Original research

Endovascular shunt feasibility in shunt responsive idiopathic intracranial hypertension: morphometric radiographic analysis

Andrew B Koo ,[1] Kshiraj V Talati,[2] Dhruv Vajipayajula ,[3] Abraham Castaneda,[1] Abdelaziz Amllay ,[1] Nanthiya Sujijantarat ,[1] Claudia Kirsch,[4] Ajay Malhotra ,[4] Ryan Hebert,[1] Guido J Falcone,[5] Kevin N Sheth,[5] Adam de Havenon ,[5] Peter Kan ,[6] Carl B Heilman,[2] Adel M Malek,[2] Charles Matouk [1]

[1]Department of Neurosurgery, Yale School of Medicine, New Haven, Connecticut, USA
[2]Department of Neurosurgery, Tufts Medical Center, Boston, Massachusetts, USA
[3]Neurosurgery, Tufts Medical Center, Boston, Massachusetts, USA
[4]Department of Radiology and Biomedical Imaging, Yale University School of Medicine, New Haven, Connecticut, USA
[5]Department of Neurology, Yale School of Medicine, New Haven, Connecticut, USA
[6]Neurosurgery, University of Texas Medical Branch at Galveston, Galveston, Texas, USA

Correspondence to
Dr Charles Matouk; charles.matouk@yale.edu

Received 6 December 2025
Accepted 20 January 2026

Check for updates

© Author(s) (or their employer(s)) 2026. No commercial re-use. See rights and permissions. Published by BMJ Group.

To cite: Koo AB, Talati KV, Vajipayajula D, *et al*. *J NeuroIntervent Surg* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/jnis-2025-024793

ABSTRACT

Background Patients with idiopathic intracranial hypertension (IIH) represent a unique population in whom mechanical shunting can be challenging. Endovascular cerebrospinal fluid shunting via the eShunt system has emerged as a potential alternative, but it is not currently approved for this indication, and its feasibility in IIH remains unknown.

Methods In this retrospective, single center study, radiographic images of consecutively treated patients with shunt responsive IIH were assessed. Radiographic parameters involving the inferior petrosal sinus (IPS) and cerebellopontine angle (CPA) cistern were measured. We also examined whether the presence of a ventricular shunt at the time of imaging influenced radiographic candidacy, given the plausibility of cisternal changes after shunting.

Results Of 53 patients (median age 41 years, 81.1% women), 24 (45.2%) were previously shunted before MRI imaging. The average CPA cisternal depth was 4.8±1.8 mm (right) and 4.9±2.1 mm (left); IPS size 3.5±0.7 mm (right) and 3.4±0.8 mm (left). The average off-axis angle trajectory from the IPS to the cistern was 128.6±9.8° (right) and 125.2±9.3° (left). In our final model, pre-existing ventricular shunt was not independently associated with endovascular shunting candidacy (OR 2.01, 95% CI 0.65 to 6.40; P=0.227). Overall, endovascular shunting was feasible in at least one side for 55% of patients, increasing to as high as 74% when assessment was based only on venous anatomy.

Conclusion In this study, a sizeable proportion of patients with IIH were radiographic candidates for endovascular shunting, regardless of the presence of a pre-existing supratentorial shunt.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Idiopathic intracranial hypertension (IIH), a debilitating condition marked by elevated intracranial pressure of unknown etiology, is often managed with mechanical shunts that pose significant challenges.

⇒ Whether endovascular cerebrospinal fluid (CSF) shunting is feasible in patients with IIH is unclear.

WHAT THIS STUDY ADDS

⇒ This study demonstrated that a sizeable proportion of patients with IIH were potential candidates for endovascular CSF shunting based on anatomical criteria, regardless of the presence of a pre-existing ventricular shunt.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE, OR POLICY

⇒ Endovascular shunting may offer an alternative treatment option for patients with difficult-to-manage IIH.

INTRODUCTION

Idiopathic intracranial hypertension (IIH) is an increasingly common condition characterized by elevated intracranial pressure (ICP) without identifiable cause, estimated to have more than tripled in the past 30 years in association with the rising prevalence of obesity.[1 2] For patients with IIH refractory to first line medical management, a common surgical intervention for relieving elevated ICP is ventricular and lumboperitoneal shunting.[3 4] Alternatively, patients with radiographic evidence of transverse venous sinus stenosis and an elevated trans-stenotic pressure gradient may be candidates for venous sinus stenting.[5 6] Although mechanical shunts can effectively lower ICP in IIH, the procedure is invasive and associated with a high rate of adverse events, including infections and mechanical failure.[4 7 8] In addition, this patient population often has small, slit-like ventricles and crowded cerebrospinal fluid (CSF) spaces, making catheter placement extremely challenging.[9] Despite these difficulties, no significant advancements in CSF diversion treatments have been made in recent decades, leaving surgical shunting as the standard approach.

