Approach to Negative Imaging

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Disclaimer

This is an exceedingly complicated and at times emotional topic.

Data represents averages, but life is individual.

I will speak in broad generalities that may not apply to individual patients; nothing I say should supersede the joint decisions of patients and their physicians.

OVERVIEW

IS IT REALLY NORMAL?

HAVE I DONE ENOUGH WORKUP?

HAVE I CONSIDERED ALTERNATE DX?

SHOULD I TREAT ANYWAY?

IS IT REALLY NORMAL?

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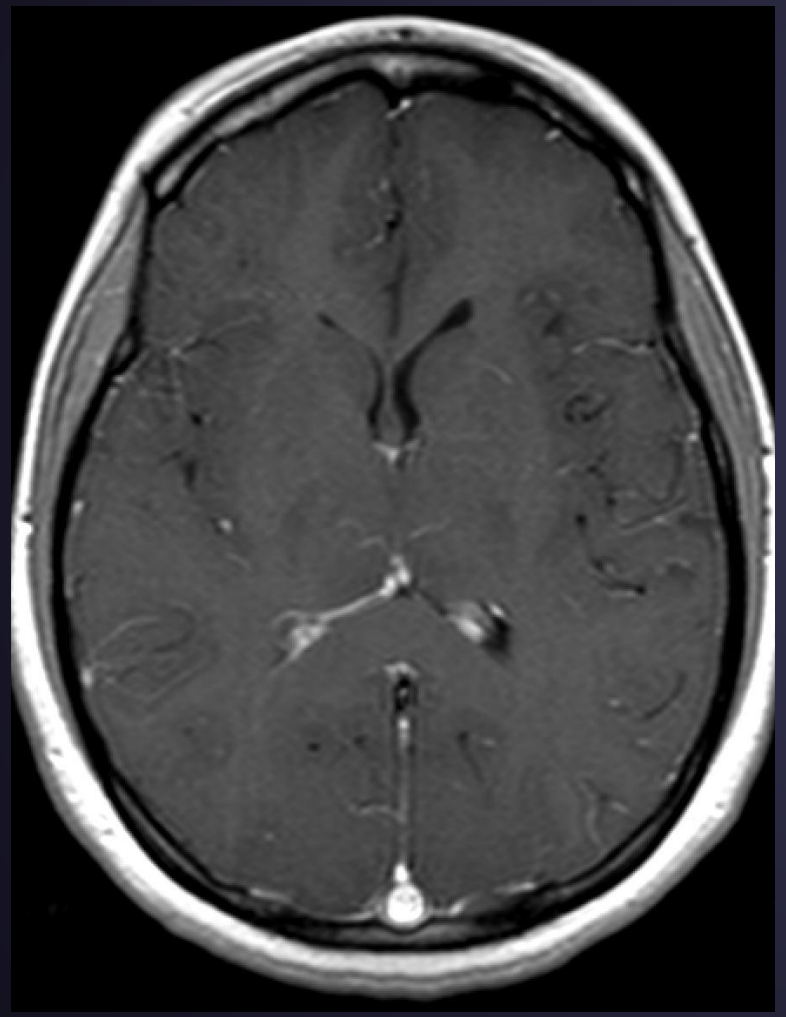
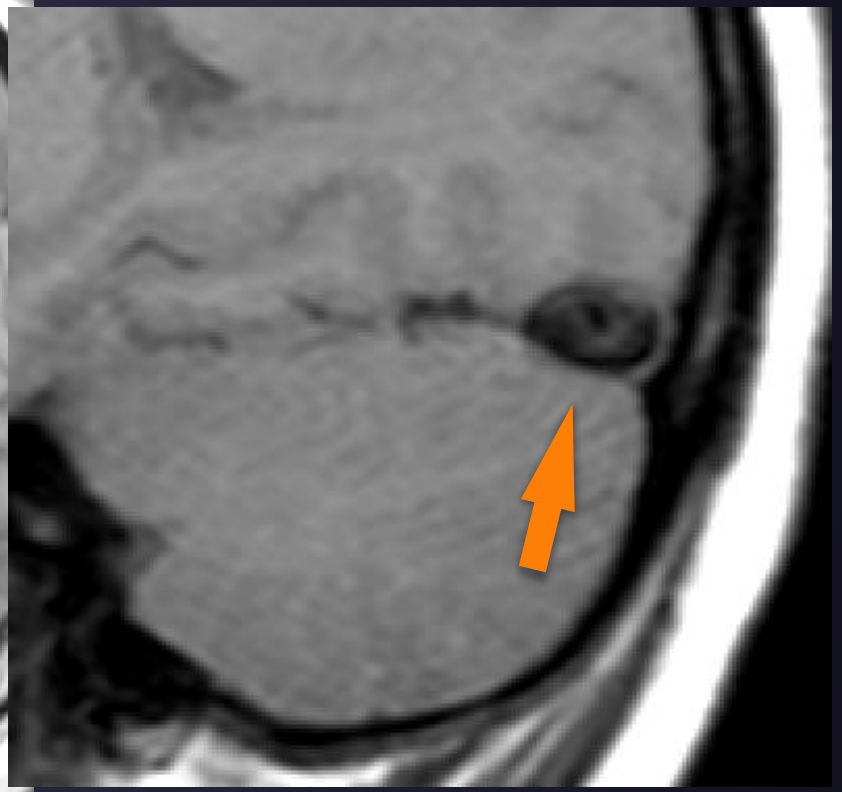
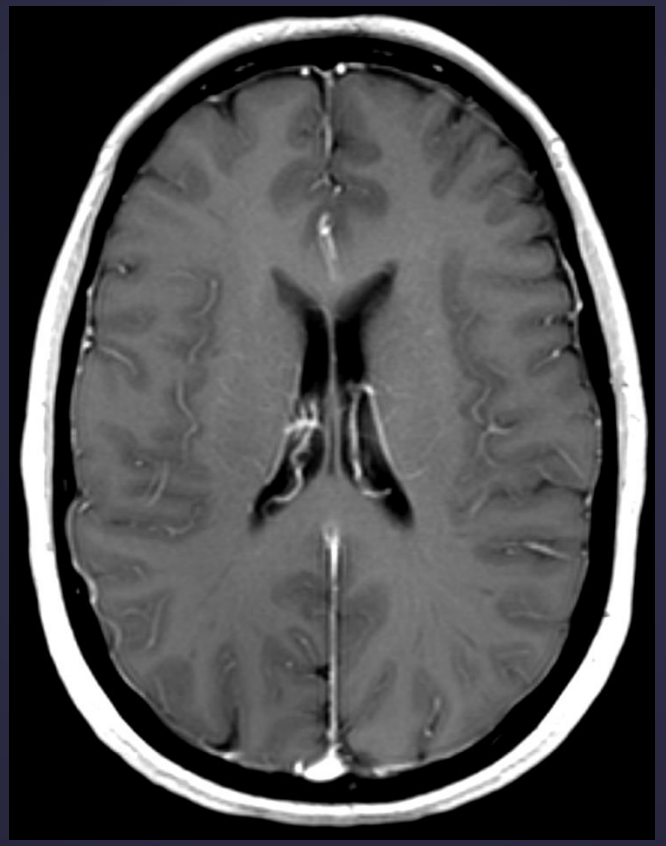




