Treat with Confirmation vs Treat without Confirmation

"Conventional Imaging Negative"

1. MRI Brain Negative
2. MRI Spine Negative
3. Conventional CT Myelography Negative.

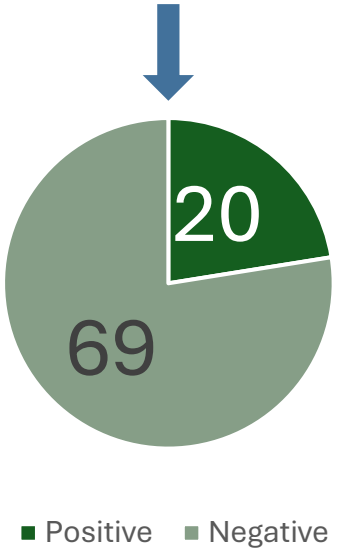
“Conventional Imaging Negative”

1. MRI Brain Negative
2. MRI Spine Negative
3. Conventional CT Myelography Negative.

(Hosoya et al. 2013)
2008-2011, 11 hospitals

100 Prospectively gathered orthostatic headaches

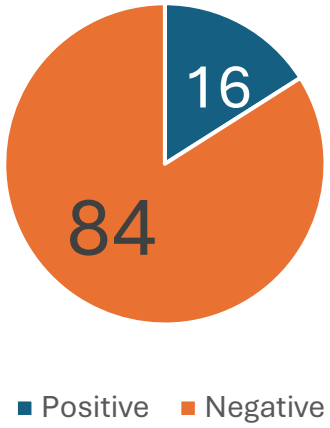
89 Brain MRI



89 Radionuclide cisternogram

70 axial T2 Spine MRI

14



86 MR Myelogram

Overall, roughly 80% of prospectively gathered patients with clear orthostatic headaches will not meet ICHD-3 criteria.

It can be dangerous to tell a patient with CSF leak symptoms they are not leaking.

“45 yo female pain started in 2014, at age 42, before age 42 she had no migraines and no headache problem.

She cannot identify a precipitating event.

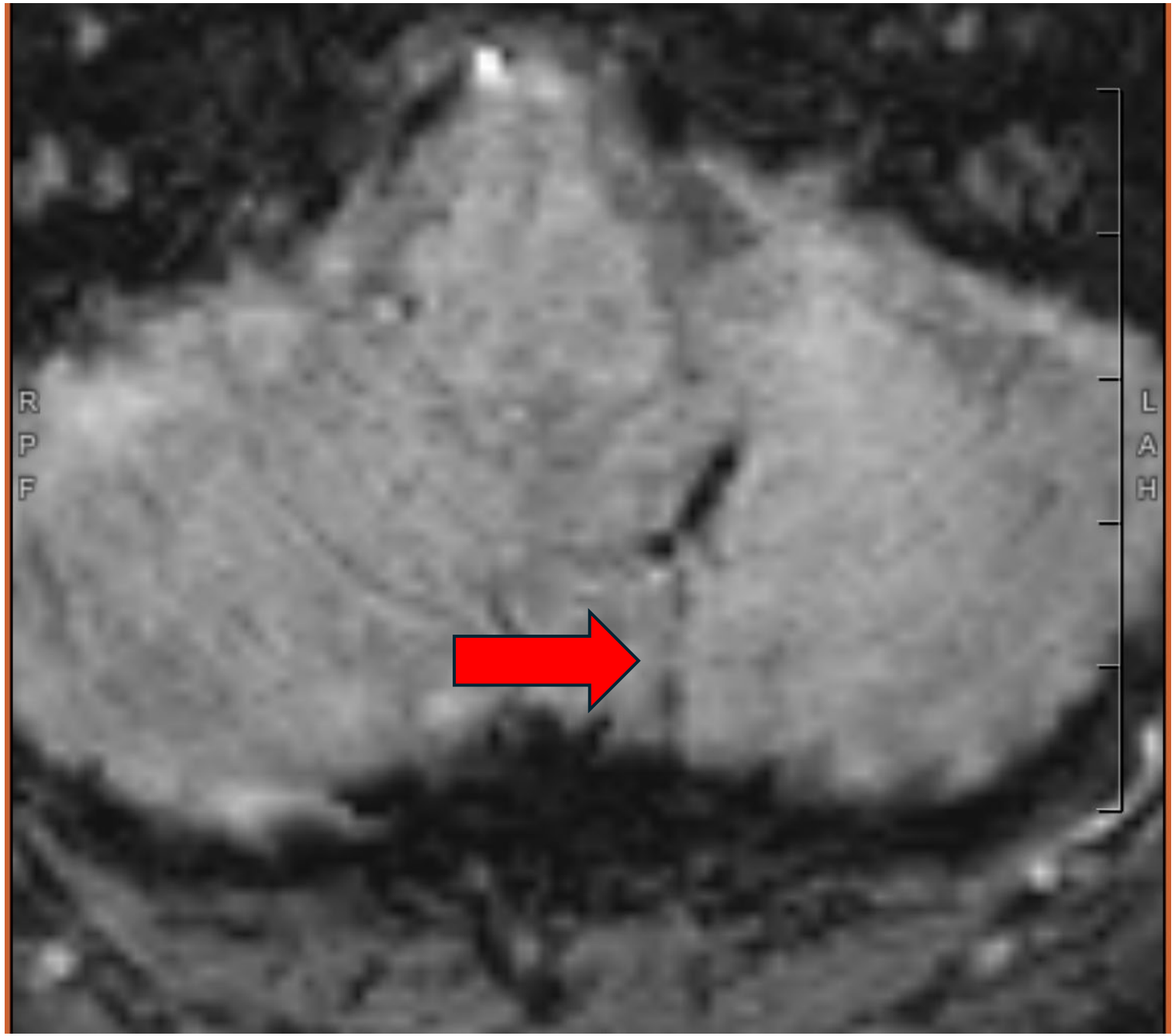
Her principal complaints are head pain [bilateral occipital and into the tongue], neck pain, mid scapular pain, all of which are better when she is flat. In addition, she has been treated in the pain clinic for glossopharyngeal neuralgia and occipital neuralgia. She does have comorbid tinnitus, chronic nausea, and fatigue”

“She did do a 48 hour flat test and reports that her symptoms were 75% better after 48 hours being flat.”

12/2017 conventional CT myelogram: No CSF leak: total protein was significantly elevated at 71

We did a multidisciplinary conference and declined to patch her.


Manufacture Model: DISCOVERY MR750
Body Part: BRAIN
Sex: F
Study Date: 19-Oct-2023
Study Time: 22:19:53
Zoom Factor: 2.73
R
L


R
P
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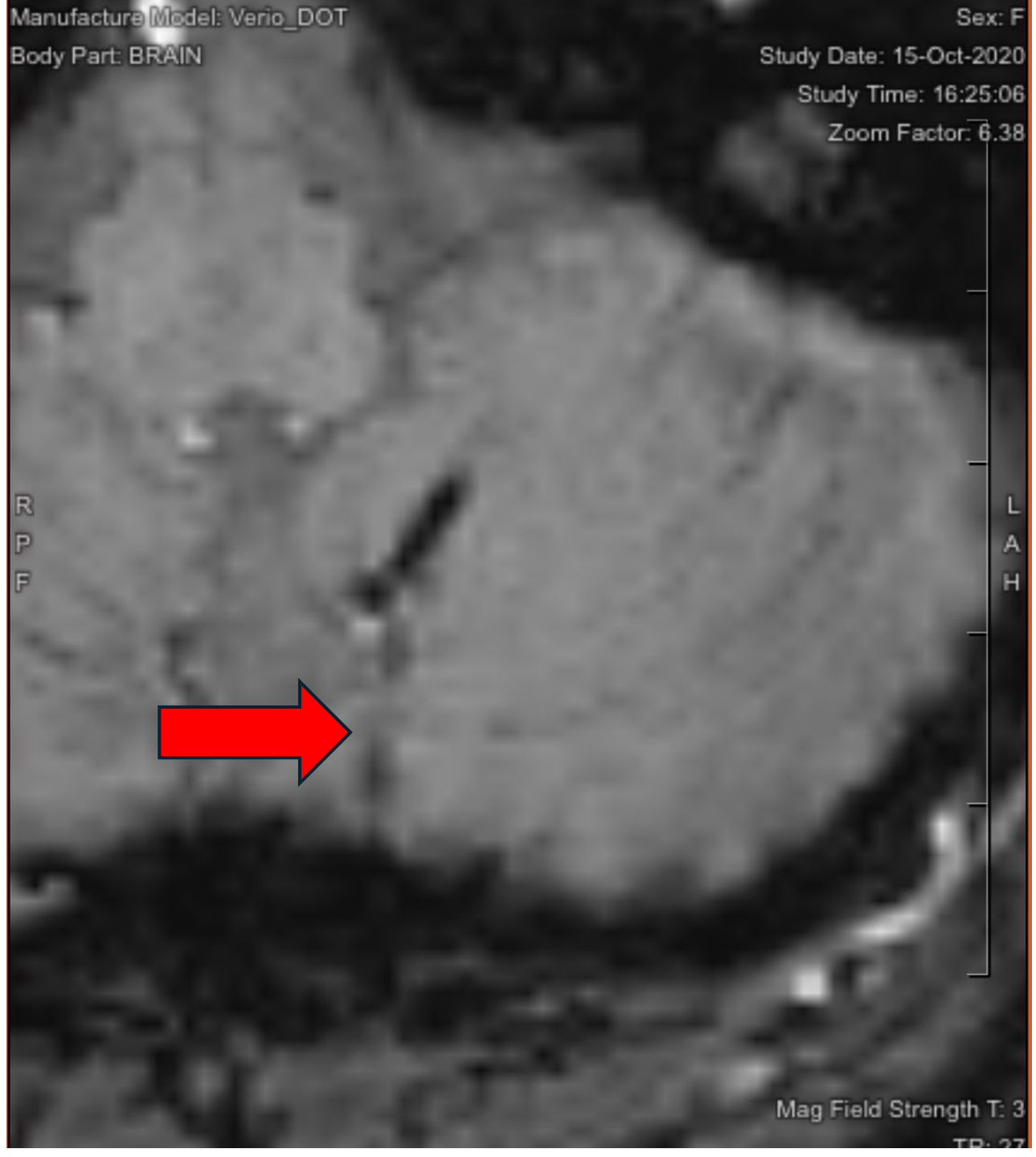
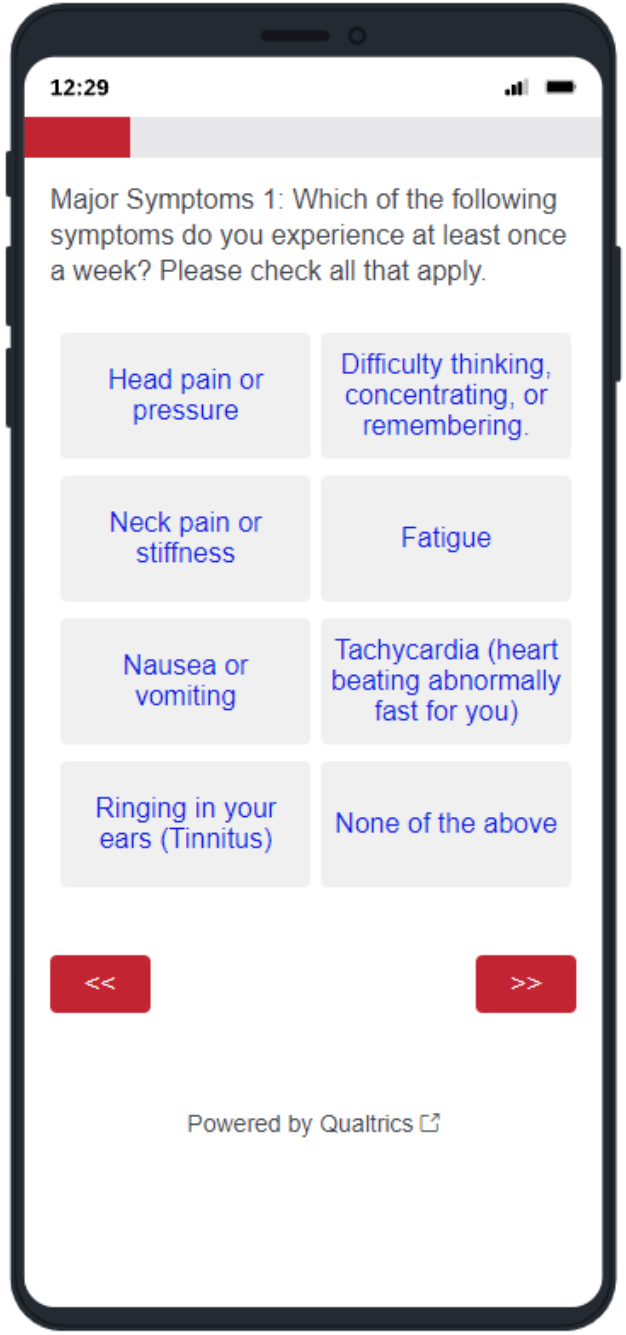
A
H


Manufacture Model: Verio_DOT
Body Part: BRAIN
Sex: F
Study Date: 15-Oct-2020
Study Time: 16:25:06
Zoom Factor: 6.38
R
P
F
L
A
H
Mag Field Strength T: 3

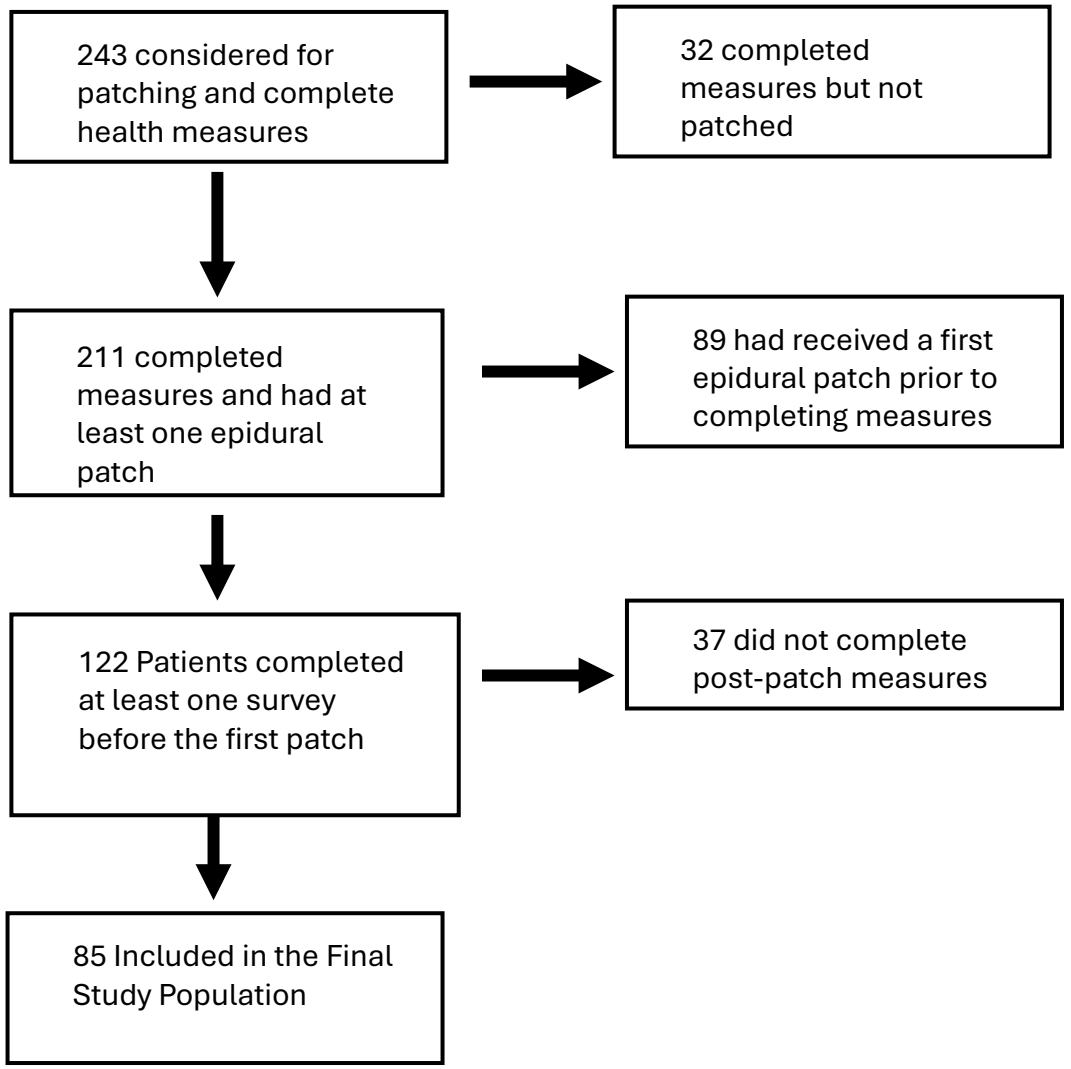
What if we had offered a patch?



Patients treated and measured from August 2016 to November 2018

1. PROMIS Global health
2. HIT-6
3. Neck Disability Index
4. Rhodes Index and Nausea Vomiting and Retching (INVR)
5. Tinnitus Handicap Inventory
6. PROMIS Applied Cognitive Questionnaire
7. Dizziness Handicap Inventory
8. PROMIS Fatigue

Patients treated and measured from August 2016 to November 2018



Characteristic		Patients With Suspected CSF Leak (N = 85) Mean± SD /n (%)
Age, years		42.5 ± 13.68
Sex		
	Male	19 (22.35)
	Female	66 (77.65)
Symptom Duration (years)		8.65 ± 8.13
General Symptoms		
	Head Pain or Pressure	84 (98.82)
	Neck Pain or Stiffness	70 (82.35)
	Tinnitus	54 (63.53)
	Cognitive Impairment	77 (90.59)
	Fatigue	81 (95.29)

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	Fatigue	81 (95.29)

Characteristic		Patients With Suspected CSF Leak (N = 85) Mean± SD /n (%)
Orthostatic Features		
	Orthostatic Head Pain	71 (83.53)
	Upright Time Before Head Pain Starts	
	Quartile 1	0 secs to 5.01 minutes
	Quartile 2	5.01 to 30.03 minutes
	Quartile 3	30.03 to 108.75 minutes
	Quartile 4	108.75 to 841.02 minutes
	Head Pain Severity After Upright 1 Hour (0-10)	5.30 ± 2.36
	Head Pain Severity After Flat 1 Hour (0-10)	2.70 ± 2.46
	Head Pain Severity After Night Recumbent (0-10)	2.24 ± 2.47

Mean global physical health is at 4th percentile.

Symptom Measure		Patients With Suspected CSF Leak (N = 85) Mean± SD /n (%)
PROMIS Global Health		
	Physical	32.67 ± 6.77 (85)
	Mental	36.83 ± 8.42 (85)
Headache Impact Test-6		66.87 ± 6.77 (83)
Neck Disability Index		45.13 ± 20.57 (85)
Dizziness Handicap Inventory		42.48 ± 27.17 (85)
PROMIS Neuro		39.61 ± 7.61 (83)
PROMIS Fatigue		66.82 ± 7.51 (85)
RINVR		1.05 ± 1.09 (85)
Tinnitus Handicap Inventory		19.67 ± 22.08 (85)

Mean Headache severity is in severe range.

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Fatigue severity is in 95th percentile.

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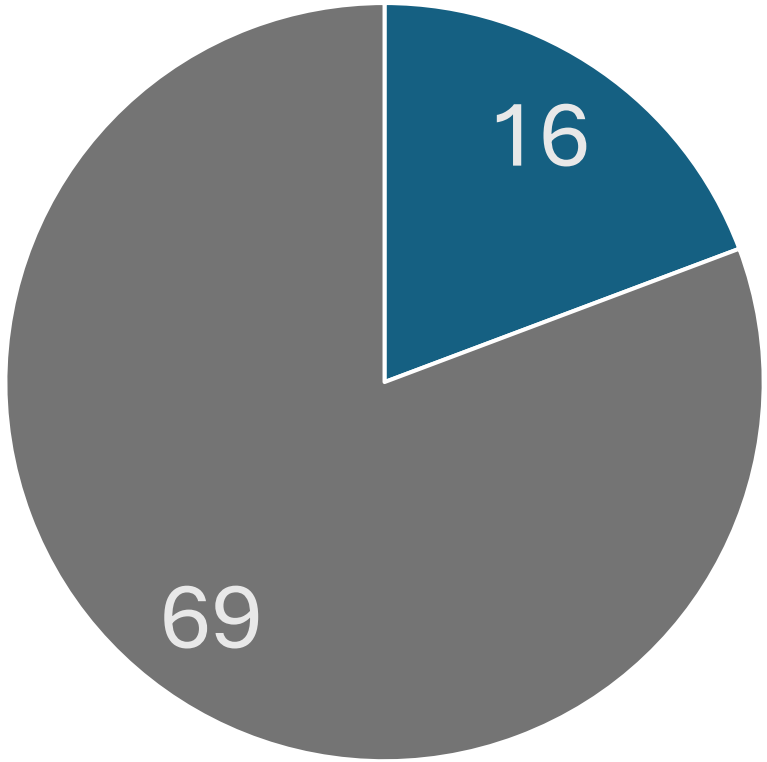
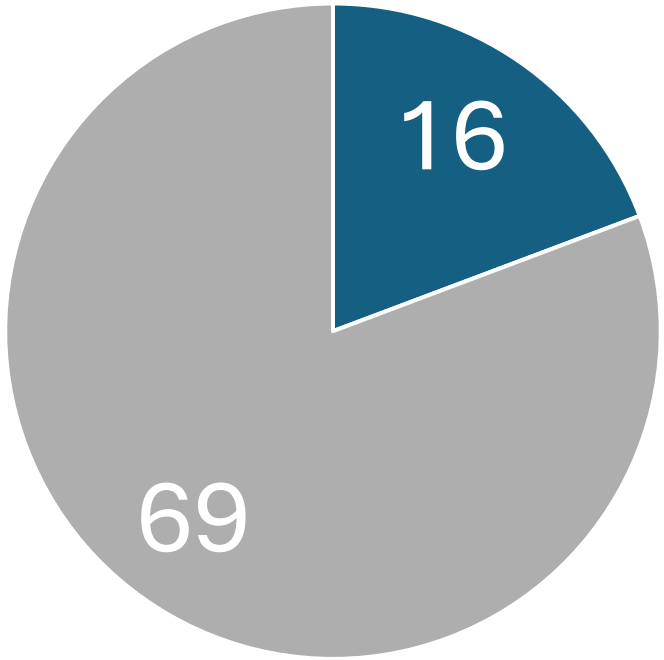
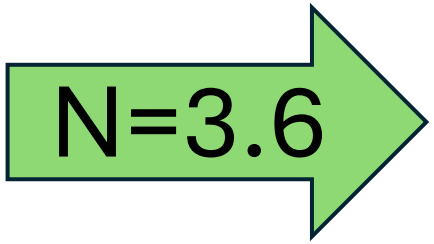
Variable	Total N with results	Positive/ Abnormal n (%)	Negative/Normal n (%)
ICHD-3 Criteria Determined	85	16 (18.82)	69 (81.18)
MRI Brain Scan	76	5 (6.58)	71 (93.42)
MRI Spine	69	5 (7.25)	64 (92.75)
CT Myelogram	70	7 (10.00)	63 (90.00)
Opening pressure <60 mm CSF	69	4 (5.80)	65 (94.20)

ICHD-3 Status- (percent)



Patients Undergo an Average of 3.6 Epidural Patches





CSF Leak Patient Qualtrics Survey Scores					
Durable Outcomes- Change from pre-patch to last assessment (mean 521 days from first patch, 377 days from last patch)					
Survey Scores	**N**	**PRE-PATCH**	**POST-PATCH**	**P-value**	**% Change (Median)**
		N (%) Mean ± SD	**N (%) Mean ± SD**		
PROMIS Physical Health	85	32.7 ± 6.8	36.9 ± 8.6	<0.001	15.4 ▲
PROMIS Mental Health	85	36.8 ± 8.4	39.4 ± 9.1	0.003	6.9 ▲
Headache Impact Test-6 (HIT-6)	83	66.9 ± 6.8	62.9 ± 8.9	<0.001	4.4 ▼
Neck Disability Index	85	45.1 ± 20.6	38.9 ± 20.5	0.002	20.8 ▼
PROMIS Fatigue	85	66.8 ± 7.5	63.5 ± 8.8	<0.001	4.8 ▼
Rhodes Index of Nausea, Vomiting and Retching (RINVR)	85	1.1 ± 1.1	0.9 ± 1.1	0.06	33 ▼
PROMIS Neuro	82	39.6 ± 7.6	41.3 ± 9.1	0.10	3.4 ▲
Tinnitus Handicap Inventory	85	19.7 ± 22.1	21.4 ± 21.9	0.58	0
Dizziness Handicap Inventory	85	42.5 ± 27.2	38.8 ± 26.2	0.14	13.6 ▼

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Is this Clinically Meaningful?

