2: Prevalence of spinal meningeal diverticula by sex

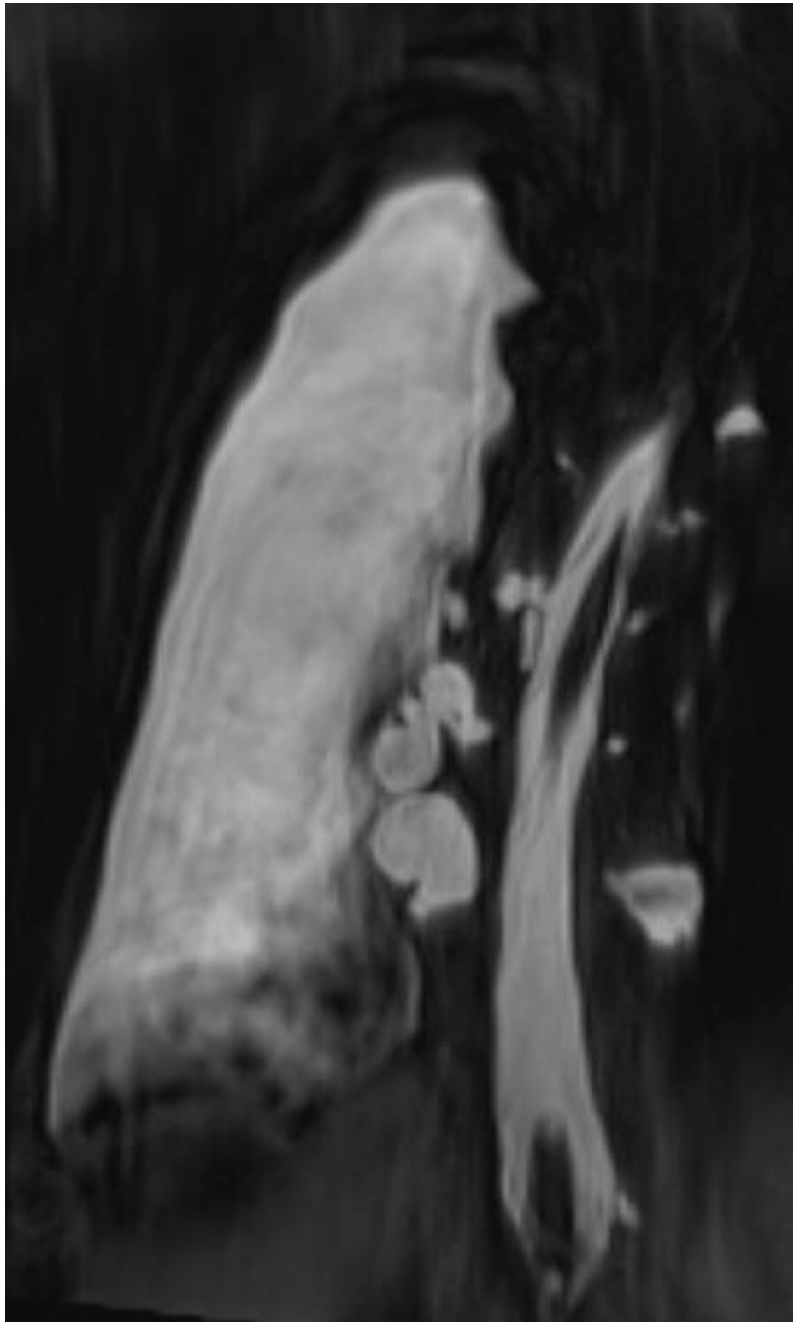
Diverticula per Patient	Male	Female	*P* Value[a]
Mean (SD)	1.6 (2.3)	6.5 (7.9)	.166
Min/median/max	0/1/7	0/1.5/23	

Note:—Min indicates minimum; max, maximum.
[a] *P* value based on the Wilcoxon rank sum test of the difference between medians.

Table 3: Prevalence of spinal meningeal diverticula and prominent nerve sheaths

	Control	SIH	*P* Value
Patients with diverticula present (No.) (%)	8 (44)	13 (68)	.141[a]
Diverticula per patient (mean)	2.2 (3.3)	6.3 (8.0)	.099[b]
Min/median/max	0/0/10	0/2/23	
Patients with prominent nerve sheaths present (No.) (%)	14 (78)	17 (89)	.405[c]
Prominent nerve sheaths per patient (mean)	2.6 (3.1)	6.1 (4.2)	.004[c]
Min/median/max	0/1.5/13	0/5/15	

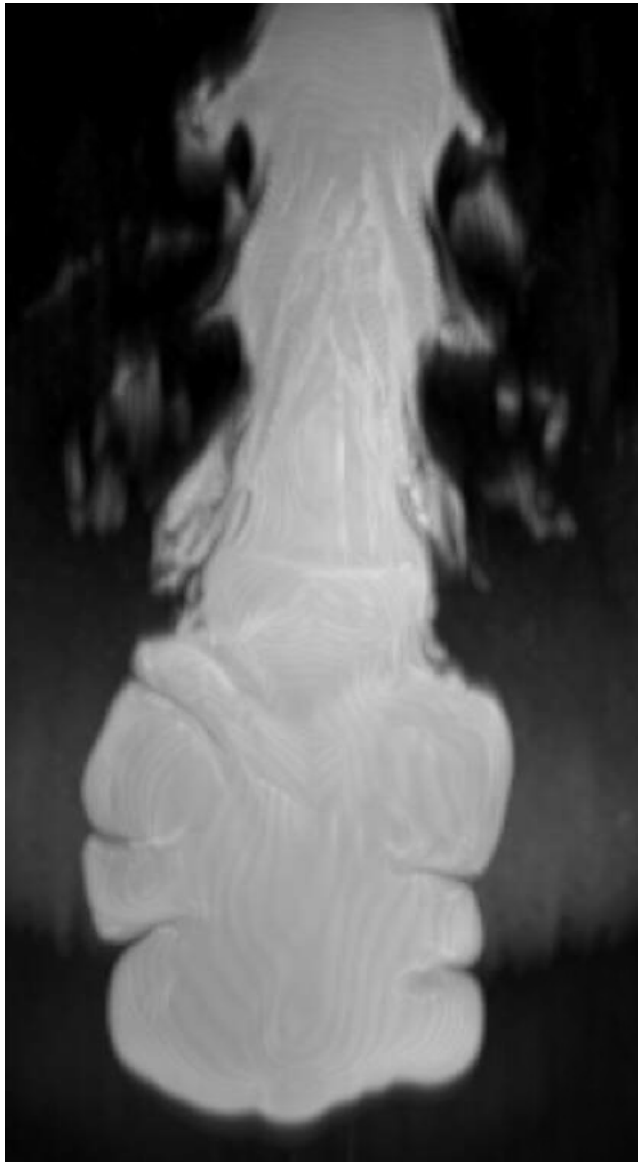
Note:—Min indicates minimum; max, maximum.
[a] *P* value based on a χ^2 test of the difference between proportions.
[b] *P* value based on the Wilcoxon rank sum test of the difference between medians.
[c] *P* value based on the Fisher exact test of the difference between proportions.

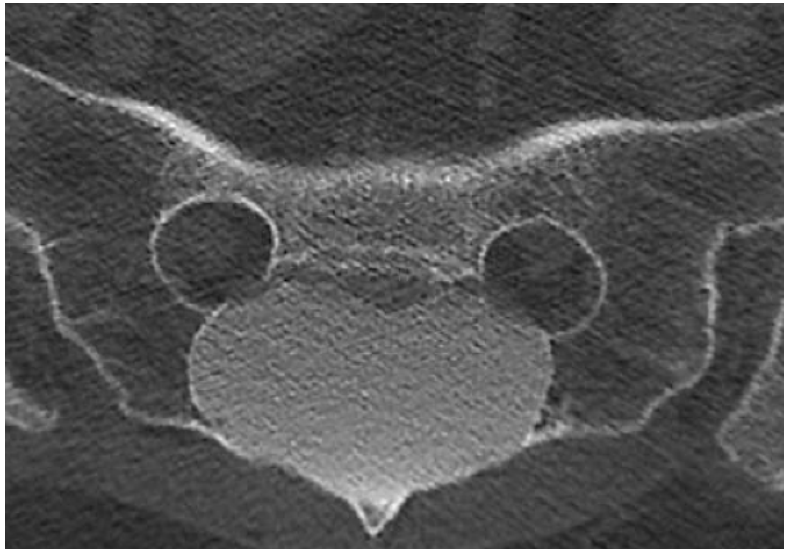


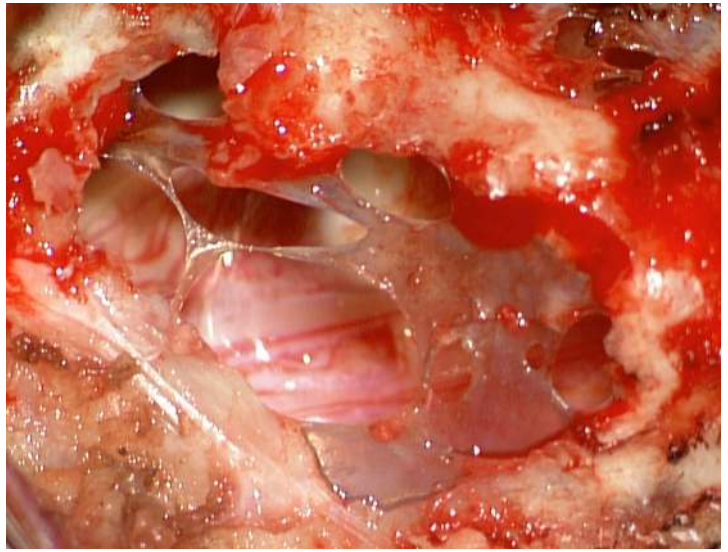
Meningeal diverticula with extradural CSF

CSF hydrothorax

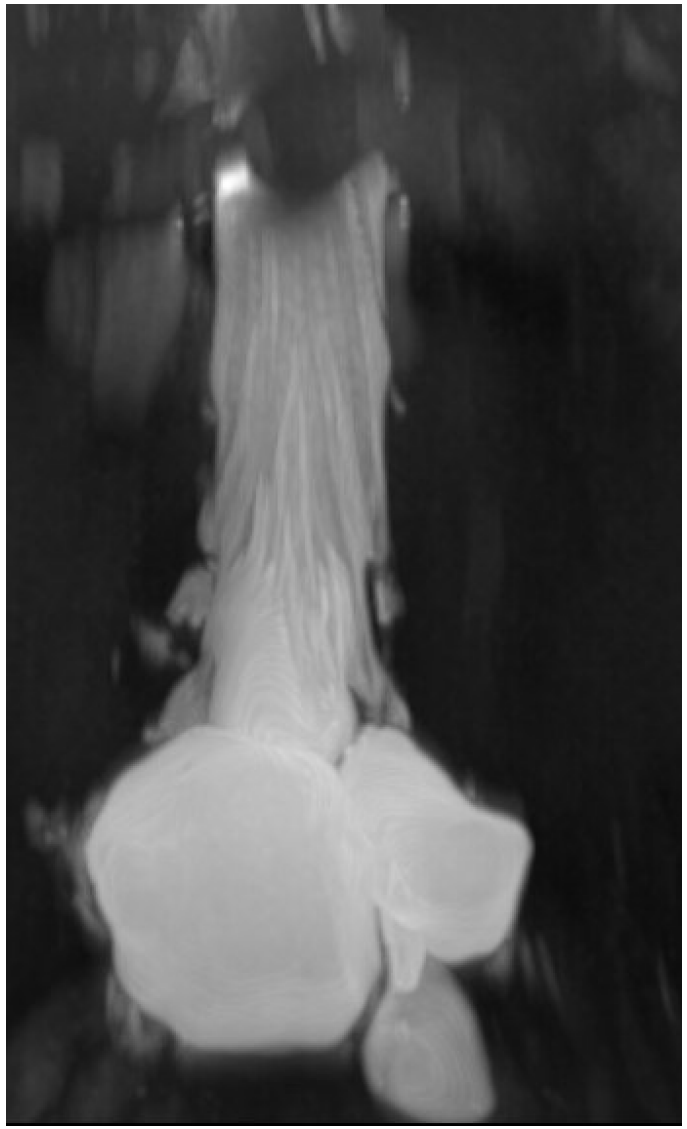
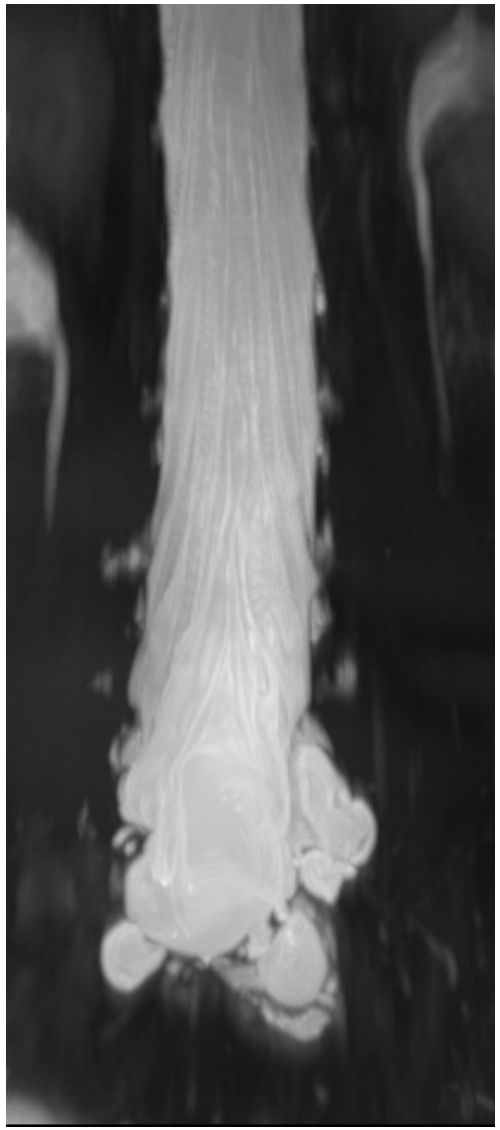
DURAL DIVERTICULA

