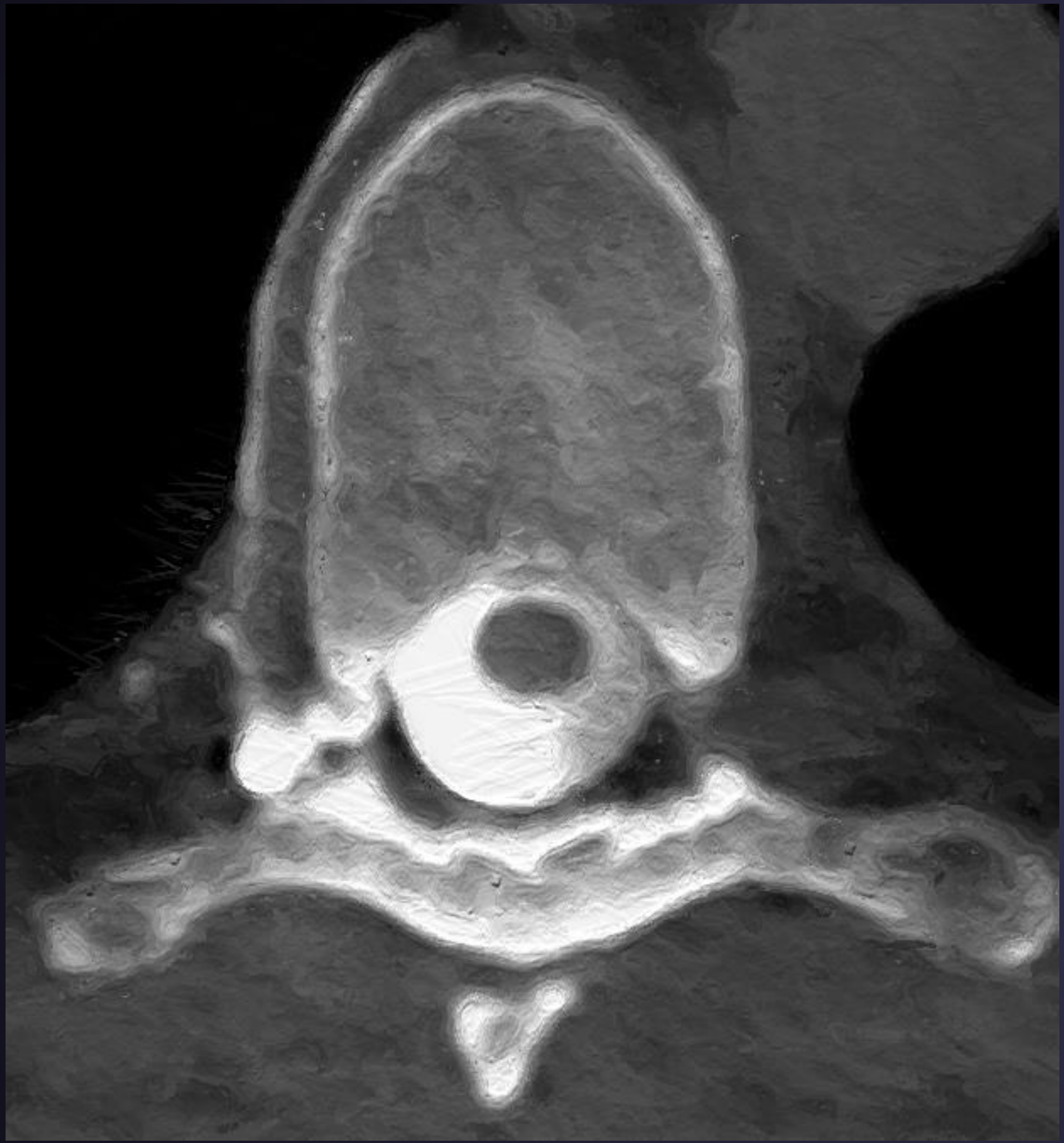

CVFs: Known and Unknown

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Duke Radiology

EPISTEMOLOGY

Epistemic humility

文A 1 language

Article Talk Read Edit View history Tools

From Wikipedia, the free encyclopedia

In the philosophy of science, **epistemic humility** refers to a posture of scientific observation rooted in the recognition that (a) knowledge of the world is always interpreted, structured, and filtered by the observer, and that, as such, (b) scientific pronouncements must be built on the recognition of observation's inability to grasp the world in itself.[1] The concept is frequently attributed to the traditions of German idealism, particularly the work of Immanuel Kant,[2][3] and to British empiricism, including the writing of David Hume.

"Reports that say that something hasn't happened are always interesting to me, because as we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns—the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tends to be the difficult ones."

https://en.wikipedia.org/wiki/Epistemic_humility

KNOWN KNOWNS

CVFs EXIST

Clinical/Scientific Notes

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

CSF-VENOUS FISTULA IN SPONTANEOUS INTRACRANIAL HYPOTENSION

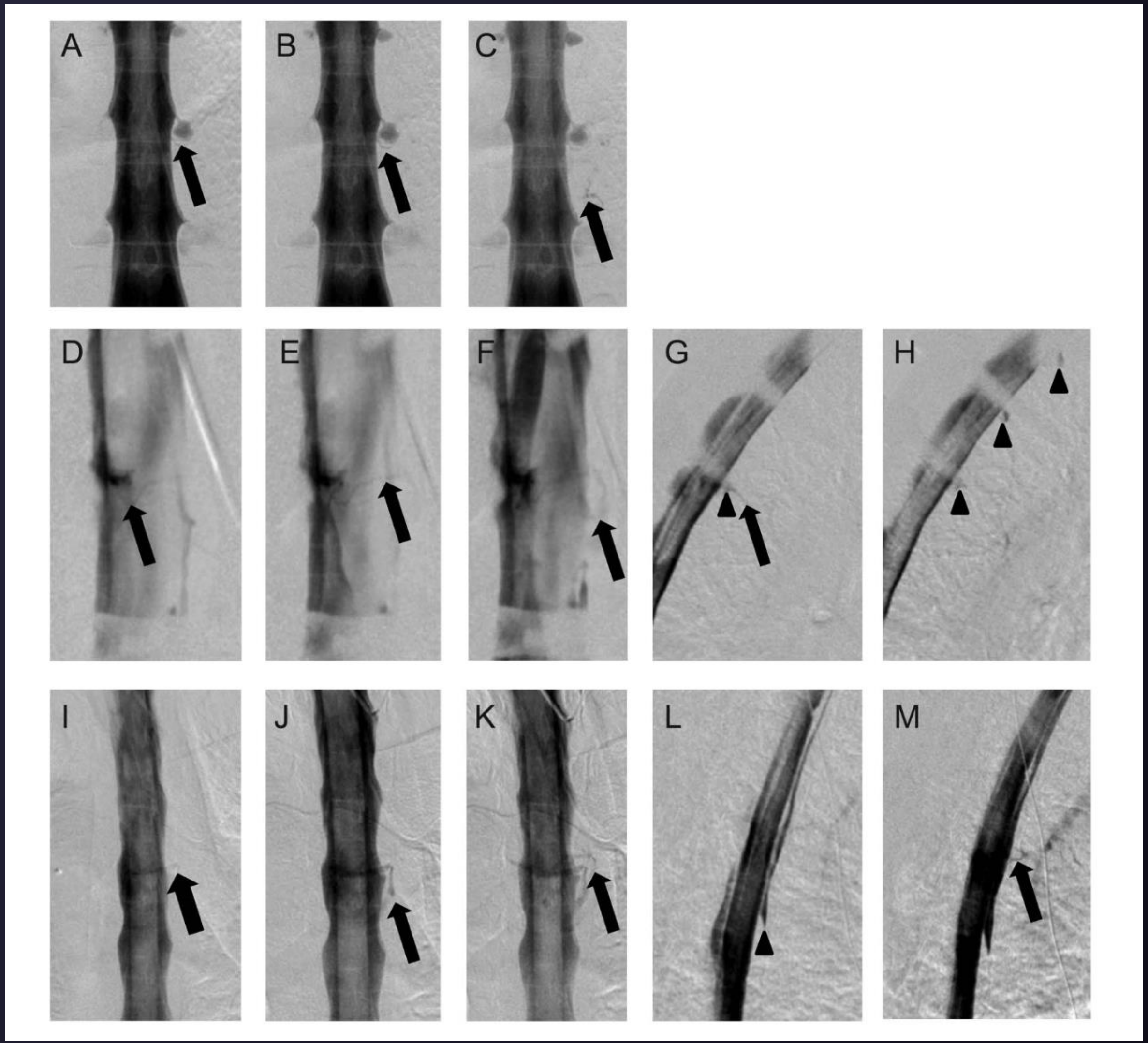
Spontaneous intracranial hypotension (SIH) is an important cause of new daily persistent headaches.[1] In most patients, the underlying cause is a CSF leak, always at the level of the spine.[2] Once escaped into the epidural space, CSF is rapidly absorbed by the spinal epidural venous plexus, which is 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]

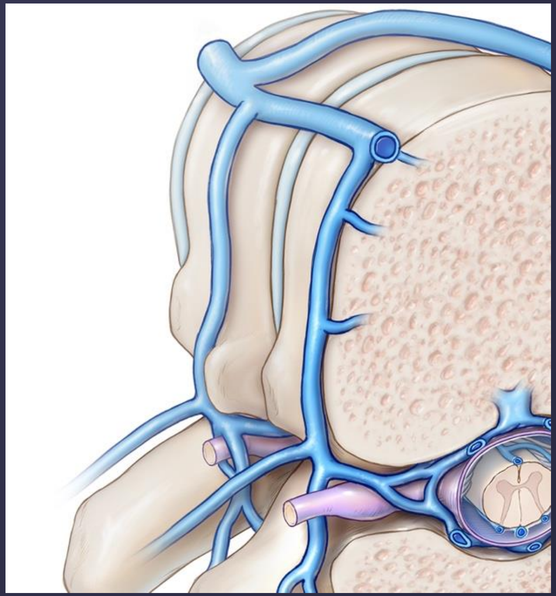
Case reports. ***Case 1.*** A 52-year-old woman noted a second half of the day headache, neck stiffness, and interscapular pain. Neurologic examination was normal. MRI showed pachymeningeal enhancement and brain sagging. CT and magnetic resonance (MR) myelography showed multiple thoracic cysts but no 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

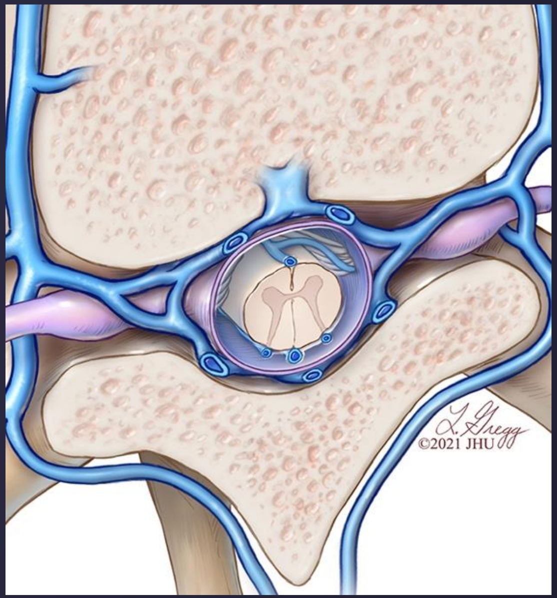
demonstrable. At surgery, epidural venous dilation was significant and a dural tear at the axilla of the left T-4 nerve root was identified and this was sutured, resulting in resolution of symptoms.

