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ORIGINAL RESEARCH

Evaluation of Spontaneous Intracranial Hypotension Probabilistic Brain MRI Scoring Systems in Normal Patients

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ABSTRACT

BACKGROUND AND PURPOSE: Probabilistic brain MRI scoring systems have been introduced to stratify the likelihood of identifying a CSF leak at myelography in spontaneous intracranial hypotension (SIH). The Bern scoring system by Dobrocky et al. is now well recognized, with a scoring system by Benson et al. introduced more recently (referred to as the "Mayo" score in this study). Neither of these scoring systems have been thoroughly evaluated in patients without SIH. The goal of this study was to evaluate these scoring systems in patients without SIH to understand the specificity of these MRI findings.

MATERIALS AND METHODS: We retrospectively reviewed normal brain MRIs performed in patients without clinically suspected SIH. Each examination was reviewed by one of four board-certified neuroradiologists with extensive experience in SIH, and all criteria of both scoring systems were evaluated and recorded.

RESULTS: 90 patients were included. Bern score was low probability in 78% and intermediate probability in 22%. Mayo score was low probability in 100%. Relatively high rates of positivity were seen in three specific Bern score parameters, including prepontine cistern effacement 5.0 mm or less (53%), decreased mammilopontine distance 6.5 mm or less (40%), and suprasellar cistern effacement 4.0 mm or less (28%). All intermediate probability Bern scores were due to suprasellar cistern effacement plus either or both prepontine cistern effacement and decreased mammilopontine distance. All other parameters of both scoring systems were either never or very rarely positive.

CONCLUSIONS: All intermediate probability Bern scores were due to decreased CSF cistern measurements, which had relatively high positivity rates in our non-SIH patient cohort. Due to substantial overlap with normals, these measurements are not specific indicators of "brain sag", a hallmark imaging finding for SIH, and are not specific for SIH when the only "positive" brain MRI finding(s). The Mayo score is likely more specific for SIH with low probability scores in all patients in our cohort.

ABBREVIATIONS: SIH, spontaneous intracranial hypotension; DSM, digital subtraction myelography; CTM, CT myelography; PC-CTM, photon counting CT myelography; CVF, CSF-venous fistula; ICC, intraclass correlation coefficient.

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SUMMARY SECTION

PREVIOUS LITERATURE: The Bern score is a previously described brain MRI scoring system used to determine the probability of localizing a spontaneous spinal CSF leak on advanced myelography in a patient with suspected SIH. Subsequently, an additional similar scoring system, the Mayo score, was also described. No prior studies have thoroughly assessed these scoring systems in normal patients without suspected SIH.

KEY FINDINGS: Bern and Mayo scores were assessed in non-SIH patients. All patients were low probability for spinal CSF leak with the Mayo score. 22% of patients were intermediate probability with the Bern score with the remainder low probability. Intermediate probability Bern scores were all due to decreased CSF cistern measurements.

KNOWLEDGE ADVANCEMENT: Subtle decreases in CSF cistern measurements are common in non-SIH patients and should not be the sole justification for advanced myelography in patients with equivocal clinical presentation for SIH. SIH diagnosis can be challenging, and this provides another piece of information to help determine which patients should undergo advanced myelography.

INTRODUCTION

Spontaneous intracranial hypotension (SIH) is a potentially debilitating condition caused by a spinal CSF leak, classically presenting with orthostatic headache. Historically, SIH has been underdiagnosed, with an estimated annual incidence of five in 100,000.1, 2 Despite increased recognition of the condition in recent years, the diagnosis of SIH can be challenging, particularly in cases without classic clinical presentation and brain MRI findings. Currently, brain MRI is the first step in the diagnostic workup in patients with clinically suspected SIH. Stigmata of SIH on brain MRI include diffuse smooth pachymeningeal enhancement, engorgement of the dural venous sinuses, subdural fluid collections, and "brain sagging" with effacement of CSF spaces. Patients with these typical stigmata present on brain MRI are more likely to have a CSF leak localized on advanced myelography, such as digital subtraction myelography (DSM), decubitus CT