Recently, endovascular CSF shunting via the eShunt system has emerged as a promising alternative for CSF diversion in communicating hydrocephalus.[10 11] The shunt is implanted transvenously at the cerebellopontine angle (CPA) via the adjacent inferior petrosal sinus (IPS) and is intended to replicate the natural physiology of arachnoid granulations.[12 13] Currently, the efficacy of endovascular

J NeuroIntervent Surg: first published as 10.1136/jnis-2025-024793 on 29 January 2026. Downloaded from http://jnis.bmj.com/ on March 6, 2026 at Tufts University Libraries. Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

shunting is being studied mainly in adults with normal pressure hydrocephalus, but early feasibility studies also suggest it may benefit broader patient populations.[14] Despite a growing body of literature on this novel endovascular approach, the feasibility of endovascular shunt placement in the IIH population remains uncertain, given distinctive radiographic features, including effaced CSF spaces and slit-like ventricles. This study aimed to assess the anatomic candidacy of endovascular shunt placement in patients with IIH and whether pre-existing mechanical shunt placement influenced anatomic eligibility.

METHODS

Data source and patient population

We obtained institutional review board approval before this retrospective study (IRB 2000028154). We reviewed medical records and radiographic imaging of consecutively treated adult patients (aged ≥18 years) with IIH at Yale New Haven Hospital from 2018 to 2025. This included all patients with a definitive diagnosis of IIH with an opening pressure of >20 cm H2O, measured from a lumbar puncture (LP) and/or appropriate clinical findings with high resolution MRI available. Patients were excluded if they had previous cervical or intracranial vascular injury, posterior fossa tumors, cerebral venous sinus disease other than transverse sinus stenosis, or intracranial or extracranial arteriovenous shunting lesions, with exclusions made to prevent confounding measurements.

Demographic variables included age, sex, and race. Comorbidities included symptoms on presentation, smoking status, obesity, venous stenosis, pulsatile tinnitus, atrial fibrillation, coronary artery disease, hypertension, hyperlipidemia, diabetes mellitus, chronic kidney disease, liver disease, alcohol use disorder, and pre-existing venous stent. Current medications and initial symptoms at presentation were assessed, as was the presence of a ventricular shunt at the time of imaging because the resulting CSF pressure changes could alter the CPA cistern anatomy.[15] This study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines for retrospective cohort studies.

Radiographic assessment

As the eShunt system remains investigational, radiographic assessment was theoretical and no IIH patients in this study underwent implantation. IPS and the CPA cistern radiographic parameters were evaluated using high resolution (T1 weighted post-gadolinium thin cut 0.9–1.2 mm isovoxel MP-RAGE) MRI and CT scans. The radiographic review was performed by a neurosurgery fellow and attending (ABK and CM), followed by adjudication from a second independent neurosurgeon (AMM), by three-dimensional multiplanar reconstruction on a standardized picture archiving and communication system to perform both quantitative and qualitative assessments. Discrepancies were resolved by consensus.

Radiographic eligibility was defined by the ongoing Evaluation of the Safety and Effectiveness of the Cerevasc eShunt System in Normal Pressure Hydrocephalus (STRIDE) clinical trial criteria: adequate cisternal depth at the CPA (>5 mm), sufficient IPS diameter (≥2.25 mm), appropriate off-axis angle to facilitate the delivery catheter (100–140°), lack of petrous bone overhang obstructing dural penetration, and a clear trajectory free from arterial or nervous structures (>5 mm).[16] The CPA cisternal depth was calculated on the axial plane by measuring the linear distance from the dural entry point of the IPS to the surface of the brainstem. The IPS angle was calculated by measuring the angle between the vertical and horizontal segments of the IPS on the reformatted plane. Distances to the adjacent structures were measured by the orthogonal distance from the planned dural access point to the nearest nerve or major artery on multiplanar reconstruction. Qualitative measurements, such as the presence of bony coverage, were assessed on CT imaging by the presence of a petrous overhang that could impede access. All assessments were performed on both the left and right sides of each patient. Figure 1 shows a sample illustration of the measurements.