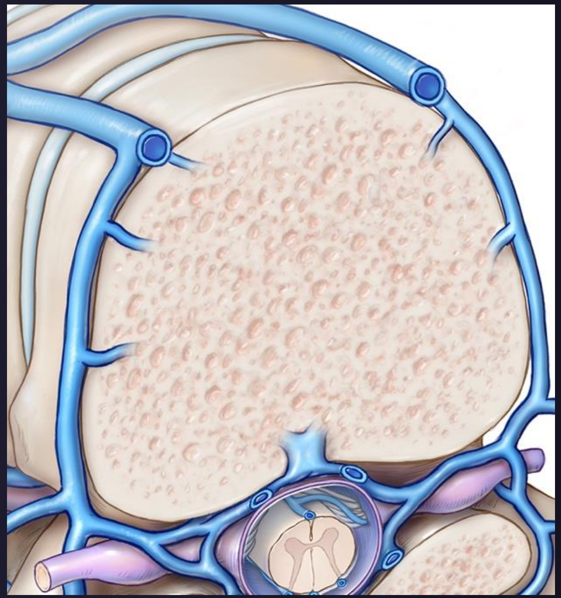
Case 3. A 48-year-old woman noted an orthostatic headache, nausea, emesis, and neck stiffness. Neurologic examination was normal. MRI showed pachymeningeal enhancement and brain sagging. CT and MR myelography showed an extensive spinal ventral extradural CSF collection. CSF examination was normal. She 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





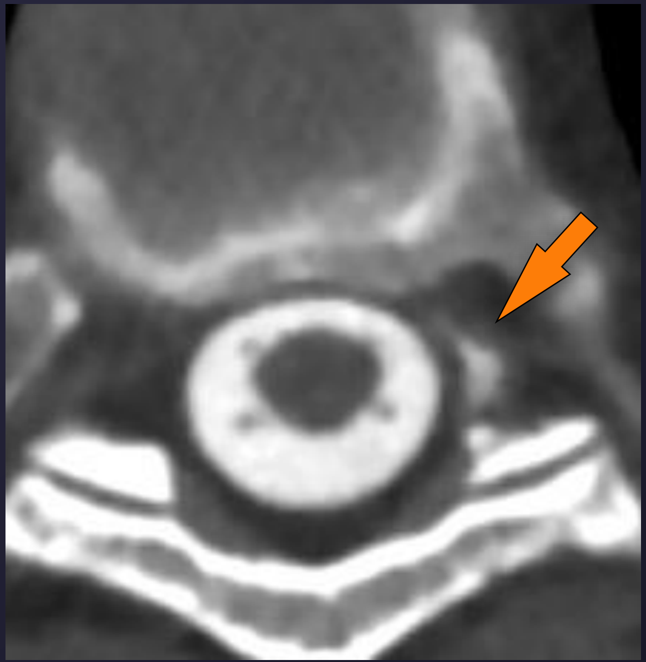




EVVP

IVVP

BASIVERTEBRAL



DECUBITUS

BRIEF/TECHNICAL REPORT
SPINE

Decubitus CT Myelography for Detecting Subtle CSF Leaks in Spontaneous Intracranial Hypotension

P.G. Kranz, L. Gray, and T.J. Amrhein

ABSTRACT

SUMMARY: Spontaneous intracranial hypotension is caused by spinal CSF leaks, but the site of the leak is not always detected on spinal imaging. We report on the additional value of decubitus positioning during CT myelography in enhancing the detection of subtle leaks.

ABBREVIATIONS: CTM = CT myelography; CVF = CSF venous fistula; SIH = spontaneous intracranial hypotension

JNS SPINE
CLINICAL ARTICLE
J Neurosurg Spine 31:902–905, 2019

Lateral decubitus digital subtraction myelography to identify spinal CSF–venous fistulas in spontaneous intracranial hypotension

Wouter I. Schievink, MD,[1] M. Marcel Maya, MD,[2] Franklin G. Moser, MD, MMM,[2] Ravi S. Prasad, MD,[2] Rachelle B. Cruz, MSN, APRN, NP-C,[1] Miriam Nuño, PhD,[3] and Richard I. Farb, MD, FRCPC[4]

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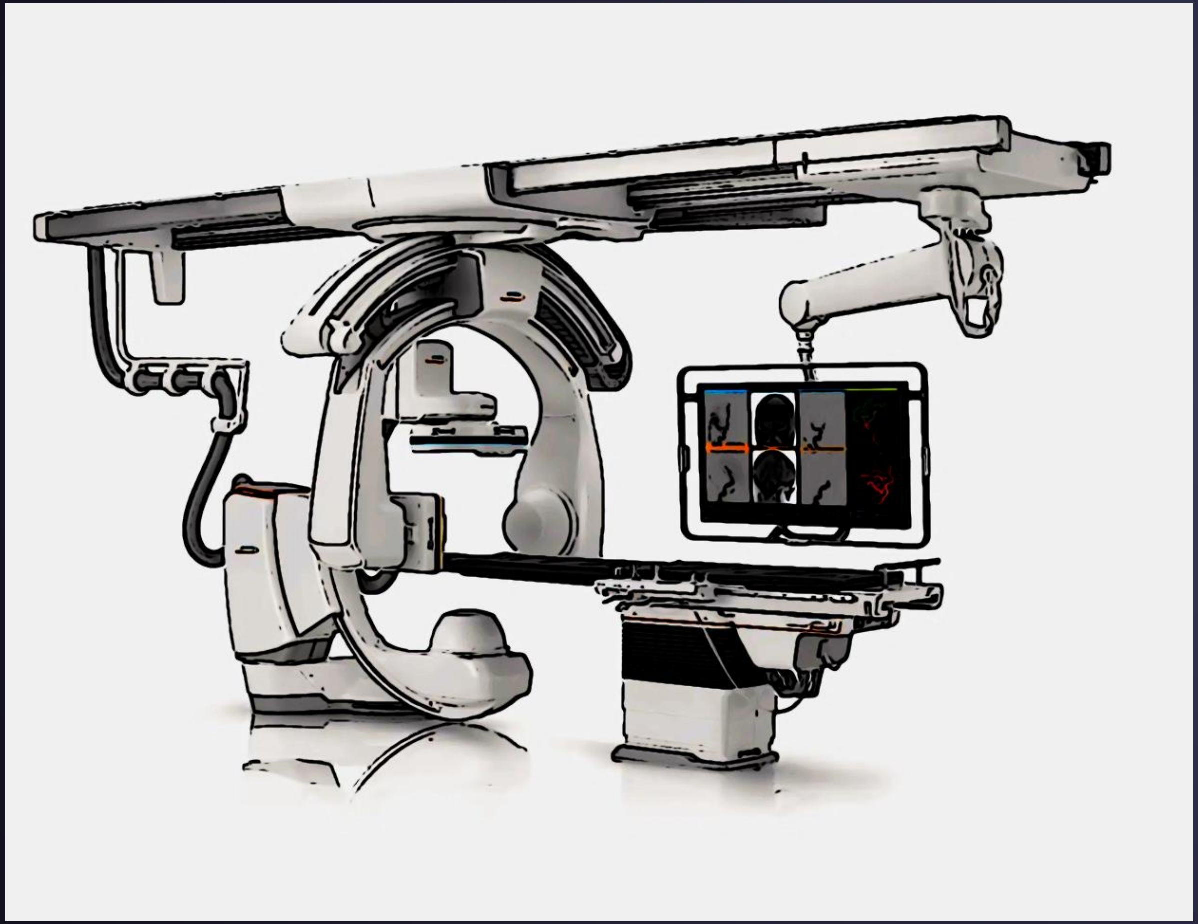
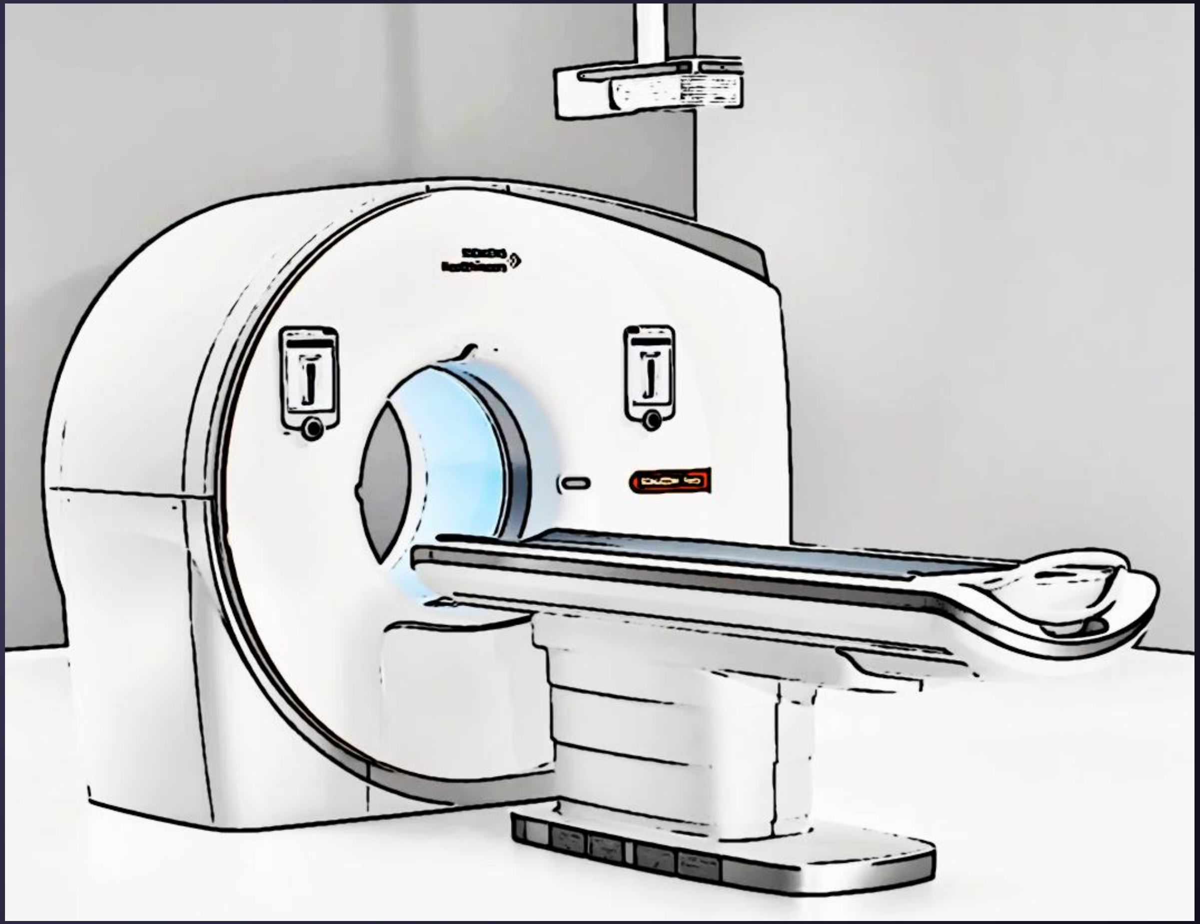
Kranz PG, Gray L, Amrhein TJ. Decubitus CT Myelography for Detecting Subtle CSF Leaks in Spontaneous Intracranial Hypotension. AJNR Am J Neuroradiol. 2019 Apr;40(4):754-756.