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myelography (CTM), and photon counting CT myelography (PC-CTM).3-6 These myelographic techniques are tailored to specifically assess for ventral or posterolateral dural tears (type 1 CSF leaks) and CSF-venous fistulas (CVFs) (type 3 CSF leaks).7, 8

Probabilistic scoring systems based on brain MRI findings have been developed and shown to predict the likelihood of finding a spinal CSF leak on advanced myelography in patients with suspected SIH. The first of these was proposed by Dobrocky et al., often referred to as the "Bern" score.[9] The Bern score assessed patients with dural tears.[7] This score has also been used to stratify the probability of findings CVFs on decubitus myelography.[6, 10, 11] A subsequent scoring system, proposed by Benson et al. (here referred to as the "Mayo" score), has more specifically assessed patients with CVFs.[12] It is important to note that these probabilistic scoring systems were not developed nor have been validated to establish the diagnosis of SIH. Nevertheless, we have noticed that subtle changes in parameters of these scoring systems, particularly slight decreases in CSF cistern measurements such as the prepontine and suprasellar cisterns and mammilopontine distance, are not uncommonly used as supporting evidence to justify pursuit of advanced myelography to look for a CSF leak in patients with equivocal clinical presentations for SIH. It is unknown whether some of these MRI findings, particularly slight decreases in CSF cistern measurements, are indicative of SIH or whether they are normal findings in patients without SIH. Proceeding to advanced myelography has associated risks, including the invasive nature of the procedure, the time and cost commitment for the patient, and radiation exposure, and it is therefore desirable to limit this workup to the patients who are most likely to benefit from it.

At this time, thorough assessment of probabilistic scoring systems in patients without SIH has not been reported. In the case-control study that developed the Bern Score, 56 out of 60 control patients without SIH were correctly categorized in the low probability group, but exact Bern scores for these patients were not reported. The retrospective study that developed the Mayo score did not evaluate patients without SIH. In this study, we sought to evaluate both probabilistic scoring systems in patients without SIH to better understand the specificity of these brain MRI findings for SIH.

MATERIALS AND METHODS

Methodology outlined in the STROBE checklist was followed in this study.

Patient Selection

Following institutional review board approval, a retrospective database search was performed to identify all brain MR examinations performed on adult patients (18 years and older) who had provided research authorization and whose MR was performed with a specific epilepsy protocol including post-gadolinium imaging at our institution from February 2023 through mid-June 2023. This time range was chosen to yield approximately 100 patients for study inclusion. Epilepsy protocol examinations for patients with suspected or known seizure disorder were chosen as they are one of the only clinical protocols at our institution aside from our SIH protocol that includes post-gadolinium 3D gradient echo T1-weighted imaging, specifically MPRAGE imaging, which was used for multiple measurements in previous scoring systems.[9] Gadolinium dosage was a standard 0.1 mmol/kg of Gadavist (Bayer HealthCare, Leverkusen, Germany). MR examinations performed without gadolinium and those not performed on a 1.5 or 3.0 Tesla magnet were excluded.

Electronic Medical Record Review

Patient demographics including sex and age at time of brain MR were recorded. Brain MR reports and electronic medical records were reviewed to determine if the patient had previously had any craniospinal surgery. If so, these patients were excluded. Brain MR reports were reviewed to determine if there was any abnormality present (for example mass/space-occupying lesion, major malformation of cortical development, or prominent areas of encephalomalacia/volume loss) that may impact Bern and/or Mayo scoring system evaluation. If so, the reason was documented, and the patient was excluded. Electronic medical record review was performed to evaluate for history of orthostatic headache/suspected SIH at the time of the brain MR and history of lumbar puncture within one month preceding the brain MR. Patients who had history of orthostatic headache/suspected SIH or lumbar puncture within one month preceding the brain MR were excluded.