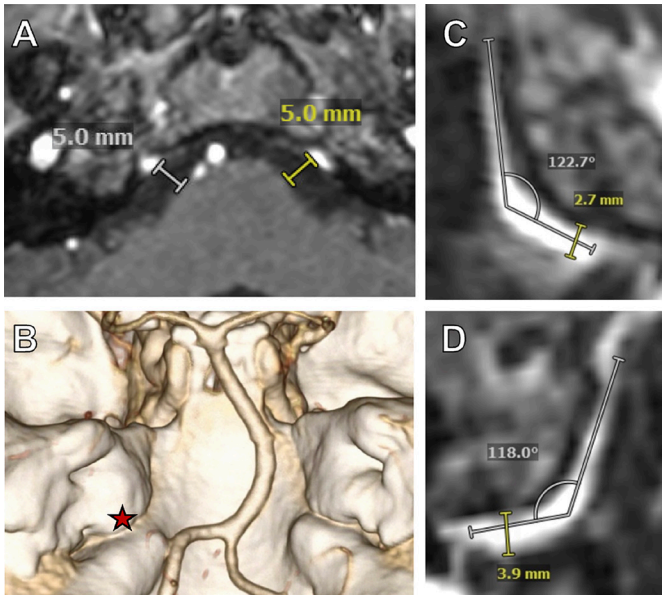


Figure 1 Morphometric analysis for endovascular shunt feasibility in a patient with idiopathic intracranial hypertension. (A) Cerebellopontine angle cisternal depth measured by the linear distance from dural entry point of the inferior petrosal sinus (IPS) to brainstem surface. (B) Petrous bone obstruction (red star) is assessed by CT reconstruction to visualize any overhang potentially impeding transdural access. (C, D) Oblique coronal multiplanar reconstruction oriented along the longest axis of the IPS at its junction with the jugular bulb shows IPS size. The IPS angle is measured on the same reformatted plane between the vertical take-off from the first horizontal segment of the IPS.

Statistical analysis

We used a complete case approach, which included individuals with available radiographic and clinical data in the dataset. Cohen's kappa coefficient (κ) was used to score inter-rater reliability. Patients were allocated to subgroups based on whether they had a pre-existing mechanical ventricular shunt at the time of MRI imaging. Normally distributed continuous data are reported as mean (SD) and compared with two sided independent t tests. Non-normally distributed continuous data are expressed as median (IQR) and compared with the Mann–Whitney U test. Nominal data are reported as frequency and percentages and compared with the χ^2 test.

To test the primary hypothesis, a multivariable logistic regression was fit with endovascular shunt eligibility as the dependent variable. Backward stepwise multivariable logistic regression analysis was used to select variables in the final model, using 0.1 as entry and stay criteria. Age, sex, obesity, venous stenosis, and papilledema were forced into the model based on the biologic plausibility for confounding, as these variables relate to elevated ICP, cerebral venous congestion, and theoretical recruitment of accessory collateral venous pathways which could influence

J NeuroIntervent Surg: first published as 10.1136/jnis-2025-024793 on 29 January 2026. Downloaded from http://jnis.bmj.com/ on March 6, 2026 at Tufts University Libraries. Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

cisternal depth and IPS size. For sensitivity analyses, we assessed whether the relationship of cisternal depth and age changed based on shunt status by fitting a single linear model and assessing the interaction term between age and shunt status. In addition, an evaluation of eligibility was made using a lenient CPA cisternal depth threshold of ≥4 mm, considering the anatomical feasibility of eShunt deployment at cisternal depths >3 mm. Note was made of the eligibility excluding petrous bone overhang and arterial/nervous structure criteria, given the possibility that these criteria are due to natural anatomic differences between individuals, rather than IIH itself. A P value <0.05 was determined to be statistically significant. Statistical analyses were performed with R V.4.4.2 (R Foundation for Statistical Computing).

RESULTS

Patient population and clinical characteristics

Among 53 adult patients (median age 41 (range 34.0–51.0) years) with IIH, 24 (45.2%) had pre-existing mechanical shunts on radiographic imaging. There were no significant differences between the two cohorts when comparing demographic factors such as age (P=0.661), gender (P=0.984), or race (P=0.688). The pre-existing shunt cohort had more former smokers (no shunt 13.8% vs shunt 45.8%; P=0.035). Other pre-existing comorbidities were similar. Additionally, no significant differences existed for initial presenting symptoms among the cohorts. The average LP opening pressure was 36.7±12.5 cm H2O, with no significant differences between the different shunt status groups. Patients with a pre-existing ventricular shunt had lower acetazolamide total daily dosage (no shunt 1418.1±1065.0 vs shunt 880.2±783.2; P=0.045). Table 1 shows the demographics and clinical characteristics.