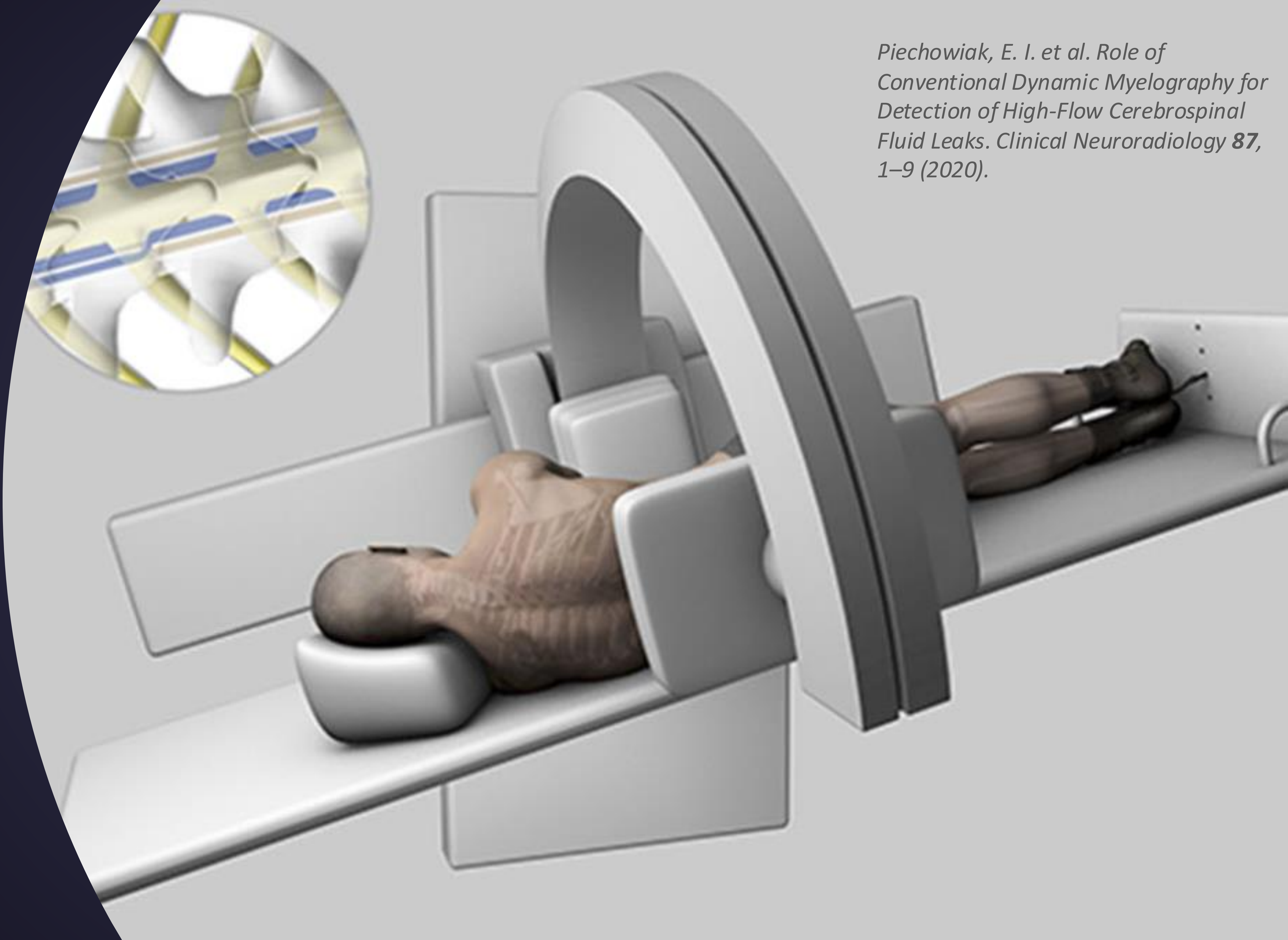
Schievink WI, Maya MM, Moser FG, Prasad RS, Cruz RB, Nuño M, Farb RI. Lateral decubitus digital subtraction myelography to identify spinal CSF-venous fistulas in spontaneous intracranial hypotension. J Neurosurg Spine. 2019 Sep 13;31(6):902-905.

HOW TO DETECT





Setup



*Piechowiak, E. I. et al. Role of Conventional Dynamic Myelography for Detection of High-Flow Cerebrospinal Fluid Leaks. Clinical Neuroradiology **87**, 1–9 (2020).*

Setup

“Static”
Decubitus
CTM

"Dynamic" Decubitus CTM

requires imaging <u>during</u> contrast injection

DECUBITUS

- Fluoro or CTM
- Decubitus
- Mostly (but not exclusively) thoracic spine

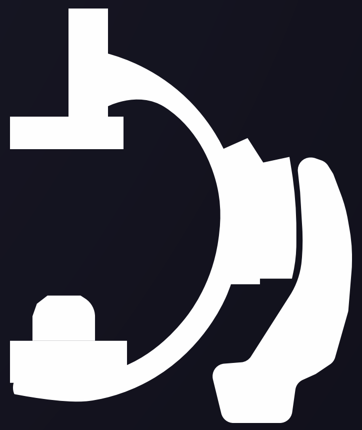
Scan 1, Prone
MIP 3.5mm

Scan 1, decubitus
MIP 3.5mm

Scan 2, decubitus
MIP 3.5mm

TREATMENT

Surgery



Embolization

EBP

KNOWN UNKNOWNS

WHY CVFs FORM

Neuroradiology 11, 221–228 (1976)

Neuroradiology

ORIGINALS

Human Spinal Arachnoid Villi and Granulations

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Department of Radiology, Cornell University Medical College and the Neuroradiology Research Laboratory, William Hale Harkness Building, New York, N. Y. USA

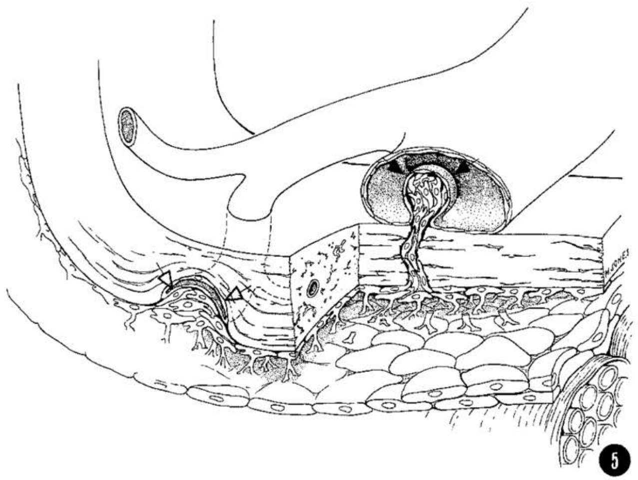


Fig. 5. Diagram showing spinal arachnoid proliferations projecting into and through the dura mater. The proliferation within the dura mater (open arrows) projects into a venous sinus which has penetrated the dura. The epidural proliferation (closed arrows) has a venous sinus surrounding its body and fundus. Both proliferations have their bases associated with the subarachnoid space which is bridged by trabeculae formed by the cytoplasmic extensions of the arachnoid cells. The subarachnoid space narrows toward the right of the diagram as it approaches the subarachnoid angle

Nerve Root	Nerve Root Location			Relation to Nerve Root Dura Mater	Relation to Venous Sinuses	Size 10 μ³
	Cord	Side	Level			
1	I	L	Th_{11}	0	None	0
2	I	R	Th_{12}	Epidural	None	1.03×10^7
3	I	L	Th_{12}	0	None	0
4	I	L	L_1	Dural	Possible	2.62×10^6
	I	L	L_1	Internal to Dura	Definite	4.52×10^7
5	I	L	L_2	Internal to Dura	Definite	2.59×10^7
6	II	R	Th_8	Dural	Definite	3.39×10^7
	II	R	Th_8	Dural	Definite	5.00×10^7
7	II	R	Th_9	Dural	Possible	8.20×10^6
8	II	R	Th_{10}	Dural	Definite	2.61×10^7
	II	R	Th_{10}	Epidural	Possible	5.56×10^7
	II	R	Th_{10}	Dural	Definite	2.86×10^7
9	II	L	Th_{10}	Epidural	Definite	5.43×10^8
	II	L	Th_{10}	Dural	Definite	2.36×10^8
10	II	R	Th_{11}	Epidural	Possible	2.45×10^7
	II	R	Th_{11}	Dural	Definite	7.73×10^7
	II	R	Th_{11}	Epidural	Definite	1.17×10^8
11	II	R	L_1	Dural	Definite	1.10×10^8
	II	R	L_1	Dural	Definite	8.48×10^7
12	II	L	L_1	Dural	Possible	1.55×10^7
	II	L	L_1	Dural	Definite	2.18×10^8
13	II	R	L_4	0	None	0
14	II	L	L_4	Dural	Definite	2.51×10^8
15	III	R	Th_4	Epidural	Definite	6.22×10^7
	III	R	Th_4	Internal to Dura	Definite	3.39×10^7
16	III	L	Th_4	Dural	Possible	7.82×10^7
17	III	R	Th_5	Dural	Definite	2.76×10^7
	III	R	Th_5	Internal to Dura	Definite	2.93×10^7
	III	R	Th_5	Epidural	Definite	2.68×10^7
18	III	L	Th_5	Dural	None	6.88×10^6
	III	L	Th_5	Epidural	None	1.36×10^6
19	III	R	Th_6	Dural	None	1.22×10^8
	III	R	Th_6	Dural	Definite	5.18×10^7
20	III	L	Th_6	Dural	Definite	1.67×10^7
	III	L	Th_6	Epidural	Definite	1.06×10^7
	III	L	Th_6	Dural	Possible	1.71×10^7
21	III	R	Th_7	Epidural	Definite	6.91×10^7
	III	R	Th_7	Dural	Definite	1.01×10^7
	III	R	Th_7	Dural	Possible	1.55×10^7
22	III	L	Th_7	Dural	Definite	4.34×10^6
23	III	L	Th_8	Dural	Possible	1.92×10^7
24	III	R	L_2	Dural	Definite	2.52×10^6
	III	R	L_2	Dural	None	9.27×10^6
25	III	R	L_3	Epidural	Definite	8.67×10^7
26	III	L	L_3	Dural	Possible	1.83×10^7