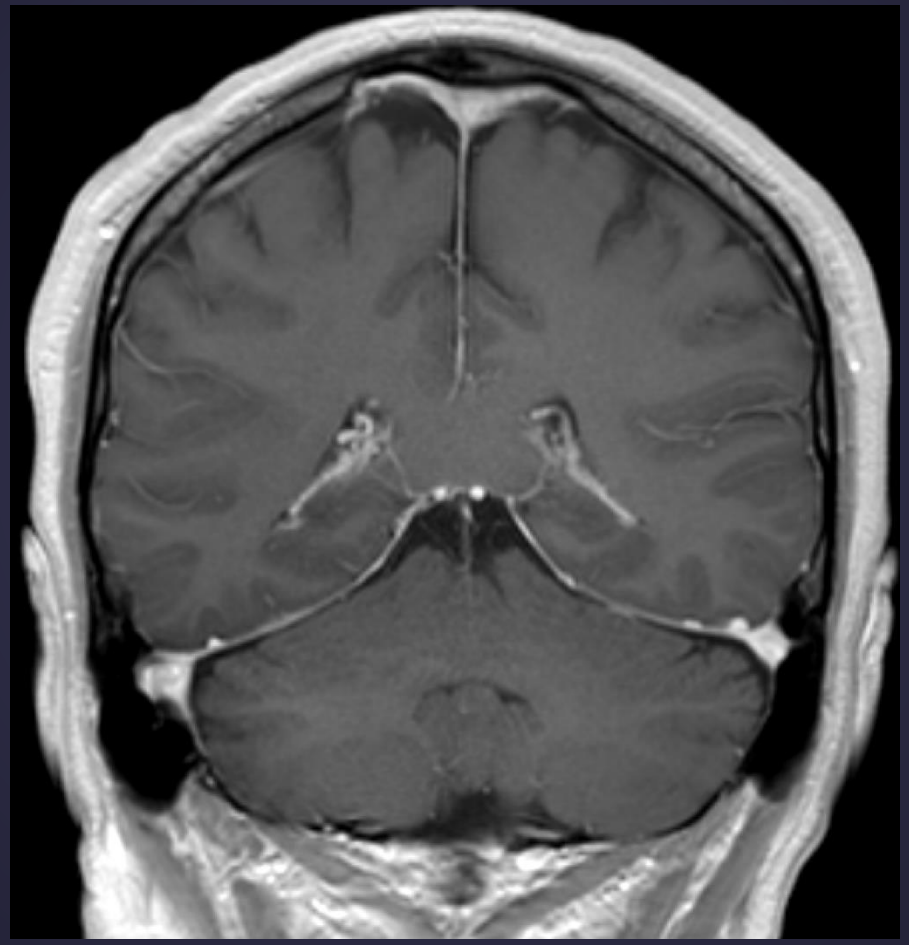
IS IT REALLY NORMAL?

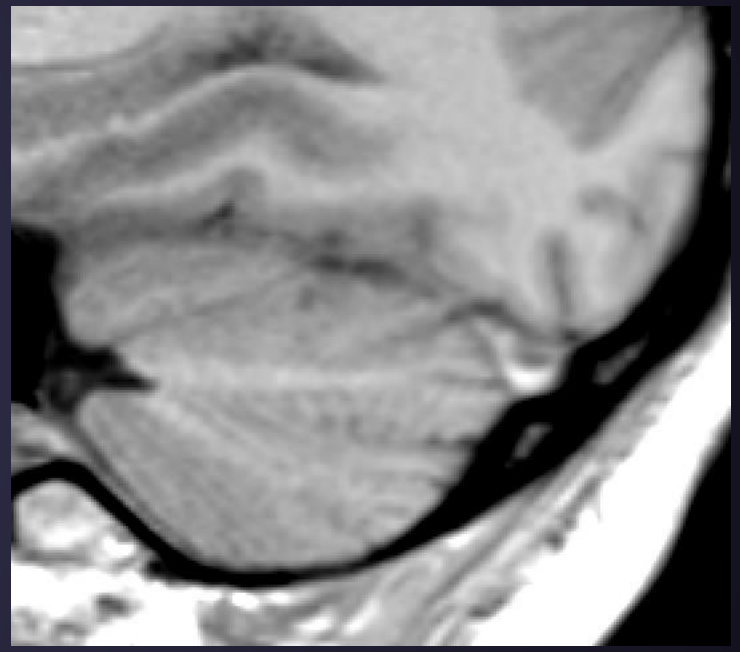
SIH WITH NORMAL BRAIN



CASE 1

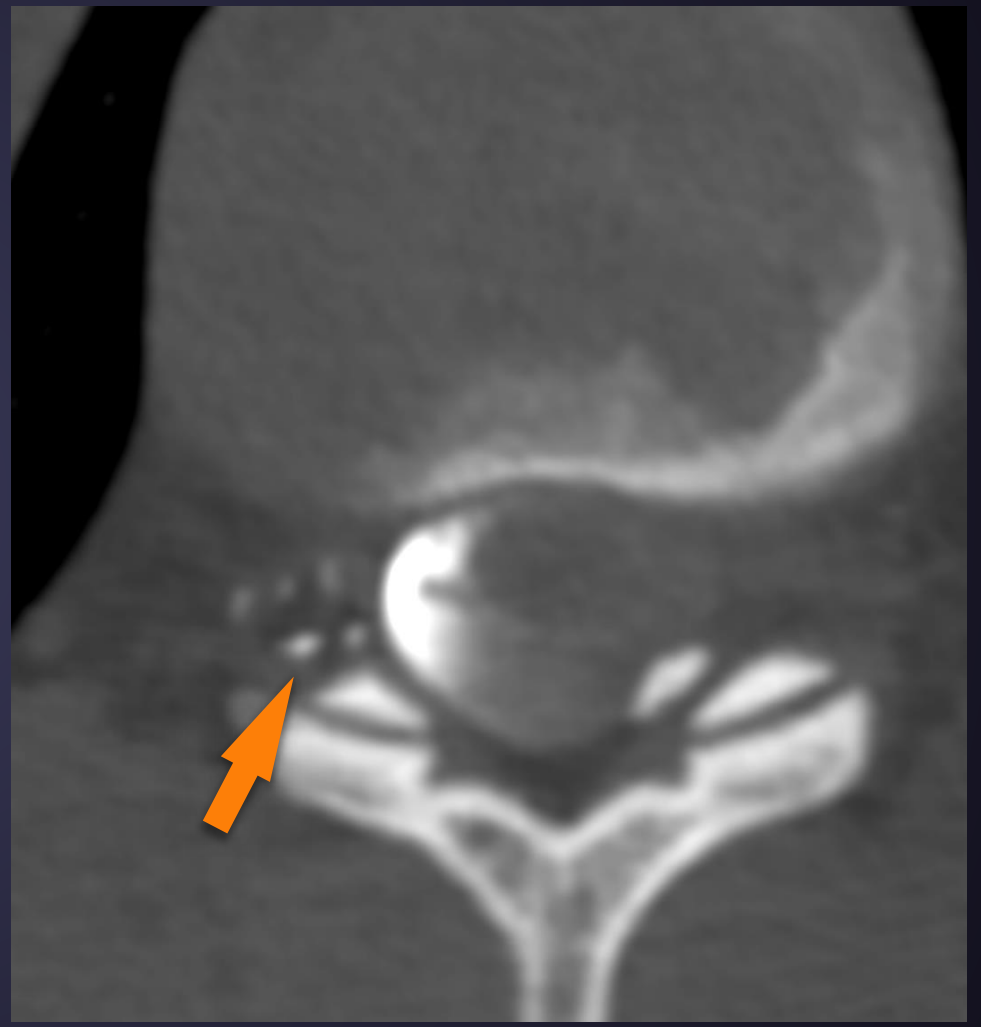
SIH WITH NORMAL BRAIN





CASE 2

SIH WITH NORMAL BRAIN



CASE 2

BERN SCORE

Dobrocky T, Grunder L, Breiding PS, Branca M, Limacher A, Mosimann PJ, Mordasini P, Zibold F, Haeni L, Jesse CM, Fung C, Raabe A, Ulrich CT, Gralla J, Beck J, Piechowiak EI. Assessing Spinal Cerebrospinal Fluid Leaks in Spontaneous Intracranial Hypotension With a Scoring System Based on Brain Magnetic Resonance Imaging Findings. JAMA Neurol. 2019 May 1;76(5):580-587.