HHS Public Access

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The minimal clinically important difference of the PROMIS and qDASH instruments in a non-shoulder hand and upper extremity patient population

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[3]University of Utah, Department of Economics, 260 Central Campus Dr #4100, Salt Lake City, UT, United States

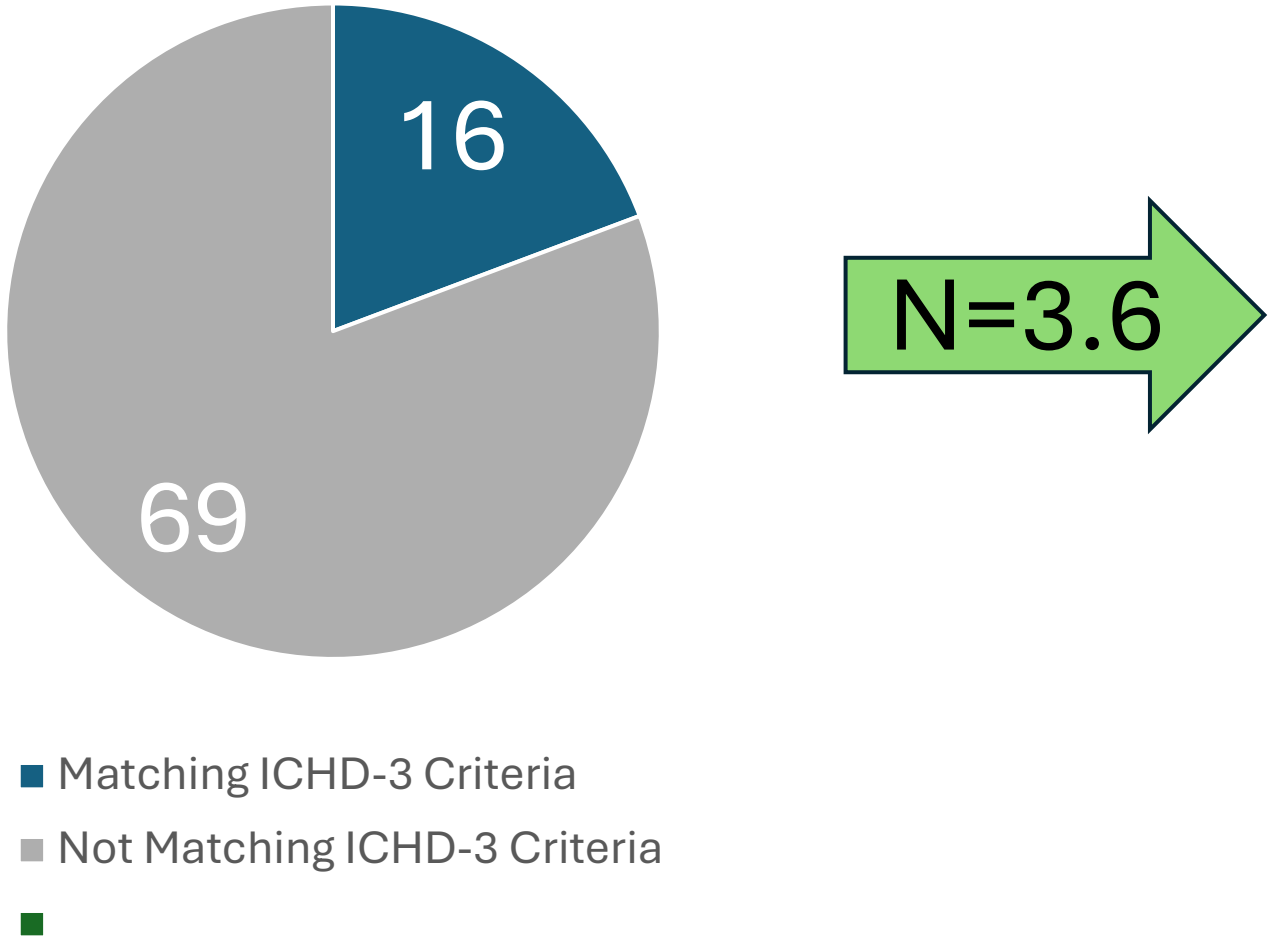
Abstract

Purpose—The minimal clinically important difference (MCID) is used in research and clinical settings as a benchmark to gauge response to treatment. The purpose of this study was to provide anchor-based MCID estimates for PROMIS and legacy instruments in a non-shoulder hand and upper extremity population.

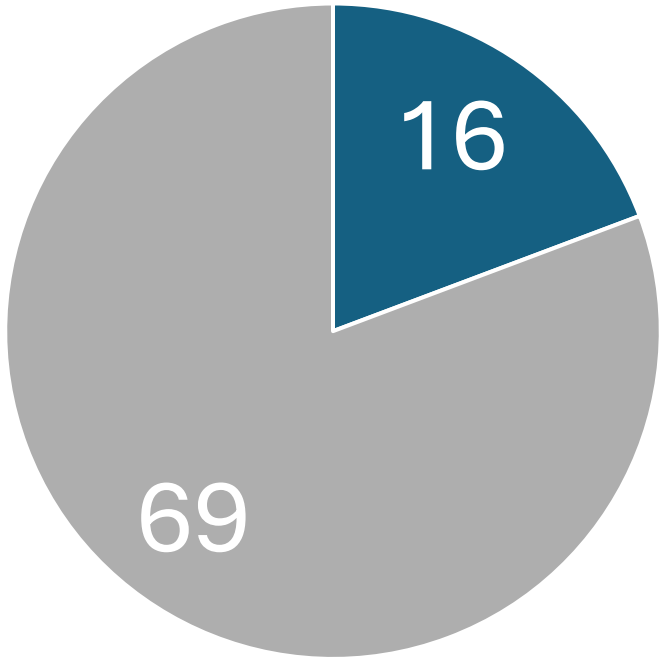
Methods—Adult patients (≥ 18 years) seeking care at a tertiary academic outpatient hand surgery clinic completed patient-reported outcome measures on tablet computers between January 2015 and August 2017. Data were collected at baseline and at six ± two weeks of follow-up. The PROMIS Upper Extremity (UE), Physical Function (PF), and Pain Interference (PI) Computer Adaptive Test (CAT) instruments were administered, along with the qDASH. A mean-change anchor-based method was used to estimate MCIDs by comparing scores between anchor groups reporting 'no change' versus 'slightly improved' in terms of function and pain.

Results—Scores for each instrument significantly improved over the study period. With significant differences in scores between groups reporting 'no change' and 'slightly improved' function, anchor-based MCID estimates were calculated as follows: 2.1 for the PROMIS UE CAT, 1.7 for the PROMIS PF CAT, and 6.8 for the qDASH. There was no significant difference in PROMIS PI CAT scores between anchor groups when queried for level of pain improvement, precluding estimation of the MCID.

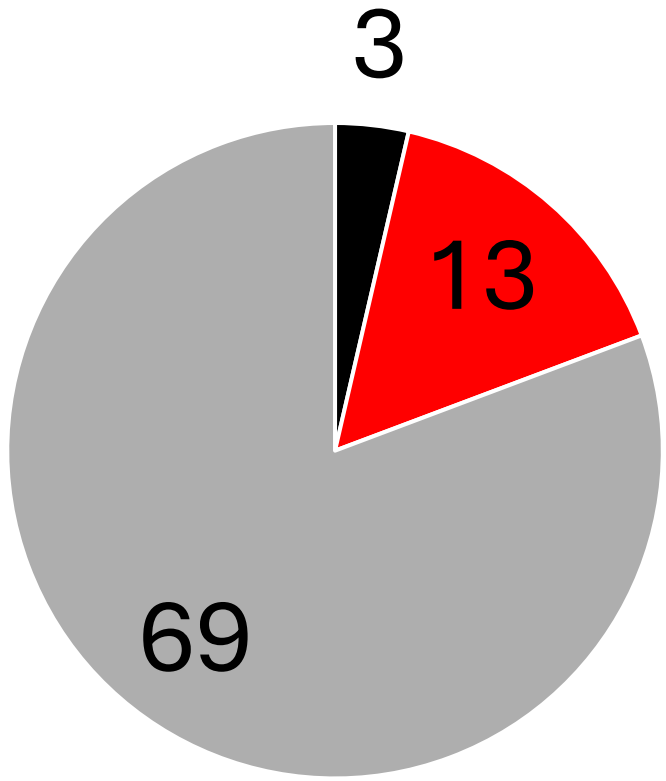
Response Rate following Epidural Patching?



81% (95% CI: 54%-96%) Clinically Meaningful Response Rate



N=3.6



Conform to ICHD-3 Criteria

Not Conforming to ICHD-3 Criteria

No Clinically Meaningful Response

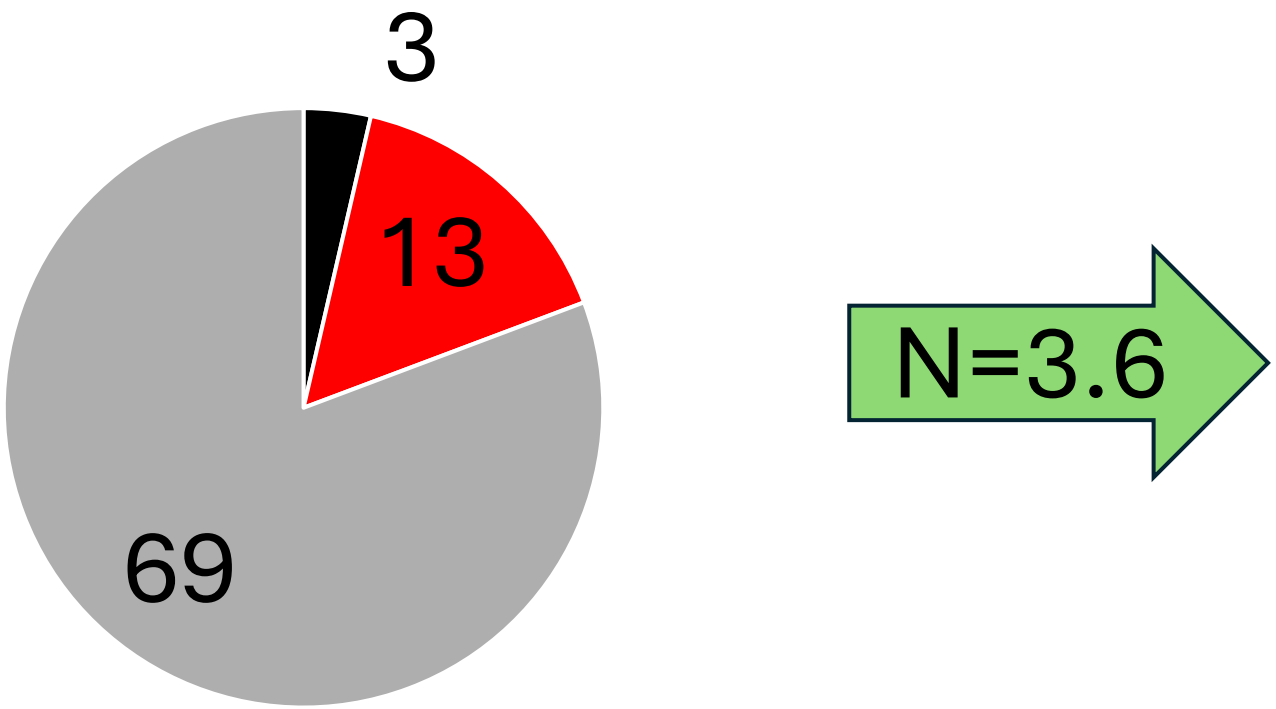
Clinically Meaningful Response

Not Conforming to ICHD-3 Criteria

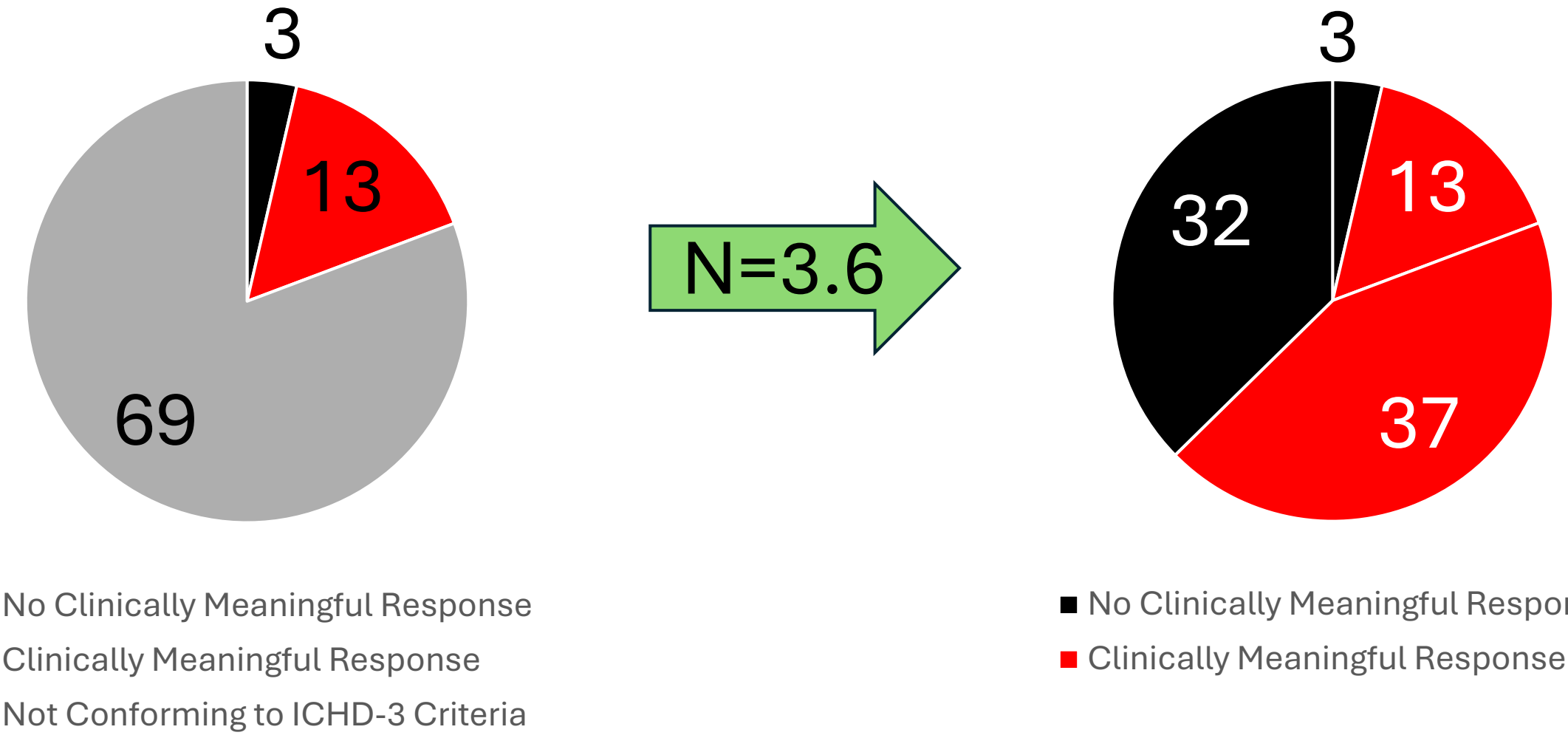
What about the 81% of patients not conforming to ICHD-3 criteria?

- Imaging negative
- Normal opening pressure

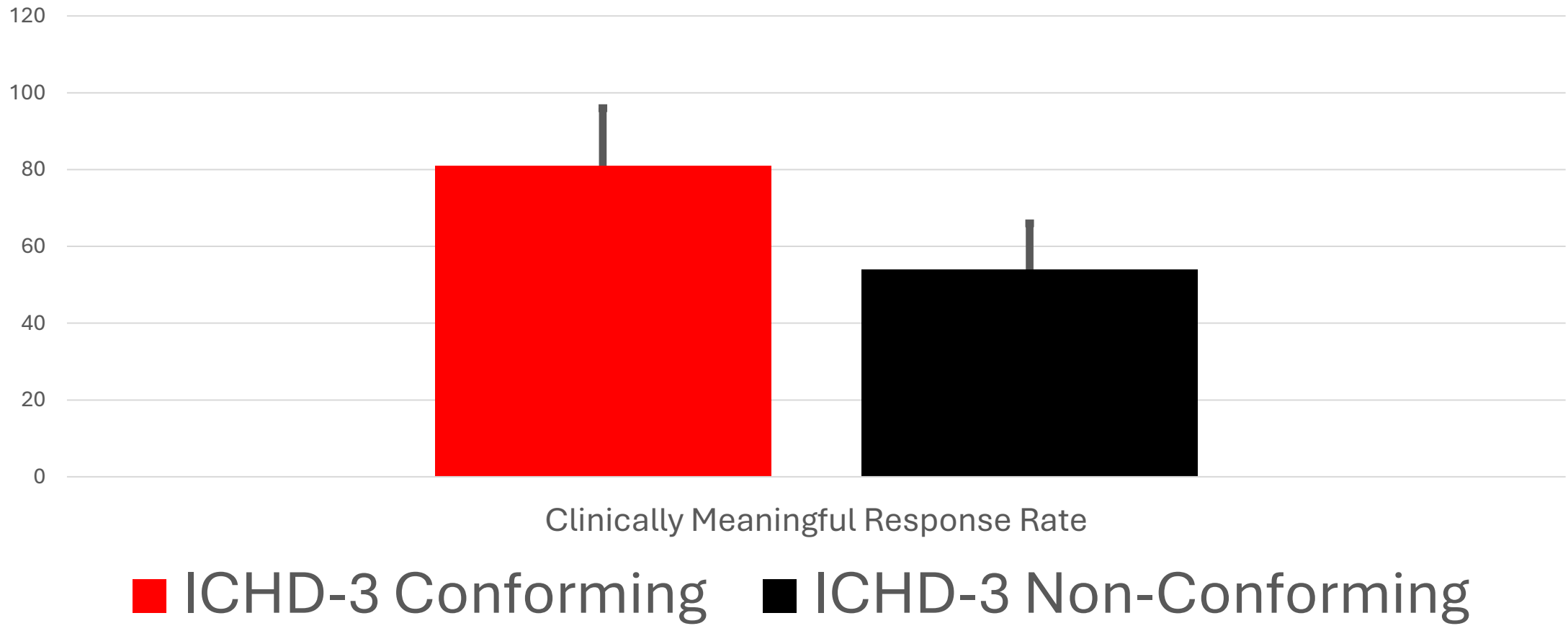
Patients Undergo an Average of 3.6 Epidural Patches