WHY CVFs FORM

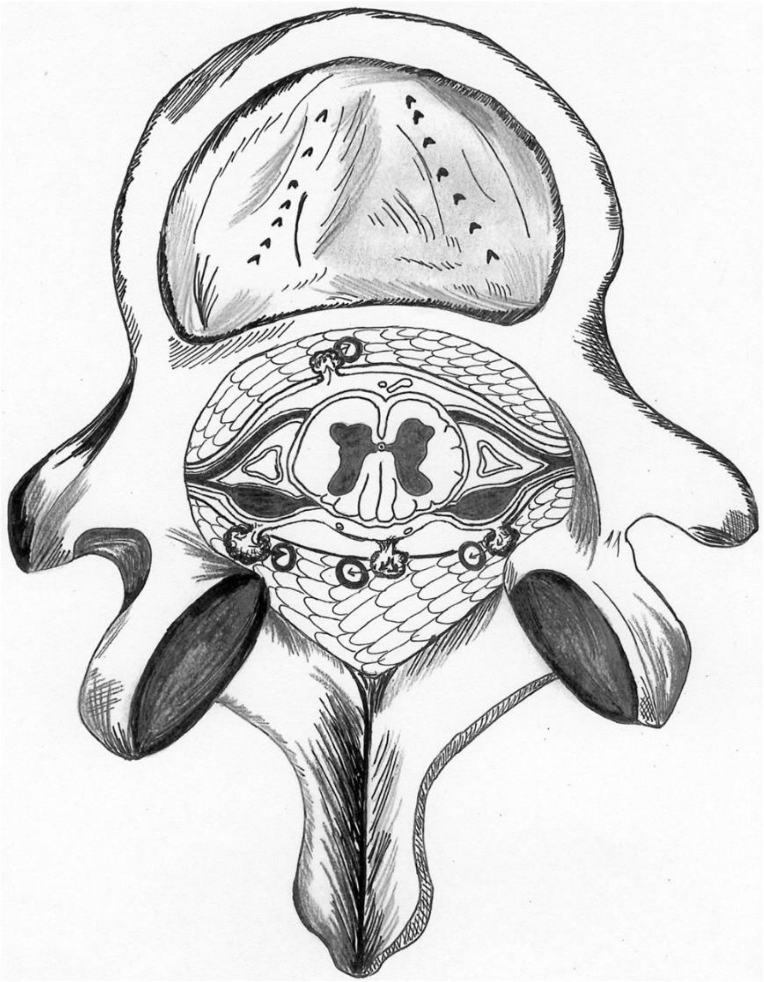


Fig. 1 Schematic diagram of the entire vertebra and spinal cord with spinal arachnoid granulations. The entire vertebra and cord with arachnoid granulations which contact with epidural veins (*curved arrows*)

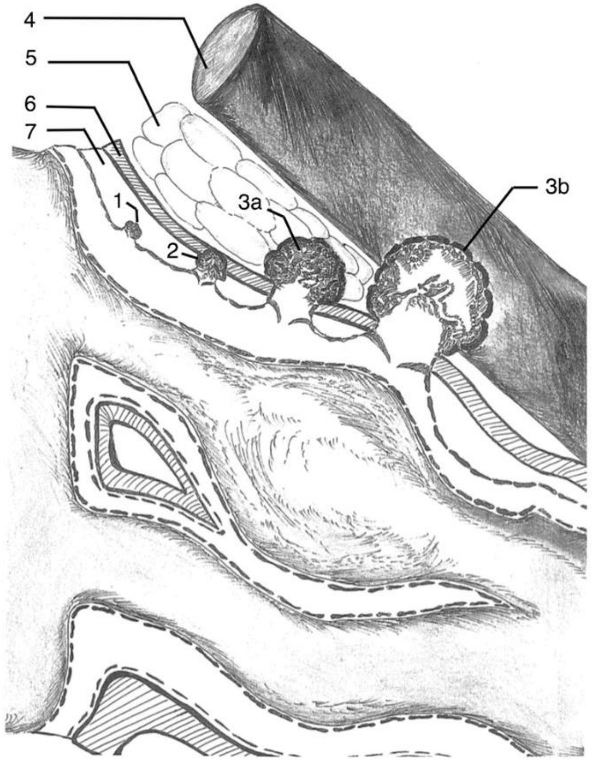
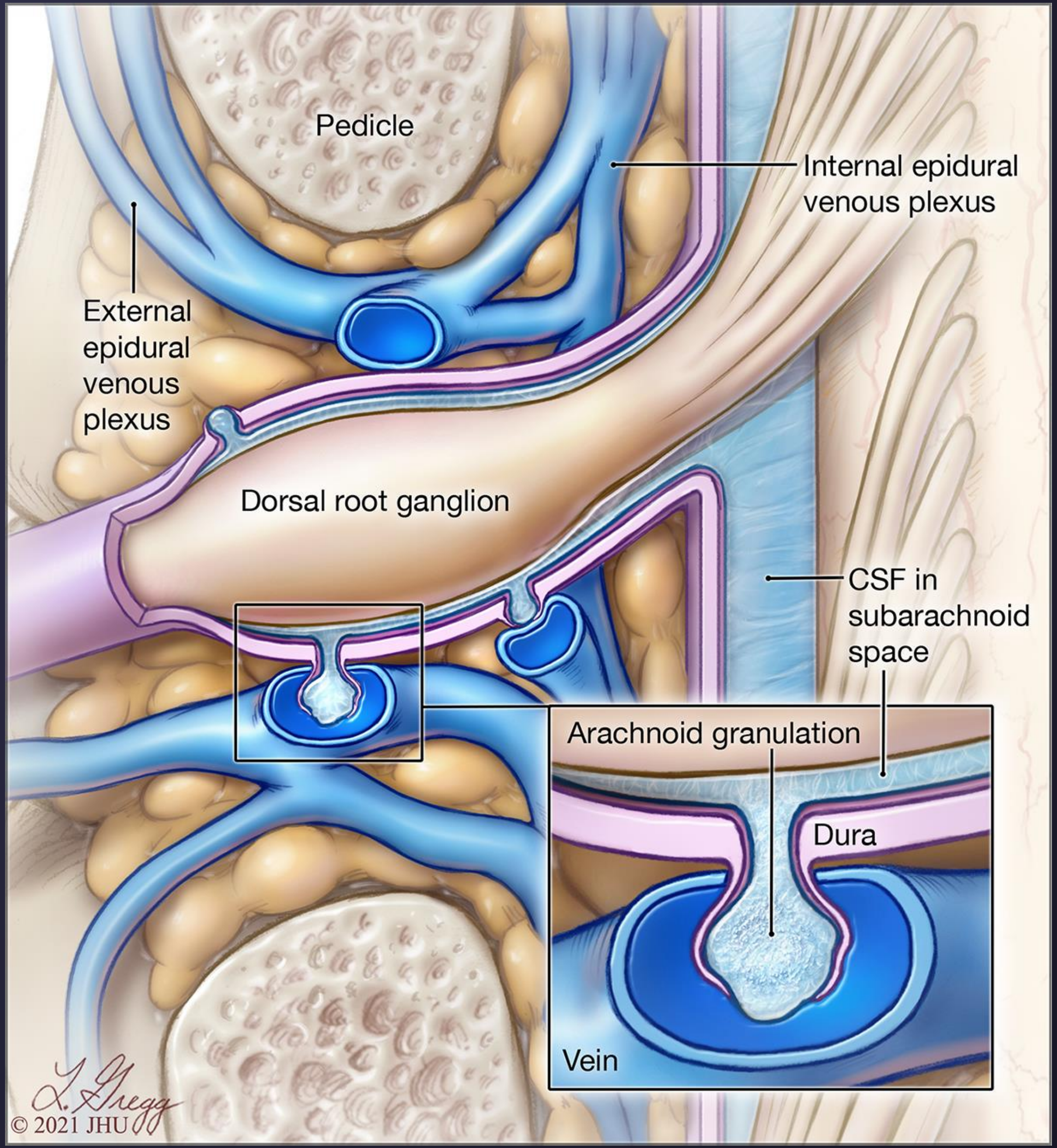


Fig. 2 The classification of spinal arachnoid granulations (SAG). Type 1 SAG (*1*): slightly protruding, which is completely inside the subdural space (*7*) and does not break into dura (*6*); type 2 SAG (*2*): protruding within the dura, which penetrates into the dura but not beyond it; type 3 SAG (*3a* and *3b*): protruding through the dura, which completely penetrates the dura and protrudes into the epidural space (*5*). This type of SAG can be further grouped into two subtypes based on their relationship with the epidural veins (*4*), as some directly contact with a vein (*3b*) while others do not (*3a*)

WHY CVFs FORM



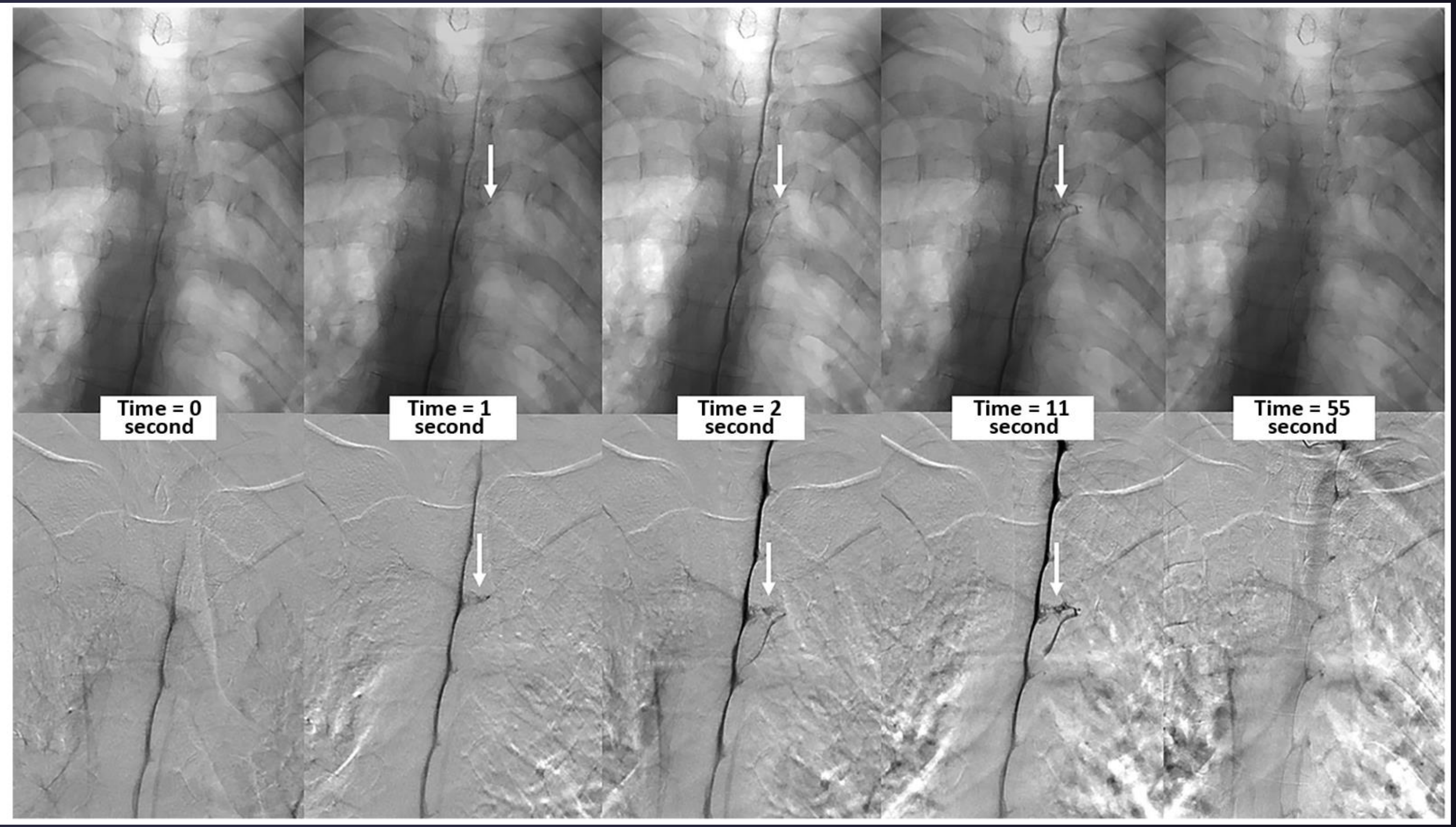
TIMING

Temporal Characteristics of CSF-Venous Fistulas on Digital Subtraction Myelography