JAMA Neurology | Original Investigation

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

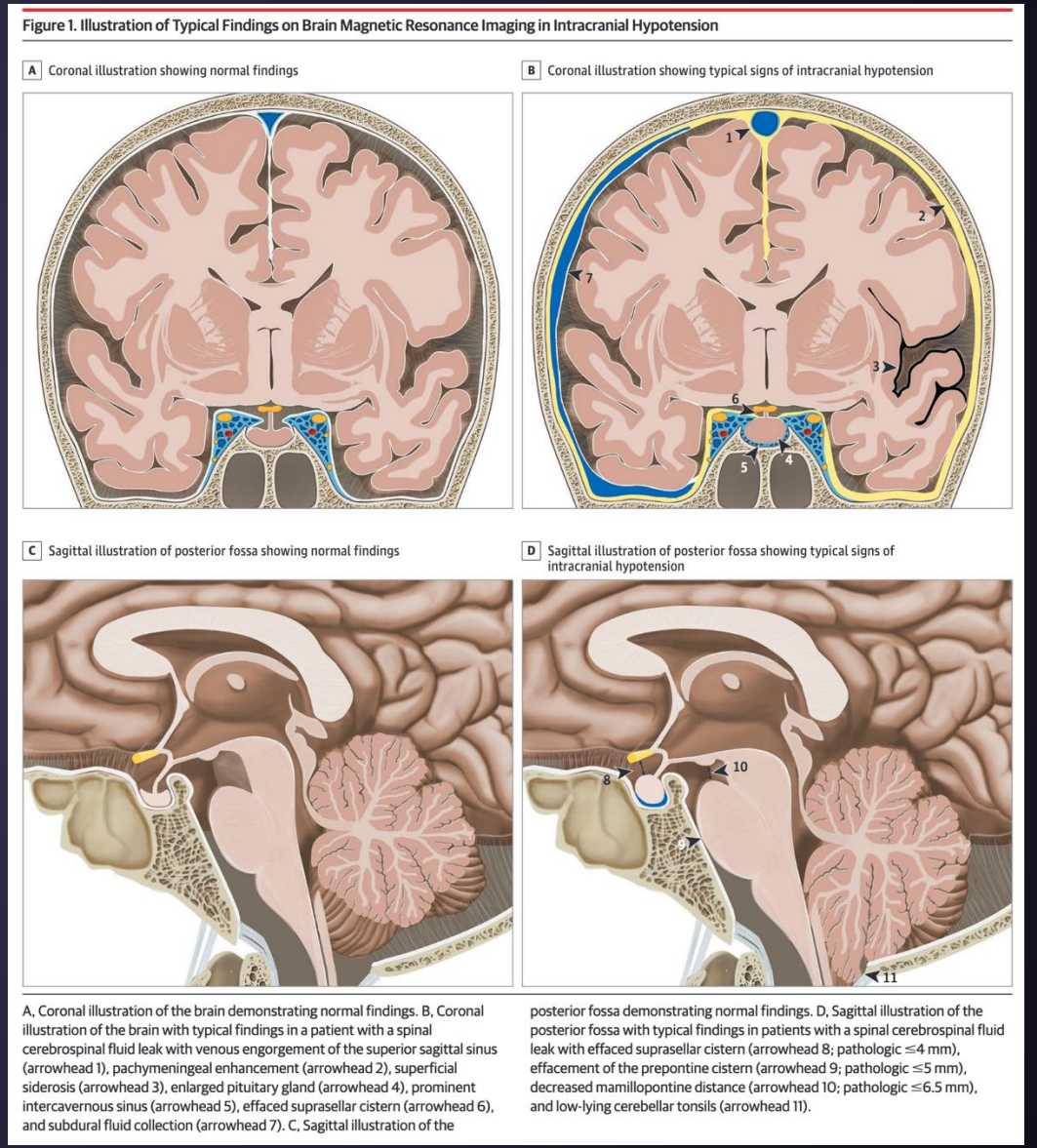
Tomas Dobrocky, MD; Lorenz Grunder, MD; Philipe S. Breiding, MD; Mattia Branca, MSc; Andreas Limacher, PhD; Pascal J. Mosimann, MD; Pasquale Mordasini, MSc; Felix Zibold, MD; Levin Haeni, MD; Christopher M. Jesse, MD; Christian Fung, MD; Andreas Raabe, MD; Christian T. Ulrich, MD; Jan Gralla, MSc; Jürgen Beck, MD; Eike I. Piechowiak, MD

Major (2 points each)

- Pachymeningeal enhancement
- Engorgement of venous sinus
- Effacement of the suprasellar cistern of ≤4.0 mm or less

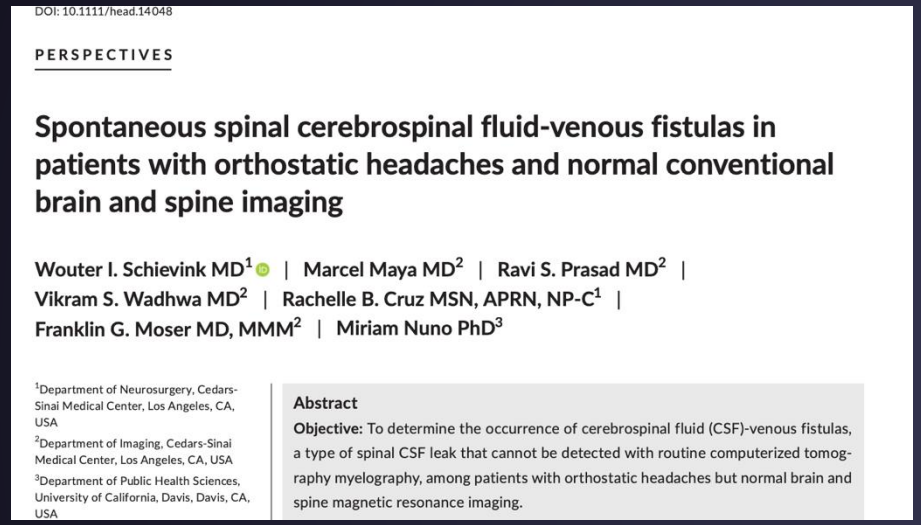
Minor (1 point each)

- Subdural fluid collection
- Effacement of the prepontine cistern of 5.0 mm or less
- Mamillopontine distance of 6.5 mm or less



HAVE I DONE ENOUGH WORKUP?