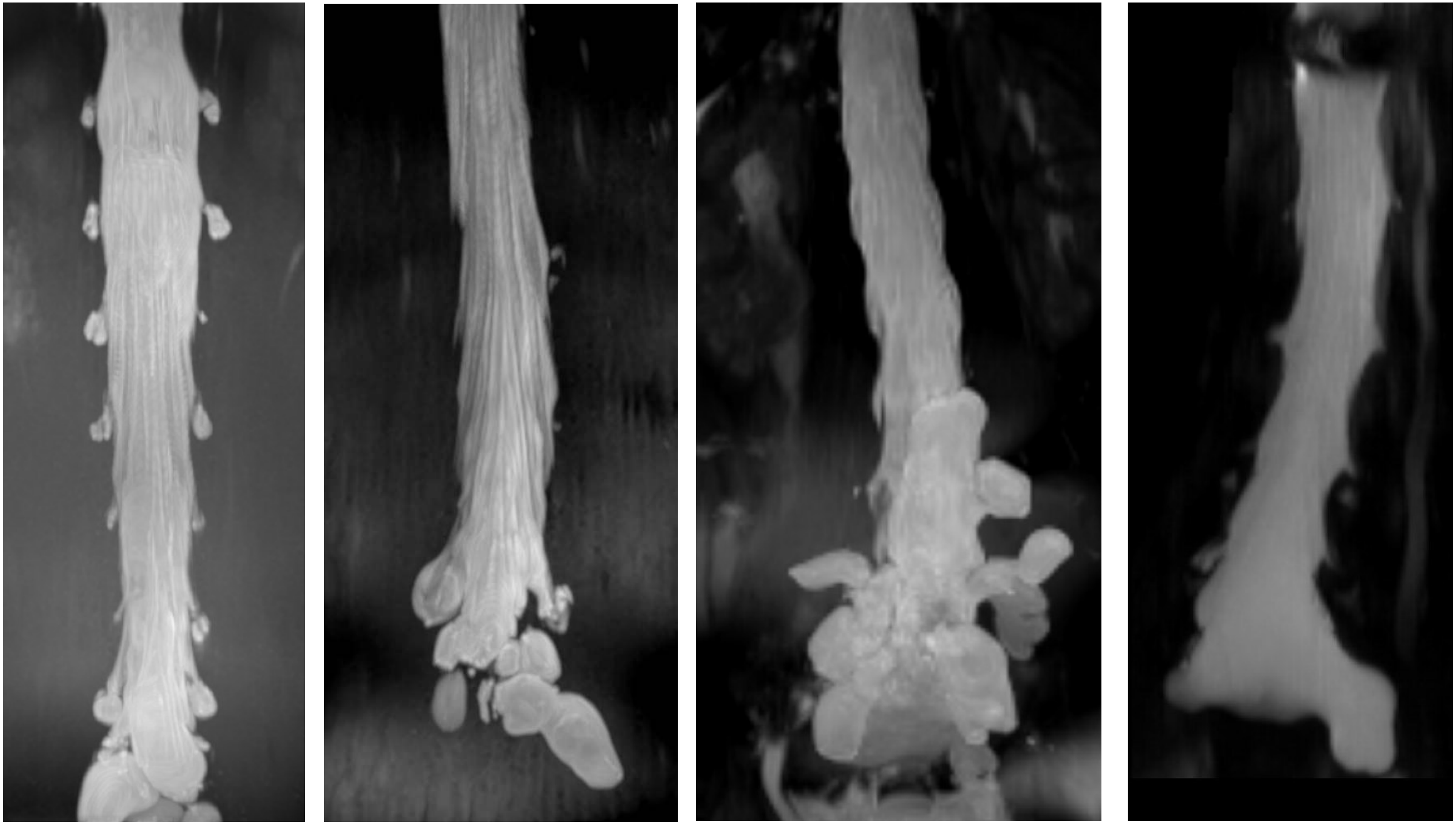






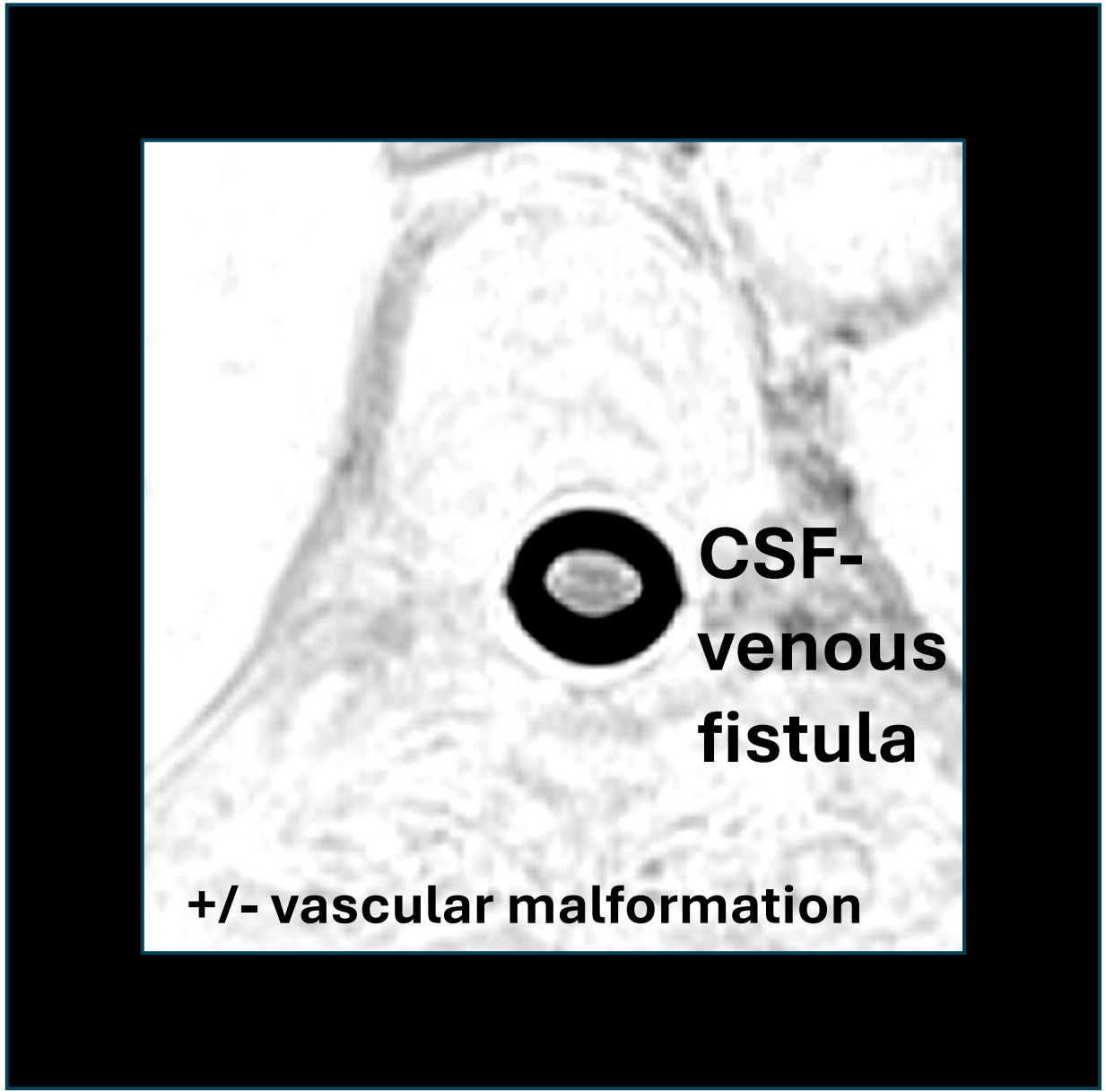
Complex meningeal diverticula/dural ectasia

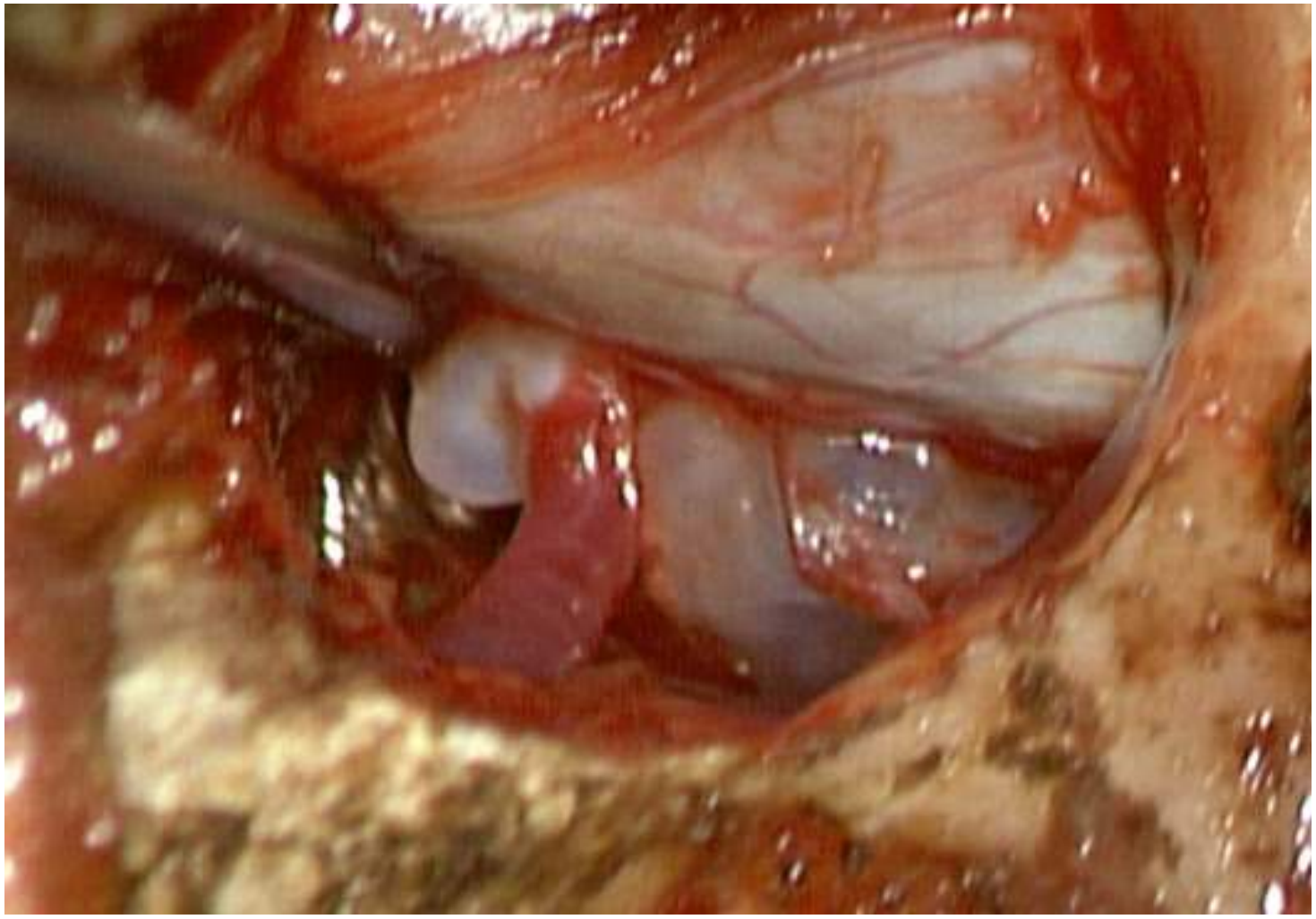





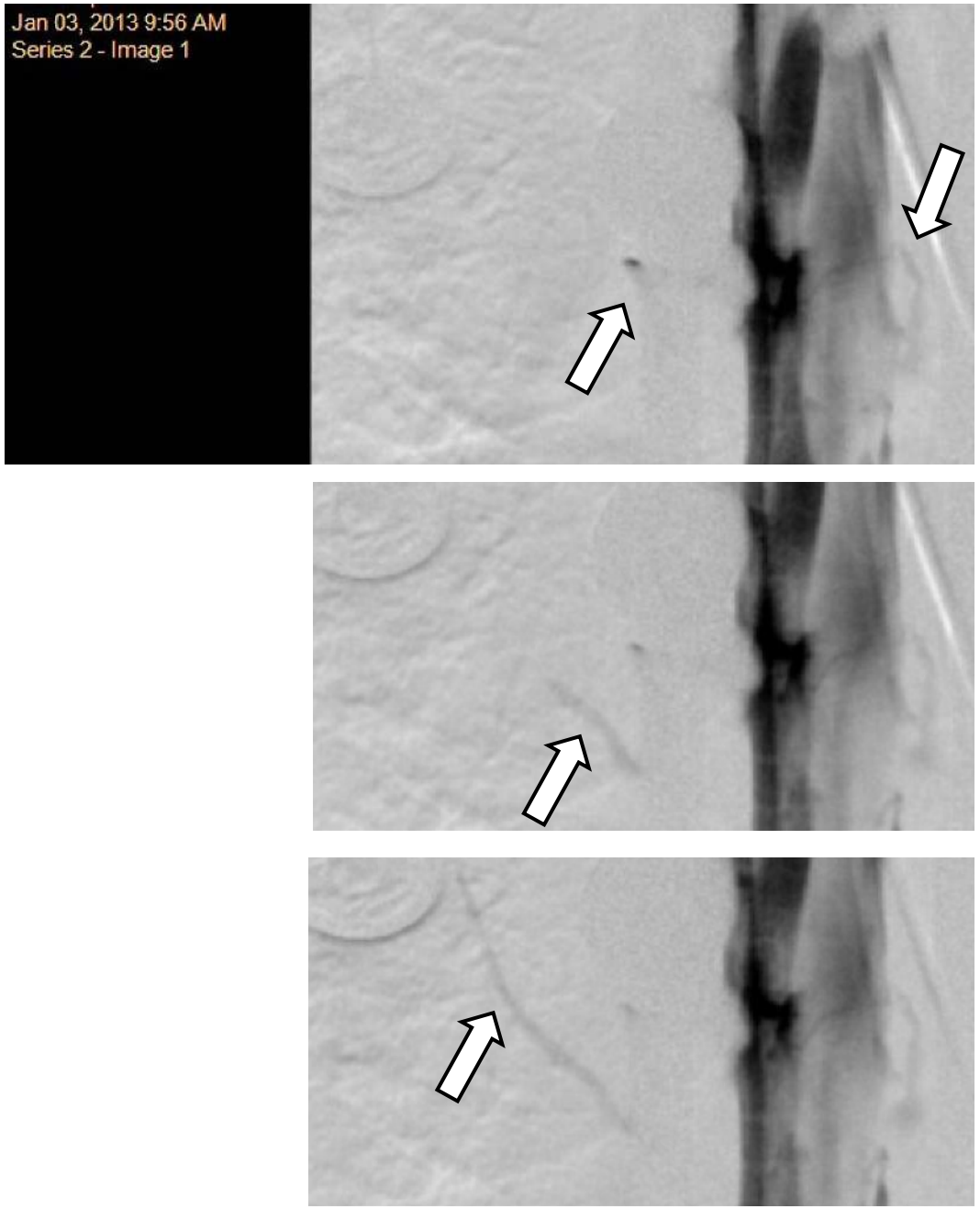
Although surgery for simple cysts is simple,
surgery for complex cysts/dural ectasia is not

FISTULAS





CSF-venous fistula



Clinical/Scientific Notes

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

CSF-VENOUS FISTULA IN SPONTANEOUS INTRACRANIAL HYPOTENSION

Spontaneous intracranial hypotension (SIH) is an important cause of new daily persistent headaches.[1] In most patients, the underlying cause is a CSF leak, always at the level of the spine.[2] Once escaped into the epidural space, CSF is rapidly absorbed by the spinal epidural venous plexus, which is often maximally dilated in the setting of SIH. With conventional imaging, the presence of contrast in epidural veins has not been demonstrated in SIH, but indirect evidence for rapid venous absorption such as contrast in the renal collection system on CT myelography or early activity of tracer in the bladder on nuclear cisternography is common.[1] We report the radiographic demonstration of direct CSF–venous fistulae in patients with SIH using digital subtraction myelography (DSM). DSM allows real-time high-resolution imaging of contrast injected through a lumbar puncture.[3–5]

Case reports. *Case 1.* A 52-year-old woman noted a second half of the day headache, neck stiffness, and interscapular pain. Neurologic examination was normal. MRI showed pachymeningeal enhancement and brain sagging. CT and magnetic resonance (MR) myelography showed multiple thoracic cysts but no CSF leak. CSF examination was normal. Bed rest provided little relief. DSM showed a direct fistula originating from the left T-10 cyst into a spinal epidural vein (figure). Percutaneous fibrin glue injection resulted in resolution of symptoms.