I. Mark, A. Madhavan, M. Oien, J. Verdoorn, J.C. Benson, J. Cutsforth-Gregory, W. Brinjikji, and P. Morris

Mean time to appear:
9.1 sec
(range 0-30 sec)

Mean duration:
48.1 sec
(range 24-73 sec)



Mark I, et al. Temporal Characteristics of CSF-Venous Fistulas on Digital Subtraction Myelography. AJNR Am J Neuroradiol. 2023 Apr;44(4):492-495. PMID: 36894299

TIMING

ORIGINAL RESEARCH
SPINE IMAGING AND SPINE IMAGE-GUIDED INTERVENTIONS

Temporal Characteristics of CSF-Venous Fistulas on Dynamic Decubitus CT Myelography: A Retrospective Multi-Institution Cohort Study

Andrew L. Callen, Mo Fakhri, Vincent M. Timpone, Ashesh A. Thaker, William P. Dillon, and Vinil N. Shah

ABSTRACT

BACKGROUND AND PURPOSE: CSF-venous fistula can be diagnosed with dynamic decubitus CT myelography. This study aimed to analyze the temporal characteristics of CSF-venous fistula visualization on multiphase decubitus CT myelography.

MATERIALS AND METHODS: A retrospective, multisite study was conducted on patients diagnosed with CSF-venous fistula at 2 institutions between June 2017 and February 2023. Both institutions perform decubitus CT myelography with imaging immediately following injection and usually with at least 1 delayed scan. The conspicuity of CSF-venous fistula was assessed on each phase of imaging.

RESULTS: Forty-eight patients with CSF-venous fistula were analyzed. CSF-venous fistulas were better visualized on the early pass in 25/48 cases (52.1%), the delayed pass in 6/48 cases (12.5%) and were seen equally on both passes in 15/48 cases (31.3%). Of 25 cases in which the CSF-venous fistula was better visualized on the early pass, 21/25 (84%) fistulas were still at least partially visible on a delayed pass. Of 6 cases in which the CSF-venous fistula was better visualized on a delayed pass, 4/6 (67%) were partially visible on the earlier pass. Six of 48 (12.5%) CSF-venous fistulas were visible only on a single pass. Of these, 4/6 (66.7%) were seen only on the first pass, and 2/6 (33.3%) were seen only on a delayed pass. One fistula was found with one pass only, and one fistula was discovered upon contralateral decubitus imaging without a dedicated second injection.

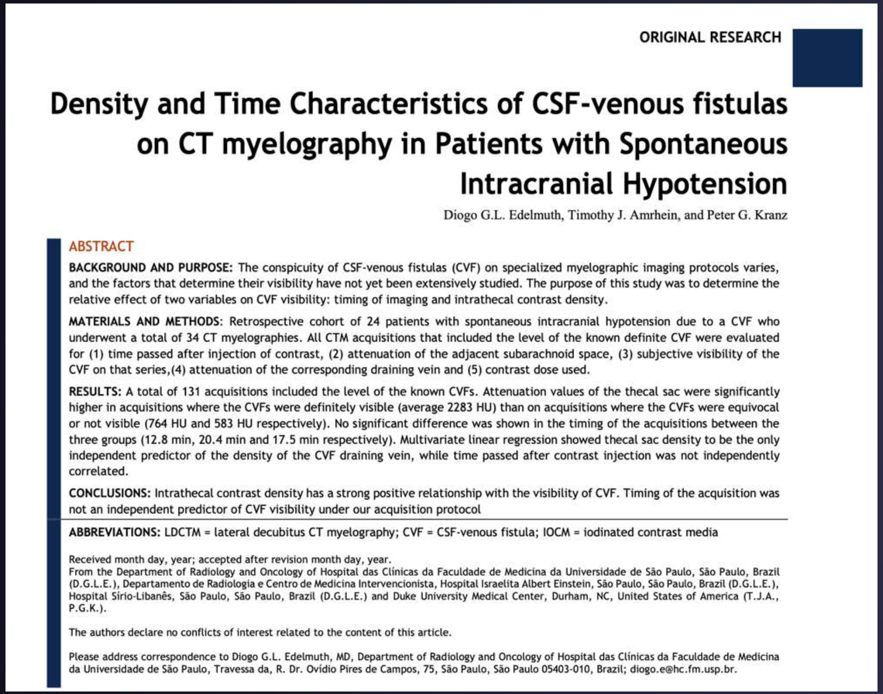
CONCLUSIONS: A dynamic decubitus CT myelography imaging protocol that includes an early and delayed phase, likely increases the sensitivity for CSF-venous fistula detection. Further studies are needed to ascertain the optimal timing and technique for CSF-venous fistula visualization on dynamic decubitus CT myelography and its impact on patient outcomes.

ABBREVIATIONS: CVF = CSF-venous fistula; dCTM = dynamic decubitus CT myelography; DSM = digital subtraction myelography; SIH = spontaneous intracranial hypotension

The fistula origin was better visualized on the first pass of imaging in 25/48 cases (52.1%), better visualized on a delayed phase of imaging in 6/48 cases (12.5%), and equally seen on both the first and subsequent phases in 15/48 cases (31.3%). Of 25 cases in which the fistula was better visualized on the first pass, 21/25 (84.0%) fistulas were still at least partially visible on a subsequent delayed pass. Of 6 cases in which the fistula was better visualized on a

Callen AL, Fakhri M, Timpone VM, Thaker AA, Dillon WP, Shah VN. Temporal Characteristics of CSF-Venous Fistulas on Dynamic Decubitus CT Myelography: A Retrospective Multi-Institution Cohort Study. AJNR Am J Neuroradiol. 2023 Dec 29;45(1):100-104.

DENSITY


ORIGINAL RESEARCH

Density and Time Characteristics of CSF-venous fistulas on CT myelography in Patients with Spontaneous Intracranial Hypotension

Diogo G.L. Edelmuth, Timothy J. Amrhein, and Peter G. Kranz

ABSTRACT

BACKGROUND AND PURPOSE: The conspicuity of CSF-venous fistulas (CVF) on specialized myelographic imaging protocols varies, and the factors that determine their visibility have not yet been extensively studied. The purpose of this study was to determine the relative effect of two variables on CVF visibility: timing of imaging and intrathecal contrast density.

MATERIALS AND METHODS: Retrospective cohort of 24 patients with spontaneous intracranial hypotension due to a CVF who underwent a total of 34 CT myelographies. All CTM acquisitions that included the level of the known definite CVF were evaluated for (1) time passed after injection of contrast, (2) attenuation of the adjacent subarachnoid space, (3) subjective visibility of the CVF on that series,(4) attenuation of the corresponding draining vein and (5) contrast dose used.

RESULTS: A total of 131 acquisitions included the level of the known CVFs. Attenuation values of the thecal sac were significantly higher in acquisitions where the CVFs were definitely visible (average 2283 HU) than on acquisitions where the CVFs were equivocal or not visible (764 HU and 583 HU respectively). No significant difference was shown in the timing of the acquisitions between the three groups (12.8 min, 20.4 min and 17.5 min respectively). Multivariate linear regression showed thecal sac density to be the only independent predictor of the density of the CVF draining vein, while time passed after contrast injection was not independently correlated.

CONCLUSIONS: Intrathecal contrast density has a strong positive relationship with the visibility of CVF. Timing of the acquisition was not an independent predictor of CVF visibility under our acquisition protocol

ABBREVIATIONS: LDCTM = lateral decubitus CT myelography; CVF = CSF-venous fistula; IOCM = iodinated contrast media

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The authors declare no conflicts of interest related to the content of this article.