54% (95% CI: 41%-66%) Clinically Meaningful Response Rate



Clinically Meaningful Response in Global Physical Health



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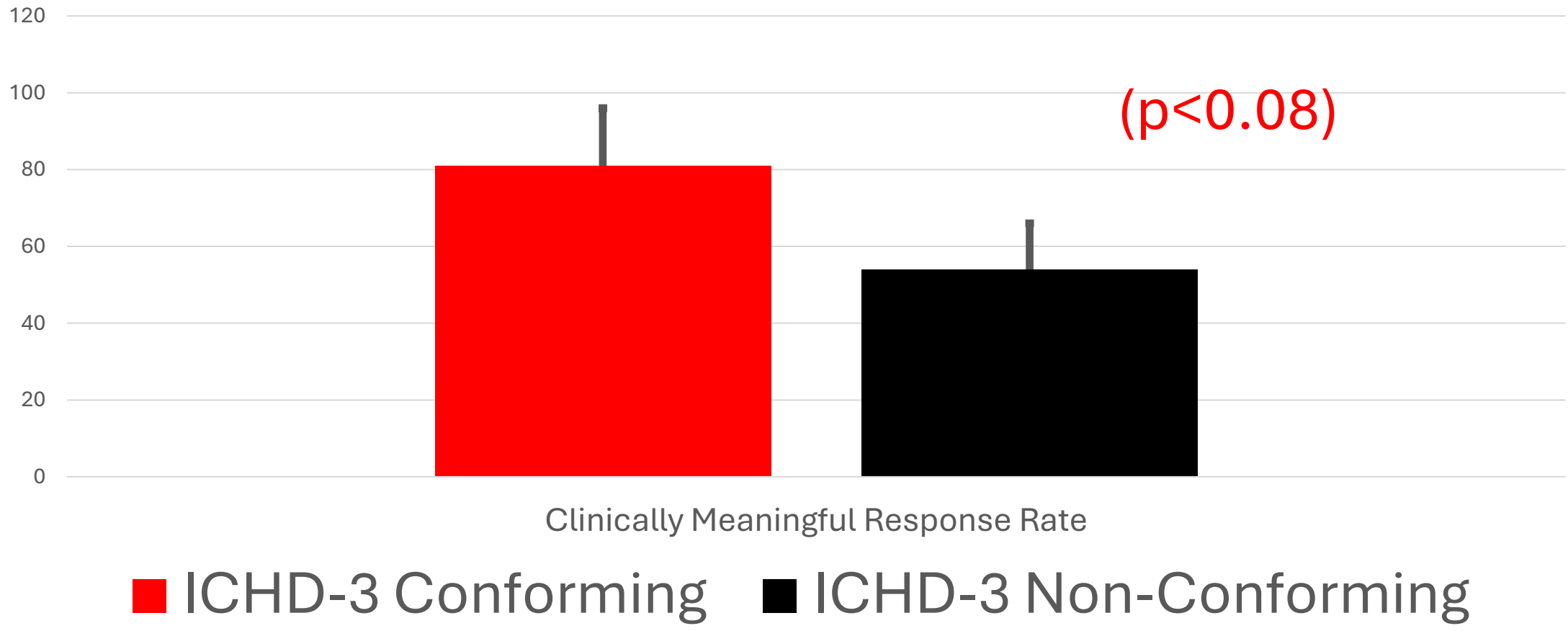
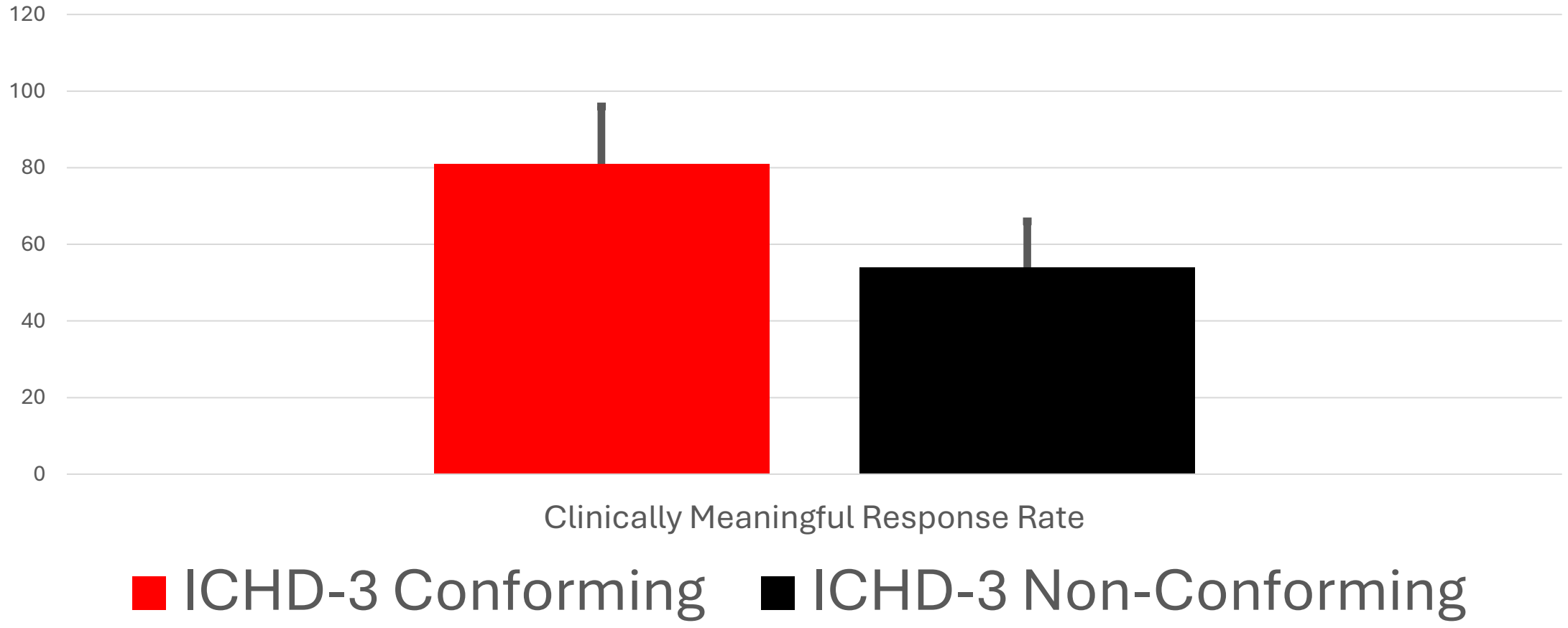
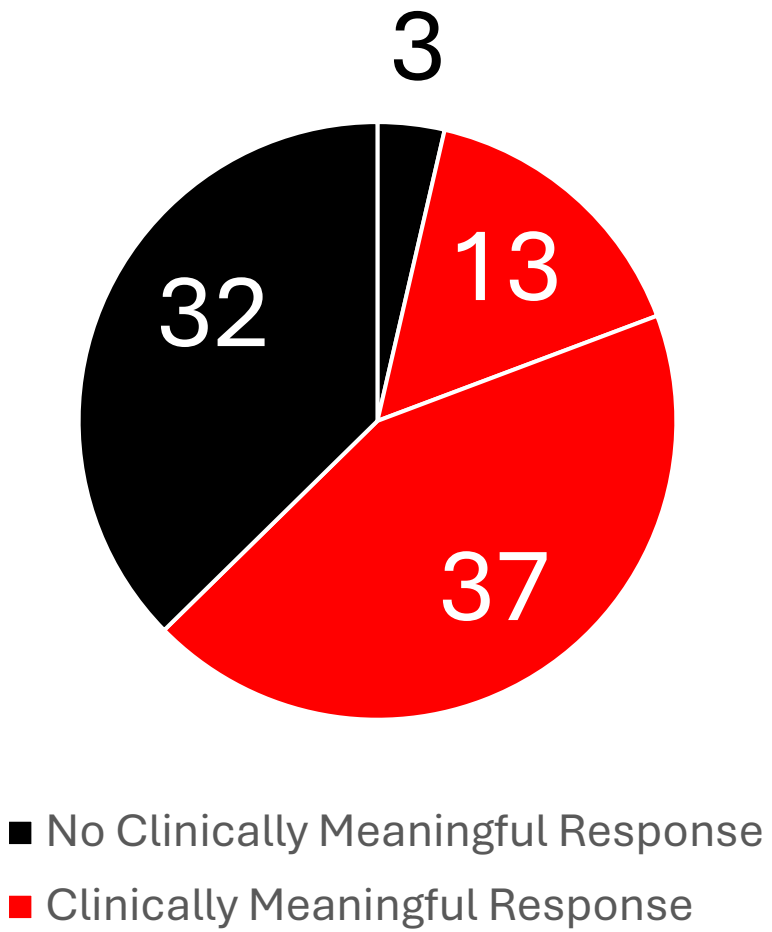


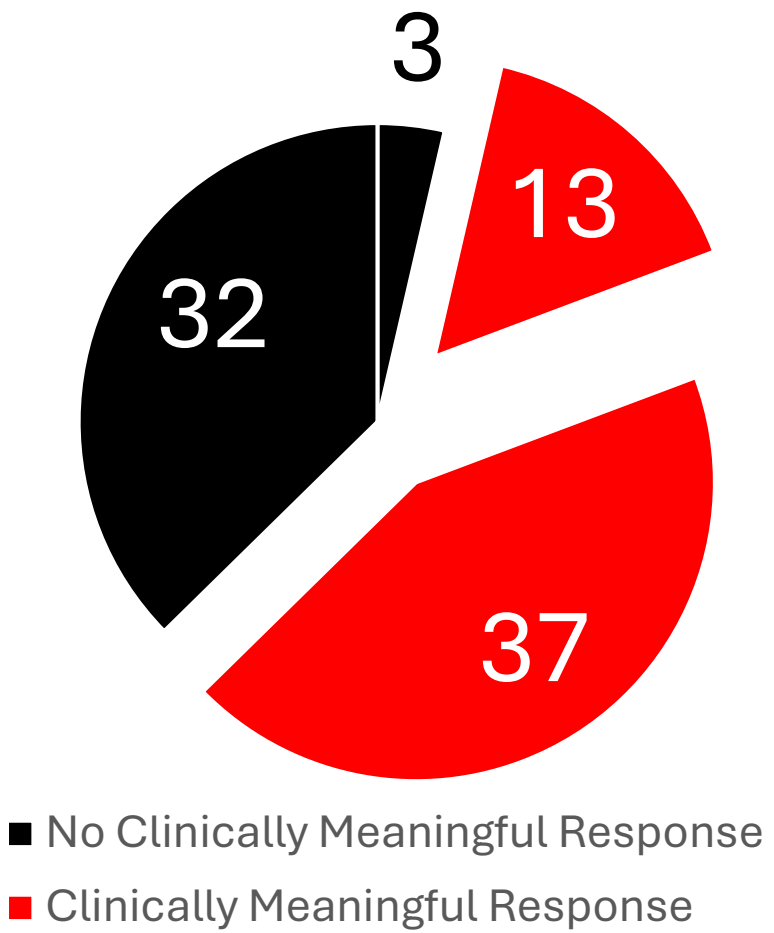
If you want to maximize your success rate only patch ICHD-3 conforming patients.



And if you want to help the highest number of people who can meaningfully benefit- don't do that.



73% of clinically meaningful responders would never have received the treatment that helped if patching had been contingent on positive Imaging or low opening pressure



What can help us identify patients most likely to have a clinically meaningful response among patients not conforming to ICHD-3 criteria?

Characteristic		Not Improved (N = 32)	Clinically Meaningful Improvement (N = 37)	Odds Ratio	P Value
Symptom Measures		Mean ± SD; n (%)	Mean ± SD; n (%)		
PROMIS Global Health					
	Physical	33.6 ± 7.4	30.7 ± 5.6	0.93	0.08
	Mental	35.2 ± 9.6	37.0 ± 6.9	1.03	0.38
Orthostatic Features					
	Orthostatic Head Pain	25 (78.13)	32 (86.49)	1.79	0.55
	Time Upright Before Head Pain Starts (min)	76.3 ± 97.6	54.0 ± 72.2	1.00	0.44
	Head Pain Severity (0-10)				
	After 1 Hour Upright	5.7 ± 2.4	5.1 ± 2.0	0.88	0.29
	After 1 Hour Flat	3.7 ± 2.4	2.1 ± 2.2	0.72[b]	0.003
	After Night Recumbent	3.0 ± 2.9	1.6 ± 2.1	0.79[b]	0.02
Migrainous Symptoms					
	Photophobia (sensitivity to light)	26 (83.87)	28 (77.78)	0.67	0.75
	Phonophobia (sensitivity to sound	23 (74.19)	28 (77.78)	1.22	0.96
	Nausea or Vomiting	22 (70.97)	25 (69.44)	0.93	1.00
Symptom Duration (years)		10.09 ± 9.89	7.49 ± 6.50	1.04	0.35

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	Photophobia (sensitivity to light)	26 (83.87)	28 (77.78)	0.67	0.75
	Phonophobia (sensitivity to sound	23 (74.19)	28 (77.78)	1.22	0.96
	Nausea or Vomiting	22 (70.97)	25 (69.44)	0.93	1.00
Symptom Duration (years)		10.09 ± 9.89	7.49 ± 6.50	1.04	0.35

Characteristic		Not Improved (N = 32)	Clinically Meaningful Improvement (N = 37)	Odds Ratio	P Value
Symptom Measures		Mean ± SD; n (%)	Mean ± SD; n (%)		
PROMIS Global Health					
	Physical	33.6 ± 7.4	30.7 ± 5.6	0.93	0.08
	Mental	35.2 ± 9.6	37.0 ± 6.9	1.03	0.38
Orthostatic Features					
	Orthostatic Head Pain	25 (78.13)	32 (86.49)	1.79	0.55
	Time Upright Before Head Pain Starts (min)	76.3 ± 97.6	54.0 ± 72.2	1.00	0.44
	Head Pain Severity (0-10)				
	After 1 Hour Upright	5.7 ± 2.4	5.1 ± 2.0	0.88	0.29
	After 1 Hour Flat	3.7 ± 2.4	2.1 ± 2.2	0.72[b]	0.003
	After Night Recumbent	3.0 ± 2.9	1.6 ± 2.1	0.79[b]	0.02
Migrainous Symptoms					
	Photophobia (sensitivity to light)	26 (83.87)	28 (77.78)	0.67	0.75
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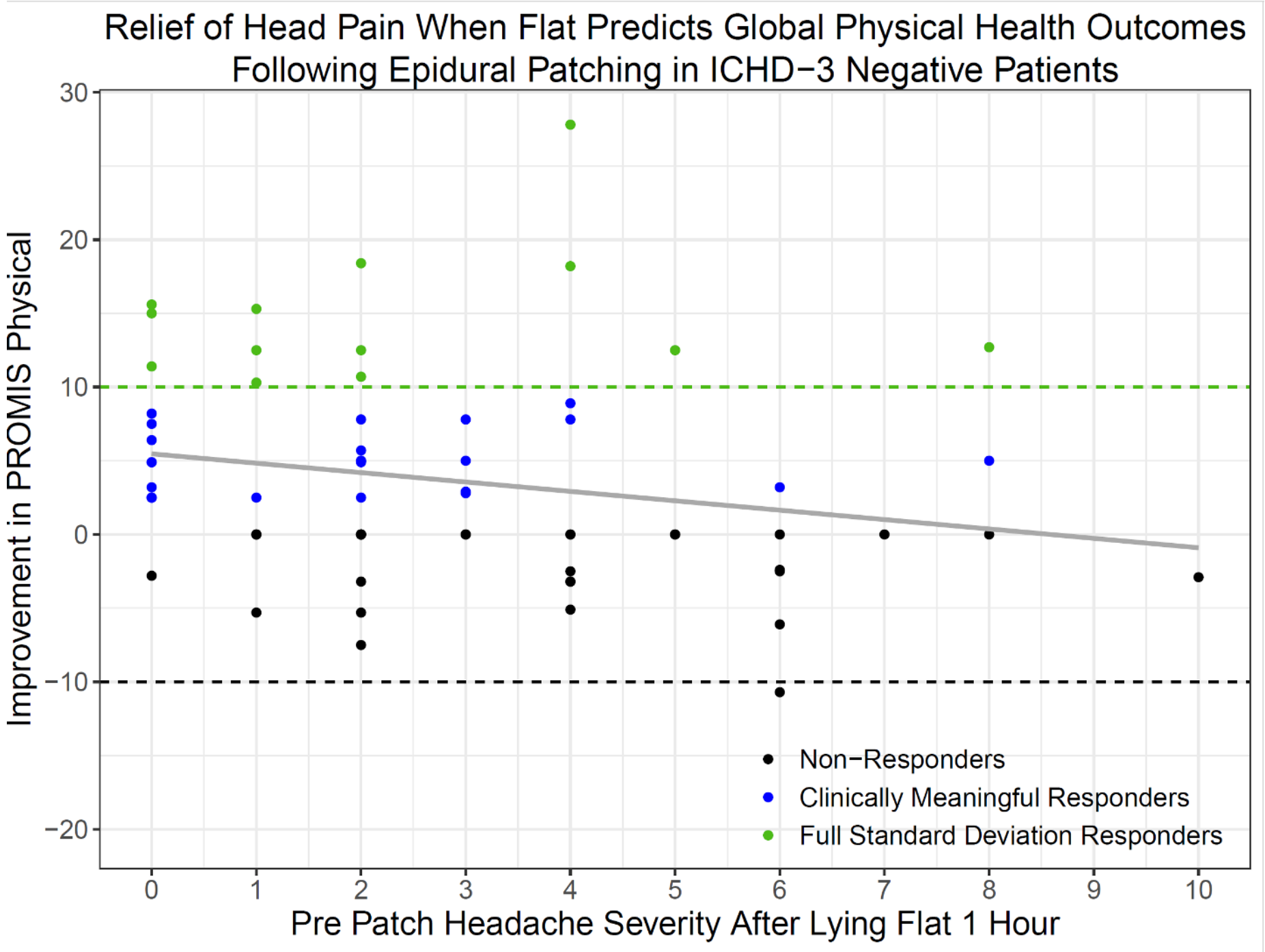
Lets look at that raw data…