YIELD OF ADVANCED MYELOGRAPHY WITH *NORMAL* BRAIN & SPINE MR



DOI: 10.1111/head.14048

PERSPECTIVES

Spontaneous spinal cerebrospinal fluid-venous fistulas in patients with orthostatic headaches and normal conventional brain and spine imaging

Wouter I. Schievink MD[1] | Marcel Maya MD[2] | Ravi S. Prasad MD[2] | Vikram S. Wadhwa MD[2] | Rachelle B. Cruz MSN, APRN, NP-C[1] | Franklin G. Moser MD, MMM[2] | Miriam Nuno PhD[3]

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[3]Department of Public Health Sciences, University of California, Davis, Davis, CA, USA

Abstract

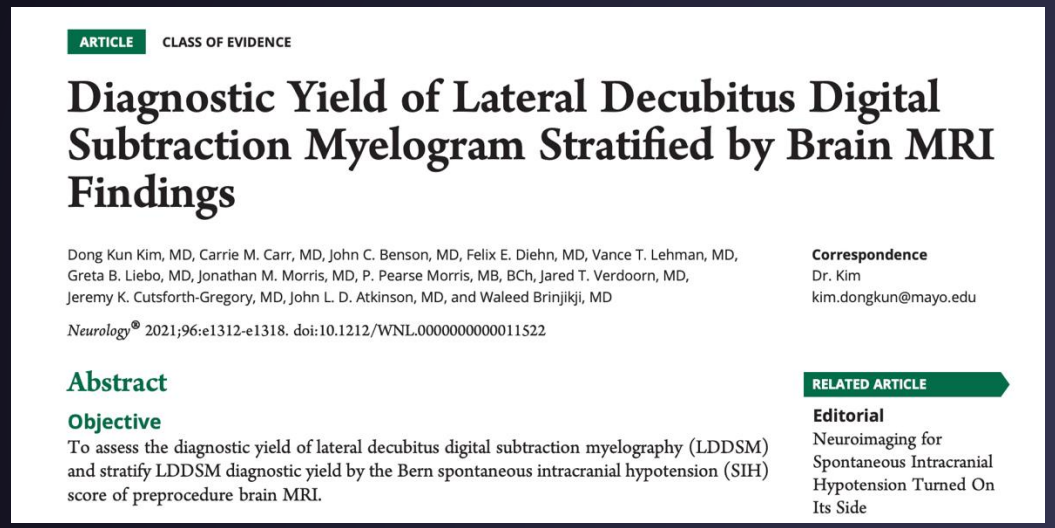
Objective: To determine the occurrence of cerebrospinal fluid (CSF)-venous fistulas, a type of spinal CSF leak that cannot be detected with routine computerized tomography myelography, among patients with orthostatic headaches but normal brain and spine magnetic resonance imaging.

Dx yield = 10% (w/ previous EBP)

- ***All 60 patients underwent EBP prior to DSM***
- ***6/60 (10%) patients had a CVF on DSM***
- ***CVFs identified in 19% of patients with spinal meningeal diverticula, but 0% in patients without diverticula***
- ***CVF not always from the largest diverticulum (only 33%)***
- ***Response to EBP:***
  - ***CVF+: 100% response***
  - ***CFV - : 81% response***

Schievink WI, Maya M, Prasad RS, et al. Spontaneous spinal cerebrospinal fluid–venous fistulas in patients with orthostatic headaches and normal conventional brain and spine imaging. Headache 2021; 61:387–391

YIELD OF ADVANCED MYELOGRAPHY WITH *NORMAL* BRAIN & SPINE MR



ARTICLE CLASS OF EVIDENCE

Diagnostic Yield of Lateral Decubitus Digital Subtraction Myelogram Stratified by Brain MRI Findings

Dong Kun Kim, MD, Carrie M. Carr, MD, John C. Benson, MD, Felix E. Diehn, MD, Vance T. Lehman, MD, Greta B. Liebo, MD, Jonathan M. Morris, MD, P. Pearse Morris, MB, BCh, Jared T. Verdoorn, MD, Jeremy K. Cutsforth-Gregory, MD, John L. D. Atkinson, MD, and Waleed Brinjikji, MD

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Neurology® 2021;96:e1312-e1318. doi:10.1212/WNL.0000000000011522

Abstract

Objective

To assess the diagnostic yield of lateral decubitus digital subtraction myelography (LDDSM) and stratify LDDSM diagnostic yield by the Bern spontaneous intracranial hypotension (SIH) score of preprocedure brain MRI.

RELATED ARTICLE

Editorial
Neuroimaging for Spontaneous Intracranial Hypotension Turned On Its Side

Dx yield = 0% for Bern score of 2 or less (n=9)

- ***Inclusion: clinical suspicion of SIH, pre-procedure brain and spine MR***
- ***Exclusion: epidural fluid on MRI***
- ***Limitation: unclear who had SIH with a low Bern score vs no SIH***

Kim DK, Carr CM, Benson JC, et al. Diagnostic yield of lateral decubitus dig- ital subtraction myelogram stratified by brain MRI findings. Neurology 2021; 96:e1312–e1318

YIELD OF ADVANCED MYELOGRAPHY WITH *NORMAL* BRAIN & SPINE MR

ORIGINAL RESEARCH
SPINE IMAGING AND SPINE IMAGE-GUIDED INTERVENTIONS

Diagnostic Yield of Decubitus CT Myelography for Detection of CSF-Venous Fistulas

Jacob T. Gibby, Timothy J. Amrhein, Derek S. Young, Jessica L. Houk, and Peter G. Kranz

ABSTRACT

BACKGROUND AND PURPOSE: Various imaging techniques have been described to detect CSF-venous fistulas in the setting of spontaneous intracranial hypotension, including decubitus CT myelography. The expected diagnostic yield of decubitus CT myelography for CSF-venous fistula detection is not fully established. The purpose of this study was to assess the yield of decubitus CT myelography among consecutive patients presenting for evaluation of possible spontaneous intracranial hypotension and to examine the impact of brain MR imaging findings of spontaneous intracranial hypotension on the diagnostic yield.

MATERIALS AND METHODS: The study included a single-center, retrospective cohort of consecutive patients presenting during a 1-year period who underwent CT myelography and had no CSF identified in the epidural space. Patients with epidural CSF leaks were included in a secondary cohort. Subjects were grouped according to positioning for the myelogram, either decubitus or prone, and the presence of imaging findings of spontaneous intracranial hypotension on preprocedural brain MR imaging. Diagnostic yields for each subgroup were calculated, and the yield of decubitus CT myelography was compared with that of prone CT myelography.

RESULTS: The study cohort comprised 302 subjects, including 247 patients with no epidural fluid. The diagnostic yield of decubitus CT myelography for CSF-venous fistula detection among subjects with positive brain MR imaging findings and no epidural fluid was 73%. No CSF-venous fistulas were identified among subjects with negative findings on brain imaging. Among subjects with an epidural leak, brain MR imaging was negative for signs of spontaneous intracranial hypotension in 22%. Prone CT myelography identified a CSF-venous fistula less commonly than decubitus CT myelography (43% versus 73%, $P = .19$), though the difference was not statistically significant in this small subgroup.