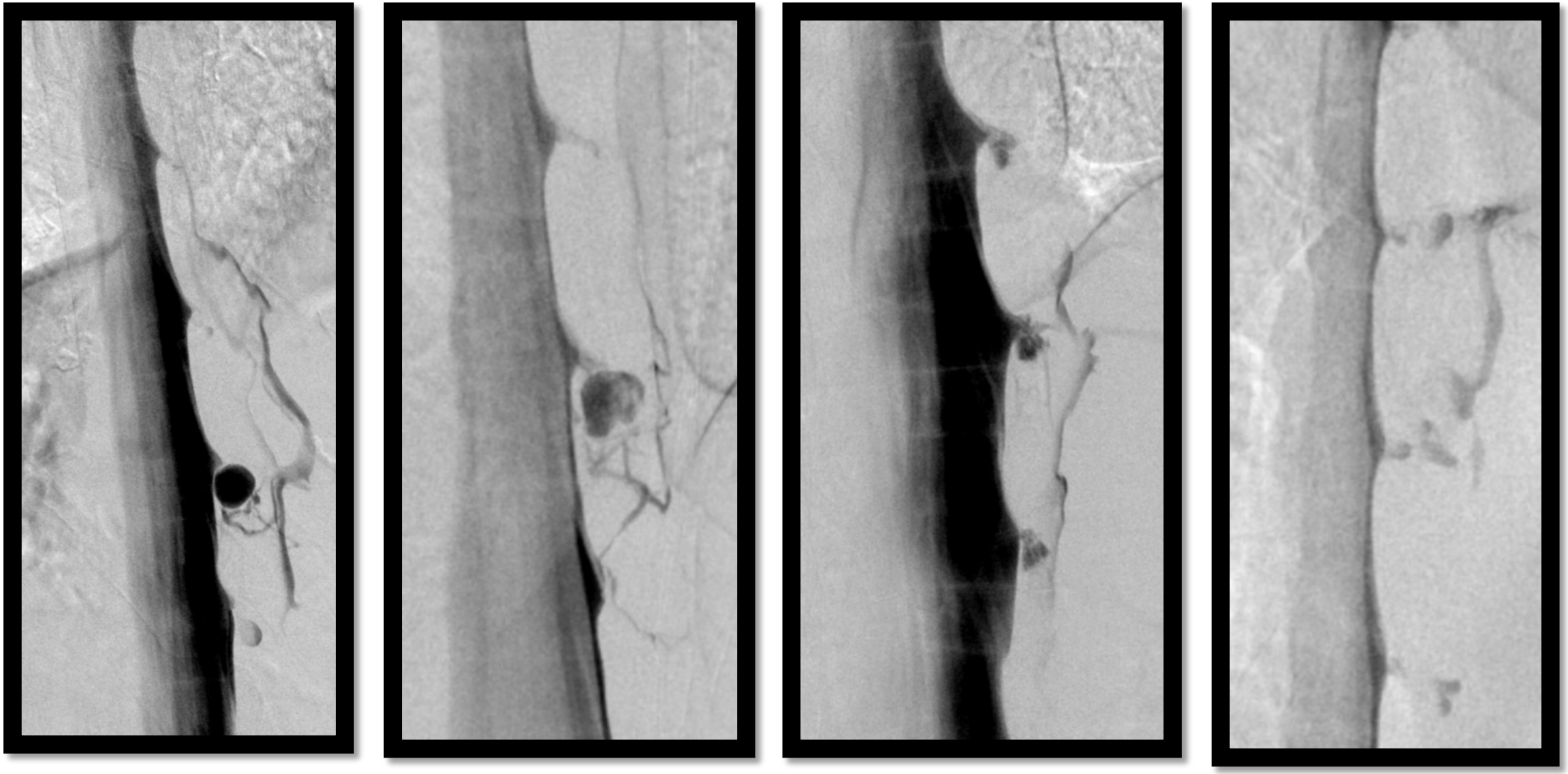
Case 2. A 31-year-old woman noted an orthostatic headache, ringing in the ears, and neck stiffness. Neurologic examination was normal. MRI showed pachymeningeal enhancement, brain sagging, and pituitary enlargement. CT and MR myelography showed an extensive spinal ventral extradural CSF collection. CSF examination was normal. The patient underwent numerous epidural blood patches but symptoms persisted. DSM showed a ventral CSF leak at T-2/3 and she underwent surgical repair resulting in resolution of symptoms. Ten months later, symptoms recurred, but CT myelography did not show any CSF leak. DSM showed a direct fistula originating from the region of the left T-4 nerve root into a spinal epidural vein (figure). The ventral CSF leak was no longer demonstrable. At surgery, epidural venous dilation was significant and a dural tear at the axilla of the left T-4 nerve root was identified and this was sutured, resulting in resolution of symptoms.

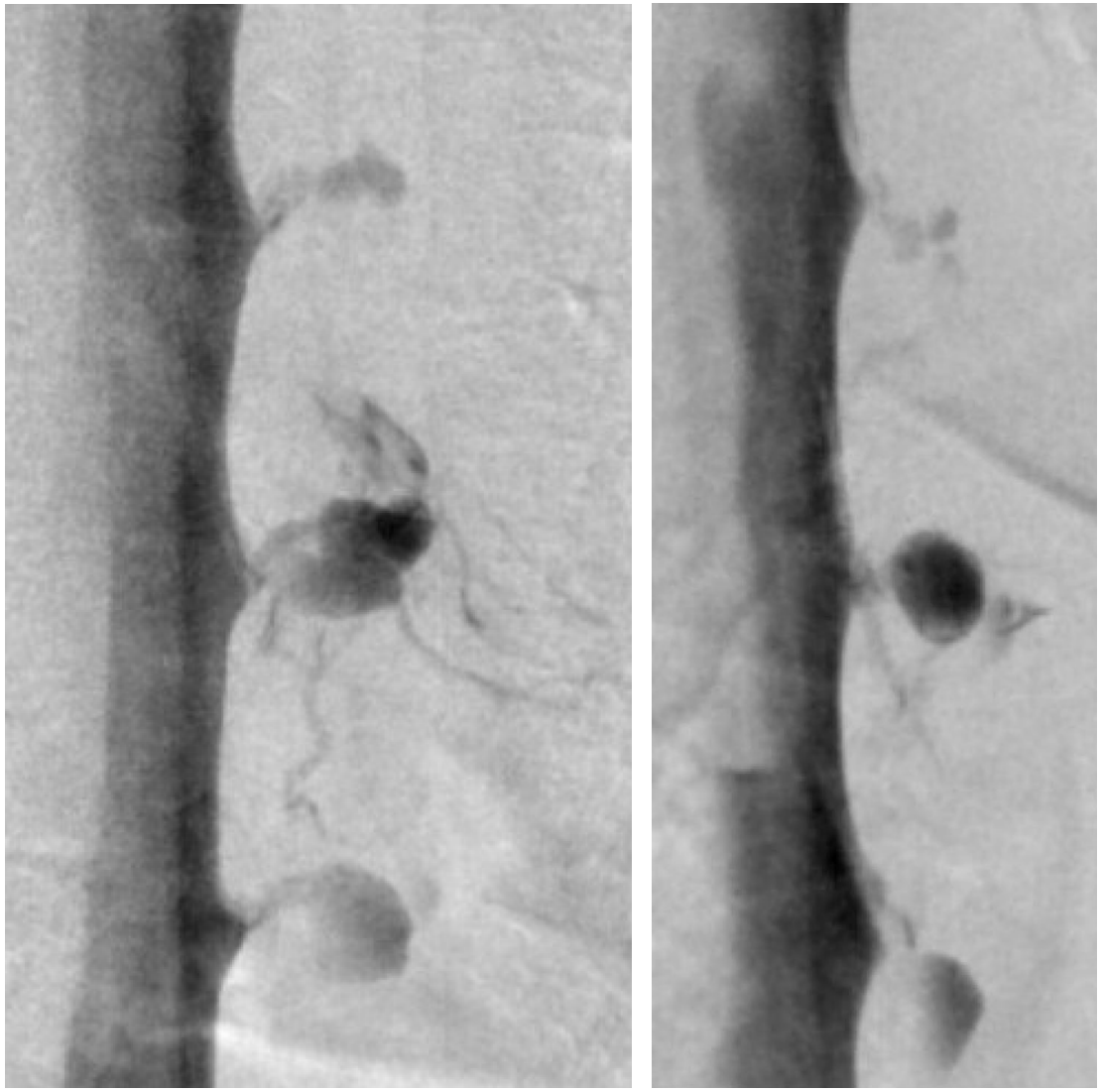
Case 3. A 48-year-old woman noted an orthostatic headache, nausea, emesis, and neck stiffness. Neurologic examination was normal. MRI showed pachymeningeal enhancement and brain sagging. CT and MR myelography showed an extensive spinal ventral extradural CSF collection. CSF examination was normal. She underwent numerous epidural blood patches but symptoms persisted. DSM showed a ventral CSF leak at T-5/6 associated with a direct communication into a spinal epidural vein (figure). At surgery, epidural venous dilation was significant and a ventral dural tear was repaired resulting in resolution of symptoms.

Discussion. In this report, we demonstrate direct fistulae between the subarachnoid space and spinal epidural veins, a previously unreported finding in SIH. In 2 of the 3 patients, the fistula provided crucial information for localizing the site of the CSF leak. In fact, MRI and CT myelography had not shown any evidence for a CSF leak in these 2 patients. Whether or not DSM should be considered for all patients with refractory SIH but unrevealing conventional spinal imaging remains to be determined. DSM usually is reserved for rapid CSF leaks visible on MRI or CT myelography as extensive longitudinal intraspinal extradural fluid collections.[3–5] DSM allows visualization of rapid CSF leaks due to its inherent temporal resolution advantage. The procedure differs from conventional myelography in several aspects, although associated risks are similar.[4] We have found that the best diagnostic information is obtained when DSM is completed with the patient under anesthesia and complete paralysis with breath hold, although others have reported excellent results without anesthesia.[4] DSM technique requires a bolus injection of intrathecal contrast to maximize visualization and allow breath hold imaging. The radiation dose of DSM is slightly higher than that of conventional myelography, but it is less than that of conventional CT myelography because demonstration of a leak is not dependent on post myelography CT imaging.

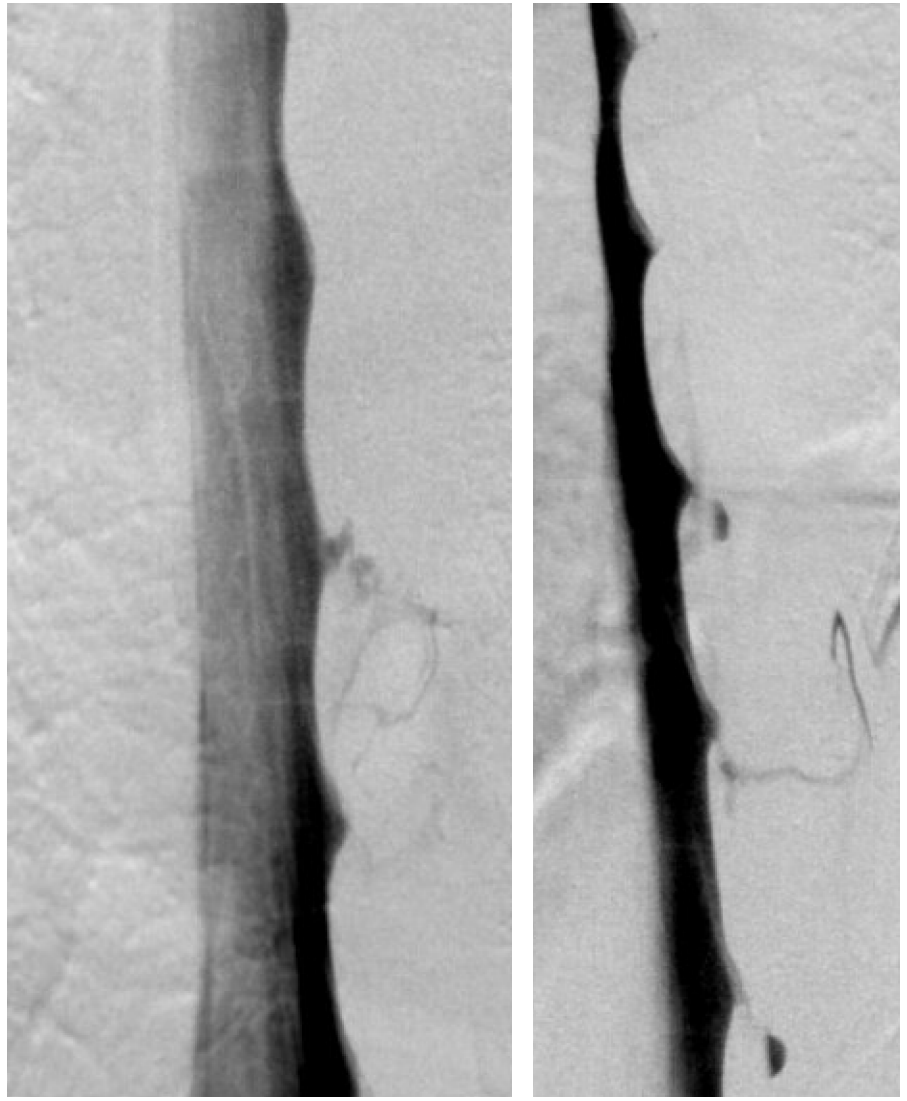
Iatrogenic CSF venous fistulae following myelography have been reported previously.[6] Our cases show that venous injury by a needle is not necessary to

