

The Chicken, The Egg, & The Herniated Brain Parenchyma



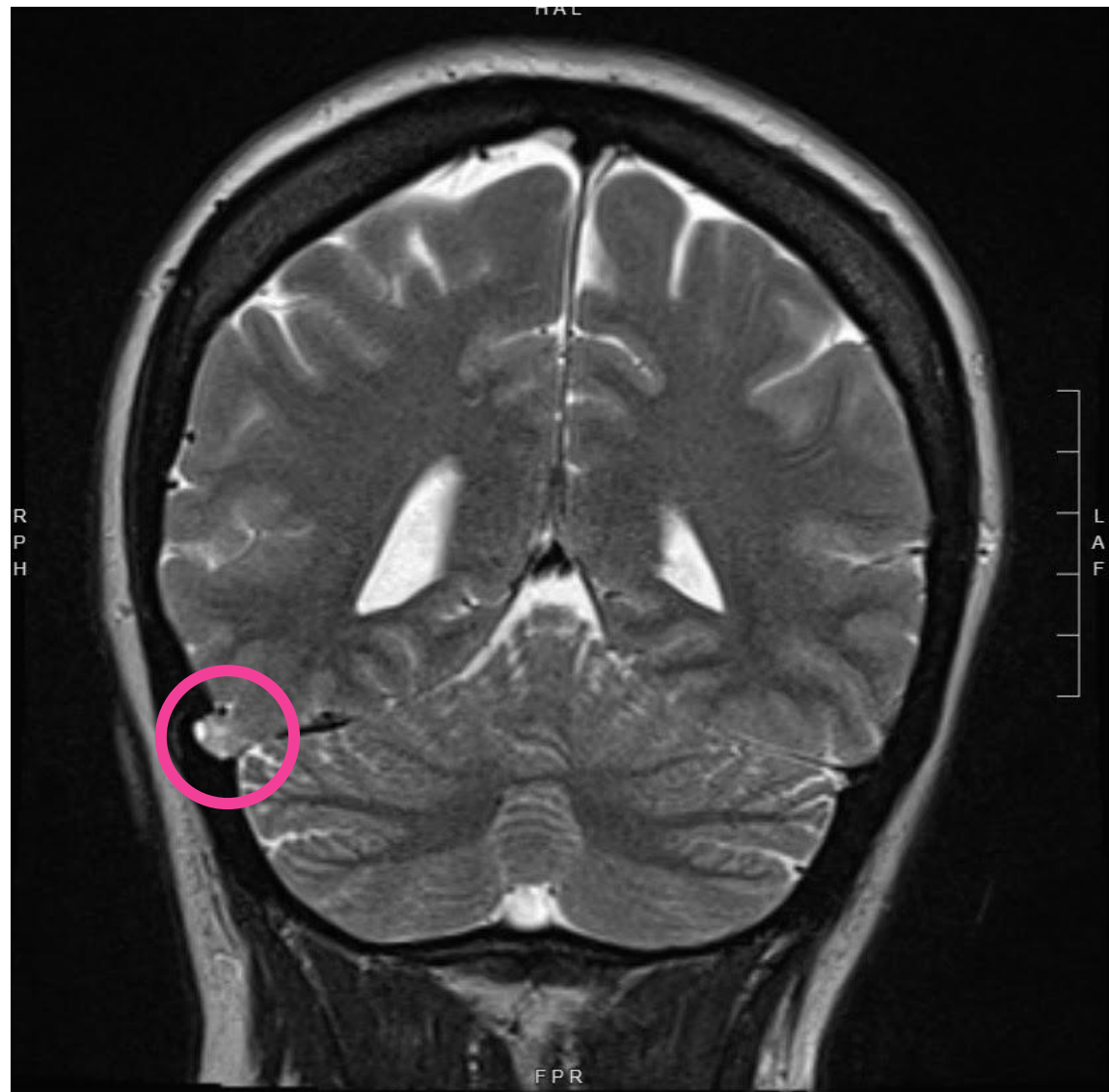
Clifton Lewis, DO
PGY-1 Neurology
Maine Medical Center