Imaging Review

Each brain MR was reviewed by one of four board-certified neuroradiologists with extensive experience in SIH and 2-8 years of post-fellowship clinical practice. Brain MRs were reviewed and measurements made on our institutional PACS, Visage Client 7.1.19 (Protocol Version 5.20.0.17). All criteria of the Bern and Mayo scores were evaluated on each MR. These criteria were assessed in the same manner as described in each of these respective studies. All measurements were made to the nearest 0.1 mm. To briefly review, the Bern score includes six criteria divided into 3 major and 3 minor criteria. The major criteria (assigned 2 points each if present and 0 if absent) include: pachymeningeal enhancement, suprasellar cistern effacement of 4.0 mm or less, and venous sinus engorgement. The minor criteria (assigned 1 point each if present and 0 if absent) include: subdural fluid collection, prepontine cistern effacement of 5.0 mm or less, and mamillopontine distance of 6.5 mm or less. The Mayo score includes seven criteria (each assigned 1 point if present and 0 if absent): smooth dural enhancement, dural enhancement in the internal auditory canals, pituitary engorgement, non-Chiari cerebellar tonsillar descent of more than 5 mm, venous sinus engorgement, iter below the incisural line, and suprasellar cistern effacement of 2.5 mm or less.

Approximately six months after initial review, each of the four reviewers re-measured the prepontine cistern, mamillopontine distance, and suprasellar cistern on 20 brain MR examinations from the original study population to evaluate both intra- and interobserver variability in these measurements. These 20 MR examinations for each reviewer consisted of 10 of the reviewer's originally reviewed cases to assess for intraobserver variability and 10 randomly selected additional cases that each reviewer assessed to evaluate for interobserver variability.

Statistical Analysis

Statistical analyses were performed with JMP (version 14; SAS Institute) and Microsoft Excel (version 2021, Microsoft Corporation). Bern and Mayo scores were calculated for each brain MR. Average Bern and Mayo scores and total number and percentage of patients with Bern score of 0 and Mayo score of 0 were also calculated. Total number and percentage of patients with low (0-2 points), intermediate (3-4 points), and high (5-9 points) probability Bern score and low (0-2 points) and intermediate to high (3-7 points) probability Mayo score were recorded. Analysis of each individual criterion of both scoring systems was performed, with total number and percentage of patients positive for each dichotomous variable reported. For each numerical measurement (suprasellar cistern, prepontine cistern, and mamillopontine distance), mean and standard deviation were calculated.

Intra- and interobserver variability were calculated and reported as the intraclass correlation coefficient (ICC) and Cohen's kappa statistic, respectively.[15]

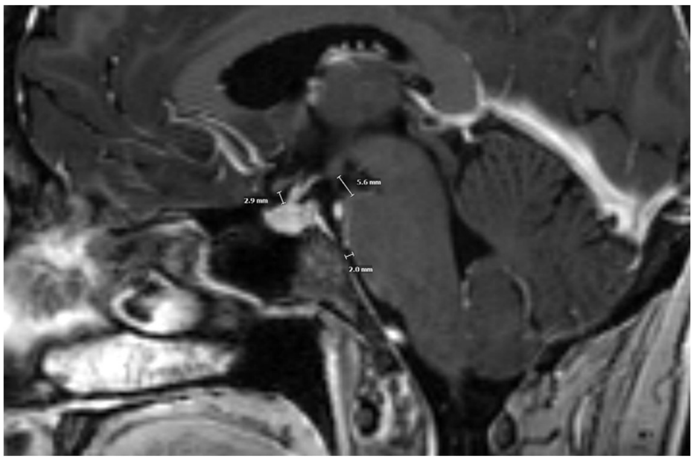

FIG 1. Midline sagittal T1 post-gadolinium MPRAGE MR image from a patient without SIH demonstrates an intermediate probability Bern score of 4 due to decreased mamillopontine distance, prepontine cistern effacement, and suprasellar cistern effacement.