Spontaneous spinal CSF-venous fistulas

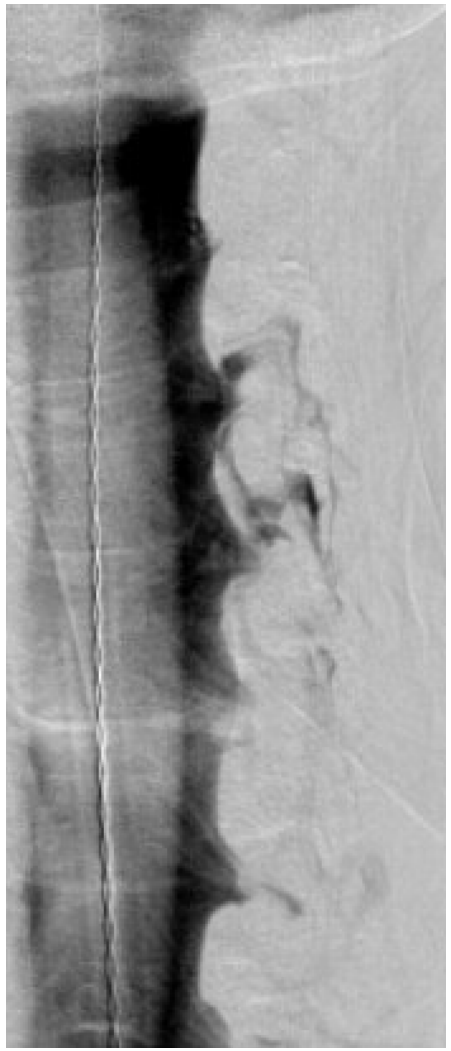




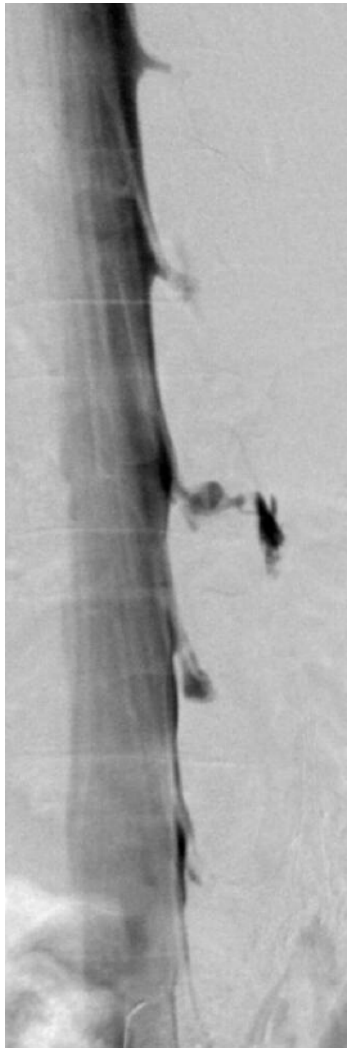
Thoracic – with meningeal diverticulum

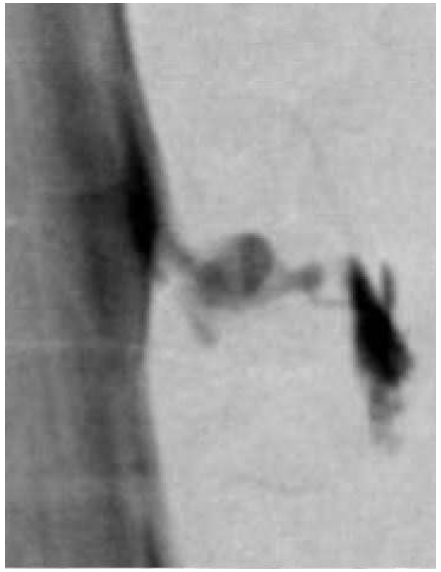


Thoracic – without meningeal diverticulum

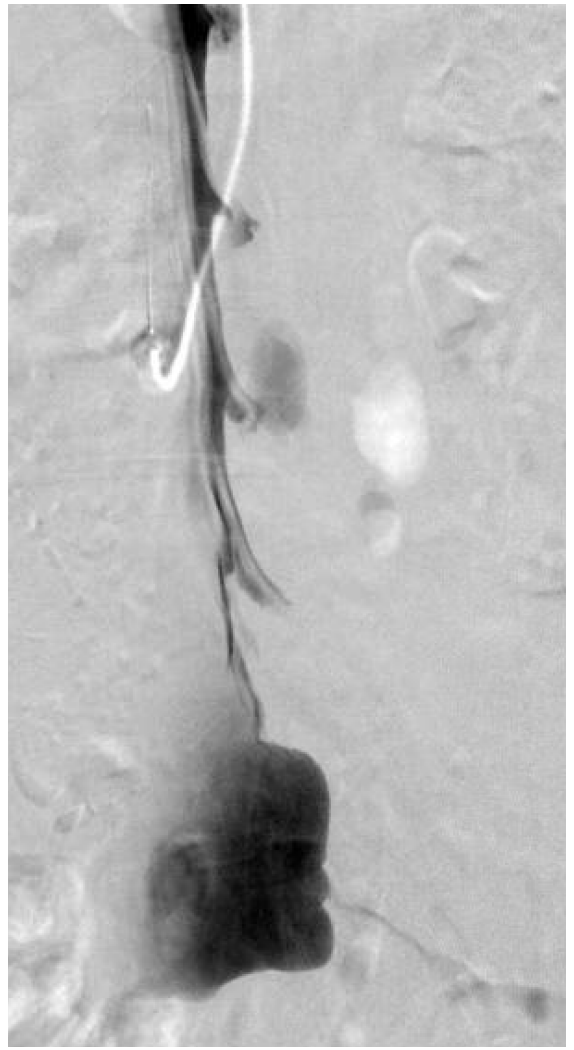


Cervical



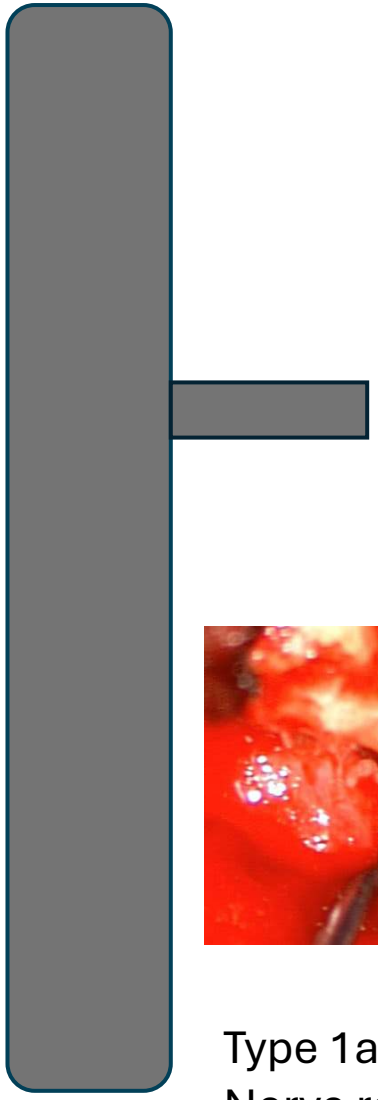


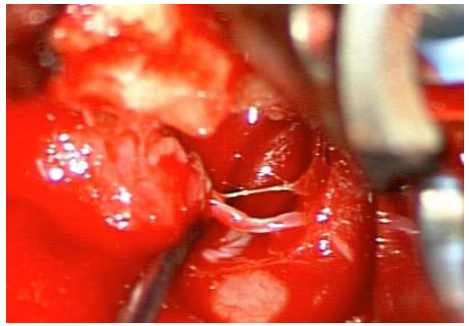
Lumbar



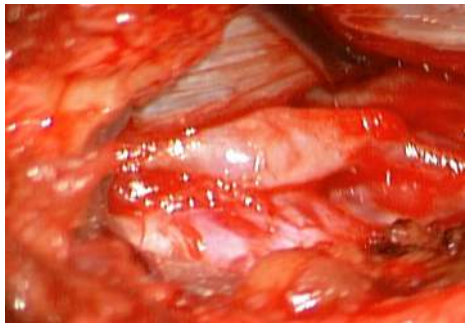
Sacral

Classification of spontaneous spinal CSF-venous fistulas

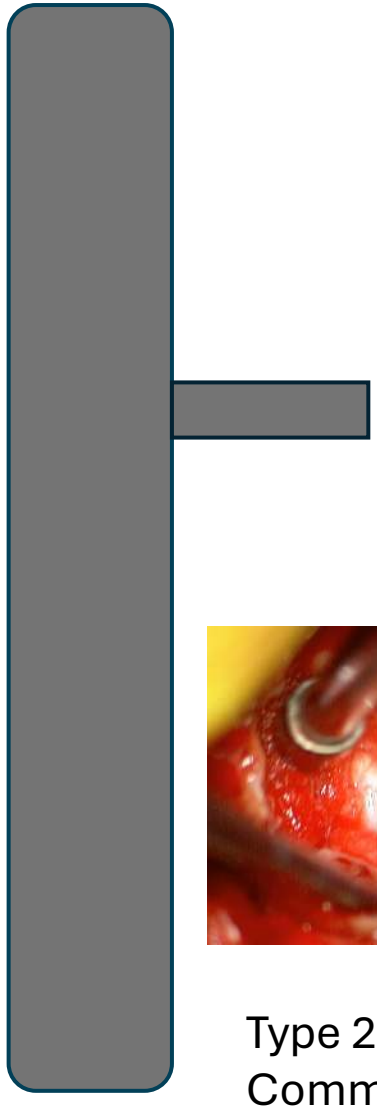


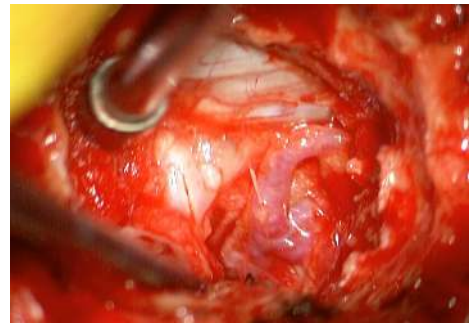


Type 1a - 80%
Nerve root sleeve – Distal



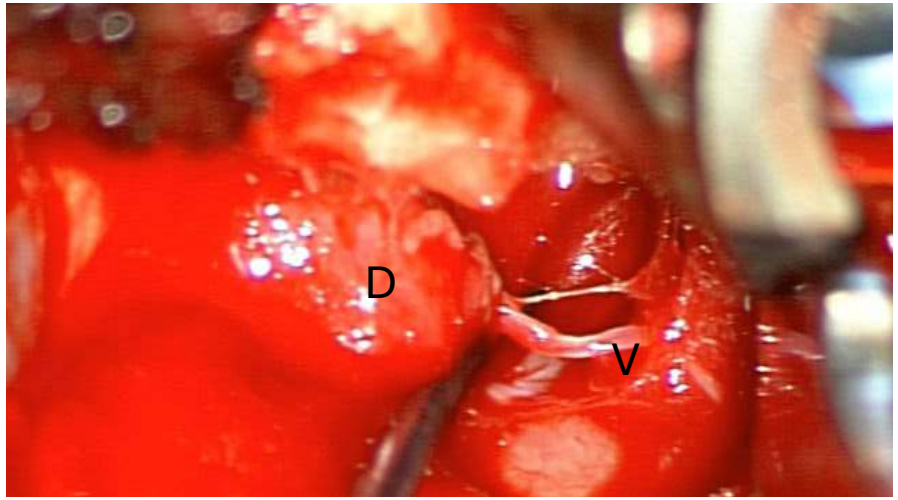
Type 1b - 10%
Nerve root sleeve – Proximal