THE CASE

- 36y/o woman seen in the ED for 2 months of worsening headaches with associated blurred vision
- Past medical history significant for
 - Obstructive sleep apnea
 - Episodic migraines
 - No tetracyclines, OCP, IUDs, retinoids
- BMI = 34.6 kg/m²
- Exam
 - Bilateral grade 1+ optic disc edema
 - Left heminasal field deficit
 - Otherwise, normal neurological exam

DIAGNOSTICS

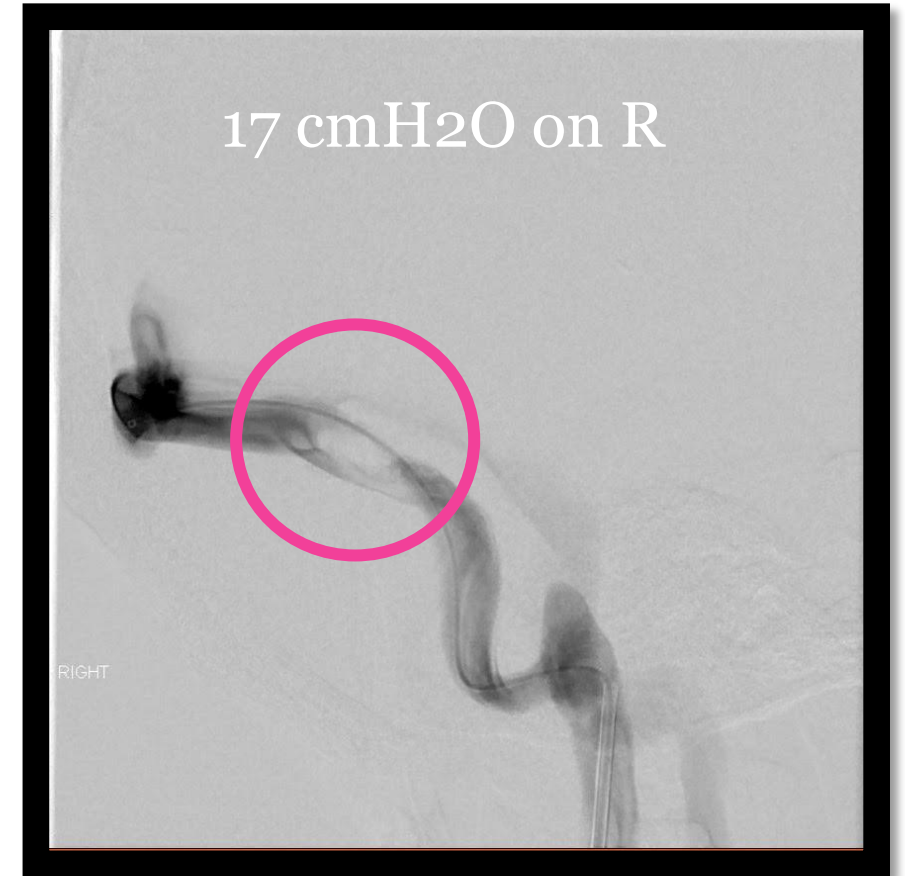
- CT scan negative
- Lumbar puncture
 - OP: 25 cmH₂O
 - Protein/cell count/glucose unremarkable
- MRI brain
 - Herniated brain in arachnoid granulation
- CTV
 - Right transverse-sigmoid junction occluded by arachnoid granulation



THERAPEUTICS

- Acetazolamide 500mg BID eventually increased to 750mg BID
- LP if headaches persist
- Follow-up with IR for venous sinus pressure assessments