RESULTS

The database search yielded 129 brain MR examinations. Three patients were excluded due to lack of post-gadolinium imaging and 6 were excluded as imaging was performed on a 7.0 Tesla magnet. Of the remaining 120 patients, 17 were excluded due to prior intracranial surgery, 12 due to brain MR abnormalities that could impact Bern and/or Mayo SIH scoring system evaluation (examples include marked diffuse volume loss, extensive areas of prior post-traumatic and post-ischemic encephalomalacia, sellar abnormalities such as Rathke cleft cyst and empty sella, large encephalocele, normal pressure hydrocephalus, post-traumatic subdural hematoma, and a patient with idiopathic intracranial hypertension), 1 due to lumbar puncture within one month preceding the brain MR, and 0 due to history of orthostatic headache/suspected SIH. Following these exclusions, a total of 90 brain MR examinations were included in the review.

Of the 90 included patients, 41 (46%) were female. Average age was 45.9 years (range 18-87 years).

Bern and Mayo scores are summarized in **Table 1**. The average Bern score was 1.5, and the average Mayo score was 0.0. The Bern score was 0 in 26/90 (29%) patients, and the Mayo score was 0 in 86/90 (96%) patients. Bern scores were low probability in 70/90 (78%) patients, intermediate probability in 20/90 (22%), and high probability in 0/90 (0%). Mayo scores were low probability in 90/90 patients (100%) and intermediate to high probability in 0/90 (0%).

The rate of positivity of each individual criterion of the Bern and Mayo scores is summarized in **Table 2**. Relatively high rates of positivity were demonstrated for the following Bern score criteria: prepontine cistern effacement of 5.0 mm or less (48/90 (53%) patients), mamillopontine distance of 6.5 mm or less (36/90 (40%) patients), and suprasellar cistern effacement of 4.0 mm or less (25/90 (28%) patients). Otherwise, positivity rates of the remaining Bern and Mayo score criteria were exceedingly low (0-2% of patients). Numerical measurements included: mean prepontine cistern 5.2 mm (standard deviation 1.6 mm), mean mamillopontine distance 7.0 mm (standard deviation 1.4 mm), and mean suprasellar cistern 5.4 mm (standard deviation 1.8 mm). All intermediate probability Bern scores (3-4) were due to suprasellar cistern effacement plus prepontine cistern effacement and/or decreased mamillopontine distance (**Figure 1**). **Table 3** summarizes CSF cistern measurements in the current study, Bern study control and SIH patients, and Mayo study SIH patients.

Intraobserver variability in CSF cistern measurements is summarized in **Table 4.** Across all reviewers, the average difference in measurements was 0.63 mm for prepontine cistern, 0.57 mm for mamillopontine distance, and 0.41 mm for suprasellar cistern. Bias-adjusted intraclass correlation coefficients suggested excellent intra-reader reliability for measurement of mammilopontine distance (ICC

= 0.81, < 0.01 bias impact) and prepontine cistern (ICC = 0.86, 0.04 bias impact), and good intra-reader reliability for measurement of suprasellar cistern (ICC = 0.72, 0.21 bias impact). Of the 40 total cases reviewed, differences in measurements would have resulted in changes in the calculated Bern score in 12/40 (30%) of patients but change in the Bern probability in only 2/40 (5%) of patients, one from low to intermediate and the other from intermediate to low probability, and therefore no overall change in the number of intermediate probability Bern scores. There were no changes that would have resulted to the Mayo score due to differences in measurements.

For interobserver variability, the average difference between the maximal and minimal measurements of the 4 reviewers for 10 cases was 0.87 mm for prepontine cistern, 0.91 mm for mamillopontine distance, and 1.56 mm for suprasellar cistern. Inter-reader reliability was excellent for all measurements (mammilopontine distance: Cohen's kappa statistic (range of values between reviewers) = 0.82-0.90, prepontine cistern: Cohen's kappa statistic (range of values between reviewers) = 0.94-0.98, and suprasellar cistern: Cohen's kappa statistic (range of values between reviewers) = 0.87-0.94). Using the average measurement of the 4 reviewers as compared to the initial single reviewer measurement would have resulted in changes in the calculated Bern score in 6/10 (60%) of patients but change in the Bern probability in only 2/10 (20%) of patients, one from low to intermediate and the other from intermediate to low probability, and therefore no overall change in the number of intermediate probability Bern scores. There were no changes that would have resulted to the Mayo score due to differences in measurements.