CONCLUSIONS: We found the diagnostic yield of decubitus CT myelography to be similar to the yield previously reported for digital subtraction myelography among patients with positive findings on brain imaging. No CSF-venous fistulas were identified in patients with negative findings on brain imaging; epidural CSF leaks accounted for all cases of patients who had spontaneous intracranial hypotension with negative brain imaging findings. This study provides useful data for counseling patients and helps establish a general benchmark for the decubitus CT myelography yield for CSF-venous fistula detection.

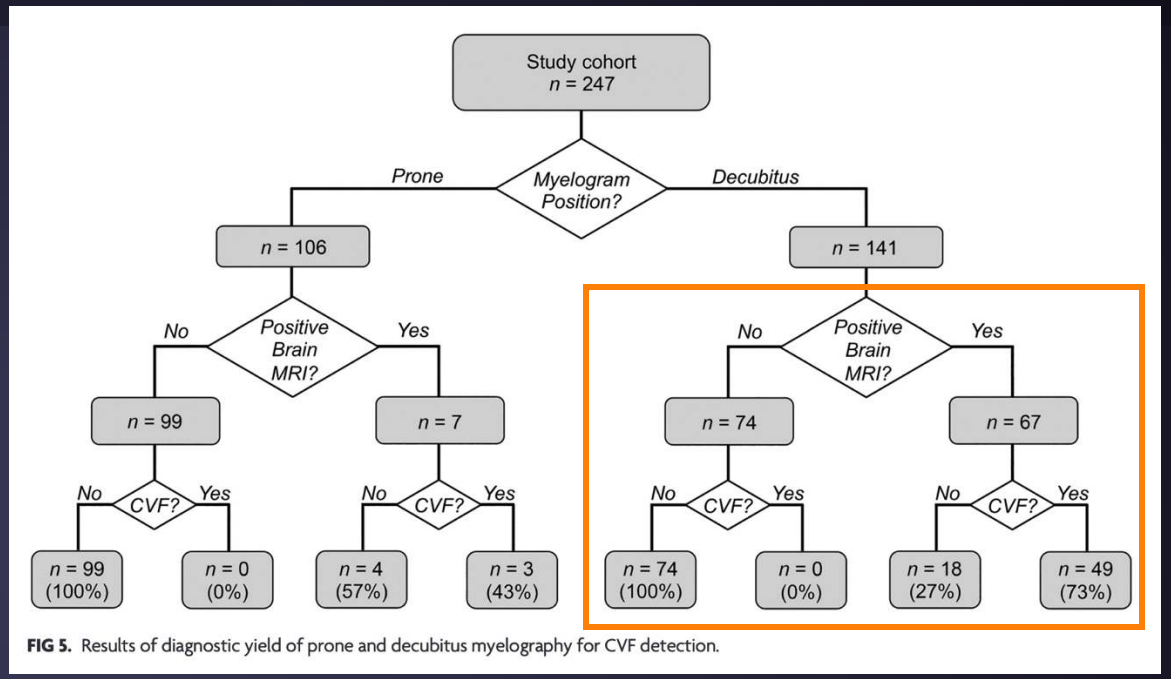

FIG 5. Results of diagnostic yield of prone and decubitus myelography for CVF detection.

Dx yield = 0%

"Of patients with an epidural leak seen on spinal imaging (n = 55), 78% (43/55) had positive brain imaging … the remaining 22% (12/55) had no signs of SIH on brain imaging."

"No CSF-venous fistulas were identified in patients with negative findings on brain imaging; epidural CSF leaks accounted for all cases of patients who had spontaneous intracranial hypotension with negative brain imaging findings."

Gibby JT, et al. Diagnostic Yield of Decubitus CT Myelography for Detection of CSF-Venous Fistulas. AJNR Am J Neuroradiol. 2024 Aug 1. doi: 10.3174/ajnr.A8330.

WHERE DOES THAT LEAVE US?

- *Consensus: strongly suspected SIH should have Brain + Spine imaging*
- *No consensus: type of spine imaging sufficient for 'complete' workup. At a referral center, probably will (and should) get advanced myelography.*
- *Negative imaging DOES NOT mean nothing is wrong*
- *More workup is not cost-free: medical, social, financial risks and costs*
- *Need more science to better guide*

HAVE I CONSIDERED ALTERNATE DX?

Challenge Case

- *Definite SIH*
- *CVF to sacral venous malformation*
- *Multiple treatments*
- *Brain imaging normalized*
- *Symptoms persisted – with frequent syncope*
- *CSF opening pressure 30 cm H20*
- *Repeat myelography: no residual CVF*
- *Active stand test:*
- *HR increase 50bpm*

Supine (after 10 minutes of resting): Heart rate: 80 bpm, BP: 120/81
Standing (after 5 minutes of active standing): Heart rate: 116 bpm, BP 117/77
Standing (after 10 minutes of active standing): Heart rate 112 bpm, BP 126/110
Standing (after 11 minutes of active standing): Heart rate: 130 bpm, heart rate 115/81

ALTERNATE DIAGNOSES?

	POTS *Postural orthostatic Tachycardia Syndrome*	**Cervicogenic**	**IIH** *Idiopathic Intracranial Hypertension*	**Craniocervical Instability**	**NDPH (primary)** *New Daily Persistent Headache*
Mechanism	• *Dysautonomia* • *Abnormal increase in HR when standing* • *Decreased filling of epidural venous plexus*	• *Upper cervical DJD* • *Referred head pain in cervical dermatomes* • *Axial loading in upright posture*	• *Increased CSF pressure* • *Exertional worsening* • *Orthostatic and exertional components can be confused*	• *Murky dx and diagnostic criteria* • *Associated with connective tissue d/o* • *Abnormal motion at skull base causes head pain*	• *Unknown mechanism* • *Abrupt onset* • *Onset may be associated with viral illness or surgery*
Clues	✓ Pre-syncope ✓ Dizziness ✓ Fatigue ✓ Abdominal pain ✓ Palpitations	✓ Unilateral occipital or temporal pain ✓ Reproducible with head turning ✓ DJD on imaging	✓ AM or ‘wake-up’ HA ✓ Obesity ✓ Vision changes	✓ Occipital HA & post neck pain ✓ Ehlers-Danlos ✓ Improves in cervical collar?	✓ Dx of exclusion

SHOULD I TREAT ANYWAY?


THE STATE OF
RESEARCH

Original Article

Cephalalgia
An International Journal of Headache

International Headache Society

Outcome of epidural blood patch for imaging-negative spontaneous intracranial hypotension

Cephalalgia
2023, Vol. 43(2) 1–9

DOI: 10.1177/03331024221140471
journals.sagepub.com/home/cep
SAGE

So Youn Choi[1], Minjung Seong[2], Eung Yeop Kim[2], Michelle Sojung Youn[3], Soohyun Cho[4], Hyemin Jang[1,5] and Mi Ji Lee[6]

Abstract

Background: Spontaneous intracranial hypotension is diagnosed by an abnormal finding in brain MRI, spinal imaging, or lumbar puncture. However, the sensitivity of each test is low. We investigated whether patients with suspected spontaneous intracranial hypotension and negative imaging findings would respond to epidural blood patch.

Methods: We prospectively recruited patients with new-onset orthostatic headache admitted at the Samsung Medical Center from January 2017 to July 2021. In patients without abnormal imaging findings and no history of prior epidural blood patch, treatment outcome—defined as both 50% response in maximal headache intensity and improvement of orthostatic component—was collected at discharge and three months after epidural blood patch.