Venous Sinus Pressure Assessment



Bilateral transverse sinus stenosis with near occlusion on R

FOLLOW-UP

- Partial response to acetazolamide

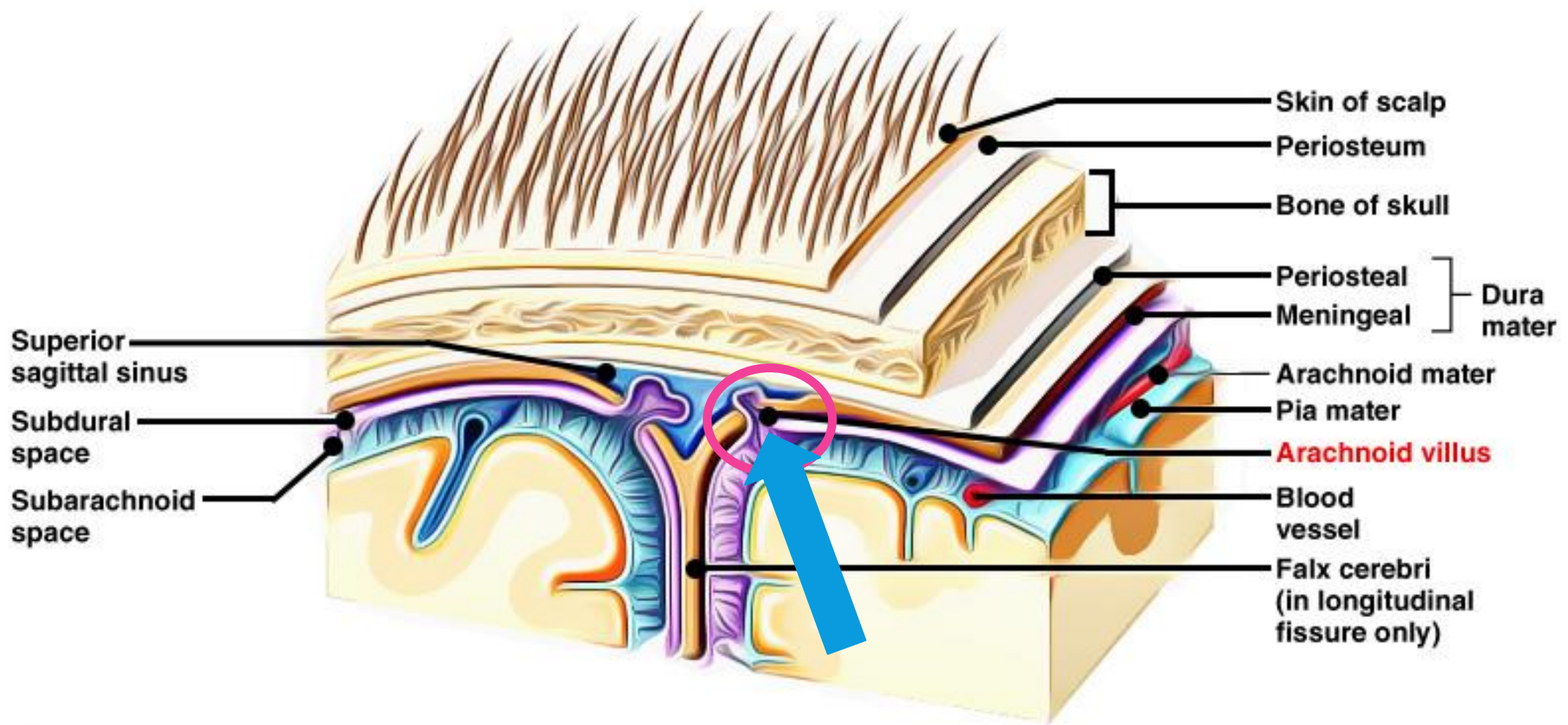
IDIOPATHIC INTRACRANIAL HYPERTENSION

Modified Dandy Criteria

- Symptoms and signs of increased intracranial pressure (eg, headache, transient visual obscurations, pulse synchronous tinnitus, papilledema, visual loss)
- No other neurologic abnormalities or impaired level of consciousness
- Elevated intracranial pressure with normal cerebrospinal fluid (CSF) composition
- A neuroimaging study that shows no etiology for intracranial hypertension
- No other cause of intracranial hypertension apparent