Table 1 Patient demographics and clinical characteristics

Variables	Overall (n=53)	No shunt (n=29)	Shunt (n=24)	P value
Age (years (median (IQR))	41.0 (34.0–51.0)	42.0 (34.0–50.0)	41.0 (34.5–52.5)	0.661
Women	43 (81.1)	23 (79.3)	20 (83.3)	0.984
Race				0.688
White	24 (45.3)	14 (48.3)	10 (41.7)	
Black	21 (39.6)	10 (34.5)	11 (45.8)	
Hispanic	8 (15.1)	5 (17.2)	3 (12.5)	
Smoking status				0.035
Current smoker	8 (15.1)	5 (17.2)	3 (12.5)	
Former smoker	15 (28.3)	4 (13.8)	11 (45.8)	
Never smoked	30 (56.6)	20 (69.0)	10 (41.7)	
Initial symptoms				
Headaches	47 (88.7)	25 (86.2)	22 (91.7)	0.850
Vision loss	40 (75.5)	20 (69.0)	20 (83.3)	0.374
Papilledema	24 (45.3)	13 (44.8)	11 (45.8)	1.000
Comorbidities				
Obesity	39 (73.6)	22 (75.9)	17 (70.8)	0.920
Venous stenosis	29 (54.7)	17 (58.6)	12 (50.0)	0.726
Pulsatile tinnitus	18 (34.0)	11 (37.9)	7 (29.2)	0.704
Atrial fibrillation	2 (3.8)	1 (3.4)	1 (4.2)	1.000
Coronary artery disease	3 (5.7)	2 (6.9)	1 (4.2)	1.000
Hypertension	19 (35.8)	9 (31.0)	10 (41.7)	0.606
Hyperlipidemia	12 (23.1)	5 (17.9)	7 (29.2)	0.526
Diabetes mellitus	10 (18.9)	5 (17.2)	5 (20.8)	1.000
Chronic kidney disease	3 (5.7)	1 (3.4)	2 (8.3)	0.866
Liver disease	4 (7.5)	2 (6.9)	2 (8.3)	1.000
Alcohol use disorder	2 (3.8)	1 (3.4)	1 (4.2)	1.000
Pre-existing venous stent	3 (5.7)	1 (3.4)	2 (8.3)	0.866
Medications				
Acetazolamide use	45 (84.9)	27 (93.1)	18 (75.0)	0.148
Acetazolamide total daily dose (mg) (mean±SD)	1174.5±977.3	1418.1±1065.0	880.2±783.2	0.045
Lumbar puncture opening pressure (cmH_2O) (mean±SD)	36.7±12.5	36.2±12.6	37.3±12.5	0.757

Data are number (%) unless indicated otherwise.

Measurements and patient eligibility

Inter-rater agreement between the independent readers was substantial (90.6%; κ=0.71 (95% CI, 0.47 to 0.94)). Median CP cisternal depth was 4.8±1.8 mm on the right and 4.9±2.1 mm on the left. When comparing CP cisternal depth across ages, there was no difference observed based on shunt status (interaction P value=0.202; figure 2A). When comparing the diameter of the IPS, both sides tended to be similar in size (right 3.5±0.7 mm, left 3.4±0.8 mm). Average trajectories for dural penetration were also similar. The right IPS measured 128.6±9.8°, while the left IPS measured 125.2±9.3°. For both sides of the IPS, the proportions of patients with >5 mm distance to the closest nerve/vessel trended to be higher in patients without shunts (right, no shunt 69.0% vs shunt 66.7%; left, no shunt 86.2% vs shunt 66.7%). Petrous bone obstruction was seen in 9.6% patients on the right and 11.5% patients on the left. All anatomic measurements were similar between the two cohorts and are shown in table 2.

Overall, when considering all radiographic criteria, 54.7% of the patients in the cohort were eligible for eShunt placement, with a higher proportion of non-shunted patients trending towards eligibility (no shunt 62.1% vs shunt 45.8%; P=0.366). When examining the reasons for radiographic ineligibility, most failures were due to arterial or nervous structure proximity to the dural access site (right 44%, left 57%). Furthermore, among patients with ventricular shunts, those with pre-existing transverse sinus venous stenosis exhibited larger IPS channels (p=0.011). This difference was not observed in patients without ventricular shunts (P=0.75) (figure 2B). In the sensitivity analysis, 67.9% of patients were eligible using a lenient CPA cisternal depth of >4 mm and 73.6% were eligible when excluding petrous bone and arterial proximity variants. In the final model, adjusting for demographics, obesity, papilledema, and transverse sinus stenosis, pre-existing ventricular shunt placement was not independently associated with endovascular shunting candidacy (OR 2.01, 95% CI 0.65 to 6.40; P=0.227).

DISCUSSION

This retrospective study of 53 patients with IIH demonstrated that most patients were radiographically suitable candidates for endovascular shunting, independent of the presence of a pre-existing ventricular shunt. These findings provide encouraging anatomical feasibility data and support the potential for future clinical trials of endovascular shunting in the IIH population.

While standard measurements of the IPS and its anatomic relationship to adjacent structures are sparsely outlined in the

J NeuroIntervent Surg: first published as 10.1136/jnis-2025-024793 on 29 January 2026. Downloaded from http://jnis.bmj.com/ on March 6, 2026 at Tufts University Libraries. Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