Relief of Head Pain When Flat Predicts Global Physical Health Outcomes
Following Epidural Patching in ICHD−3 Negative Patients
Improvement in PROMIS Physical
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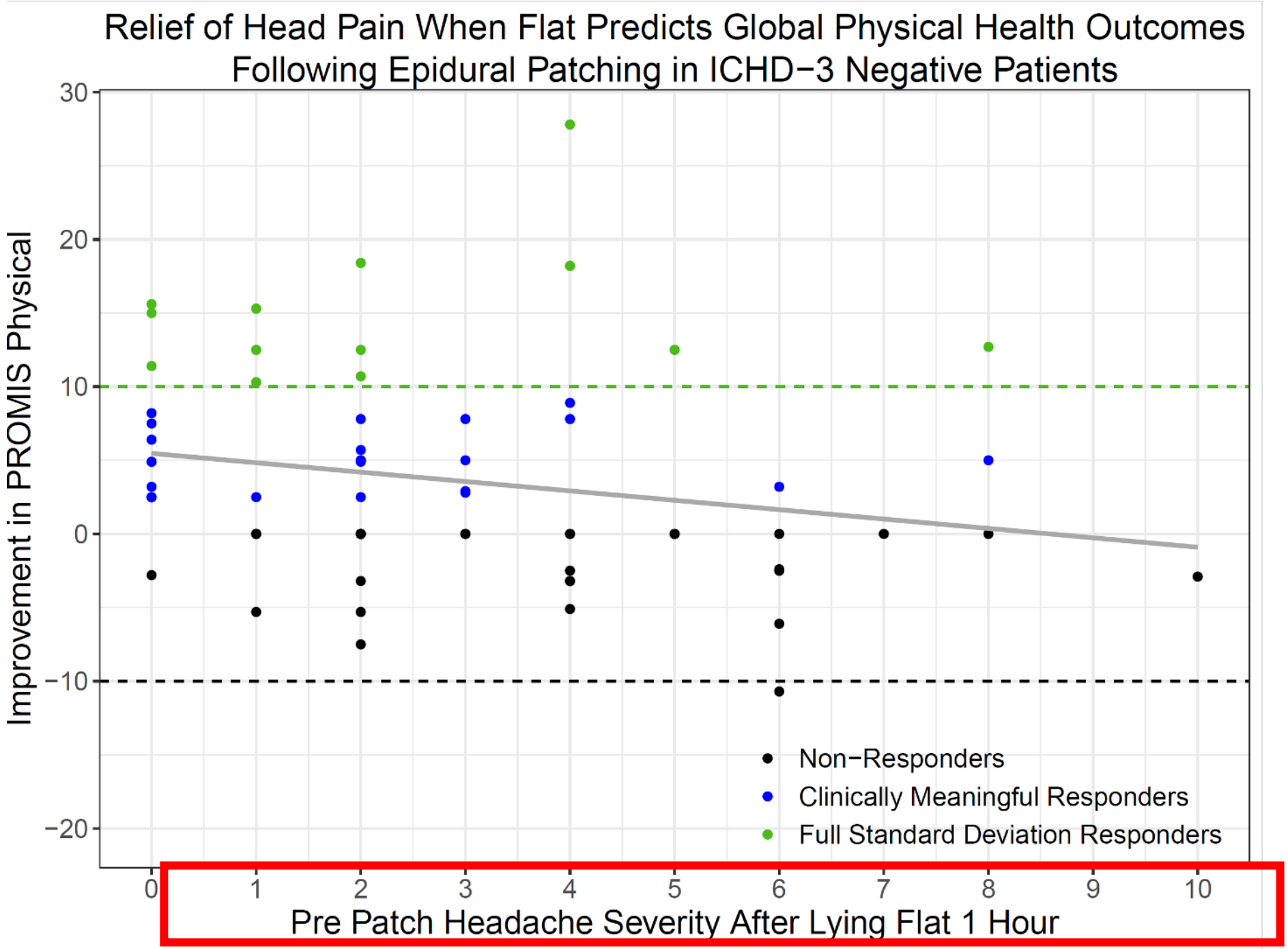
Pre Patch Headache Severity After Lying Flat 1 Hour
Non−Responders
Clinically Meaningful Responders
Full Standard Deviation Responders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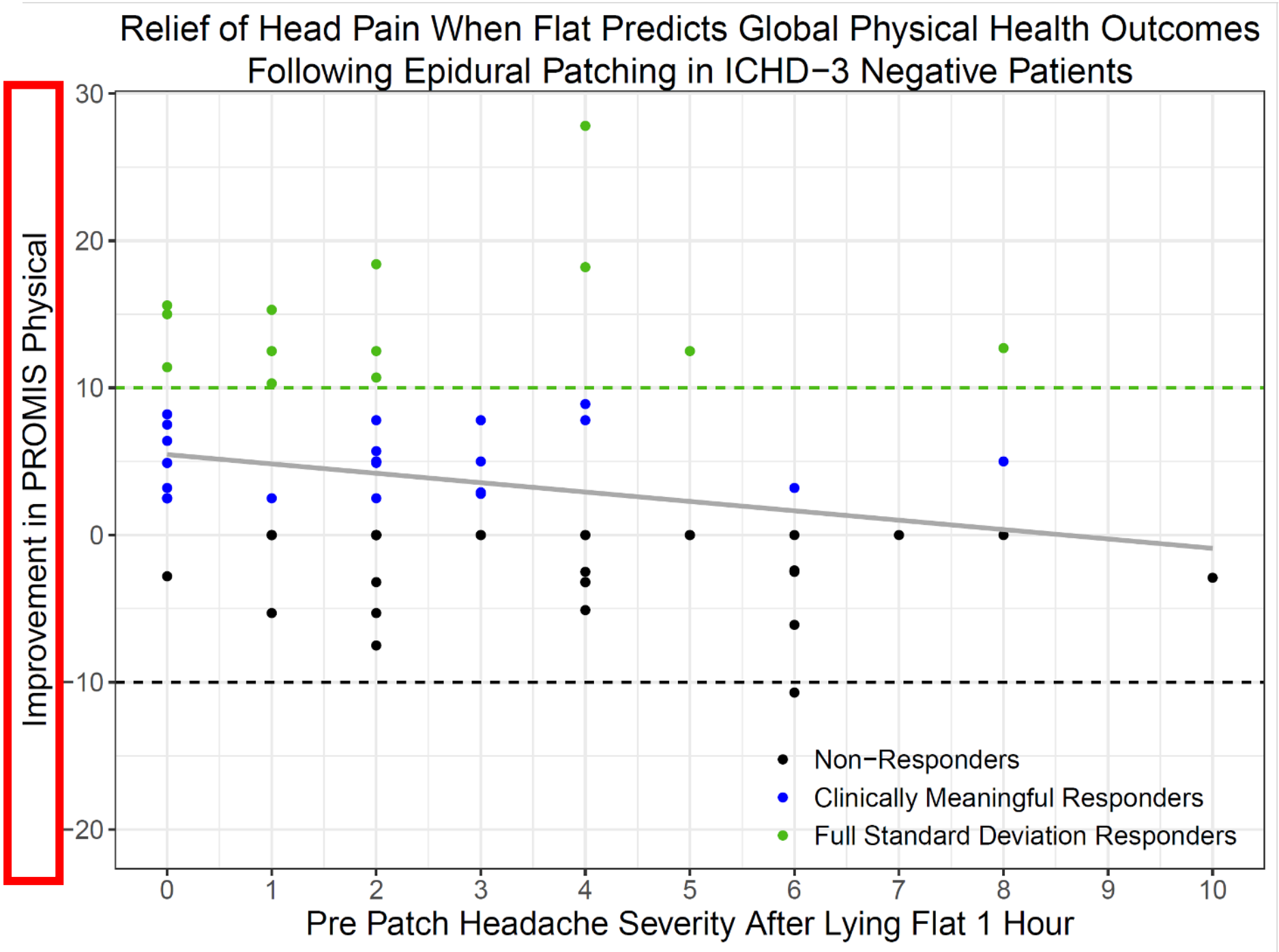
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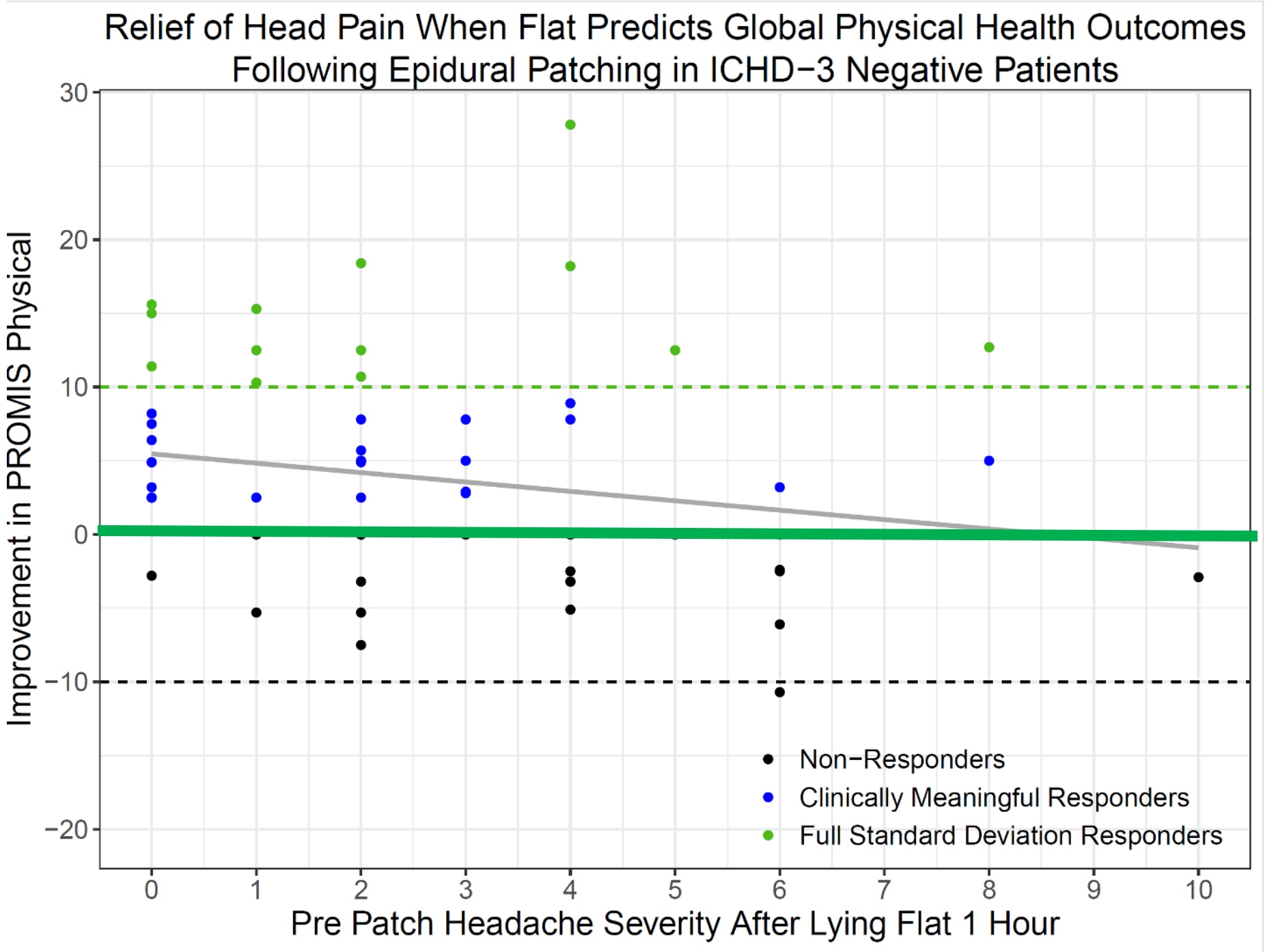
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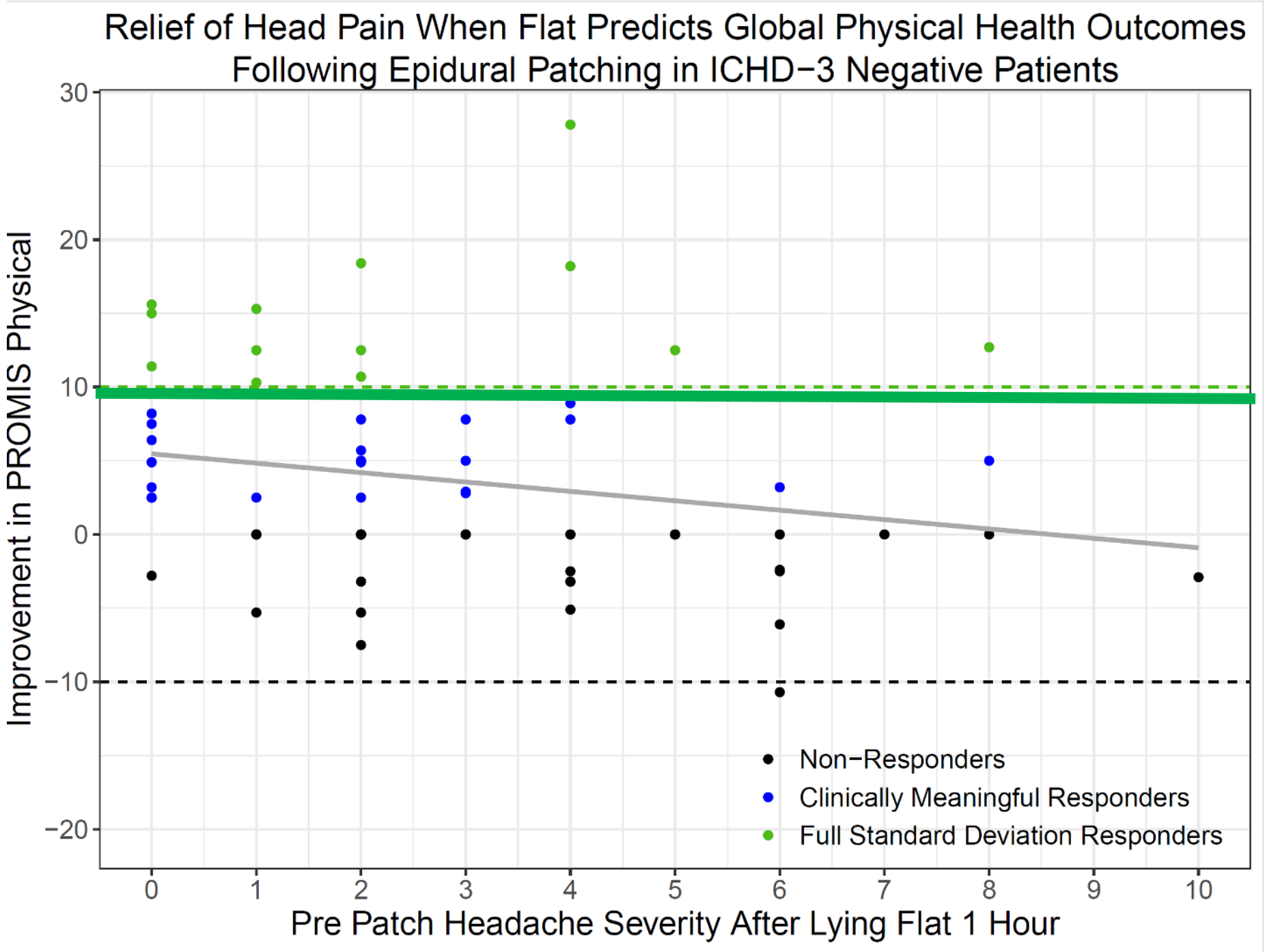
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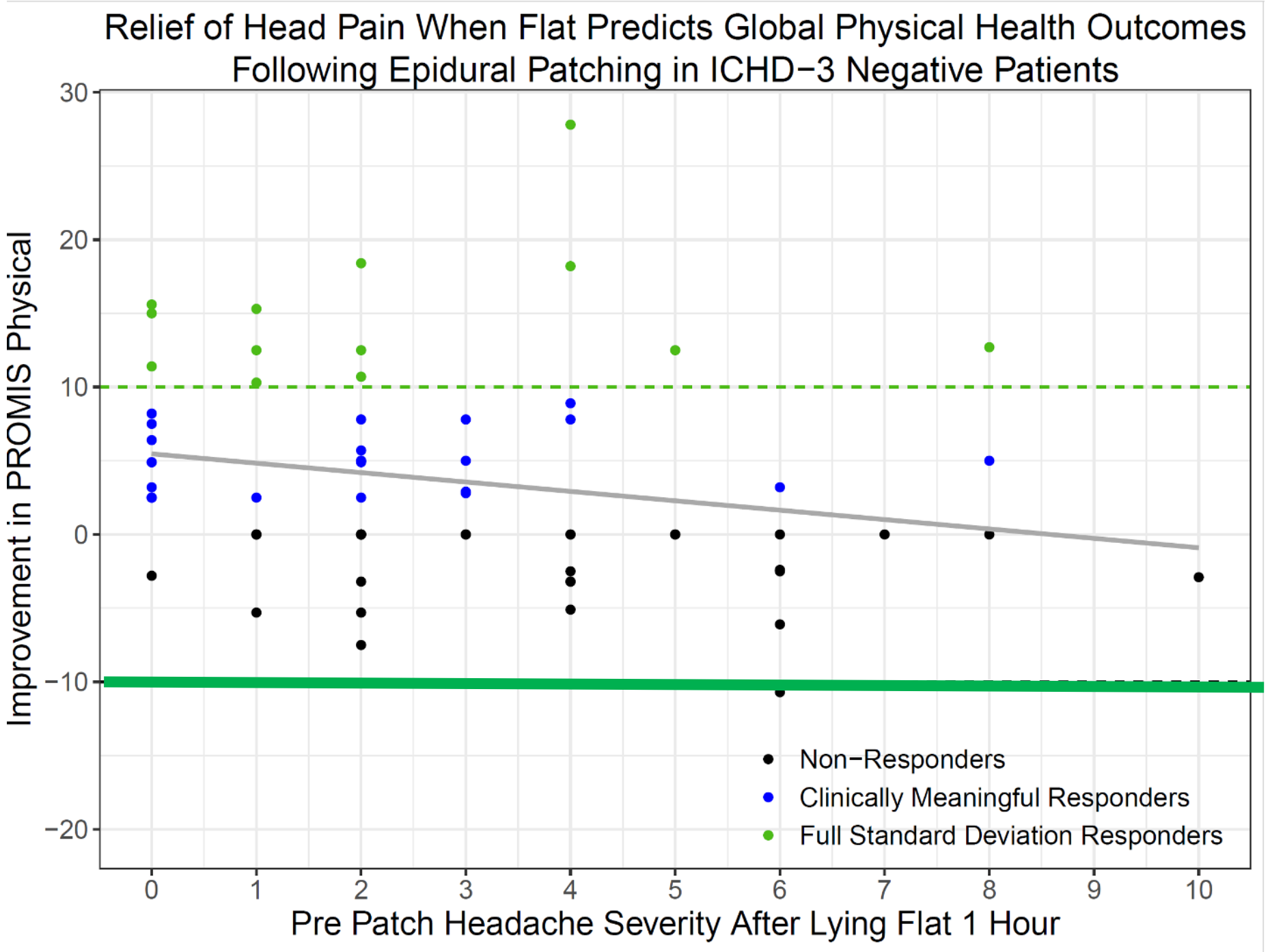
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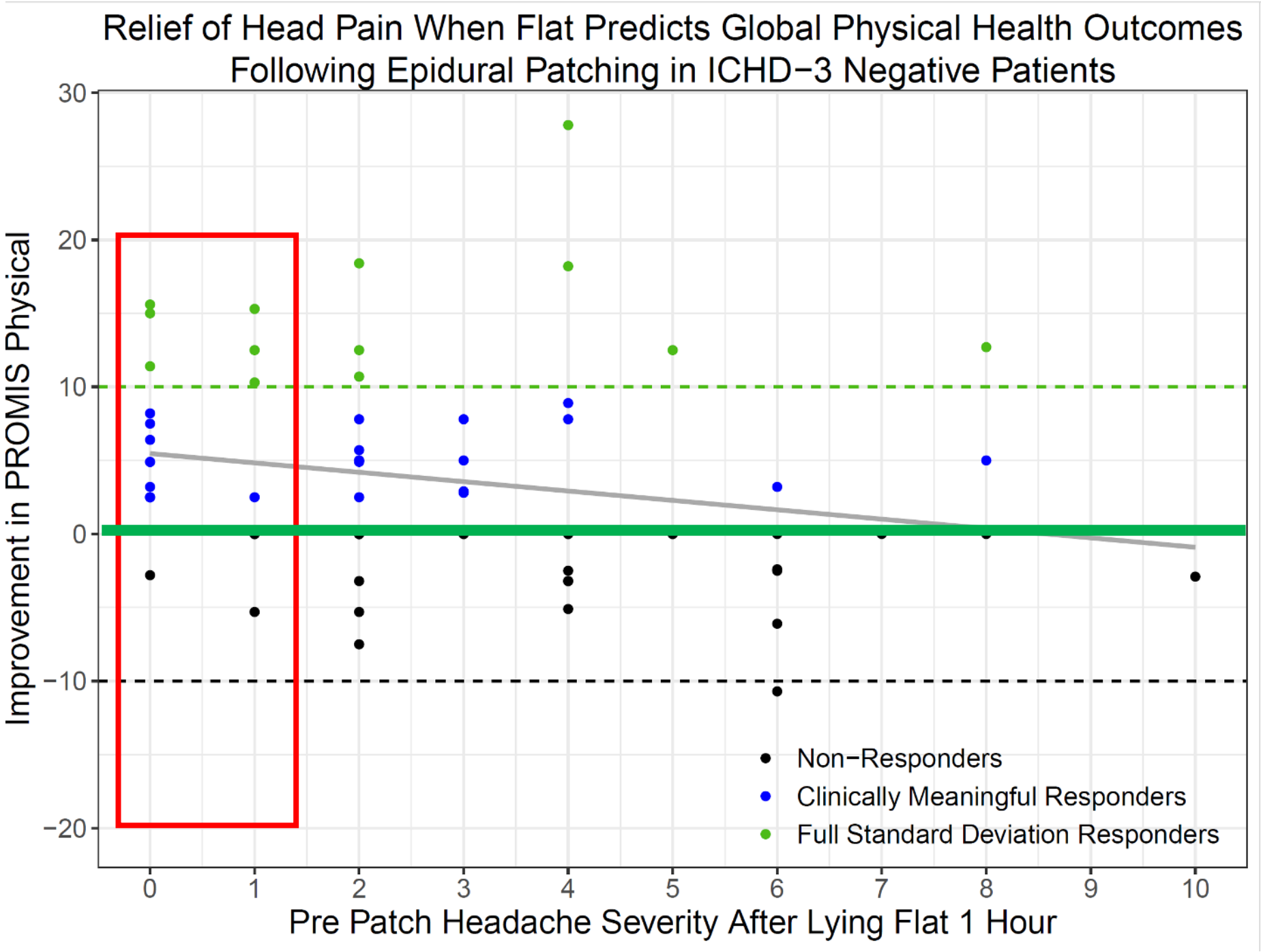
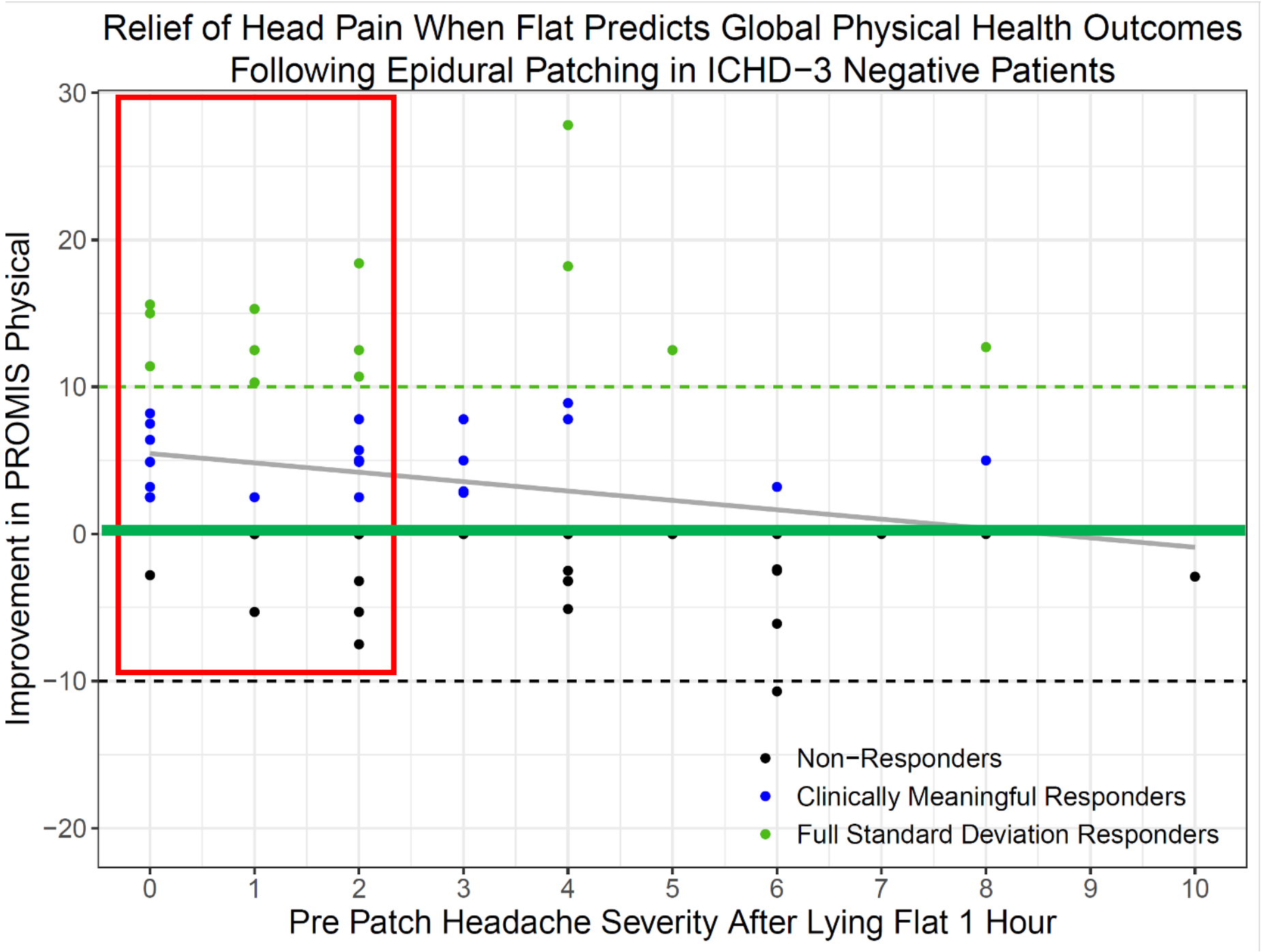
Pre Patch Headache Severity After Lying Flat 1 Hour
Non−Responders
Clinically Meaningful Responders
Full Standard Deviation Responders

16/21 (76%) with head pain ≤ 1 after being flat for an hour had a durable clinically meaningful response.

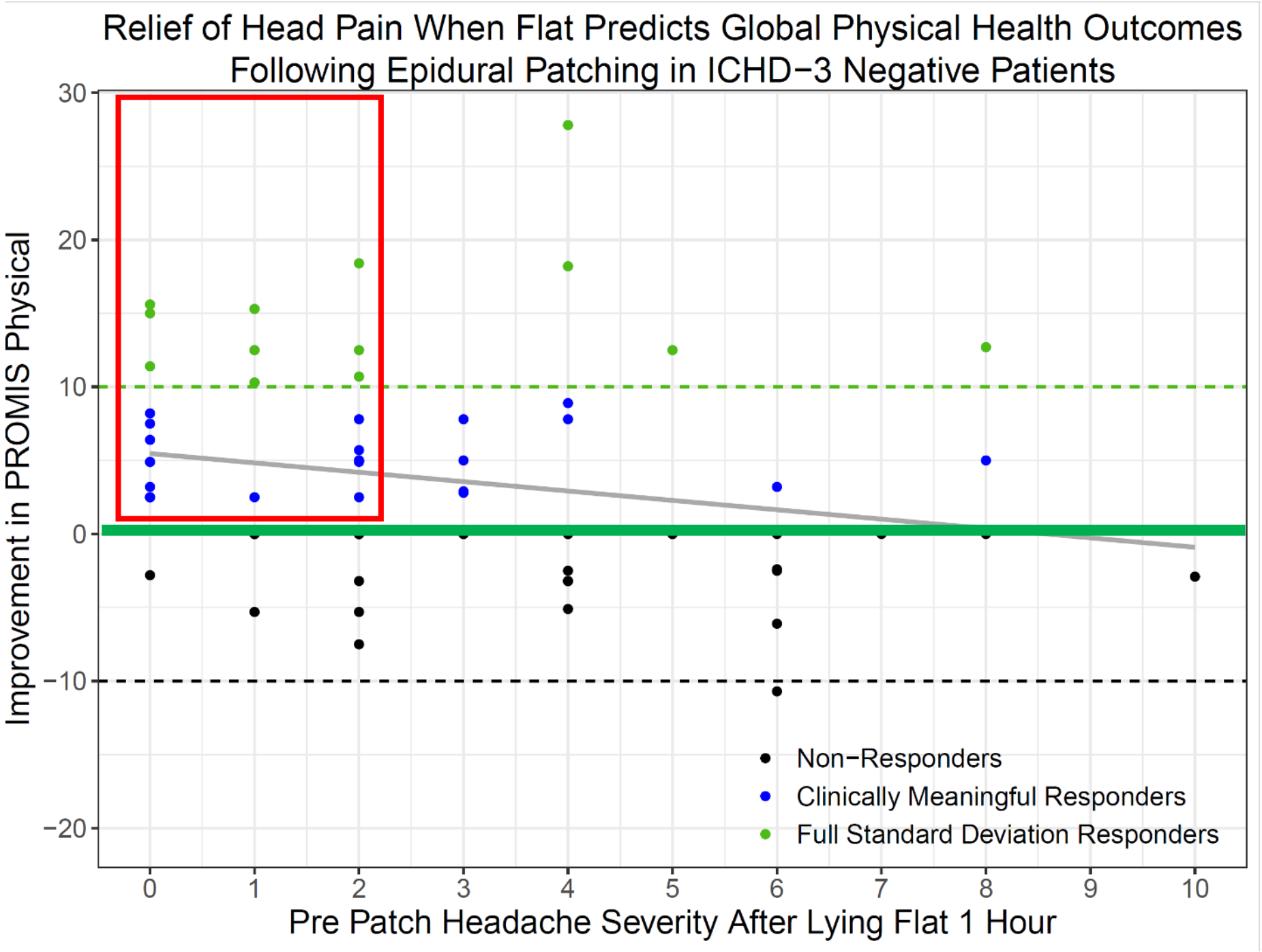


20/32 (62%) with head pain ≤ 1 after being flat for an hour had a durable clinically meaningful response.