Results: We included 21 treatment-naïve patients with orthostatic headache and negative brain and spinal imaging results who received epidural blood patch. After epidural blood patch (mean 1.3 times, range 1–3), 14 (66.7%) and 19 (90.5%) patients achieved both 50% response and improvement of orthostatic component at discharge and three months post-treatment, respectively. Additionally, complete remission was reported in 11 (52.4%) patients at three-month follow-up, while most of the remaining patients had only mild headaches. Among nine (42.9%) patients who underwent lumbar puncture, none had an abnormally low opening pressure (median 13.8 cm H_2O, range 9.2–21.5).

Conclusion: Given the high responder rates of epidural blood patch in our study, empirical epidural blood patch should be considered to treat new-onset orthostatic headache, even when brain and spinal imaging are negative. The necessity of lumbar puncture is questionable considering the high response rate of epidural blood patch and low rate of "low pressure."

Keywords
Low-pressure headache, CSF leak, myelogram, dural defect

Date received: 23 August 2022; revised: 7 September 2022; accepted: 17 October 2022

Seventeen (81.0%) patients received a single EBP, while two each (9.5%) received EBP twice and thrice.

Table 2. Treatment outcome at discharge and 3 months after epidural blood patch.

	At discharge	Three months
Remission of orthostatic headache	16 (76.2%)	20 (95.2%)
50% reduction of maximal headache intensity	17 (81.0%)	19 (90.5%)
Any of both	19 (90.5%)	20 (95.2%)
Both of remission and 50% response	14 (66.7%)	19 (90.5%)

Choi SY, Seong M, Kim EY, Youn MS, Cho S, Jang H, Lee MJ. Outcome of epidural blood patch for imaging-negative spontaneous intracranial hypotension. Cephalalgia. 2023 Feb;43(2).

EBP WHEN IMAGING IS NEGATIVE

RESEARCH ARTICLE OPEN ACCESS

Long-Term Epidural Patching Outcomes and Predictors of Benefit in Patients With Suspected CSF Leak Nonconforming to ICHD-3 Criteria

Ian Carroll, MD, MS,* Lichy Han, MD, PhD,* Niushen Zhang, MD, Robert P. Cowan, MD, Bryan Lanzman, MD, Syed Hashmi, MD, Meredith J. Barad, MD, Addie Peretz, MD, Leon Moskatel, MD, Oyindamola Ogunlaja, MBBS, MSc, Jennifer M. Hah, MD, Nada Hindiyeh, MD, Carol Barch, MN, Selene Bozkurt, PhD, Tina Hernandez-Boussard, PhD,† and Andrew L. Callen, MD†

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Neurology® 2024;102:e209449. doi:10.1212/WNL.0000000000209449

Abstract

Background and Objectives

Spinal CSF leaks lead to spontaneous intracranial hypotension (SIH). While International Classification of Headache Disorders, Third Edition (ICHD-3) criteria necessitate imaging confirmation or low opening pressure (OP) for SIH diagnosis, their sensitivity may be limited. We offered epidural blood patches (EBPs) to patients with symptoms suggestive of SIH, with and without a documented low OP or confirmed leak on imaging. This study evaluates the efficacy of this strategy.

Methods

We conducted a prospective cohort study with a nested case-control design including all patients who presented to a tertiary headache clinic with clinical symptoms of SIH who completed study measures both before and after receiving an EBP between August 2016 and November 2018.

Results

The mean duration of symptoms was 8.7 ± 8.1 years. Of 85 patients assessed, 69 did not meet ICHD-3 criteria for SIH. At an average of 521 days after the initial EBP, this ICHD-3–negative subgroup experienced significant improvements in Patient-Reported Outcomes Measurement Information System (PROMIS) Global Physical Health score of +3.3 (95% CI 1.5–5.1), PROMIS Global Mental Health score of +1.8 (95% CI 0.0–3.5), Headache Impact Test (HIT)-6 head pain score of −3.8 (95% CI −5.7 to −1.8), Neck Disability Index of −4.8 (95% CI −9.0 to −0.6) and PROMIS Fatigue of −2.3 (95% CI −4.1 to −0.6). Fifty-four percent of ICHD-3–negative patients achieved clinically meaningful improvements in PROMIS Global Physical Health and 45% in HIT-6 scores. Pain relief following lying flat prior to treatment was strongly associated with sustained clinically meaningful improvement in global physical health at an average of 521 days (odds ratio 1.39, 95% CI 1.1–1.79; $p < 0.003$). ICHD-3–positive patients showed high rates of response and previously unreported, treatable levels of fatigue and cognitive deficits.

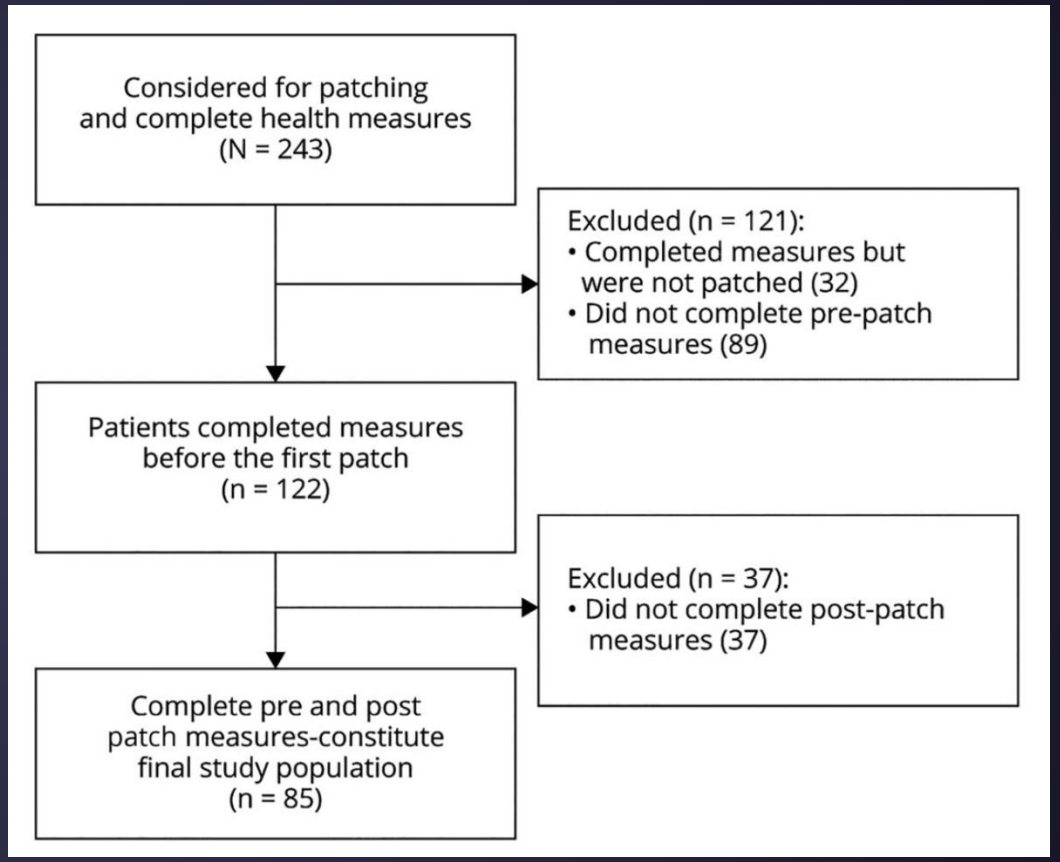
Discussion

Patients who did not conform to the ICHD-3 criteria for SIH showed moderate rates of sustained, clinically meaningful improvements in global physical health, global mental health,

MORE ONLINE

CME Course
NPub.org/cmelist

Class of Evidence
Criteria for rating therapeutic and diagnostic studies
NPub.org/coe



Carroll I, et al. Long-Term Epidural Patching Outcomes and Predictors of Benefit in Patients With Suspected CSF Leak Nonconforming to ICHD-3 Criteria. Neurology. 2024 Jun 25;102(12):e209449.