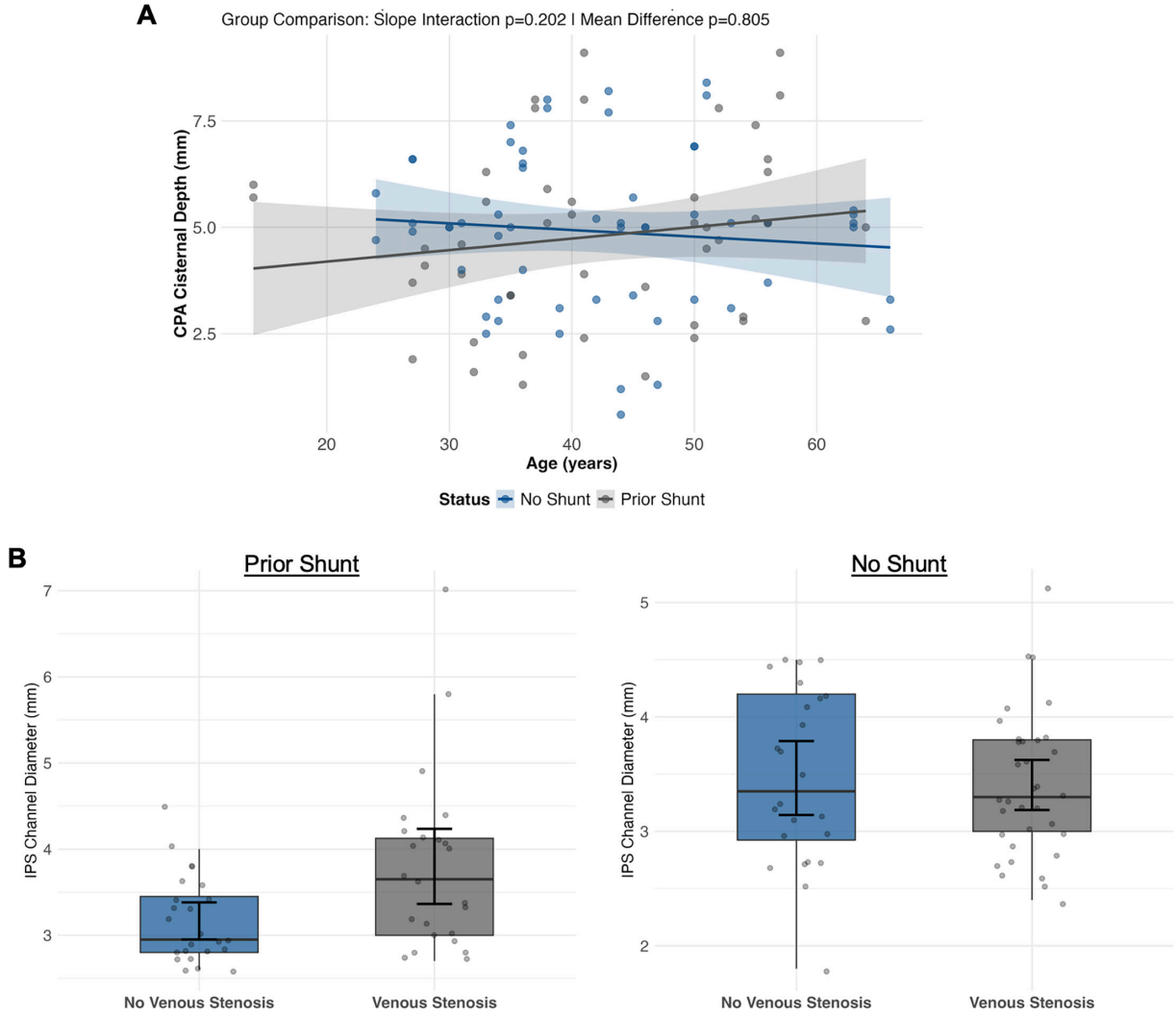


Figure 2 Radiographic assessment of cerebellopontine angle (CPA) cisternal depth and inferior petrosal sinus (IPS) diameter in idiopathic intracranial hypertension. (A) Relationship of CPA cisternal depth and age in patients with versus without pre-existing ventricular shunt. (B) Box plots showing the distribution of IPS diameters in patients with and without radiographic venous stenosis, grouped by pre-existing ventricular shunt status.

literature, previous researchers have attempted to characterize its anatomy using non-invasive imaging measurements in distinct clinical populations. For example, in a retrospective institutional study of 36 MRI images selected from the Tufts Medical Center gamma knife imaging database, Heilman *et al* examined mean IPS diameter, identifying a range between 2.27 and 3.31 mm, with >90% of the cohort >1.46 mm.[17] Similarly, in a retrospective study of 50 patients who underwent contrast enhanced CT with a multidetector scanner, Tanoue *et al* identified the largest diameter of the minimum axis of the IPS, with a mean of 0.99 mm and 2.04 mm on the right and left sides, respectively.[18] In another retrospective study of 120 cerebral CT angiograms (most from patients with vascular pathologies), Zhang *et al* measured IPS diameter at the cranial exit, revealing similar bilateral measurements: 1.95±0.68 mm and 1.96±0.74 mm for the right and left sides, respectively.[19]

In patients with IIH, cerebral venous system changes are often complex due to the influence of CSF altering medications, such as Diamox, and distal transverse sinus stenosis leading to increased intracranial venous pressures. This reduced gradient across the major venous outlets can result in increased outflow resistance, leading to theoretically engorged collateral veins and congested accessory pathways, including the IPS channel. These findings may, in part, explain our finding that IPS measurements in the IIH population were as large as, or even exceeded, those reported in previous literature. Importantly, transverse venous sinus stenting can improve cerebral venous outflow and therefore secondarily improve CSF absorption at the arachnoid granulations and reduce cisternal CSF compartmentalization. However, as this study was not specifically designed to evaluate the impact of these patient level factors, including transverse sinus stenting, future dedicated investigations will be required.