ARACHNOID GRANULATIONS

- Structures filled with CSF that extend into the venous sinuses through openings in the dura mater
- Allow the drainage of CSF from subarachnoid space into venous system
- Giant AG are >1 cm
- Enlarge with age and increased CSF pressure



BRAIN PARENCHYMA HERNIATIONS

- Prevalence is 0.32%¹
- Most common sites by frequency²
 - Occipital squama
 - Transverse sinus
 - Lateral lacunae of the superior sagittal sinus
 - Straight sinus
- Can occur spontaneously or due to increased intracranial pressure³
- Usually, incidental finding with patient asymptomatic⁶

DDX

- Thrombosis

- Involves large segment or multiple sinuses, can extend into cortical veins
- AG produce defined defects

- Intrasinus tumors

- Misshapen, no diffusion restriction
- AG rounded, CSF-like signal intensity, intrinsic vessels

PROCEDURAL OPTIONS

- Serial LPs

- Shunt

- Optic nerve sheath fenestrations

- Venous sinus stenting (VSS)

VSS:
INDICATIONS

Elevated maximal venous pressures

Or

Significant trans-stenosis pressure gradient
($>8\text{cmH}_2\text{O}$)

And

Medically refractory idiopathic intracranial
hypertension

Or

Intolerance of medication

Pre-Stent Evaluation

- Pretreat with Aspirin 325mg & Clopidogrel 75mg for 7 days
- Place Femoral artery and vein sheath in a sedated patient
- Use a 0.014" microwire in a 0.027" microcatheter to get to the SSS
- Perform an arteriography and venography
- Attach pressure transducer to venous microcatheter for venous pressures
- Get pre-stenosis and post-stenosis pressures
- If MVP is >8mmHg, proceed with stenting

Stenting

- Change the General Anesthesia
- Give Heparin bolus for ACT goal of 250-300sec
- Gain access to the SSS
- Start deploying the stent >10mm from the point of stenosis
- End of Stent deployment should be >10mm from point of stenosis
- Perform venogram to visualize flow improvement before closing
- Perform post placement CT scan to rule out hemorrhage

Post-Stenting

- Continue Dual antiplatelets for 1 month and Aspirin 3 months post-treatment
- Repeat Angiogram when symptoms worsen to rule out juxta-stent stenosis
- If there is juxta-stent stenosis, deploy new stent
- If no juxta-stent stenosis, proceed with CSF diversion

VSS: DATA

- No randomized data yet
- Reduced pressure gradients by 20.1 cmH₂O to 4.4 cmH₂O¹⁰
- Majority of patients had improvement in headaches, pulsatile tinnitus, papilledema, and vision over 2 years¹⁰
- Case report of correction of bilateral CNVI palsy within 8 hours of stenting¹¹

VSS: COMPLICATIONS

- Stent migration
- Venous sinus perforation
- In-stent thrombosis
- Subdural hemorrhage
- Recurrent stenosis proximal to the stent