Table 2 Epidural Patch Outcomes in Patients Not Meeting ICHD-3 Criteria

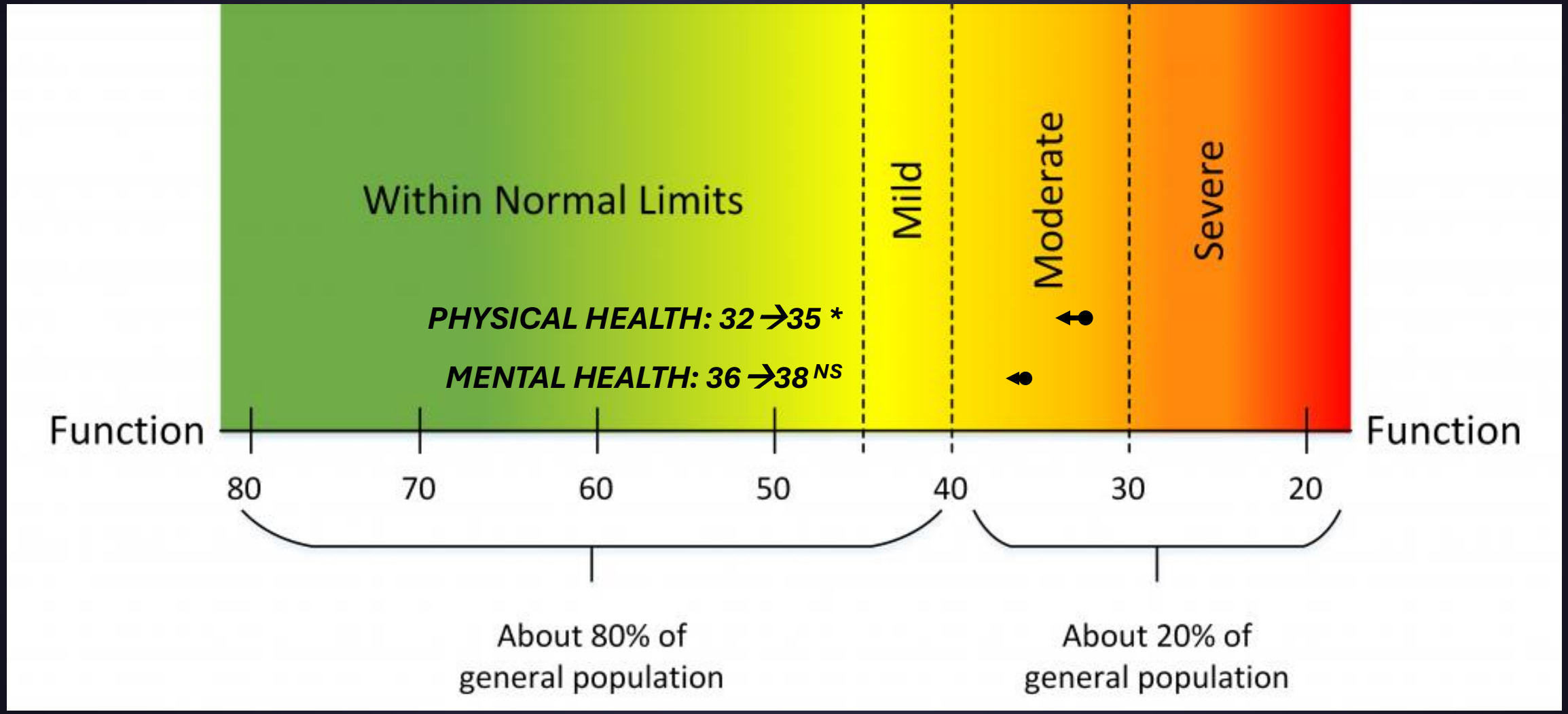
Survey scores	N	PRE-PATCH Mean ± SD	POST-PATCH Mean ± SD	Difference (95% CI)	*p* Value
Early outcomes: Change from pre-patch to first post-patch assessment (mean 225 d)					
PROMIS physical health	69	32.0 ± 6.6	35.2 ± 6.7	3.2 (1.6 to 4.8)	<0.001
PROMIS mental health	69	36.2 ± 8.2	37.0 ± 9.0	0.9 (−0.8 to 2.5)	0.29
Headache Impact Test-6	67	67.6 ± 5.6	64.3 ± 9.0	−3.6 (−5.8 to −1.4)	0.001
Durable outcomes: Change from pre-patch to last post-patch assessment (mean 521 d)					
PROMIS physical health	69	32.0 ± 6.6	35.4 ± 7.2	3.3 (1.5 to 5.1)	<0.001
PROMIS mental health	69	36.2 ± 8.2	38.0 ± 8.6	1.8 (0 to 3.5)	0.046
Headache Impact Test-6	67	67.6 ± 5.6	64.1 ± 8.23	−3.8 (−5.7 to −1.8)	<0.001

"Patients received a mean of 3.6 ± 2.9 EBPs, at a mean of 2.5 ± 1 spinal levels treated per patch. Average days between patches was 71 ± 80."

"Patients who did not conform to the ICHD-3 criteria for SIH showed moderate rates of sustained, clinically meaningful improvements in global physical health, global mental health, neck pain, fatigue, and head pain after EBP therapy."