DISCUSSION

Our study demonstrated that three of the Bern score parameters, specifically suprasellar cistern effacement, decreased mamillopontine distance and prepontine cistern effacement, were frequently positive in patients who have no clinical evidence of SIH. Given the absence of orthostatic headache, none of the patients in this study met International Classification of Headache Disorders criteria for SIH.[13] Furthermore, when comparing the cohort of patients with SIH in the studies by Dobrocky et al. and Benson et al. with the cohort of patients without SIH in our study, there was only 1-2 mm difference in the mean CSF cistern measurements (**Table 3**). These findings suggest that there is likely a wide range of normal CSF cistern measurements and subtle "decreases" in these measurements are not specific to SIH.

In our cohort of patients without SIH, the Mayo scoring system had no false positive scores as defined by intermediate to high probability. In comparison, the Bern scoring system characterized 22% of our normal patients as intermediate probability, which was always due to decreased CSF cistern measurements. As the remaining parameters of both scoring systems were rarely or never positive, the differences in the specificity are likely due to differences in the parameters used as surrogate markers for "brain sagging". Overall, the Mayo scoring system utilizes more qualitative measures for "brain sagging" and is less reliant on accurate measurements of minute distances. For example, compared to the relative high positivity rates of decreased CSF cistern measurements in the Bern scoring system, only two patients had positioning of the iter below the incisural line. Additionally, 28% of our patients had suprasellar cistern measurements of 4 mm or less, a Bern score parameter, but none measured less than 2.5 mm, a Mayo score parameter. Findings suggest decreased CSF cistern measurements can indicate "brain sagging", though caution should be taken when using a specific cutoff value to determine presence or absence of "brain sagging", particularly in isolation of other SIH imaging findings and when accounting for margin of error in minute measurements. Instead, it may be preferable to use a more subjective assessment of "brain sagging" determined based on a constellation of findings and neuroradiologist experience.

In patients with spontaneous extradural CSF collections on spine imaging, it is generally reasonable to pursue advanced myelography even in the setting of a normal brain MR, because the presence of a CSF leak can be inferred from noninvasive spine imaging. Contrarily, in patients without extradural CSF on spine imaging, especially those with equivocal clinical presentations for SIH, brain MR findings are more important in helping to decide whether advanced myelography is warranted. Both the Bern score and Mayo score have demonstrated value in predicting the probability of localizing a CVF in patients without extradural CSF on spine imaging. However, in patients with a low probability (0-2) Bern score, the yield of decubitus myelography for localizing a CVF is quite variable in the literature.[6, 10, 14] Some of this variability is likely attributable to differences in the type of myelography performed in these studies (DSM, CTM, and PC-CTM); these myelographic modalities may inherently have different diagnostic yields. However, this variability may also suggest that a near-normal brain MRI is not necessarily helpful to exclude the presence of a CVF in patients with a clinical diagnosis of SIH. Indeed, the authors have anecdotally found other features, such as the presence of meningeal diverticula on spine imaging or relatively recent onset of orthostatic headaches, to be more predictive than subtle brain MRI measurements. Thus, the application of brain MRI scoring systems to quantify "brain sagging" as a surrogate for an SIH diagnosis could potentially lead to both overdiagnosis in patients without SIH, as well as underdiagnosis in patients with SIH.