In patients with IIH, several therapeutic interventions significantly alter both CSF anatomy and intracranial venous flow, warranting further investigation in the context of endovascular shunting. For example, in a study examining the intracranial fluid flow dynamics in a patient with IIH before and after LP, medical therapy, and venous sinus stenting, Agarwal *et al* demonstrated that improvements in venous outflow only occurred after CSF removal via LP and venous sinus stenting.[20] CSF velocity amplitude, however, remained elevated, suggesting persistent impaired intracranial compliance after shunting. In another case study of a 30-year-old man with medically refractory IIH and a severe radiographic stenosis of the dominant transverse sinus, Buell *et al* documented real time intraoperative cerebral venous pressures during ventriculoperitoneal shunting.[21] The authors

J NeuroIntervent Surg: first published as 10.1136/jnis-2025-024793 on 29 January 2026. Downloaded from http://jnis.bmj.com/ on March 6, 2026 at Tufts University Libraries. Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

Table 2 Radiographic measurements

Variables	Overall (n=53)	No shunt (n=29)	Shunt (n=24)	P value
CP cisternal depth (mm) (mean±SD)				
Right	4.8±1.8	4.9±1.8	4.7±1.9	0.592
Left	4.9±2.1	4.9±2.0	5.0±2.2	0.885
Right IPS				
Diameter (mm) (mean±SD)	3.5±0.7	3.5±0.7	3.5±0.7	0.733
Trajectory angle (°) (mean±SD)	128.6±9.8	128.2±9.8	129.0±10.0	0.764
Distance to vessel >5 mm	36 (67.9)	20 (69.0)	16 (66.7)	1.000
Petrous bone obstruction	5 (9.6)	4 (14.3)	1 (4.2)	0.446
Left IPS				
Diameter (mm) (mean±SD)	3.4±0.8	3.4±0.6	3.4±1.1	0.871
Trajectory angle (°) (mean±SD)	125.2±9.3	125.1±8.1	125.3±10.7	0.952
Distance to vessel >5 mm	41 (77.4)	25 (86.2)	16 (66.7)	0.173
Petrous bone obstruction	6 (11.5)	2 (7.1)	4 (16.7)	0.525
eShunt eligibility				
Right IPS only	8 (15.1)	7 (24.1)	1 (4.2)	0.102
Left IPS only	13 (24.5)	9 (31.0)	4 (16.7)	0.374
Both IPS	8 (15.1)	2 (6.9)	6 (25.0)	0.148
Overall eligibility (5 mm)	29 (54.7)	18 (62.1)	11 (45.8)	0.366
Overall eligibility (4 mm)	36 (67.9)	21 (72.4)	15 (62.5)	0.635
CPA/IPS/angle eligibility (5 mm)	37 (69.8)	23 (79.3)	14 (58.3)	0.175
CPA/IPS/angle eligibility (4 mm)	39 (73.6)	23 (79.3)	16 (66.7)	0.468

Data are number (%) unless indicated otherwise.
CP, cerebellopontine; CPA, cerebellopontine angle; IPS, inferior petrosal sinus.

showed that CSF diversion progressively decreased the venous pressures and relieved the trans-stenotic pressure gradient.[21]

Furthermore, the impact of ventricular shunting on CSF distribution has previously been studied mostly in the context of normal pressure hydrocephalus (NPH). For example, in a retrospective study of 54 patients with NPH who underwent MRI before and after ventricular shunting, Yamada *et al* found that while the volume of the total ventricles and subarachnoid spaces decreased within 1 month after shunting, the volume of the total subarachnoid spaces increased after more than 1 year after shunting.[22] Interestingly, in another study of 21 patients with shunt responsive iNPH, Hiraoka *et al* showed that the volumes of the ventricles and infra-sylvian subarachnoid CSF spaces (including the CPA cistern) decreased significantly 1 year after shunting (mean change rate −26.1% (P<0.0001) and −4.5% (P<0.05), respectively).[23] These findings highlight the complexity of shunting on intracranial fluid dynamics and venous pressures beyond simply ICP reduction. Although pre-existing ventricular CSF shunting might theoretically reduce the CPA cisternal space, these findings suggest that CPA cisternal depth did not vary significantly between patients with and without pre-existing shunts. Future efforts that assess the long term morphological changes following eShunt drainage and its relationship with clinical outcome will be necessary to identify those patients who will benefit from endovascular CSF diversion.