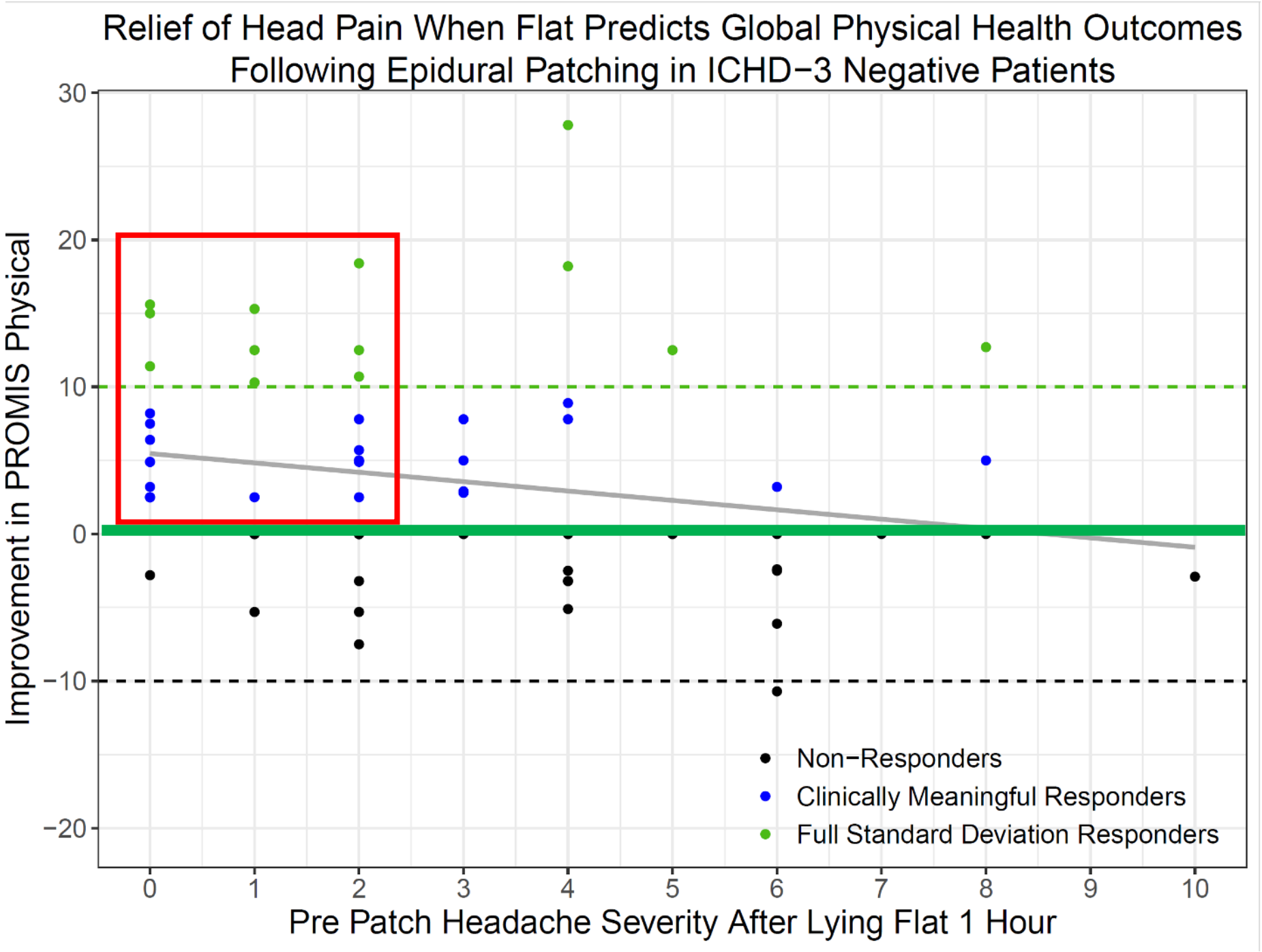


20/32 (62%) with head pain ≤ 1 after being flat for an hour had a durable clinically meaningful response.

AND 9/20 (45%) of clinically meaningful responders will still be more than a standard deviation improved a year after patching.



9/20 (76%) with head pain ≤ 2 after being flat for an hour had a durable clinically meaningful response.



Conclusions:

- Its hard to explain the statistically significant relationship between relief when flat (two measures) and subsequent clinically meaningful improvement amongst ICHD-3 negative patients with placebo response, regression to the mean or Hawthorne effect.

Conclusions:

- Among patients with chronic, disabling, symptoms suggesting CSF leak in whom imaging does not confirm a leak, 54% of patients show clinically meaningful improvement at long term follow up after an average of 3.6 epidural patches.
- Two factors specifically associated with CSF leak- more complete resolution of head pain upon reclining for an hour ($p<0.003$) or overnight ($p<0.02$)—significantly predicted the likelihood of being a clinically meaningful responder in global physical health.
- Most of the patients who experienced meaningful clinical improvement following epidural patching came from the ICHD-3 negative group by a ratio of 3:1
- Nonetheless, a higher rate of response is seen among ICHD-3 positive patients.
- So think about your goals: high rate of response vs helping the most people.

And If Patching Fails?

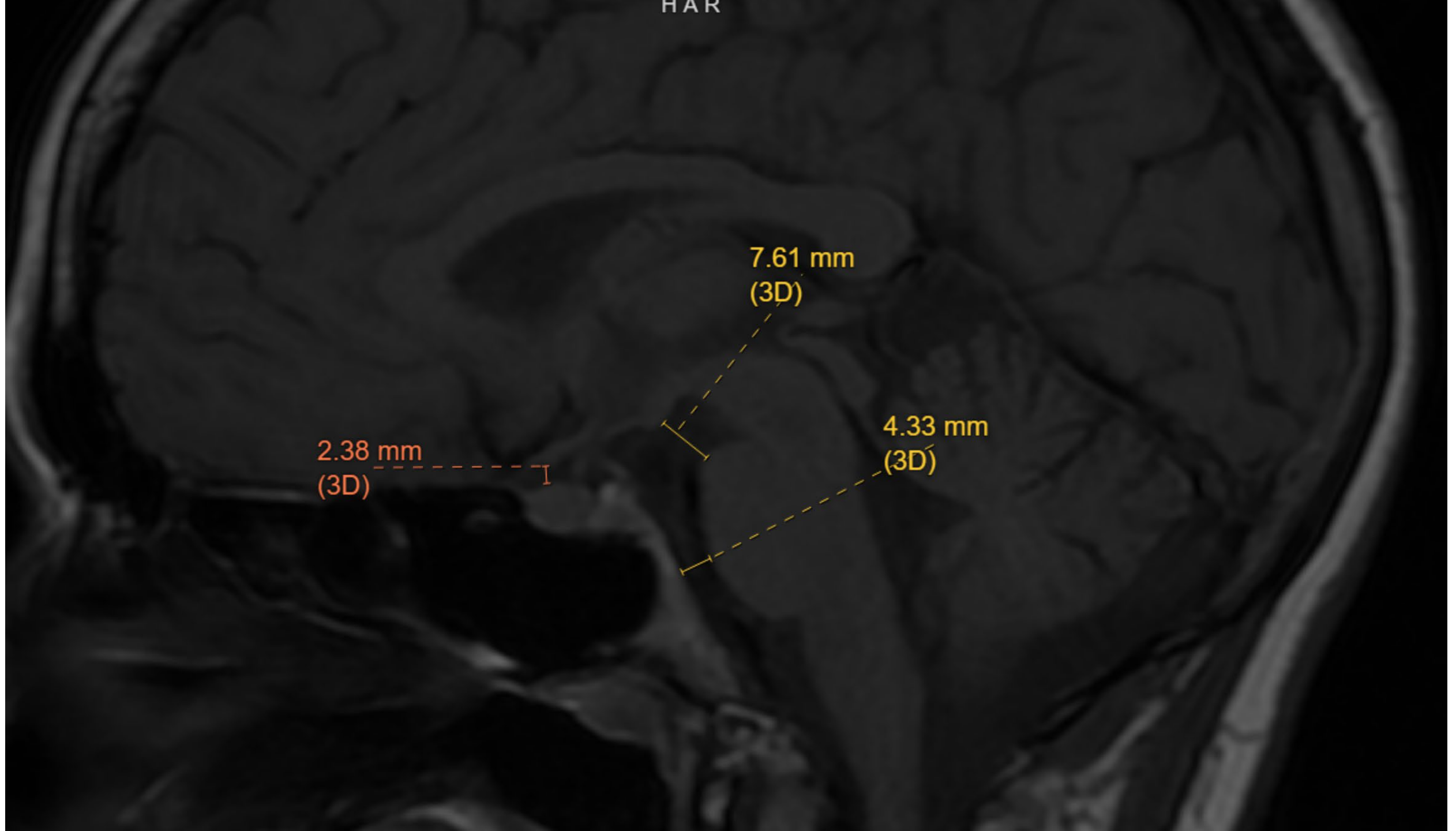
AS: 23 year old female with a history of epilepsy, factor V leiden on hormonal contraceptive

"Symptoms began in October 2018 with a SZ on an airplane from SFO to Boston (to travel to college). Within 3 days started having terrible orthostatic headaches with bad neck pain. She essentially became bedridden and returned home. It was assumed she had a concussion because of the headache and difficulty concentrating…

…Always felt better in the morning"

48 hour flat test

Symptom:	Before 48 hours Flat	After 48 hours Flat	2 hours After resuming Upright
Head Pain	7	2	6
Neck Pain	4	0	5
Nausea	5	0	4
Cognitive SX	5	0	2
Tinnitus	0	0	0
Fatigue	4	0	2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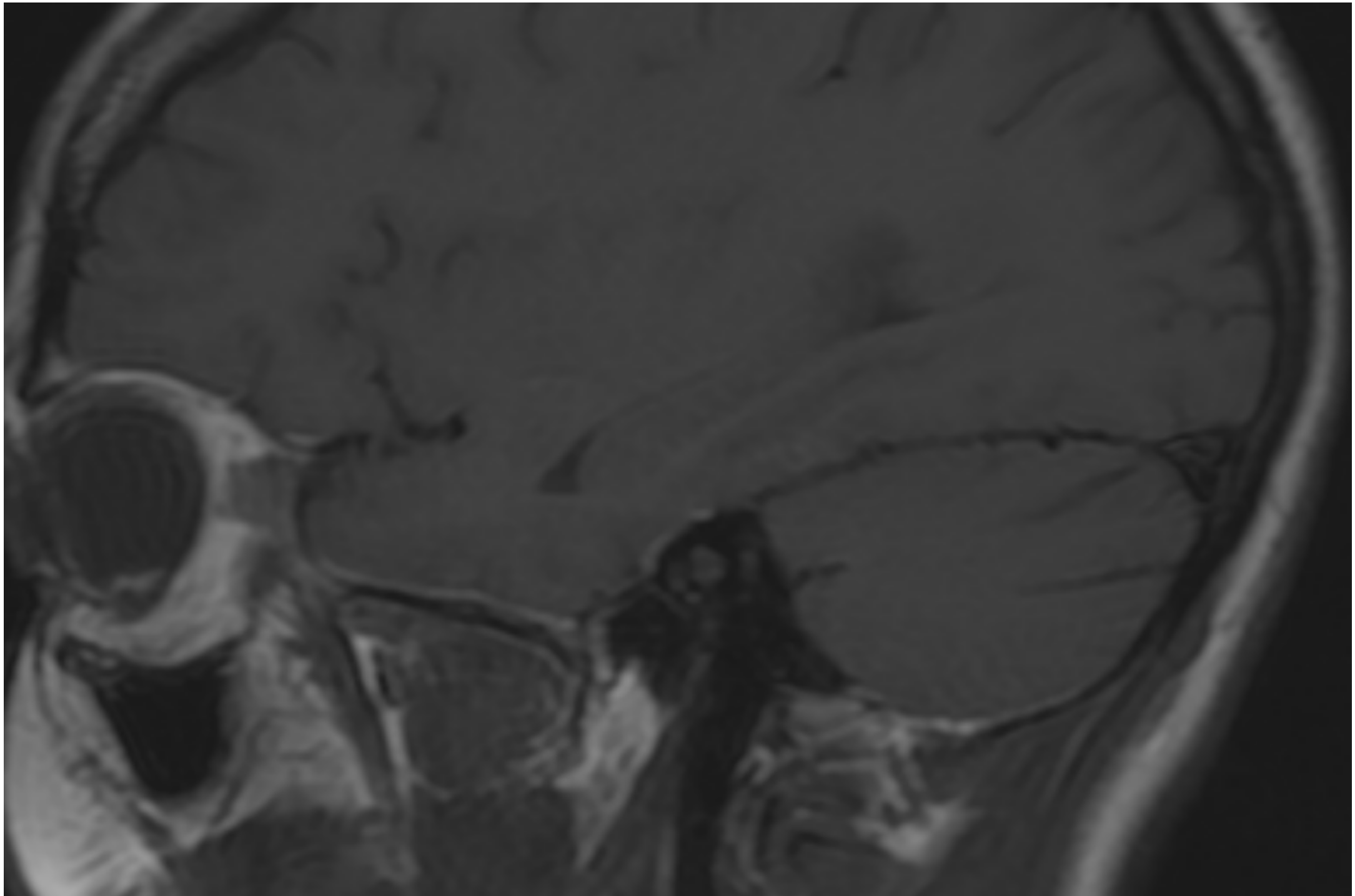
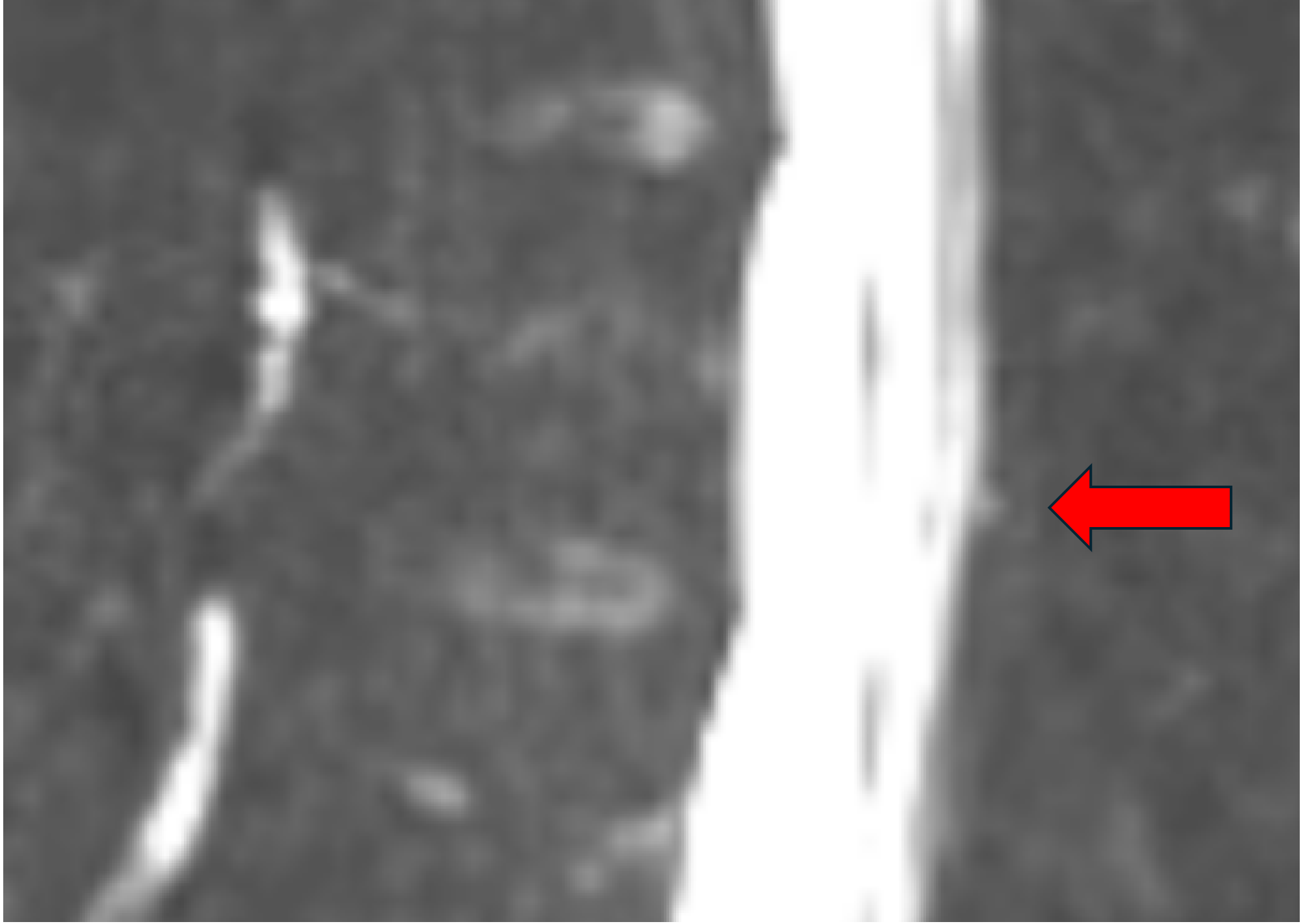
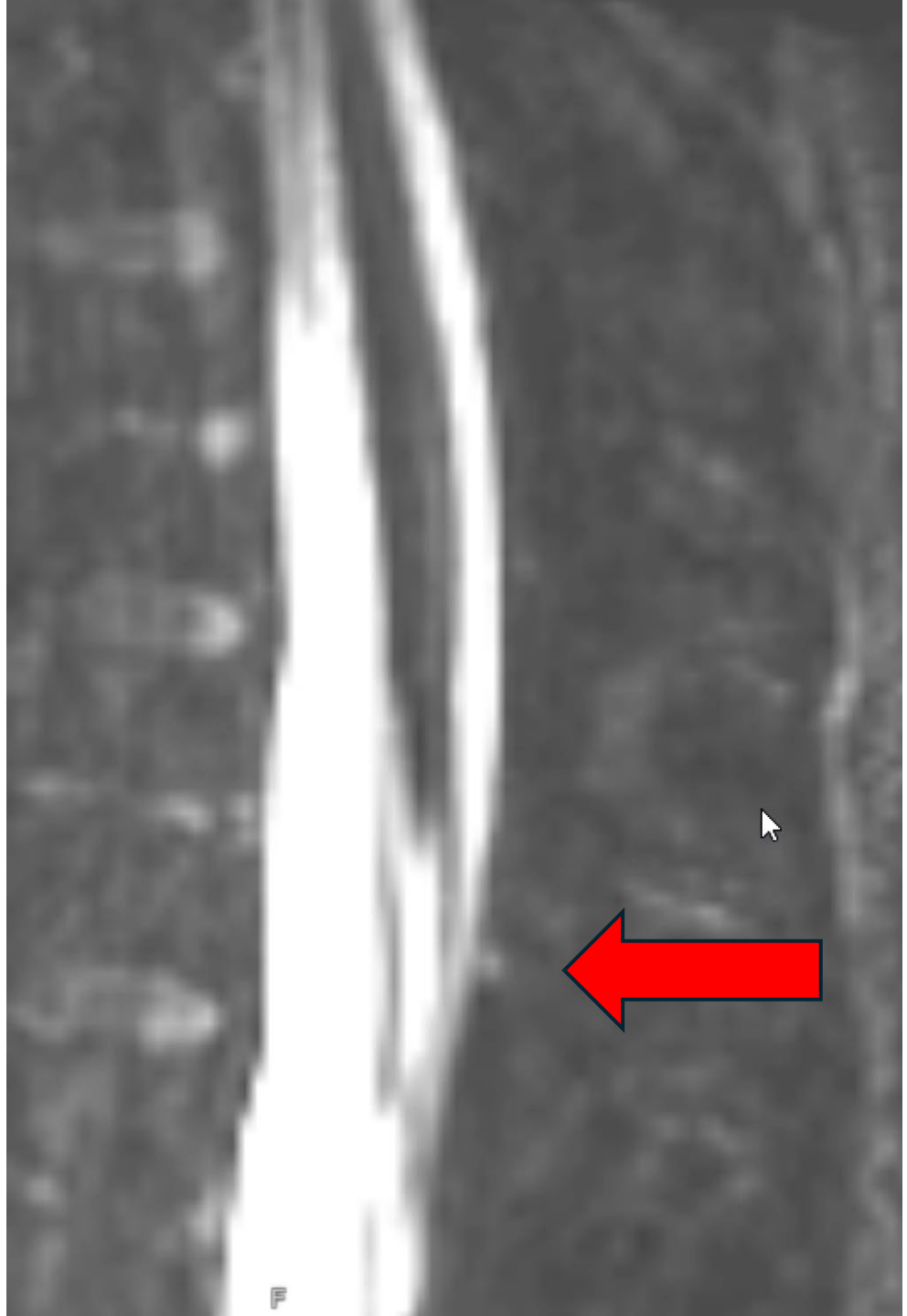
4.33 mm
(3D)
2.38 mm
(3D)



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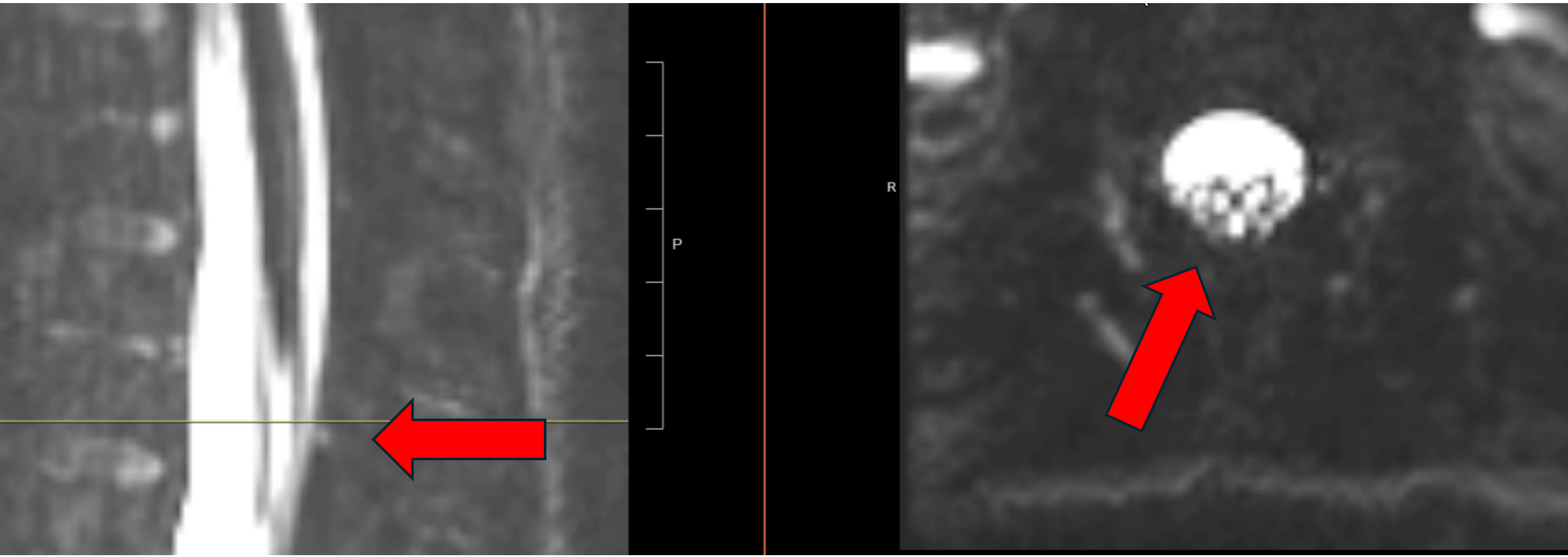
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Class of 2025
UC SANTA BARBAR

Why I favor treatment

- The risks of not treating should not be assumed to be trivial
- Many patients improve, and some improve dramatically
- Those having dramatic improvements outweigh those declining by the same amount by a ratio of 13:1
- Response to treatment is informative and leads to additional therapies

Indispensable Help Came From:

- Rob Cowan MD
- Meredith Barad MD
- Stanford Headache Faculty
- Stanford Neuroradiology: Bryan Lanzman, Hashmi Syed
- Stanford Neurosurgery: Gerry Grant, Casey Halpern
- Niushen Zhang MD
- Elliot Krane MD
- Wouter Schievink MD
- Andrew Callen MD

Treat without confirmation vs treat with confirmation

Wouter I Schievink, MD
Professor of Neurosurgery
Cedars-Sinai Medical Center
Los Angeles, California
USA

The clinical dilemma

- Patient with orthostatic (or other SIH type) headaches
- Normal brain MRI
- Normal spine MRI/Mr-myelogram/conventional CT-myelogram

Orthostatic (or other SIH type) headaches and normal brain MRI and normal conventional CT-myelogram/MR-myelogram

What to do?