The Bern scoring system remains an excellent tool in the diagnostic workup of patients with clinically suspected SIH and has been shown to predict the presence of a CSF leak. The original case-control study by Dobrocky et al. showed higher specificity with 93% low probability scores in their control group compared to 78% in the current study. However, since exact Bern scores and associated positive parameters in the control group were not reported, it is difficult to compare results. Our study suggests there is likely variability of specificity of Bern score based on which parameters are positive. For example, a CSF leak is probably more likely to be found in a patient with equivocal clinical presentation for SIH when brain MR demonstrates venous sinus engorgement and pachymeningeal enhancement (Bern score = 4) compared to the same score due to decreased suprasellar cistern, prepontine cistern, and mamillopontine distances, which may be seen in a normal patient. Future studies comparing these two subsets of parameters in their ability to predict CSF leaks on advanced myelography, particularly in patients without extradural CSF who are suspected to have CVFs, would be helpful to validate our results.

Finally, it is important to emphasize that these MRI based probabilistic scoring systems were not developed nor have been validated to establish the diagnosis of SIH. Therefore, there must be clinical suspicion or findings supportive of SIH before these scores are applicable. Furthermore, a low probability score or normal brain MRI exam does not exclude the possibility of a CSF leak in a patient with clinically suspected SIH. The yield of advanced myelography in patients with a normal brain MRI varies in the literature widely.[6, 10, 14]

Our study has limitations. First, the conclusions are based on a retrospective review at a single institution. In addition, reviewers were not blinded to the study, which could have potentially biased score assignments. Furthermore, each study was only reviewed by a single neuroradiologist, so there is potential for minor measurement errors/variations, although assessment of intra- and interobserver variability suggested excellent reliability and consistency in the measurements collected by each reviewer and a high degree of agreement in these measurements between reviewers. Despite risks of slight measurement variations within and between reviewers, it did not result in substantial changes to Bern probability assignments in the cases we analyzed.

1: Summary of Bern and Mayo scores

	Bern Score	**Mayo Score**
Total Score	Number of patients (%)	Number of patients (%)
0	26 (29%)	86 (96%)
1	25 (28%)	4 (4%)
2	19 (21%)	0 (0%)
3	9 (10%)	0 (0%)
4	11 (12%)	0 (0%)
5 or above	0 (0%)	0 (0%)

Table 2: Rates of positivity of Bern and Mayo score criteria

	Positivity Rate
Bern Score Criteria	Number of patients (%)
Pachymeningeal enhancement	0 (0%)
Suprasellar cistern effacement of 4.0 mm or less	25 (28%)
Venous sinus engorgement	0 (0%)
Subdural fluid collection	0 (0%)
Prepontine cistern effacement of 5.0 mm or less	48 (53%)
Mamillopontine distance of 6.5 mm or less	36 (40%)
Mayo Score Criteria	
Smooth dural enhancement	0 (0%)
Dural enhancement in the internal auditory canals	0 (0%)
Pituitary engorgement	2 (2%)
Non-Chiari cerebellar tonsillar descent of more than 5 mm	0 (0%)
Venous sinus engorgement	0 (0%)
Iter below the incisural line	2 (2%)
Suprasellar cistern effacement of 2.5 mm or less	0 (0%)

Table 3: Mean (SD) CSF cistern measurements

	Current study	Bern Control Patients	Bern SIH Patients	Mayo SIH Patients
Prepontine cistern distance	5.2 mm (1.6)	6.1 mm (1.5)	4.1 mm (1.5)	4.1 mm (1.5)
Mamillopontine distance	7.0 mm (1.4)	7.5 mm (1.1)	5.7 mm (1.7)	5.6 mm (1.9)
Suprasellar cistern distance	5.4 mm (1.8)	6.5 mm (1.9)	3.1 mm (1.9)	3.9 mm (2.5)

Table 4: Intraobserver variability – Average Differences in Measurements for each Reviewer

	Reviewer 1	Reviewer 2	Reviewer 3	Reviewer 4
Prepontine cistern distance	0.71 mm	0.69 mm	0.68 mm	0.44 mm
Mamillopontine distance	0.64 mm	0.77 mm	0.60 mm	0.26 mm
Suprasellar cistern distance	0.39 mm	0.75 mm	0.30 mm	0.19 mm

CONCLUSIONS

Brain MRI-based probabilistic scoring systems are valuable tools in the diagnostic workup of patients with clinically suspected SIH. However, certain parameters of these systems, specifically subtle decreases in CSF cistern measurements, are common in normal patients and should not be used in isolation to justify advanced myelography in patients with equivocal clinical presentation for SIH. We encourage a comprehensive evaluation of the full clinical picture prior to proceeding to advanced myelography, using brain MRI scoring systems as one of several important factors.