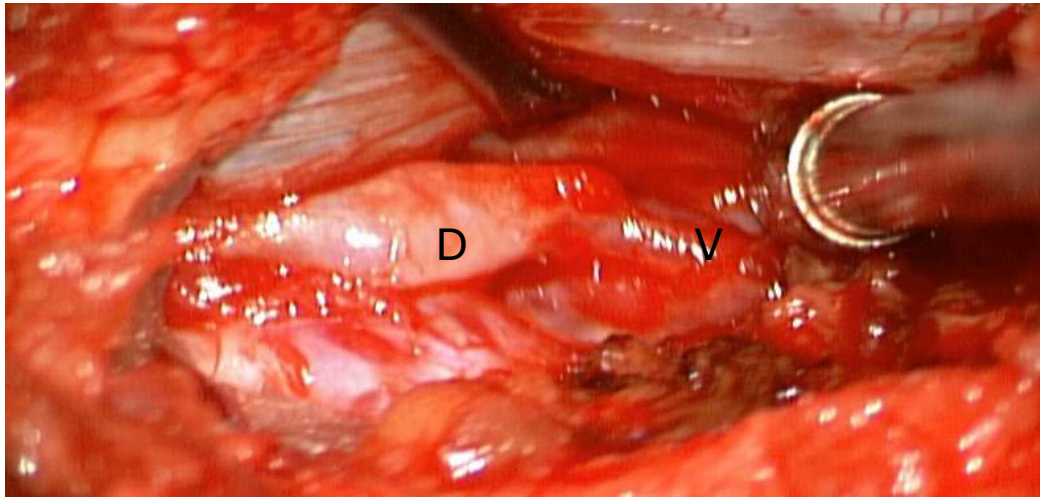


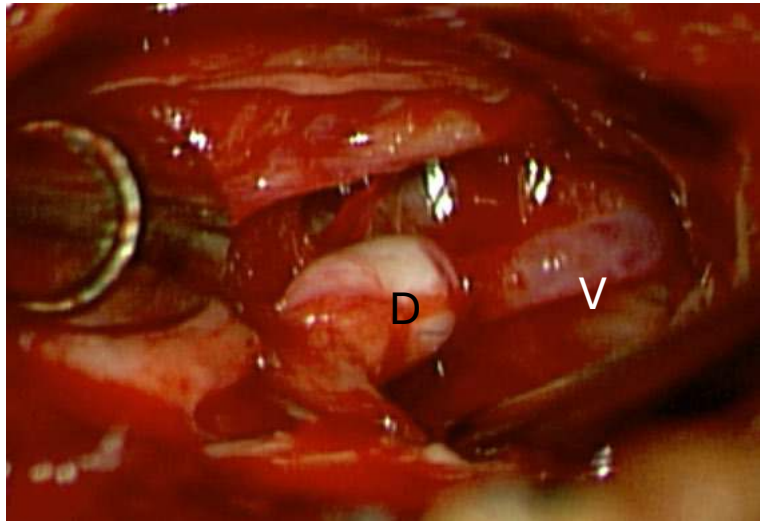


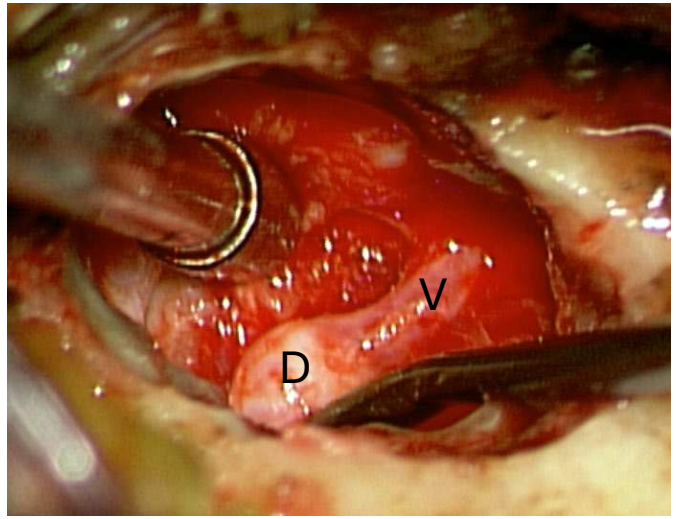
Type 2 - 10%
Common thecal sac

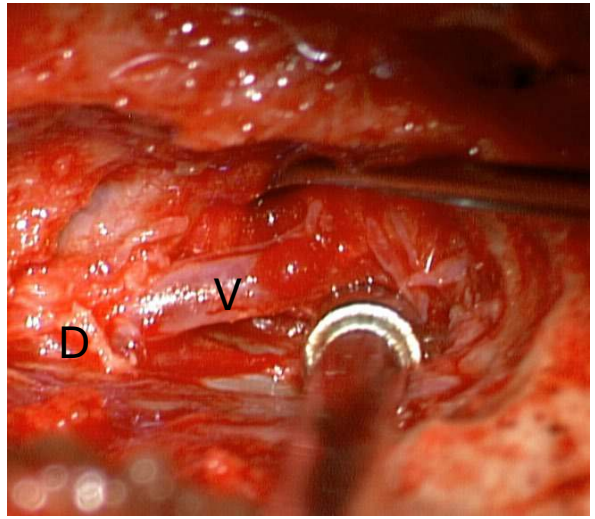
Spontaneous spinal CSF-venous fistulas



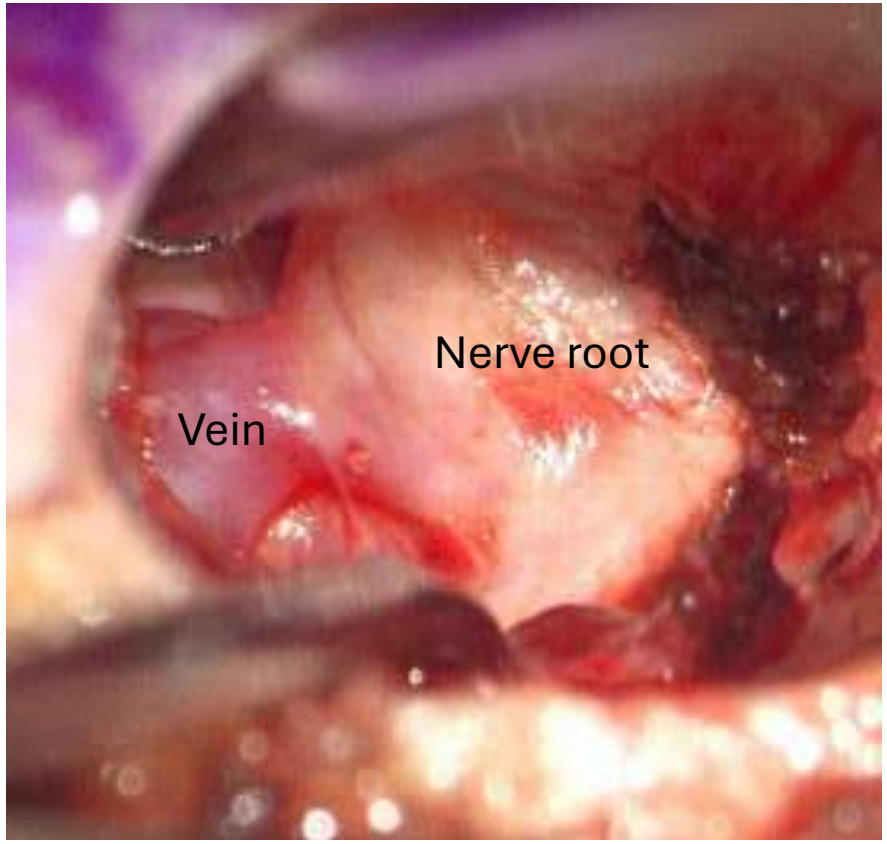


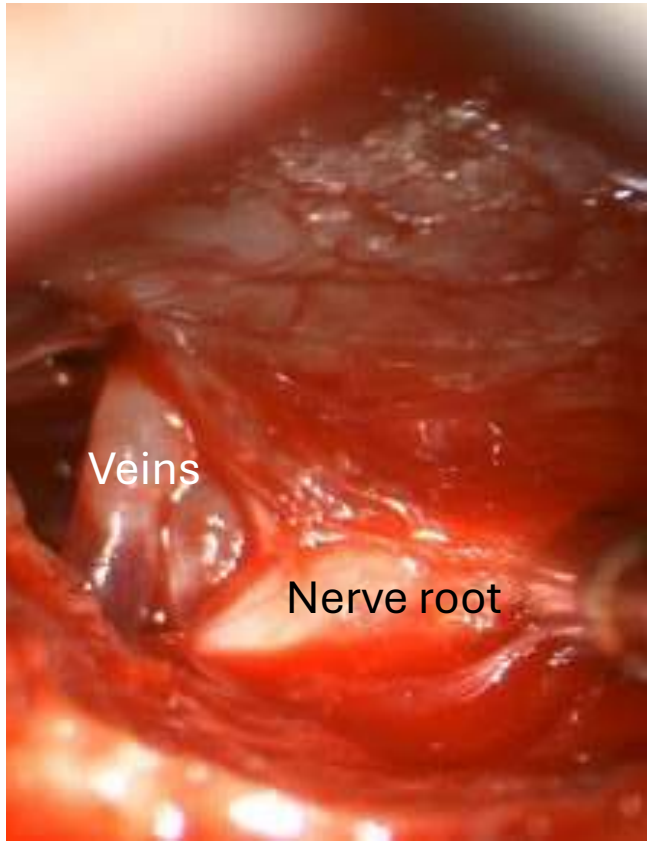


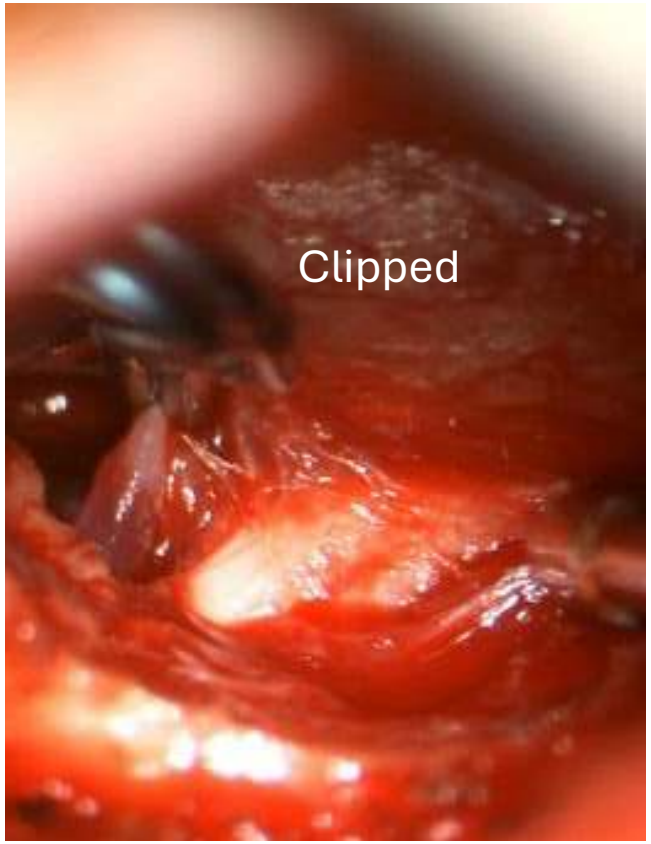


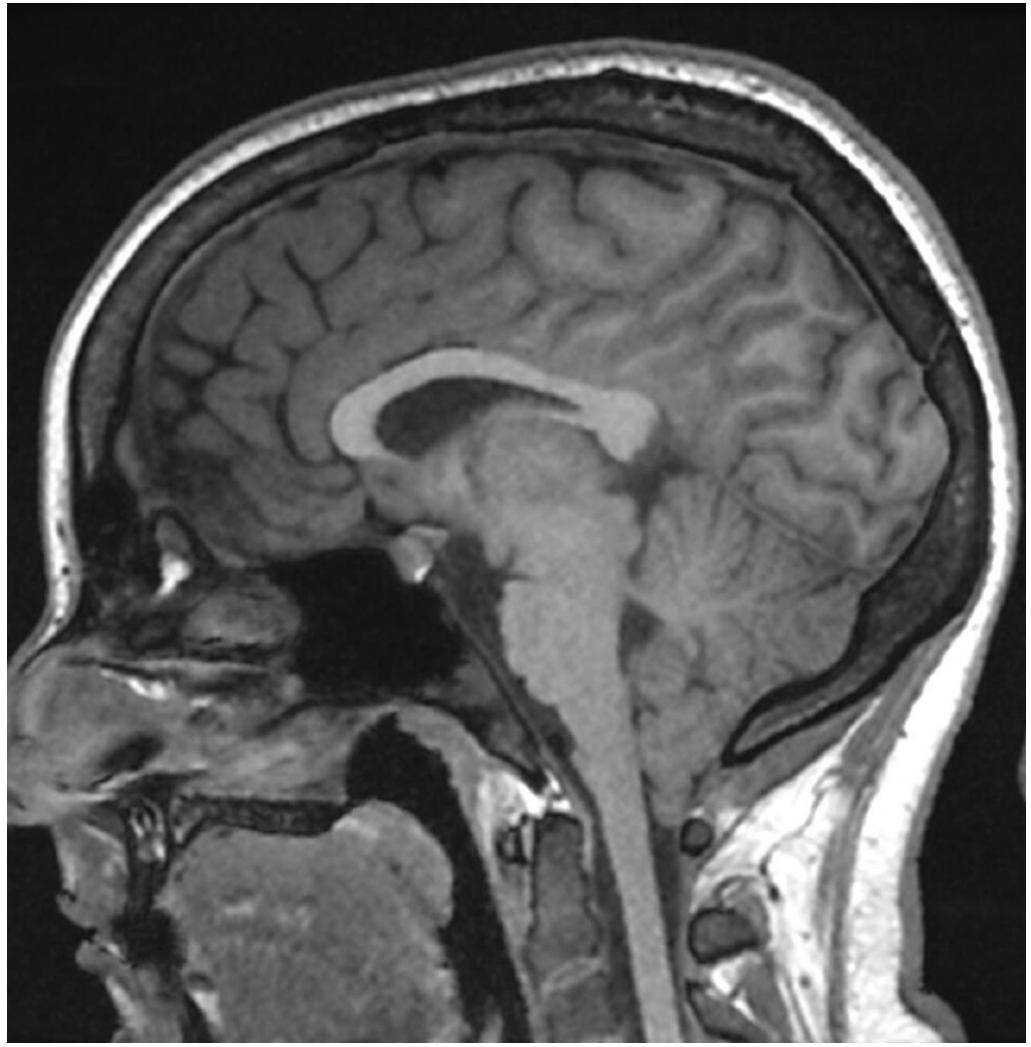


Spontaneous spinal CSF-venous fistulas

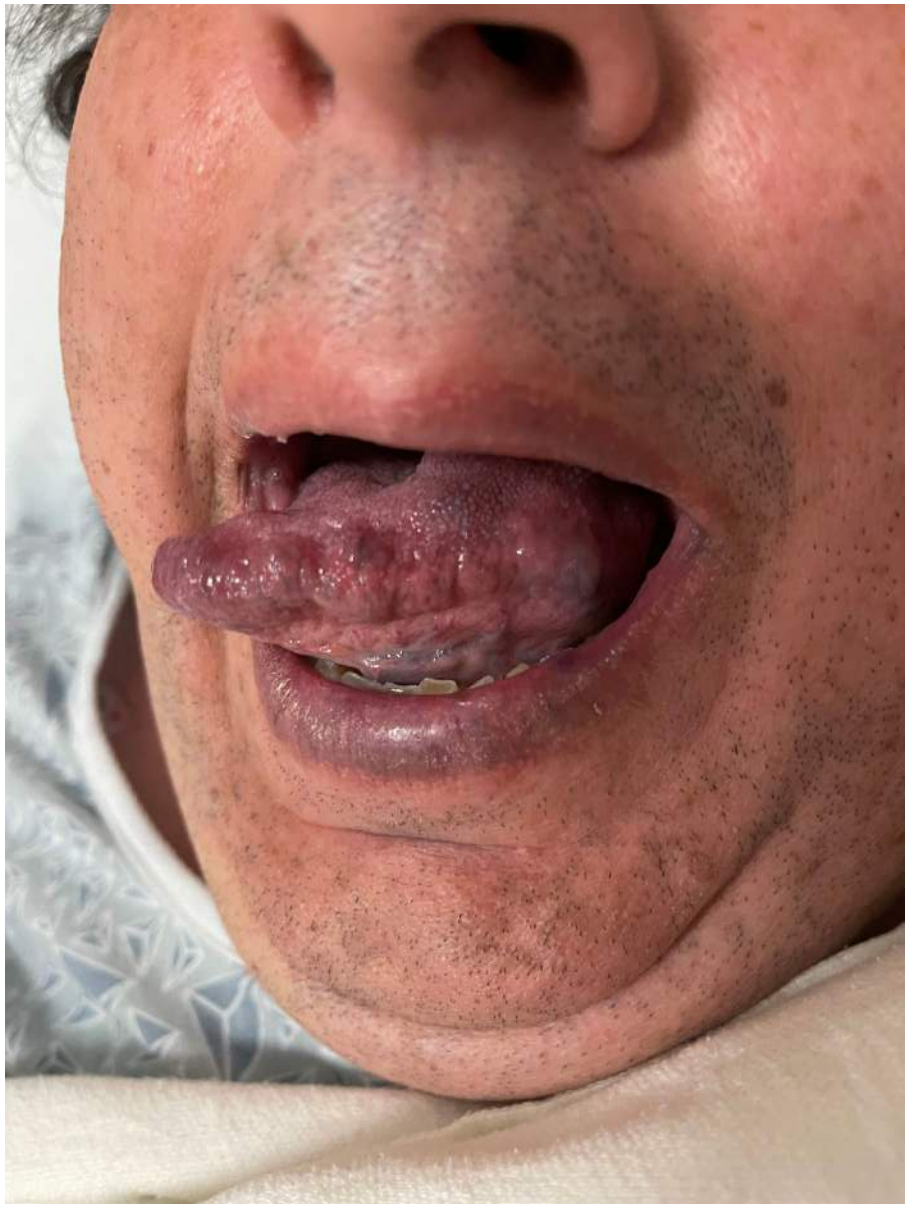






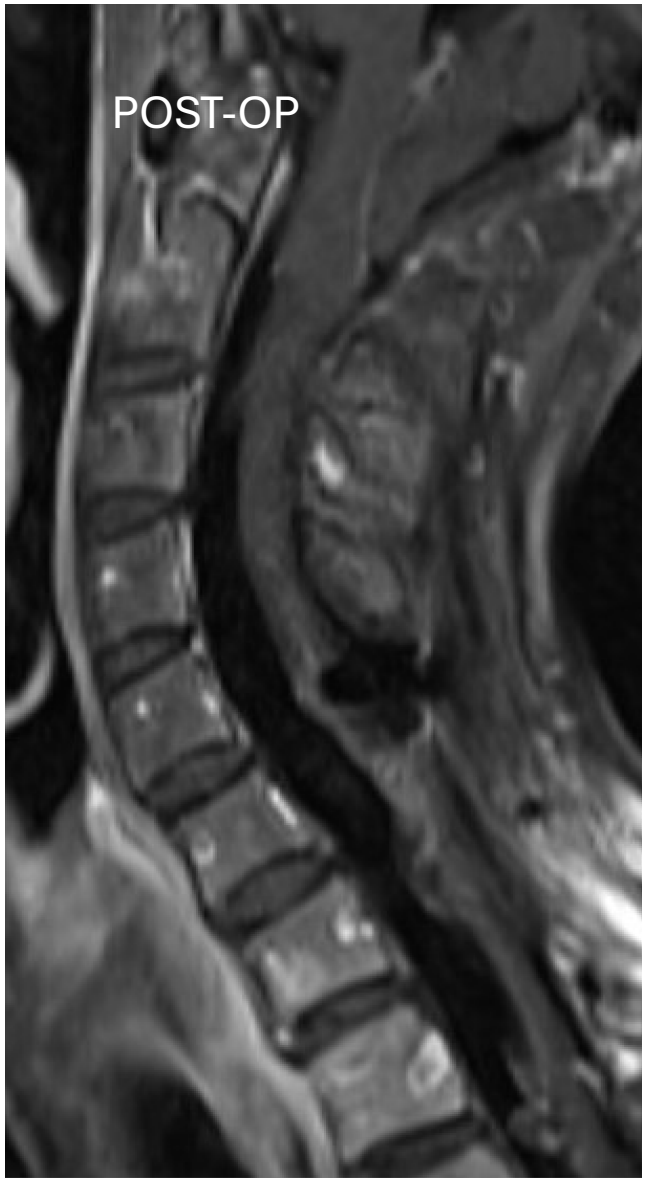


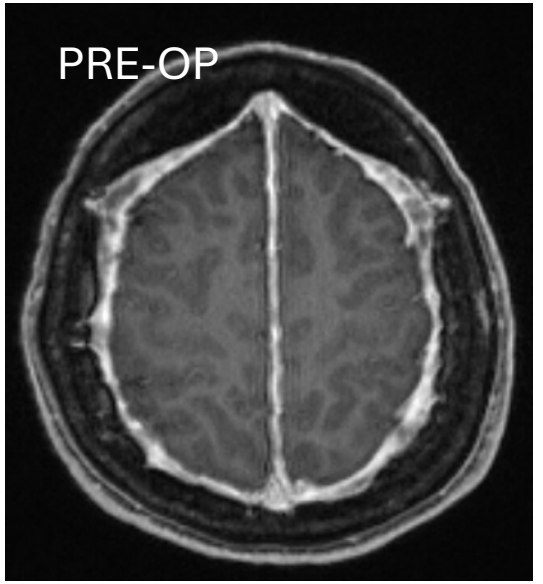
MV: 17-year-old girl with one month history of progressive orthostatic headaches