185 total patients

221 total stents placed

5.4% complication rate

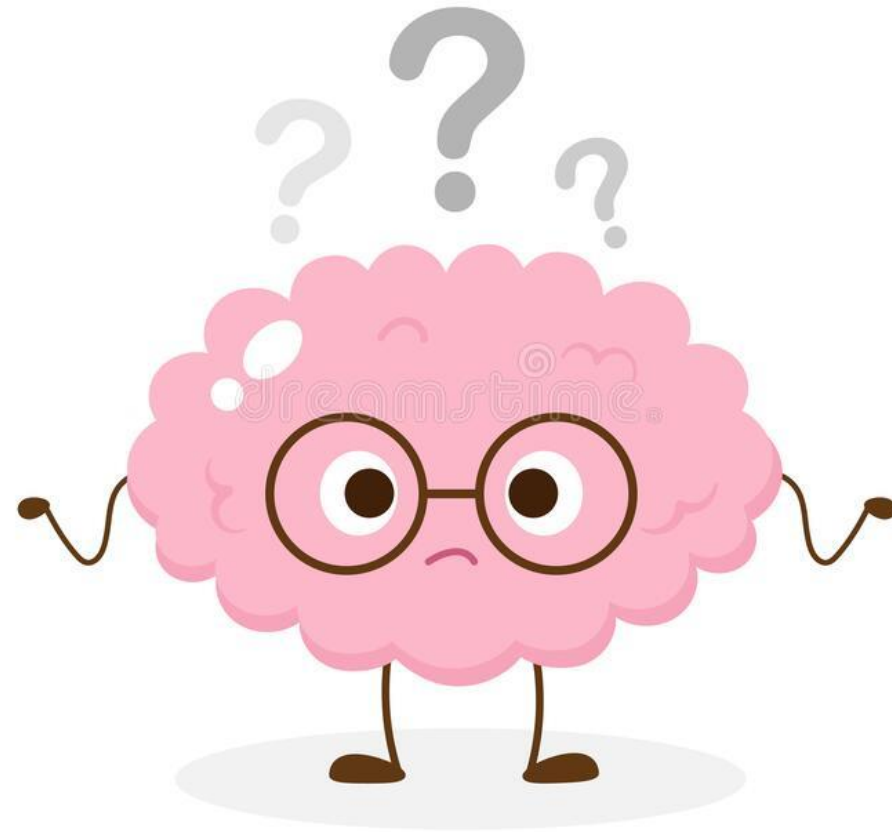
Author/year	Number of patients	Number of stentings	Complications	Complication rate	Complications requiring additional procedure
Higgins et al. 2002 [4]	1	1	0	0%	N/A
Owler et al. 2003 [5]	4	4	0	0%	N/A
Higgins et al. 2003 [6]	12	14	0	0%	N/A
Ogungbo et al. 2003 [7]	1	1	0	0%	N/A
Rajpal et al. 2005 [8]	1	1	0	0%	N/A
Donnet et al. 2008 [9]	10	11	0	0%	N/A
Paquet et al. 2008 [10]	1	1	0	0%	N/A
Arac et al. 2009 [11]	1	1	0	0%	N/A
Bussière et al. 2010 [12]	10	13	0	0%	N/A
Zheng et al. 2010 [13]	1	1	0	0%	N/A
Ahmed et al. 2011 [14]	52	60	2 major (SDH); 2 minor (transient hearing loss)	7.7%	2 (1 SDH, 1 SDH/ICH/SAH both requiring emergent craniotomy)
Albuquerque et al. 2011 [15]	15	30	1 minor RPH not requiring transfusion	3.3%	0
Kumpe et al. 2012 [16]	18	19	1 major (SAH/SDH); 2 minor (UTI and syncope)	16.7%	1 (SAH/SDH hematoma requiring EVD)
Teleb et al. 2012 [17]	1	1	0	0%	N/A
Radvany et al. 2013 [18]	12	12	0	0%	N/A
Fields et al. 2013 [19]	15	15	1 minor (femoral pseudoaneurysm)	6.7%	0 (femoral pseudoaneurysm resolved compression)
Ducruiet et al. 2014 [20]	30	36	1 minor (femoral pseudoaneurysm)	2.8	1 (femoral pseudoaneurysm requiring femoral artery stent)



REVIEW OF MAJOR POINTS

- Pathologic positive feedback loop in IIH
- Differentiating herniation through AG vs. other pathology
- VSS indications and current data

QUESTIONS?