This study had limitations. First, the relatively small sample size limits the generalizability of our findings. Larger, multi-center analyses with greater radiographic and clinical granularity will be needed to precisely define which imaging characteristics most strongly influence eShunt eligibility and treatment effect. Furthermore, we cannot comment on CPA cisternal depth or IPS morphology of patients previously treated with an LP shunt or transverse sinus stent, as they were not primarily included in the study cohort. In addition, although MRI was used to visualize and measure the IPS, most anatomical studies on the veins of the skull base use invasive or venographic modalities, with the knowledge that cross sectional imaging can underestimate their true size. Third, assessment of the distance to nearby arteries, nerves, and cisternal depth in the reformatted plane is less accurate and may overestimate or underestimate the actual three-dimensional transdural access trajectory. We attempted to address this limitation by performing multiple measurements on different planes and reporting the proportion of cases with distances >5 mm for arterial/nervous proximity. In addition, this study did not assess the clinical outcomes of these patients, as this was beyond the scope of this morphometric study. Finally, the study did not account for the duration of previous ventricular shunt presence, which may have potential implications on the measured radiographic findings. Despite these limitations, the results of this study suggested that eShunt placement was feasible in a significant proportion of patients with shunt responsive IIH and warrants further investigation.

CONCLUSION

In this study, we found that endovascular shunting was feasible in most patients with shunt responsive IIH. The presence of a pre-existing ventricular shunt was not associated with radiographic eligibility. Further studies are warranted to explore the use of endovascular shunting as a potential treatment option for this increasingly common condition.

Contributors ABK and CM conceptualized and designed the study. ABK, KVT, DV, and AC participated in data collection and statistical analysis. ABK, KVT, AC, AA, NS, participated in data interpretation, drafting, and revising the manuscript. RH, AM, CK, GJF, KNS, AdH, PK, CBH, AMM, and CM revised the manuscript critically for important content. All authors read and approved the final manuscript. CM is the guarantor of the study.

Funding CK is supported by the American Society of Head and Neck Radiology and the National Institutes of Health (R21NS122389 and R01CA202911). PK is supported by the National Institutes of Health (1U18EB029353-01, 4UH3NS128397-02, and UG3NS128397), a Siemens research grant (CON30434), the Joe Niekro Foundation (CON30914), and the Trauma Research and Combat Casualty Care Collaborative (TRC4).

Competing interests CK reports royalties from Primal Pictures 3D anatomy, speaker honoraria from McGill University, payment for expert witness review (Gleason, Flynn, Emig and McAfee), monetary support for attending the 2025 Congress of Neurological Surgeons annual conference, and ongoing patents (Nos 6,503,225 and 8,696,626) for a debubbler device to remove air from IV lines; serves on the board of the North American Skull Base Society, Yale Whitney Cushing Library, and Scientific Committees for the American Society of Functional Neuroradiology and American Association of Woman Radiologists; and has equity in Karamedica, Abiomed, and Cologuard. PK serves on the editorial board for the Journal of Neurointerventional Surgery (JNIS) and is the Vice President of the Society for Neurointerventional Surgery; holds stock/shareholder interests in Vena Medical, Deinde, Prometheus, Neurofine, and Vented; and is a consultant for Stryker Neurovascular. CBH reports consulting fees, stock ownership, and patent rights associated with CereVasc, as well as potential future royalties, and serves as a board member for CereVasc. AMM reports consulting fees, travel support, stock ownership, and patent rights associated with CereVasc, and serves as the head of the DSMB for the Stryker Neurovascular Contour Study. CM reports consulting fees from Silk Road Medical Boston Scientific, Terumo Neurovascular, and Penumbra; serves as DSMB chair for Fluid Biomed and Neurofine; and serves on the medical advisory boards for J&J MedTech and Aesculap. CM holds stock options in CereVasc, Neurofine, and Jiva Medical.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by Yale University institutional review board (2000028154).

Provenance and peer review Not commissioned; externally peer reviewed.

J NeuroIntervent Surg: first published as 10.1136/jnis-2025-024793 on 29 January 2026. Downloaded from http://jnis.bmj.com/ on March 6, 2026 at Tufts University Libraries. Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.

Data availability statement Data are available upon reasonable request. The relevant anonymized patient level data are available upon reasonable request from the authors.

ORCID iDs
Andrew B Koo https://orcid.org/0000-0002-2854-649X
Dhruv Vajipayajula https://orcid.org/0009-0004-2998-7985
Abdelaziz Amllay https://orcid.org/0000-0003-3357-4134
Nanthiya Sujijantarat https://orcid.org/0000-0002-5857-5718
Ajay Malhotra https://orcid.org/0000-0001-9223-6640
Adam de Havenon https://orcid.org/0000-0001-8178-8597
Peter Kan https://orcid.org/0000-0001-6649-4128
Charles Matouk https://orcid.org/0000-0003-3234-9541