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REFERENCES

1. Pradeep A, Madhavan AA, Brinjikji W, et al. Incidence of spontaneous intracranial hypotension in Olmsted County, Minnesota: 2019-2021. *Interv Neuroradiol* 2023:15910199231165429
2. Schievink WI, Maya MM, Moser FG, et al. Incidence of spontaneous intracranial hypotension in a community: Beverly Hills, California, 2006-2020. *Cephalalgia* 2022;42:312-316
3. Schievink WI, Maya MM, Moser FG, et al. Lateral decubitus digital subtraction myelography to identify spinal CSF-venous fistulas in spontaneous intracranial hypotension. *J Neurosurg Spine* 2019:1-4
4. Madhavan AA, Cutsforth-Gregory JK, Benson JC, et al. Conebeam CT as an Adjunct to Digital Subtraction Myelography for Detection of CSF-Venous Fistulas. *AJNR Am J Neuroradiol* 2023;44:347-350
5. Madhavan AA, Yu L, Brinjikji W, et al. Utility of Photon-Counting Detector CT Myelography for the Detection of CSF-Venous Fistulas. *AJNR Am J Neuroradiol* 2023;44:740-744
6. Madhavan AA, Cutsforth-Gregory JK, Brinjikji W, et al. Diagnostic Performance of Decubitus Photon-Counting Detector CT Myelography for the Detection of CSF-Venous Fistulas. *AJNR Am J Neuroradiol* 2023;44:1445-1450
7. Schievink WI, Maya MM, Jean-Pierre S, et al. A classification system of spontaneous spinal CSF leaks. *Neurology* 2016;87:673-679
8. Madhavan AA, Farb RI, Brinjikji W, et al. Expounding on the Distinction between Lateral Dural Tears and Leaking Meningeal Diverticula in Spontaneous Intracranial Hypotension. *AJNR Am J Neuroradiol* 2024
9. Dobrocky T, Grunder L, Breiding PS, et al. Assessing Spinal Cerebrospinal Fluid Leaks in Spontaneous Intracranial Hypotension With a Scoring System Based on Brain Magnetic Resonance Imaging Findings. *JAMA Neurol* 2019;76:580-587
10. Huynh TJ, Parizadeh D, Ahmed AK, et al. Lateral Decubitus Dynamic CT Myelography with Real-Time Bolus Tracking (dCTM-BT) for Evaluation of CSF-Venous Fistulas: Diagnostic Yield Stratified by Brain Imaging Findings. *AJNR Am J Neuroradiol* 2023;45:105-112
11. Kim DK, Carr CM, Benson JC, et al. Diagnostic Yield of Lateral Decubitus Digital Subtraction Myelogram Stratified by Brain MRI Findings. *Neurology* 2021;96:e1312-e1318
12. Benson JC, Madhavan AA, Mark IT, et al. Likelihood of Discovering a CSF Leak Based on Intracranial MRI Findings in Patients without a Spinal Longitudinal Extradural Collection: A New Probabilistic Scoring System. *AJNR Am J Neuroradiol* 2023;44:1339-1344
13. Headache Classification Committee of the International Headache Society (IHS) The International Classification of Headache Disorders, 3rd edition. *Cephalalgia* 2018;38:1-211
14. 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
15. Ranganathan P, Pramesh CS, Aggarwal R. Common pitfalls in statistical analysis: Measures of agreement. *Perspect Clin Res*. 2017;Oct-Dec;8(4):187-191

SUPPLEMENTAL FILES

None.