REFERENCES

- 1) B. Battal, S. Hamcan, V. Akgun et al., "Brain herniations into the dural venous sinus or calvarium: MRI findings, possible causes and clinical significance," *European Radiology*, vol. 26, no. 6, pp. 1723–1731, 2016.
- 2) S. Malekzadehlashkariani, I. Wanke, D. A. Rüfenacht, and D. San Millán, "Brain herniations into arachnoid granulations: about 68 cases in 38 patients and review of the literature," *Neuroradiology*, vol. 58, no. 5, pp. 443–457, 2016.
- 3) W. C. Chan, V. Lai, Y. C. Wong, and W. L. Poon, "Focal brain herniation into giant arachnoid granulation: a rare occurrence," *European Journal of Radiology Extra*, vol. 78, no. 2, pp. e111–e113, 2011.
- 4) G. Çoban, E. Yildirim, B. Horasanli, B. E. Çifçi, and M. Ağildere, "Unusual cause of dizziness: occult temporal lobe encephalocele into transverse sinus," *Clinical Neurology and Neurosurgery*, vol. 115, no. 9, pp. 1911–1913, 2013.
- 5) B. Battal, S. Hamcan, V. Akgun, S. Sari, and B. Karaman, "Brain herniation with surrounding CSF into the skull or encepholecele?" *Journal of Neuroradiology*, vol. 42, no. 3, pp. 187–188, 2015.
- 6) P. Kan, E. A. Stevens, and W. T. Couldwell, "Incidental giant arachnoid granulation," *American Journal of Neuroradiology*, vol. 27, no. 7, pp. 1491–1492, 2006.
- 7) S. C. Chin, C. Y. Chen, C. C. Lee et al., "Giant arachnoid granulation mimicking dural sinus thrombosis in a boy with headache: MRI," *Neuroradiology*, vol. 40, no. 3, pp. 181–183, 1998.
- 8) B. De Keyzer, S. Bamps, F. Van Calenbergh, P. Demaerel, and G. Wilms, "Giant arachnoid granulations mimicking pathology: a report of three cases," *Neuroradiology Journal*, vol. 27, no. 3, pp. 316–321, 2014.
- 9) H. J. Choi, C. W. Cho, Y. S. Kim, and J. H. Cha, "Giant arachnoid granulation misdiagnosed as transverse sinus thrombosis," *Journal of Korean Neurosurgical Society*, vol. 43, no. 1, pp. 48–50, 2008.
- 10) Starke RM, Wang T, Ding D, et al.: Endovascular treatment of venous sinus stenosis in intracranial hypertension: complications, neurological outcomes, and radiographic results. *ScientificWorldJournal*. 2015, 2015:140408.
- 11) Ding D, Chen CJ, Starke RM, Liu KC, Crowley RW: Rapid recovery of bilateral abducens nerve palsies after venous sinus stenting for idiopathic intracranial hypertension. *J Neurol Sci*. 2015, 357:335-337.
- 12) Raper D, Buell TJ, Ding D, Chen CJ, Starke RM, Liu KC: Pattern of pressure gradient alterations after venous sinus stenting for idiopathic intracranial hypertension predicts stentadjacent stenosis: a proposed classification system. *J Neurointerv Surg*. 2018, 10:391-395.
- 13) Dave SB, Subramanian PS. Pseudotumor cerebri: an update on treatment options. *Indian J Ophthalmol*. 2014;62(10):996-998. doi:10.4103/0301-4738.145991
- 14) Daggubati LC, Liu KC. Intracranial Venous Sinus Stenting: A Review of Idiopathic Intracranial Hypertension and Expanding Indications. *Cureus*. 2019;11(2):e4008. Published 2019 Feb 4. doi:10.7759/cureus.4008
- 15) Giridharan N, Patel SK, Ojugbeli A, Nouri A, Shirani P, Grossman AW, Cheng J, Zuccarello M, Prestigiacomo CJ. Understanding the complex pathophysiology of idiopathic intracranial hypertension and the evolving role of venous sinus stenting: a comprehensive review of the literature. *Neurosurg Focus*. 2018 Jul;45(1):E10. doi: 10.3171/2018.4.FOCUS18100. PMID: 29961379.

THANK YOU!