- NoDoz?
- Abdominal binder?
- “Blind” epidural blood patch?
-”Targeted” epidural blood patch/glue/surgery
- Search for a CSF-venous fistula

Orthostatic or other SIH type headaches and normal brain MRI and normal conventional CT-myelogram/spine MRI

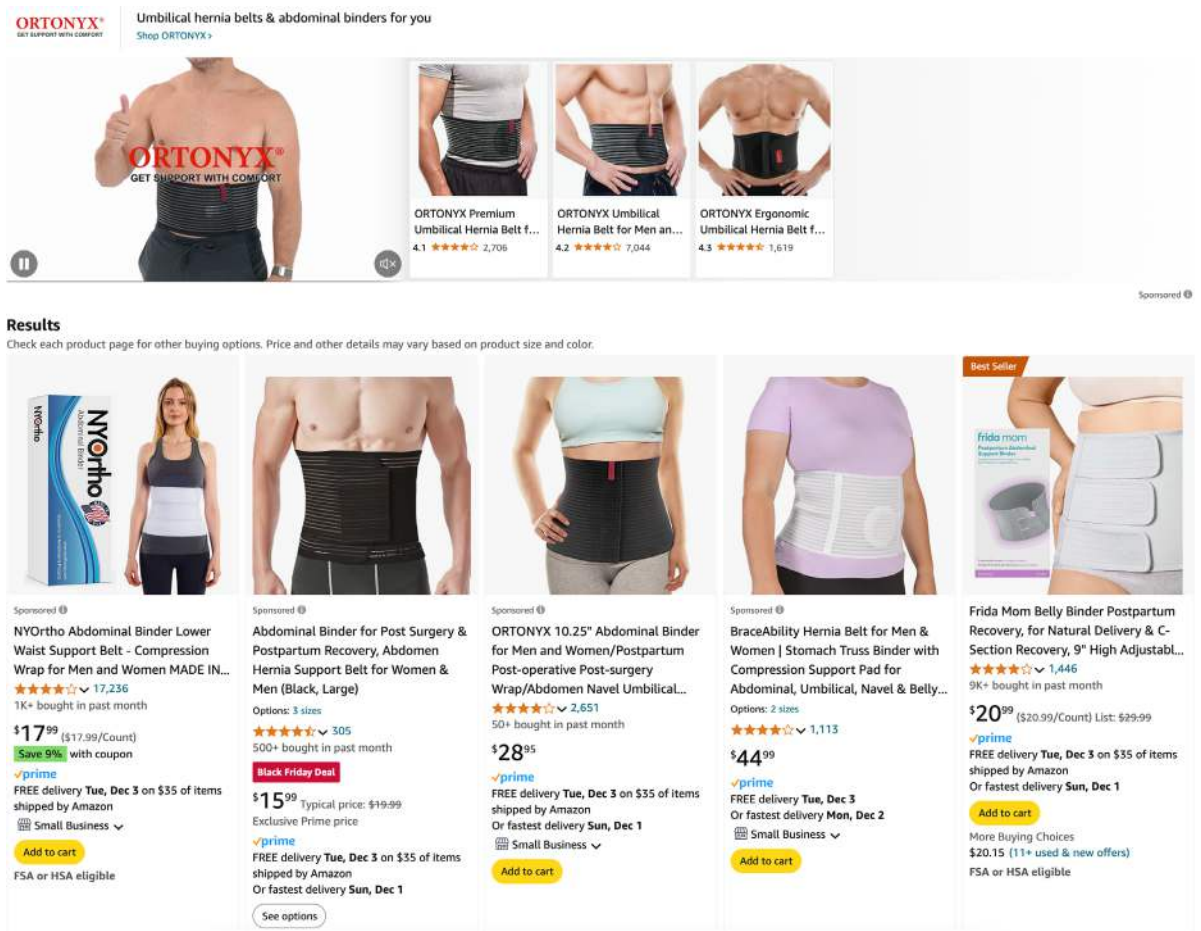
What to do?

- NoDoz

Orthostatic or other SIH type headaches and normal brain MRI and normal conventional CT-myelogram/spine MRI

What to do?

- NoDoz?
- Abdominal binder?



Orthostatic or other SIH type headaches and normal brain MRI and normal conventional CT-myelogram/spine MRI

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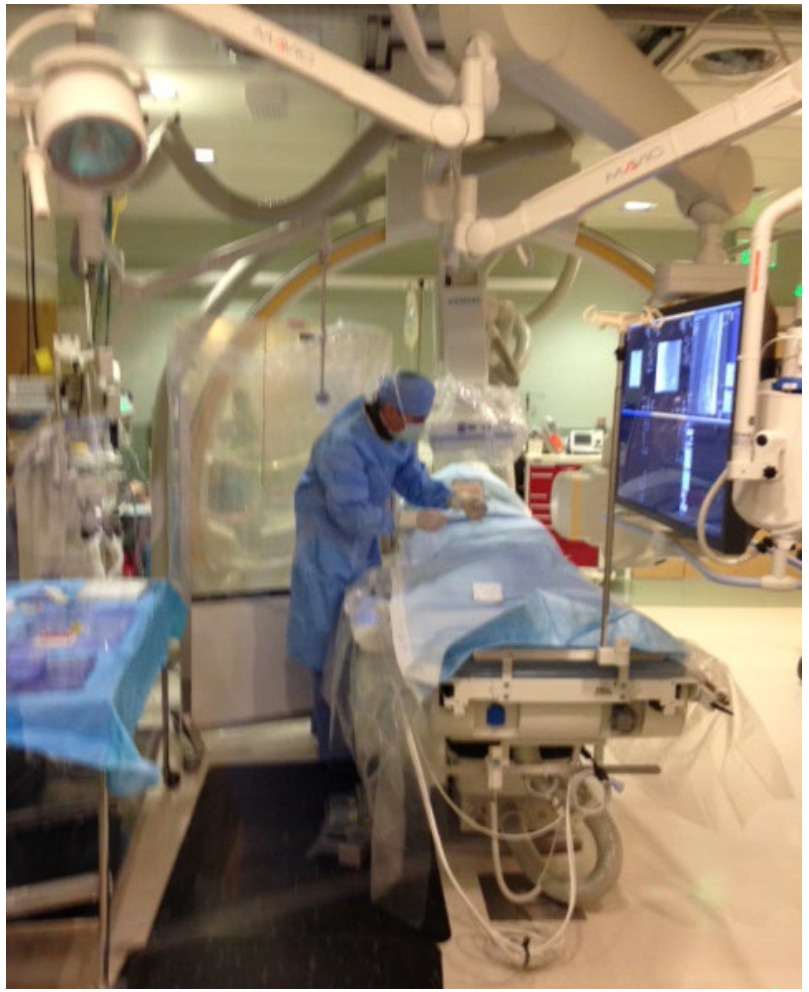
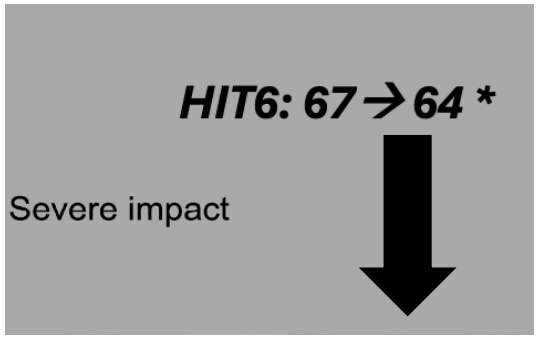


Long-Term Epidural Patching Outcomes and Predictors of Benefit in Patients With Suspected CSF Leak Nonconforming to ICHD-3 Criteria

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†

Correspondence
Dr. Carroll
ic38@stanford.edu

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



No patients in this cohort developed any serious adverse events (e.g., epidural hematoma, abscess, or neurologic injury).

A two-level large-volume epidural blood patch protocol for spontaneous intracranial hypotension: retrospective analysis of risk and benefit

Ryan Martin ,[1] Charles Louy,[2] Vijay Babu,[3] Yi Jiang,[4] Azita Far,[2] Wouter Schievink[5]

Apr 2001-Sep 2010
“ICHD2 criteria”

A two-level large-volume epidural blood patch protocol for spontaneous intracranial hypotension: retrospective analysis of risk and benefit

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Apr 2001-Sep 2010

Meet the “ICHD2 criteria”?

analysis. The diagnosis of SIH was based on the diagnostic criteria for headache due to spontaneous CSF leak and is consistent with the definition of intracranial hypotension according to the International Classification of Headache Disorders, second ed.[8] This includes the presence of a diffuse and/or dull headache that worsens on sitting or standing and is associated with greater than one of the following: neck stiffness, tinnitus, hyperacusis, photophobia, and nausea. If the clinical symptoms were not classic for intracranial hypotension, the diagnosis was presumed if they had a confirmatory physical examination in which increased intra-abdominal pressure resulted in improvement or resolution of their headache or symptoms. This was accomplished with the patient standing or sitting and the examiner wrapping his arms around the patient’s abdomen and progressively squeezing.

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48 hour Flat Test Instructions

Louy manoeuvre **vs** **Stanford 48 hour flat test**

How to diagnose SIH – ICHD-II to ICHD-III

A. Diffuse and/or dull headache that worsens within 15 minutes after sitting or standing, with at least one of the following and fulfilling criterion D:

1. neck stiffness
2. tinnitus
3. hypacusia
4. photophobia
5. nausea

B. At least one of the following:

1. evidence of low CSF pressure on MRI (eg, pachymeningeal enhancement)
2. evidence of CSF leakage on conventional myelography, CT myelography or cisternography
3. CSF opening pressure <60 mm H_2O in sitting position

C. No history of dural puncture or other cause of CSF fistula

D. Headache resolves within 72 hours after epidural blood patching

ICHD-II criteria 2004

A. Any headache fulfilling criterion C

B. Low CSF pressure (<60 mm CSF) and/or evidence of CSF leakage on imaging

C. Headache has developed in temporal relation to the low CSF pressure or CSF leakage, or led to its discovery

D. Not better accounted for by another ICHD-3

Diagnosis

ICHD-III criteria (April 2011)

A two-level large-volume epidural blood patch protocol for spontaneous intracranial hypotension: retrospective analysis of risk and benefit

Ryan Martin ,[1] Charles Louy,[2] Vijay Babu,[3] Yi Jiang,[4] Azita Far,[2] Wouter Schievink[5]

Table 3 Symptoms leading to termination of each two-level epidural blood patch

Limiting factor	*n*	%
Radicular pain	124	76.1
Back pain	95	58.3
Abdominal or flank pain	23	14.1
Transient headache	7	4.3
Inadvertent entry into subdural space	5	3.1
Worsening of baseline symptoms	2	1.2

The epidural blood patch

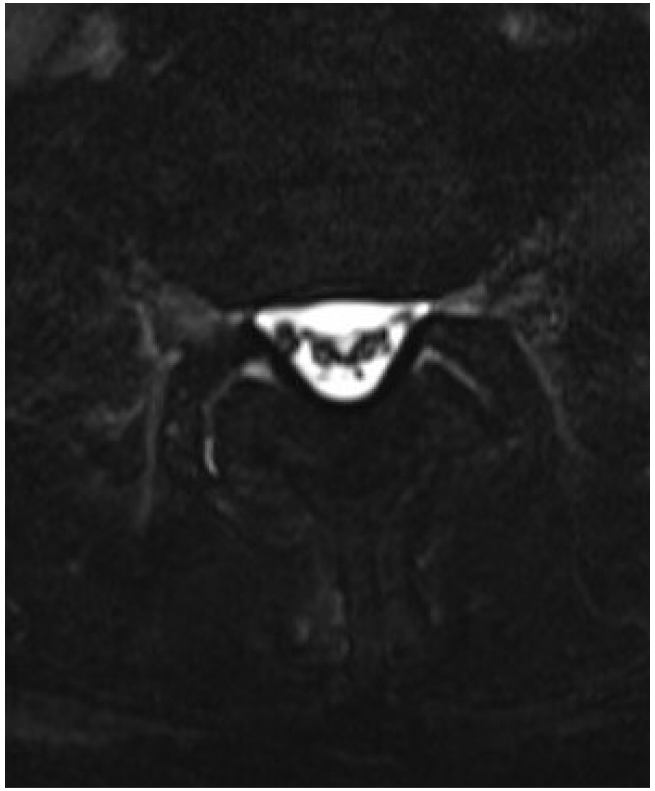
One hundred and sixty-three two-level EBPs were performed. The mean volume per EBP was 43.2±21.7 mL (range of 4–124 mL).

Serious adverse events (n=2): Paraparesis (transient)
Chronic cauda equina syndrome/arachnoiditis

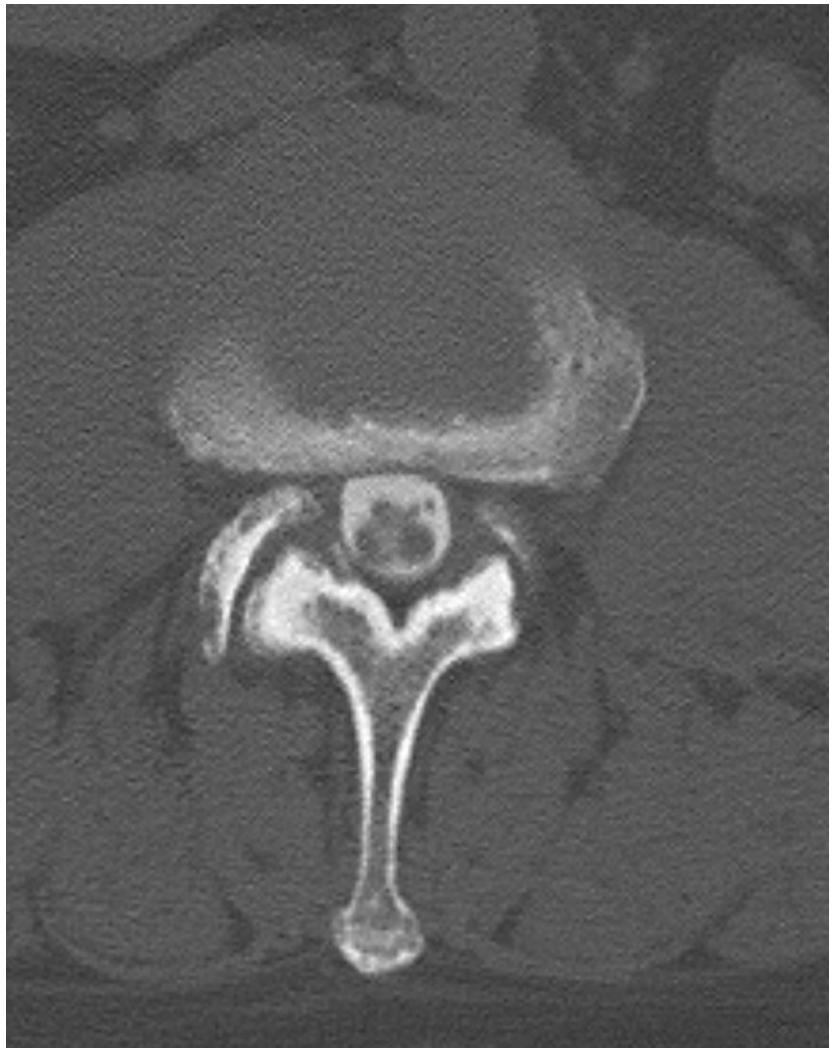
The subdural blood patch

Pre-patch

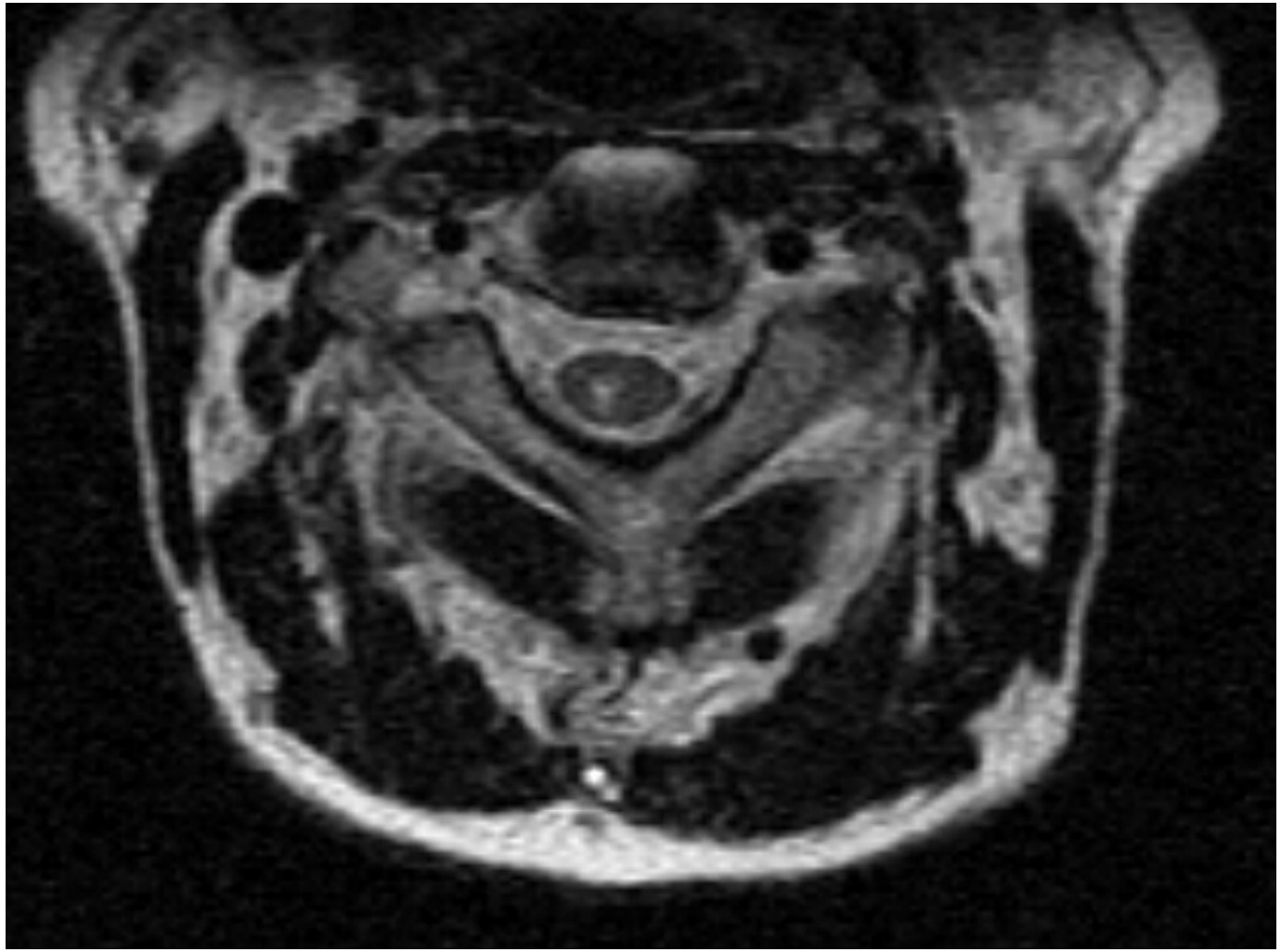
Post-patch



NORMAL

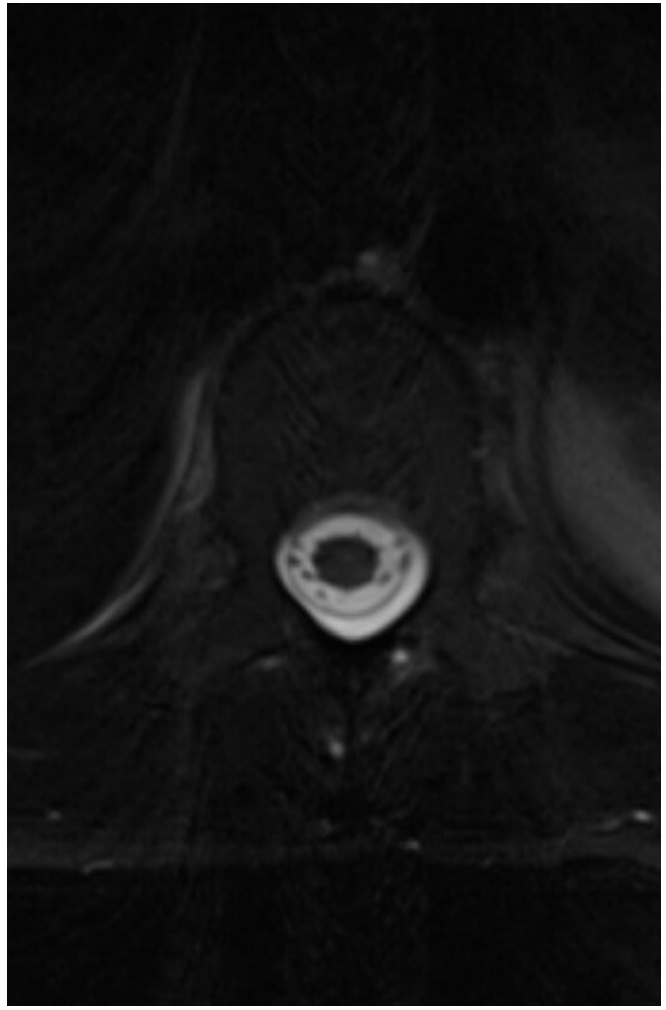


S/P LUMBAR EBP x2



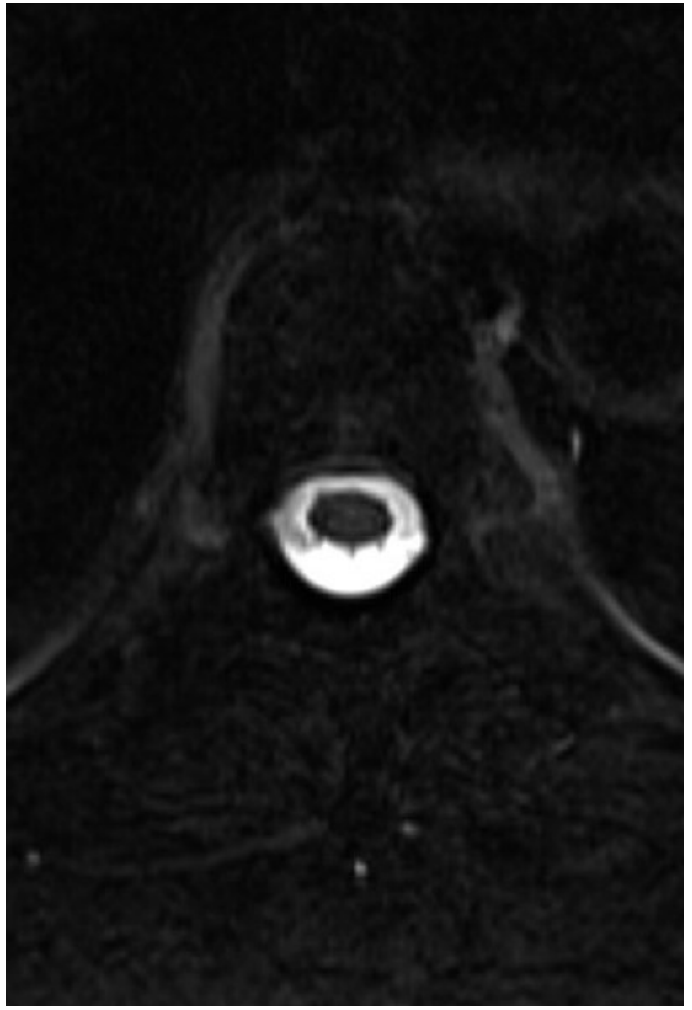
S/P CERVICAL EPIDURAL BLOOD PATCH

Imaging positive



Ample epidural space

Imaging negative



No epidural space

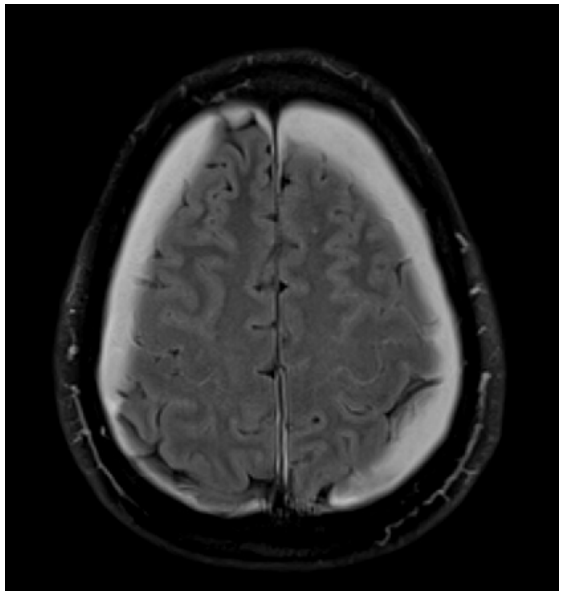
Orthostatic (or other SIH type) headaches and normal brain MRI and normal conventional CT-myelogram/MR-myelogram

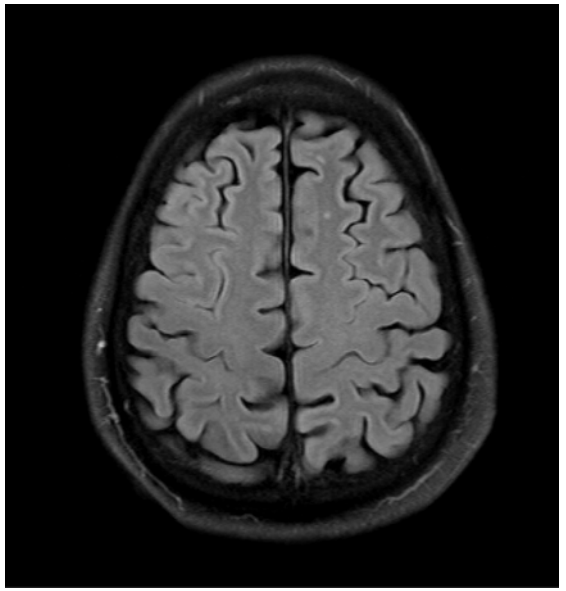
What to do?