AT: 54-year-old man with 13-year history of orthostatic headaches


PRE-OP


POST-OP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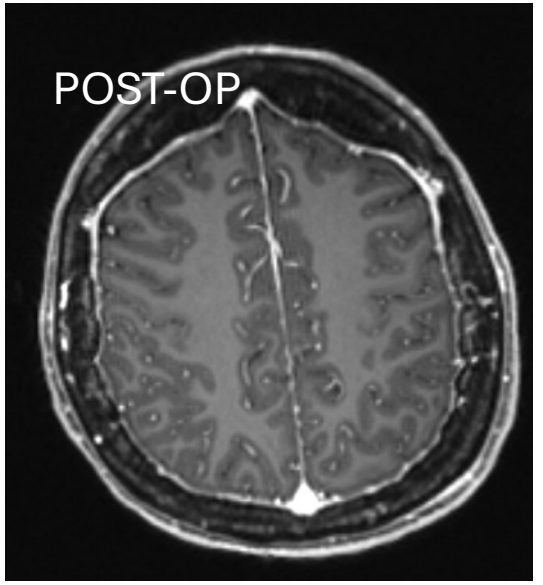
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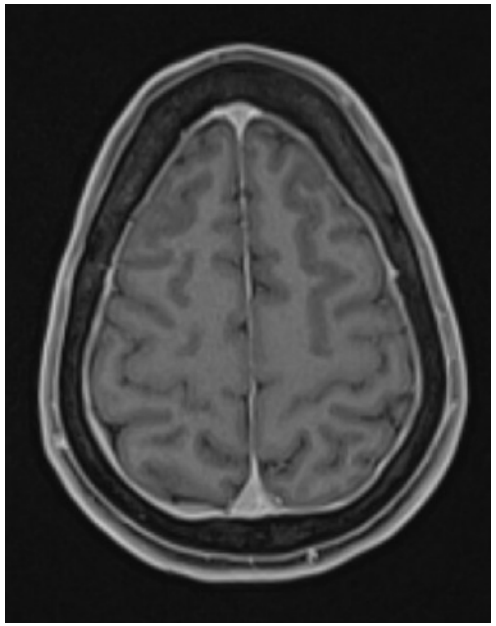
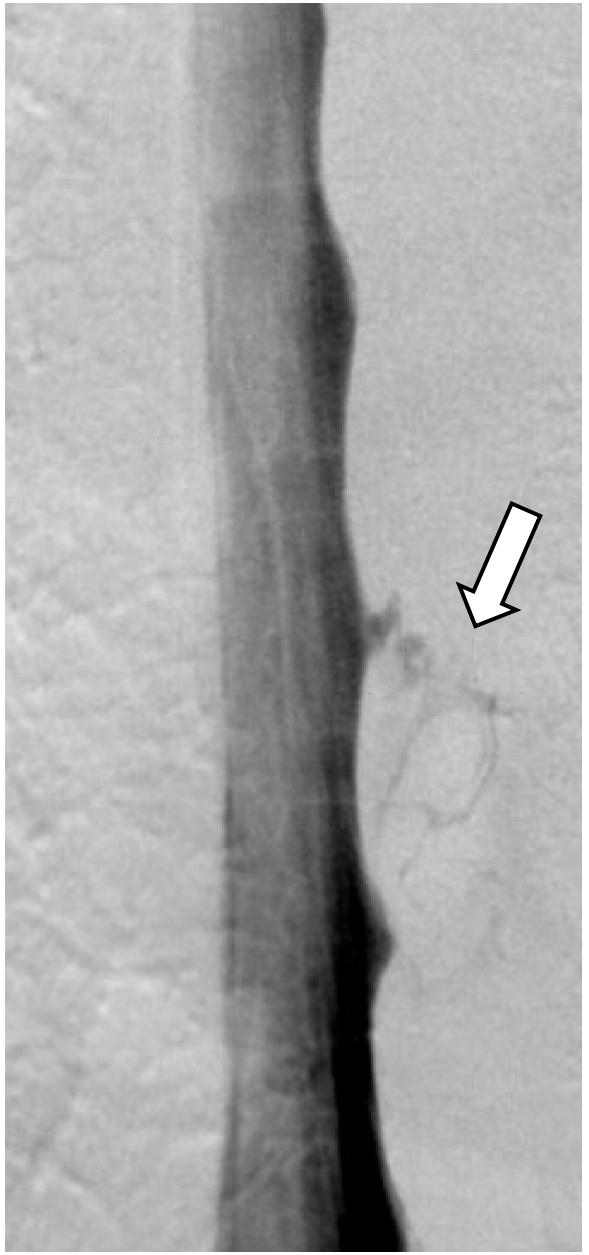
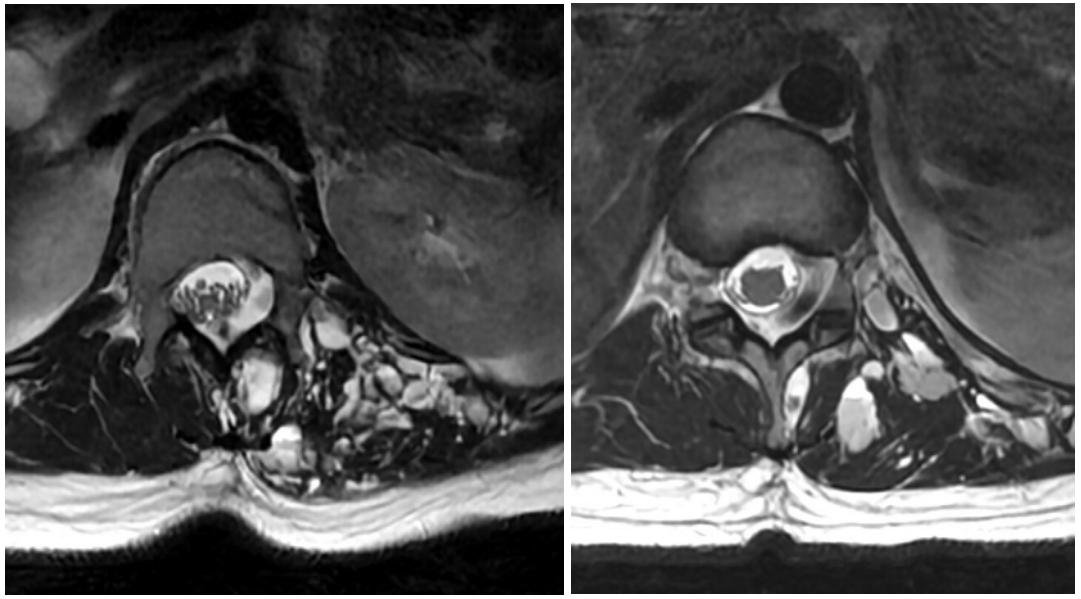
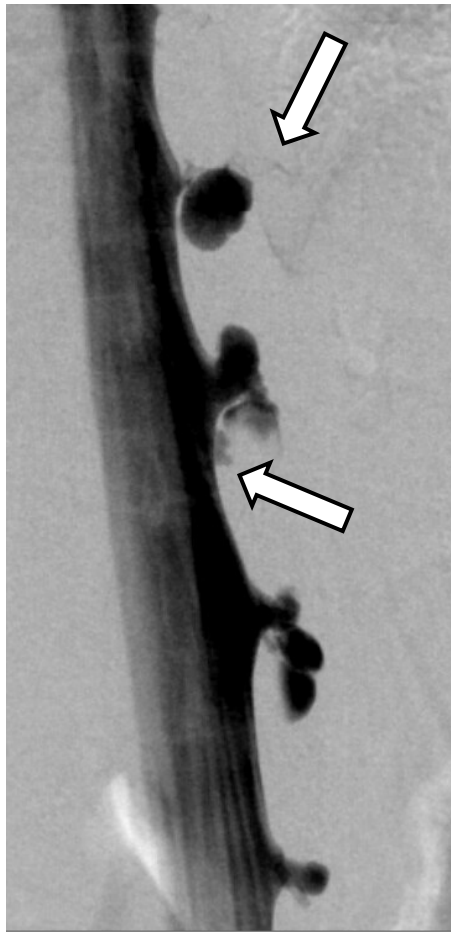


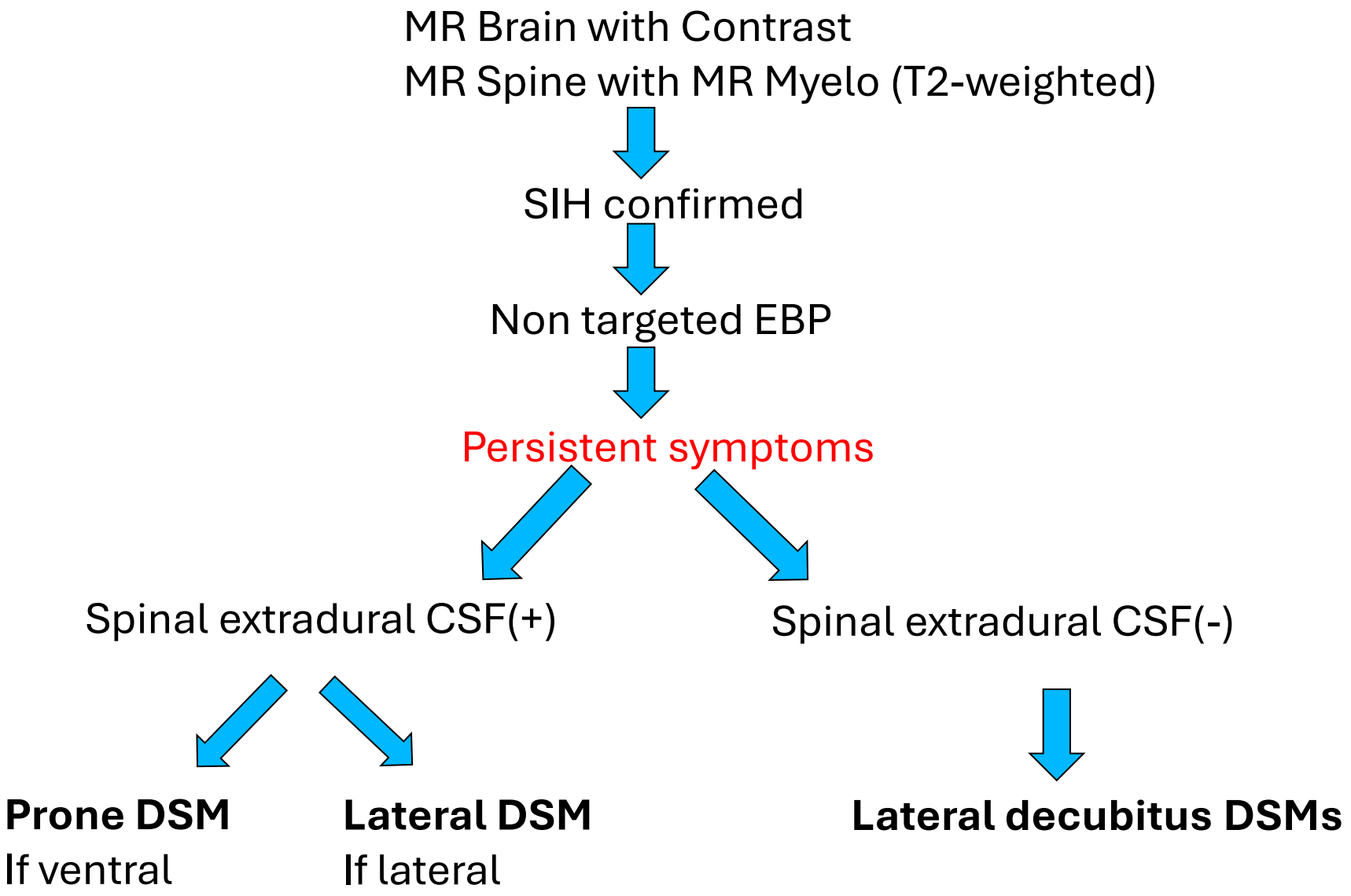




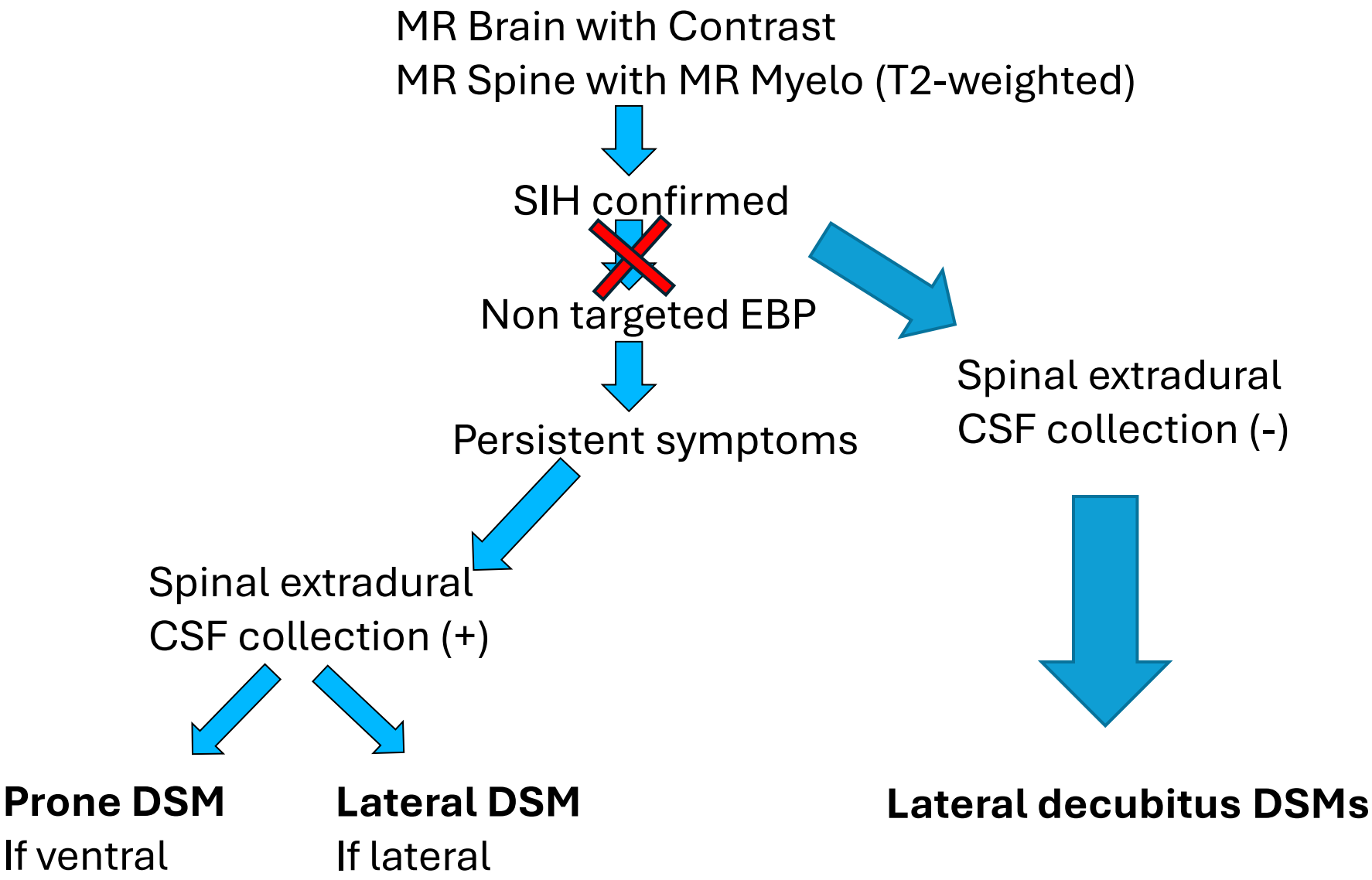


TJ: 26 year-old woman with 2 year history of headache

Cedars-Sinai approach to suspected SIH



Cedars-Sinai approach to suspected SIH and CSF-venous fistulas



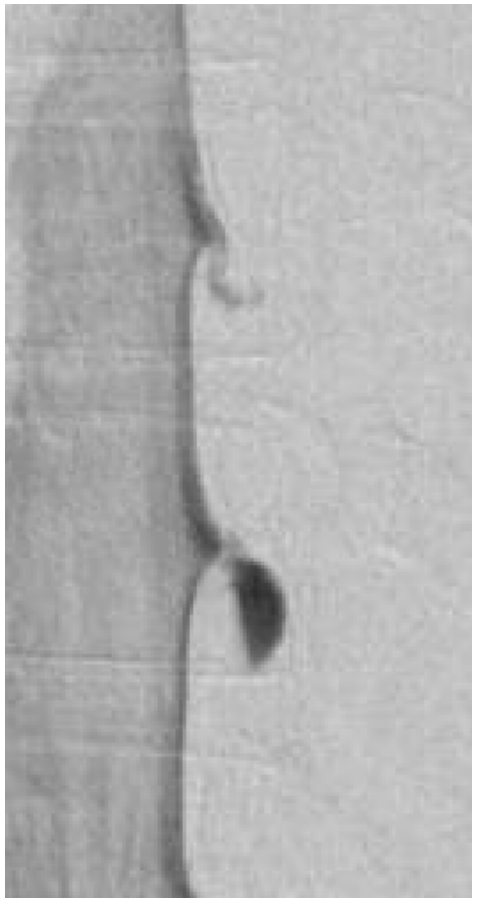
Pros and cons of CSF-venous fistula treatments