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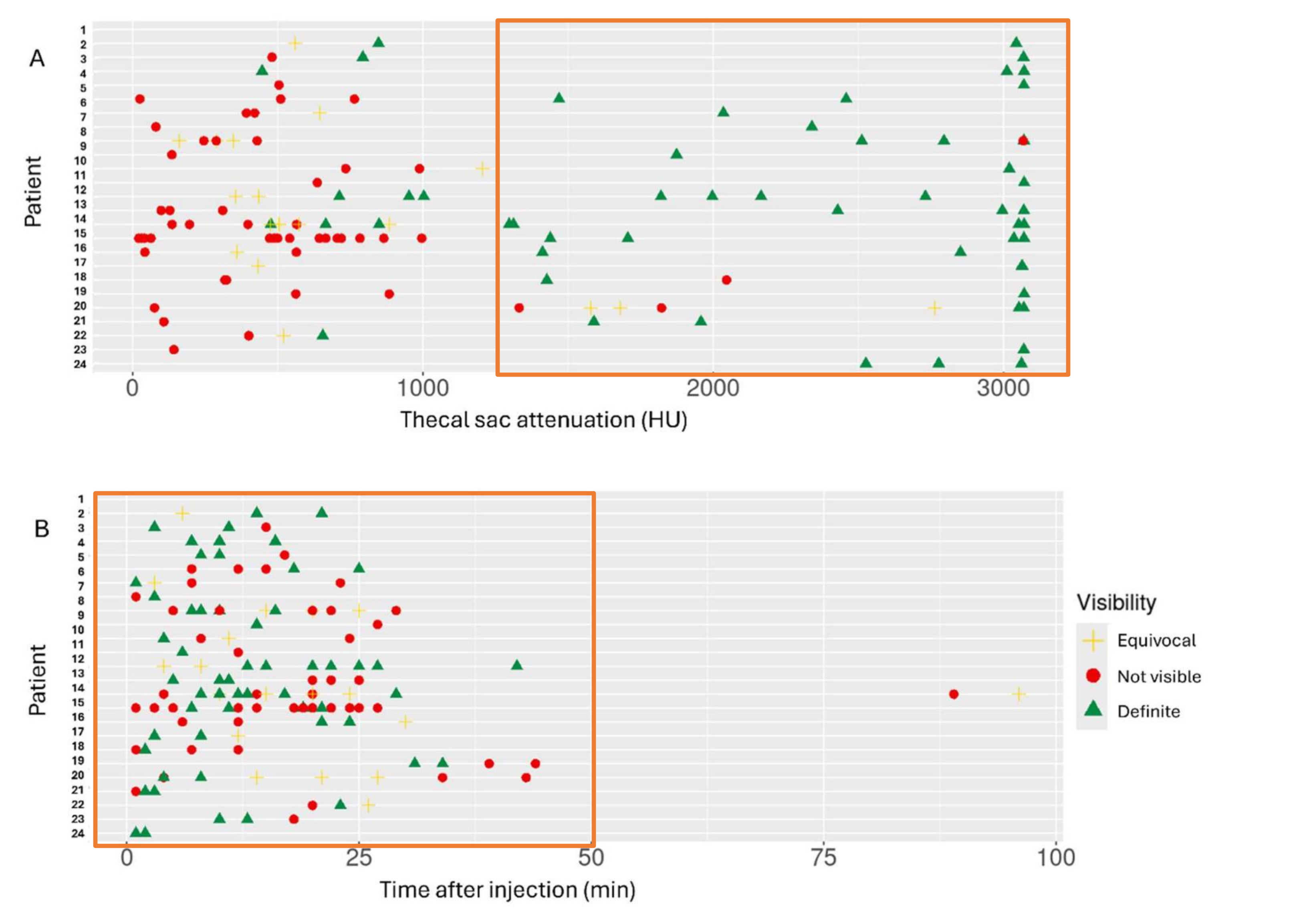
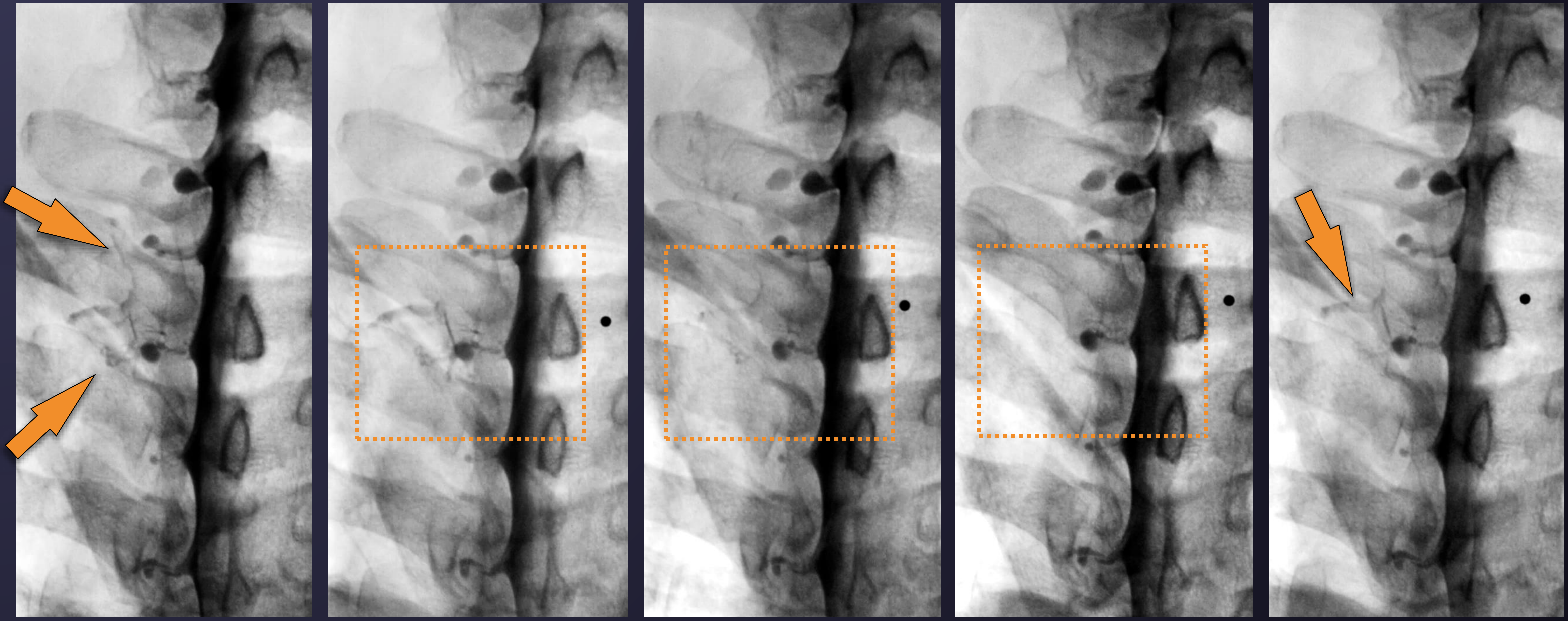


FIG 2. Each row in A and B represents a single patient. Each dot represents a CTM acquisition. In A, the x axis denotes the thecal sac attenuation on the level of a known CVF. In B, the x axis denotes the time passed between contrast injection and the acquisition. Colors represent the subjective visibility of the CVF on that acquisition.

Edelmuth DGL, Amrhein TJ, Kranz PG. Density and Time Characteristics of CSF-venous fistulas on CT myelography in Patients with Spontaneous Intracranial Hypotension. AJNR Am J Neuroradiol. 2024 Sep 30.

RESPIRATION



inspiration

Valsalva

inspiration

HOW TO BEST DETECT

ORIGINAL RESEARCH
SPINE

Resisted Inspiration Improves Visualization of CSF-Venous Fistulas in Spontaneous Intracranial Hypotension

P.G. Kranz, M.D. Malinzak, L. Gray, J. Willhite, and T.J. Amrhein

ABSTRACT

BACKGROUND AND PURPOSE: CSF-venous fistulas are an important cause of spontaneous intracranial hypotension but are challenging to detect. A newly described technique known as resisted inspiration has been found to augment the CSF-venous pressure gradient and was hypothesized to be of potential use in CSF-venous fistula detection but has not yet been investigated in patients with spontaneous intracranial hypotension. The purpose of this investigation was to determine whether resisted inspiration results in improved visibility of CSF-venous fistulas on CT myelography in patients with spontaneous intracranial hypotension.

MATERIALS AND METHODS: A retrospective cohort of patients underwent CT myelography from November 2022 to January 2023. Patients with an observed or suspected CSF-venous fistula identified during CT myelography using standard maximum suspended inspiration were immediately rescanned using resisted inspiration and the Valsalva maneuver. The visibility of the CSF-venous fistula among these 3 respiratory phases was compared, and changes in venous drainage patterns between phases were assessed.

RESULTS: Eight patients with confirmed CSF-venous fistulas who underwent CT myelography using the 3-phase respiratory protocol were included. Visibility of the CSF-venous fistula was greatest during resisted inspiration in 5/8 (63%) of cases. Visibility was optimal with the Valsalva maneuver and maximum suspended inspiration in 1 case each, and it was equivalent in all respiratory phases in 1 case. In 2/8 (25%) cases, the pattern of venous drainage shifted between respiratory phases.

CONCLUSIONS: In patients with spontaneous intracranial hypotension, resisted inspiration improved visualization of CSF-venous fistulas in most, but not all, cases. Further investigation is needed to determine the impact of this technique on the overall diagnostic yield of myelography in this condition.

ABBREVIATIONS: CTF = CT fluoroscopy; CTM = CT myelography; CVF = CSF-venous fistula; DSM = digital subtraction myelogram; SIH = spontaneous intracranial hypotension

"__Eight__ patients with confirmed CSF-venous fistulas who underwent CT myelography using the 3-phase respiratory protocol were included. Visibility of the CSF-venous fistula was greatest during resisted inspiration in 5/8 __(63%)__ of cases."

CTM vs DSM

Original research

Direct comparison of digital subtraction myelo
versus CT myelography in lateral decubitus po
evaluation of diagnostic yield for cerebrospina
venous fistulas

Niklas Lützen ,[1] Theo Demerath,[1] Urs Würtemberger,[1] Nebiyat Filate Be
Enrique Barvulsky Aleman,[1] Katharina Wolf,[2] Amir El Rahal,[2] Florian Volz,[2]
Christian Fung,[2] Jürgen Beck,[2] Horst Urbach[1]

OPEN ACCESS

► Additional supplemental material is published online only. To view, please visit the journal online (http://dx.doi.org/10.1136/jnis-2023-020789).

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Accepted 4 September 2023

ABSTRACT
Background Cerebrospinal fluid (CSF)-venous fistulas (CVFs) are increasingly identified as a cause of spontaneous intracranial hypotension (SIH). Lateral decubitus digital subtraction myelography (LD-DSM) and CT myelography (LD-CTM) are mainly used for detection, but the most sensitive method is yet unknown.
Objective To compare LD-DSM with LD-CTM for diagnostic yield of CVFs.
Methods Patients with SIH diagnosed with a CVF between January 2021 and December 2022 in which the area of CVF(s) was covered by both diagnostic modalities were included. LD-CTM immediately followed LD-DSM without repositioning the spinal needle, and the second half of the contrast agent was injected at the CT scanner. Patients were awake or mildly sedated. Retrospectively, two neuroradiologists evaluated data independently and blinded for the presence of CVF.
Results Twenty patients underwent a total of 27 combined LD-DSM/LD-CTM examinations (4/20 with follow-up and 3/20 with bilateral examinations). Both raters identified significantly more CVFs with LD-CTM than with LD-DSM (rater 1: 39 vs 9, P<0.001; rater 2: 42

WHAT IS ALREADY KNOWN ON TH
⇒ Imaging of cerebrospinal fluid (CS
fistulas is challenging—one reas
entity was not even known as a
spontaneous intracranial hypoter
initial description in 2014. As the
diagnostic modality for their dete
yet known, a direct comparison o
diagnostic methods is warranted.

WHAT THIS STUDY ADDS
⇒ This study is the first to compare
subtraction myelography and CT
in the lateral decubitus position i
patients and demonstrates the su
myelography in detecting CSF-ve