REFERENCES

1 Mollan SP, Aguiar M, Evison F, *et al*. The expanding burden of idiopathic intracranial hypertension. *Eye (Lond)* 2019;33:478–85.
2 Binder DK, Horton JC, Lawton MT, *et al*. Idiopathic Intracranial Hypertension. *Neurosurgery* 2004;54:538–52.
3 Bjornson A, Tapply I, Nabbanja E, *et al*. Ventriculo-peritoneal shunting is a safe and effective treatment for idiopathic intracranial hypertension. *Br J Neurosurg* 2019;33:62–70.
4 Sinclair AJ, Kuruvath S, Sen D, *et al*. Is cerebrospinal fluid shunting in idiopathic intracranial hypertension worthwhile? A 10-year review. *Cephalalgia* 2011;31:1627–33.
5 Intrapiromkul J, Rai AT, Lakhani DA. Transverse venous sinus stenting versus cerebrospinal fluid shunting in idiopathic intracranial hypertension: a multi-institutional and multinational database study. *J Neurointerv Surg* 2025:jnis-2025-023699.
6 Khalili BF, Ansari S, Chojnacki MR, *et al*. Influence of clinical, anatomical, and manometric factors on unilateral transverse sinus stent placement for idiopathic intracranial hypertension. *Neurosurg Focus* 2026;60:E11.
7 Brune AJ, Girgla T, Trobe JD. Complications of Ventriculoperitoneal Shunt for Idiopathic Intracranial Hypertension: A Single-Institution Study of 32 Patients. *J Neuroophthalmol* 2021;41:224–32.
8 Greener DL, Akarca D, Durnford AJ, *et al*. Idiopathic Intracranial Hypertension: Shunt Failure and the Role of Obesity. *World Neurosurg* 2020;137:e83–8.
9 Sunderland GJ, Jenkinson MD, Conroy EJ, *et al*. Neurosurgical CSF Diversion in Idiopathic Intracranial Hypertension: A Narrative Review. *Life (Basel)* 2021;11:393.
10 Malek AM, Beneduce BM, Heilman CB. Endovascular Shunting for Communicating Hydrocephalus Using a Biologically Inspired Transdural Cerebrospinal Fluid Valved eShunt® Implant. *Neurosurg Clin N Am* 2024;35:379–87.
11 Koo AB, Lylyk I, Antonios J, *et al*. eShunt system: a technical video. *J Neurointerv Surg* 2025;17:792.
12 Lylyk P, Lylyk I, Bleise C, *et al*. First-in-human endovascular treatment of hydrocephalus with a miniature biomimetic transdural shunt. *J NeuroIntervent Surg* 2022;14:495–9.
13 Malek A, Heilman C. E-020 design of an endovascular transdural cerebrospinal fluid shunt implant to mimic arachnoid granulation function. *J Neurointerv Surg* 2018;10:A57.
14 Colasurdo M, Chen K, Chen H, *et al*. Morphometric analysis of the inferior petrosal sinus and cerebellopontine angle cistern to assess feasibility of endovascular shunting in pediatric patients. *J Neurointerv Surg* 2025:jnis-2025-023137.
15 Hamilton RB, Scalzo F, Baldwin K, *et al*. Opposing CSF hydrodynamic trends found in the cerebral aqueduct and prepontine cistern following shunt treatment in patients with normal pressure hydrocephalus. *Fluids Barriers CNS* 2019;16:2.
16 CereVasc Inc. Pivotal study to evaluate the safety and effectiveness of the cerevasc® eshunt® system in the treatment of normal pressure hydrocephalus. clinicaltrials.gov. 2025. Available: https://clinicaltrials.gov/study/NCT06498960
17 Heilman CB, Basil GW, Beneduce BM, *et al*. Anatomical characterization of the inferior petrosal sinus and adjacent cerebellopontine angle cistern for development of an endovascular transdural cerebrospinal fluid shunt. *J Neurointerv Surg* 2019;11:598–602.
18 Tanoue S, Kiyosue H, Sagara Y, *et al*. Venous structures at the craniocervical junction: anatomical variations evaluated by multidetector row CT. *Br J Radiol* 2010;83:831–40.
19 Zhang W, Ye Y, Chen J, *et al*. Study on inferior petrosal sinus and its confluence pattern with relevant veins by MSCT. *Surg Radiol Anat* 2010;32:563–72.
20 Agarwal N, Contarino C, Limbucci N, *et al*. Intracranial Fluid Dynamics Changes in Idiopathic Intracranial Hypertension: Pre and Post Therapy. *Curr Neurovasc Res* 2018;15:164–72.
21 Buell T, Ding D, Raper D, *et al*. Resolution of venous pressure gradient in a patient with idiopathic intracranial hypertension after ventriculoperitoneal shunt placement: A proof of secondary cerebral sinovenous stenosis. *Surg Neurol Int* 2021;12:14.
22 Yamada S, Ishikawa M, Yamaguchi M, *et al*. Longitudinal morphological changes during recovery from brain deformation due to idiopathic normal pressure hydrocephalus after ventriculoperitoneal shunt surgery. *Sci Rep* 2019;9:17318.
23 Hiraoka K, Yamasaki H, Takagi M, *et al*. Changes in the volumes of the brain and cerebrospinal fluid spaces after shunt surgery in idiopathic normal-pressure hydrocephalus. *J Neurol Sci* 2010;296:7–12.

J NeuroIntervent Surg: first published as 10.1136/jnis-2025-024793 on 29 January 2026. Downloaded from http://jnis.bmj.com/ on March 6, 2026 at Tufts University Libraries. Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.