Percutaneous fibrin glue injection (outpatient)

Since 2013

local/MAC

70-80% cure rate



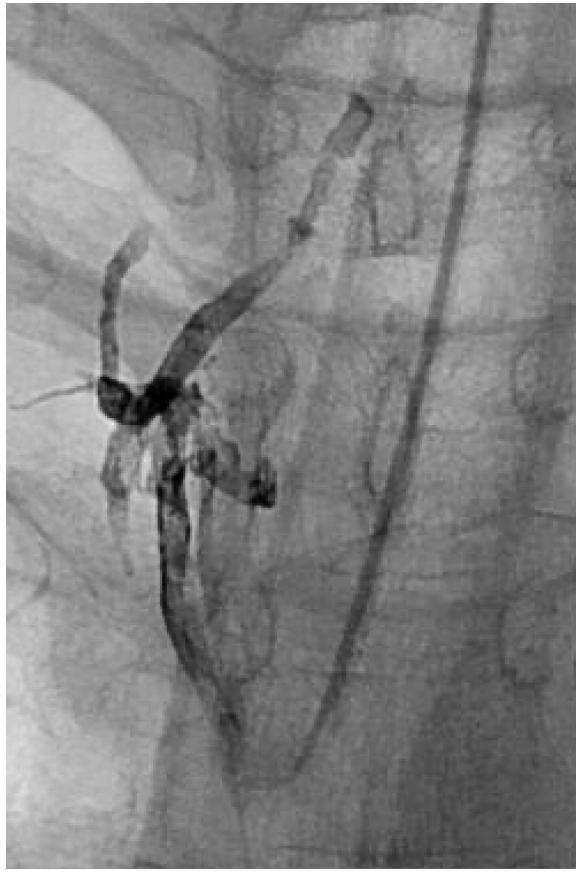
Pros and cons of CSF-venous fistula treatments

Endovascular Onyx embolization (outpatient)

Since 2020

General anesthesia

70-80% cure rate



Pros and cons of CSF-venous fistula treatments

Surgical ligation (inpatient)

Since 2013

General anesthesia

>99% cure rate

aneurysm clips

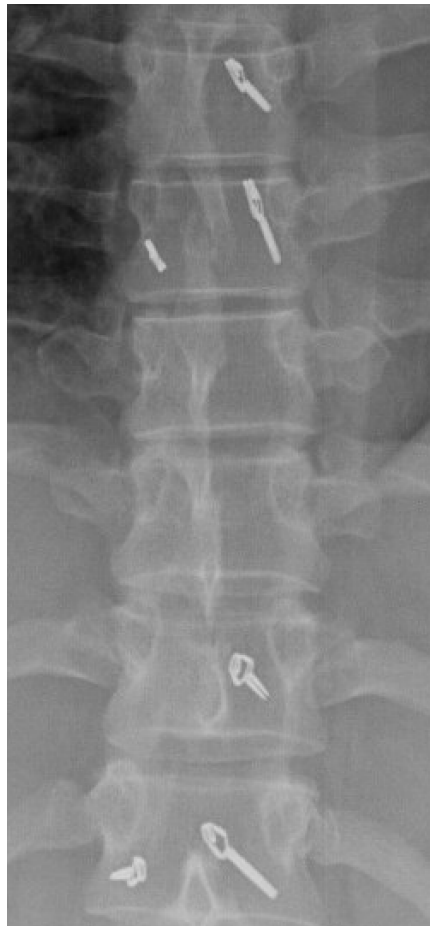
hemoclips

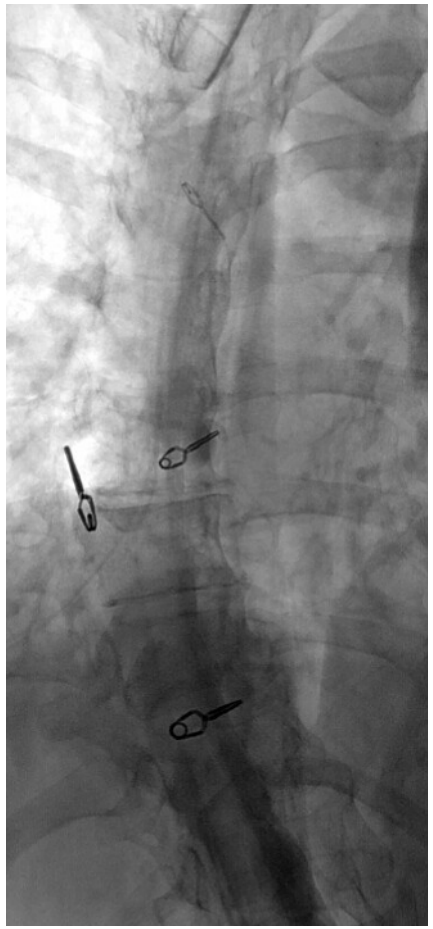
What are the consequences of nerve root clip ligation?

A study of 547 thoracic nerve roots clipped (T2-T12)

What are the consequences of nerve root clip ligation?

A study of 547 thoracic nerve roots clipped (T2-T12) ≠ 547 patients

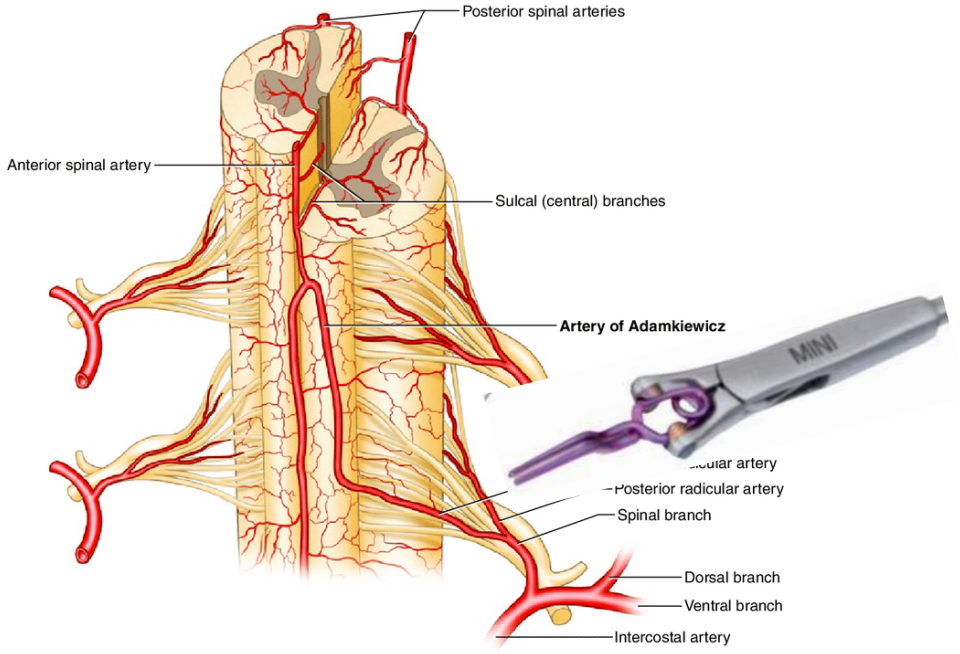




What are the consequences of nerve root clip ligation? - Major

A study of 547 thoracic nerve roots clipped (T2-T12)

Spinal cord infarction (Artery of Adamkiewicz): 0



What are the consequences of nerve root clip ligation? - Major

A study of 547 thoracic nerve roots clipped (T2-T12)

Spinal cord infarction (Artery of Adamkiewicz): 0

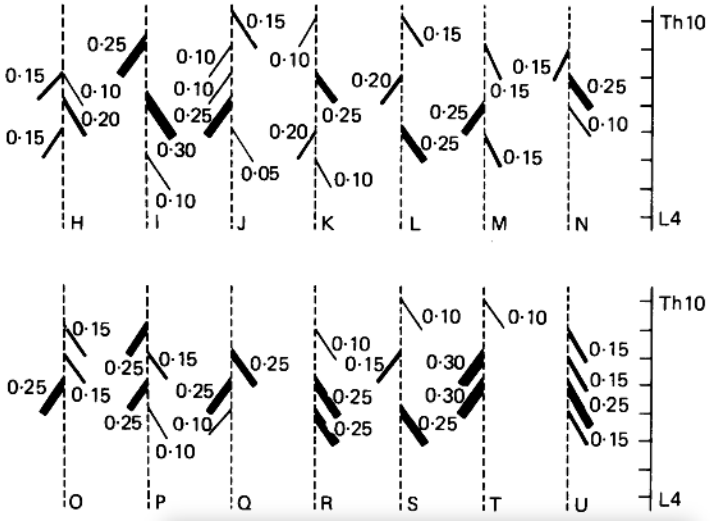
J. Anat. (1988), **161**, pp. 95–101
With 6 figures
Printed in Great Britain

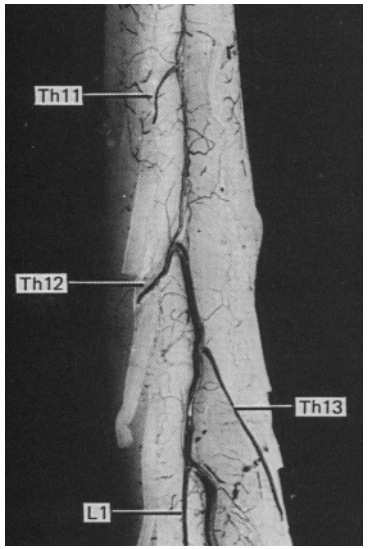
Does the artery of Adamkiewicz exist in the albino rat?

W. I. SCHIEVINK, W. LUYENDIJK* AND J. A. LOS

*Department of Anatomy, University of Amsterdam, Academic Medical Centre Meibergdreef 15, 1105 AZ Amsterdam and *Department of Neurosurgery, Academic Hospital, Leiden, The Netherlands*

(*Accepted* 19 *February* 1988)





What are the consequences of nerve root clip ligation?
Need for spinal angiogram?

What are the consequences of nerve root clip ligation? - Minor

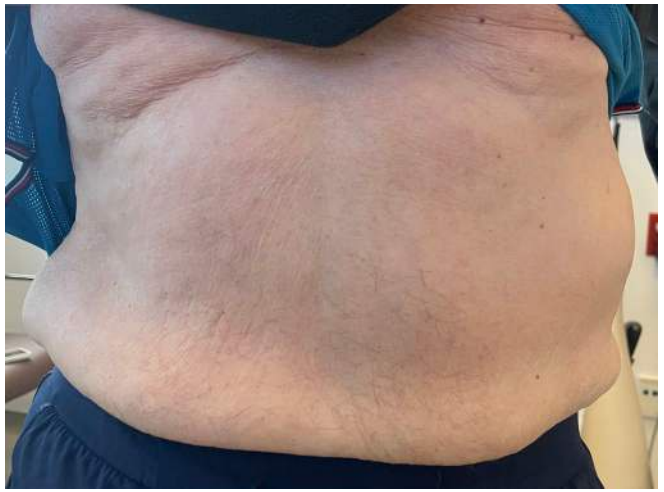
A study of 547 thoracic nerve roots clipped (T2-T12)

Abdominal muscle herniation: 8 (at least)

What are the consequences of nerve root clip ligation? – “Minor”

Abdominal muscle herniation






What are the consequences of ~~nerve root clip ligation~~ endovascular embolization (T11 and T12)? – “Minor” Abdominal muscle herniation

Preferred treatment for spinal CSF-venous fistula

- **Patient preference**
- **Patient preference**
- **Patient preference**

BUT!