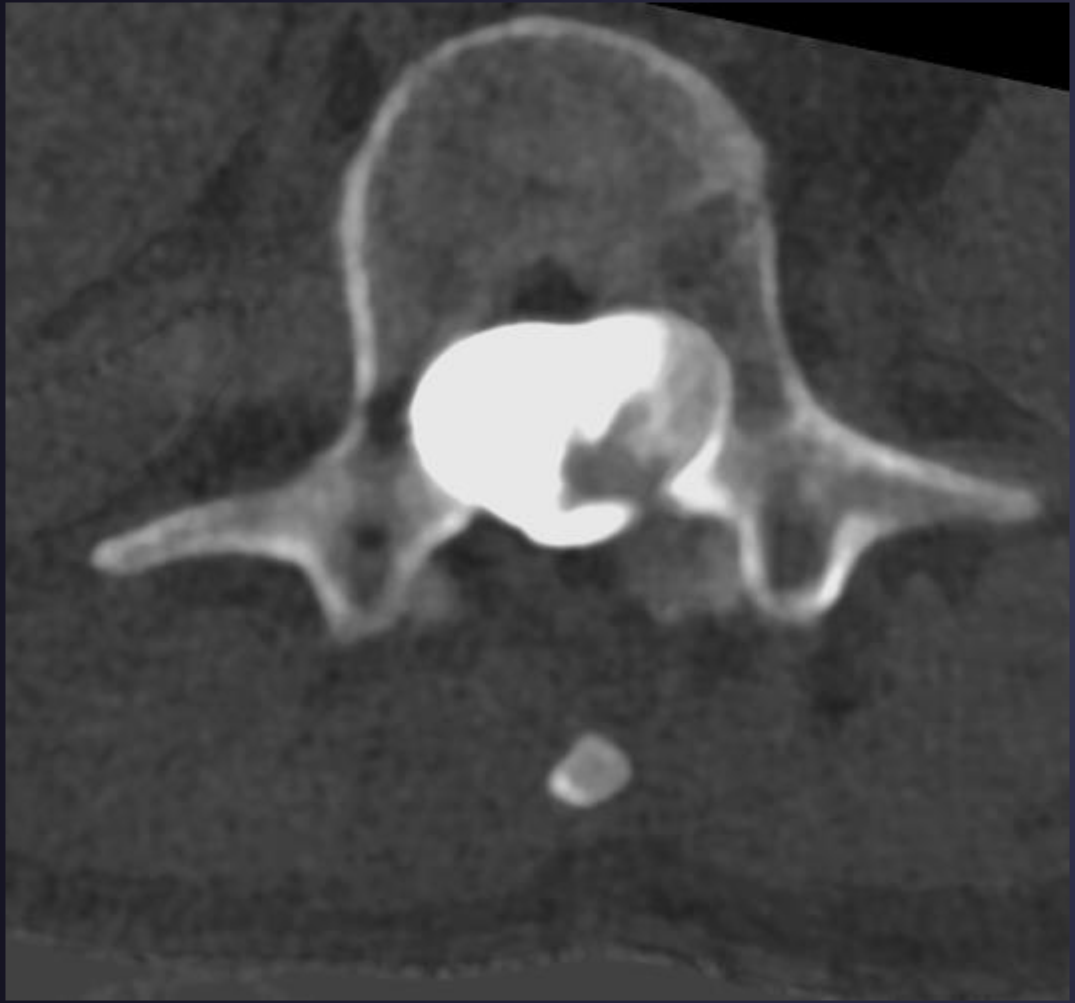
HOW THIS STUDY MIGHT AFFECT
PRACTICE OR POLICY
⇒ As CT is also widely available and
easy to use, the detection rate of
fistulas may further increase.

Results Twenty patients underwent a total of 27 combined LD-DSM/LD-CTM examinations (4/20 with follow-up and 3/20 with bilateral examinations). Both raters identified significantly more CVFs with LD-CTM than with LD-DSM (rater 1: 39 vs 9, P<0.001; rater 2: 42 vs 12, P<0.001). Inter-rater agreement was substantial for LD-DSM (κ=0.732) and LD-CTM (κ=0.655). The results remained significant after considering the senior rating for cases of disagreement (39 vs 10; P<0.001), and no CVF detected on LD-DSM was missed on LD-CTM.

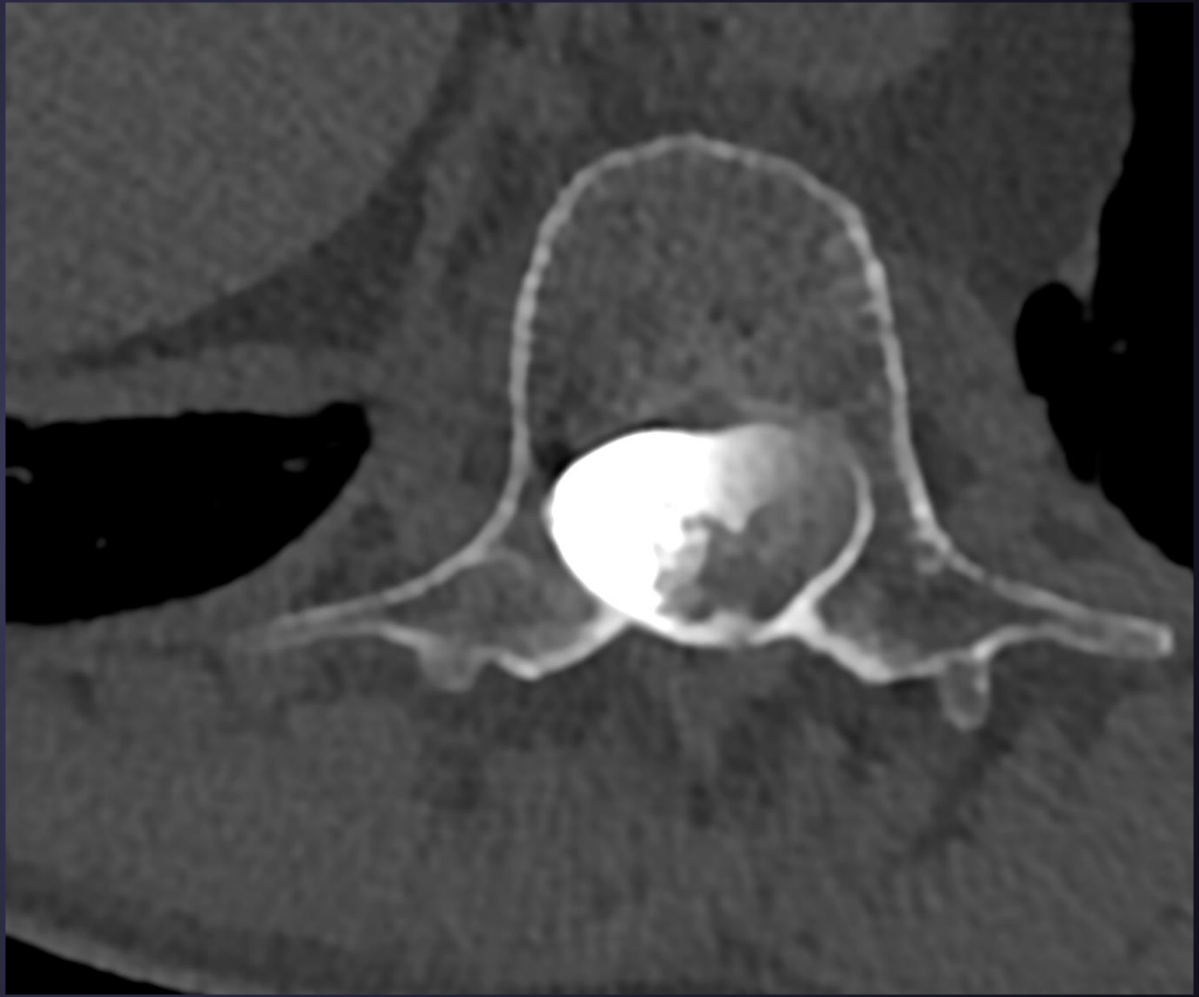
Conclusion In this study, LD-CTM has a higher diagnostic yield for the detection of CVFs than LD-DSM and should supplement LD-DSM, but further studies are needed. LD-CTM can be easily acquired in awake or mildly sedated patients with the second half of contrast injected just before CT scanning, or it may be considered as a stand-alone investigation.

Needs further investigation

CONVENTIONAL vs PCCT



EID CT *(0.625mm)*



PCCT CT *(0.2mm)*

CONVENTIONAL vs PCCT

CLINICAL REPORT
SPINE

Utility of Photon-Counting Detector CT Myelography for the Detection of CSF-Venous Fistulas

A.A. Madhavan, L. Yu, W. Brinjikji, J.K. Cutsforth-Gregory, F.R. Schwartz, I.T. Mark, J.C. Benson, and T.J. Amrhein

ABSTRACT

SUMMARY: CSF-venous fistulas are an increasingly recognized type of CSF leak that can be particularly challenging to detect, even with recently improved imaging techniques. Currently, most institutions use decubitus digital subtraction myelography or dynamic CT myelography to localize CSF-venous fistulas. Photon-counting detector CT is a relatively recent advancement that has many theoretical benefits, including excellent spatial resolution, high temporal resolution, and spectral imaging capabilities. We describe 6 cases of CSF-venous fistulas detected on decubitus photon-counting detector CT myelography. In 5 of these cases, the CSF-venous fistula was previously occult on decubitus digital subtraction myelography or decubitus dynamic CT myelography using an energy-integrating detector system. All 6 cases exemplify the potential benefits of photon-counting detector CT myelography in identifying CSF-venous fistulas. We suggest that further implementation of this imaging technique will likely be valuable to improve the detection of fistulas that might otherwise be missed with currently used techniques.

ABBREVIATIONS: CTM = CT myelography; CVF = CSF-venous fistula; DSM = digital subtraction myelography; EID = energy-integrating detector; LDDSM = lateral decubitus digital subtraction myelography; PCD = photon-counting detector; SIH = spontaneous intracranial hypotension; SR = standard resolution; T3D = low-energy threshold; UHR = ultra-high-resolution mode; VMI = virtual monoenergetic image

"In 5 [of 6] cases, the CSF-venous fistula was previously occult on decubitus digital subtraction myelography or decubitus dynamic CT myelography using an energy-integrating detector system."

ORIGINAL RESEARCH
SPINE IMAGING AND SPINE IMAGE-GUIDED INTERVENTIONS

Diagnostic Performance of Decubitus Photon-Counting Detector CT Myelography for the Detection of CSF-Venous Fistulas

Ajay A. Madhavan, Jeremy K. Cutsforth-Gregory, Waleed Brinjikji, Girish Bathla, John C. Benson, Felix E. Diehn, Laurence J. Eckel, Ian T. Mark, Pearse P. Morris, Melissa A. Payne, Jared T. Verdoorn, Nikkole M. Weber, Lifeng Yu, Francis Baffour, Joel G. Fletcher, and Cynthia H. McCollough

ABSTRACT

BACKGROUND AND PURPOSE: CSF-venous fistulas are a common cause of spontaneous intracranial hypotension. Lateral decubitus digital subtraction myelography and CT myelography are the diagnostic imaging standards to identify these fistulas. Photon-counting CT myelography has technological advantages that might improve CSF-venous fistula detection, though no large studies have yet assessed its diagnostic performance. We sought to determine the diagnostic yield of photon-counting detector CT myelography for detection of CSF-venous fistulas in patients with spontaneous intracranial hypotension.

MATERIALS AND METHODS: We retrospectively searched our database for all decubitus photon-counting detector CT myelograms performed at our institution since the introduction of the technique in our practice. Per our institutional workflow, all patients had prior contrast-enhanced brain MR imaging and spine MR imaging showing no extradural CSF. Two neuroradiologists reviewed pre-procedural brain MRIs, assessing previously described findings of intracranial hypotension (Bern score). Additionally, 2 different neuroradiologists assessed each myelogram for a definitive or equivocal CSF-venous fistula. The yield of photon-counting detector CT myelography was calculated and stratified by the Bern score using low-, intermediate-, and high-probability tiers.

RESULTS: Fifty-seven consecutive photon-counting detector CT myelograms in 57 patients were included. A single CSF-venous fistula was definitively present in 38/57 patients. After we stratified by the Bern score, a definitive fistula was seen in 56.0%, 73.3%, and 76.5% of patients with low-, intermediate-, and high-probability brain MR imaging, respectively.

CONCLUSIONS: Decubitus photon-counting detector CT myelography has an excellent diagnostic performance for the detection of CSF-venous fistulas. The yield for patients with intermediate- and high-probability Bern scores is at least as high as previously reported yields of decubitus digital subtraction myelography and CT myelography using energy-integrating detector scanners. The yield for patients with low-probability Bern scores appears to be greater compared with other modalities. Due to the retrospective nature of this study, future prospective work will be needed to compare the sensitivity of photon-counting detector CT myelography with other modalities.