- NoDoz?
- Abdominal binder?
- “Blind” epidural blood patch?
- “Targeted” epidural blood patch/glue/surgery

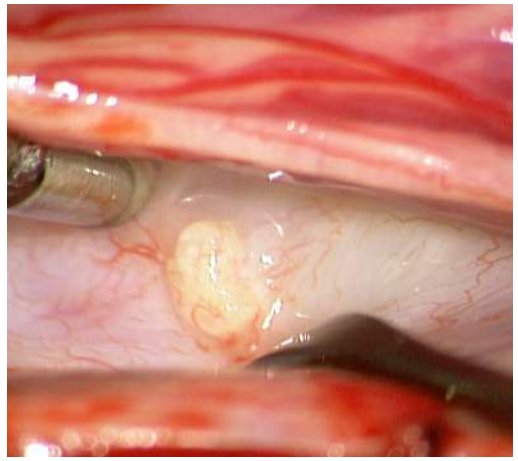
What to target?

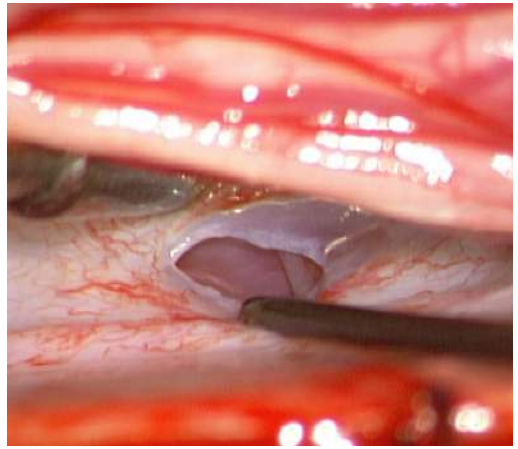
What to target?

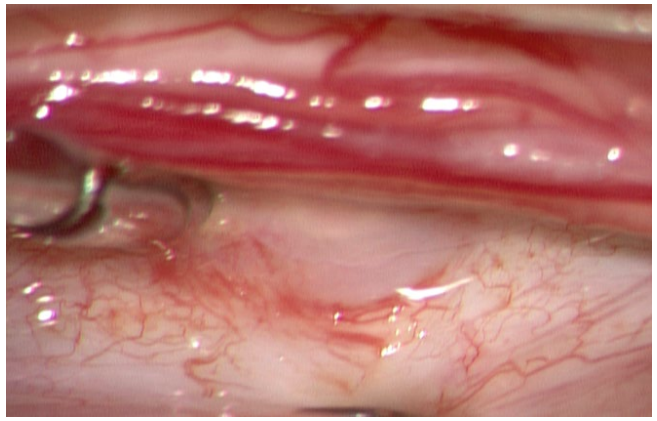


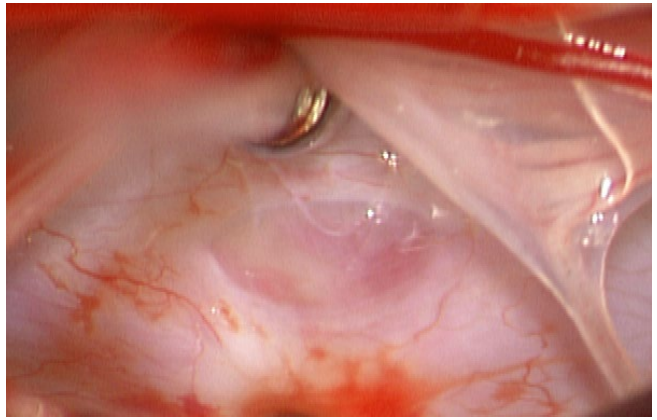


What to target?









Orthostatic (or other SIH type) headaches and normal brain MRI and normal conventional CT-myelogram/MR-myelogram

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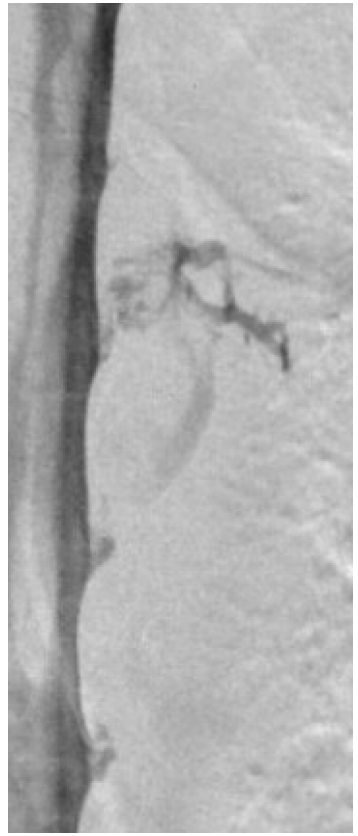

Search for a CSF-venous fistula? – what are the risks

- PDPH
- Ionizing radiation
- Stigmatizing patient
- Costs
- Disruptions

Patient

- Resources
- Costs
- Physician/tech support enthusiam

Hospital

Search for a CSF-venous fistula?

- Risk of PDPH
- Ionizing radiation
- Stigmatizing patient
- Costs
- Disruptions

- Resources
- Costs
- Physician/tech support enthusiam

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]

[1]Department of Neurosurgery, Cedars-Sinai Medical Center, Los Angeles, CA, USA

[2]Department of Imaging, Cedars-Sinai Medical Center, Los Angeles, CA, USA

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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.

Background: Spontaneous spinal CSF leaks cause orthostatic headaches but their detection may require sophisticated spinal imaging techniques.

Methods: A prospective cohort study of patients with orthostatic headaches and normal brain and conventional spine imaging who underwent digital subtraction myelography (DSM) to look for CSF-venous fistulas, between May 2018 and May 2020, at a quaternary referral center for spontaneous intracranial hypotension.

Results: The mean age of the 60 consecutive patients (46 women and 14 men) was 46 years (range, 13–83 years), who had been suffering from orthostatic headaches between 1 and 180 months (mean, 43 months). DSM demonstrated a spinal CSF-venous fistula in 6 (10.0%; 95% confidence interval [CI]: 3.8–20.5%) of the 60 patients. The mean age of these five women and one man was 50 years (range, 41–59 years). Spinal CSF-venous fistulas were identified in 6 (19.4%; 95% CI: 7.5–37.5%) of 31 patients with spinal meningeal diverticula but in none (0%; 95% CI: 0–11.9%) of the 29 patients without spinal meningeal diverticula ($p = 0.024$). All CSF-venous fistulas were located in the thoracic spine. All patients underwent uneventful surgical ligation of the fistula. Complete and sustained resolution of symptoms was obtained in five patients, while in one patient, partial recurrence of symptoms was noted 3 months postoperatively.

Conclusion: Concerns about a spinal CSF leak should not be dismissed in patients suffering from orthostatic headaches when conventional imaging turns out to be normal, even though the yield of identifying a CSF-venous fistula is low.

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

TABLE 1 Characteristics of patients with orthostatic headaches and normal brain and conventional spine imaging for the presence or absence of spinal CSF-venous fistula

	All patients	Spinal CSF venous fistula		
		Yes	No	*p*-value
Number of patients (%)	60	6 (10.0)	54 (90.0)	
Age (years)				0.560
Mean (SD)	46.2 (14.9)	50.3 (7.0)	45.7 (15.5)	
Median (IQR)	48 [36–56]	49 [46–58]	47 [35–56]	
Range (min–max)	13–83	41–59	13–83	
Body mass index				0.393
Mean (SD)	24.6 (5.4)	23.3 (7.5)	24.7 (5.2)	
Median (IQR)	23 [21–27]	19 [18–27]	24 [22–27]	
Range (min–max)	16–45	18–37	16–45	
Female Sex	46 (76.7)	5 (83.3)	41 (75.9)	>0.999
Headache, *N* (%)				0.180
Occipital/suboccipital	32 (53.3)	3 (50.0)	29 (53.7)	
Frontal	14 (23.3)	3 (50.0)	11 (20.4)	
Other	14 (23.3)	0 (0)	14 (25.9)	
Worsening of headache (minutes), *N* (%)				0.847
0–10	30 (50.0)	4 (66.7)	26 (48.2)	
11–60	21 (35.0)	2 (33.3)	19 (35.2)	
>60	9 (15.0)	0 (0)	9 (16.6)	
Initial opening pressure, cm H_2O[a]				0.433
Low	3 (10.3)	1 (25.0)	2 (8.0)	
Normal	22 (75.9)	3 (75.0)	19 (76.0)	
Borderline elevated	4 (13.8)	0 (0)	4 (16.0)	
High				
Opening pressure at time of DSM, cm H_2O[a]				0.541
Low	3 (5.0)	1 (16.7)	2 (3.7)	
Normal	53 (88.3)	5 (83.3)	48 (88.9)	
Borderline elevated	2 (3.3)	0 (0)	2 (3.7)	
High	2 (3.3)	0 (0)	2 (3.7)	
Symptom duration, months				0.385
Mean (SD)	43.0 (42.2)	35.7 (34.4)	43.9 (43.2)	
Median (IQR)	299 [17–52]	22 [17–31]	30 [16–53]	
Range (min–max)	1–180	17–105	1–180	
Positive effect of EBP				0.581
Yes	49 (81.7)	6 (100.0)	43 (79.6)	
No	11 (18.3)	0 (0)	11 (20.4)	
Presence of spinal meningeal diverticula, N (%)				0.024
Yes	31 (51.7)	6 (100.0)	25 (46.3)	
No	29 (48.3)	0 (0)	29 (3.7)	

[a]Opening pressure: low (<6), normal (6–20), borderline elevated (21–25), and high (>25). Thirty-one patients did not have data for initial openin pressure and were excluded from that analysis, but there were no missing data otherwise.

Yield: 20% vs 0%,
presence vs absence of meningeal diverticula

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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.

Optic Nerve Sheath MR Imaging Measurements in Patients with Orthostatic Headaches and Normal Findings on Conventional Imaging Predict the Presence of an Underlying CSF-Venous Fistula

Wouter I. Schievink, Marcel M. Maya, Angelique Sao-Mai S. Tay, Peyton L. Nisson, Jay Acharya, Rachelle B. Taché, and Miriam Nuño

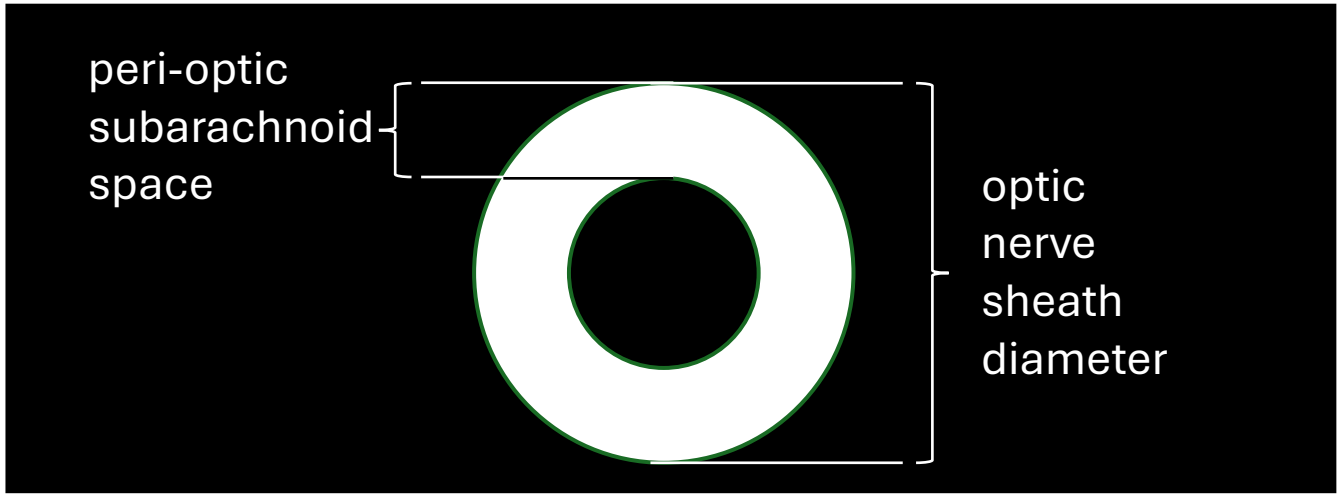
ABSTRACT

BACKGROUND AND PURPOSE: Spontaneous spinal CSF leaks typically cause orthostatic headache, but their detection may require specialized and invasive spinal imaging. We undertook a study to determine the value of simple optic nerve sheath MR imaging measurements in predicting the likelihood of finding a CSF-venous fistula, a type of leak that cannot be detected with routine spine MR imaging or CT myelography, among patients with orthostatic headache and normal conventional brain and spine imaging findings.

MATERIALS AND METHODS: This cohort study included a consecutive group of patients with orthostatic headache and normal conventional brain and spine imaging findings who underwent digital subtraction myelography under general anesthesia to look for spinal CSF-venous fistulas.

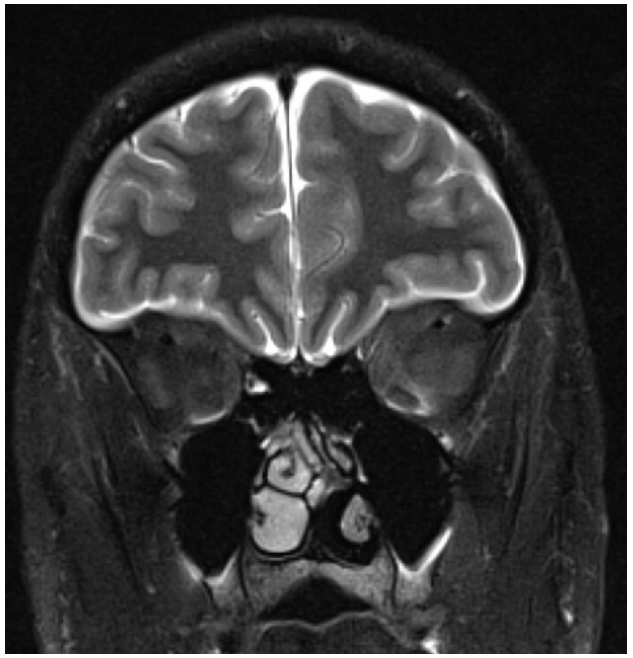
RESULTS: The study group consisted of 93 patients (71 women and 22 men; mean age, 47.5 years; range, 17–84 years). Digital subtraction myelography demonstrated a CSF-venous fistula in 15 patients. The mean age of these 8 women and 7 men was 56 years (range, 23–83 years). The mean optic nerve sheath diameter was 4.0 mm, and the mean perioptic subarachnoid space was 0.5 mm in patients with a CSF-venous fistula compared with 4.9 and 1.2 mm, respectively, in patients without a fistula ($P < .001$). Optimal cutoff values were found at 4.4 mm for optic nerve sheath diameter and 1.0 mm for the perioptic subarachnoid space. Fistulas were detected in about 50% of patients with optic nerve sheath diameter or perioptic subarachnoid space measurements below these cutoff values compared with <2% of patients with optic nerve sheath diameter or perioptic subarachnoid space measurements above these cutoff values. Following surgical ligation of the fistula, optic nerve sheath diameter increased from 4.0 to 5.3 mm and the perioptic subarachnoid space increased from 0.5 to 1.2 mm ($P < .001$).

CONCLUSIONS: Concerns about a spinal CSF leak should not be dismissed in patients with orthostatic headache when conventional imaging findings are normal, and simple optic nerve sheath MR imaging measurements can help decide if more imaging needs