- Spinal level “functional” nerve root → embolization
- Closely associated vascular malformation → embolization

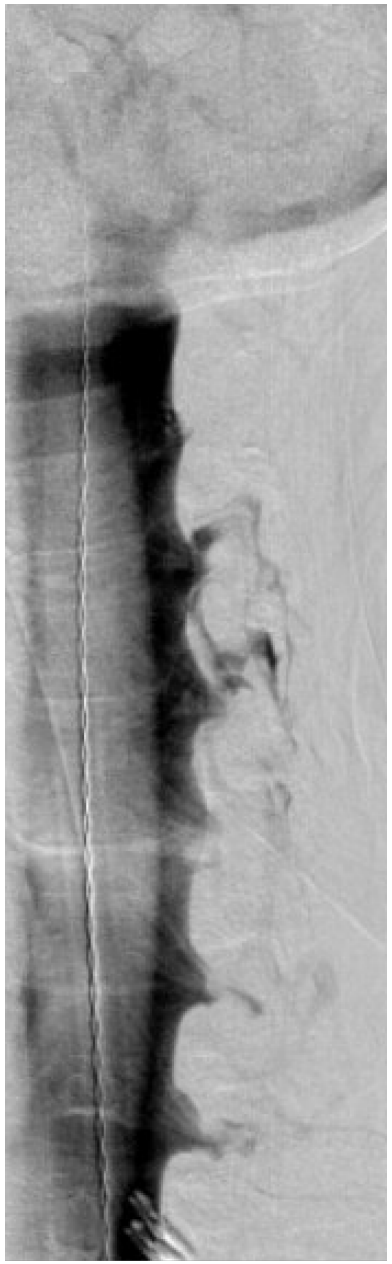
Preferred treatment for spinal CSF-venous fistula

- **Patient preference – poll March 2025**

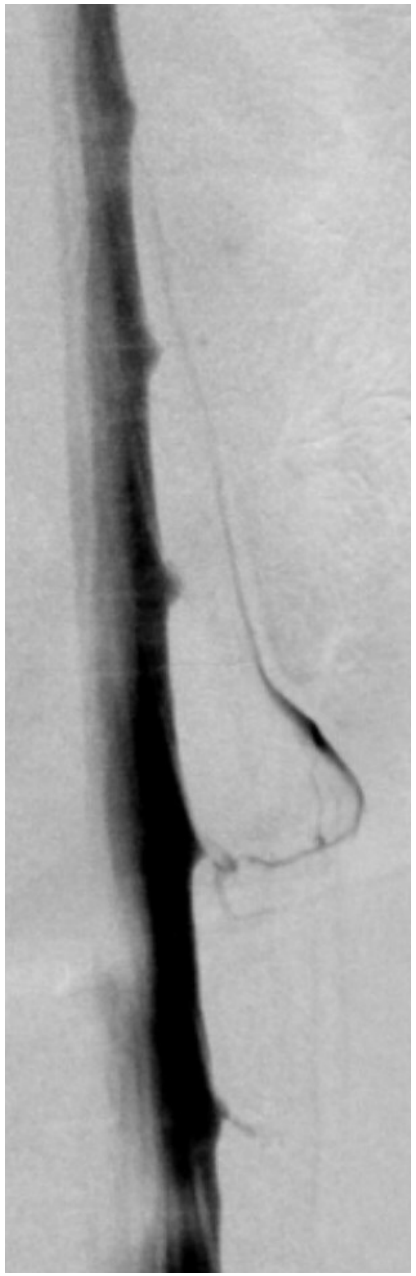
Reason for choosing surgery over embo (n=37):

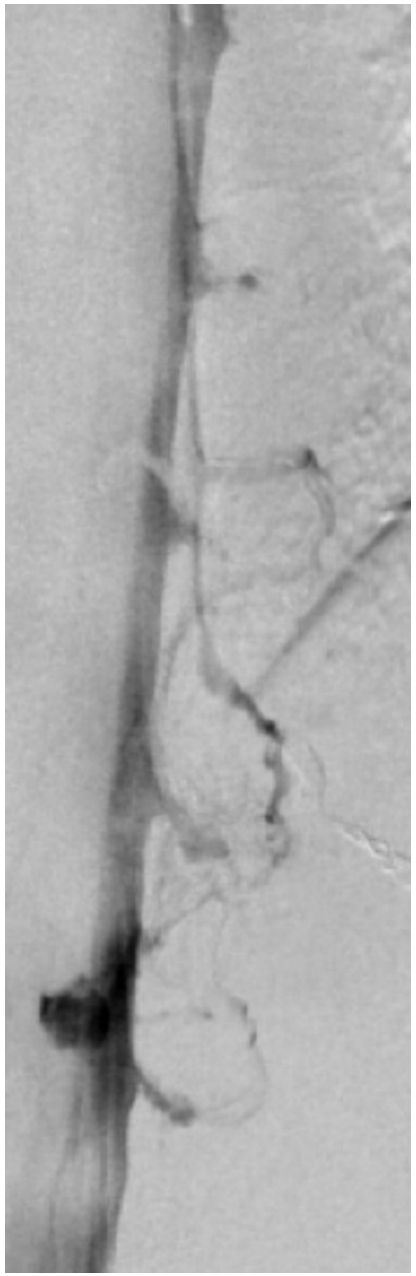
84% **“One and done”**
5% **Did not want to disappoint me**
5% **Worry about long-term Onyx effects**
3% **Permanent blindness after MMA embo**
3% **What is embolization?**

No improvement – do not repeat DSM

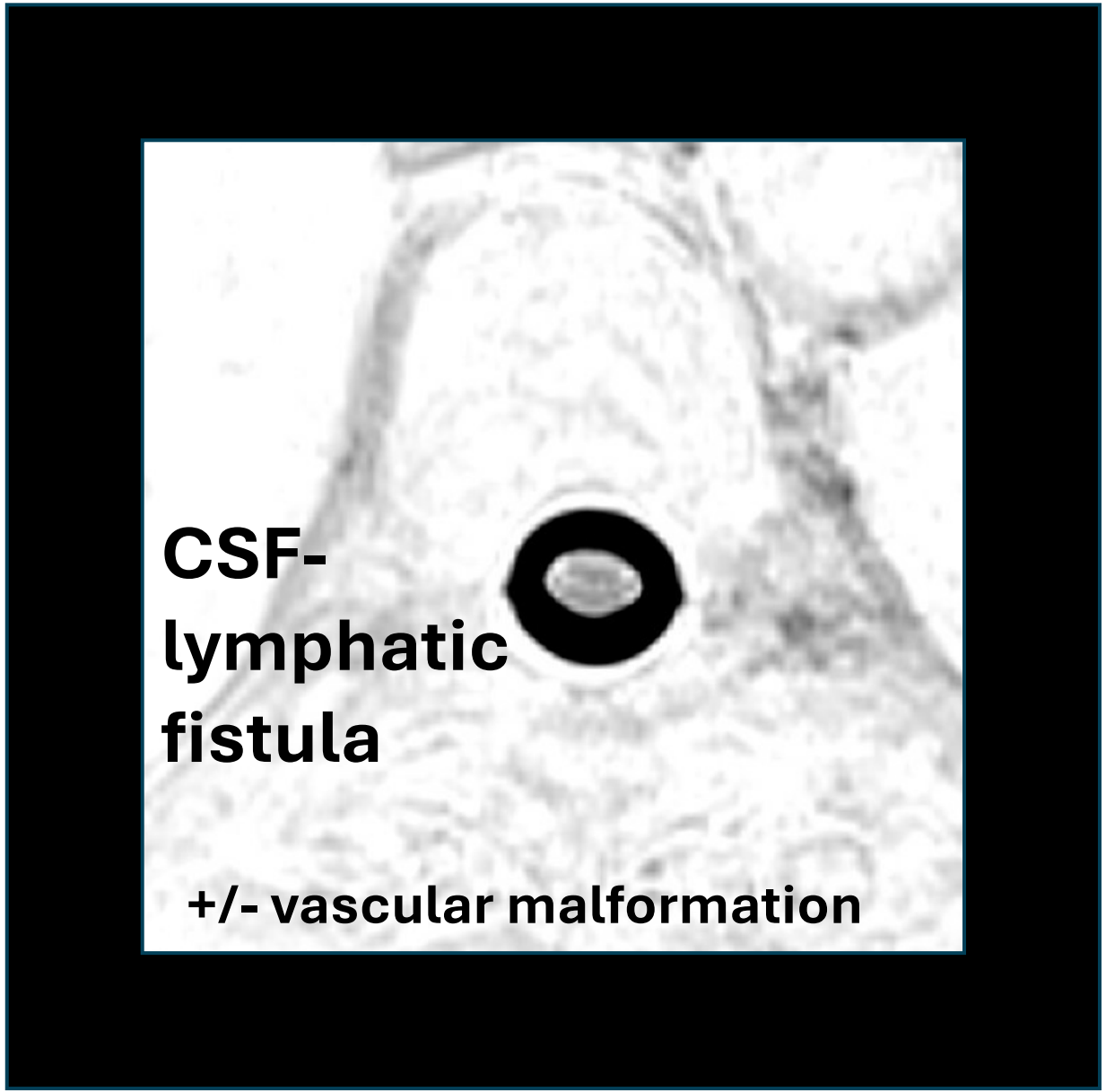


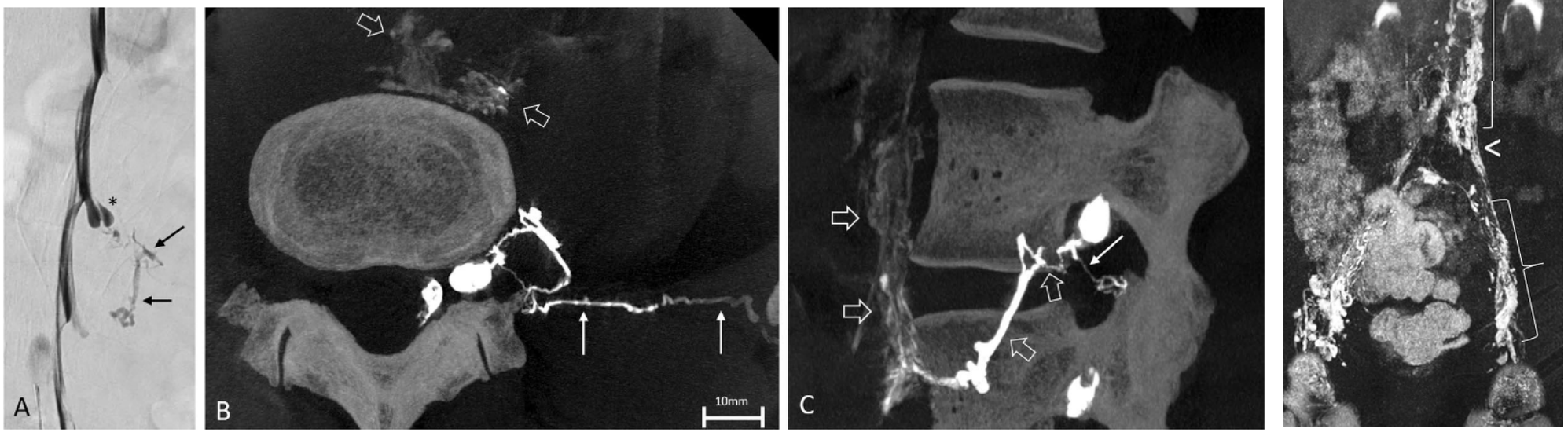
Transient improvement – repeat DSM





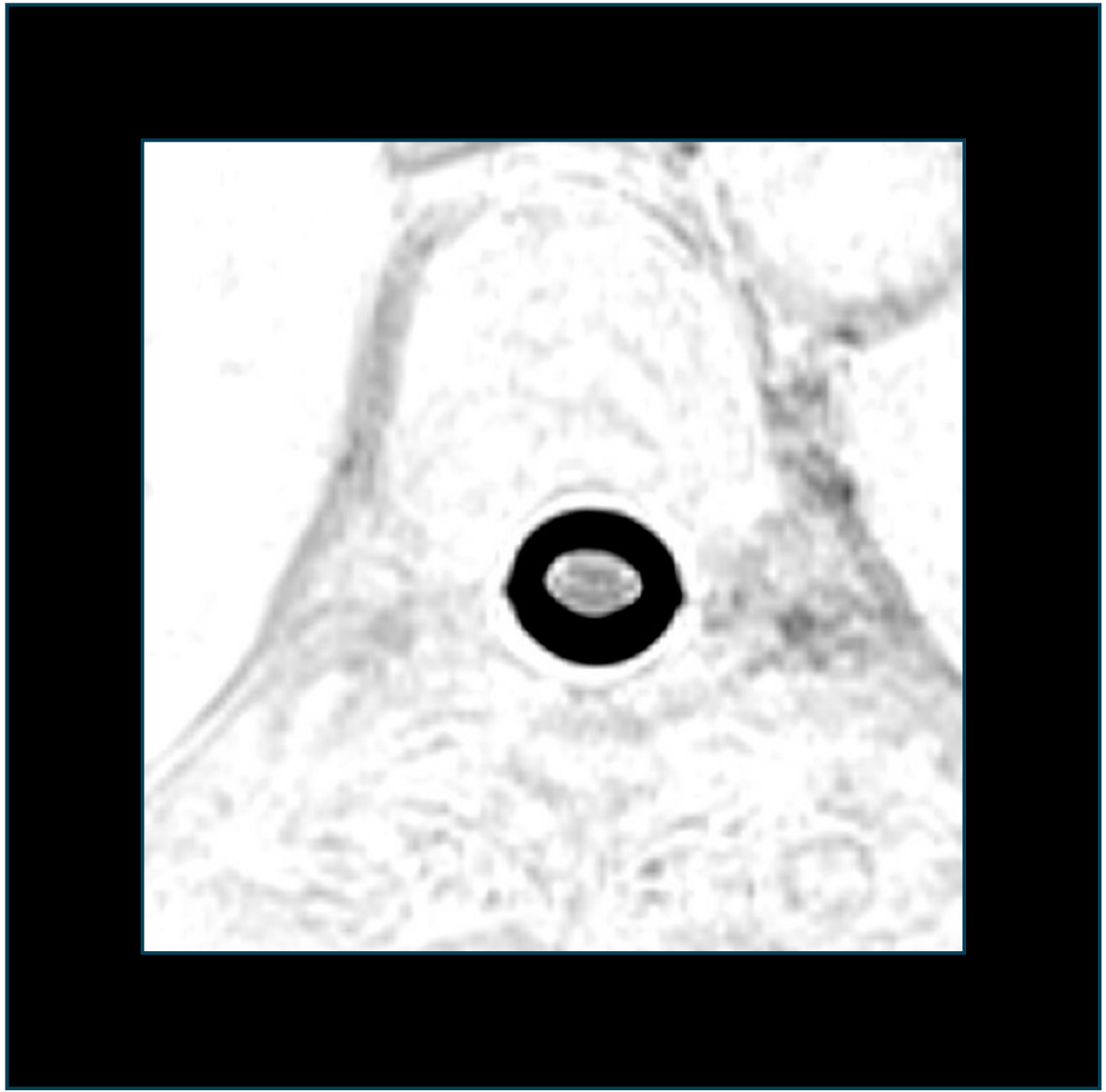
FISTULAS

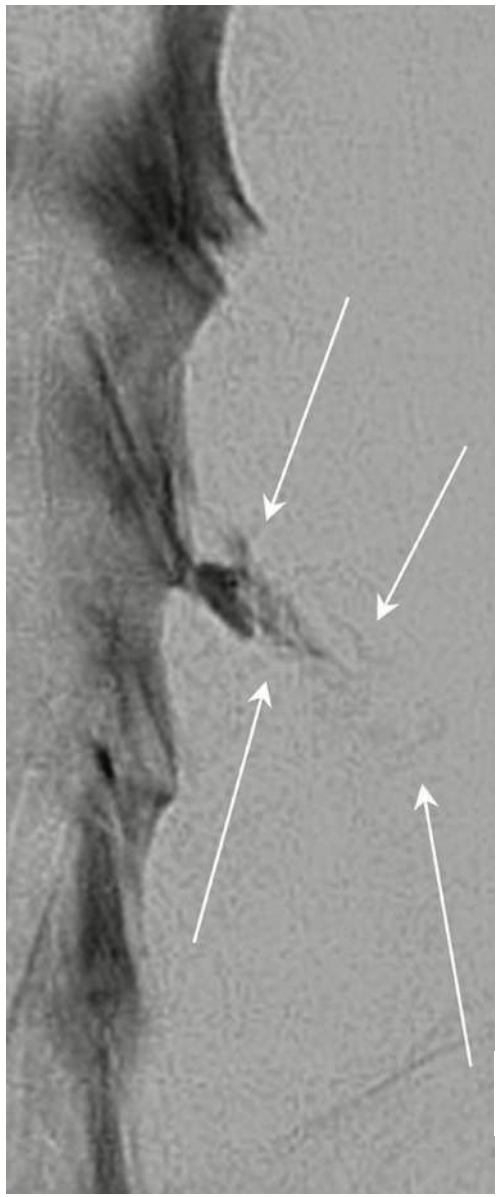




N. Luetzen & J. Beck

DISTAL NERVE ROOT TEARS





R.I. Farb

Surgical repair of spontaneous spinal CSF leaks

- Imaging is key to successful surgery
- Less invasive and more impactful surgery
- Dural repair surgery is durable
- Surgical solutions depend on CSF leak type
- Randomized controlled trials

Thank you

schievinkw@cshs.org