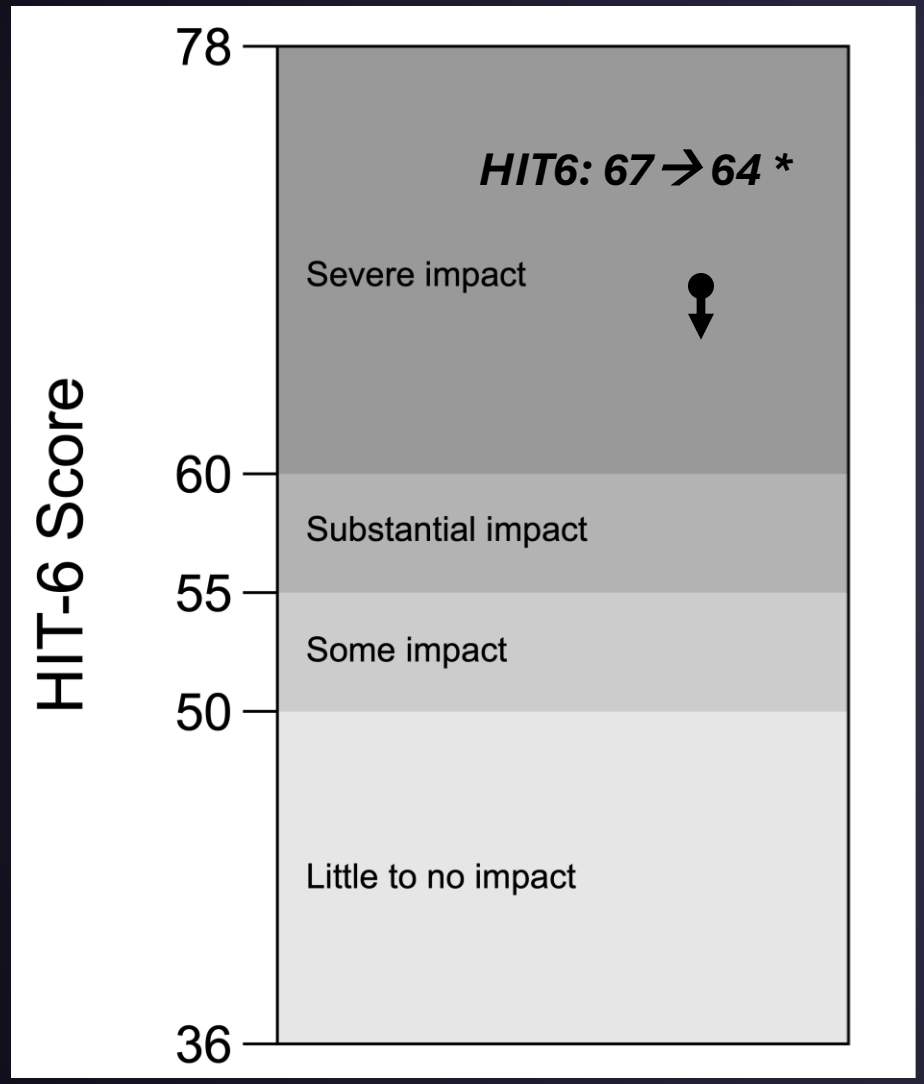
Carroll I, et al. Long-Term Epidural Patching Outcomes and Predictors of Benefit in Patients With Suspected CSF Leak Nonconforming to ICHD-3 Criteria. Neurology. 2024 Jun 25;102(12):e209449.

EBP WHEN IMAGING IS NEGATIVE



PROMIS MEASURES

EBP WHEN IMAGING IS NEGATIVE

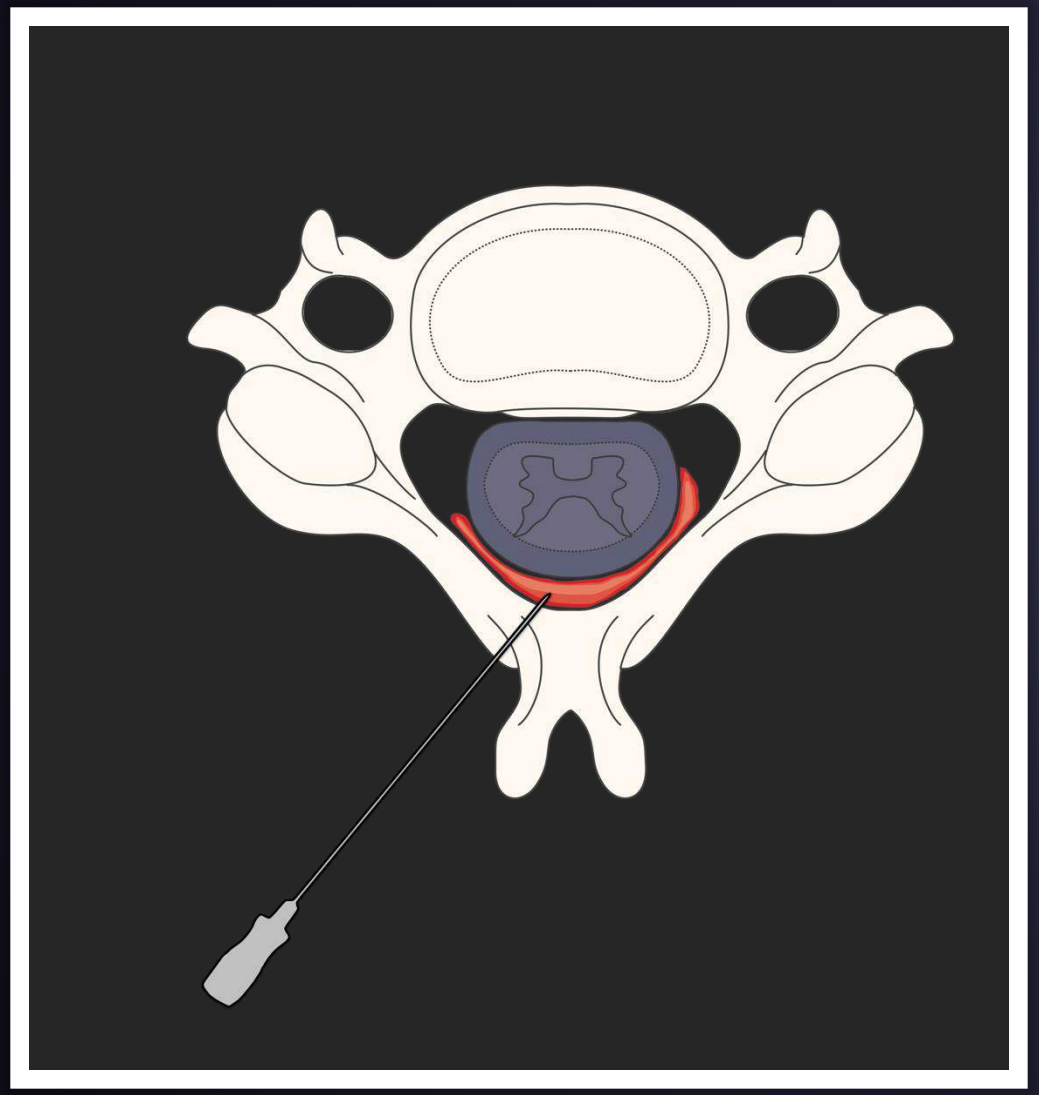


- *Average 3.8-point improvement after average 3.6 EBP*
- *Whether this is worth it is in the eye of the beholder, no right answer*
- *But having this information undoubtedly improves our ability to counsel patients*
- ***Wherever we are, its not far enough***

WHY YOU SHOULD BE OPTIMISTIC

- *This paper represents a strong commitment to understanding what to do when imaging is negative*
- *Well designed and executed*
- *This is the most difficult and important question in the field currently*
- *Answers will be found not with belief or hunches, but with science like this*
- *We will see more studies like this*

EBP WHEN IMAGING IS NEGATIVE



- *Empiric EBP may be an option*
- *Be clear about what to expect*
- *Keep doing if working, stop if not working*
- *Response to EBP is a poor diagnostic tool (*my opinion)*

Benefits

Harms

WHAT ARE THE HARMS?

- *Failure to pursue other diagnoses (“tunnel vision”)*
- *Procedural complications*
- *Financial*
- *Anxiety about procedures and prognosis*
- *Radiation risks*
- *Patient time/fatigue*
- *Physician access*

GOALS

- *Understand the diagnostics (strengths and limitations)*
- *Be honest with your patient*
- *…but also be honest with yourself*
- *Respect your patient's journey*
- *…but you also owe an objective assessment to your patient*
- *Don't blame/criticize others too harshly for dealing with unknowns differently*
- *Set clear expectations*
- *Proceed practically*

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