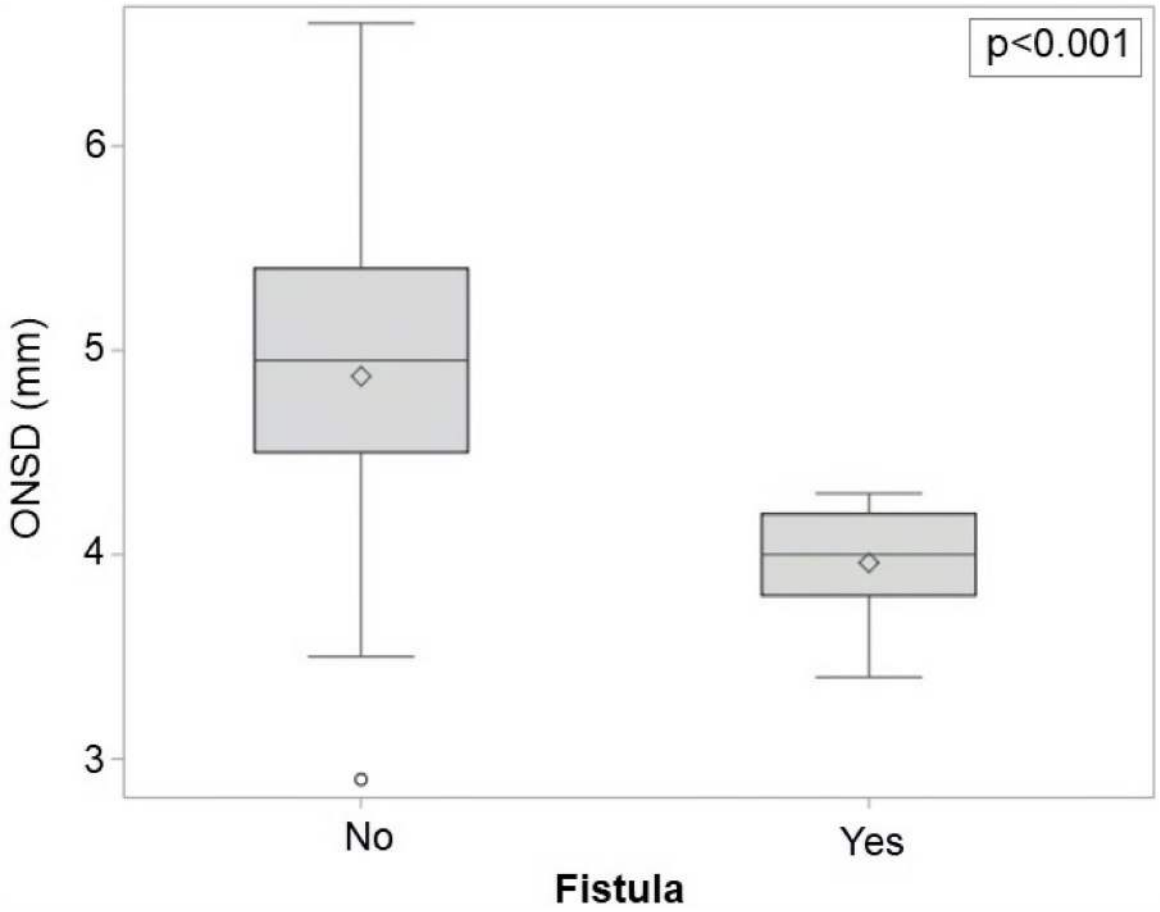
A

4 minute extra scanning time



B

C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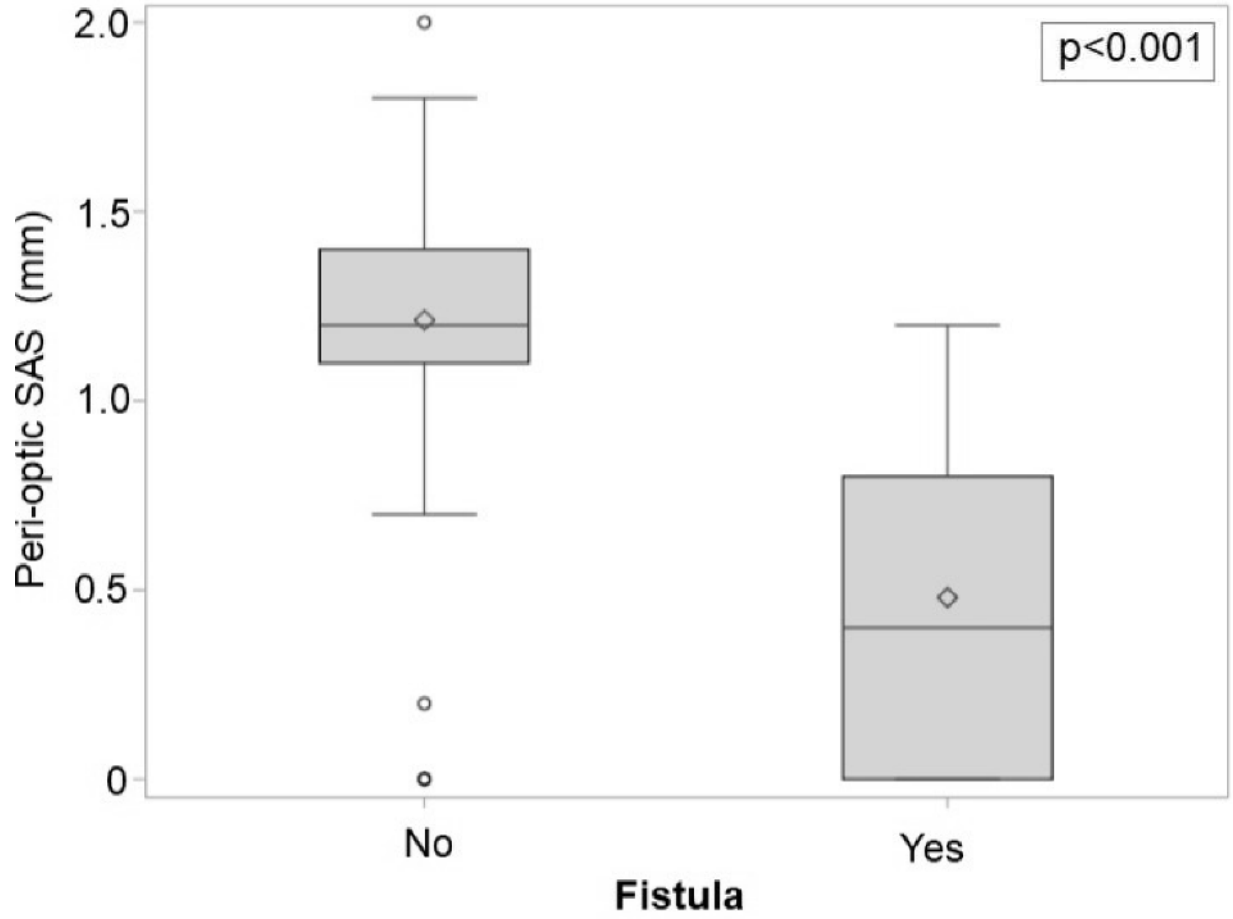
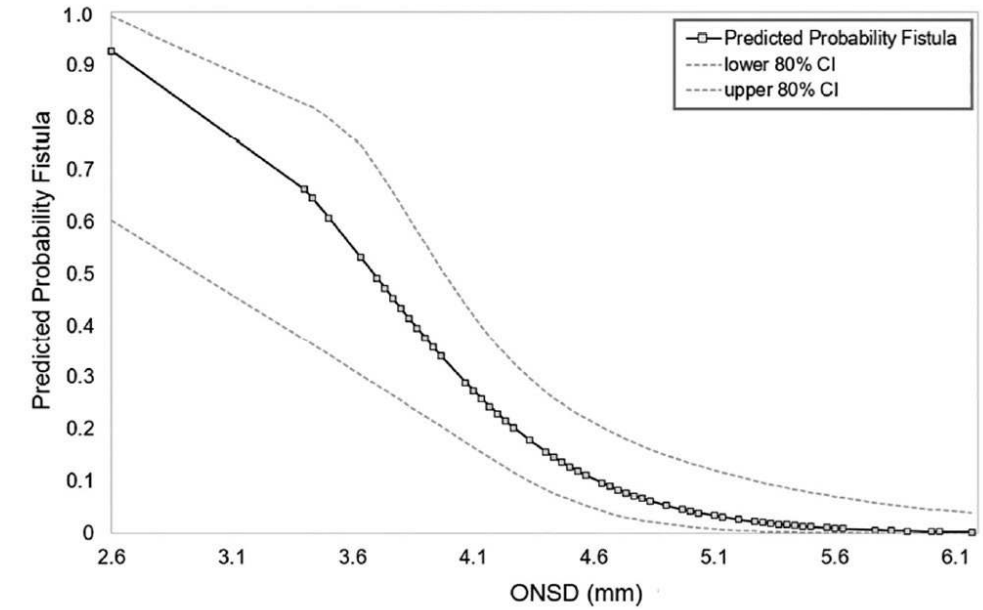
6
5
4
3
No
Yes
Fistula


p<0.001
Peri-optic SAS (mm)
2.0
1.5
1.0
0.5
0
No
Yes
Fistula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lower 80% CI
upper 80% CI
Predicted Probability Fistula
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
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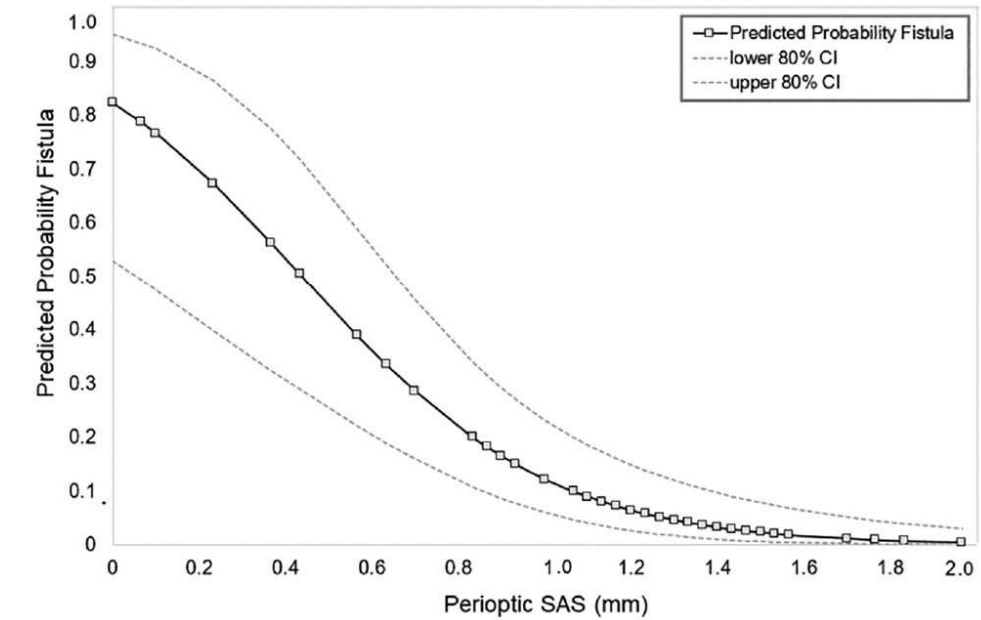
3.6
4.1
4.6
5.1
5.6
6.1
ONSD (mm)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0.6
0.5
0.4
0.3
0.2
0.1
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0.2
0.4
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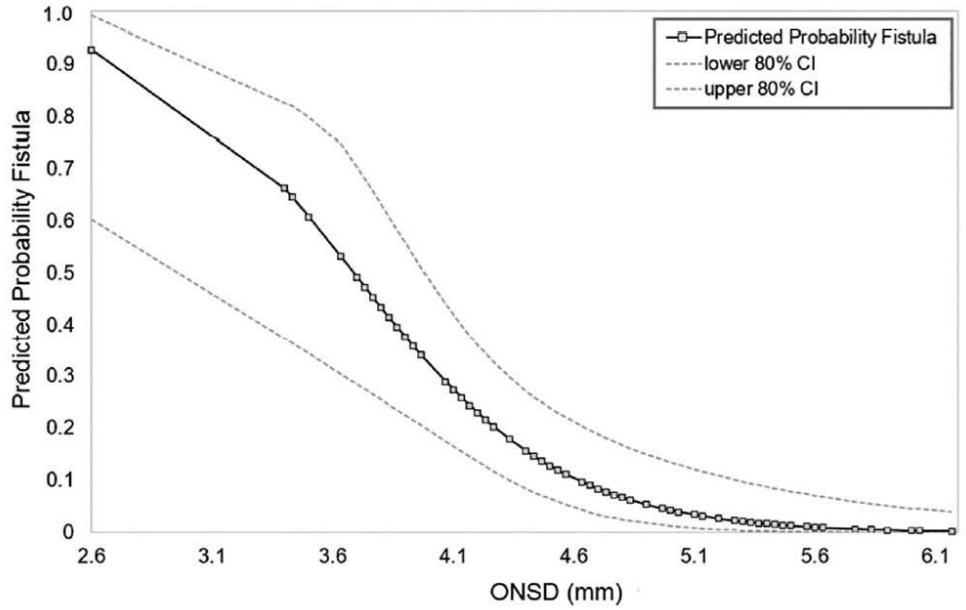
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Perioptic SAS (mm)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lower 80% CI
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Predicted Probability Fistula
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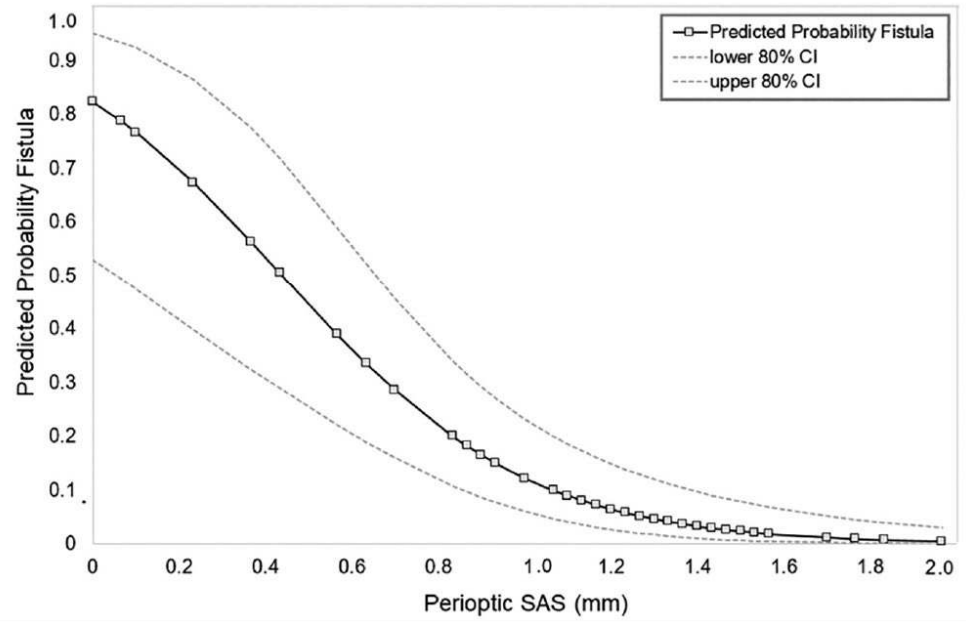
6.1
ONSD (mm)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lower 80% CI
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1.0
0.9
0.8
0.7
0.6
0.5
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0.2
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0
0
0.2
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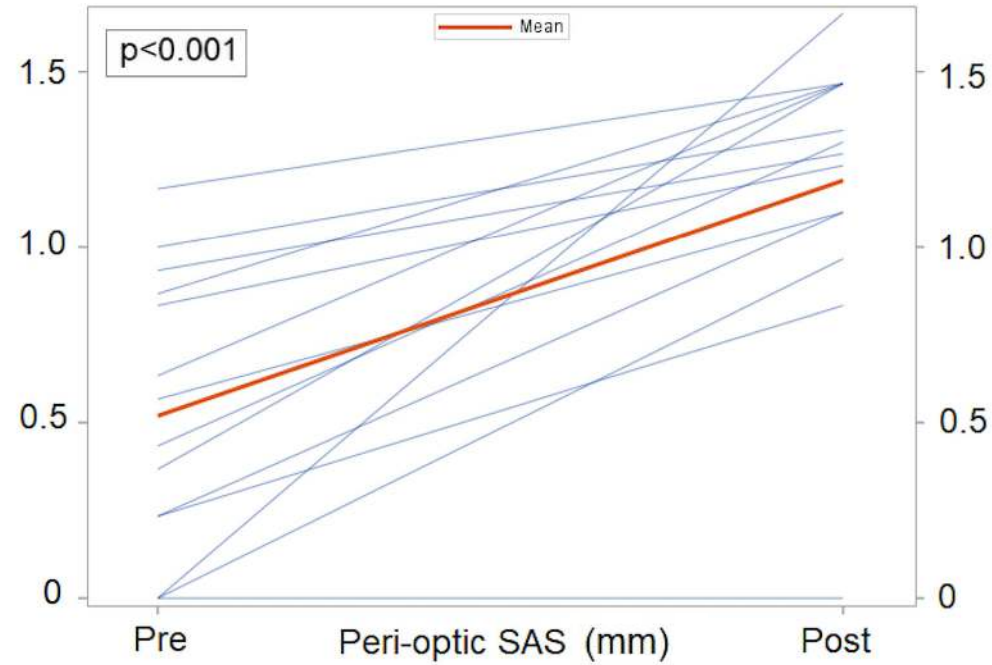
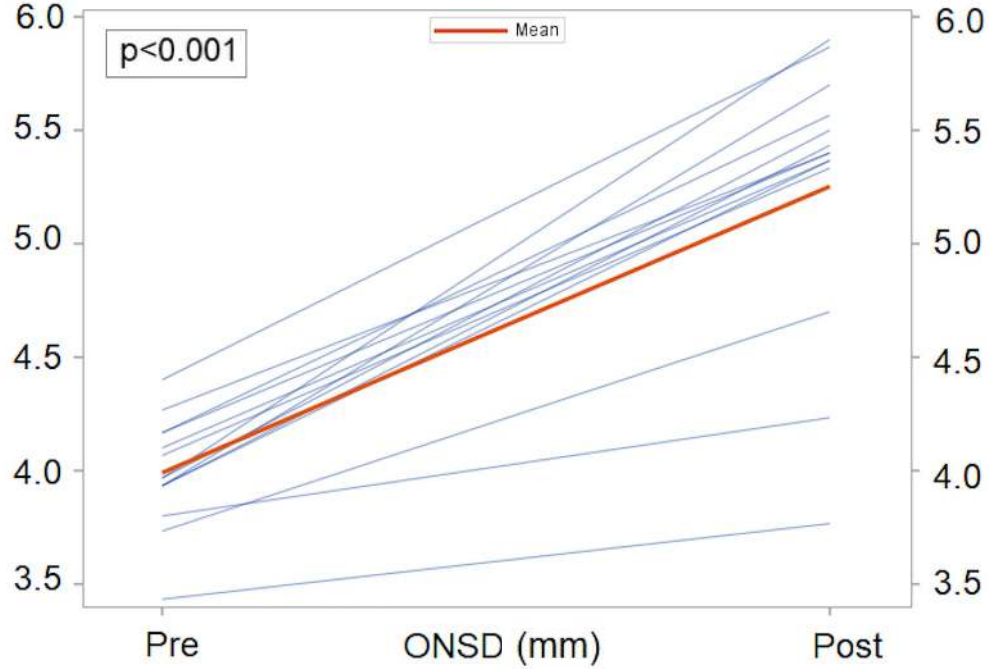
0.6
0.8
1.0
1.2
1.4
1.6
1.8
2.0
Perioptic SAS (mm)

80% CI!


Mean
p<0.001
1.5
1.0
0.5
0
Pre
Peri-optic SAS (mm)
Post


Mean
p<0.001
6.0
5.5
5.0
4.5
4.0
3.5
Pre
ONSD (mm)
Post

Other predictors of finding a CSF-venous fistula in patients with SIH type symptomatology but normal imaging

1) “A good story for a leak”

Headache, *N* (%)				0.180
Occipital/suboccipital	32 (53.3)	3 (50.0)	29 (53.7)	
Frontal	14 (23.3)	3 (50.0)	11 (20.4)	
Other	14 (23.3)	0 (0)	14 (25.9)	
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>60	9 (15.0)	0 (0)	9 (16.6)	

2) Response to epidural blood patching

Positive effect of EBP				0.581
Yes	49 (81.7)	6 (100.0)	43 (79.6)	
No	11 (18.3)	0 (0)	11 (20.4)	

Orthostatic headaches but normal brain and spine imaging – Is clinical evaluation important?

Referring neurologist batting average (minimum 3 plate appearances):

BA:
.800
.429
.250
.222
.125
.125
.059
.000
.000
.000

Orthostatic headaches but normal brain and spine imaging – Is clinical evaluation important?

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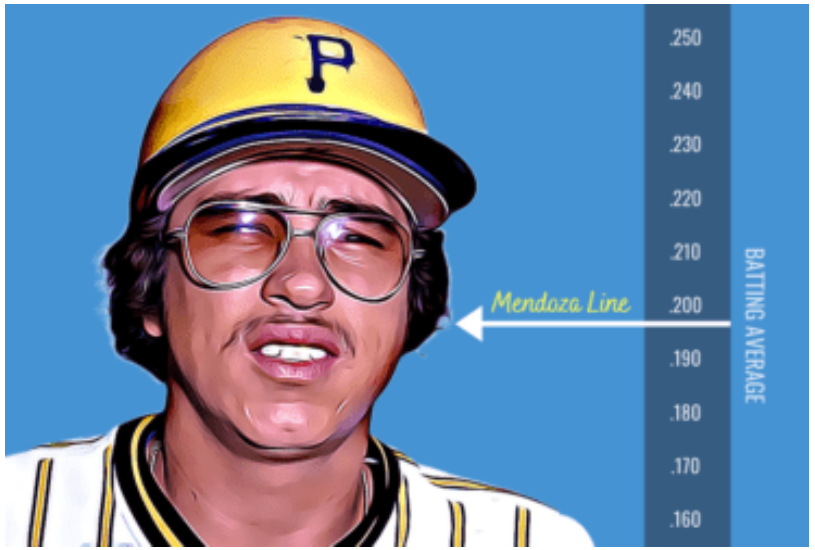

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.059
.000
.000
.000

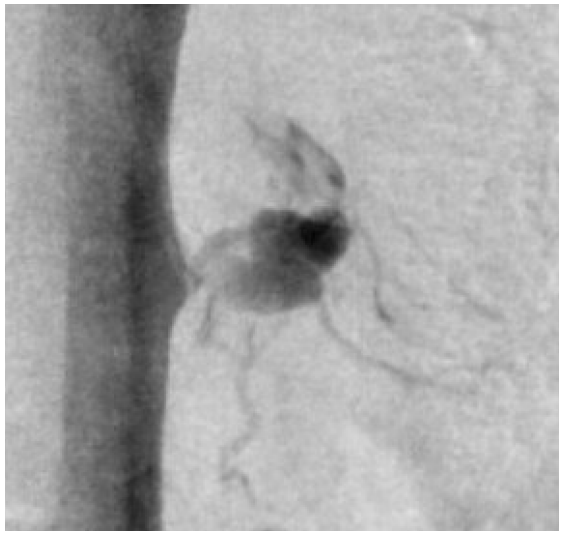
Orthostatic headaches but normal brain and spine imaging – Is response to patching important?

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]

Brain negative:
CSF-venous fistulas in 6/60 patients (10%)

DSM



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

Brain negative:
CSF-venous fistulas in 0/74 patients (0%)

Dynamic CT-myelography

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

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Is DSM superior to dynamic CT-myelography?

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

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Brain negative
CSF-venous fistulas in 0/74 patients (0%)

Is DSM superior to dynamic CT-myelography? → No!

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]

Brain positive
CSF-venous fistulas in 17/23 patients (74%)

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

Brain positive
CSF-venous fistulas in 49/67 patients (73%)

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]

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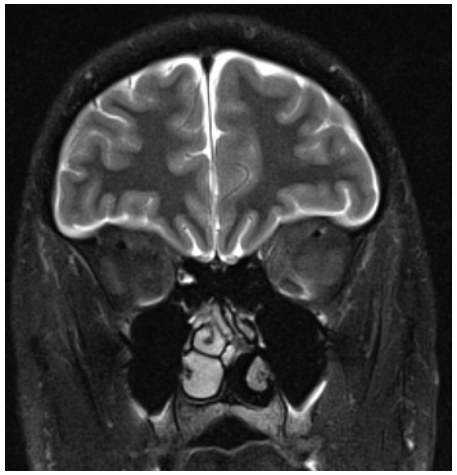
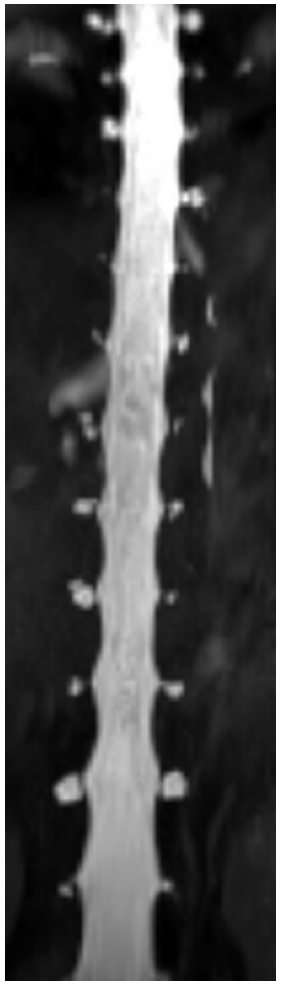
Jacob T. Gibby, Timothy J. Amrhein, Derek S. Young, Jessica L. Houk, and Peter G. Kranz

Brain negative
CSF-venous fistulas in 0/74 patients (0%)

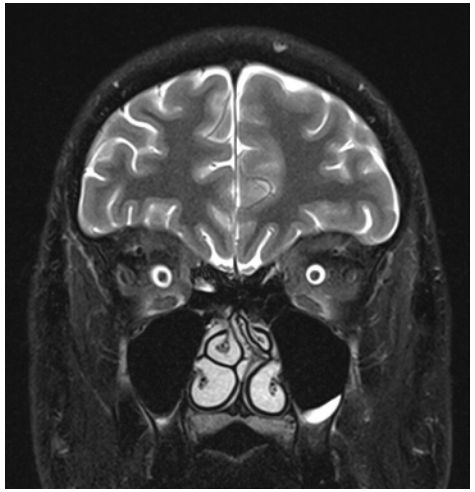
Is DSM superior to dynamic CT-myelography? → No!; response to epidural blood patching?

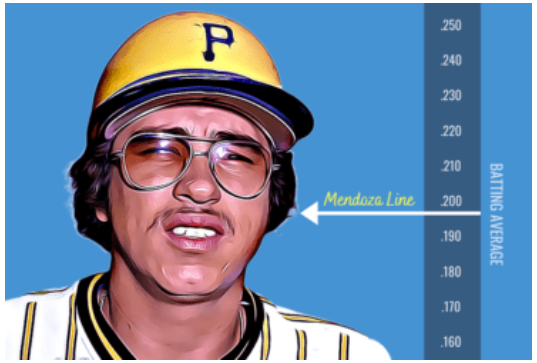
All patients were initially treated with epidural blood patching

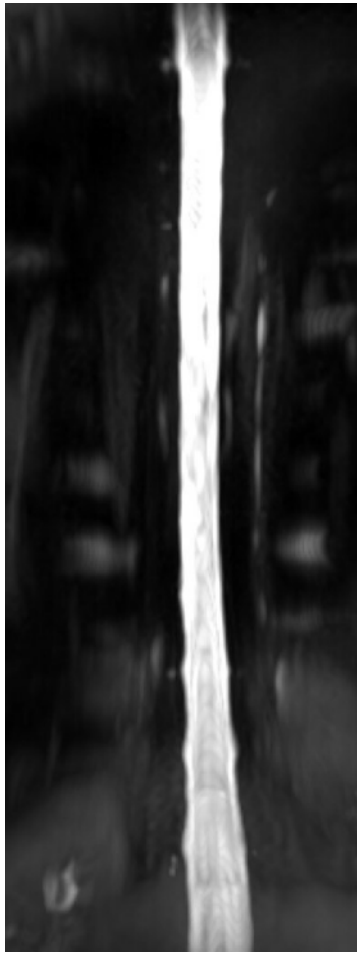




YIELD > 50%







YIELD < 5%

The imaging negative patient: what to do

The imaging negative patient: what to do

- Rely on clinical acumen or radiology?
- ICHDII to ICHDIII = clinical features to radiologic findings
- Some radiologic clues in ”imaging negative” patients
- Reasonable to offer blood patch to imaging negative patients with a “good story” but risk is not negligible

Thank you

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