ABBREVIATIONS: CTM = CT myelography; CVF = CSF-venous fistula; DSM = digital subtraction myelography; EID = energy-integrating detector; EVVP = external vertebral venous plexus; IVVP = internal vertebral venous plexus; PC = photon-counting detector; SIH = spontaneous intracranial hypotension; SR = standard resolution; T3D = low-energy threshold; UHR = ultra-high resolution; VMI = virtual monoenergetic image

"PC-CTM identified a definitive CVF in 66.7% of consecutive patients presenting with SIH in the absence of an extradural CSF."

HOW TO BEST DETECT

- Literature is inconclusive still
- Must work at your institution
- Equipment availability, referral, experience patterns matter
- Operator experience > Technology

RECURRENCE

LITERATURE REVIEW

Check for updates

Surgical Treatment Efficacy of CSF-Venous Fistulas: Systematic Review

Anton Konovalov, Vadim Gadzhiagaev, Evgeniy Vinogradov, Nikita Nikitin, Shalva Eliava, Nikolay Konovalov

Table 2. Studies Included in Analysis and Relevant Data

Study	Sample Size	EBP Performed in	Stereotactic Fibrin Glue Injection	Surgical CSF Ligation	Resolution of Symptoms
Schievink et al., 2014[2]	3	2/3	1/3	2/3	100%
Kumar et al., 2016[8]	3	3/3	0/3	3/3	100%
Kranz et al., 2016[7]	3	3/3	0/3	3/3	100%
Shievink et al., 2016[11]	10	0	4/10	9/10	90%
Kranz et al., 2017[9]	22	22	0	10	59%
Duvall et al., 2019[10]	44	40/44	0	42/44	47%
Shievink et al., 2019[20]	3	2/3	0	3/3	66%
Madhavan et al., 2020[21]	2	0	0	1/2	50%
Chazen et al., 2020[13]	3	3/3	0	3/3	100%
Wang et al., 2020[14]	20	20/20	0	20/20	90%
Ortega-Porcayo et al., 2020[15]	1	0	0	1/1	0%
Mamlouk et al., 2021[16]	13	0	13/13	0	100%
Malinzak et al., 2021[19]	4	0	0	4/4	25%
Brinjikji et al., 2021[17]	5	0	0	5/5 (endovascular embolization)	80%
Shievink et al., 2021[18]	6	6/6	1/6	6/6	83%
Total	142	101	0	107	64%

"According to our analysis, the recurrence rate after treatment in all groups is approximately 6%, which is relatively low, considering that experience with diagnosis and treatment is limited."

Konovalov A, et al. Surgical Treatment Efficacy of CSF-Venous Fistulas: Systematic Review. World Neurosurg. 2022 May;161:91-96.

RHP

LITERATURE REVIEW

Check for updates

Surgical Treatment Efficacy of CSF-Venous Fistulas: Systematic Review

Anton Konovalov, Vadim Gadzhiagaev, Evgeniy Vinogradov, Nikita Nikitin, Shalva Eliava, Nikolay Konovalov

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"Data on postoperative complications are scarce in the evaluated studies. Rebound syndrome was observed in 18 patients after surgery (16.8%). They regressed commonly within a month without additional treatment. Acetazolamide was administered for 2–3 weeks in selected patients.

Endovascular treatment was described only in study ... No complications were registered."

Konovalov A, et al. Surgical Treatment Efficacy of CSF-Venous Fistulas: Systematic Review. World Neurosurg. 2022 May;161:91-96.

UNKNOWN UNKNOWNS

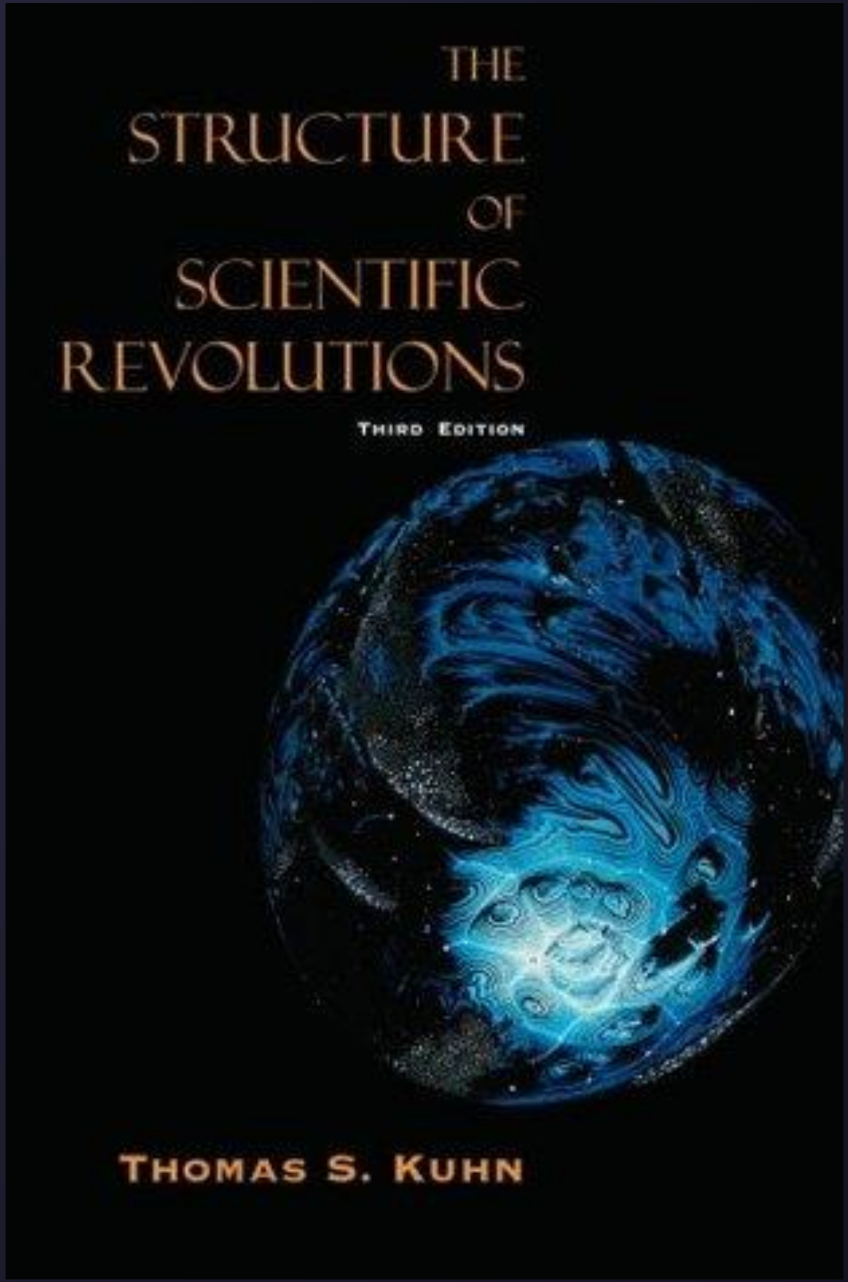
"There are more things in heaven and earth, Horatio, Than are dreamt of in your philosophy"

(Hamlet I.5:159–167)

Normal Science

Anomaly

Revolution

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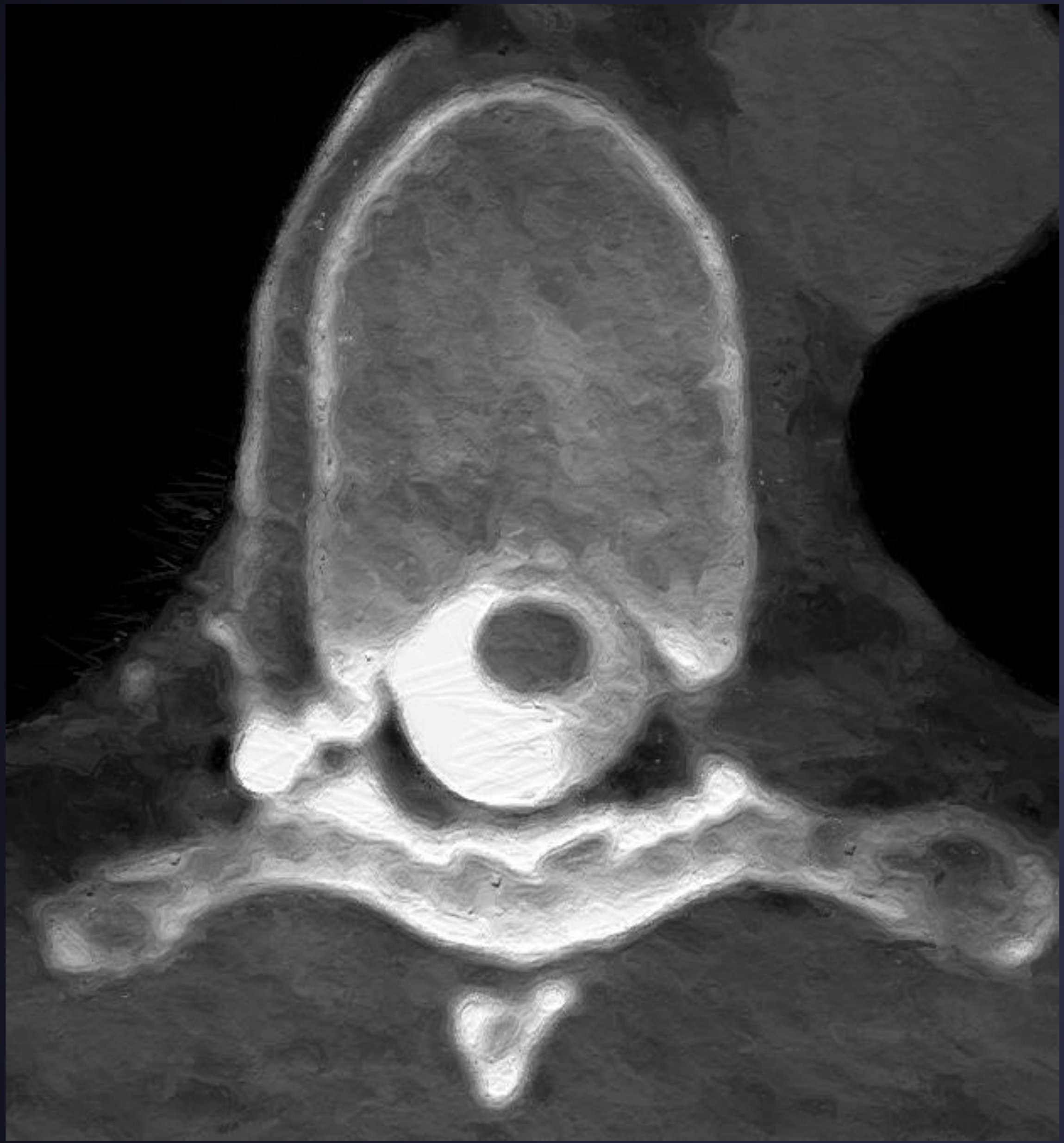

CVFs: Known and Unknown

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Duke Radiology